

THE FAUNA OF INDIA
AND
THE ADJACENT COUNTRIES

LARVAL TREMATODES OF INDIA

Part II

PARAPLEUROLOPHOCERCA

AND

ECHINOSTOME CERCARIAE

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सत्यमेव जयते

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AUTHOR'S PREFACE

In India after the publication of Sewell's (1922) memoir on Indian cercariae, no serious efforts were made to explore the cercarial fauna of the entire country. However, in recent years some attention has been paid by a few workers to elucidate the life histories of selected groups of trematodes, particularly the parasites of economic importance, and to study the larval trematodes in some areas.

The examination of fresh water snails by the present author has revealed that these snails are infected with a large number of larval trematodes and some species carry a very heavy load of cercarial infection. Many fresh water snails act as a vector of quite a number of trematodes. The study of cercarial fauna and their life histories constitute an important component of trematode studies as these form a dependable base for the taxonomic studies of the adult trematodes.

Under the present series, the first part dealing with the amphistome cercariae has been published. The present part deals with the Parapleurolophocerca and Echinostome cercariae. Both these groups of cercariae need second intermediate host to complete their life histories.

I am indebted to the Director, Zoological Survey of India, Calcutta for providing the necessary facilities. My thanks are also due to Shri Monoj Sengupta, Artist, for the execution of drawings and to Shri R. C. Maity, for typing the manuscripts.

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PARAPLEUROLOPHOCERCA CERCARIAE

Faust (1929) erected two superfamilies Opisthorchioidea and Heterophyioidea for the families Opisthorchiidae and Heterophyidae respectively. Witenberg in the same year due to the similiarity in the anatomy of adult and the larvae placed these two families under the superfamily Opisthorchioidea. Studies on the life histories of the parasites belonging to these two families indicate that the cercariae are substantially similar in type and show close relationship. Sewell (1922) established two groups—Pleurolophocerca and Parapleurolophocerca to include the cercariae of the superfamily Opisthorchioidea. He has seperated these two groups of cercariae by the presence or absence of ventral sucker. The Pleurolophocerca are monostome cercariae and the Parapleurolophocerca are the distome cercariae. In other structures and in the life cycle there are so close similiarities between these two groups of cercariae that it can be concluded that they are closely related to each other and they represent the same line of evolution.

Sewell (1922) proposed Parapleurolophocerca group to accommodate his two distome cercariae which possess a tail without furcal rami and without setae and whose breadth at the base is very much less than that of the body. The other characters of these cercariae are that they are small, the tail is longer than body and is provided throughout its whole length with paired lateral fin membranes. The body is pyriform in shape and a pair of pigmented eye spots are present laterally in the anterior region. The surface of the body is armed wholly or partially with backwardly directed spines or hair like processes. The anterior spines are arranged in transverse rows and the spines of the first two or three rows are much larger than those situated more posteriorly. The anterior end of body is occupied by a retractile oral sucker. The mouth leads back to a well developed pharynx, there is no trace of oesophagus and intestinal caeca and the prepharynx is present. Salivary glands composed of several cells lie behind and to the outer side of pharynx and the ducts pass forwards to open on the anterior tip of the mouth. The excretory vesicle is large and thick-walled. Its long axis placed transversely to the body length. A pair of main excretory canals arise from the lateral margin of the excretory vesicle and pass forwards to the level of the ventral sucker where they divide into anterior and posterior branches. The anterior collecting tube terminates into capillaries and flame cells. The posterior collecting tube passes backward almost to the posterior end of body and then divides into two accessory collecting

tubes, each of which terminates into flame cells. The primordia of genital organs are represented by a mass of cells lying between ventral sucker and excretory bladder.

Elongated saccular rediae are without locomotor processes. The mouth of the redia is terminal and leads back to a well developed pharynx which may be surrounded posteriorly by a mass of granular salivary cells. The cercariae leave the rediae generally while still in an immature state and complete their development in the host tissue.

In case of larval trematodes the type slides and permanent mounts are not maintained. So the descriptions are based on the published accounts and the personal observations of the author.

Key to Indian Species

1. Body spination extend beyond the posterior margin of oral sucker ; eye spots conical and not divided into two units. ... 2
 Body spination restricted to level of posterior margin of oral sucker ; eye spots not conical and divided into two identical units. ... *Cercaria* sp. IV Kerala.
 Entire body surface covered with spines or sensory hairs. ... 3
 Body spines extend to half the body length from the anterior end. ... *Cercariae indicae* XXXI.
3. Body surface covered with backwardly directed spines ; prepharynx short ; ventral sucker well developed ; fin folds extend to whole length of lateral margin of tail. ... *Cercariae indicae* L.
 Body surface with large sensory hair like processes ; prepharynx long ; ventral sucker poorly developed ; dorso-ventral fin folds extend throughout tail length on one side and partly on the other side. ... *Cercaria bhimtalensis*.

1. *Cercaria bhimtalensis* Malaki and Singh

(Fig. 1 A-C)

1962. *Cercaria bhimtalensis* Malaki and Singh, *Indian J. Helm.*, XIV (2) ; 133-153

Diagnosis : Cercariae large in size ; during swimming tail actively vibrates driving the contracted body through water ; positive phototropic ; after a short period of swimming cercaria settles down at bottom of the container and attached by its anterior end with its tail directed towards the surface of water and hanging freely ; body oblong, anterior and pointed and armed with several rows of cuticular spines, anterior half of body with small spines, small number of large sensory

hair like process present all over body, body capable of considerable degree of extension and contraction, body measures $0.372-0.526$ (0.424) \times $0.105-0.162$ (0.121)*; a large number of golden brown pigment bodies present all over the body; a pair of pigmented eye spots

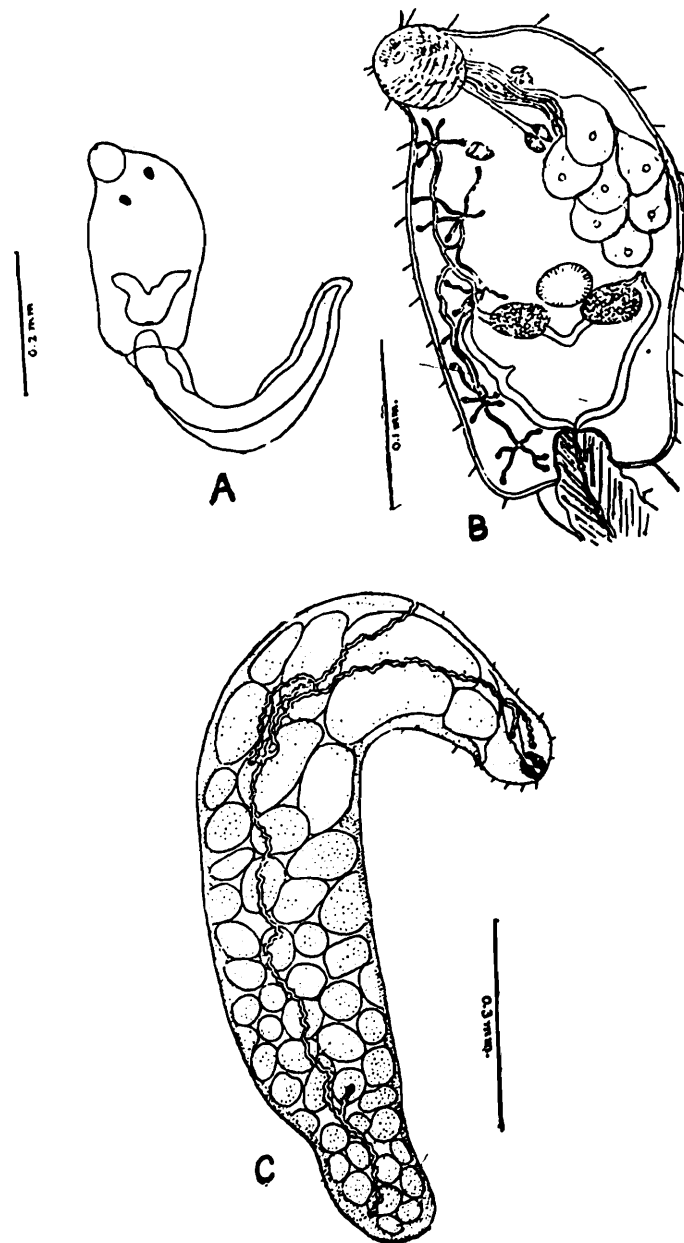


Fig. 1. A—B. *Cercaria bhimtalensis* Malaki and Singh, 1962.
C. Redia of *C. bhimtalensis* Malaki and Singh, 1962.
(After Malaki and Singh, 1962)

with conical lenses present near anterior end of body; seven pairs of penetration gland cells present between the area of eye spots and anterior margin of excretory vesicle, ducts of these glands open dorsal to mouth opening; anterior portion of body bends toward ventral side; mouth opening provided with a well developed piercing apparatus consisting of four acicular spines in a row and immediately dorsal to these situated

* Unless otherwise stated all measurements are in millimeters.

a row of 11-13 spines ; small spines cover cuticle of the anterior half ; first few rows of spines in the region of oral sucker being more prominent, this whole apparatus constitutes the organ of penetration ; oral sucker occupied the anterior end of body, well developed, measures 0.043-0.052 (0.046) in diameter ; mouth subterminal ; prepharynx elongate, measures 0.115-0.127(0.121) in length ; pharynx muscular, measures 0.018-0.025 (0.020) in diameter ; caeca absent ; excretory vesicle thick walled, 'V' shaped, a pair of main excretory ducts pass forward from antero-lateral regions of the vesicle, main ducts divide in the mid region of the body into anterior and posterior branches, anterior branch running forward divides into two anterior collecting ducts—one of which runs forward lateral to prepharynx and gives off five flame cells close to oral sucker, second duct of anterior branch further subdivides into two collecting ducts—one of which extends upwards dorsally and gives off five flame cells behind pharynx while other duct descends downward and gives off another five flame cells at level of ventral sucker, posterior branch of main excretory duct descends downward and gives off fourth and fifth sets of five flame cells each at about 1/4th region of posterior part of body, flame cell formula can be represented by $2[(5 + 5 + 5) + (5 + 5)] = 50$; tail as long as body, measures 0.453 – 0.567(0.498) \times 0.043 – 0.064(0.053), median caudal duct present, lophocercous caudal organ with dorso-ventral fin folds extending throughout tail length on one side and partly on the other ; ventral sucker poorly developed, occupying posterior mid-ventral portion of body ; genital primordia consist of two oval bodies on same level present posterior to ventral sucker and anterior to excretory bladder partly overlapped by anterior margin of excretory vesicle.

Redia occurs in hepatic glands of host, measures 0.513-0.704 (0.625) \times 0.093-0.145 (0.111) ; pharynx well developed, measures 0.010-0.012 (0.011) in diameter ; caeca small measures 0.20-0.38 (0.31) ; mouth situated at anterior end ; birth pore situated at a short distance from anterior end of body, large number of developing cercariae and germ balls present ; excretory system well developed and consists of five pairs of flame cells, anterior pair present anterior region of caeca and drained by narrow excretory ducts which soon join to form a common duct which runs posteriorly to meet another duct that drains only one flame cell present near anterior third of body, anterior duct thus formed runs posteriorly for a short distance before joins by posterior collecting duct, posterior pair of flame cells drained by narrow convoluted ducts which soon unite at 1/6th from posterior end of body and there after duct runs forward as a common duct to join anterior collecting duct,

common duct runs anterior to open on lateral side at about 1/5th from anterior end of body.

Snail Host : *Melanoides tuberculatus* var. *tigrina*. Locality : Bhimtal, Naukuchital (U. P.)

2. *Cercariae indicae* XXXI Sewell

(Fig. 2. A—B)

1922. *Cercariae indicae* XXXI Sewell, *Indian J. Med. Res.* (Suppl.) X : 96-98.

Diagnosis : *Cercaria* swims well and during swimming body assumes circular in shape, body in semi extended condition pyriform in outline, measures $0.175-0.232 \times 0.140-0.100$, greatest width occurs at about level of a ventral sucker, posterior end bluntly rounded ; oral sucker feeble, rounded ; extreme anterior end with three rows of large hook-like spines ; body armed with a series of small retroverted spines arranged in transverse rows which extend back for about half body length, but behind this point cuticle appears to be devoid of any armature ; oral sucker and anterior end of body can be retracted and forms a hemispherical cavity, which imitates an enlarged mouth ; a pair of eyes composed of numerous small black pigment granules situated laterally just behind level of oral sucker, irregular patches of brown pigment scattered over the posterior third of body ; a number of round refractile globules of a pale yellow colour of appearance of fat droplets dotted over posterior two-thirds of body ; body surface appears to possess a series of irregular spaces in which lie numerous small round refractile globules apparently of an excretory nature ; ventral sucker smaller than oral sucker with a diameter of $0.036-0.043$, situated about 1/3 of body length from posterior end ; tail attached to ventral aspects of posterior end of body, measures $0.263-0.298$ in length when fully extended, on either side a clear transparent fin-fold, with a width equal to about half of tail stem extends along each lateral margin from anterior proximal end almost to distal sharply pointed end ; mouth situated almost terminally or only slightly subterminally, leads back into a narrow tube which continued backwards as a long prepharynx to a globular pharynx, lying about 1/3 of body length from anterior end ; cells of salivary gland arranged in two groups situated in ventral sucker region on either side of body, anterior group lies some what in front of level of ventral sucker consists of three small pyriform cells with round clear nuclei and granular protoplasm, posterior group lying at ventral sucker level consists of five large pyriform cells with large rounded clear nuclei and granular protoplasm, from each group of cell ducts arise which open

to sides of oral sucker ; excretory system consists of large excretory vesicle, its long axis placed transversely to body length, situated in posterior end, from antero-lateral regions of bladder on each side of body a main excretory tube runs forward and outward as far as level of anterior margin of ventral sucker where it divides into anterior and posterior

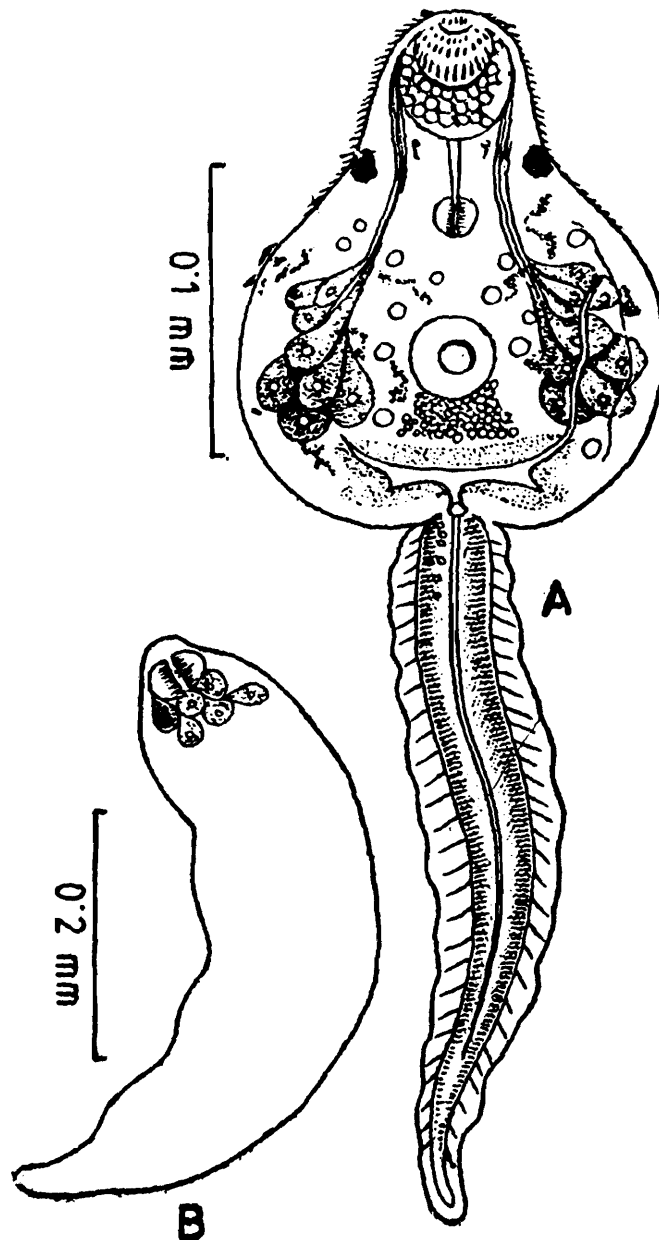


Fig. 2. A. *Cercariae indicae* XXXI Sewell, 1922. B. Radia of *C. indicae* XXXI Sewell, 1922. (After Sewell, 1922)

collecting tubes, a wide caudal canal arises from posterior end of bladder and passes down to tail ; genital organ represented by a mass of rounded cells lying between posterior margin of ventral sucker and anterior wall of excretory bladder.

Cercariae developed in sausage shaped radia which show no trace of any locomotor appendages ; mouth terminal, leads back into a well developed globular pharynx ; sac-like short stomach contains brown

black colour granules ; rediae contains a number of cercariae in varying stages of development ; a birth pore situated a little distance behind level of pharynx.

Snail Host ; *Digoniostoma cerameopoma*. Locality : Calcutta.

3. *Cercariae indicae* L. Sewell

(Fig. 3. A)

1922. *Cercariae indicae* L Sewell, *Indian J. Med. Res.* (Suppl.) X : 98-100.

Diagnosis : Body measures 0.210-0.263 × 0.123-0.149 ; tail measures 0.386 in length ; pyriform body shows considerable extension

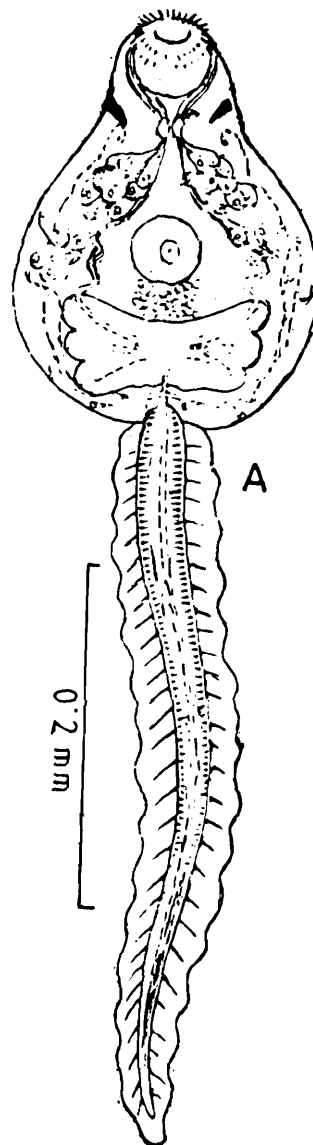


Fig. 3. A. *Cercariae indicae* L Sewell, 1922. (After Sewell, 1922)

and contraction ; pair pigmented conical eyes situated antero-laterally behind oral sucker ; anterior end armed with two or three transverse rings of stout backwardly pointing spines ; body surface covered with small backwardly-directed close-set of spines ; ventral sucker central in

position, measures 0.039 in diameter ; tail attached on ventral side of posterior end of body ; on either side of tail a transparent fin fold extends throughout its whole length which ends bluntly pointed posteriorly, all along sides of tail a number of delicate lines run outwards across fin fold resembling fin rays ; mouth terminal leads back into a well-developed anterior sucker which measures 0.054 in diameter ; prepharynx short ; pharynx well developed with a diameter of 0.021 ; behind and outer side of pharynx lies a well developed salivary gland, this gland divides into two parts anterior part consists of ten pyriform cells with granular protoplasm, round clear nuclei and further back in body on either side of ventral sucker lies a second group of five similar cells, ducts from both these groups pass forwards to middle line in posterior pharyngeal region and then diverge, those of each side passing laterally and dorsally around oral sucker open on the dorsal tip of the mouth ; posterior end of body occupied by a large and conspicuous excretory bladder, sides of bladder thrown into folds into which cavity penetrates, from anterolateral angles a main excretory tube follows a wavy course first forwards and then outwards to level of ventral sucker then it divides into anterior and posterior branches, anterior branch runs forward and ends in two flame cells, while posterior branch runs backward to posterior end of body and gives off branch to two posterior flame cells then turning forwards again ends in two cells situated laterally in middle region of body, in all six pairs of very small flame cells present, from posterior end of bladder a caudal excretory canal passes down to tail, an elongate transversely oval excretory pore situated at base of tail ; genital organ represented by a compact mass of small round cells situated immediately behind ventral sucker and in front of anterior wall of excretory bladder.

Rediae measure 0.614×0.141 ; posterior end bluntly pointed ; pharynx well developed having a diameter of 0.040 ; behind pharynx a group of granular refractile cells present ; each redia contains about 12 immature cercariae.

Snail host : *Amnicola travancorica* (= *Gabbia travancorica*)

Locality : Paddy field on the Calicut Sultan's Battery Road at mile 50.3 furlongs ; Wynaad district, Madras Presidency.

4. *Cercaria* sp. IV Kerala Mohandas

(Fig. 4 A-D)

1976. *Cercaria* sp. IV kerala Mohandas, *Vest. Cs. Spol. Zool.*, XL(3) : 196-205.

Diagnosis : *Cercaria* fairly large, emerges largely at noon, stops

suddenly while swimming and keeping tail upwards floats freely, during locomotion tail moves first and body drawn behind, body capable of independent contraction and extension and during contraction body assumes a triangular shape ; body measures $250-375 \times 175-225^*$,

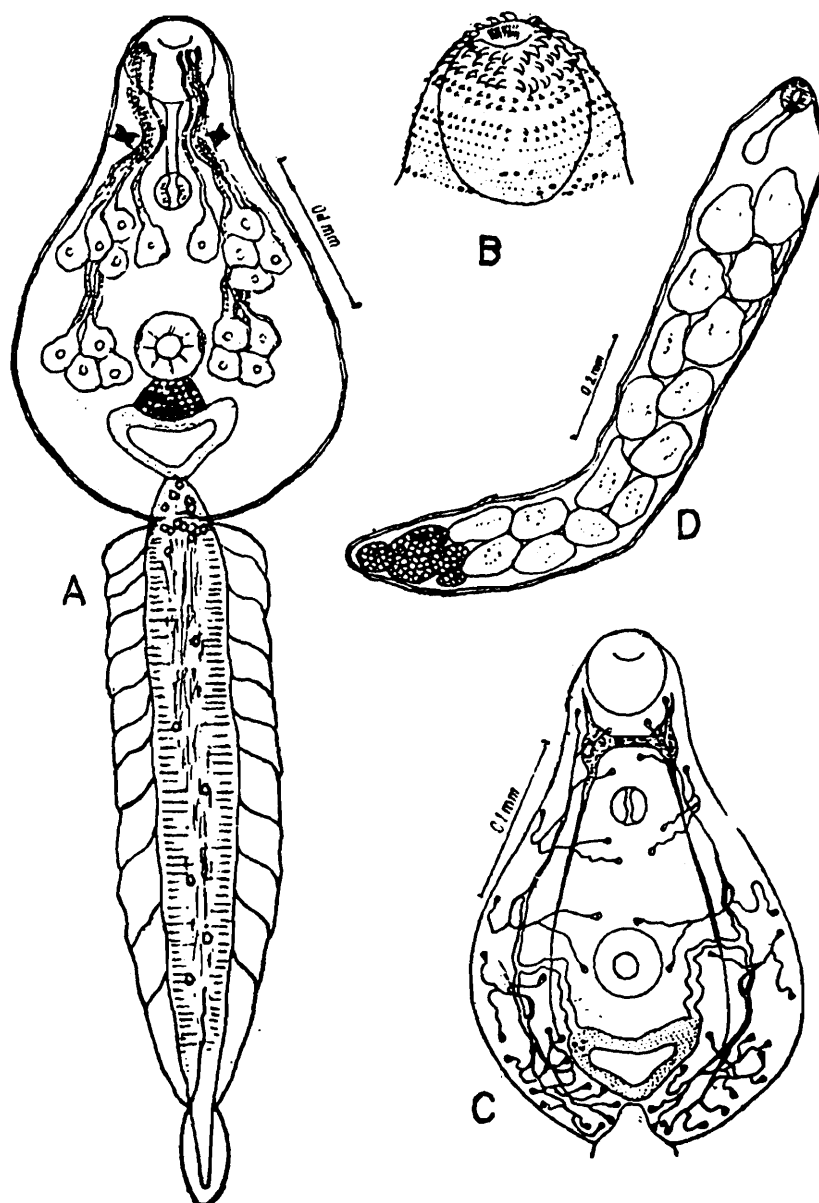


Fig. 4. A.-C. *Cercariae sp. IV Kerala* Mohandas, 1976. D. Redia of *C. sp. IV Kerala* Mohandas, 1976. (After Mohandas, 1976)

brown pigments sparsely distributed in posterior half of body, spination restricted to level of posterior margin of oral sucker, first three rows of spines very large, parrot beak shaped spines measure 10-12 in length, below this row two rows of slightly smaller spines and after a gap third set of spines consisting of 10-11 rows, size of spines decreases as they run posteriorly, eighteen preoral spines in double rows ; setae absent on body ; cystogenous cells numerous with granular material ; paired

* All measurements are in millimicrons.

eye spots with conspicuous lens and each eye with two identical units ; oral sucker circular or slightly oval shaped, measures $50-62 \times 40-50$; ventral sucker equatorial or slightly post equatorial, measures $37-50$ in diameter ; mouth subterminal and prepharynx long and narrow ; pharynx globular, measures $20-25$ in diameter ; oesophagus and caeca absent ; penetration glands nine pairs arranged in three groups—one group of four cells at level and on either side of ventral sucker, two groups of four cells between pharynx and ventral sucker and remaining two cells situated medially below pharynx, gland cells with nuclei and granular protoplasm ; thick walled excretory bladder triradiate, main excretory duct runs anteriorly to level of ventral sucker then divides into two—one running anteriorly and other posteriorly, flame cell formula can be represented by $2(3+3+3+3+3+3+3+3)=48$; nervous system with two masses of cells located on either side of prepharynx and connected by transverse nerve fibres and paired antero-lateral and postero-lateral nerve cords ; rudimentary reproductive system with a mass of cells situated between ventral sucker and excretory bladder ; tail with well developed fin folds, measures $325-425 \times 87-105$, lateral fin fold extend whole length of tail but dorso-ventral fin fold restricted to small portion at posterior end.

Redia pale white, occurs in hepatopancreas of host, measures $525-1450 \times 125-225$; appendages absent ; pharynx measures $45-70$ in diameter ; caeca very short.

Snail Host : *Digoniostoma pulchella* Locality : Trivandrum district.

ECHINOSTOMES

Echinostomes are mainly the parasites of reptiles, birds and mammals but they have also been reported from fishes. The body of echinostomes are usually elongated, oval or leaf-like and are characterised by the presence of collar and collar spines. The collar spines are arranged in single or in double rows. The oral sucker surrounding the mouth at or near the anterior end and the ventral sucker lies on the ventral surface usually in the anterior or posterior half of body. The body vary significantly in size, ranging from small to large in size. The collar in the anterior side is reniform or disc shaped. The collar spines are marginal and ventro-lateral and at times the ventral corner spines are separated off from the rest. The collar spines are continuous or interrupted dorsally. The body cuticle may be armed with small spines or plates or unarmed.

Ventral sucker is larger and strongly developed than the oral sucker. Pharynx and oesophagus present and intestinal caeca generally extend upto the posterior part of body.

Excretory vesicle 'V', 'Y' or tubular shaped. The main excretory vessel extends forward to the region of pharynx or oral sucker where it loops back and descends down as retrograde vessel.

Genital pore median and located between the intestinal bifurcation and ventral sucker, cirrus sac usually present. Testes usually median, symmetrical, tandem and situated in the posterior half of the body. Ovary anterior to testes and either median or lateral, seminal receptacle and Laurer's canal present. Vitellaria lateral, generally extending behind ventral sucker or testicular level to posterior end of body. Uterus with one ascending column which forms many loops. Eggs large and operculated.

The presence of flukes in the gut of the host causes lesions as well as physiological and functional disturbances. Though numerous species of echinostomes have been reported from vertebrates, particularly from birds, but not much is known about its pathogenicity. Heavy infection may cause severe enteritis. The infected birds show inappetence, thirst, diarrhoea, lassitude and progressive weakness. On post-mortem slight atrophy of breast muscles and catarrhal enteritis with mucus and haemorrhage behind duodenum can be seen in the infected host. The parasites are chiefly found in the middle portion of the intestine and the infection may be heavy at times. In mammals heavy infection may occur without producing any symptoms. However, certain mammals are very susceptible to the infection which produces haemorrhagic enteritis in the hosts. During infection Alkaline Phosphates decrease in the duodenum, ileum and rectum. Significant decreases in the levels of enterokinases occur in the mucosa and contents of the duodenum but increases in the rectum and droppings.

LIFE HISTORY OF ECHINOSTOMES

The ovoid egg when laid is operculated and the ovum slowly develops into a fully developed miracidium within a few days after deposition. Hatching takes place in light and in darkness and the fully developed miracidium emerges after pushing open the operculum. The miracidium after hatching swims rapidly and constantly in the water. The minute, elongated and ovoid miracidium is covered with flattened ciliated epidermal plates and provided with gut, penetrating cells, excretory system and germ balls. The arrangement of the epidermal

plates can only be seen after staining with silver-impregnation techniques. The miracidium possess six plates in the anterior most tier, six in the next tier, four and two respectively in the next two tiers. The anterior tip of the miracidium is provided with an apical papilla. The miracidium also contains a nerve mass and nerve fibers. On emerging the miracidium attacks the intermediate snail host and after penetrating into the snail host it transforms into a sporocyst.

The sporocyst produces mother rediae which in turn produces into daughter rediae. The second generation of rediae produces cercariae. The sporocyst is non-ciliated, ovoid to elongated in shape which contains germ balls and rediae.

The redia is an elongated structure with a pharynx and a gut. The redia also possess birth pore, collar, excretory system, locomotor appendages, germ balls and daughter rediae or cercariae.

The cercariae after escaping from the snail host swim actively in the water and seeking the next intermediate host. Like the adult parasites the cercariae are provided with collar and collar spines. Upon coming in contact with a suitable second intermediate host the cercariae encyst and the final infection of the definitive host is accomplished when they inject these metacercariae. Upon being freed into the body of the final host the metacercariae developed into the adult parasites.

ECHINOSTOME CERCARIAE

An echinostome cercaria is provided with a flat body and a powerful tail and are characterised by the possession of a collar and collar spines, surrounding the anterior end of body. The cercaria is also provided with well developed oesophagus and long intestinal caeca. The cercaria possess well developed oral and ventral sucker and is also provided with cystogenous cells and paired excretory orifices on the lateral margins of tail. The excretory system well developed and the middle part of the main excretory vessel contains excretory granules. The main vessel after reaching the region of pharynx or oral sucker forms a loop and descends down as a retrograde excretory vessel. Body spines may be present or absent. The powerful tail may be smaller, same size or bigger than the body and may or may not be provided with the fin folds. This powerful muscular tail acts as a swimming organ.

Sewell (1922) divided the echinostome cercariae into three sub-groups. In this series these three sub-groups have been retained and one more subgroup, Megacaudata, has been added. Where ever necessary the characters proposed by Sewell have been modified.

Key to groups

- | | | | |
|----|---|-----|--------------|
| 1. | Tail massive and much larger than body | ... | Megacaudata |
| | Tail not massive and smaller, same or larger than body. | ... | 2 |
| 2. | Caudal fin folds present | ... | Echinatoides |
| | Caudal fin folds absent | ... | 3 |
| 3. | Retrograde excretory vessels divide into anterior and posterior branches near the middle of body or ventral sucker | ... | Coronata |
| | Retrograde excretory vessels divide into anterior and posterior branches near posterior parts of body or retrograde vessels pass extreme posterior end of body then turning forward to continue to the side of oral sucker anteriorly | ... | Echinata |

I. *CORONATA GROUP*

Diagnosis (emended): Fin folds on tail absent, retrograde excretory vessels divide near middle of body or near ventral sucker into anterior and posterior branches.

KEY TO INDIAN SPECIES

- | | | | |
|----|--|-----|----------------------------------|
| 1. | Body spines present | ... | 2 |
| | Body spines absent | ... | 12 |
| 2. | Body spines restricted in distribution | ... | 3 |
| | Body spines present in whole body | ... | 4 |
| 3. | Body spines present behind collar, collar spines 29 in numbers and flame cells 18 in numbers | ... | <i>C. indicae</i> XX |
| | Body spines present dorsally and ventrally upto level of ventral sucker, collar spines 33 in numbers and flame cells 42 in numbers | ... | <i>C. andhraensis</i> |
| 4. | Collar spines not more than 32 in numbers | ... | 5 |
| | Collar spines more than 32 in numbers | ... | 8 |
| 5. | Collar spines 32 in numbers | ... | 6 |
| | Collar spines less than 32 in numbers | ... | 7 |
| 6. | Penetrating glands cells 5 pairs, flame cells 24 in numbers and two types of cystogenous cells | ... | <i>C. nawabanjensis</i> |
| 7. | Collar spines 24 in numbers, arranged in single row, 6 pairs of penetrating glands and flame cells 30 in numbers | ... | <i>C. unnaoensis</i> V |
| | Collar spines 28 in numbers, arranged in double row, 4 pairs of penetrating glands, flame cells 36 in numbers | ... | <i>C. oviglandulata</i> |
| 8. | Collar spines 43 in numbers, 7 pairs of penetrating glands | ... | <i>C. Echinoparyphium hymani</i> |

- | | | | |
|-----|---|--|----|
| | Collar spines 45 in numbers, penetrating glands less than 7 pairs | ... | 9 |
| 9. | Flame cells not more than 28 in numbers | ... | 10 |
| | Flame cells more than 28 in numbers | ... | 11 |
| 10. | Flame cells 22 in numbers, penetrating glands 5 pairs present lateral to oesophagus | ... <i>C. Echinoparyphium vitellocompactum</i> | |
| | Flame cells 28 in numbers, penetrating glands 4 pairs present lateral to oesophagus | ... <i>C. Echinoparyphium lanceolatum</i> | |
| 11. | Flame cells 42 in numbers, penetrating glands 4 pairs present posterior to ventral sucker | ... <i>C. sp. VII Kerala</i> | |
| 12. | Main excretory canal with lateral branches | ... | 13 |
| | Main excretory canal without lateral branches | ... | 14 |
| 13. | Collar spines 40 in numbers, penetrating glands 28 in numbers, cystogenous cells behind middle of body | ... <i>C. beaveri</i> | |
| | Collar spines 28 in numbers, penetrating glands 12 in numbers, cystogenous cells throughout the body | ... <i>C. chillavanensis</i> | |
| 14. | Collar spines not more than 32 in numbers | ... | 15 |
| | Collar spines more than 32 in numbers | ... | 21 |
| 15. | Collar spines 32 in number | ... | 16 |
| | Collar spines less than 32 in numbers | ... | 18 |
| 16. | Collar spines arranged in single row | ... | 17 |
| | Collar spines arranged in double row | ... <i>C. itoi</i> | |
| 17. | Flame cells 10 in numbers, caudal excretory canal bifurcates into two lateral canals soon on entering the tail | ... <i>C. dharmatallensis</i> | |
| | Flame cells 36 in numbers, caudal excretory canal runs along tail enters into a caudal appendage and swollen to form a blind vesicle | ... <i>C. komiyai</i> | |
| 18. | Collar spines 24 in numbers | ... | 19 |
| | Collar spines more than 24 in numbers | ... | 20 |
| 19. | Penetrating glands 16 in numbers, flame cells 28 in numbers, caudal excretory canal bifurcates into two lateral canals soon on entering the tail | ... <i>C. Echinochasmus bagulai</i> | |
| | Penetrating glands 2 in numbers, flame cells 36 in numbers, caudal excretory canal runs upto posterior tip of tail and opens by a small pore, the two lateral canals of caudal excretory canal originate slightly anterior to tip of tail | ... <i>C. megaglandulata</i> | |
| 20. | Collar spines 26 in numbers, penetrating glands 2 in numbers, flame cells 18 in numbers, caudal excretory canal bifurcates into two lateral canals near the end of the tail | ... <i>C. chinahatensis</i> | |
| | Collar spines 27 in numbers, penetrating glands 8 in numbers, | | |

- flame cells 24 in numbers, caudal excretory canal bifurcates into two lateral canals soon on entering the tail ... *C. unnaoensis* IV.
21. Collar spines 37 in numbers arranged in double row dorsally, flame cells 30 in numbers, penetrating glands 10 in numbers ... *C. dietzi*
- Collar spines 58 in numbers arranged in single row, flame cells 20 in numbers, penetrating glands 6 in numbers ... *C. narindapurensis*

5. *Cercaria andhraensis* Ganapati and Hanumantha Rao

(Fig. 5. A—B)

1969, *Cercaria andhraensis* Ganapati and Hanumantha Rao, *Proc. Indian Acad. Sci.*, 69 (B) : 277-283.

