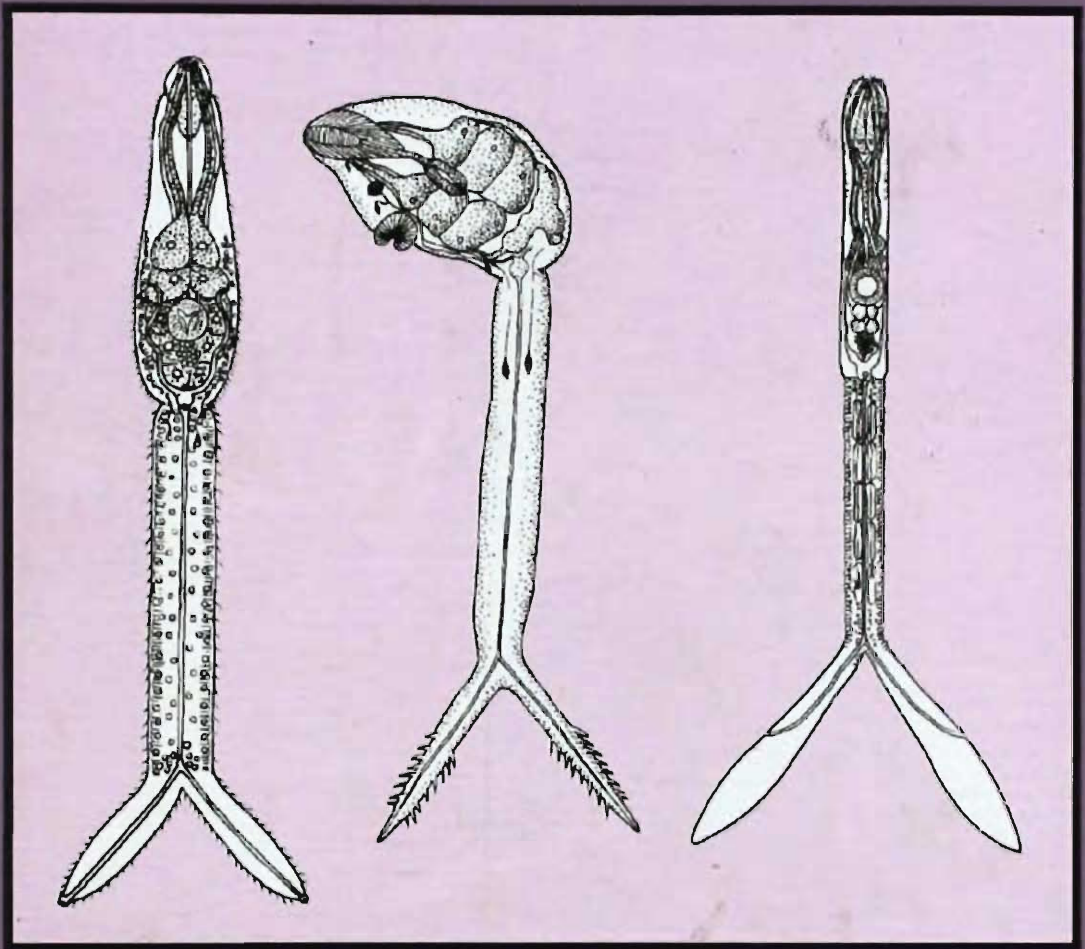


Fauna of India



LARVAL TREMATODES

Distome Furcocercous Cercariae

Part-III

R. P. MUKHERJEE

FAUNA OF INDIA
AND
THE ADJACENT COUNTRIES

LARVAL TREMATODES

(Part-III)

DISTOME FURCOCERCOUS CERCARIAE

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FOREWORD

As per the objectives of the Zoological Survey of India, a number of groups of animals were included in the Fauna of India series. The present one forms volume III of the Fauna of India on Larval Trematodes. This volume includes the detailed description of distome furcocercous cercariae. This work will certainly serve useful purpose as it gives a comprehensive taxonomic account of larval trematodes to the researchers and students of helminths. The present volume deals with a total of 77 cercaria with detailed figures of each species.

The author has already completed the faunal work on Amphistome and Panapleurolophocerca and Echinostome cercariae in two previous volumes. This volume is the last part of larval Trematodes of India.