Diagnosis : *Cercaria* emerges at dawn and continue to do so till late afternoon ; it swims briskly, occasionally body rolled into a ball ;

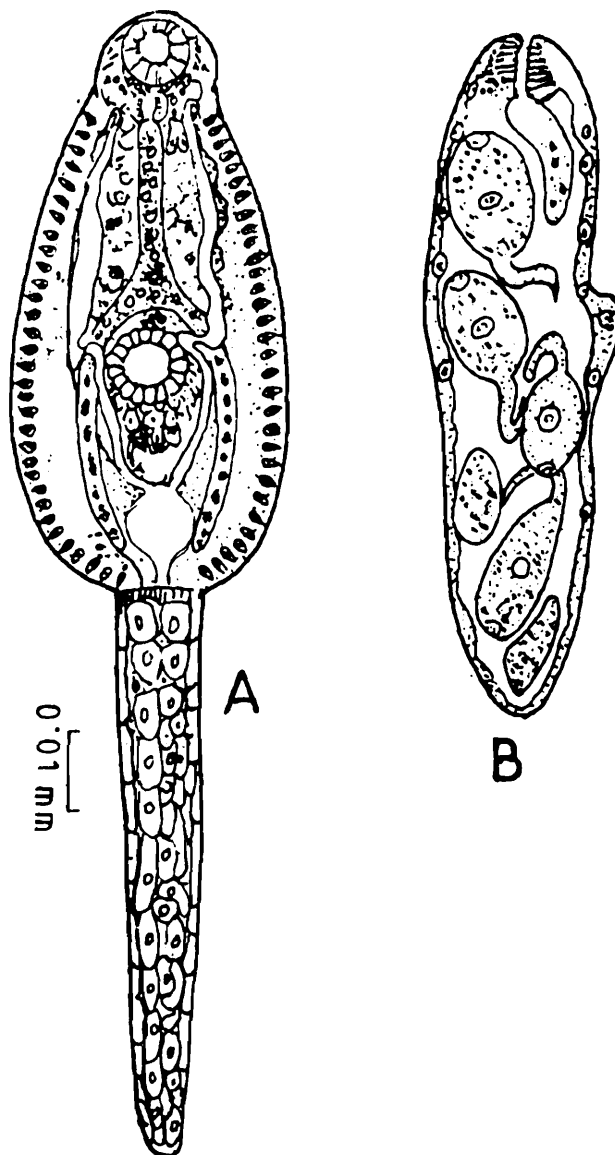


Fig. 5. A. *Cercaria andhraensis* Ganapati and Hanumantha Rao, 1969. B. Redia of *C. andhraensis* Ganapati and Hanumantha Rao, 1969. (After Ganapati and Hanumantha Rao, 1969)

body measures 0.53 in length in moderately extended specimens with a breadth of 0.28 ; oral sucker of 0.06 in diameter ; collar well developed, spines inconspicuous, collar spines 33 in numbers, measuring 11μ each, with 4 corners, 13 median and 16 corners ; body spines present dorsally and ventrally upto level of acetabulum ; acetabulum located at a distance of 0.8 from anterior end and measures 0.07 in diameter ; mouth leads into prepharynx of 0.03 in length ; pharynx 0.03 in diameter ; oesophagus and caeca in form of solid columns of cells, these cells with granules ; cystogenous gland cells and other gland cells present, cystogenous gland cells with rod shaped bodies, situated in dorsal and dorsolateral regions beneath tegument ; other gland cells located ventral to digestive system and some of these cells extend to anterior end and to open out by fine ducts ; reproductive system consists of rudiments of cells situated posterior to acetabulum and connected to a smaller preacetabular mass by a strand of cells ; excretory system with 21 pairs of flame cells and of typical echinostome type ; nervous system with two conspicuous ventro lateral nerve cords, these cords connected by transverse dorsal commissure at level of oesophagus some what overlapping anterior end of pharynx ; matrix of tegument of tail relatively thin and nucleated region of cytoplasm lies immediately underneath it, nuclei measure 3μ in diameter, striations run around tail, epidermis followed by conspicuous layer of longitudinal muscles, vesicular nuclei of cells measure 6μ in diameter.

Redia measures 2.5 in length ; contains 5-6 cercariae and 2-3 germinal masses, wall of redia provided with circular and powerful longitudinal muscles.

Cercaria capable of encystment in snail host ; spherical cyst measures 0.152 in diameter.

Snail Host : *Pila globosa* Locality : Waltair

6. *Cercaria beaveri* Pandey and Agrawal (Figs. 6 A-D)

1977. *Cercaria beaveri* Pandey and Agrawal, *Indian J. Parasit.*, 1 (2) : 79-82.

Diagnosis : Larva comes out of host in small numbers during day time, it swims by lashing powerful tail and by contracting body, at bottom of container it makes caterpillar like movements with help of its suckers, swimming interrupted by short period of rest during which it remains hanging in water, sometimes emerged cercaria enters in another or same snail and encyst on mantle wall, a large number of them also encyst in rediae without leaving hosts ; body of cercaria

aspinose with narrow anterior and broad round posterior end ; it measures $0.27-0.35 \times 0.12-0.16$ in live and $0.16-0.24 \times 0.05-0.10$ in fixed specimens ; circular oral sucker terminal and measures $0.03-0.04 \times 0.03-0.05$ in live and $0.01-0.02 \times 0.02-0.03$ in fixed specimens ; ventral sucker larger than oral sucker, situated behind middle of body and measures $0.05-0.06 \times 0.05-0.07$ in live and $0.03-0.04 \times 0.03-0.05$ in fixed specimens,

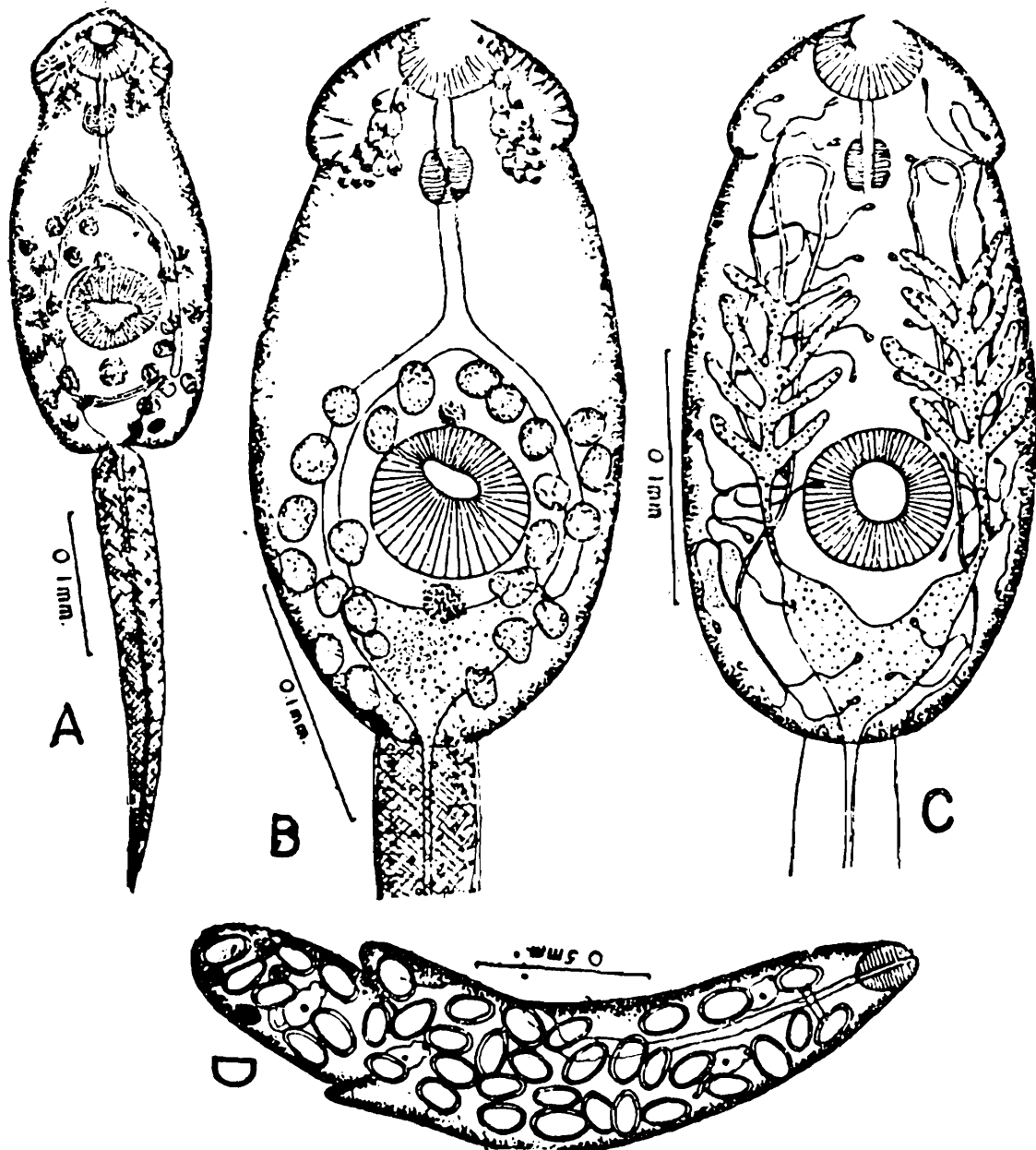


Fig. 6. A.—C. *Cercaria beaveri* Pandey and Agrawal, 1977. D. Redia of *C. beaveri* Pandey and Agrawal, 1977. (After Pandey and Agrawal, 1977)

cephalic collar well developed, armed with 40 collar spines including 5 end group spines on each side and arranged in single row ; prepharynx present ; rounded pharynx measures $0.01-0.02$ in live and $0.009-0.01$ in fixed specimens ; oesophagus short ; intestinal caeca extend almost upto posterior region of body penetration glands in two groups of 14 small

and oval shaped, situated on each side of pharynx, each gland with an eccentric nucleus and fine granules, opens to exterior by short duct close to mouth ; cystogenous gland cells round to oval with fine granules and distributed behind middle of body ; genital rudiments represented by two rounded masses, one present at anterior and other at posterior border of ventral sucker ; aspinose tail with well developed longitudinal and circular muscles, it measures $0.27-0.35 \times 0.02-0.05$ in live and $0.16-0.26 \times 0.01-0.02$ in fixed specimens, tail parenchyma with large number of small rounded nuclei arranged in irregular rows ; excretory bladder V-shaped, two main limbs of excretory canal originate from lateral cornua of excretory bladder on either side of body, each main canal runs ahead upto ventral sucker and dilates to accomodate globular refractile granules of different sizes, it gives rise to four blind arms on outer as well as inner side of body which gorged with refractile granules, it further extends as a narrow canal upto level of pharynx, it turns back and runs posteriorly roughly upto middle of body dividing into anterior and posterior collecting canals, anterior collecting canal runs upto pharynx and divides into three fine capillaries, each capillary provided with three flame cells, posterior collecting canal runs upto hind region of body and dividing into three fine tubules, each tipped with a flame cell, it gives rise to two additional branches each with three capillaries which tipped with flame cells, with flame cell formula of $2[(3 + 3 + 3) + (3 + 3 + 3)] = 36$, a caudal excretory canal extends from posterior side of excretory bladder and runs upto tip of tail, a pair of lateral tubules arise from caudal excretory canal at about one third of its length, run outward and backward to open outside by small pores.

Elongated rediae occured in hepatopancreas and gonads of host ; they measure $0.91-2.30 \times 0.35-0.57$ in live and $0.43-0.52 \times 0.10-0.26$ in fixed specimens ; birth pore and collar located at anterior region of body ; terminal mouth leads into a muscular pharynx, measuring $0.09-0.23 \times 0.08-0.15$ in live and $0.04-0.12 \times 0.05-0.07$ in fixed specimens ; blind gut gorged with blackish food material and extends roughly upto middle of body ; procoelocula present ; each redia with 1-3 cercariae, a few immature cercariae and a number of metacercariae ; in some rediae contain only metacercariae.

Snail Host : *Vivipara bengalensis* (= *Bellamya bengalensis*) Locality : Kathauta Tal, Lucknow (U.P.).

7. *Cercaria chillavanensis* Agrawal and Sharma
(Figs. 7 A-C)

1980. *Cercaria chillavanensis* Agrawal and Sharma, *J. Inst. Sci.*, 3 (1): 215-220.

Diagnosis: Cercariae sluggish, emerge in large number in morning, they survive for 8-10 hours, while swimming body kept straight ahead and tail performs pendulous movements, swimming followed by long period of rest and at rest cercariae remain hanging in water, at bottom of container cercariae perform creeping movements with help of

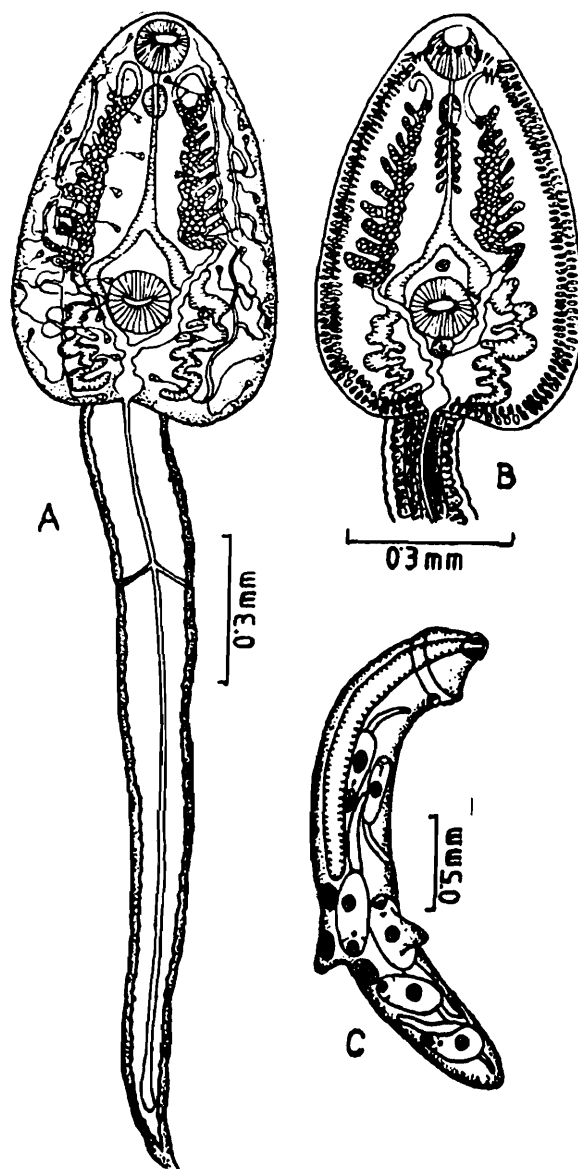


Fig. 7. A.-B. *Cercaria chillavanensis* Agrawal and Sharma, 1980. C. Redia of *C. chillavanensis* Agrawal and Sharma, 1680.
(After Agrawal and Sharma, 1980)

sucker and tail ; cercariae large, pear-shaped, broad round posterior end, cuticular spines absent ; subterminal oral sucker, round to oval in shape ; ventral sucker round, situated little posterior to middle of body,

slightly larger than oral sucker ; collar not well marked, with 28 collar spines including 5 end group spines, arranged in single row ; mouth leads into a short and narrow prepharynx ; pharynx elongate oval, large with well developed muscles ; oesophagus long, narrow, extends roughly to middle of body ; intestinal caeca run into sinuous course upto posterior end of body ; oesophagus and intestinal caeca filled with oval, slining food particles ; penetration glands six pairs, six on either side of oesophagus, each gland oval in shape with fine granules, posteriorly placed nucleus, ducts short open to oesophageal region ; cystogenous glands elongate arranged in packed rows, filled with fine brown granules : gonads represented by two large round masses of cells—one situated anterior and other behind ventral sucker ; tapering thick tail longer than body, well developed muscles with oval caudal bodies located laterally ; excretory bladder round to oval in shape with a short median collecting canal which divides into two main collecting canals—one on each side of body, each main collecting canal runs upto acetabular region becomes wide and filled with excretory granules, each canal has a number of diverticula chiefly on its outer margins, each canal runs upto posterior extremity of oral sucker then makes a loop and descends upto intestinal bifurcation where it divides into anterior and posterior collecting canals, anterior canal ascends upto level of pharynx and divides into three capillaries tipped with flame cells further it gives off two short branches—one at oesophageal region and other at level of intestinal bifurcation each bearing three capillaries capped with flame cells, posterior collecting canal runs upto excretory bladder where it gives of three capillaries capped with flame cells further it gives off two more sets of three capillaries—one at level of ventral sucker and other in between ventral sucker and excretory bladder, capped with flame cells, caudal excretory canal runs a little anterior to tip of tail where it swells to form a small pear shaped sac, two fine canals—one on each side given off from caudal excretory canal in anterior third of tail which open to outside through separate pores thirty six flame cells arranged with a flame cell formula of $2[(3 + 3 + 3) + (3 + 3 + 3)] = 36$.

Rediae found in digestive gland, long, thin walled ; pharynx small, terminal, round ; gut long, wide extends upto middle of body, filled with brown granules ; collar thick, present in anterior region ; small proscuscula, situated behind middle of body ; redia contains numerous germ balls, developing cercariae, 3-8 mature cercariae.

Snail Host : *Lymnaea acuminata*. Location : Digestive gland. Locality : Behsa (Chillavan), Lucknow (U. P.).

8. *Cercaria chinhatensis* Srivastava
(Figs. 8 A-C)

1978. *Cercaria chinhatensis* Srivastava, *Proc. Indian Acad. Sci.*, 87 (80): 329-337.

Diagnosis : Cercaria emerged from snail host throughout day but in large numbers during morning hours ; they swim by wriggling movement of their tail ; body aspinose, blunt narrow anterior and broad round posterior end ; body measures $0.44-0.48 \times 0.24-0.27$ in live specimens while $0.26 \times 0.10-0.11$ in fixed specimens ; tail aspinose, equal

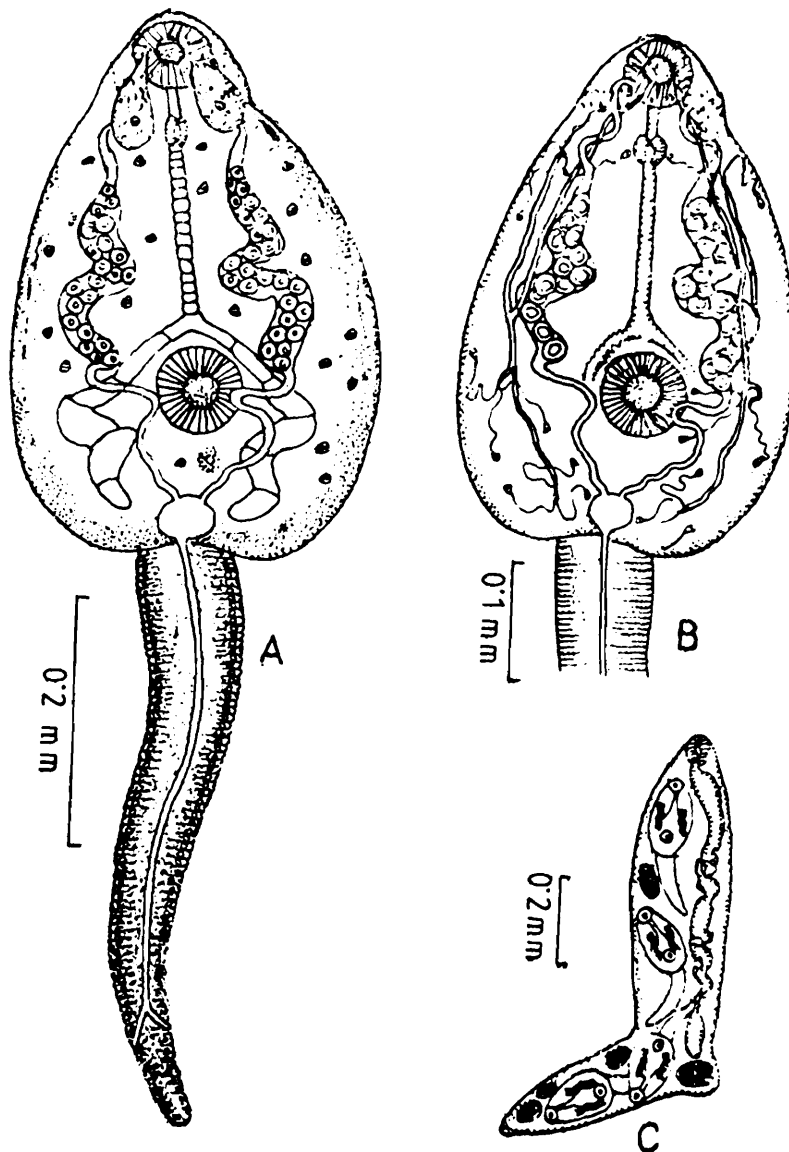


Fig. 8. A.—B. *Cercaria chinhatensis* Srivastava, 1978. C. Radia of *C. chinhatensis* Srivastava, 1978. (After Srivastava, 1978)

to or slightly longer than body, measures $0.44-0.51$ in length and $0.06-0.08$ in width near base in live specimens while $0.36-0.04$ in fixed specimens, caudal fin fold absent, a large number of rounded nuclei embedded in tail parenchyma and arranged in slightly irregular parallel

rows, tail on contraction gives an appearance of transverse striations throughout whole length ; oral sucker terminal, spherical or subspherical, measures $0.04-0.05 \times 0.05-0.06$ in live specimens and 0.04 in diameter in fixed specimens ; ventral sucker longer than oral sucker, situated slightly posterior to equatorial line, measures $0.06-0.08 \times 0.06-0.09$ in live specimens ; cephalic collar feebly developed ; armed with 26 collar spines arranged in single row, all spines of equal size, and group spines absent ; prepharynx short, measures $0.04-0.05$ in length in live specimens and 0.01 in length in fixed specimens ; pharynx globular muscular measures 0.02 in diameter ; oesophagus long, measures $0.14-0.15$ in length in live specimens while $0.06-0.07$ in length in fixed specimens, single row of longitudinal cells present, bifurcates at a short distance in front of ventral sucker into intestinal caeca which extend tortuously almost upto posterior end of body ; a pair of oval sac like penetration glands—one on each side of body posterior to oral sucker present, each pear shaped gland contains a nucleus and fine granules, opening separately close to mouth by short ducts ; cystogenous gland cells oval, triangular or irregular in shape, contains small rod—like bodies which arranged in parallel rows ; rudiments of gonads oval or rounded in shape present behind ventral sucker ; excretory system of echinostome type, excretory bladder rounded in shape, located at posterior end of body, two main collecting canals open one on each side of antero—lateral margin of excretory bladder, three flame cells on each side in anterior third of body capillaries of which unite to form anterior collecting canal which runs posteriorly upto region of intestinal bifurcation, flame cells in posterior half of body arranged in triples in two groups, three flame cells near posterior extremity of body and three in region of ventral sucker, with flame cell formula of $2(3) + 2(3 + 3) = 18$, capillaries of flame cells of posterior half of body unite to form posterior collecting canal which runs anteriorly upto region of intestinal bifurcation where it joins with anterior collecting canal and joins main collecting canal, on each side main collecting canal runs upto region of oral sucker which makes a loop and runs backward upto a short distance behind pharynx where it widens and runs upto middle region of ventral sucker where it again becomes narrow and proceeds posteriorly to open at anterior border of excretory bladder, caudal excretory canal runs into tail from posterior side of excretory bladder upto about $4/5$ of tail length where a pair of lateral canals arise from it which runs outward and backward to open outside by separate pores, a short distance anterior to distal end of tail.

Redia large, elongated, measures $1.12-1.88$ in length and $0.24-0.28$

in breadth in live specimens, terminal mouth leads into a muscular pharynx, measures 0.06×0.04 in live specimens ; gut extends posteriorly upto about $2/3$ rd of body length, gut contains blackish material, proportionately much longer in developing rediae ; each redia contains 4 to 8 developed and some developing cercariae with some germ balls ; birth pore about 0.12-1.86 from anterior end of body ; proscuscula at about 0.40-0.45 from posterior end of body.

Snail Host : *Indoplanorbis exustus*. Locality : Chinahat Lake, Lucknow (U. P.).

9. *Cercaria dharmatallensis* Mukherjee and Ghosh

(Figs. 9. A—B)

1977. *Cercaria dharmatallensis* Mukherjee and Ghosh, *Rec. zool. Surve. India*. 72 : 277-280.

Diagnosis : Body flat, measures $0.27-0.43 \times 0.12-0.20$; muscular tail measures $0.36-0.46 \times 0.04-0.06$; oral sucker measures $0.06-0.08 \times 0.06-0.08$; pharynx measures $0.03-0.04 \times 0.02-0.04$; collar carries 32 spines ; body and tail without spines ; mouth terminal and prepharynx long and narrow ; oesophagus long, bifurcates just above ventral sucker into two straight caeca ; caeca terminate anterior or middle level of excretory bladder ; uninucleate cells present in oesophagus and caeca ; muscular ventral sucker situated mid-region at post-equatorial part of body ; cystogenous cells compactly arranged ; excretory bladder transversely elongated, thin walled, oval in shape, situated posterior end of body two narrow excretory ducts arise from antero-lateral part of excretory bladder and runs forward in a zig-zag course ; descending excretory canals form loops near prepharynx, portions of ascending canals between ventral sucker and pharynx contain refractile excretory granules, five pairs of flame cells present, caudal excretory canal short and divides into two lateral ducts which open on lateral sides of tail.

Elongated redia measures $1.45-1.96 \times 0.06-0.07$; locomoter appendages present but collar absent ; pharynx measures $0.06-0.08 \times 0.05-0.07$; gut broad, elongated sac and gut contents yellowish in colour, it measures $0.05-0.45 \times 0.06-0.17$; birth pore at posterior level of pharynx ; each redia with 6 to 10 cercariae and germ balls.

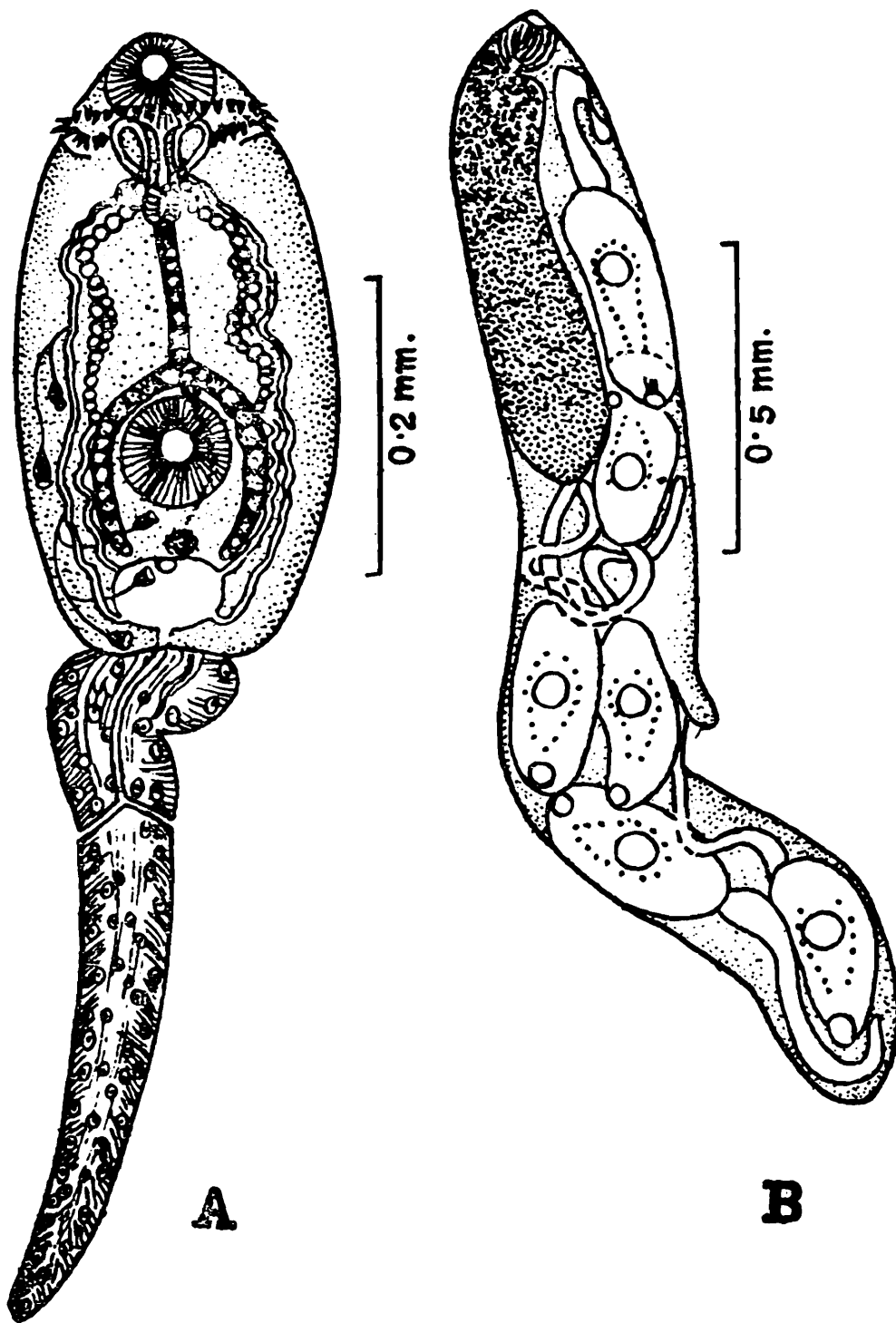


Fig. 9. A. *Cercaria dharmatallensis* Mukherjee and Ghosh, 1977.
 B. Redia of *C. dharmatallensis* Mukherjee and Ghosh, 1977.
 (After Mukherjee and Ghosh, 1977)

Snail Host : *Gyraulus convexiusculus*. Locality : Dharmatalla, Calcutta.

10. *Cercaria dietzi* Singh
 (Figs. 10. A—C)

1977. *Cercaria dietzi* Singh, *Proc. Nat. Acad. Sci. India*. 47 (B) : 17-24.

Diagnosis : Body aspinose, measures $0.21-0.30 \times 0.08-0.13$; collar distinct with 37 collar spines of equal size, arranged in double dorsally

uninterrupted rows, corner spines 6 on each ventral lappet of collar, 2 lateral spines on each side, dorsals arranged in double rows of 10 orals and 11 aborals; oral sucker spherical, measures 0.03-0.04 in diameter; prepharynx 0.01 long; pharynx spherical 0.01-0.02 in diameter; oesophagus solid, measures 0.05-0.06 long made up of 9 rectangular cells; intestinal caeca run posteriorly and end blindly near excretory bladder; five pairs of penetration glands lie laterally on either side of oesophagus; acetabulum post-equatorial, measures $0.04-0.05 \times 0.07$;

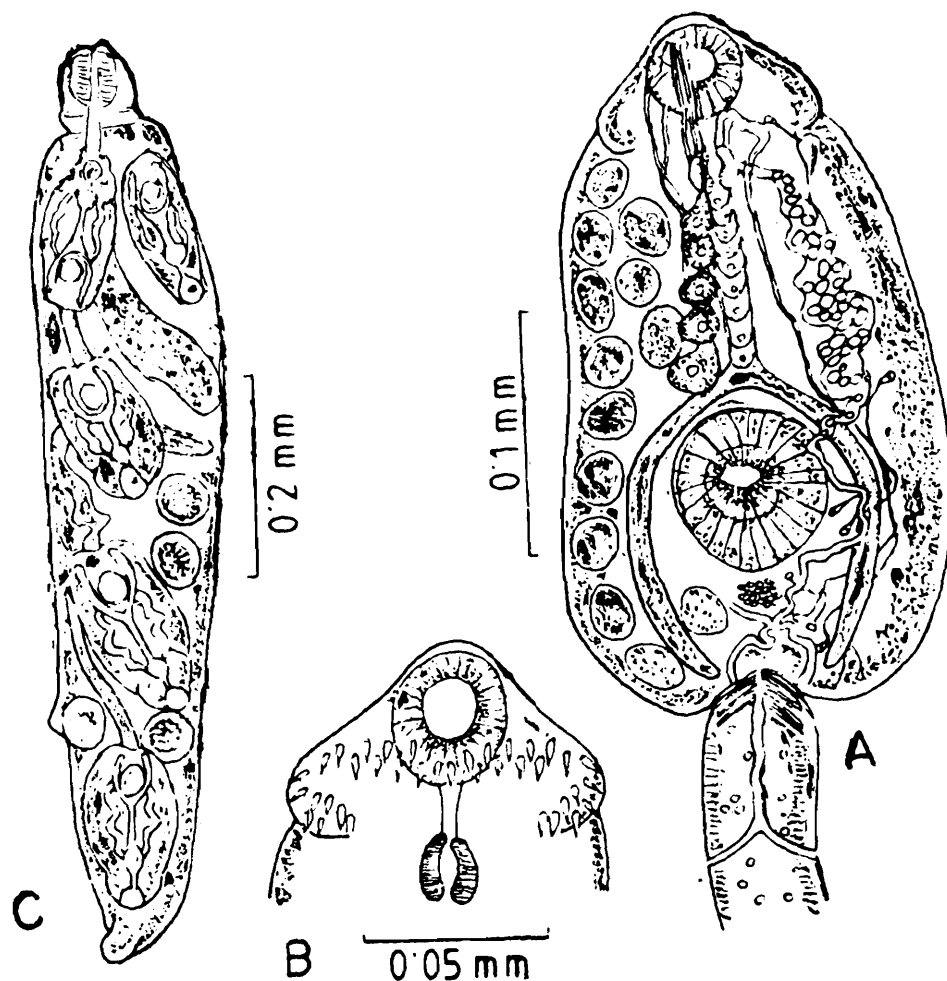


Fig. 10. A.—B. *Cercaria dietzi* Singh, 1977. C. Redia of *C. dietzi* Singh, 1977. (After Singh, 1977)

cells of genital primordium in form of a single mass situated between posterior margin of acetabulum and upper chamber of excretory bladder of about 0.02 long and 0.05 wide; cystogenous cells numerous; tail longer than body, aspinose, measures $0.40-0.41 \times 0.01-0.04$; excretory bladder bipartite, measures $0.02-0.02 \times 0.03-0.04$, upper chamber small, communicating with main collecting excretory ducts of both sides, excretory pore situated at junction of body and tail, main collecting ducts run anteriorly from excretory bladder in a sinuous course, ducts of each side dilate in their anterior course from acetabular region upto pharyngeal region, filled with refractile excretory granules, in prepharyngeal

region main duct of each side forms a loop and extends posterior upto acetabular level where it bifurcates into anterior and posterior collecting tubules, flame cells 30 in numbers and represented by formula of 2 $[(3+3) + (3+3+3)] = 30$, caudal excretory duct originates from posterior excretory bladder extends into tail and bifurcates at anterior 1/6th into lateral branches.

Redia measures 1.00-1.09 long and 0.18-0.18 wide at anterior end, 0.19 wide at midbody and 0.13 wide at level of posterior end ; pharynx subglobular, measures 0.06×0.05 ; collar conspicuous in young rediae but less prominent in mature ones ; locomotor organs in form of pair of procoscules situated at a distance of 0.29-0.31 from posterior extremity ; redia contains cercariae and germ balls.

Metacercaria spherical, measures 0.20-0.23 in diameter ; encyst in mantle, foot, heart and gonads.

Snail Host : *Lymnaea luteola f. australis*. Location : Hepatopancreas. Locality : Pujari Talab, Durg (M. P.).

11. Cercaria of *Echinochasmus bagulai* Ramalingam

(Figs. 11 A-C)

1960. Cercaria of *Echinochasmus bagulai* Ramalingam, *J. Mar. biol. Ass. India*. 2 (1) : 35-50.

Diagnosis : Cercaria emerged in greater numbers during day time than during nights thus exhibiting a diurnal periodicity ; cercariae move towards source of light (positive photo-tropic) ; live cercariae measure 0.91-1.10 in length, in contracted condition they measure 0.25-0.28, fixed specimens measure $0.58-0.88 \times 0.16-0.26$; oval in shape ; tail 1/3rd length of body, a pair of glands present at posterior extremity of tail which open into vesicle ; ventral sucker in posterior region of middle third of body, it measures $82\mu-119\mu$ in diameter ; collar with 12 spines on each half, dorsal inner most spines overlaps oral sucker, inner row of spines measure 7μ in length and outer row 9μ in length except 8th and 10th spines on either corner of collar which measure 11μ in length ; four pairs of penetrating glands present on either side of median line ; unicellular glands present throughout body ; four pairs of glands present along posterior wall of oral sucker and open at anterior end ; oral sucker $45\mu-62\mu$ in diameter ; prepharynx short, measures $22\mu-49\mu \times 27\mu-38\mu$; oesophagus 0.18-0.27 long, bifurcates in front of ventral sucker ; caeca terminate blindly to posterior end of body ; posterior chamber of excretory vesicle larger than anterior chamber, vesicle opens to outside posteriorly on dorsal surface of body at point of attachment of tail, from antero—lateral border of anterior chamber two

collecting trunks arise, trunks broad and full of excretory granules upto posterior level of ventral sucker, trunks proceed forward as narrow tubes from about middle of ventral sucker upto pharynx, two ducts converge a little posterior to pharynx, main canals narrow beyond pharynx level,

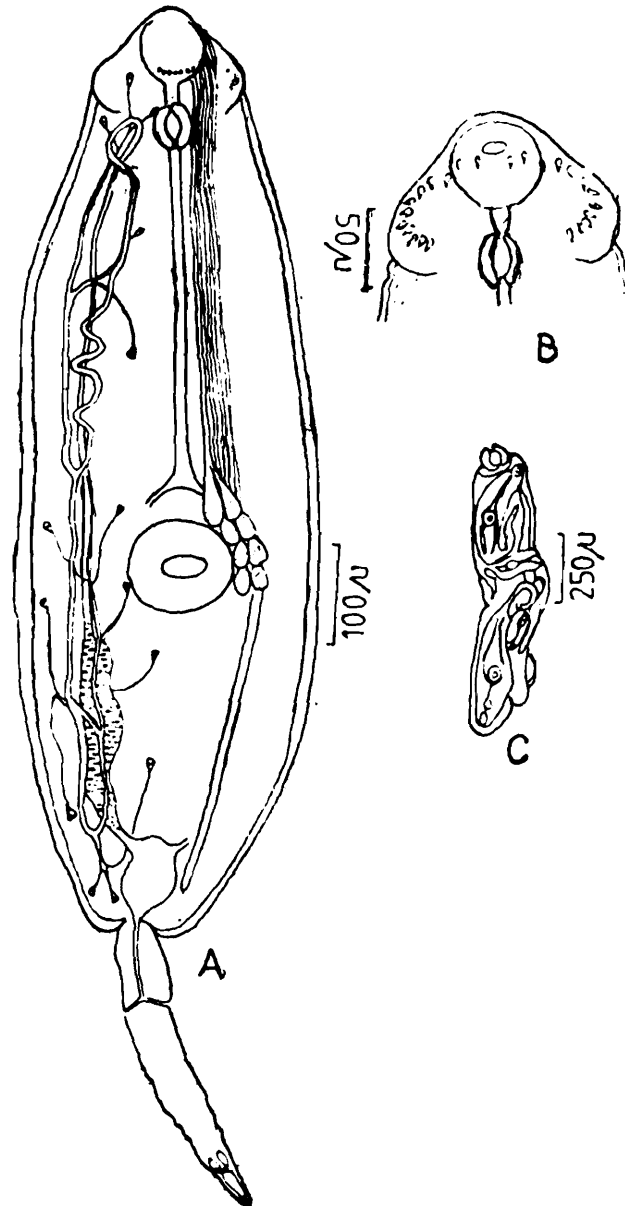


Fig. 11. A.—B. Ceraria of *Echinochasmus bagulai* Ramalingam, 1960.

C. Redia of *E. bagulai* Ramalingam, 1960. (After Ramalingam, 1960)

they pass backward on inner side of main ascending and bifurcate in front of ventral sucker into anterior and posterior secondary collecting tubules, anterior collecting tubule divides into two branches—tertiary tubules, posterior collecting tubule divides into three branches, flame cell formula represented by $2[(3 + 2) + (3 + 3 + 3)] = 28$, caudal excretory canal starts from posterior point of vesicle and runs to 1/4th of its length and it bifurcates into two lateral ducts at this level, lateral ducts reach sides of tail.

Rediae measure 0.90-1.25 in length and 0.26-0.29 in breadth ; collar conspicuous in younger specimens ; birth pore dorsal, on left side, posterior to collar, 0.15-0.18 from anterior end ; a pair of ventro—lateral appendages present, appendages quite pronounced in young specimens ; pharynx well developed, measures 44μ - 56μ in diameter ; gut saccular, extending as far as level of appendages in young specimens ; on either side of opening of mouth situated small mass of gland cells which open into vestibule ; cercariae in various stages of development occur in older rediae, redia contains developing cercariae from 4 to 8.

Snail Host : *Natica marochiensis*. (= *Natica gualteriana* Reduz)
Locality : Pamban.

12. Cercaria of *Echinoparyphium hymani* Singh (Figs. 12 A-C)

1975. Cercaria of *Echinoparyphium hymani* Singh, *Proc. Nat. Acad. Sci. India*. 45 (B) : 249-255.

Diagnosis : Body spines densely distributed in preacetabular region and sparsely in posterior region of body, body measures 0.34 - 0.35×0.05 - 0.08 ; collar distinct, measures 0.07 in width, with 43 spines of unequal size arranged in double dorsally uninterrupted rows and orals of dorsal row smaller than aborals ; oral sucker terminal, spherical, measures 0.02-0.03 in diameter ; prepharynx 0.01 long ; pharynx globular, measures 0.01 in diameter ; oesophagus with 11 rectangular nucleated cells ; caeca extend upto posterior end of body ; penetration glands seven pairs arranged in lateral oesophageal field, four pairs of glands form an anterior group and their ducts open at anterior margin of oral sucker remaining three pairs form a posterior group and their ducts open a little lateral to ducts of anterior group ; ventral sucker postequatorial, measures 0.03-0.04 in length and 0.05-0.05 in width ; genital primordium consisting of one group of cells, measuring 0.01-0.02 in diameter ; cystogenous cells numerous with granular contents distributed laterally in body ; aspinose tail longer than body, measures 0.57-0.58 in length ; excretory bladder bipartite, 0.02 broad, excretory pore situated at junction of body and tail, main excretory collecting ducts with numerous excretory granules distended between ventral sucker and pharyngeal levels and recurve to form triangular loops at prepharyngeal level then proceed posteriad to bifurcate at level of ventral sucker into anterior and posterior collecting tubules, 15 pairs of flame cells present with flame cell formulā of $2[(3+3)+(3+3+3)] = 30$, caudal excretory duct extending upto 1/4th length of tail before bifurcating into lateral branches,

Second generation of redia measures $1.68-1.73 \times 0.05-0.09$; conspicuous subspherical pharynx measures 0.06×0.04 ; gut measures $0.30-0.32 \times 0.03$; collar distinct, measures 0.03×0.07 ; birth pore 0.13 from anterior extremity ; a pair of procusculae situated 0.64 from posterior extremity.

Metacercarial cysts spherical, measures $0.18-0.19$ in diameter ; cyst wall double layered ; in laboratory cercariae encyst in *Lymnaea luteola*

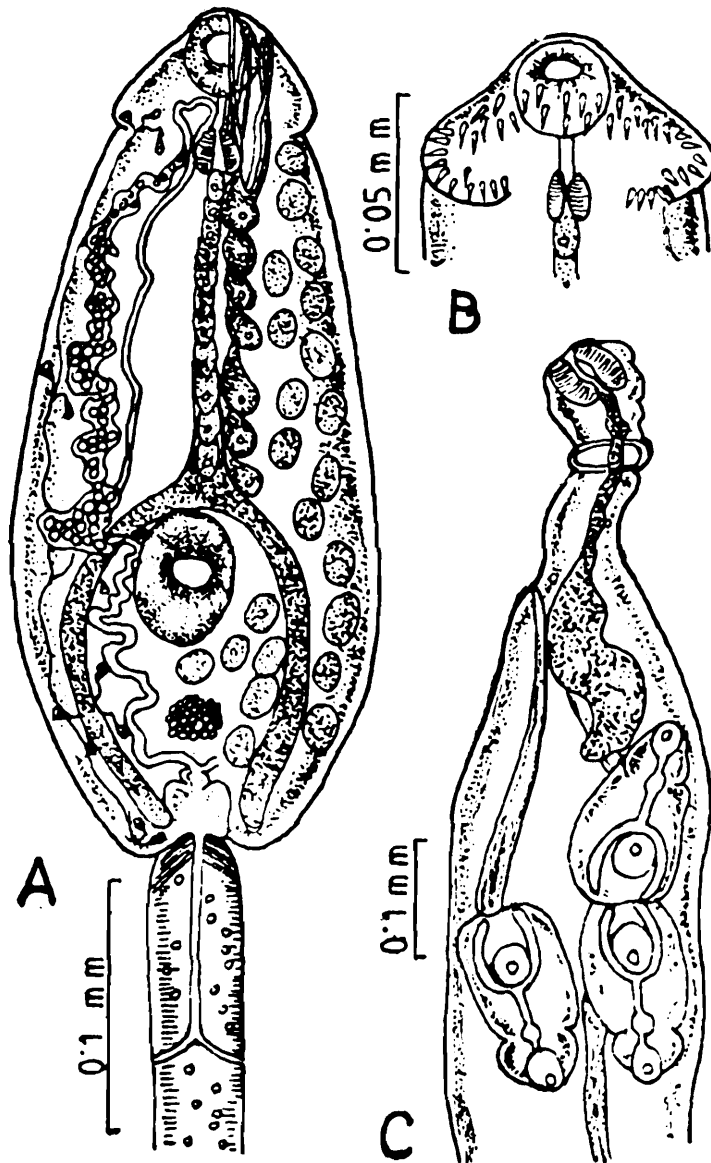


Fig. 12. A.—B. Cercaria of *Echinoparyphium hymani* Singh, 1975.

C. Redia of *E. hymani* Singh, 1975. (After Singh, 1975)

and *Indoplanorbis exustus* in foot, mantle, pericardial sac and renal regions ; cysts viable 28 to 30 days and become infective 48 hours after encystment.

Snail Host : *Lymnaea luteola f. australis*. Locality : Polsapara tank, Durg (M. P.).

13. Cercaria of *Echinoparyphium lanceolatum* Singh
(Figs. 13 A-F)

1975. Cercaria of *Echinoparyphium lanceolatum* Singh, *Proc. Nat. Acad. Sci. India*, 45 (B) IV : 261-268.

Diagnosis : Body spinose, measures $0.34-0.40 \times 0.16-0.19$; collar well developed with 45 collar spines, four corner, unequal dorsal spines arranged in double uninterrupted rows ; oral sucker subterminal,

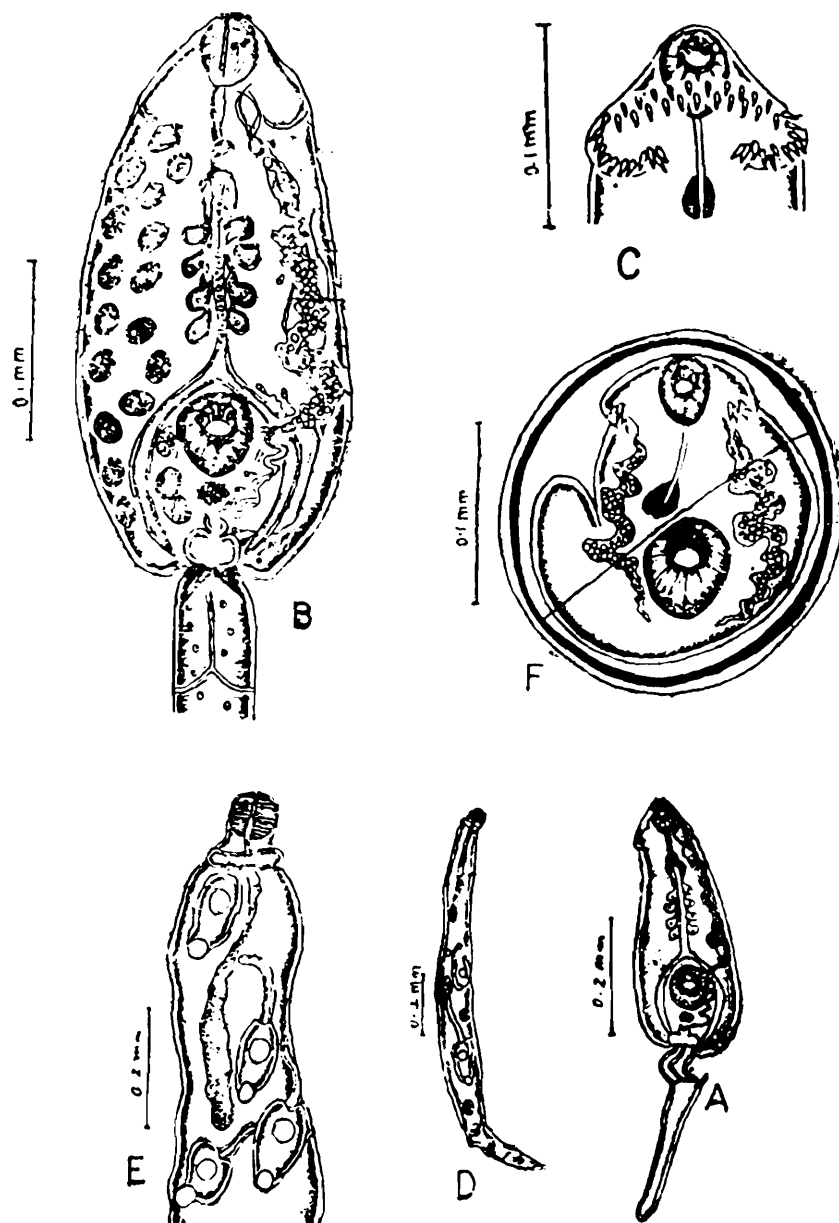


Fig. 13. A.—C. Cercaria of *Echinoparyphium lanceolatum* Singh, 1975.
D.—E. Redia of *E. lanceolatum* Singh, 1975.
F. Metacercaria of *E. lanceolatum* Singh, 1975.
(After Singh, 1975)

spherical, measures $0.03-0.04$ in diameter, prepharynx long, measures $0.03-0.04$ in length ; pharynx ovoid, measures $0.01-0.02 \times 0.01$; oesophagus with 14 nucleated rectangular cells, $0.08-0.09$ in length, bifur-

cated in front of ventral sucker ; caeca extend upto posterior end of body ; four pairs of penetration glands located along lateral side of oesophagus, with prominent nuclei, ducts open at anterior margin of oral sucker through minute pores ; ventral sucker postequatorial measures $0.04-0.05 \times 0.04-0.05$; genital primordium in form of a single mass of cells, measures $0.01-0.02 \times 0.02-0.03$, situated between ventral sucker and excretory bladder ; excretory bladder rectangular, bipartite, measures $0.04-0.05 \times 0.04-0.05$, excretory pore situated at junction of body and tail, main collecting excretory duct of each side extends from upper smaller chamber and runs anterior in a sinuous course, contains numerous excretory granulas in distended portion between ventral sucker and pharynx, duct of each side in pharyngeal region recurvate after forming triangular loops extend posterior upto level of ventral sucker where they bifurcate into anterior and posterior collecting tubules, 14 pairs of flame cells present and represented by a formula of $2[(3+3)+(3+3+2)] = 28$, caudal excretory duct runs posterior into two lateral branches which open to exterior through minute pores ; tail aspinose, measures $0.39-0.40 \times 0.02-0.05$, almost same length as body or slightly longer.

Rediae elongated, colourless, measures $0.70-0.80 \times 0.05-0.07$ in diameter ; gut $0.12-0.13$ long ; locomoter appendages in form of a pair of procoxae, situated at a distance of 0.17 from posterior extremity.

Cyst spherical measures $0.16-0.17$ in diameter, become infective after 48 hours of encystment, remain viable 30-32 days post encystment ; cyst wall of two layers, outer layer transparent, 0.01 thick, inner layer opaque 0.002 thick ; collar spines and excretory granules distinct ; cyst found in pericardial sac, mantle foot and kidney of snail host ; encyst on *Lymnaea luteola* and *Indoplanorbis exustus*.

Snail Host : *Lymnaea luteola f. australis*. Location : Hepatopancreas. Locality : Mohan Nagar Tank, Durg (M. P.).

14. Cercaria of *Echinoparyphium vitellocompactum* Singh

(Figs. 14. A-C)

1976. Cercaria of *Echinoparyphium vitellocompactum* Singh, *Proc. Nat. Acad. Sci. India*. 46 (B) IV : 519-526.

Diagnosis : Body $0.39-0.40$ long and $0.18-0.21$ wide in fixed condition, body spines distributed throughout but sparsely in postacetabular region ; collar well developed, with 45 spines, five collar spines in each ventral lappet, nine lateral spines on each side in a single row,

dorsal spines in double uninterrupted rows, 8 oral spines smaller than 9 aboral; subterminal oral sucker spherical, 0.04–0.05 in diameter; prepharynx 0.03–0.04 long; pharynx ovoid, 0.03–0.04 long and 0.02–0.03 wide; oesophagus with 12 nucleated somewhat rectangular cells, 0.13–0.15 long; caeca extend upto posterior end of body; penetration glands 5 pairs in lateral oesophageal fields on each side,

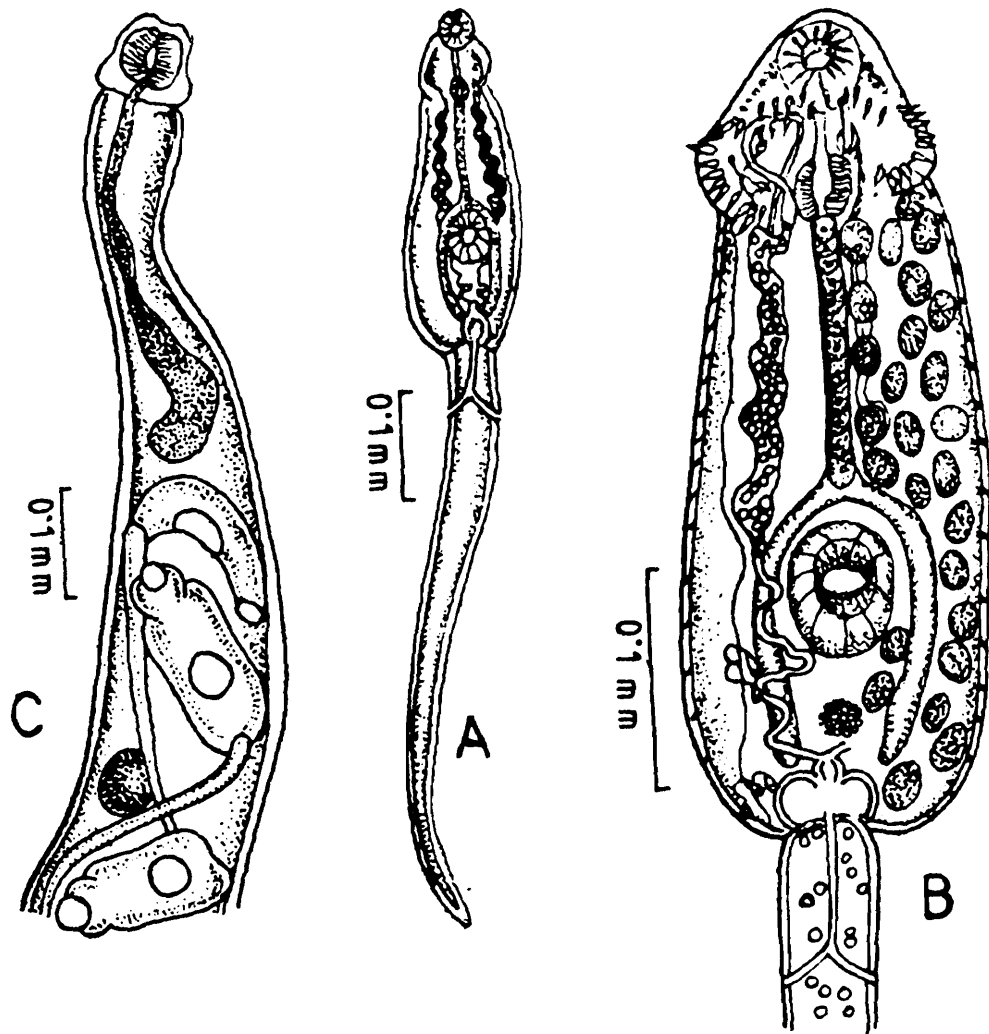


Fig. 14. A.—B. Cercaria of *Echinoparyphium vitellocompactum* Singh, 1976.
C. Redia of *E. vitellocompactum* Singh, 1976. (After Singh, 1976)

ducts of glands open at anterior margin of oral sucker; ventral sucker 0.060–0.062 in diameter; genital primordia in form of compact oval mass of cells, 0.040–0.044 long and 0.05 wide, situated between ventral sucker and excretory bladder; tail aspinose, slightly longer than body, 0.42–0.43 long and 0.061 wide at proximal end and 0.02 wide at distal end; excretory bladder bipartite, 0.04–0.05 long and 0.12 wide, opens through an excretory pore situated at junction of body and tail, main collecting ducts originate from upper chamber and taking up a sinuous course, each duct contains numerous excretory granules in distended part, each duct recurvates at prepharyngeal region forming a triangular

loop and then extends posteriorly upto ventral sucker where it bifurcates into anterior and posterior collecting tubules, 22 flame cells represented by formula of $2 [(3) + (3 + 2 + 3)] = 22$, caudal excretory duct runs $1/5$ th length of tail and bifurcates into two lateral branches opening through two minute pores situated on lateral margins of tail.

Mature redia contains fully developed cercariae ; it measures 0.74 long and 0.05-0.07 wide ; pharynx small, 0.06 long and 0.05 wide ; gut 0.26-0.28 long and 0.03 wide ; birthpore 0.08 from anterior end ; proscuscula 0.37 from posterior end.

Metacercaria spherical ; 0.16-0.17 in diameter ; cyst wall double layered, outer layer transparent and inner layer opaque ; collar spines, excretory granules, oesophagus and caeca conspicuous,

Snail Host : *Lymnaea luteola f. australis*. Locality : Polsapara Tank, Durg (M. P.).

15, *Cercariae indicae* XX Sewell

(Figs : 15. A)

1922. *Cercariae indicae* XX Sewell, *Indian J. Med. Res.* (Suppl.) X : 117-120.

Diagnosis : Cercaria swims actively, body shows considerable degree of extension and contraction, it measures $0.23-0.54 \times 0.21-0.07$; tail measures 0.53×0.85 ; in fixed specimen body measures 0.32×0.14 and tail measures 0.35×0.05 ; anterior end of body rounded ; angle collar spines set at an angle with others and point backwards and inwards, four distinct angle collar spines on each side larger than other collar spines, 29 needle like collar spines arranged in double row ; body behind collar armed with numerous fine spines directed posteriorly and arranged in transverse rows ; cystogenous cells contain number of elongated refractile rods arranged irregularly in cells protoplasm ; ventral sucker situated at about $1/3$ rd total length of body from posterior end, it measures 0.04×0.05 ; tail covered externally with thick cuticle a number of rounded nuclei scattered throughout parenchyma and numerous at proximal end near point of attachment ; mouth situated subterminally leads back into an anterior sucker ; oral sucker measures 0.03×0.04 ; prepharynx short ; pharynx pyriform, measures 0.03×0.02 ; oesophagus long extends backwardly upto ventral sucker, in greater part of its length it consists of a column of cells, in front of ventral sucker oesophagus bifurcates into a pair of intestinal caeca which also composed of row of single cells ; caeca pass laterally round ventral sucker and then bend slightly outwards and continued back nearly posterior end of body ; salivary glands situated on either side of

oesophagus and extending from level of pharynx to anterior region of ventral sucker, duct of salivary gland opens to anterior part of mouth, protoplasm of salivary gland contains coarse granules; excretory bladder situated at posterior end of body, transversely oval or pyriform, opens to dorsal surface at point of attachment of tail by an oval

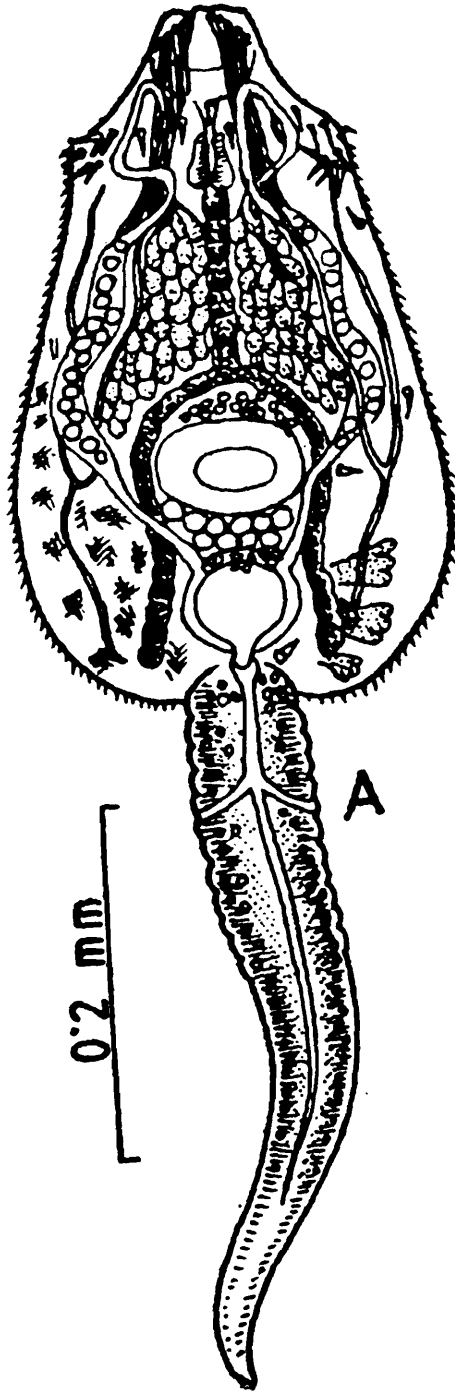


Fig. 15. A. *Cercariae indicae* XX Sewell, 1922.
(After Sewell, 1922)

excretory pore, bladder well composed of a layer of small rounded cells; from ventro lateral regions of bladder main excretory tubes arises, excretory ducts follow a slightly wavy course outwards and forwards upto anterior margin of ventral sucker, dilated part of excretory ducts

contain numerous rounded refractile excretory granules, retrograde vessels run upto level of ventral sucker where it bifurcate into two, one branch turns forward and runs upto sides of oral sucker, other branch runs backward, 9 pairs of flame cells detected, caudal excretory tube runs back in tail, about 1/8th of tail length from proximal end a pair of small lateral tubes pass outwards and open on surface; genital system represented by a mass of rounded cells lying between excretory bladder and ventral sucker, second mass of rounded cells representing genital aperture lies between ventral sucker and intestinal bifurcation, on posterior end and postero-lateral regions of body lies a series of digitate cells representing rudiment of vitelline glands.

Rediae possess an orange colour; external surface dotted over with small rounded globules occuring in groups or lines; body measures $1.40-2.19 \times 0.16-0.21$; collar indistinct exist about 1/10th of total length behind anterior end, it may be represented merely by a circular groove, it contracts and expands at irregular intervals; locomotor processes well developed, situated about 1/3rd of total length from posterior end, terminal portion bluntly rounded or taper gradually to a pointed tip; mouth terminal, surrounded by fleshy lip, cavity opens into a small pharynx; pharynx diameter 0.07; stomach sausage shaped, filled with dark yellowish brown granular material which extends back as far or farther than posterior locomotor processes; birth pore situated laterally behind collar region; 6 flame cells situated in lateral region about 4/6th of distance from anterior end to locomotor processes.

Snail Host: *Indoplanorbis exustus*. Locality: Zoological garden, Alipore, Calcutta.

16. *Cercaria itoi* Pandey and Agrawal

(Figs. 16. A—C)

1977. *Cercaria itoi* Pandey and Agrawal, *Indian J. Zoot.*, XVIII (I): 1-50.

Diagnosis: Cercariae phototropic, shed in large numbers in morning hours, they move like caterpillar at bottom of container; body aspinose, anterior end narrow, posterior end broad and rounded, body measures $0.44-0.51$ (0.48) \times $0.23-0.28$ (0.25) in living and $0.21-0.25$ (0.23) \times $0.15-0.17$ (0.16) in fixed conditions; oral sucker circular, terminal, measures, $0.05-0.07$ (0.06) \times $0.02-0.03$ (0.02) in living and $0.03-0.04$ (0.03) \times $0.008-0.015$ (0.01) in fixed conditions; ventral sucker larger than oral sucker, located behind equatorial line of body, measures $0.10-0.12$ (0.10) in living and $0.04-0.06$ (0.05) in fixed conditions; well developed collar, armed with 32 spines, arranged in

double row, all collar spines equal in length except 8 end group spines ; prepharynx well developed, muscular pharynx rounded, pharynx measures $0.01 - 0.03$ (0.02) \times $0.09 - 0.12$ (0.11) in living and $0.007 - 0.014$ (0.01) \times $0.04 - 0.06$ (0.05) in fixed conditions ; oesophagus long, divided into 8 - 10 chambers ; intestinal caeca extend upto posterior border of ventral sucker, gorged with fine granules ; a dozen of small elongate oval penetration glands located on either side of oesophagus behind pharynx, each gland with a nucleus and fine granules, glands open to

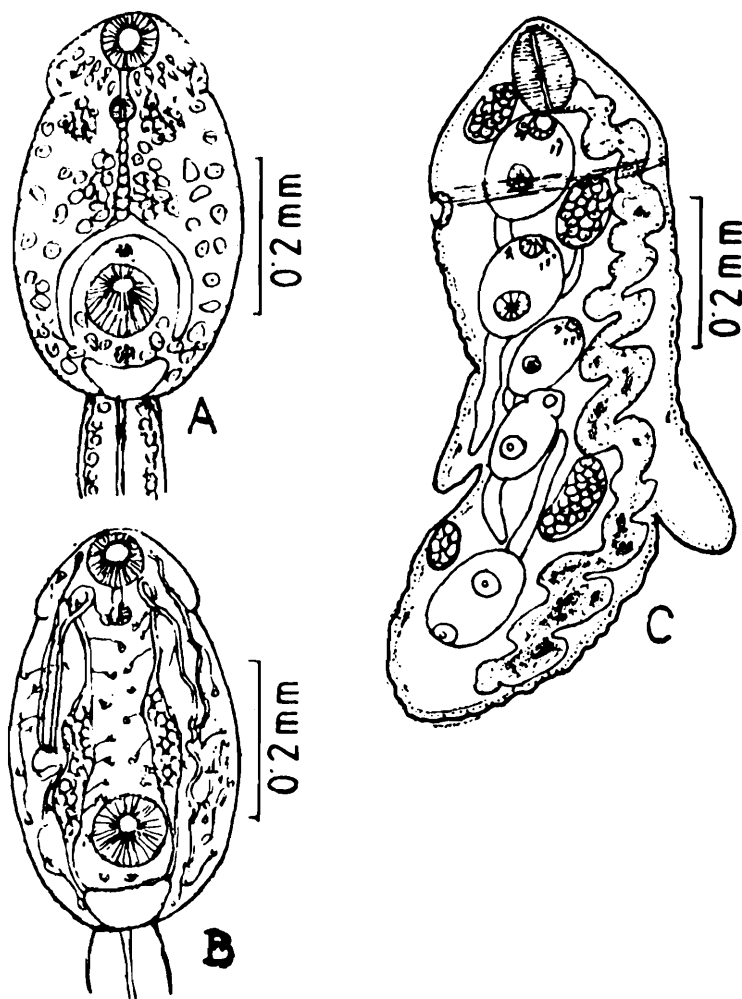


Fig. 16. A.-B. *Cercaria itoi* Pandey and Agrawal, 1977.
C. Redia of *C. itoi* Pandey and Agrawal, 1977.
(After Pandey and Agrawal, 1977).

exterior close to anterior region of mouth ; cystogenous gland cells irregular with rod shaped bodies, arranged in parallel rows, distributed throughout body and present in large numbers behind ventral sucker ; tail aspinose, longer than body, muscles well developed, measures $0.69 - 0.75$ (0.72) \times $0.09 - 0.10$ (0.09) in living and $0.34 - 0.39$ (0.37) \times $0.04 - 0.05$ (0.04) in fixed condition ; excretory bladder single chambered, transversely elongated, two collecting canals—one on each side of body arise from anterolateral sides of excretory bladder, each canal runs

ahead and dilates to accommodate excretory granules, it divides into two branches—anterior and posterior, anterior canal connected with 3 capillaries with 3 flame cells, posterior canal runs upto hind end of body and divides into three branches each with 3 capillaries from flame cells, with flame cell formula of $2[(3+3+3) + (3+3+3)] = 36$, caudal excretory canal extends upto end of tail, a pair of lateral branches arise from caudal excretory canal at about 1/3rd of its length and open laterally by small pores; rudimentary reproductive organs represented by two rounded mass of cells—one present anterior and other posterior to ventral sucker.