November, 2007
Kolkata

Dr. Ramakrishna
Director
Zoological Survey of India

AUTHOR'S PREFACE

Since the publication of Sewell's (1922) monograph on larval trematodes of India many furcocercous cercariae have been reported from India. The cercariae belonging to this group are generally with long tail which bifurcates at the distal end and the slender body can not be retracted in it. The furcocercous cercariae belong to such important order and suborders as Strigeatoidea-Schistosomata, Strigeata, Bucephalata, Brachylaimata and Clinostomata. Many species of schistosome have been reported from cattle and buffalo in India. Stray cases of human schistosomiasis have also been reported from this country.

This is the third part under Fauna of India series on larval trematodes. The first two parts deal with the Amphistome and Parapleurolophocerca and Echinostome cercariae respectively. This part includes the description of distome furcocercous cercariae having well developed or indistinct ventral sucker. Furcocercous cercariae belonging to Azygidae and Transversotrematidae have not been included as they differ from true furcocercous cercariae in many respect.

I am indebted to the Director, Zoological Survey of India, Kolkata, for providing necessary facilities.

Zoological Survey of India
Kolkata.

R. P. Mukherjee

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INTRODUCTION

The studies on larval trematodes were initiated when it was feared that human Schistosomiasis may be introduced by the Indian troops and followers returning from the active service overseas and establish in India. In this connection more emphasis was given to the study of the furcocercous cercariae. Initially the study was undertaken by Kemp and Gravely (1919) which was followed by Sewell (1922). In 1919 Sewell described *Cercariae indicae xxx*, which was morphologically indistinguishable from that of the cercaria of *Schistosoma japonicum*, a human parasite that is found in China and Japan, and he doubted it to be the larva of *S. japonicum*. Soparkar (1921) described a few furcocercous cercariae from Bombay and described the life history of *S. spindlis*.

A large number of furcocercous cercariae have been described from India but the complete life cycle has been worked out in a few cases. The comparative studies of the various larval stages and their phylogenic relationships can only be established when their life histories have been fully elucidated.

The furcocercous cercariae do not possess cystogenous cells but they have well developed penetration gland cells whose secretion helps the cercariae to penetrate the tissues of either the second intermediate host or the final host. Through the adaptation of their hosts they are either chemiotactic or haemotrophic and due to this adaptation they develop their affinity for blood of the host. Some furcocercariae turn into metacercariae with or without encystation after entering into the second intermediate host which develop into the adult when the intermediate host is eaten by the final host. In others the furcocercariae grow into adult after penetrating the final host through the skin directly. Due to this adaptation of entering the host through the skin their penetration glands have become very strongly developed.

Similarly the apharygeal type of furcocercous cercariae have been evolved due to their adaptation to mode of life in the blood of the final host.

The words like "Furcocerca" and "Furcocercariae" were proposed by Lamarck (1815) and Luhe (1909) respectively. Since then attempts were made by several workers to classify this large group of cercariae. For the past few decades the importance of the studies of cercariae and their various developmental stages have been realized as they provide evidence of phylogenetic relationships among various groups of trematodes and help to evolve the classification of digenea based on the evolutionary history of the group.

Looss (1896) described furcocercous cercariae from Germany and neighbouring countries. Lühe (1909) first attempted to classify the cercariae and recognized five major groups. His observations were based on such morphological characters as the

presence or absence and location of suckers, presence or absence of stylet, structure of the tail, etc. Attempts have been made by various workers from time to time to modify Lühe's scheme and to throw new light on the conception of relationships between various groups of cercariae. Lebour (1912) proposed a scheme for the larvae based on the development of these larvae in their sporocysts and rediae in addition to the structure of the tail. She attempted to lay more importance on the mode of origin of cercariae.

Leiper (1915) described furcocercous cercariae in much detail and separated the schistosome cercariae from other groups of furcocercous cercariae mainly on the basis of absence of pharynx, pigmented eye-spots, cubicular keel on the furcae and the length of the furcae which are half of the length of the tail-stem. Cort (1917) laid special emphasis on the excretory system in the classification of furcocercous cercariae. He through his study on the forked-tailed cercariae of North America divided the furcocercous cercariae into three distinct groups. His first group is characterised by the absence of pharynx, short furcal rami being less than half the length of the tail-stem, constriction of the furcal rami at the base and the presence of eye-spots. His second group is characterised by the absence of pharynx, short furcal rami as in group one and the absence of eye-spots. His third group is characterised by the presence of pharynx, long furcae almost as long as tail-stem, the presence of constriction at their base and the absence of eye-spots.