Rediae elongated with rounded ends, body measures 0.89-1.58 (1.24) \times 0.25-0.42 (0.34) in living and 0.42-0.81 (0.63) \times 0.12-0.23 (0.18) in fixed conditions; mouth terminal; pharynx muscular, measures 0.07-0.08 (0.08) in living and 0.03-0.04 (0.04) in fixed conditions; gut extends upto hind region of body, gorged with blackish food material; muscular collar well developed; proscutula on each side at hind region of body; with one to seven well developed cercariae and germ balls.

Snail Host: *Lymnaea auricularia*. Location Hepatopancreas and gonads. Locality: Kathauta Tal, Lucknow (U. P.).

17. *Cercaria komiyai* Pandey and Agrawal (Figs. 17. A—C)

1977. *Cercaria komiyai* Pandey and Agrawal, *Indian J. Zoot.*, XVIII (1): 1-50.

Diagnosis: Cercariae emerge throughout day, make active movements with body downwards and tail upwards, can crawl with their suckers at bottom; body aspinose, measures 0.69-0.75 (0.71) \times 0.41-0.52 (0.47) in living and 0.32-0.36 (0.34) \times 0.21-0.27 (0.23) in fixed conditions; well differentiated collar; oral sucker terminal, rounded, measures 0.07-0.08 (0.08) \times 0.04-0.07 (0.06) in living and 0.03-0.04 (0.04) \times 0.02-0.03 (0.03) in fixed conditions; prepharynx short, narrow pharynx rounded, muscular, measures 0.04-0.07 (0.05) \times 0.09-0.12 (0.11) in living and 0.02-0.03 (0.02) \times 0.04-0.06 (0.05) in fixed conditions; oesophagus long, extending upto middle of body; intestinal caeca extend nearly upto anterior cornua of excretory bladder, fine granular food material fills whole gut; ventral sucker well developed, rounded, situated behind middle of body, measures 0.09-0.11 (0.10) in living and 0.04-0.06 (0.05) in fixed conditions; collar with 32 equal collar spines, arranged in uninterrupted single row; penetration glands about a dozen, situated in lateral sides of oesophagus, open through long ducts

at anterior border of oral sucker, each gland with posterior placed nucleus and fine granules ; cystogenous gland cells irregular, fill whole body ; genital rudiments represented by two unequal round mass of cells—a smaller mass situated anterior to ventral sucker and large one just posterior to excretory bladder, a thin cord of small cells connects two cell masses ; tip of aspinose tail swollen into a bulbous rattle to form a peculiar caudal appendages capable of being retracted inside tail, cuticle wrinkled, nuclei arranged in linear fashion except in caudal appendages, well developed muscles, closely packed cells present, paren-

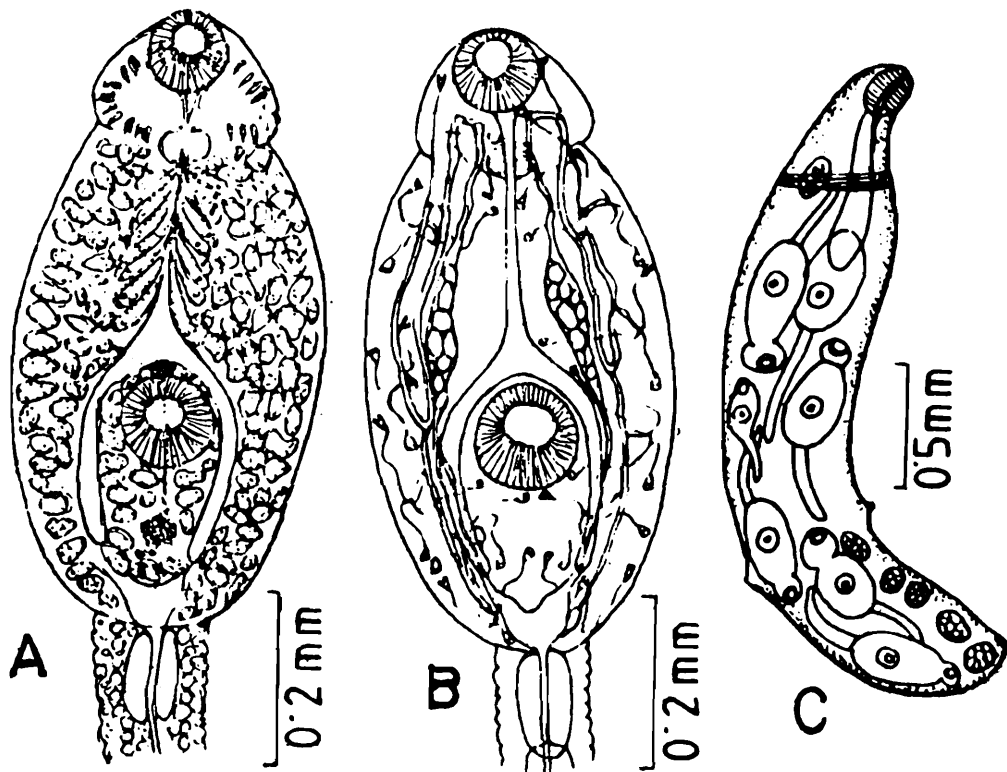


Fig. 17. A.—B. *Cercaria komiyai* Pandey and Agrawal, 1977.
C. Redia of *C. komiyai* Pandey and Agrawal, 1977.
(After Pandey and Agrawal, 1977)

chymatous cells large with thin cellular boundary ; excretory bladder 'V' shaped, with rounded excretory corpuscles, from each lateral cornua of excretory bladder originates a main excretory canal which runs antero-laterally and expands to accomodate excretory corpuscles of more or less equal size, it runs forward as narrow canal upto pharynx and turns down and extending upto ventral sucker and bifurcates into an anterior and posterior collecting canals, anterior canal runs upto pharynx and divides into three branches each branch with three capillaries bearing flame cells, posterior collecting canal also bears three ducts each duct having three fine capillaries bearing flame cells with flame cell formula of $2[(3 + 3 + 3) + (3 + 3 + 3)] = 36$, caudal excretory canal originates from

excretory bladder and runs along tail and enters caudal appendage and swells to form vesicle and ends blindly.

Rediae elongated, sac like ; body measures $1.99-2.89 \times 0.47-0.59$ (2.44×0.53) in living and $0.99-1.45 \times 0.23-0.28$ (1.22×0.26) in fixed conditions ; pharynx terminal, muscular, rounded, measures $0.15-0.23 \times 0.11-0.14$ (0.19×0.12) in living and $0.07-0.09 \times 0.06-0.07$ (0.08×0.06) in fixed conditions ; blind gut gorged with minute black food particles ; germ balls mostly on posterior region ; rediae contain cercariae in different stages of development.

Snail Host : *Vivipera bengalensis* (= *Bellamya bengalensis*) Location : Digestive glands. Locality : Kathauta Tank. Lucknow (U. P.).

18. *Cercaria megaglandulata* Agrawal (Figs. 18 A-E)

1974. *Cercaria megaglandulata* Agrawal, *Indian J. Zoot.*, XV (3) : 131-134.

Diagnosis : *Cercaria* emerges from host throughout day but in large numbers during morning hours, phototropic, swimming actively interrupted for a while during which cercaria remains hanging in water till it settles down in bottom, cercaria moves in bottom of container with help of suckers, it lives for a short period ; body aspinose, anterior end narrow, posterior end broad, measures $0.54-0.59 \times 0.28-0.31$ in live and $0.38-0.45 \times 0.12-0.19$ in fixed, tail aspinose, without finfold, roughly equal to body, measures $0.50-0.52 \times 0.07-0.09$ in live and $0.41-0.45 \times 0.05-0.06$ in fixed, circular and longitudinal muscles of tail well developed, a large number of rounded nuclei arranged in irregular rows in tail parenchyma ; terminal oral sucker circular, measures $0.07-0.08$ in live and $0.05-0.06$ in fixed ; ventral sucker larger than oral sucker, located behind equatorial line, measures 0.09×0.11 in live and $0.06-0.07$ in fixed ; collar well developed, collar spines 24 in number, arranged in a single row, spines equal in size, without group spines ; sensory papillae present in whole body, papillae more concentrated on ventral and lateral sides of body, papillae of two kinds—one pair of large and disc like located on each side of oral sucker in collar region and measure $2-3\mu$. second type of papillae smaller in size, irregularly arranged and distributed throughout body ; prepharynx well developed, $0.05-0.07$ in live and $0.03-0.04$ in fixed ; muscular pharynx, measures $0.02-0.03$ in live and $0.01-0.02$ in fixed ; oesophagus long, measures $0.15-0.17$ in live and $0.09-0.10$ in fixed, bifurcates just anterior to ventral sucker into intestinal caeca, caeca extend upto hind end of body, gut gorged with fine granular food matter ; two penetration glands one on either side of

prepharynx located just behind oral sucker, each gland large, pear shaped with fine granules, nucleus located behind middle of gland with opening close to mouth by short ducts ; cystogenous gland cells irregular in shape with granuler bodies, located mostly in lateral region from

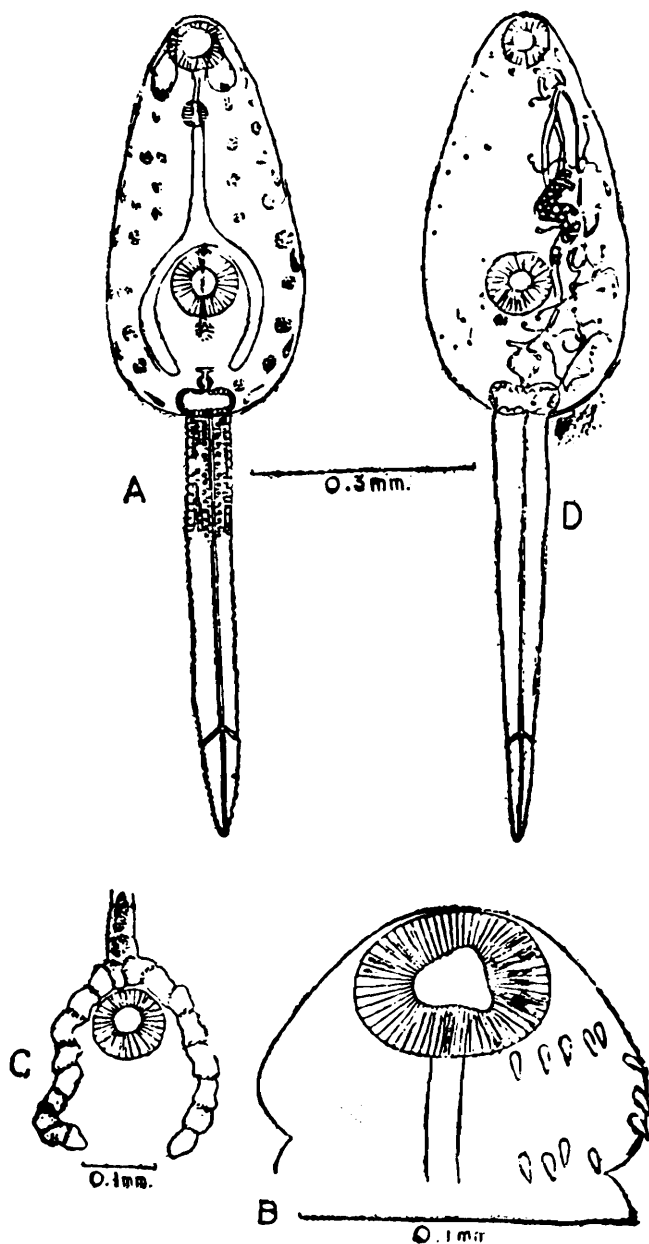
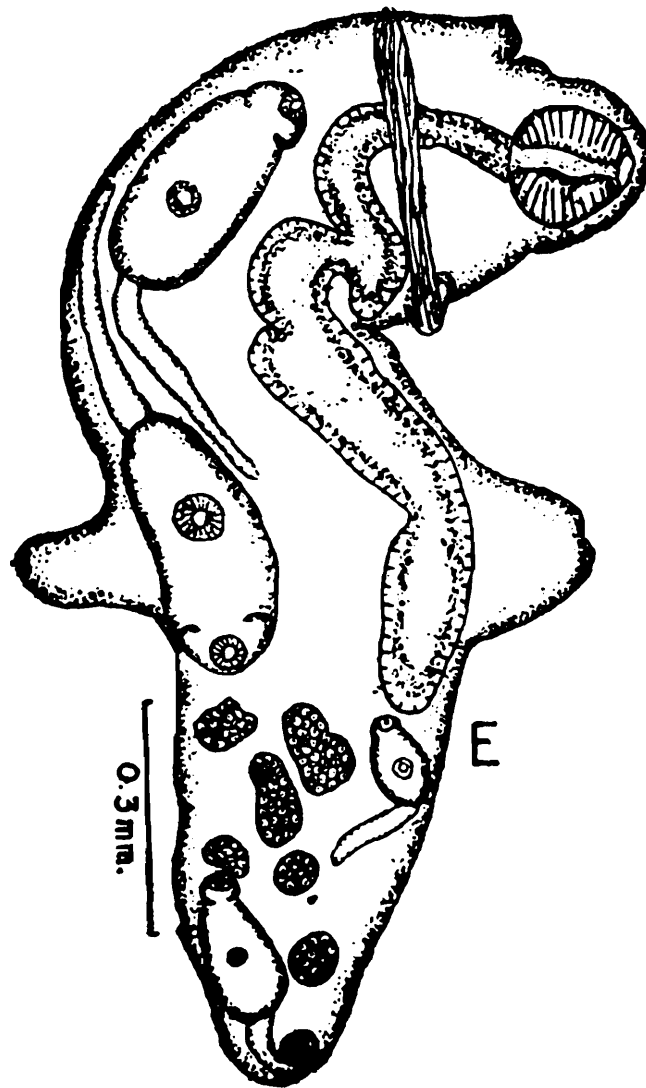


Fig. 18. A.—D. *Cercaria megaglandulata* Agrawal, 1974.

pharynx to hind end of body ; number of elongated glands representing mucoid glands with small ducts and granules inside distributed on lateral margins of body ; reproductive primordium in form of two oval masses of cells located anterior and posterior to ventral sucker, two masses of cells joined by a thin streak of cells ; excretory bladder two chambered—a transversally oval posterior chamber and small round anterior chamber, main collecting canal arises one on each side from anterior chamber and runs upto oral sucker where it forms a loop and runs posteriorly upto region of ventral sucker and divides into an

anterior and posterior collecting canals at intestinal bifurcation, main collecting canal widens and accomodates about 30-45 round conglomerations which may be closely packed in excretory canal, anterior collecting canal gives rise to three branches in preacetabular region of



18. E. Redia of *C. megaglandulata* Agrawal, 1974.
(After Agrawal, 1974)

body, each branch redivides into three fine branches each ending in a flame cell ; posterior collecting canal gives rise to three branches each dividing into three fine canals ending in flame cell, flame cell formula represented by $2[(3 + 3 + 3) + (3 + 3 + 3)] = 36$, caudal excretory canal runs upto tip of tail and opens by small pore, two lateral branches – one on each side open slightly anterior to tip of tail. Redia brown in colour, elongate, measures $1.62-1.84 \times 0.42-0.48$ in live and $1.20-1.56 \times 0.21-0.29$ in fixed ; muscular pharynx measures $0.16-0.18$ in live and $0.11-0.12$ in fixed ; gut filled with blackish food material, variable in extension, gut in young redia short ; birthpore

in region of collar ; proscuscula well developed ; each redia with 2-3 mature cercariae and a number of developing cercariae and germ balls.

Snail Host : *Indoplanorbis exustus*. Location : Hepatopancreas and gonads. Locality : Kathauta Tal, Lucknow (U. P.).

19. ***Cercaria narindapurensis* Pandey and Singh**
(Figs. 19 A-D)

1984. *Cercaria narindapurensis* Pandey and Singh, *Indian J. Helm* (N. S.)
1 (1 & 2) : 54-59.

Diagnosis : While swimming body becomes elongated and anterior end turns upward ; tail moves in a whip like lashing manner and body also vibrates ; larva also crawls at bottom of container with help of its sucker ; body elongated oval with blunt anterior and broad round posterior end, covered with thick cuticle and measures $0.48-0.51 \times 0.28-0.30$ in live and $0.19-0.24 \times 0.09-0.12$ in fixed specimens, vertical striations present on whole body surface ; tail about one and half times longer than body, measures $0.76-0.80 \times 0.09-0.11$ in live and $0.44-0.54 \times 0.03-0.04$ on fixed specimens, provided with longitudinal and circular muscles, tail fin entirely absent, rounded caudal bodies irregularly arranged in tail parenchyma ; oral sucker spherical and measures $0.07-0.08$ in diameter in live and $0.03-0.04$ in fixed specimens ; ventral sucker larger than oral sucker and situated posterior two third of body, measures $0.08-0.09$ in diameter in live and $0.04-0.05$ in fixed specimens ; a distinct collar present at anterior end of body ; it bears a single row of 58 uninterrupted spines including three large spines ; numerous irregular refractile bodies scattered through out body surface of cercaria ; mouth situated in middle of oral sucker and leads into a prepharynx, measuring $0.04-0.06$ in length in live and $0.01-0.02$ in fixed specimens ; pharynx globular in shape and measures $0.03-0.04$ in diameter in live and $0.01-0.02$ in fixed specimens ; pharynx leads into a short oesophagus, measuring $0.07-0.08$ in length in live and $0.03-0.04$ in fixed specimens and bifurcates in front of ventral sucker ; intestinal caeca simple, extends upto posterior margin of ventral sucker, three pairs of penetration glands located in collar region at postero lateral sides of oral sucker, each gland oval in shape with prominent central nucleus, these glands open out separately by fine ducts ; oval to rounded cystogenous cells fill entire space of body ; rudiments of genital organs represented by two groups of cell masses and a streak of cells joining them, large cell mass located at posterior border of ventral sucker and smaller one on anterior margin of ventral sucker ; excretory bladder four

chambered, situated at posterior end of body, posterior chamber oval and anterior chamber transversely elongated, main excretory canals arise from each side of excretory bladder and run anteriorly in convoluted manner, on reaching ventral sucker they dilate to accommodate a large number of rounded excretory corpuseles, in collar region they become narrow and make loops and run posteriorly as descending

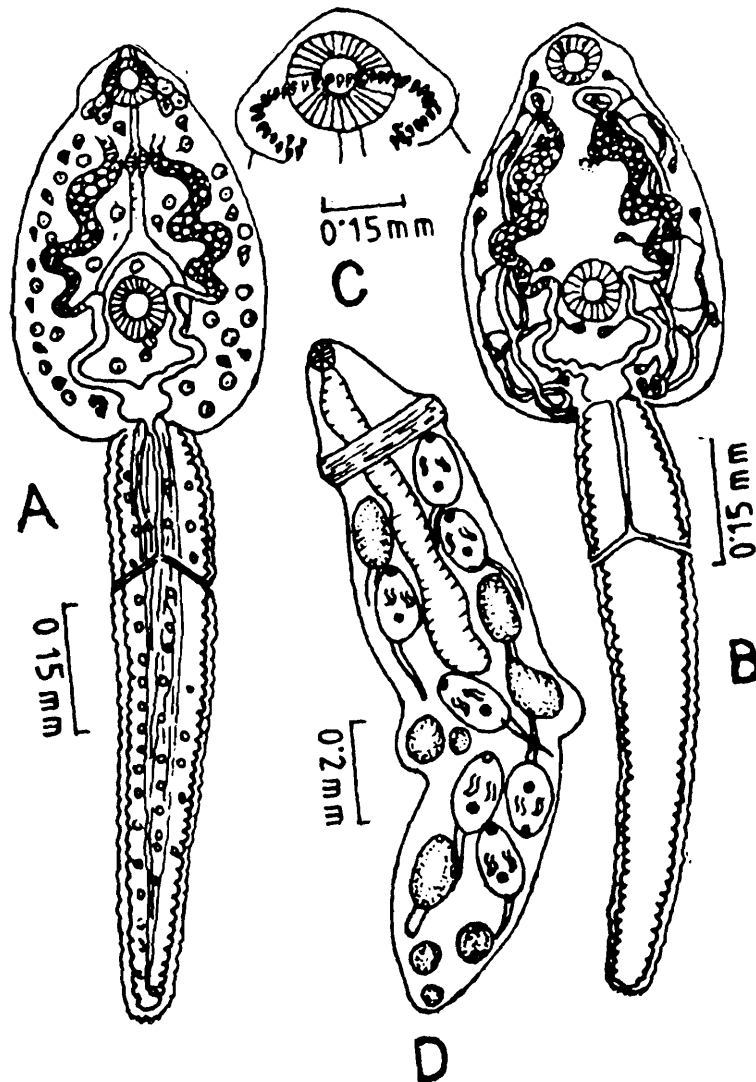


Fig. 19. A—C. *Cercaria narindapurensis* Pandey and Singh, 1984.
D. Redia of *C. narindapurensis* Pandey and Singh, 1984,
(After Pandey and Singh, 1984).

canals along outer margins of main excretory canals, at level of ventral sucker they divide into two branches—an anterior and a posterior collecting canals, anterior collecting canal gives rise to two branches, each divides into two capillaries ending into flame cells, similarly posterior collecting canal also gives rise to three branches, each dividing into two capillaries ending into flame cells with flame cell formula of $2[(2+2)+(2+2+2)] = 20$, a caudal excretory canal arises from posterior chamber of excretory bladder and runs upto anterior one third of tail

where it divides into two short lateral branches each opening outside through separate pores.

Rediae collected from hepatopancreas of infected snails, brownish in colour, elongated and measure $1.40-2.13 \times 0.28-0.32$ in live and $0.80-1.91 \times 0.12-0.16$ in fixed specimen ; a distinct muscular collar present ; mature rediae contain golden yellow granules which absent in young rediae ; birth pore present ; mouth terminal and leads into a pharynx which measures $0.04-0.05$ in diameter in live and $0.03-0.04$ in fixed specimens ; pharynx followed by a blind gut which extends upto pro-cuscula, filled with food material ; pro-cuscula well developed and located posterior two third of body ; each redia contains about 8-10 mature cercariae, a number of developing cercariae and two germ balls.

Snail Host : *Indoplanorbis exustus*. Location : Hepatopancreas. Locality : Gulal-ka-tara, Narindpur, Sultanpur (U. P.).

20. *Cercaria nawabganjensis* Pandey and Singh (Figs. 20 A-D)

1984. *Cercaria nawabganjensis* Pandey and Singh, *J. Zool. Soc. India*. 36 (1 & 2) : 73-82.

Diagnosis : Cercariae shed by infected snails in large number in early morning, swimming actively with interruptions of short rest, at bottom of container they move like caterpillar with aid of their suckers ; body elongate-oval with narrow anterior and broad posterior ends ; carcaria measures $0.48-0.65 \times 0.32-0.38$ in live and $0.24-0.30 \times 0.08-0.11$ in fixed conditions ; body cuticle beset with minute backwardly directed spines ; cylindrical tail longer than body and devoid of spines, tail measures $0.56-0.71 \times 0.08-0.11$ in live and $0.36-0.43 \times 0.03-0.08$ in fixed conditions, tail provided with circular, longitudinal and oblique muscles and round small bodies in parenchyma ; terminal oral sucker circular, measures $0.07-0.09$ in live and $0.03-0.05$ in fixed specimens ; ventral sucker larger than oral sucker, located in posterior two thirds of body length, measures $0.10-0.14$ in live and $0.05-0.06$ in fixed conditions ; collar distinct, bears 32 collar spines including 8 end groups, arranged in double rows, end group of spines 4 in number on each side and larger than other spines ; prepharynx short, measures $0.04-0.05$ in live and $0.01-0.02$ in fixed specimens muscular pharynx globular, measures $0.03-0.05$ in live and $0.01-0.02$ in fixed conditions ; oesophagus long, measures $0.14-0.16$ in live and $0.09-0.12$ in fixed specimens, oesophagus divides into two caeca in front of ventral sucker ; wide caeca extend upto excretory bladder ; gut divided into many septa ;

five pairs of penetration glands located on either side of pharynx, penetration glands oval in shape with centrally placed nuclei, open outside by short ducts; cystogenous cells two types—one round to oval and filled with fine granular cytoplasm and other rectangular and irregular

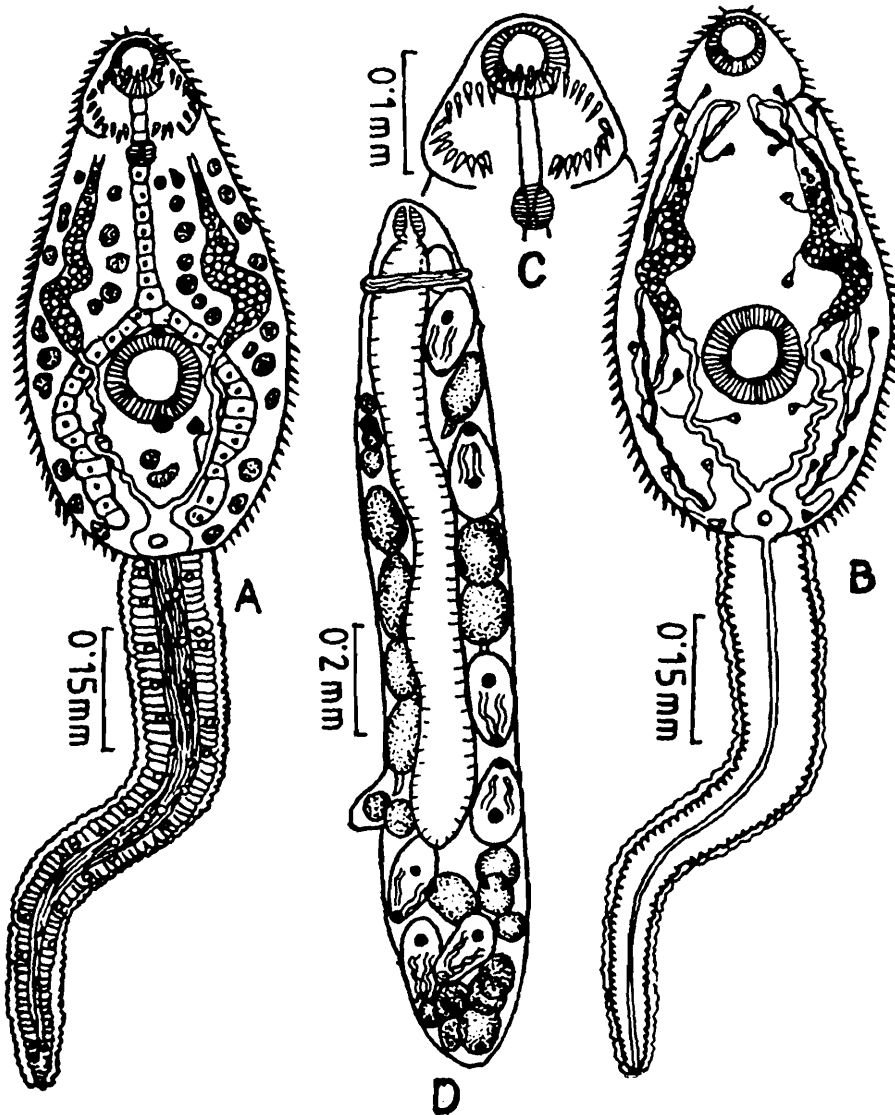


Fig. 20. A—C. *Cercaria nawabganjensis* Pandey and Singh, 1984.
D. Redia of *C. nawabganjensis* Pandey and Singh, 1984.
(After Pandey and Singh, 1984).

in shape and filled with rod shaped bodies arranged in parallel rows; genital primordia arranged in two cell masses—anterior smaller mass situated to anterior part and posterior mass larger than anterior situated posterior part of ventral sucker; excretory bladder rounded in shape and opens outside by an excretory pore, two main excretory canals originate from either side of excretory bladder and run anteriorly in convoluted manner, on reaching ventral sucker they dilated and contained large number of excretory granules, in collar region they make loop and run posteriorly as descending canals, in region of ventral

sucker they divide to form anterior and posterior collecting canals, each canal gives rise to two branches which in turn divides into three capillaries which finally end into flame cells, flame cells represented by a formula $2[(3+3)+(3+3)]=24$, caudal canal opens at tip of tail.

Redia white, thin walled, elongated ; measures $1.05-2.00 \times 0.02-0.32$ in live and $0.73-1.82 \times 0.12-0.17$ in fixed conditions ; light brown coloured granules distributed throughout body in mature redia ; collar present ; mouth terminal ; pharynx circular and muscular and measures $0.03-0.05$ in live and $0.01-0.03$ in fixed specimens ; gut long and extends posteriorly upto foot and filled with dark brown food material ; foot present at posterior two thirds of body ; each mature redia contains 5-9 cercariae, developing cercariae and germ balls.

Snail Host : *Indoplanorbis exustus*. Location : Hepatopancreas. Locality : Pakshi-Vihar, Nawabganj, Unnao (U. P.).

21. *Cercaria oviglandulata* Pandey (Figs. 21. A—B)

1973. *Cercaria oviglandulata* Pandey, *Indian J. Zoot.*, XIV (3): 149-154.

Diagnosis : *Cercaria* comes out from snail host during day time ; it swims in water by lashing powerful tail and by contracting body ; at bottom of container it makes caterpillar like movements, swimming activity alternates with a short period of rest ; body spinose, it measures $0.35-0.42 \times 0.20-0.25$ in live and $0.30-0.37 \times 0.07-0.10$ in fixed conditions ; body spines arranged in regular transverse rows ; aspinose tail longer than body, measures $0.40-0.75 \times 0.06-0.07$ in live and $0.30-0.45 \times 0.04-0.05$ in fixed specimens ; terminal oral sucker circular, measures $0.05-0.06$ in live and $0.03-0.04$ in fixed conditions ; ventral sucker larger than oral sucker, situated behind equatorial line of body, measures $0.06-0.07$ in live and $0.04-0.05$ in fixed specimens ; cephalic collar well developed, armed with 28 collar spines, arranged in double rows, collar spines equal and measure 0.02 in length, end group spines absent ; a bilobed refractile dorsal body present near posterior margin of oral sucker ; prepharynx measures $0.02-0.03$ in live and $0.01-0.02$ in fixed specimens ; pharynx round, measures $0.01-0.02$; oesophagus measures $0.04-0.06$ in live and $0.03-0.04$ in fixed specimens ; penetrating glands four pairs, elongate-oval, each with nucleus and fine granules, located on either side of oesophagus, open near anterior region of mouth ; cystogenous gland cells with rod shaped bodies arranged in parallel rows ; two rounded masses of cells—one present anterior and other posterior border of ventral sucker represent gonads ; two chambered

excretory bladder located at hind end of body, anterior chamber gives rise two collecting canals on either side of body, each canal fills with globular refractile granules of different sizes numbering 5—9 ; main canals turn back at level of oral sucker and divides into anterior and posterior canals near middle region of body, anterior collecting canal runs upto pharynx and connected with three flame cells, it receives two

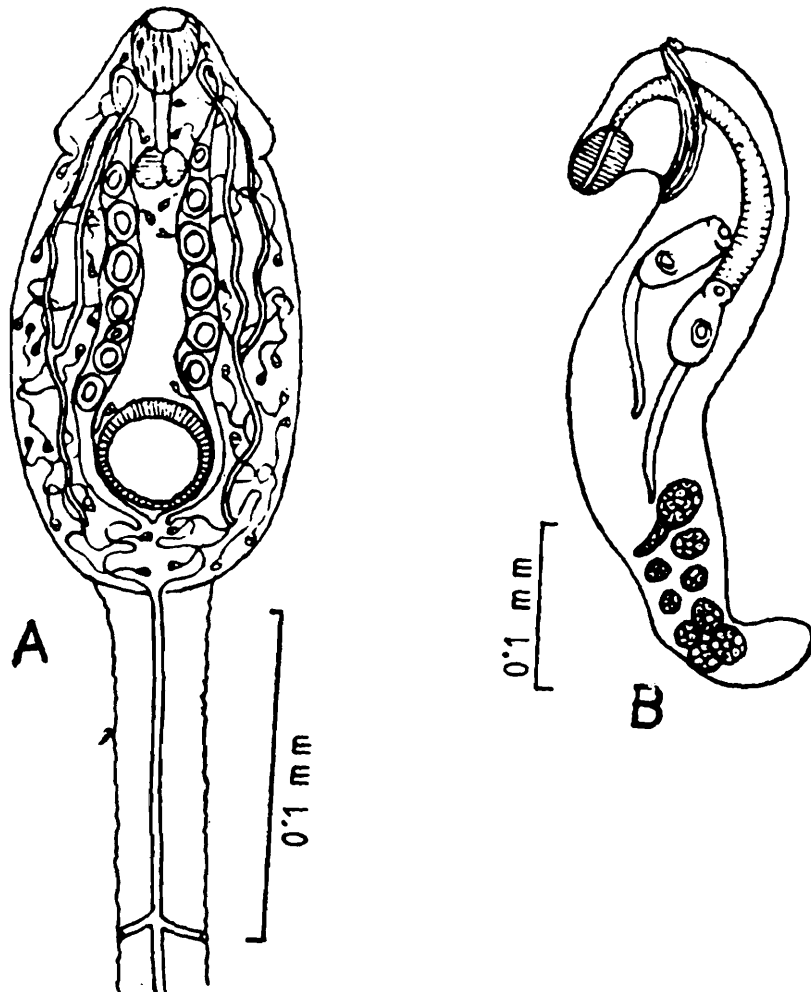


Fig. 21. A. *Cercaria oviglandulata* Pandey, 1973.
 B. Redia of *C. oviglandulata* Pandey, 1973.
 (After Pandey, 1973).

branches each with three flame cells, posterior collecting canal terminates in three flame cells at hind end of body, it receives two branches each with three flame cells with flame cell formula of $2 [(3+3+3) + (3+3+3)] = 36$, caudal excretory canal starts from posterior side of excretory bladder and runs upto base of tail, lateral tubules arise from caudal excretory canal at about 1/3rd of length and run outward and backward to open outside by small pores.

Rediae infect hepatopancreas and gonads, measure $0.81-1.23 \times 0.15-0.24$ in live and $0.64-0.86 \times 0.12-0.13$ in fixed specimens ; pharynx measures $0.05-0.12$ in live and $0.04-0.08$ in fixed specimens ; blind gut

filled with blackish food material and extends roughly upto middle of body ; birth pore and procoelocula present ; redia with one to three well developed cercariae and a number of developing cercariae and germ balls at hind region of body.

Snail Host : *Limnaea stagnalis* (L). (= *Lymnaea stagnalis*) Locality Chinhat Lake, Lucknow (U. P.).

22. *Cercaria* sp. VII Kerala Mohandas

(Figs. 22. A—D)

1981. *Cercaria* sp. VII Kerala Mohandas, *Proc. Indian Acad. Sci. (Anim. Sci.)*, 90 (4) : 433-444.

Diagnosis : *Cercaria* swims actively, it emerges in morning hours and survive for 6-10 hours ; body ovoid, measures 350μ - $525\mu \times 175$ - 250μ , brown in colour ; oral sucker 40 - 60μ wide ; ventral sucker postequatorial, 70 - 90μ in diameter, slightly larger than oral sucker ; collar prominent, 110 - 140μ wide with 45 same size collar spines out of which 5 corner spines on each side (3 oral and 2 aboral), 6 laterals on each side arrange in a single row and 23 dorsals (12 oral and 17 aboral), measure 10 - 15μ long ; body spines arranged in transverse rows, dorsally body spines extending from anterior end to posterior margin of ventral sucker ; integumentary papillae two types, first type with setae distributed all over body dorsally and ventrally and appearing as complete rings and second type very few in numbers arranged in double rings and distributed dorsally in region of collar ; cystogenous cells with granular protoplasm, distributed greatly in middle of body ; tail measures 400 - $625\mu \times 50$ - 80μ , papillae present ; mouth subterminal ; short and narrow prepharynx ; pharynx slightly ovoid, measures 25 - $30\mu \times 20$ - 25μ ; long and solid oesophagus measures 100 - 150μ , consists of 14-17 rectangular cells with prominent nuclei and protoplasm ; caeca extending to posterior end of body, four pairs of penetrating glands located posterior to ventral sucker ; excretory bladder bipartite, each main excretory duct with 150-200 yellowish green concretions, retrograde ducts with ciliated patches, flame cells in 21 pairs in three groups with flame cell formula of $2 [(3 + 3 + 3) + (3 + 3 + 3 + 3)] = 42$ caudal excretory canal opens through lateral pores ; genital primordia with two groups of cells situated anterior and posterior to ventral sucker and connected by a strand of cells.

Two generation of rediae occur, daughter redia measures 1560 - $3000\mu \times 200$ - 300μ and contains deep orange yellow colour ; pharynx

measures $60-85\mu$ wide ; gut very short and saccular ; daughter redia with 3-10 developing cercariae and many germ balls.

Metacercariae found in kidney and pericardial sac of same snail which liberated cercariae ; ovoid cyst in two layers and measures $163-$

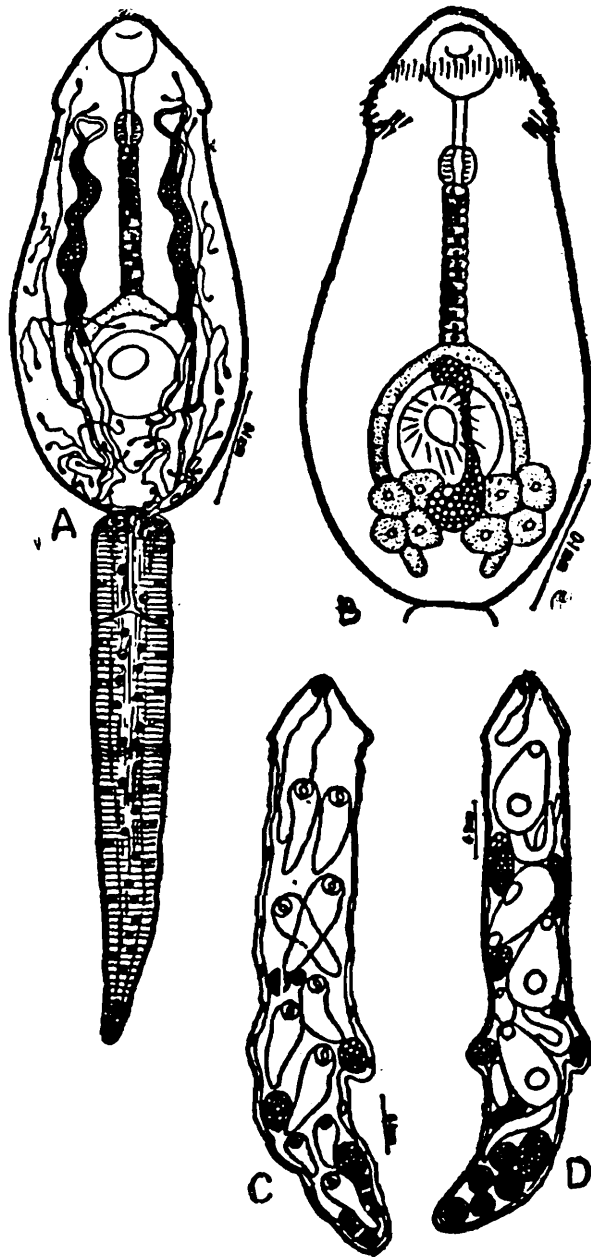


Fig. 22. A.—B. *Cercaria* sp. VII kerala Mohandas, 1981.
C.—D. Redia of *C. sp. VII kerala* Mohandas, 1981.
(After Mohandas, 1981).

$185\mu \times 150-175\mu$; thin and transparent outer layer with $12-16\mu$ thick and opaque inner layer with 4μ in thickness.

Snail Host : *Lymnaea luteola* f. *typica*. Location : Hepatopancreas. Locality : Trichur, Palghat and Ernakulam districts.

23. *Cercaria unnaoensis* IV Pandey, Singh and Lal
(Figs. 23. A—C)

1982. *Cercaria unnaoensis* IV Pandey, Singh and Lal, *Read. Zool.*, 1 (2): 17-38.

Diagnosis: *Cercaria* emerges in large numbers from snails throughout day, it crawls like a caterpillar with aid of suckers at bottom of container, remains alive for about 6 hours after emergence; whitish, sluggish, photonegative cercaria with elongate oval body with narrow

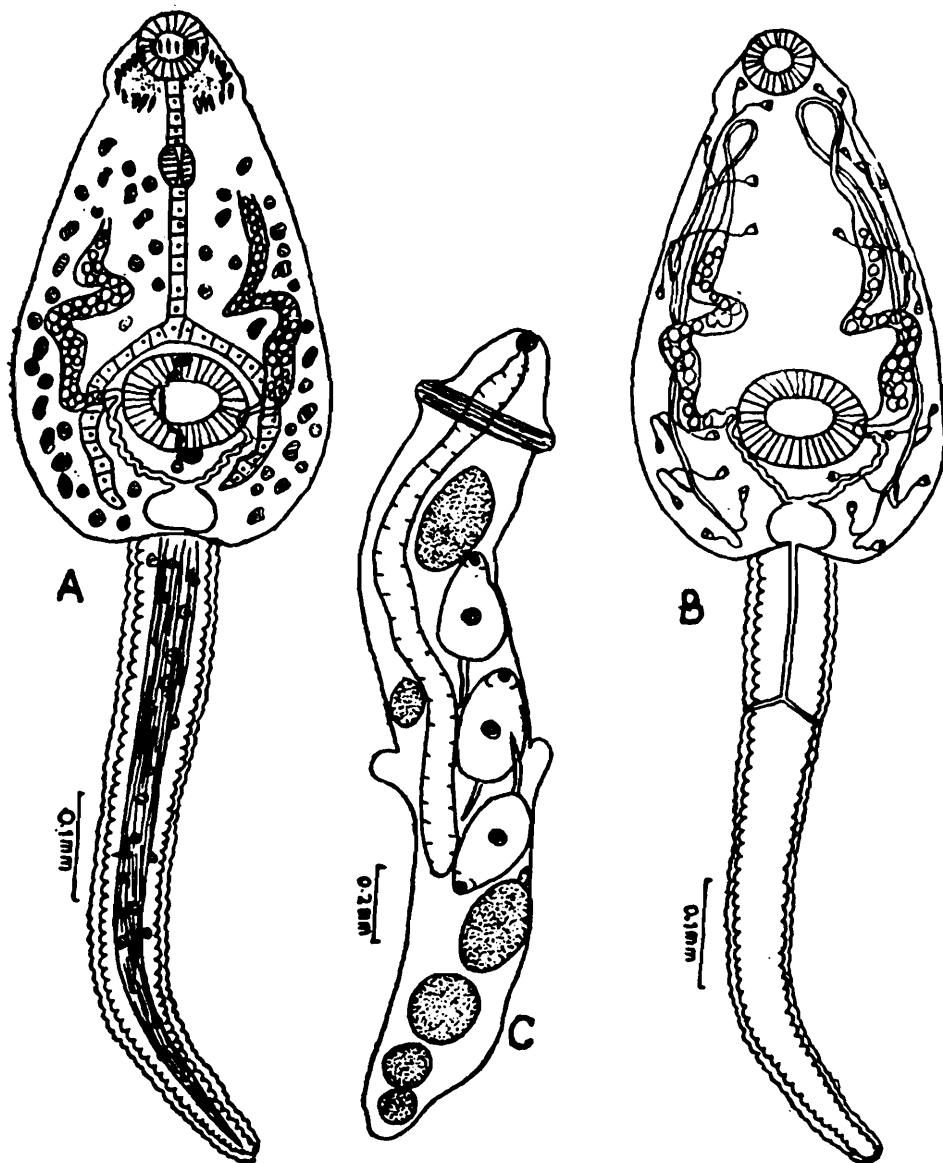


Fig. 23. A.—B. *Cercaria unnaoensis* IV Pandey, Singh and Lal, 1982.
C, Redia of *C. unnaoensis* IV Pandey, Singh and Lal, 1982.
(After Pandey, Singh and Lal, 1982)

anterior and broad posterior ends, measures $0.42-0.50 \times 0.25-0.30$ in live and $0.24-0.32 \times 0.12-0.16$ in fixed specimens; thick cuticle without spines; muscular collar present at anterior end of body, collar spines 27 in numbers, including 3 end group spines, arranged alternately; long

and posteriorly tapers tail measures $0.55-0.62 \times 0.04-0.06$ in live and $0.28-0.034 \times 0.02-0.04$ in fixed specimens, tail consists of circular, longitudinal and oblique muscles, caudal bodies irregularly arranged in tail parenchyma, tail fin absent ; oral sucker small, circular, measures $0.05-0.06$ in live and $0.02-0.03$ in fixed specimens ; ventral sucker cup shaped with fringed margins, large about twice diameter of oral sucker, measures $0.12-0.13$ in live and $0.04-0.06$ in fixed specimens, located posterior half of body ; mouth leads into short prepharynx followed by globular pharynx measures $0.02-0.03$; oesophagus long, measures $0.13-0.15$ in live and $0.05-0.06$ in fixed specimens ; intestinal caeca extends upto hind end of body, gut chambered ; penetration glands four pairs, poorly demarcated, located in collar region with short inconspicuous ducts ; rudiment of genital organs represented by three unequal cell masses, one situated anterior and two posterior to ventral sucker, cell masses joined together with a streak of cells ; flame cell formula represented by $2 [(2+2+2) + (2+2+2)] = 24$.

Redia contains golden yellow pigment, measures $2.00-2.80 \times 0.25-0.30$ in live and $1.50-1.80 \times 0.12-0.15$ in fixed specimens ; muscular collar and birth pore located in anterior region of body ; marginal lappets present in middle of body ; mouth leads into circular pharynx which measures $0.06-0.10$ in live and $0.04-0.06$ in fixed specimens ; gut extends upto posterior two third of body ; redia contains a number of cercariae and germ balls.

Snail Host : *Lymnaea auricularia*. Location : Hepatopancreas, Locality : Priyadarshni Jheel, Unnao (U. P.).

24. *Cercaria unnaoensis* V Pandey, Singh and Lal (Figs. 24. A - C)

1982. *Cercaria unnaoensis* V Pandey, Singh and Lal, *Read. Zool.*, 1 (2) : 17-38.

Diagnosis : Cercaria comes out from snail throughout day, at bottom of container it crawls like caterpillar with help of sucker, it survives for about 8 hours after emergence ; body elongate oval with blunt narrow anterior and broad round posterior ends, body beset with minute backwardly directed spines, body measures $0.52-0.07 \times 0.25-0.30$ in live and $0.25-0.30 \times 0.12-0.15$ in fixed specimens ; muscular collar distinct, present at anterior end of body, bears 24 collar spines including 3 end group spines, spines arranged in single row and dorsally uninterrupted ; tail cylindrical, tapers posteriorly, measures $0.43-0.58 \times 0.09-0.10$ in live and $0.26-0.32 \times 0.04-0.05$ in fixed specimens, dorsally atta-

ched to hind end of body, muscles consists of circular, longitudinal and oblique, caudal bodies irregularly distributed in tail parenchyma, fin fold absent ; oral sucker terminal, small, circular, measures 0.06-0.08 in live and 0.03-0.04 in fixed specimens, ventral sucker circular, larger than

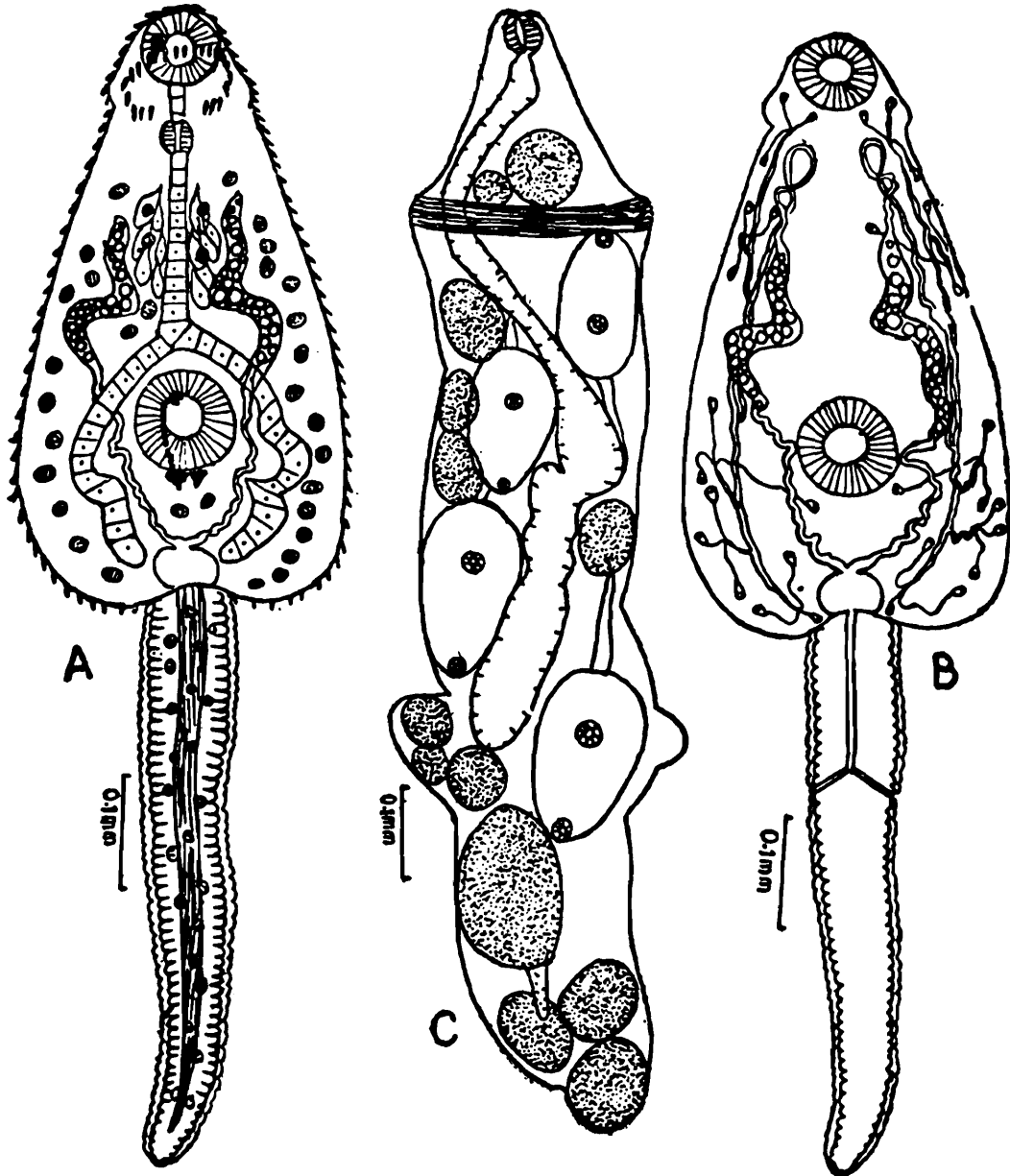


Fig. 24. A.—B. *Cercaria unnaoensis* V Pandey, Singh and Lal, 1982.
C. Redia of *C. unnaoensis* V Pandey, Singh and Lal, 1982
(After Pandey, Singh and Lal, 1982)

oral sucker, measures 0.09-0.10 in live and 0.05-0.06 in fixed specimens, located behind middle of body ; mouth leads into a short prepharynx ; pharynx small, globular, measures 0.03-0.04 in live and 0.01-0.02 in fixed specimens ; oesophagus long, measures 0.16-0.19 in live and 0.56-0.62 in fixed specimens, it divides into two intestinal caeca in front of ventral sucker ; caeca broad, extend upto hind region of body, gut divided by septa into chambers ; penetration glands 6 pairs, situated on either side of oesophagus, oval in shape, granular cytoplasm and

centrally placed nuclei, gland opens anteriorly in region of oral sucker by distinct duct; cystogenous cells two types—rounded filled with granular cytoplasm and oval containing rod shaped bodies; primordia of genital organ represented by three cell masses, smaller cell mass situated at anterior margin of ventral sucker, two other cell masses located posterior border of ventral sucker and joined with each other with a streak of cells; flame cell formula represented by $2 [(3+3) + (3+3+3)] = 30$.

Redia elongated with bright, brownish, yellow pigmented granules, measures $1.00-1.80 \times 0.19-0.25$ in live and $0.58-0.92 \times 0.05-0.10$ in fixed specimens; well developed collar and birth pore present in anterior region of body; marginal lappets well developed, located behind middle of body; pharynx rounded, measures $0.04-0.05$ in live and $0.02-0.03$ in fixed specimens; gut extends posteriorly upto marginal lappets; each redia with cercariae and germ balls.

Snail Host: *Indoplanorbis exustus*. Location: Hepatopancreas. Locality: Priyadarshni Jheel, Unnao (U. P.).

II. ECHINATA GROUP

Diagnosis (Emended): Fin folds on tail absent, retrograde excretory vessels divide into anterior and posterior branches near posterior part of body or retrograde vessels run to extreme posterior end of body then turning forward to continue to the side of the oral sucker anteriorly.

Key to Indian Species

- | | | | |
|----|---|--------------------------------|---------------------------------|
| 1. | Collar spines not more than 43 in number | ... | 2 |
| | Collar spines more than 43 in number | ... | 3 |
| 2. | Entire body covered with spines | ... | 4 |
| | Body covered with spines behind collar. | <i>Cercariae indicae XXIII</i> | |
| 3. | Collar spines 51 in number, in single row, penetration glands 4 in number | ... | <i>Cercaria sp. VIII Kerala</i> |
| 4. | Conical end portion of tail distinctly separated from tail, lateral caudal canal absent, penetrating glands in single set, flame cells more than 24 in number | .. | <i>Cercaria mehrai</i> |
| | Conical end portion of tail not separated, lateral canal present, penetrating glands in two sets, flame cells 20 in number | ... | <i>Cercariae indicae XII</i> |

25. *Cercariae indicae* XII Sewell
(Figs. 25 A-C)

1922. *Cercariae indicae* XII Sewell, *Indian J. Med. Res.*, (Suppl.), X : 123-131.

Diagnosis : *Cercaria* very active, body measures $0.21-0.44 \times 0.21$; tail varies in length from 0.39 to 0.49 ; body brown tinge ; collar distinct, collar spines of two kinds—ventrally on either side of middle line a group of four angle spines, gap between these two groups totally devoid of spines; rest of collar armed with 35 spines arranged alternately in two rows, an anterior and posterior, collar and angle spines of same size ; behind ventral sucker body narrows abruptly and continued back posteriorly in truncated form ; whole of body surface covered with backwardly directed spines arranged in transverse rows, spines of one row alternating with those of row in front and behind, body spines triangular in shape and appear like small three cornered scales ; cystogenous cells numerous ; oral sucker well developed having a diameter of 0.06 ; ventral sucker circular, situated at about 1/3rd of body length from posterior end, free margin of ventral sucker provided with a ring of small papillae, it measures 0.07 ; tail provided with circular and longitudinal muscle fibres ; mouth subterminal leads back to oral sucker ; oral sucker leads to prepharynx which passes back to a well developed globular pharynx ; pharynx measures 0.03 in diameter ; alimentary canal composed of single series of rectangular finely granular cells placed end to end ; oesophagus bifurcates into two intestinal caeca at anterior margin of ventral sucker ; two caeca pass around sides of ventral sucker and continued backwards to posterior end of body and terminating on a level of excretory vesicle ; two masses of small pyriform granular cells representing salivary glands located on either side of body in pre-acatabular region, inner mass of gland cells extend back to point of bifurcation of oesophagus but outer mass continued back laterally to ventral sucker and intestinal caeca as far as level of excretory bladder, from these two masses of cells corresponding series of ducts pass forwards and inwards and unite to form a single group of ducts on each side at postero-external margin of oral sucker and open to anterior margin of oral aperture ; excretory bladder transversely oval, situated in front of point of attachment of tail, excretory pore opens posteriorly and situated dorsally, in front of bladder located a second excretory cavity sub-spherical in shape from which two main excretory tubes arise and pass forwards and outwards, in front of ventral sucker excretory tube widen and filled with globular refractile masses of excretory materials, near pharynx main excretory

canals form loops and pass backwards through whole length of body to level of excretory bladder, ten pairs of flame cells have been detected, most anterior pair situated close against margin of oral sucker in lateral region, second pair situated laterally in collar region, a caudal excretory canal passes backward into tail, about 1/4th tail length from base a pair of small lateral canals pass outwards and backwards and

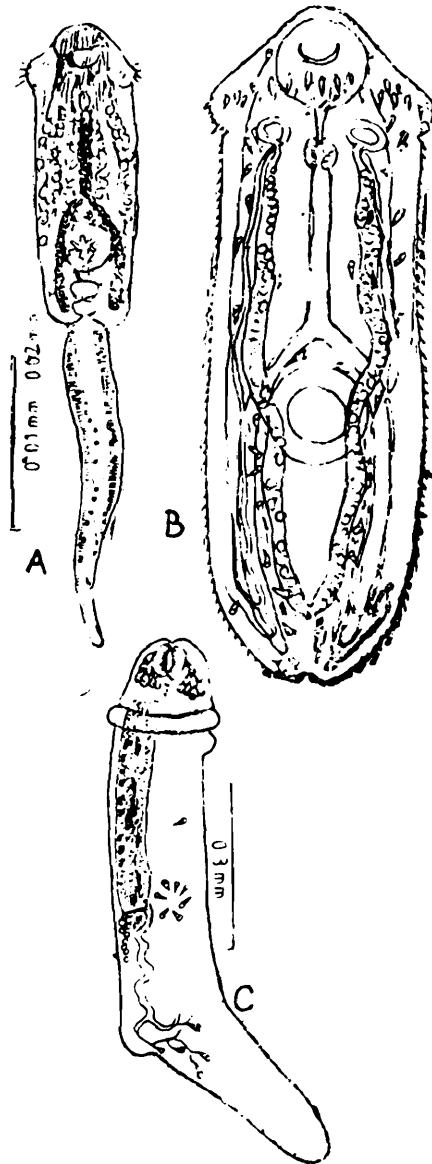


Fig. 25. A,—B. *Cercariae indicae* XII Sewell, 1922.
C. Redia of *C. indicae* XII Sewell, 1922.
(After Sewell, 1922)

appear to open on surface ; genital organs represented by a mass of small rounded granular cells situated at anterior end of excretory bladder around origin of two main excretory canals, from this a column of cells passes forward to a small triangular mass occupying space enclosed by anterior margin of ventral sucker and in front and sides by diverging caeca, this represent genital or vaginal orifice while posterior mass and connecting column of cells represent ovary and uterus, from

sides of vagina a small mass of cells projects laterally possible representing cirrus sac, behind and outside ovarian rudiment a pair of small rounded masses of cells representing rudiments of testes ; linear group of cells outside main excretory canal in front of ventral sucker region represent vitelline glands ; rudimentary nerve system be detected by a pair of nerves passing forwards laterally on ventral side of body which anteriorly connected with each other by a transverse commissure passing across middle line of body in front of pharynx.

Redia orange in colour measures $0.81-1.67 \times 0.12-0.21$; body shows certain degree of variation in shape and anterior end roundad ; collar present ; body behind collar to posterior locomoter appendages parallel but behind locomoter appandages body may be either wide or bluntly rounded ; terminal mouth leads back to rounded thick walled pharynx, having a diameter $0.09 (0.05 \times 0.78)$; numerous small pyriform cells located behind and outer side of pharynx ; anterior gut narrow and short and posteriorly it widens to form saccular stomach which reaches back for a variable distance, in some cases it extends back for a short distance behind collar but in other cases it reached further back to a point almost midway between two extremities ; daughter rediae present ; along each side of body runs a convoluted wide excretory tube which anteriorly open into a series of lacunae forming bladder tube, around base of each locomoter appedages a group of five or six flame cells which open into capillaries and these unite to form an irregular network which in turn connects with main excretory tube, second group of six or seven flame cells located $1/3$ rd distance from locomoter appendages to anterior end and a single flame cell occasionally lying further forward ; germ cell situated at extreme posterior end of body ; mature rediae contained 18-20 young cercariae ; birth pore of redia situated laterally and somewhat towards ventral aspect of body immediately behind collar.

Snail Host : *Gyraulus euphraticus* and *Indoplanorbis exustus*.
Locality : Indian Museum Tank, Calcutta.

26. *Cercariae indicæ* XXIII Sewell

(Figs. 26 A-C)

1922. *Cercariae indicæ* XXIII Sewell. *Indian J. Med. Res.* (Suppl.), X : 131-135.

Diagnosis : Body capable of considerable extension and retraction, it measures $0.32-0.44 \times 0.10-0.14$, body widest at level of acetabulum ; tail measures 0.44×0.04 ; collar bears double row of spines, four

angle spines distinctly larger than others, collar apart from angle spines possesses 35 spines arranged in double row ; body surface behind collar covered with small backwardly directed spines, numerous cystogenous cells scattered over surface of body beneath cuticle ; oral sucker circular having a diameter of 0.05 ; ventral sucker situated $\frac{1}{3}$ rd body length from posterior end, measures 0.07 in diameter ; mouth subterminal,

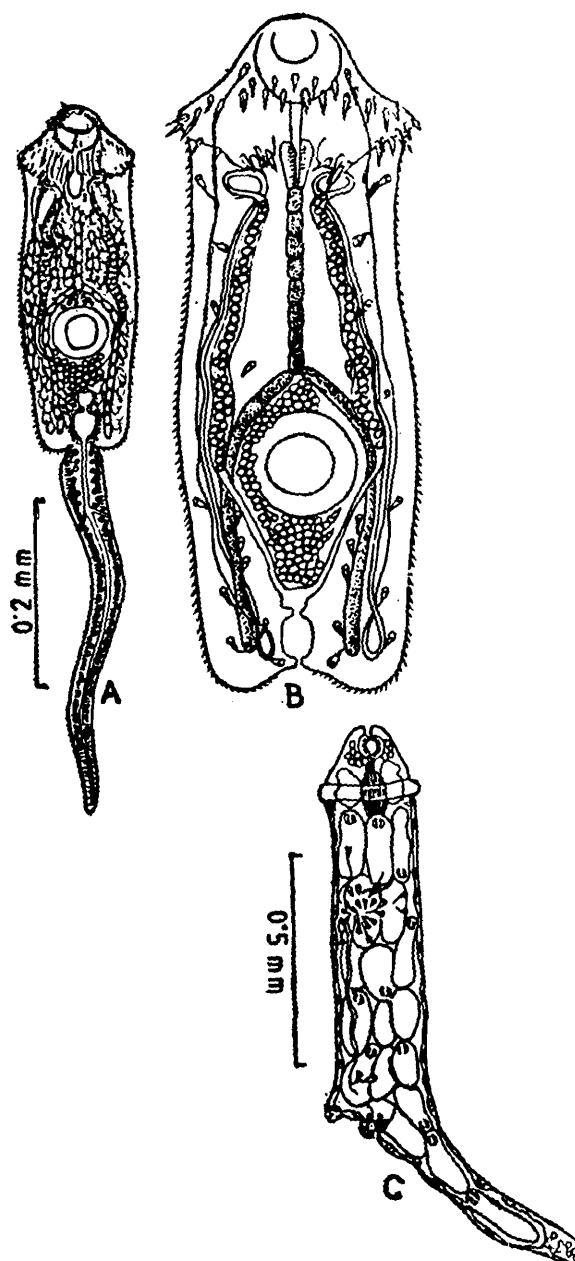


Fig. 26. A.—B. *Cercariae indicae* XXIII Sewell, 1922.
C. Redia of *C. indicae* XXIII Sewell, 1922.
(After Sewell, 1922)

opens into cavity of oral sucker ; prepharynx short ; pharynx elongated, pyriform ; oesophagus long composed of rectangular finely granular cells, arranged in linear series in middle line, extending back almost as far as anterior border of acetabulum and here it divides into two intestinal caeca which pass round sides of acetabulum and continued backward to

sides of excretory bladder ; two large salivary glands situated on each side of body, of these internal group of cells extend back as far as bifurcation of gut while external continued backwards laterally as far as posterior end of body, each gland composed of large number of small pyriform cells, numerous ducts originate from glands which open to mouth ; excretory bladder situated posterior end of body and opens by a small orifice on dorsal surface at point of attachment of tail, quadrilateral in shape and from its anterior surface a short canal passes forward in middle line and opens into a triangular cavity formed by conjoined ends of main excretory canals, these canals pass forwards and some what outwards around acetabulum and dilate into wide canals filled with round refractile excretory globules, canals loop behind and outside pharynx and pass backwards to extreme posterior end of body and again turning forwards continued to side of oral sucker, 18 pairs of flame cells present, a caudal excretory canal passes backward into tail and continued almost to extreme tip of tail, about 1/5th of length of tail from base a pair of short straight branches diverge laterally from caudal canal and open to surface ; rudiments of genital organs represented by a mass of small rounded cells lying behind acetabulum, between it and excretory bladder, this may be rudiments of ovary, from this mass a column of cells passes forward around acetabulum to a second small mass of cells, lying in angle between anterior margin of acetabulum and intestinal caeca, these masses of cells probably anlage of uterus and vagina respectively.

Redia yellow colour, mature redia measures $1.40-2.28 \times 0.17-0.21$; a pair of rounded locomoter processes situated about 1/3rd total length from posterior end ; immediately behind anterior end situated a well developed collar ; mouth terminal and leads back into a pharynx having a diameter of 0.05, succeeded by a narrow oesophagus which widens into a short wide saccular stomach ; stomach extends a little behind level of collar and usually completely empty.

Snail Host : *Limnaea acuminata* (= *Lymnaea acuminata*), *Limnaea ovalis* (= *Lymnaea ovalis*), *Limnaea leuteola* (= *Lymnaea leuteola*)
 Locality : Zoological Garden Tank, Alipore, Indian Museum Tank, Calcutta.

Remarks : Rao (1933) obtained *Cercariae indicae* XXIII Sewell, 1922 from *Limnaea luteola* from Madras. They were negative phototropic. In nature they encyst on *Planorbis exustus* and *Limnaea leuteola* and they encyst also on the gills of the fish *Barbus stigma*. By feeding experiments he recovered certain parasites which according to Rao (1933) come very close to *Euparyphium malayanum* Leiper (1911).

27. *Cercaria mehrai* Faruqui
(Figs. 27. A-C)

1930. *Cercaria mehrai* Faruqui, *Indian J. Med. Res.*, 17 : 1205-1214.

Diagnosis : *Cercaria* small, swims actively, it can also moves on a substratum by alternate use of two suckers ; body measures 0.33×0.19 , body capable of contraction and expansion, greatest width at level of ventral sucker ; tail measures 0.35 long ; collar distinct, armed with 43 spines, arranged in two rows ; posterior region of body slightly elongated ; body covered with backwardly directed spines, arranged in transverse rows ; cystogenous cells numerous filled with cystogenous rods ; oral sucker well developed, measures 0.03 in diameter ; ventral sucker situated at about 0.02 of length of body from posterior end ; long tail conical at free end, measures 0.09 long, conical portion distinctly separated from tail stem, junction of terminal cone with tail proper present bulb like processes, flexible cone covered with thin cuticle ; mouth subterminal which leads into cavity of oral sucker ; prepharynx narrow, well developed ; oesophagus long, thicker, bifurcate in front of anterior margin of ventral sucker into two caeca ; caeca extends to posterior end of body ; salivary gland six in number, anterior to ventral sucker, arranged on each side of oesophagus, each cell of these glands contain a nucleus ; excretory bladder spherical, situated posterior end of body, two main collecting ducts originate anteriorly from dorsal surface of excretory bladder and run forward and outward, excretory bladder may assume various shape due to contraction and expansion of body, posterior wall of canals thin walled and narrow calibre, main tubes much broader in front of middle of ventral sucker and filled with 5 globular or oval refractile excretory granules, near pharynx main canals become narrow and form loops, ducts continue backwards as narrow canals towards hinder end of body where they turn again towards anterior end of body, 12 pairs of flame cells present in body, tail without any flame cell, first pair of flame cell lies close to margin of oral sucker, second pair lies anterior to loop of main excretory canals, third pair lies posterior to loop near first excretory granule, fourth pair situated laterally to level of third excretory granules, fifth pair located anterior to ventral sucker in space enclosed by bifurcation of caeca, sixth pair lies at level of ventral sucker posterior to 5th excretory granules, seventh pair lies posterior to ventral sucker, remaining five pairs lie posterior and outside posterior region of caeca ; caudal excretory canal originates from posterior end of dorsal side of excretory bladder and runs back through tail stem, caudal excretory canal runs

straight for most of its course except for a short distance in posterior region becomes somewhat wavy, lateral caudal canals absent; two masses of small cells representing rudiments of genital organs present, first mass of cells present in front of excretory bladder representing ovary and uterus and second mass of cells lie in front of ventral sucker and intercaecal representing genital pore.