Faust (1917) advocated that all the fork-tailed apharyngeate distome cercariae were members of the schistosomatidae. He in 1918 again modified his views on the basis of subsequent discoveries of other forms and laid more emphasis on the presence or absence of pharynx and intestine.

Sewell (1922) was the first who have studied the larval trematodes of India extensively and was of the opinion that the furcocercous cercariae is a composite group of larval forms which possess certain characters which are sufficient enough to separate them from most of the other groups of cercariae on one hand and connect furcocercous distomes with certain monostome groups of cercariae on the other hand. The characters are the bifid tail with central caudal excretory canal which bifurcates near the base of the furcae and the branches extend into the furcal rami and the presence of flame cells in the tail-stem.

Sewell (1922) modified the classification of distome furcocercous cercariae proposed by Cort (1917). He merged Cort's groups I and II into one and divided the group III of Cort into two groups. The group I of the Sewell is characterised by short furcal rami, fin folds may be present, eye-spots may be present or absent, anterior organ forms protrusible penetrating organ, salivary glands divided into anterior and posterior regions, excretory system of the two sides of the body completely separate, branch of the caudal excretory canal opening at the extreme tip of the furca and oesophagus without pharynx. This group is further divided into two series depending mainly on the presence or absence of hollow spines at the anterior end of body capping the ducts

of the penetrating glands. Group II is characterised by the anterior protrusible penetrating organ in form of true sucker, salivary glands consist of a few cells, excretory system of the two sides separate, branch of the caudal excretory canal open at half of the length of furca, furcal rami long and not constricted off from the tail-stem, absence of fin folds and absence of eye-spots. This group is divided further into two series depending on the presence or absence of pharynx. Sewell's group III includes forms with leaf like appearance, absence of or reduced ventral sucker, furcal rami with fin folds of moderate length, well developed caeca, presence of pharynx, salivary gland cells composed of several groups of small cells and present in the anterior region of body, trifoliate excretory bladder, two pairs or main excretory canals and the median pair uniting to form a single trunk which is connected with an anastomosing canal between the lateral pair, branch of the caudal canal traversing the whole length of furca.

Faust (1924) classified furcocercous larvae based on excretory system and flame cells and opined that this grouping is more natural as the excretory system is a common system that is carried over from the cercariae to adults.

Miller (1926) contradicted Faust's classification. He stated that the flame cells of the cercariae have potentialities for more rapid division so that the pattern of the adults could not be predicted. Stunkard (1929) advocated caution for the use of the excretory system in the classification of cercariae as in most cases the development of cercariae to metacercariae and adults leads to increase in flame cells number and ducts. Brown (1933) was of the opinion that the change in the excretory system during development might be due to the physiological needs of the parasite and not necessarily an indication of phylogenetic relationship. La Rue (1926) supported Cort's idea and also suggested that the number of flame cells in the miracidia might give additional support to the claims of relationship. Miller (1926) attached more importance on the presence and absence of pharynx and the length of the furcae. He gave little importance to the presence or absence of ventral sucker. He divided the two main groups-Pharyngeal and Apharyngeal into two subgroups-Brevifurcate and Longifurcate. Each of these were further divided into Monostome and Distome groups, except the pharyngeal brevifurcate group in which no monostome cercaria has been recorded. Most of the present day workers accepted Miller's classification of furcocercous cercariae with little modifications. However, Singh (1960) does not support the classification of Miller.

Dubois (1929) based his classification of cercariae mainly on the basis of excretory system in addition to other characters. He recognised two types of excretory system and he named them as "Stenostoma" and "Mesostoma" In the former type the lateral excretory canals extend forward to pharynx and then turn about dividing into anterior and posterior branches whereas in the latter type the canals extend to the level of ventral sucker and dividing into anterior and posterior vessels. He also advocated that the cercaria of Stenostoma type develop in rediae whereas Mesostoma type develop in sporocysts. Furcocercous cercariae belong to Mesostoma.