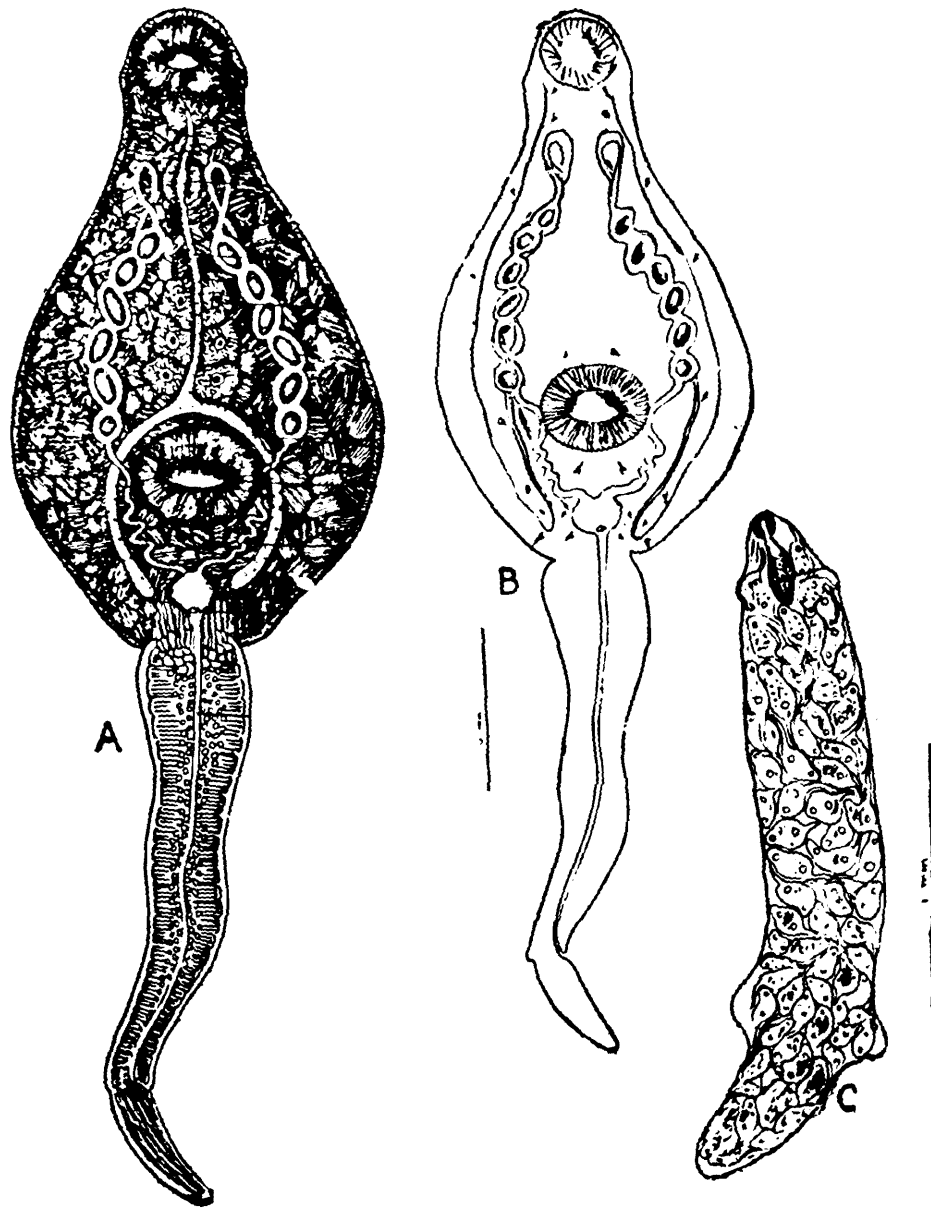


Fig. 27. A.—B. *Cercaria mehrai* Faruqui, 1930.
C. Redia of *C. mehrai* Faruqui, 1930.
(After Chatterjee, 1933)

Two generations of rediae present; mother redia large with small intestine; smallest mother redia measures 0.47×0.15 and largest measures 1.12×0.28 ; pharynx large; germinal masses of mother redia with unicellular and multicellular components attached at posterior end of body cavity; smallest daughter redia measures 0.64×0.11 ; colourless; maximum width in front of posterior locomotor appendages; mouth

terminal ; pharynx muscular well developed ; oesophagus short and narrow ; gut well developed which extends upto 0.19 from anterior end of body ; posterior locomotor appendages well developed ; whole body of daughter redia filled with large number of germ cells, fully developed daughter redia measures $1.31-2.40 \times 0.24$; mouth situated at anterior end ; protrusible pharynx well developed measures 0.22 in diameter ; gut short, narrow and brown in colour, extends backward to a point 0.24 from pharynx ; indistinct collar present ; birth pore situated behind collar ; body provided with a pair of locomotor appendages ; each mature daughter redia contains a large number of cercariae in various stages of development ; germ balls occupy extreme posterior end of body.

Metacercaria spherical in shape ; measures 0.14×0.10 ; transparent cyst wall measures 0.01 in thickness ; cyst wall composed of two layers.

Remarks : *Cercaria mehrai* Faruqui (1930) and *Cercaria palustris* Chatterji (1933) are so closely related to each other that they exhibit no specific characters by which they can be distinguished. Faruqui (1930) found it practically impossible to see any collar spines in his form and he described it as spineless echinostome cercariae, whereas Chatterji (1933) omitted the exact number of spines of *C. palustris* and also their mode of distribution.

As regards the systematic position of *C. mehrai*, Chatterji was justified in placing his form *C. palustris* in 'Echinata group' of Sewell (1922). Faruqui (1930) wrongly placed his form, *C. mehrai*, in 'Agilis group' of Sewell. Sewell considered that the excretory system is one of the characters and by which he separated the echinostome cercariae into three group—Echinotoides, Coronata and Echinata. *C. mehrai* comes much closer to 'Echinata group' due to the absence of fin fold in the tail and the course the excretory canal follows. Jain (1958) described the egg and miracidium of *Paryphostomum mehrai* as follows :

Egg : The eggs are entirely undeveloped when passed out with the faeces, oval in shape, yellow to light green in colour, thin transparent shell ; ovum located in middle of egg and surrounded by yolk cells ; at 26°C eggs hatch out in a week, but in winter they take longer time to hatch ; flame cells and cilia appear before embryo fully developed ; at about 12-13 days of development embryo takes spherical shape which becomes elongated in a few days, ciliated, two flame cells developed and right flame cell shifts to a more anterior position in a few days.

Miracidium : Pyriform miracidium, measures 0.02×0.04 ; miracidium swims rapidly ; body provided with cilia ; epidermal plates 18 in

number, arranged in four circumferential rows in ratio of 6:6:4:2 = 18 ; subepithelial cells long and flattened ; primitive gut sac like, filled with coeres granules ; a pair of penetration glands situated one on each side of gut, open below tip of apical papilla, provided with a distinct nucleus at hinder region ; body provided with one pair of flame cells, right flame cell situated posterior level of penetration glands and left flame cell a little behind this at about middle of third tier of epidermal plates, ducts of flame cells much conveluted, excretory pores lie on each side between third and fourth tiers of epidermal plates ; germ cells lie in germinal sac and occupy posterior two thirds of body ; germ cells large and contain nucleus with conspicuous nucleolus.

Snail Host : *Indoplanorbis exustus* Locality : Allahabad (U. P.)

28. *Cercaria* sp. VIII Kerala Mohandas

(Figs. 28. A—C).

1981. *Cercaria* sp. VIII kerala Mohandas, *Proc. Indian Acad. Sci. (Animal Sci.)*, 90 (4) : 433-444.

Diagnosis : *Cercaria* large, active swimmer, emerges from infected snails in morning hours, remains alive for 6-8 hours ; ovoid body measures 310-440 μ \times 170-210 μ ; oral sucker 40-50 μ in diameter ; ventral sucker post equatorial ; 60-75 μ wide ; collar prominent, 100-125 μ wide, collar spines 51 in number-two groups of 5 corner spines (3 oral and 2 aboral), two groups of 6 laterals in a single row and 29 dorsals in a single row ; two types of integumentary papillae present ; sensory hairs two pairs at oral sucker region ; cystogenous cells with granular protoplasm ; tail aspinose, 310-450 μ \times 50-75 μ and devoid of fin folds ; one type of integumentary papillae present ; mouth subterminal ; prepharynx short and stumpy ; pharynx well developed ; oesophagus solid and straight with 8 columnar cells and caecum with 9-11 cells ; caeca extend to posterior end ; penetration glands two pairs, situated below ventral sucker and between it and excretory vesicle, each gland with well developed nucleous and granular protoplasm ; excretory vesicle bipartite, each main duct dilates from mid level of ventral sucker anteriorward to accomodate 175-225 concretions, retrograde excretory duct with ciliated patches, flame cells 21 pairs in triplets, caudal excretory duct opens through lateral ducts ; nervous system represented by two masses situated on either side of prepharynx, nerve masses connected by nerve fibres, one pair of nerve arises from nerve masses, runs antero dorsally and other pair runs postero ventrally ; genital rudiments consist of two

groups of cells situated anterior and posterior to ventral sucker and connected by a strand of cells.

Fully mature rediae orange-yellow colour but immature forms colourless ; mature redia measures $1290-2850\mu \times 300-450\mu$; gut short and saccular ; excretory system well developed ; each redia contains 5-12 fully developed cercariae and many germ balls.

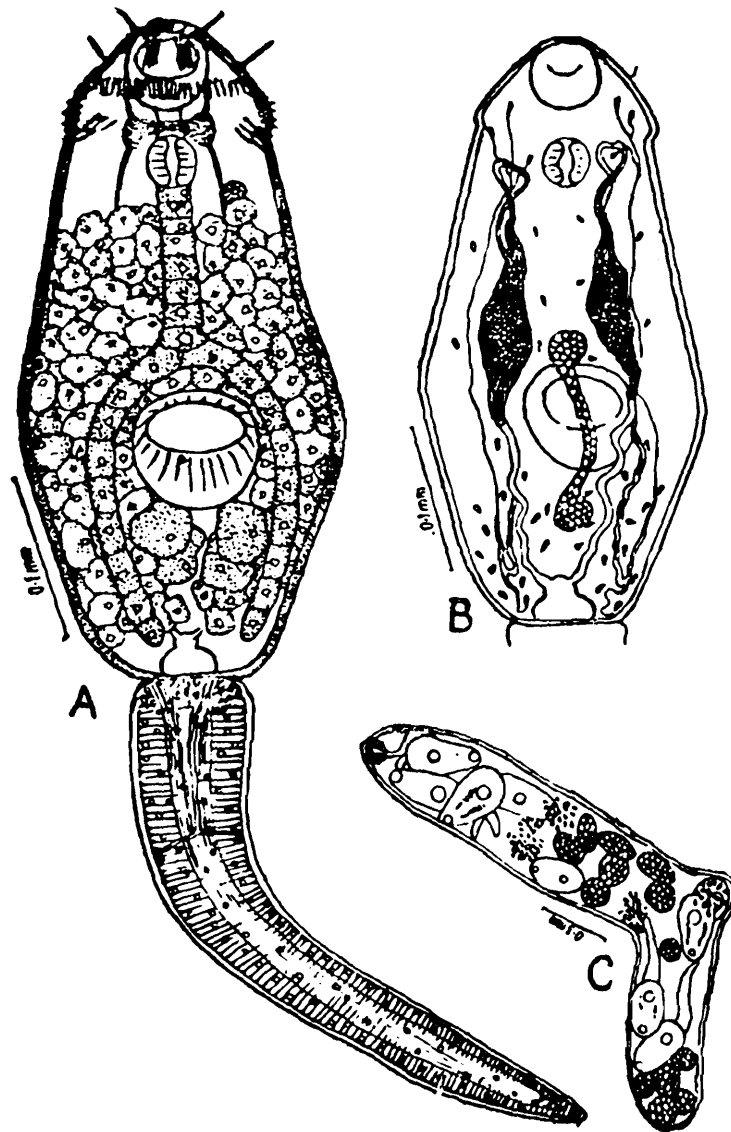


Fig. 28. A.—B. *Cercaria sp. VIII kerala* Mohandas 1981.
C. Redia of *C. sp. VIII kerala* Mohandas, 1981.
(After Mohandas, 1981)

Metacercaria found in same snail which liberates cercariae ; cercariae encyst within redia itself ; metacercariae spherical, measure $160-190\mu$ with an outer hyaline layer of $8-12\mu$ thickness and an inner opaque layer.

Snail Host : *Limnaea luteola f. typica*. Location : Hepatopancreas
Locality : Palghat and Trivandrum districts.

III. *ECHINATOIDES GROUP*

Diagnosis (emended) : Fin folds on tail present, retrograde excretory vessels divide into anterior and posterior branches near ventral sucker or between ventral sucker and posterior end of body.

Key to Indian Species

1. A pair of small bodies or small spines present at the posterior border of oral sucker or beginning of prepharynx ... 2
Small bodies or small spines at posterior border of oral sucker or beginning of prepharynx absent ... 7
2. Body spines present ... 3
Body spines absent ... 4
3. Collar spines 32 in number arranged in two rows, end group of spines present ... *Cercaria tandani*
Collar spines 42 in number, arranged in single row, end group spines absent ... *Cercaria tetraglandulata*
4. Invaginable caudal process present at tip of tail ... 5
Invaginable caudal process absent ... 6
5. Collar spines 41 in number arranged in two rows, flame cells 36 in number ... *Cercaria triglandulata*
Collar spines 48 in number arranged in single row, flame cells 30 in number ... *Cercaria mainpurensis*
6. Two irregular bodies with highly refractile granules present on the posterior border of oral sucker, flame cells 30 in number, penetrating glands 6 in number ... *Cercaria nairi*.
A mass of tiny spines present at beginning of prepharynx, flame cells 24 in number, penetrating glands 8 in number ... *Cercaria granulosa*
7. Collar spines not more than 38 in number ... 8
Collar spines more than 32 in number ... 11
8. Setae present in body and tail, two pairs of dorso ventral and one pair of ventro lateral caudal fin present ... *Cercaria Echinostoma ivaniosi*
Setae absent in the body and tail ... 9
9. Two short fin folds present near tip of tail ... *Cercaria unnaoensis III*
Fin folds long ... 10
10. Fin folds assymetrical on two sides of tail, penetrating glands 6 in number ... *Cercaria spinosa*

- Fin folds present on dorsal and ventral sides, penetrating glands 8 in number ... *Cercaria Echinostoma revolutum*
11. Collar spines 43 in number, spines dorsal to prepharynx absent, sensory hairs on tail absent ... *Cercariae indicae XLVIII*,
Collar spines 47 in number, spines dorsal to prepharynx present, sensory hairs on tail present ... *Cercaria sp. VI Kerala*

29. *Cercaria* of *Echinostoma ivaniosi* Mohandas
(Figs. 29. A-D)

1973. *Cercaria* of *Echinostoma ivaniosi* Mohandas, *J. Helm.*, XVIII (4): 421-438.

Diagnosis: While swimming body often curved ventrally, oval in shape in semi contracted state, it performs leech like movements on a smooth surface with a thin film of water, body measures 300-510(390) × 175-250 μ ; oral sucker 50-75(60) μ in diameter; collar 90-125(115) μ wide and bears 37 spines of 12-15 μ long; protrusible acetabulum situated in post equatorial region with a diameter of 60-90(75) μ ; body spines with 10-12 pairs of small setae at anterior half; cystogenous cells with granular material which sparse at region of pharynx and anterior to it; tail measures 290-565(450) × 45-65(55) μ , in mid zone 9-10 pairs of setae present, two pairs of dorso ventral and one pair of ventro lateral fins present; mouth subterminal; prepharynx 20-45(38) μ long; pharynx 20-25(23) μ in diameter; oesophagus long and solid consisting of 7 cells; intestinal caecum comprises 6 cells, an additional cell present at point of bifurcation; penetration glands two pairs, glands indistinct but duct openings conspicuous; paraoesophageal gland cells located posterior to pharynx in two mesial rows, one or two cells may be situated laterally; excretory bladder bipartite, anterior to acetabulum, main ducts dilate to accommodate excretory concentration, yellowish green coloured and numbering between 20 and 65 in each, at level of pharynx each duct forms a loop by itself and takes a downward course, this descending duct lined with 6 ciliated patches and bifurcates at level of excretory bladder, 18 pairs of flame cells arranged in groups of three, 2[(3 + 3 + 3 + 3 + 3 + 3)] = 36; caudal excretory duct bifurcates almost at 1/6th distance from base of tail and branches open out laterally; genital rudiments consists of two masses of cells at acetabular level and connected by a ribbon of cells; two types of papillae present in cercariae—one with setae and another without setae, second type less in number and formed at anterior region of body.

Newly released mother redia colourless with sacculate gut reaching posteriorly far below level of locomoter organs ; fixed redia measures 275-300(288) μ in length ; during development yellow or yellowish orange pigments appear in body and gut becomes dark orange coloured ; fully grown mother redia measures 750-1250(1050) \times 175-250(225) μ ; old mother redia which no longer produce daughter rediae with shrivelled bodies and intestine occupying greater portion of body, daughter

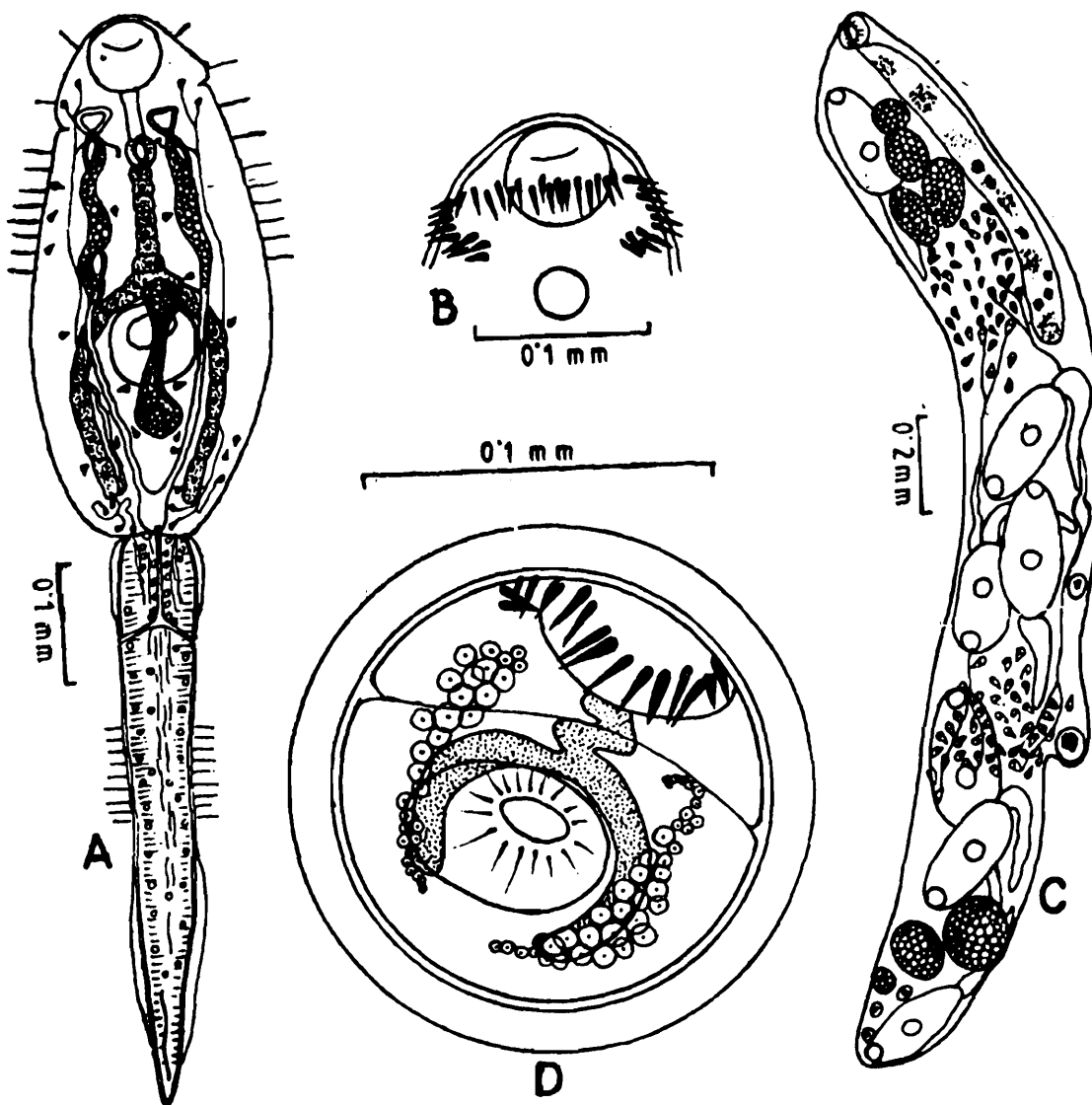


Fig. 29. A.—B. Cercaria of *Echinostoma ivaniosi* Mohandas, 1973.

C. Redia of *E. ivaniosi* Mohandas, 1973.

D. Metacercaria of *E. ivaniosi* Mohandas, 1973.

(After Mohandas, 1973)

redia yellowish orange coloured and measures 1.085-2.875(2.275) \times 0.225-0.375 (0.325) mm ; mature redia contains 7-15 cercariae and germ balls ; two groups of flame cells situated in anterior half and two groups in posterior half of body, anterior and posterior excretory tubes of each side empty into a lacuna situated almost at mid level of body, exact number of flame cells could not be counted.

Cercariae encyst in same snail hosts which liberated it or in other snails ; cysts spherical or slightly oval, measure 150-162 (155) × 142-150 (145) μ ; cyst wall consists of two layers—an outer thin and transparent layer of 12-15 (14) μ thick and an inner opaque layer 3-5 (4) μ thick.

Snail Host : *Limnaea luteola f. typica*, *Limnaea acuminata f. graciler*. Locality : Palghat, Trichur, Ernakulum and Trivandrum districts.

30. Cercaria of *Echinostoma revolutum* Patnaik and Ray

(Figs. 30. A-F)

1960. Cercaria of *Echinostoma revolutum* Patnaik and Ray, *Indian Vet. J.* 43 (7) : 591-600.

Diagnosis : Cercaria whitish, spinose ; collar present with 37 spines, spines measure 6-7 long ; body covered with oval or pentagonal small cystogenous cells ; protrusible ventral sucker, measures 0.04 in diameter, situated at beginning of posterior third of body ; oral sucker 0.02-0.03 in diameter ; short prepharynx and pharynx ; oesophagus narrow, solid, cellular ; oesophagus divides into two solid caeca just before ventral sucker and extend upto anterior lateral jone of excretory bladder ; excretory bladder situated medially at posterior end of body ; two main excretory tubes running longitudinally on either side of ventral sucker and oesophagus upto pharyngeal region, containing many refractile excretory granules ; four pairs of penetration gland cells present which lay on either side of oesophagus, four pairs of ducts of penetration glands open in anterior region around oral sucker ; cercaria measures 0.29-0.32 × 0.10-0.13 in fixed condition ; tail measures 0.28-0.36 × 0.03-0.04 ; cercaria negative geotropic and positive phototropic ; cercariae penetrate within 2-3 hours into snail host and encyst.

Redia develops 16-25 days after infection ; two generations of rediae present—one yellowish brown, sacular, containing cercariae and second type less pigmented, containing germ balls and daughter rediae ; redia develops in digestive glands and mantle cavity of snail ; oral sucker terminal, measures 0.04-0.06 in diameter ; gut sacular, measures 0.58 long, filled with brownish contents ; body cavity filled with active cercariae ; head collar measures 0.08 across ; locomotor appendages measure 0.05 long, appendages locate at 0.53 from oral sucker ; mature redia measures 0.56-2.73 × 0.10-0.27, smaller and less pigmented.

Metacercaria spherical in shape ; transparent ; 14-17 μ thick ; cyst uniform in size and shape ; measures 0.15-0.16 in diameter ; occasionally encyst in redia.

Snail Host : *Limnea auricularia* var. *rufescens*. (= *Lymnaea auricularia* var. *rufescens*). Locality : Sambalpur, Bargarh, Chipillima, Burla, Barapalli, Agalpur, Bhubaneswar, Bipilli, Sakhigopal, Chandaka, Bhaiyanagar, Surada, Jaganathprasad, Parlakemedi, Kasinagar, Gunpur,

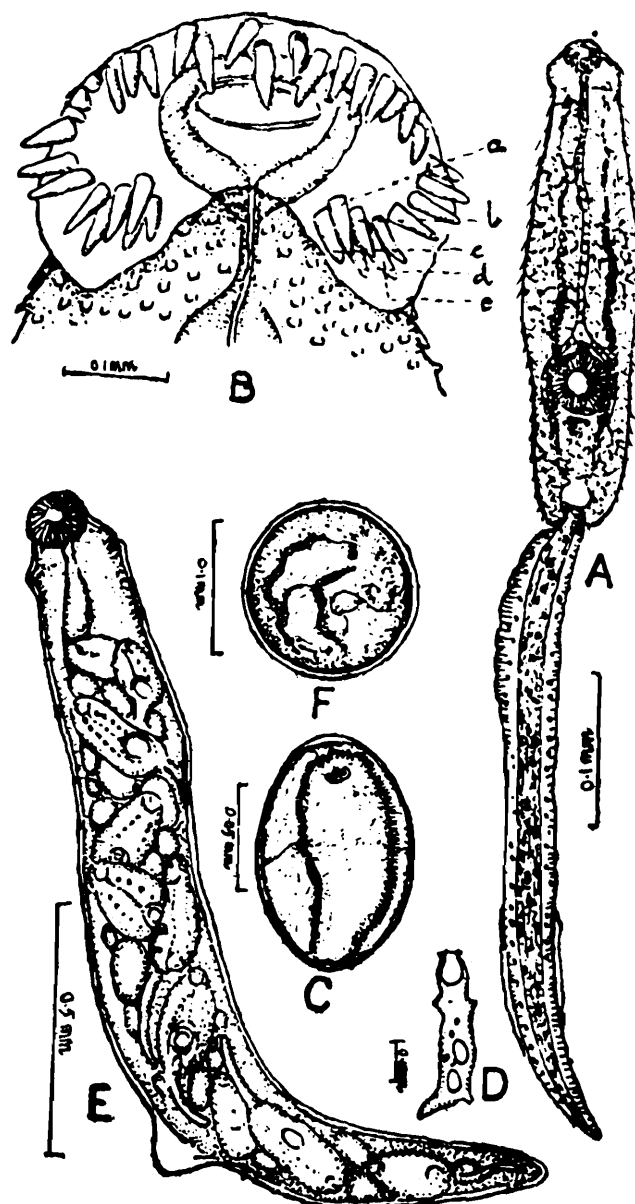


Fig. 30. A.—B. Cercaria of *Echinostoma revolutum* Patnaik and Ray, 1960.
 C. Egg with miracidium of *E. revolutum* Patnaik and Ray, 1960.
 D.—E. Redia of *E. revolutum* Patnaik and Ray, 1960.
 F. Metacercaria of *E. revolutum* Patnaik and Ray, 1960.
 (After Patnaik and Ray, 1960)

Gudari, Bisam-Cuttack, Jaipur, Kotpad, Phulna-Khara, Barang, Cuttack.

Remarks : *Echinostoma revolutum* is a common parasite of avian hosts and is occasionally found in man. The life cycle of this trematode has extensively been studied and numerous molluscan intermediate hosts have been reported from other countries. In India Peter (1955) reported the occurrence of Cercaria *Echinostome revolutum* Beayer (1937) in

Limnaea luteola. He has also worked out the post cercarial part of the life cycle (Peter, 1957).

Sirvastava (1982) is of the opinion that there is no material difference between the larval as well as adult stages of *Echinostoma ivaniosi* Mohandas (1973) and *E. revolutum*, hence, he considered the two species as conspecific.

31. *Cercaria granulosa* Baugh

(Figs. 31. A-C)

1975. *Cercaria granulosa* Baugh, *Rev. Iber. Parasitol.*, 35 (3-4) : 311-328.

Diagnosis : *Cercaria* emerges at noon, lives for a short period not exceeding four to five hours, it settles at bottom of container, crawls for a while and dies ; positive phototactic ; crawls on substratum with help of suckers ; body aspinose, elongate oval, anterior end blunt, posterior end broad, measures 0.56-0.65 in length and 0.28-0.29 in maximum breadth in region of ventral sucker in live specimens and 0.22-0.25 in length and 0.14 in maximum breadth in fixed specimens ; tail aspinose and tapers posteriorly, dorsal and ventral fin folds present at distal third, small invaginable process present at tip of tail, in live specimen tail almost as long as body, measuring 0.61-0.64 in length and 0.08 in breadth at base, in fixed specimen it appears longer than body and measures 0.46-0.53 ; oral sucker longer than broad, measures 0.07-0.08 in length and 0.05-0.06 in breadth in live specimen and 0.03-0.04 in length and 0.02-0.03 in breadth in fixed specimens ; ventral sucker larger than oral sucker, situated approximately in middle of posterior half of body, measures 0.08 in diameter in live and 0.04 in fixed specimens ; cephalic collar well developed, prominent with 43 spines arranged in two alternate rows, no spines arranged in groups in ventro lateral corners of collar ; prepharynx distinct, measuring 0.04 in length, a mass of tiny spine like bodies present at beginning of prepharynx ; pharynx lengthwise oval in shape, measures 0.03 in length and 0.01 in width in live specimens ; oesophagus long, measures 0.17 in length in live specimen, oesophageal bifurcation lies in front of ventral sucker ; intestinal caeca extend posteriorly upto level of excretory bladder, caeca and oesophagus compose of number of coarsely granular cells arranged end to end, oesophagus consists of nine to ten such cells and caeca of 14-15 cells ; penetration gland cells four pairs, lobate, each with fine granules and a large round nucleus, arranged along sides of oesophagus, ducts of cells open at anterior margin of mouth opening ; from pharyngeal level

upto posterior end packed with numerous round or oval cystogenous cells, each with round nucleus and fine characteristic granules ; small mass of germ cells representing germinal primordium located behind ventral sucker ; excretory bladder oblong, placed transversely at posterior end of body, two main sinuous excretory canals open seperately into anterior side of bladder, each canal runs forward as ascending

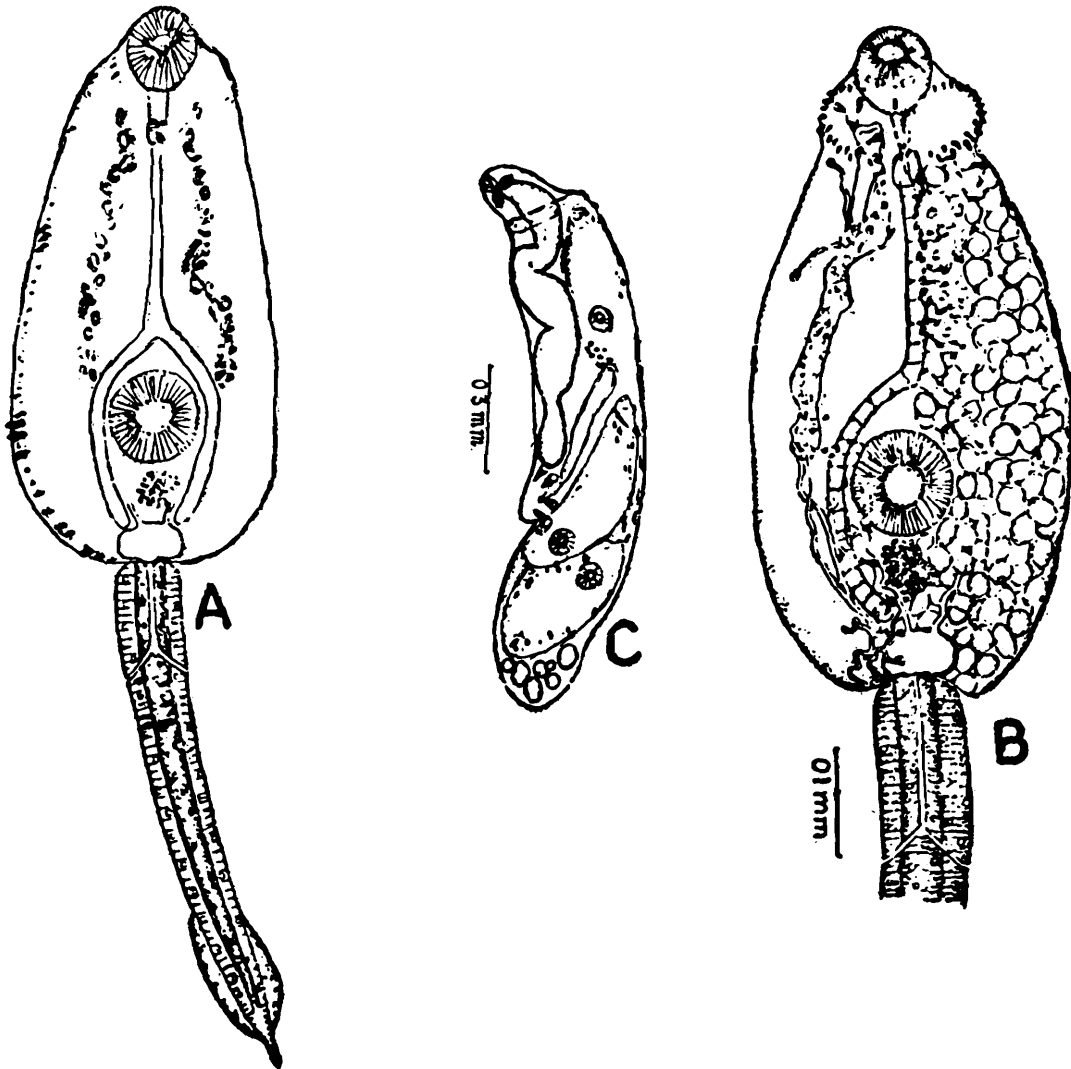


Fig. 31. A.—B. *Cercaria granulosa* Baugh, 1975.
C. Redia of *C. granulosa* Baugh, 1975.
(After Baugh, 1975)

limb upto prepharynx wherefrom it turns back forming a loop and runs posteriorly as descending limb in a sinuous way much beyond ventral sucker and roughly midway between posterior border of ventral sucker and hind end of body where it divides into two secondary branches— anterior and posterior collecting canals, of these two canals, anterior much longer than posterior one, ascending limbs of main excretory canals much dilated in preacetabular region and contains large number of round refractile excretory corpuscles, anterior as well as posterior collecting canal of each side of body have two short tertiary branches

connected with capillaries of flame cells arranged in sets of three, flame cell formula represented by $2[(3+3)+(3+3)] = 24$, caudal excretory canal arises from middle of posterior side of excretory bladder and after covering a distance of about 1/6th length of tail dilates before bifurcating into fine canals which open outside by pores located at margins of tail.

Redia transparent when young but pale yellow when fully developed ; each redia elongated sac like structure narrow anterior and broad posterior end, measures 1.42-1.64 in length and 0.35 in maximum breadth, collar situated about 0.15 behind anterior end ; birth pore located on one side behind collar ; locomotor processes present about 0.35-0.49 in front of posterior end ; mouth terminal leads into a sub-globular pharynx, measures 0.04 in diameter ; gut long with yellowish contents and extends posteriorly upto level of locomoter processes ; several unicellular gland cells open into anterior part of gut just behind pharynx ; in young redia four flame cells present on each side at level of locomotery processes ; each redia with cercariae and germ balls.

Snail Host : *Limnaea acuminata*. Locality : Telibagh, Lucknow.

32. *Cercariae indicae* XLVIII Sewell (Figs. 32. A-C)

1922. *Cercariae indicae* XLVIII Sewell, *Indian J. Med. Res.* (Suppl.), X : 113-116.

Diagnosis : Cercariae while swimming curls its body ventrally ; body varies considerably in shape in living cercariae, widest portion near ventral sucker, body measures $0.19-0.37 \times 0.14-0.07$; tail measures 0.26×0.04 ; anterior end bluntly rounded ; oral sucker spherical, measures 0.05 in diameter ; collar spines 43 in number, 4 angle spines at each end, remaining 35 arranged in double row around dorso lateral region, spines approximately same size ; body devoid of armature ; cystogenous cells oval or rounded with round nuclei and rod like cystogenous material ; circular ventral sucker situated one quarter to one third of total body length from posterior end, it measures 0.05 in diameter ; powerful tail attached to ventral side of body, ensheathed in a thick well developed cuticle, which form a fin fold at posterior part, on middle line of ventral aspect cuticle thickened, circular muscle well developed, extreme tip of tail pointed ; mouth subterminally, leads back into cavity of oral sucker ; prepharynx short ; pharynx globular, having a diameter of 0.02 ; oesophagus narrow ; no trace of lumen, it bifurcates in front of anterior margin of ventral sucker into two solid

narrow intestinal caeca which extends backward as far as to excretory bladder ; salivary glands composed of four pyriform cells with round nuclei and finely granular protoplasm, glands lie on either side of oesophagus between it and excretory tube, glands open on anterior and dorsal lip of mouth ; excretory bladder transversely oval with thin muscular coat, main excretory tubes arise from anterior aspect of

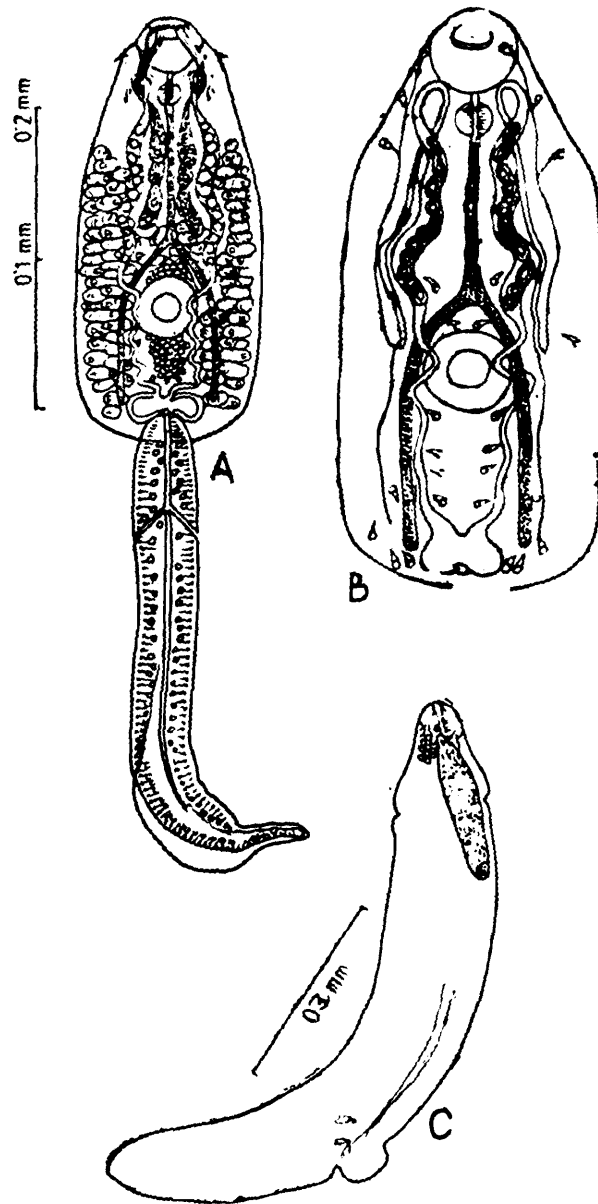


Fig. 32. A.—B. *Cercariae indicae* XLVIII Sewell, 1922.
C. Redia of *C. indicae* XLVIII Sewell, 1922.
(After Sewell, 1922)

bladder, take a wavy course and run upto pharyngeal region, dilated portion of tube contains refractile excretory granules, opposite pharynx tube becomes constricted and forming a loop on itself passes backward to ventral sucker region where it bifurcates into anterior and posterior collecting tubes, anterior tube passes forward to side of oral sucker and terminates into three anterior flame cells, posterior tube passes back-

ward to posterior end of body, body contains 14 pairs of flame cells, excretory bladder opens posteriorly on dorsal surface of point of attachment of tail, excretory pore oval, caudal canal passes backward through greater part of length of tail, it gives out a pair of lateral canals at about 1/6th distance from base of tail; genital rudiments represented by a mass of small rounded cells lying posterior to ventral sucker, another group of small mass of cells lying anterior to ventral sucker and between two caecal bifurcation representing genital orifice; nervous system forms a triangular mass situated laterally to pharynx, apex of each triangle directed medially and connecting commissure passes from side to side in front of pharyngeal bulb.

Mature redia measures 1.75×0.30 ; orange colour; tapers at each end, anterior end bluntly rounded; collar situated about 1/9th of total length from extreme tip; short blunt locomotor appendages present 1/3rd total length from posterior end; mouth terminal; pharynx well developed, having a diameter of 0.03; stomach short, filled with mass of black granular material; salivary gland cells represented by a group of small granular cells surrounding narrow anterior end of stomach; birth pore situated just behind collar region; opposite posterior locomotor processes on each side of body situated a group of three flame cells, wide excretory tube runs forward.

Snail Host : *Indoplanorbis exustus*. Locality : Manantoddy, North Wynaad and Sultan's Battery, Wynaad.

Remarks : Thapar (1969) while describing this cercaria observed a large number of secreting glands.

33. *Cercaria mainpurensis* Pandey (Figs. 33. A-C)

1965. *Cercaria mainpurensis* Pandey, *Proc. Nat. Acad. Sci. India*, XXX (B) IV : 390-392.

Diagnosis : Cercariae positive phototropic, emerge in morning; while swimming they settle to bottom of container and crawl a while; body large, aspinose, elongate oval, narrow anterior and broad posterior end, measures $0.25-0.32 \times 0.12-0.15$ in live and $0.19-0.23 \times 0.07-0.09$ in fixed; tail aspinose with an invaginable caudal process at its tip, larger than body, measures $0.30-0.39$ in length in live and $0.32-0.40$ in fixed, dorsal fin fold present roughly at least quarter of tail and extends upto middle of caudal process, large number of round nuclei about 63 in number present in tail parenchyma; oral sucker terminal, circular, measures 0.03×0.03 in live and also in fixed specimens; ventral sucker

larger than oral sucker, on posterior half of body, measures 0.04-0.05 in live and 0.05 in fixed ; collar prominent, armed with 48 spines, arranged in single row, four end group spines larger than others ; two closely opposed masses of spherical granules present at entrance of prepharynx ; prepharynx short, measures 0.03-0.04 in length ; pharynx globular to oval, measures 0.04-0.07 × 0.03-0.04 ; oesophagus long, measures 0.07-0.08 in length, bifurcates in front of ventral sucker into

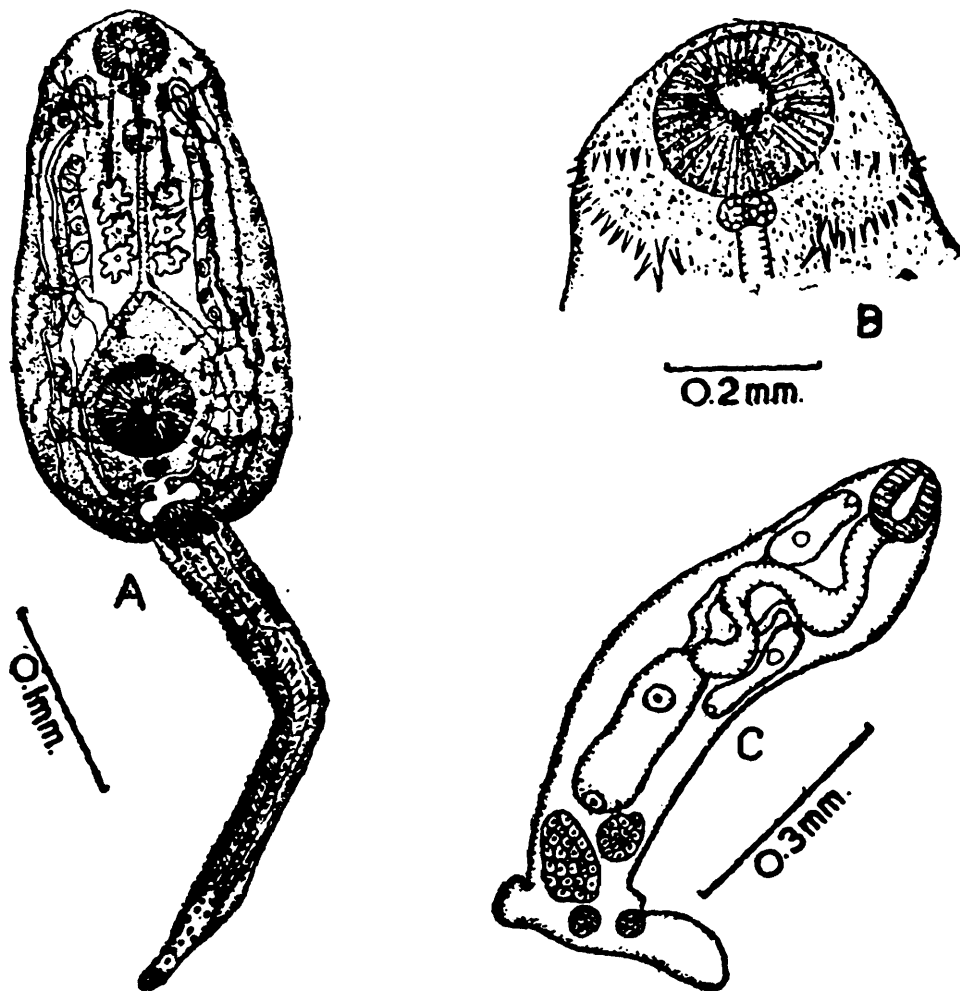


Fig. 33. A.—B. *Cercaria mainpurensis* Pandey, 1965.
C. Redia of *C. mainpurensis* Pandey, 1965.
(After Pandey, 1965)

intestinal caeca ; caeca extends upto posterior end of body ; penetration glands three pairs, lobate, at sides of oesophagus, each gland contains nucleus, fine granules, five ductless glands run together on each side anteriorly and open close to anterior border of oral sucker ; cystogenous glands present ; a mass of gland cells present at origin of tail ; excretory bladder transversely elongated, two excretory ducts join to form a small chamber (secondary chamber) which opens into anterior side of excretory bladder, each excretory duct runs anteriorly as ascending canal upto level of oral sucker where it forms a loop and turns back upto middle

region of body where it divides into anterior and posterior branches, anterior canal much dilated as it contains globular refractile granules of different sizes—numbering 6 or 7, anterior branch connected with 3 flame cells, posterior branch terminates in capillaries of 3 flame cells and receives two tertiary branches each with capillaries of 3 flame cells and with flame cell formula of $2[(3 + 3) + (3 + 3 + 3)] = 30$, caudal excretory canal extends into tail from posterior sides of excretory vesicle and runs upto base of caudal process, a pair of lateral tubules arise from caudal excretory canal about 1/3rd of its length and run outwards to open outside by pores located 0.01 from base of tail.

Young rediae large, elongated, golden yellow ; collar present about 0.3-0.9 from anterior end of body, birth pore present behind collar ; two short ambulatory processes present about 0.3-0.7 in front of hind end ; mouth terminal ; pharynx muscular measuring $0.05-0.08 \times 0.03-0.04$; gut rhabdoceel, long extends behind about 0.06-0.17 in front of ambulatory processes, gut in older rediae short, contains blackish material but in young rediae it appears long ; few well developed cercariae 1-4 in number present in each redia, several germ cells and balls present in rediae.

Metacercariae encyst in digestive gland and mantle of snail host ; cyst round to oval, transparent double walled.

Snail Host : *Indoplanorbis exustus*. Location : Digestive gland, Locality : Mainpuri, U. P.

34. *Cercaria nairi* Peter (Figs. 34. A)

1955. *Cercaria nairi* Peter, *Indian J. Vet. Sci. Anim. Husb.*, XXV (3) : 219-224.

Diagnosis : *Cercaria* very active swimmer, creeping movements accomplished by contraction and extension of body and aided by two suckers ; in semi contracted state widest portion of pyriform body being at about level of ventral sucker ; in live specimens body measures 0.22×0.16 in contracted and 0.40×0.09 in extended conditions and tail measures 0.37×0.04 in contracted and 0.47×0.04 in extended conditions, body of fixed specimens measure 0.24×0.14 and tail measures 0.40×0.04 , body and tail aspinose ; eye spots absent ; cystogenous glands round to oval, arranged in two or three bundle like formation ; oral and ventral suckers well developed, oral sucker smaller than ventral sucker and spherical in shape with diameter of 0.04, large anteriorly directed acetabulum highly muscular and heart shaped and wider horizontally

than antero posteriorly and measures 0.05×0.06 ; collar spines 41 in number—15 dorsal collar spines equal in size arranged in two alternative rows of 8 orals and 7 aborals, 8 lateral collar spines on either side which continues with dorsal aborals and 5 angle spines placed on

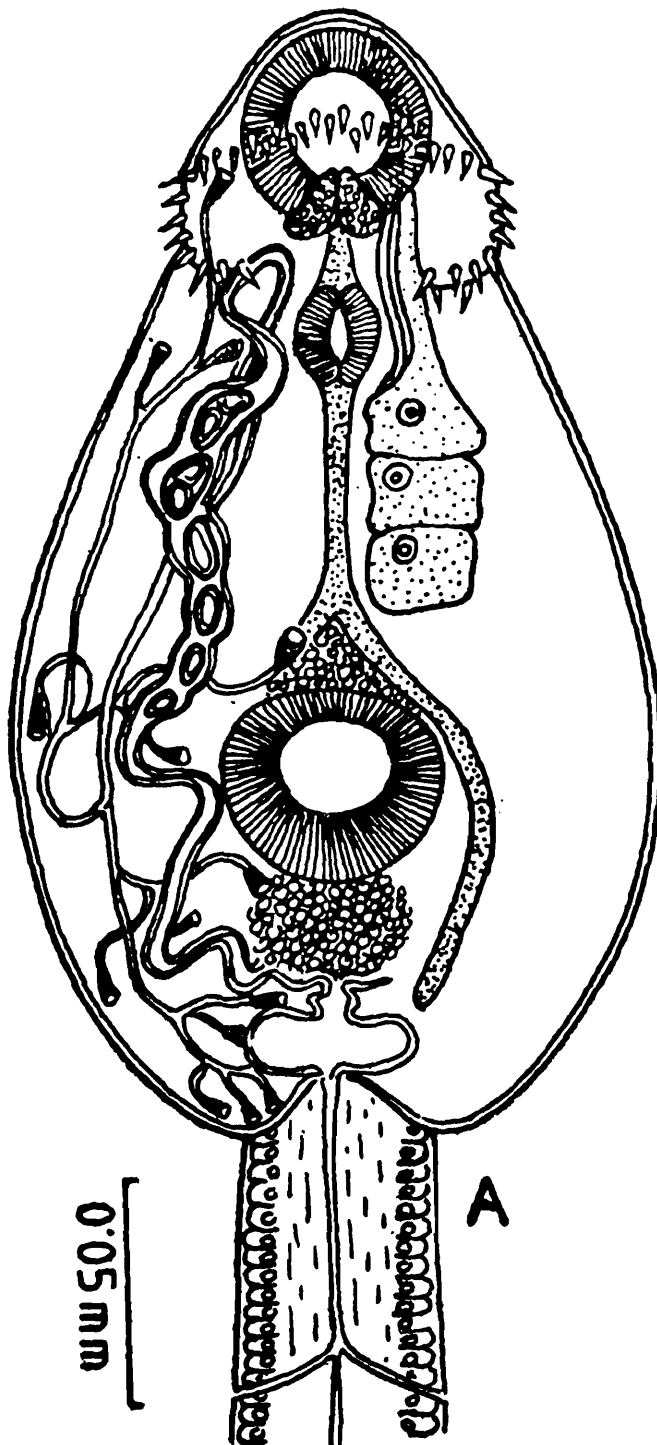


Fig. 34. A. *Cercaria nairi* Peter, 1955.
(After Peter, 1955)

each ventro lateral lappet, angle spines slightly larger than rest and set at an angle to others ; about level of posterior border of oral sucker on dorsal surface two irregular bodies contain highly refractile granules and measure 0.011×0.014 ; cuticle of tail expands on median dorsal aspect

at posterior third into a cuticle fold or fin which extends backward to about half length of conical projection, tail containing circular and longitudinal muscles and rounded nuclei; mouth sub terminal; pre-pharynx short; pharynx pyriform and muscular, measuring 0.02×0.01 ; oesophagus divides anterior to acetabulum into two caecae; caeca passes round sides of acetabulum and extends upto antero lateral aspects of bladder; secretory glands composed of three pyriform cells arranged longitudinally, gland cells contain round nucleus and finally granular protoplasm, ducts of gland cells open on anterior border of mouth opening; excretory bladder situated at posterior end of body, it consists of large reniform posterior chamber and a small anterior one, bladder opens by small pore posterior on dorsal surface of body at points of attachment of tail, main excretory canals originate medially from anterior chamber of bladder pursue outward and forward as very wide tubes and on reaching level of pharynx they become suddenly narrower and form loops and pass backward as narrow tubes to acetabular region where they bifurcate into anterior and posterior collecting tubules, anterior collecting tubule divides into two branches each one giving off three capillaries capped with flame cells whereas posterior collecting tubule divides into three branches each leading to a set of three flame cells, 15 flame cells present on either side of body—six with anterior tubule and nine with posterior tubule all occurring in groups of three, with flame cell formula of $2[(3+3)+(3+3+3)] = 30$, a longitudinal caudal canal present and about $1/6$ th distance from root of tail this canal gives off a pair of lateral tubes open through minute pores, dilated portion of main canals contain very large and highly refractile conspicuous excretory granules which roughly oval in shape and with different sizes; genital organs represented by two masses or round cells—a large mass lying posterior to acetabulum and excretory bladder and smaller mass representing rudiments of genital pore occupying narrow triangular space bounded by anterior margin of acetabulum and proximal portions of two diverging caeca.

Rediae infest digestive gland and reproductive organs of molluscan host; rediae contain golden yellow pigment granules in body wall and measure 0.38×0.07 ; anterior end bluntly rounded; birth pore situated $1/9$ th distance from extreme tip; locomotor appendages present from $1/3$ rd distance from posterior end of body; globular pharynx measures 0.04 in diameter; gut sac like, filled with dark reddish brown granular content, in young specimens gut may extend posteriorly to level of locomotor appendages while in grown up forms it stops short at a point behind collar region, proximal part of gut surrounded by a group of small

granular salivary gland cells ; at about level of locomoter appendages a group of three flame cells present either side of body ; rediae contain germ balls and cercariae.

Cercariae encyst within primary molluscan host ; cyst globular, transparent and measure 0.15 in diameter.

Snail Host : *Indoplanorbis exustus*. Locality : Madras city.

35. *Cercaria* sp. VI Kerala Mohandas.

(Figs. 35. A)

1981. *Cercaria* sp. VI Kerala Mohandas, *Proc. Indian Acad. Sci.*, 90 (4) : 433-444.

Diagnosis : *Cercaria* swims actively in water, emerges in morning hours and does not exhibit any taxis ; body pyriform, aspinose, slightly brown in colour and measures $350-350\mu \times 210-280\mu$; oral sucker $56-70\mu$ in diameter ; protrusible acetabulum $70-100\mu$, equatorial or post equatorial ; collar $125-155\mu$ wide, bearing 47 spines—5 corner spines on each side (3 oral and 2 aboral), 7 lateral spines in a single row on each side and 23 dorsals (12 oral and 11 aboral), spines of equal size of $12-18\mu$ long ; sensory hairs 11-14 pairs, one pair at oral sucker region and remaining at anterior half ; 65-85 upwardly directed spines present dorsal to prepharynx ; cystogenous cells with granular protoplasm ; tail aspinose, slightly longer than body, measures $400-630\mu \times 60-85\mu$; fin folds present, lateral fin fold at proximal end and dorsoventral at posterior half of body ; sensory hairs 12-14 pairs in posterior half ; mouth subterminal ; short prepharynx ; slightly oval pharynx ; oesophagus long and solid with 10 cells ; caeca extend upto posterior end of body ; penetration glands three on either side of oesophagus and with coarsely granular protoplasm ; excretory vesicle bipartite, each main duct accomodates 60-90 concretions, retrograde duct with ciliated patches and 18 pairs of flame cells in three groups, with flame cell formula of $2[(3+3+3)+(3+3+3)] = 36$, caudal excretory duct opens through lateral excretory pores ; genital primordia consists of two groups of cells situated anterior and posterior to acetabulum and connected by cord of cells ; two small nerve masses situated on either side of prepharynx and connected by transverse nerve fibres.

Redia measures $540-1950\mu \times 266-350\mu$; gut saccular with yellowish black materials, extends to posterior half of body ; redia contains as many as 8 cercariae and germ balls.

Metacercaria found in pericardial sac of infected snails ; encysta-

tion takes place on glass slides ; cysts spherical, measure 190-200 μ wide with two layers, outer layer transparent and 10-15 μ thick, inner layer opaque and 4-6 μ thick.

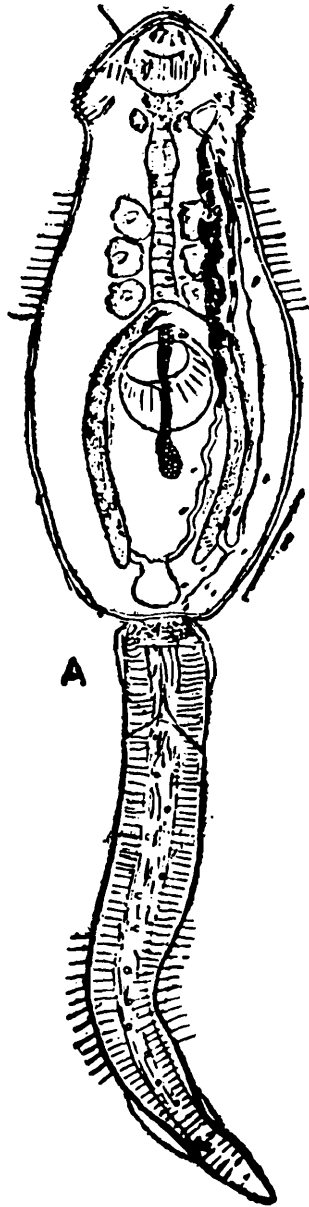


Fig. 35. A. *Cercaria* sp. VI Kerala Mohandas, 1981.
(After Mohandas, 1981)

Snail Host : *Limnaea luteola*. Location : Hepatopancreas.
Locality : Trivandrum district.

36. *Cercaria spinosa* Pandey and Singh
(Figs. 36. A-D)

1984. *Cercaria spinosa* Pandey and Singh, *J. Zool. Soc. India*, 36 (1&2) : 73-82.

Diagnosis : Cercariae whitish, anterior end turns ventrally while swimming ; body elongated oval, body cuticle thick and beset with

backwardly directed minute spines ; cercaria measures $0.54-0.81 \times 0.30-0.42$ in live and $0.27-0.40 \times 0.11-0.18$ in fixed condition ; body surface with transverse striations ; cylindrical tail measures $0.64-0.88 \times 0.07-0.10$ in live and $0.40-0.52 \times 0.03-0.05$ in fixed individuals, tail with circular,

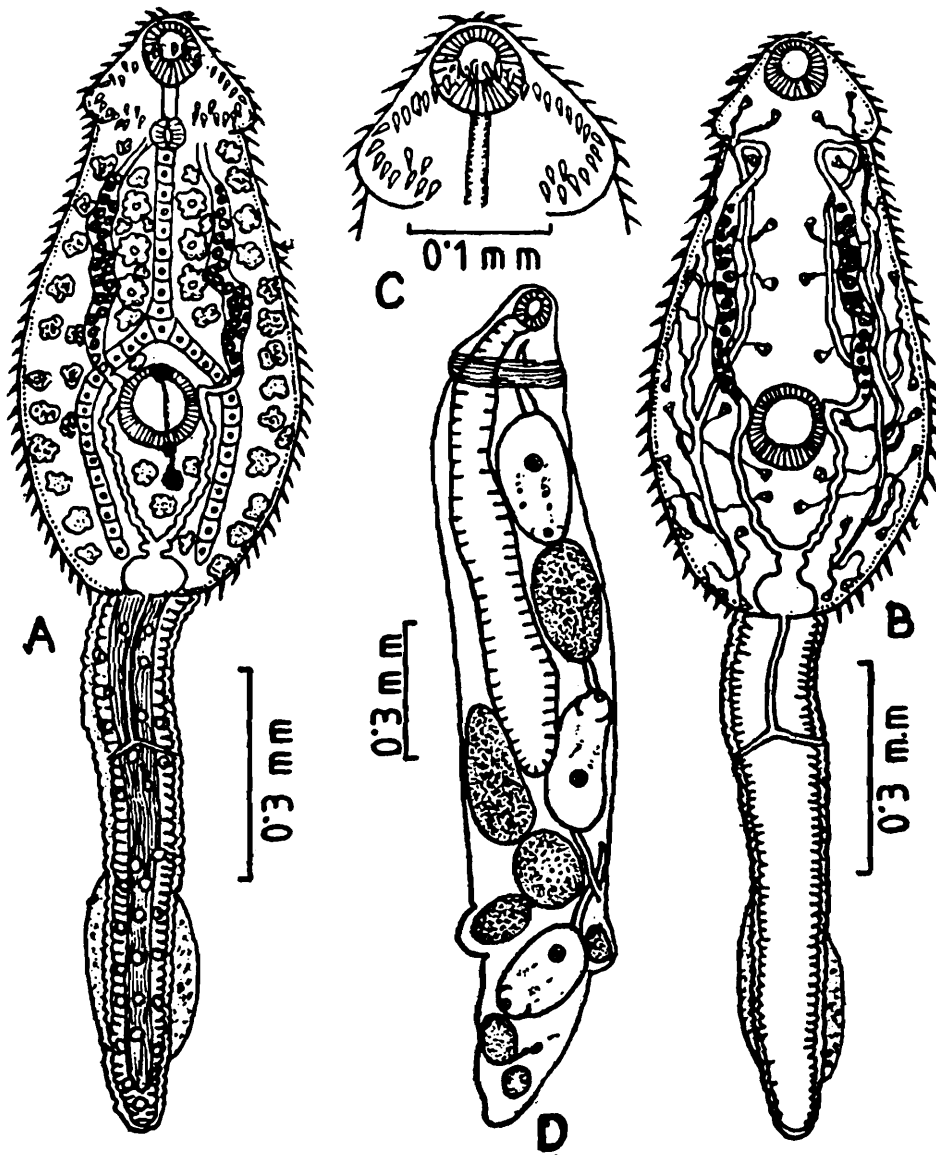


Fig. 36. A.—C, *Cercaria spinosa* Pandey and Singh, 1984.
D. Redia of *C. spinosa* Pandey and Singh, 1984.
(After Pandey and Singh, 1984)

longitudinal and oblique muscles, fin folds of two sides of tail assymetrical ; circular terminal oral sucker measures $0.05-0.07$ in live and $0.03-0.04$ in fixed specimens ; circular ventral sucker larger than oral sucker, measures $0.09-0.12$ in live and $0.04-0.07$ in fixed specimens, located posterior to mid body ; collar distinct, collar spines 37-38 in number, end group of spines 5 in number and measure $0.01-0.02$; mouth leads into short prepharynx, measuring $0.06-0.08$ in length in live ; $0.02-0.03$ in fixed specimens ; pharynx globular, measures $0.03-0.05$ in diameter in live and $0.01-0.02$ in fixed specimens ; oesophagus long, measures

0.12-0.20 in live and 0.08-0.12 in fixed specimens ; oesophagus divides in front of ventral sucker into intestinal caeca which extends upto hind region of body ; gut divided into compartments by septa and filled with coarsely granular food material ; three pairs of large and round to oval shape penetrating glands situated on either side of oesophagus, filled with granular cytoplasm and prominent centrally placed nucleus ; primordia of genital organs represented by three cell masses, anterior cell mass which represents genital atrium situated anterior border of ventral sucker, middle mass representing ovary situated just behind ventral sucker, larger posterior mass of cells representing future testes situated behind middle mass of cells posterior to ventral sucker, these cell masses joined by streak of cells representing various genital ducts ; excretory bladder two chambered, main collecting excretory canal originates one on either side of anterior small chamber, main canals run anteriorly in convoluted manner and at level of ventral sucker turn inward and in region of pharynx form loops and run posteriorly and at level of ventral sucker divide into anterior and posterior canals, dilated portion of excretory canals contain excretory granules, anterior canals divide into three branches bearing flame cells ; posterior collecting canals also divides into three branches with flame cells, flame cell formula— $2[(3+3+3)+(3+3+3)] = 36$, caudal excretory duct runs posteriorly through tail upto anterior 1/3rd of tail where it divides into two lateral branches each opening outside by a pore.

Redia developed into digestive glands and gonads of host ; thin walled and whitish in colour ; elongated redia provided with narrow ends ; measures $1.21-2.00 \times 0.28-0.38$ in live and $0.45-0.31 \times 0.14-0.19$ in fixed specimens ; collar prominent ; birth pore present behind collar ; mouth of redia terminal ; pharynx circular measures 0.10-0.12 in live and 0.03-0.06 in fixed specimens ; gut long, blind, runs posteriorly upto middle of body, filled with blackish food material ; foot well developed in posterior region ; each redia with 3-4 mature cercariae, developing cercaria and germ balls.

Metacercaria measures $0.25-0.28 \times 0.23-0.25$ in live and $0.19-0.20 \times 0.14-0.19$ in fixed specimens ; cyst wall thin, transparent, single layered.

Snail Host : *Belamya bengalensis*. Location : Digestive gland and gonad. Locality : Nawabganj, Unnao (U. P.).

37. *Cercaria tandani* Pandey and Singh
(Figs. 37. A-E)

1982. *Cercaria tandani* Pandey and Singh, *Read. Zool.*, 1 : 70-74.

Diagnosis : *Cercaria* emerges throughout day, active swimmers, at bottom of container it creeps like caterpillar with help of suckers ; body elongate oval, anterior end blunt and posterior end rounded, measures $0.19-0.22 \times 0.12-0.14$ in live and $0.11-0.12 \times 0.05-0.06$ in fixed specimens, covered with spines and thick cuticle, cuticular striations on body present ; anterior region prominent collar present, collar spines 32 in number, arranged in double rows, end group spines three pairs, end group spines slightly larger than rest ; posterior border of oral sucker and in region of prepharynx located two oval masses, entire structure measures 0.005×0.002 and contains number of round, highly refractile granules ; oral sucker well developed, subterminal, measures $0.03-0.04$ in diameter in live and $0.01-0.02$ in fixed specimens ; ventral sucker well developed, post equatorial, larger than oral sucker, measures $0.04-0.05$ in diameter in live and $0.02-0.03$ in fixed specimens ; mouth leads into narrow prepharynx ; pharynx highly muscular, measures $0.01-0.02$ in diameter in live and $0.008-0.010$ in fixed specimens ; oesophagus long measures $0.12-0.18$ in live and $0.08-0.11$ in fixed specimens ; intestinal caeca extend upto hind region of body ; penetration glands three pairs, irregular, arranged in linear fashion on either side of oesophagus, glands open to outside through separate pores by long ducts, each gland contains prominent central nucleus and granular cytoplasm ; cystogenous cells two types—smaller cells rounded in shape, filled with granular cytoplasm and larger cells round to oval, filled with rod shaped bodies arranged in parallel rows ; rudiment of genital organs represented by two round masses of cells, one situated at anterior margin of ventral sucker and other at posterior margin of ventral sucker, two masses joined by a strand of cells ; excretory bladder situated at posterior end of body, two chambered, posterior chamber oval, large, opens into another chamber with long cornua, main collecting canal on each side of body runs forward in a convoluted manner, on reaching ventral sucker it dilates to accomodate 6 to 10 excretory granules of different sizes, main canal narrows and forms a loop in region of oral sucker and it runs posteriorly along outer side of main excretory canal, it divides into two branches an anterior and posterior at level of ventral sucker, anterior collecting canal gives rise to two branches—each with two capillaries with flame cells, posterior canal gives rise to two fine branches which bear two capillaries tipped with flame cells, flame cell formula represent-

ed by $2[(2+2)+(2+2)] = 16$, posterior chamber of excretory bladder a fine duct arises and runs into tail, at about 1/3rd from anterior end of tail it gives rise to two short lateral branches opening to exterior through pores ; tail longer than body, measures $0.24-0.25 \times 0.04-0.05$ in live and $0.21-0.22 \times 0.01-0.02$ in fixed specimens, provided with longitudinal and

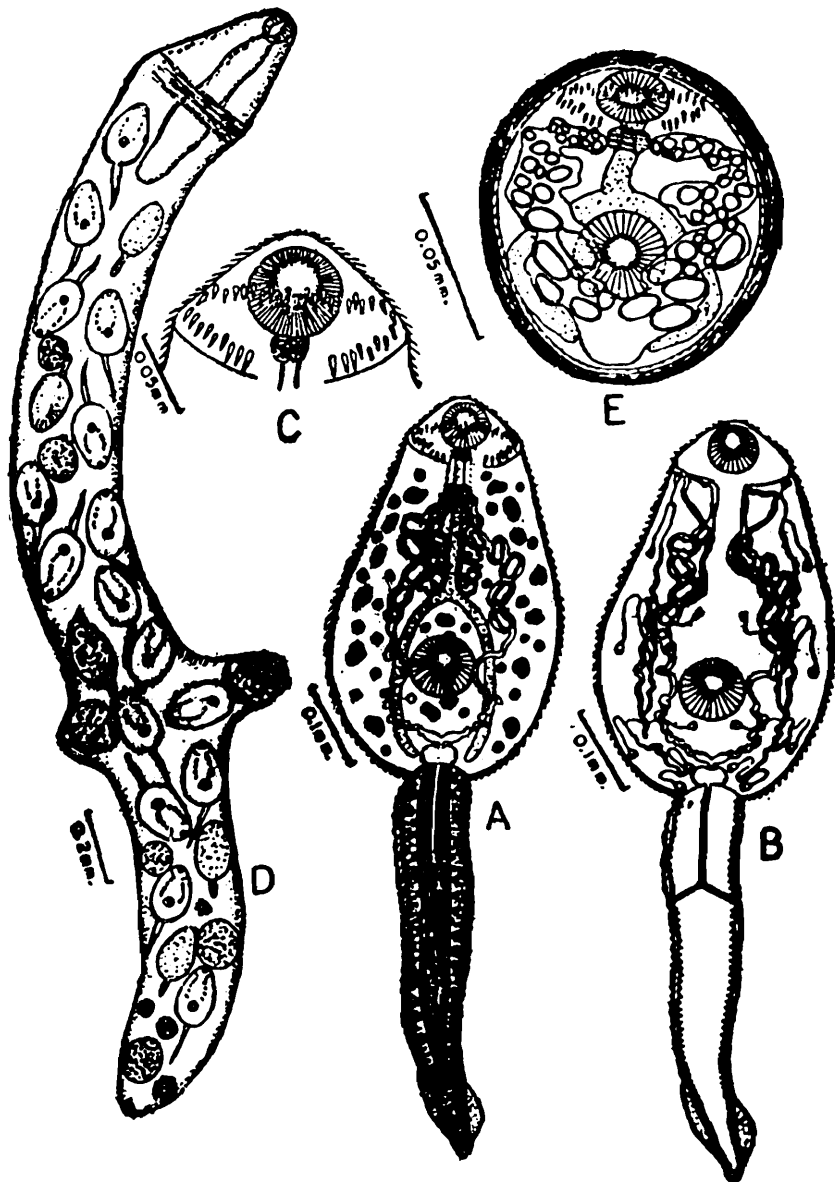


Fig. 37. A.—C. *Cercaria tandani* Pandey and Singh, 1982.
 D. Redia of *C. tandani* Pandey and Singh, 1982.
 E. Metacercaria of *C. tandani* Pandey and Singh, 1982.
 (After Pandey and Singh, 1982)

circular muscles, longitudinal muscles end at a short distance from tip of tail, at tip of tail only circular muscles present, fin fold present near tip of tail, a large number of small, rounded caudal bodies embedded in tail parenchyma.

Redia exhibits slow movements ; elongated and brownish colour redia measures $0.51-1.20 \times 0.07-0.10$ in live and $0.32-0.88 \times 0.05-0.09$ in

fixed specimens ; muscular collar present in anterior region of body ; golden yellow granules present in mature redia and absent in young redia ; birth pore present at anterior region near collar ; mouth leads into a well developed, muscular pharynx which measures 0.01-0.02 in diameter ; gut blind, extends upto a short distance from anterior end, filled with dark black material in mature redia ; a pair of well developed lappets present near posterior third of body ; in young redia region behind gut filled with germ balls ; mature redia packed with cercariae and germ balls.

Cercaria encysts into wall of mantle cavity of primary intermediate host ; round, thick and double layered cyst measures 0.11×0.82 ; long slender body metacercaria measures $0.15-0.17 \times 0.01-0.06$; oral sucker measures 0.02-0.03 in diameter ; ventral sucker measures 0.03-0.04 in size ; prepharynx measures 0.01-0.02 in length ; rounded prepharynx measures 0.01-0.02 in diameter ; oesophagus measures 0.03-0.04 in length ; penetration glands and cystogenous cells absent ; excretory bladder 'Y' shaped ; excretory granules present.

Snail Host : *Indoplanorbis exustus*. Location : Digestive gland. Locality : Narindapur, Sultanpur (U. P.).

38. *Cercaria tetraglandulata* Srivastava (Figs. 38. A-C)

1968. *Cercaria tetraglandulata* Srivastava, *Proc. Nat. Acad. Sci. India*. 30 (B) III & IV : 230-234.

Diagnosis : Body spinose, with narrow anterior and broad round posterior end, it measures $0.37-0.42 \times 0.21-0.30$ in live specimens and $0.22-0.27 \times 0.07-0.10$ in fixed specimens, body spines present all over body and arranged in transverse rows ; spinose tail longer than body, measures $0.45-0.52 \times 0.06-0.07$ near base of body in live specimens and $0.30-0.37 \times 0.04$ in fixed specimens, caudal fin present in form of two small membranes on lateral margins and near distal end of tail, a number of small rounded nuclei arranged in slightly irregular parallel rows seen embedded in tail parenchyma, tail on contraction appears transversely striated throughout its whole length ; oral sucker terminal, spherical or subspherical, measuring 0.05-0.06 in diameter in live specimens and 0.03-0.04 in diameter in fixed specimens ; ventral sucker slightly larger than oral sucker, situated behind equatorial line of body, measures 0.06-0.07 in diameter in live specimens and 0.04-0.05 in diameter in fixed specimens ; cephalic collar well developed, armed with single row of 42 collar spines, spines roughly equal in size, measures

0.01 in length, end group spines absent ; posterior margin of oral sucker with a pair of refractile dorsal body ; prepharynx present ; pharynx muscular, measuring 0.02-0.03 in diameter in live specimens and 0.01-0.02 in diameter in fixed specimens ; oesophagus measures 0.09-0.14 in length, it bifurcates short distance in front of ventral sucker into two intestinal caeca which extend posteriorly almost upto posterior end of

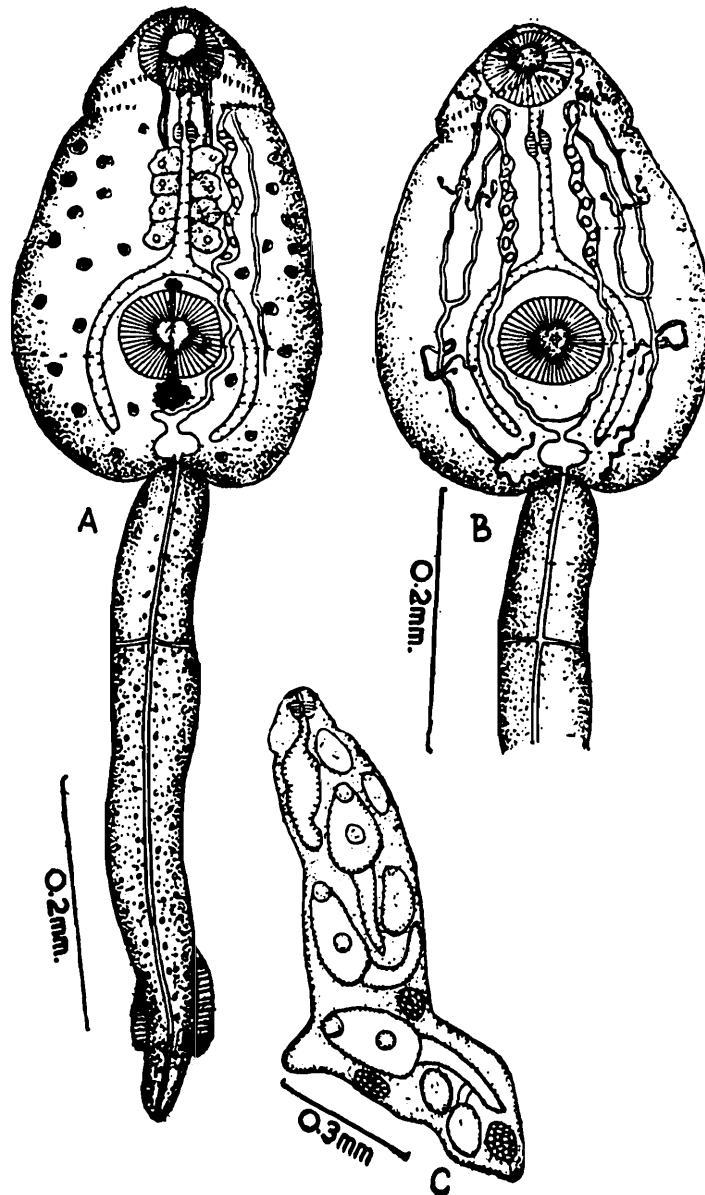


Fig. 38. A.—B. *Cercaria tetraglandulata* Srivastava, 1968.
C. Redia of *C. tetraglandulata* Srivastava, 1968.
(After Srivastava, 1968).

body ; penetration glands four pairs, located one behind other on either side of oesophagus, each gland contains a nucleus and fine granules, glands open to exterior by means of separate pores near anterior end of body and close to mouth ; cystogenous gland cells present all over body, cells irregular in shape, contain small rod like bodies arranged in parallel rows ; genital rudiments present just in front and behind ventral

sucker in form of spherical or subspherical masses joined together by a row of cells ; excretory bladder consists of two chambers—a transversely oval posterior chamber and a small 'T' shaped anterior chamber, two main collecting canals open one on side on anterior lateral side of anterior chamber of excretory bladder, capillaries of two flame cells near oral sucker unite to form anterior collecting canal which runs posteriorly upto region of anterior border of ventral sucker, capillaries of two flame cells at level of oesophagus unite together and open into anterior collecting canal, capillaries of two flame cells near posterior end of body unite to form posterior collecting canal, capillaries of a pair of flame cells open into posterior collecting canal at middle level of ventral sucker, posterior collecting canal on each side runs anteriorly upto anterior border of ventral sucker where it joins with anterior collecting canal and forms main collecting canal, main canal proceeds anteriorly upto posterior border of oral sucker makes a loop and runs upto pharyngeal region where it widens and proceeds upto region of intestinal bifurcation where it again becomes narrow and runs posteriorly to open in anterior chamber of excretory bladder, widened portion of main collecting canal on each side filled with 6-9 round to oval excretory granules of different sizes, flame cells arranged in doubles with a flame cell formula of $2[(2+2)+(2+2)]=16$, caudal excretory canal extends into tail from posterior end of excretory bladder, it gives off two small lateral canals one on each side at posterior region of anterior third of tail which run towards lateral margin of tail and open to outside, main caudal excretory canal proceeds posteriorly almost upto distal end of tail.

Rediae show slow movements of contraction and expansion ; numerous orange coloured pigment spots present all over body ; rediae measure $0.81-1.23 \times 0.15-0.24$ in live specimens and $0.54-0.66 \times 0.12-0.13$ in fixed specimens ; muscular pharynx measures $0.05-0.12$ in diameter in live and $0.05-0.06$ in diameter in fixed specimens ; gut filled with blackish material and measures $0.25-0.34$ in length in live and $0.17-0.22$ in length in fixed specimens ; birth pore present at about $0.10-0.18$ from anterior end of body and proscuscula at about $0.18-0.45$ distance from posterior end of body, 3-12 well developed cercariae present in each redia ; some developing cercariae and germ balls also present in each redia.

Snail Host : *Indoplanorbis exustus*. Location : Hepatopancreas.
Locality : Gazipur, Lucknow (U. P.).

39. *Cercaria triglandulata* Baugh
(Figs. 39. A—D)

1975. *Cercaria triglandulata* Baugh, *Rev. Iber. Parasitol.*, 35 (3-4) : 311-328.

Diagnosis : *Cercaria* emerges in morning and continues to emerge till noon, positive phototactic ; body large, aspinose, pear shape, bluntly pointed anterior and broadly round posterior ends, measures 0.35-0.36 in length and 0.18-0.19 in maximum breadth in live specimens; tapering tail devoid of spines, measures 0.38-0.40 in length and 0.05 in breadth at base in live specimens, a short conical caudal process invaginable in nature present at tip of tail, dorsal and ventral fin folds present at posterior half of tail and extend upto tip of tail ; body measures 0.17-0.22 in length and 0.09-0.10 in maximum breadth in fixed and mounted specimens ; tail measures 0.33-0.38 in length and 0.031-0.038 in breadth at proximal part ; oral sucker terminal measures 0.04-0.05 in diameter in live specimens and 0.03-0.04 in fixed specimens ; ventral sucker situated in middle of posterior half of body, measures 0.05-0.06 in diameter in live specimens and 0.04 in fixed specimens ; collar prominent, armed with 41 spines arranged in two alternate rows, end group spines absent ; prepharynx short, measures 0.02 in length ; pharynx subglobular, measures 0.01-0.10 in diameter in live specimens ; a mass of granules spherical and refractile in nature present at entrance of prepharynx ; oesophagus bifurcates in front of ventral sucker into intestinal caeca ; caeca extends upto excretory bladder at posterior end of body ; penetration gland cells three, large and lobate, present on each side of oesophagus, each gland cell contains a large nucleus and finely granular cytoplasm, duct opens at anterior margin of mouth ; cystogenous cells numerous, present from pharyngeal region to posterior end of body, each cell with nucleus and bacilliform rods arranged in parallel way ; excretory bladder situated at posterior end of body, rectangular in outline, two main excretory canals open seperately at anterior lateral corners of bladder, each canal runs forward as ascending limb upto prepharyngeal region where from it turns backward forming a loop and runs as descending limb upto middle region of ventral sucker where it bifurcates into two secondary branches—anterior and posterior collecting canals, anterior canal longer than posterior, ascending limb of each canal contains 6 to 9 even 10 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 composed of two partly fused corpuscles, anterior as well as posterior collecting canal of either side have three short tertiary branches connected each with

capillaries of three flame cells, flame cell formula can be represented by $2 [(3+3+3)+(3+3+3)] = 36$, caudal excretory canal springs from middle of posterior side of excretory bladder and enters into tail wherein it runs backward and after covering a distance of about $1/4$ th of entire length of tail forks into two fine branches which obliquely outward and

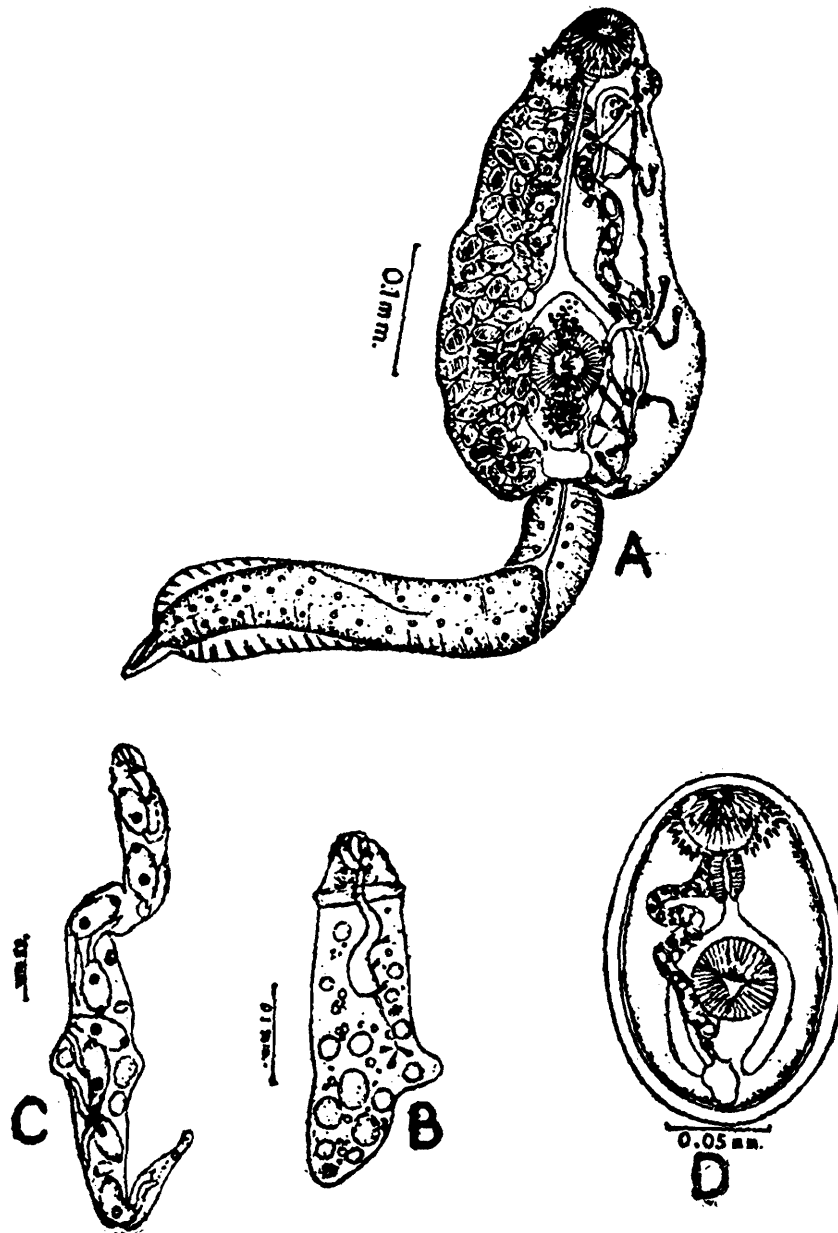


Fig. 39. A. *Cercaria triglandulata* Baugh, 1975.
 B.—C. Redia of *C. triglandulata* Baugh, 1975.
 D. Metacercaria of *C. triglandulata* Baugh, 1975.
 (After Baugh, 1975)

backward and opening outside by pores located at sides of tail, caudal excretory canal not extended beyond its point of bifurcation in tail ; two masses of germ cells—one placed close to anterior border and other to posterior border of ventral sucker constitute germinal primordium, these two masses interconnected by an isthmus running across ventral sucker.

Young redia transparent, small whereas older ones pale brown, long with narrow aboral end; young live redia measures 0.68-0.71 in length and 0.12-0.13 in maximum breadth, live mature redia measures 1.76-1.92 in length and 0.19-0.22 in maximum breadth; collar present around body about 0.09-0.11 behind anterior end, on one side just behind collar situated a small papilla with birth pore; locomotor processes present towards posterior region of body about 0.68-0.91 in front of hind end in fully developed redia; terminal mouth leads into a pharynx measuring $0.04-0.05 \times 0.03-0.04$; short gut, extends behind beyond collar, gut appears longer in young redia and contains brownish substance; a mass of gland cells surrounds anterior part of gut behind pharynx; redia contains cercariae and germ balls; six flame cells present on each side in young redia—three present near locomotor process and three in region of posterior part of gut and open on each side into a lateral collecting canal.

Cercariac encyst in liver and mantle edge of same infected snail; cyst transparent, oval, measures 0.17 in live condition; collar spines of encysted metacercaria prominent; refractile excretory corpuscles more in metacercaria than in cercaria; some granules forming plug at entrance of pharynx appear to have been absorbed.

Snail Host: *Indoplanorbis exustus*. Location: Digestive gland. Locality: Purnea village, Lucknow (U. P.).

40. *Cercaria unnaoensis* III Pandey and Lal

(Figs. 40. A—D)

1982. *Cercaria unnaoensis* III Pandey and Lal, *Recd. Zool.*, 1 (2) : 17-38.

Diagnosis: *Cercaria* emerges throughout day, swims actively, while swimming anterior end elongates and turns ventrally, crawls at bottom of container with suckers, remain alive for about 10 hours; spinose body with elongate oval anterior and round posterior ends, measures $0.52-0.72 \times 0.30-0.40$ in live and $0.26-0.38 \times 0.10-0.17$ in fixed specimens; collar distinct, bears 37 spines including 5 end group of spines, spines dorsally interrupted; tail cylindrical, measures $0.60-0.80 \times 0.06-0.09$ in live and $0.30-0.50 \times 0.03-0.05$ in fixed specimens, consists of circular, longitudinal and oblique muscles and irregularly arranged caudal bodies, two short fin folds present near tip of tail; oral sucker small, circular, measures 0.05-0.07 in live and 0.02-0.03 in fixed specimens; ventral sucker larger than oral sucker, located behind equatorial line of body, measures 0.08-0.10 in live and 0.03-0.06 in fixed speci-

mens ; prepharynx short, measures 0.05-0.07 in length in live and 0.02-0.03 in fixed specimens ; pharynx globular, measures 0.03-0.04 in live and 0.01-0.02 in fixed specimens ; oesophagus long, measures 0.10-0.20 in live and 0.07-0.10 in fixed specimens ; intestinal caeca narrow, extends upto hind end of body ; oesophagus and caeca divided by many septa ;

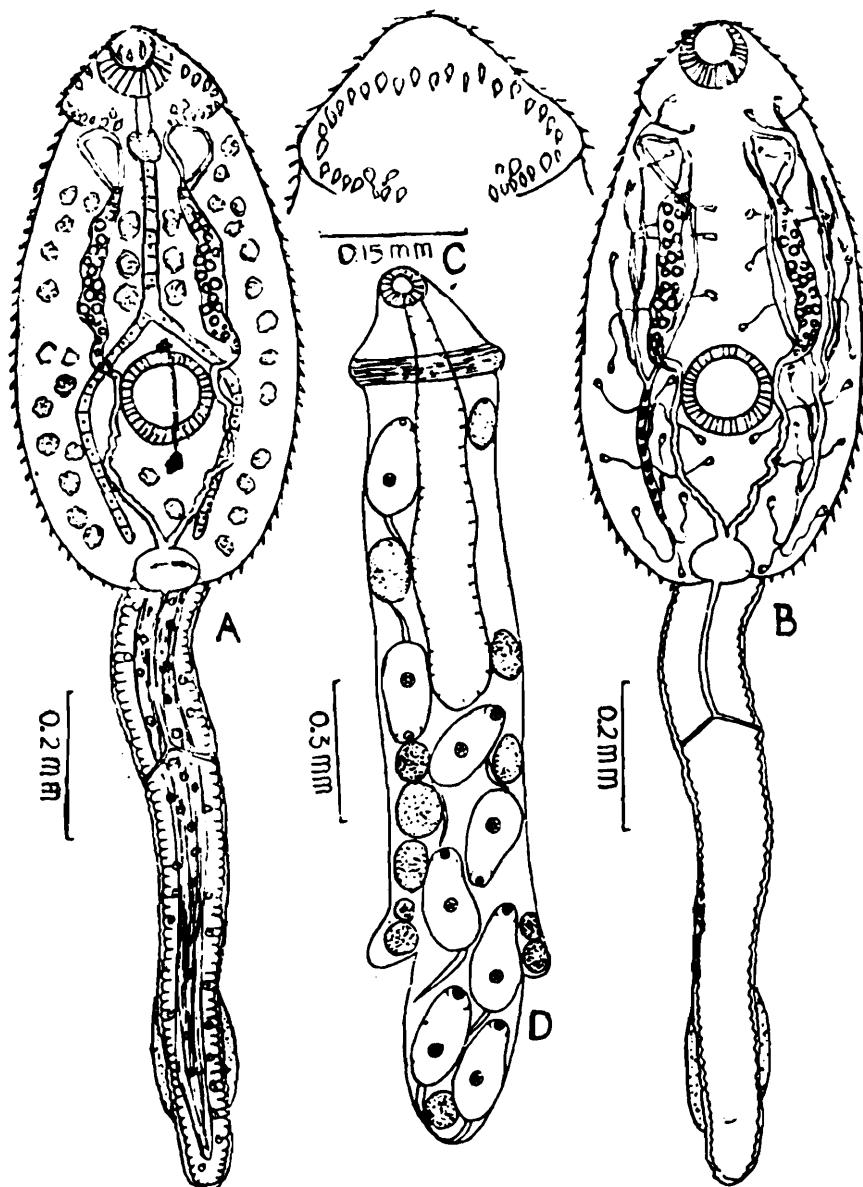


Fig. 40. A.—C. *Cercaria unnaoensis* III Pandey and Lal, 1982.
D. Redia of *C. unnaoensis* III Pandey and Lal, 1982.
(After Pandey and Lal, 1982)

penetration glands three pairs, situated on either side of oesophagus, oval to round with centrally placed nuclei ; cystogenous cells large, irregular with coarse granular cytoplasm ; rudiments of genital organs represented by two dark stained cell masses located anterior and posterior to ventral sucker, joined together by a streak of cells ; excretory bladder oval, located at hind end of body, main excretory canal originates from anterior region of chamber and runs forward, it dilates to accommodate a large number of excretory corpuscles in region of oesopha-

gus, in region of pharynx it narrows and turns back, at level of ventral sucker it divides into two branches—an anterior and a posterior collecting canal, anterior collecting canal divides into three branches each of which in turn divides into three capillaries tipped with a flame cell, posterior collecting canal divides into three branches, each dividing into three capillaries tipped with a flame cell, flame cell formula represented by $2[(3+3+3)+(3+3+3)]=36$, from hind end of excretory bladder a caudal excretory duct arises and runs posteriorly upto anterior third of tail and bifurcates into two fine branches each opening laterally.

Redia thin walled, elongate, narrow ends, measures $1.80-2.80 \times 0.25-0.32$ in live and $0.50-1.10 \times 0.13-0.15$ in fixed specimens ; muscular collar located slightly behind anterior end ; birth pore situated behind collar ; marginal lappets present in hind region of body ; pharynx measures $0.09-0.15$ in live and $0.03-0.06$ in fixed specimens ; blind gut runs upto middle of body ; each redia contains cercariae and germ balls.

Snail Host : *Vivipara bengalensis* (= *Bellamyia bengalensis*), *Limnea auricularia*, *Indoplanorbis exustus*. Location : Hepatopancreas. Locality : Priyadarshini Jheel, Unnao (U. P.).

IV. MEGACAUDATA GROUP

Diagnosis : Tail massive and much larger than body, body small.

Key to Indian Species

1. Body aspinose, large number of small spines arranged in a triangular area posterior to pharynx ... *C. rithorensis*
 Body spinose, dense mass of small gland cells present on each side of pharynx ... *C. megacauda*

41. *Cercaria megacauda* Baugh (Figs. 41. A—C)

1975. *Cercaria megacauda* Baugh, *Rev. Iber. Parasitol.*, 35 (3-4) : 311-328.

Diagnosis : Large tailed cercaria, it emerges in large number during early hours of morning and remains active throughout day ; cercaria large, performs wriggling movements, it suspends from surface of water and then slowly sinks to bottom of container, wriggling movements caused by action of huge tail, cercaria positively phototactic ;

body appears as a mere knob at broad anterior end of large tail, body spinose, oval in shape, bluntly pointed anterior and broadly round posterior ends, measures 0.27-0.32 in length in live and 0.09-0.17 in

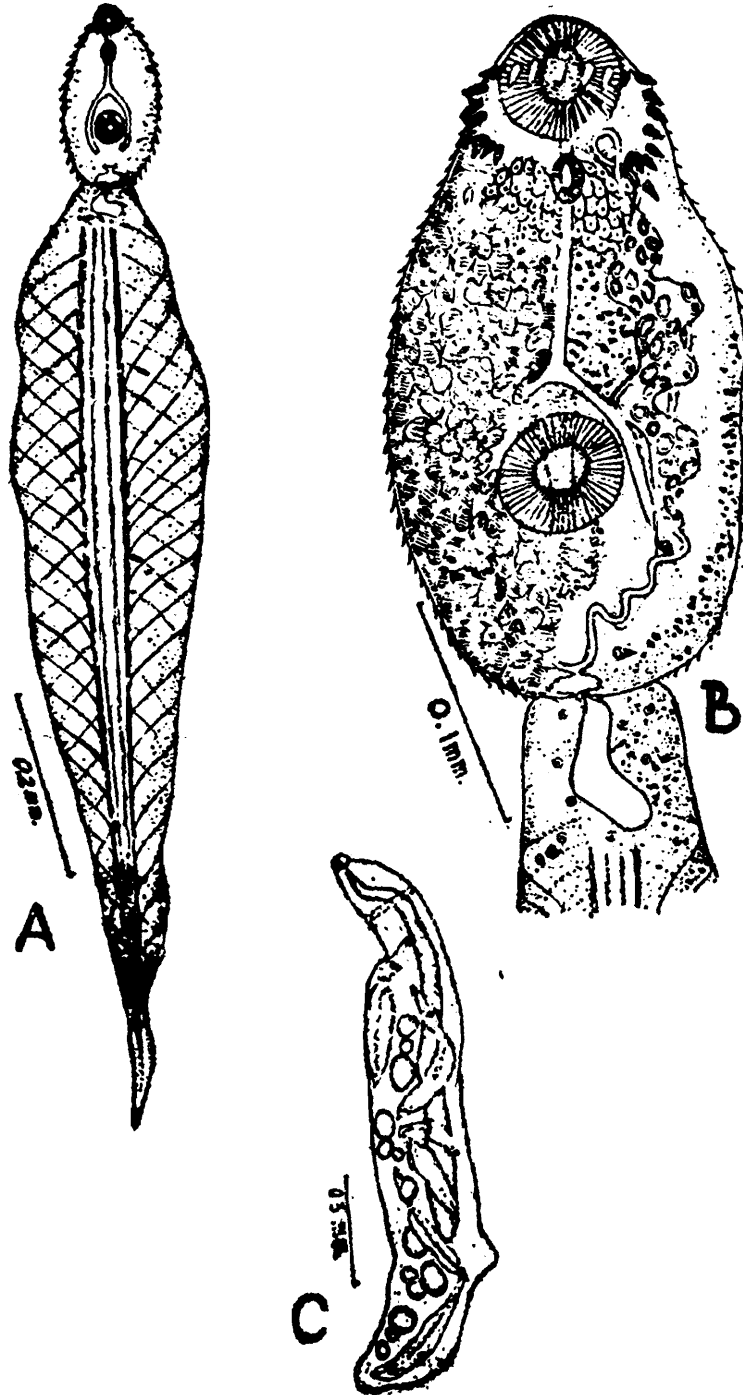


Fig. 41. A.—B. *Cercaria megacauda* Baugh, 1975.
C. Redia of *C. megacauda* Baugh, 1975.
(After Baugh, 1975)

maximum breadth in acetabular region, in fixed specimens it measures 0.16-0.18 in length and 0.061-0.063 in maximum breadth ; tail massive, long, aspinose, lanceolate in structure in extended condition with an acuminate posterior end, tail includes longitudinal and diagonal muscles, longitudinal bundles four in number of which two dorsal and

two ventral and run through middle of tail, diagonal bundles run through lateral regions of tail, nuclei interspersed with diagonal muscles, tail measures 0.91-1.01 in extended condition and 0.21-0.25 in maximum breadth in live specimens and 0.38-0.42 in length and 0.14-0.16 in maximum breadth in fixed specimens ; suckers aspinose, more or less equal in size, oral sucker terminal, roughly circular, measures 0.05-0.06 in live and 0.02 in diameter in fixed specimens ; ventral sucker situated in posterior half of body, measures $0.05-0.06 \times 0.061-0.064$ in live and 0.02×0.03 in fixed specimens ; collar prominent with 22 collar spines in a single row, present in cephalic end of body ; mouth opens into a short prepharynx measures 0.01 in length ; pharynx subspherical or oval, measures 0.019-0.021 in diameter ; oesophagus long, measures 0.079-0.081 in length ; intestinal bifurcation occurs at about middle and caeca terminate near posterior end of body, dense mass of small gland cells present on each side in region of pharynx, each gland cell contains granular cytoplasm with a conspicuous nucleus ; cystogenous cells numerous, present behind collar region, bacilliform contents arranged in a parallel way ; two compact masses of cells, one placed close to anterior border while other behind posterior border of ventral sucker constitute genital primordium, these cells interconnected by an isthmus of similar cells running over ventral sucker ; excretory bladder rectangular, located posterior end of body, extends through a narrow constricted region into basal part of tail as large and elongated excretory reservoir, two main excretory canals open together in middle of anterior side of excretory bladder, each canal runs anteriorly as ascending limb upto prepharynx where from it flaxes backward and runs posteriorly as descending limb, middle region of ascending limb of each canal much dilated and contained refractile excretory corpuscles, these corpuscles may be round, oval or oblong and vary from 66 to 75 in number in each canal.

Redia elongated saccular attenuated oral end, measures 1.17 to 2.02 in length ; mouth terminal, leads through muscular pharynx into a long gut extending beyond middle of body almost upto locomotor appendages ; collar present a short distance behind oral end ; birth pore placed just behind collar about 0.16-0.21 from anterior end ; locomotor processes located about 0.37 in front of posterior end of body.

Snail Host : *Gyraulus convexiusculus*. Location : Liver. Locality : Lucknow (U. P.).

42. *Cercaria rithorensis* Mukherjee
(Figs. 42. A—C)

1963. *Cercaria rithorensis* Mukherjee, *Indian J. Helm.*, XV (2) : 77-84.

Diagnosis : *Cercaria* swims near bottom of container, free swimming cercaria appears whitish in colour ; body assumes globular in shape in contracted and elongated in shape in extended conditions ; body and tail aspinose ; body measures 0.33×0.16 ($0.26-0.38 \times 0.12-0.17$) in size ; spherical anteriorly located oral sucker measures 0.05 (0.05-0.06) in diameter ; highly muscular ventral sucker measures 0.06

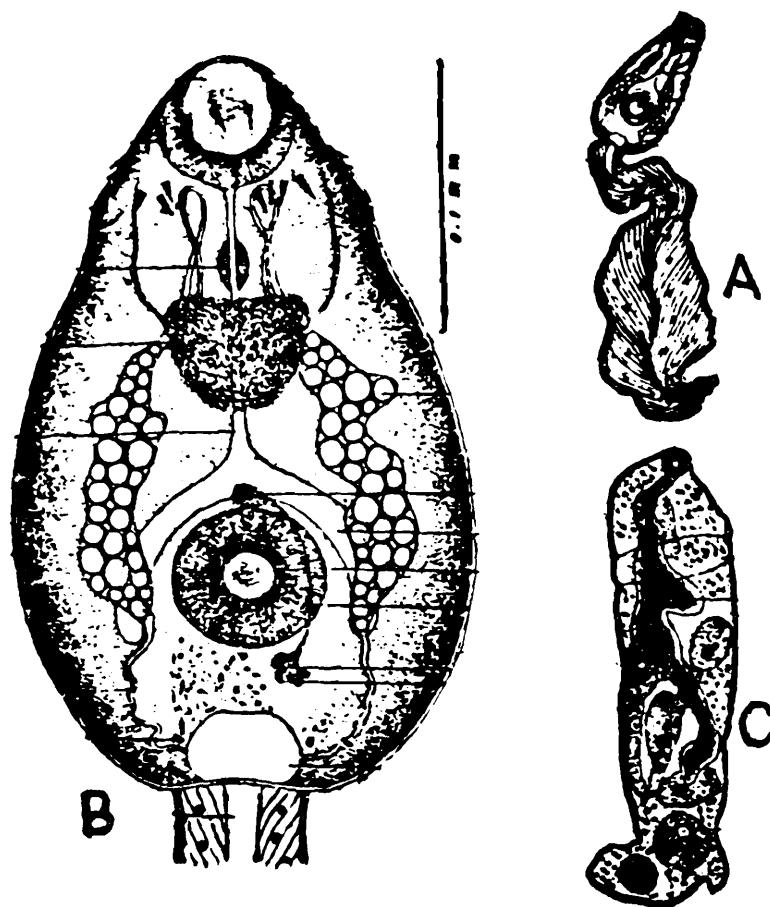


Fig. 42. A.—B. *Cercaria rithorensis* Mukherjee, 1963.
C. Redia of *C. rithorensis* Mukherjee, 1963,
(After Mukherjee, 1963)

(0.05-0.06) in diameter and situated about 2/3rd of total body length from anterior tip of body ; collar distinct and carries 19 spines ; spines of equal size and arranged in single row ; prepharynx long ; oblong pharynx well developed and muscular ; oesophagus long and narrow and it divides into two wide intestinal caeca near anterior margin of ventral sucker ; caeca pass round sides of ventral sucker and terminate near posterior end of ventral sucker ; large number of small spines arranged in a triangular area posterior to pharynx ; excretory

bladder consists of a single rounded chamber, main excretory canals originate from middle of bladder and run outward and forward to sides of ventral sucker in zig-zag course, dilated middle portion of canals filled with various sizes of refractile excretory granules, each canal on reaching posterior level of oral sucker takes a backward turn and forms a loop, each retrograde vessel gives of a branch near level of middle part of oesophagus, at posterior end of body present two flame cells, caudal canal present ; rudiments of genital organs represented by four groups of cells, a group of cell mass located posterior to ventral sucker represents rudiments of ovary, two small groups of cells on either sides of ovary represent testes, another group of cells located in space anterior margin of ventral sucker and bifurcation of caeca represent rudiments of genital pore, a cord of cells connecting rudimentary ovary and genital pore represents uterus ; massive tail shows little contraction and expansion, big and heavy tail make it difficult for larva to swim actively, due to massive structure of tail cercaria settles down to bottom of container, longitudinal muscles well developed, free end of tail bluntly pointed, tail measures 0.53×0.17 ($0.45-0.66 \times 1.12-0.26$).

Redia dark brown in colour ; it measures $0.7-0.8 \times 0.2$; a well defined collar, a birth pore and a pair of locomotor appendages present ; pharynx rounded and situated at anterior end of body ; gut long, extends from anterior end to two thirds of body length and filled with dark black contents.

Snail Host : *Gyraulus convexiusculus*. Locality : Mathurapur, Rithora village of Bareilly (U. P.).

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