La Rue (1938) suggested that the significance of excretory system as a basis for natural system of classification can only be considered when more information on the process of formation of excretory vesicle is available. He further opined that natural taxonomic system must be based on comparative anatomy of all stages in the life history and concluded that in cercaria attention should be given to penetration apparatus, tail and other external characters like pharynx, excretory system including the flame cell pattern and proportions of excretory vesicle. He was of the opinion that the formation of excretory vesicle and the excretory pore may prove to be important characters.

Niewiadomska (1971) considered morphological features like the development of reserve bladder, opening of caudal canal on the furcae, number of flame cells, number and position of the penetrating glands, presence or absence of preoral spines, presence or absence of spines on ventral sucker, etc, are important characters for the classification of furcocercous cercariae.

Singh (1960) suggested that the characters like number and position of penetration glands, shape of the excretory bladder, the branching or excretory tubules and flame cell number, the shape and size of body, tail and furcae and their spination, etc are less important characters for definite specific diagnosis but more important for showing group and subgroup relationships. He has grouped the furcocercous cercariae with special reference to Indian forms into eight groups without giving any definition. These eight groups are—Aporocotylid-Sanguinicolid group, Spirorchid group, Schistosome group, Clinostome group, Strigeid group, Brachylaimid group, Gasterostome group and Fellodistomatid group. Here the classifications of Sewell and Miller have been adopted with certain modifications.

This is the third part under the Fauna of India Series and deals with the distome furcocercous cercariae in which the ventral sucker is either indistinct or well developed. The first two parts under this series deal with the Amphistome and Parapleurolophocerca and Echinostome cercariae respectively. The material and methods adopted here are the same as given in the earlier parts. Unless otherwise stated all measurements are in millimeters.

Cercaria shibi Dutt (1958) has not been included in this part as it has not been fully describes and only an abstract has been published.

Key to Groups

1. Ventral sucker not well developed VIVAX
 Ventral sucker well developed 2
2. Furca short BREVIFURCA
 Furca long LONGIFURCA

1. *Brevifurca* Group

Diagnosis : Ventral sucker well developed; furcae half, less or a little more than half the length of tail-stem.

Key to the Species

1. Fin fold present 2
- Fin fold absent 3
2. Fin fold present on dorsal side of body only *C. manteri*
- Fin fold present on dorsal side of body and on furcae or present only on furcae 4
3. Penetrating gland cells three pairs 5
- Penetrating gland cells five pairs 6
4. Fin fold present of dorsal sides of body and on furcae *C. of Plasmiorchis orientalis*
- Fin fold present on furcae only 7
5. Flame cells in body five pairs and one pair in tail-stem, caeca short 8
- Flame cells in body six pairs and flame cell in tail stem absent, caeca long *C. pandei*
6. Pigmented eye-spot present 9
- Pigmented eye-spot absent 10
7. Flame cells in body not more than four pairs 11
- Flame cells in body more than four pairs 12
8. Spines present on body, head gland absent *C. sultanpurensis*
- Spines absent on body, head gland present *C. anasagari*
9. A well developed head gland present, caeca in form of dilatation *C. indicae XLVII*
- Four paire of head gland present, two short caeca present *C. tuberculatusi*
10. Flame cells in body three pairs 13
- Flame cells in body four paire 14
11. Flame cells in body three pairs 15
- Flame cells in body four pairs *C. indicae XXV*

12. Flame cells in body five to six pairs 16
 – Flame cells in body eight pairs *C. hardayali*
13. Spines on ventral sucker absent, caeca small bilobed *C. S. haematobium*
 – Spines on ventral sucker present, caeca end in small sac or small bilobed .. 17
14. Penetration glands with finely granular protoplasm *C. O. turkestanicum*
 – Penetration glands with coarsely and finely granular protoplasm 18
15. Penetration glands five pairs *C. ajmeri*
 – Penetration glands twelve pairs *C. indicas XXXVI*
16. Flame cells in body five pairs 19
 – Flame cells in body six pairs 20
17. Caeca sac-like dilatation *C. indicae XXX*
 – Caeca small bilobed *C. O. dattai*
18. Penetration glands on two sides not overlapping each other and situated on two sides of body, flask shaped, flame cells of tail stem larger then those of body *C. S. spindalis*
 – Penetration glands on two sides not overlapping each other, flask or boot shaped, flame cells of tail-stem and body of same size 21
19. Number of penetrating glands six pairs, spines present on ventral sucker
 *C. simhai*
 – Number of penetrating glands five pairs, spines on ventral sucker absent
 *C. bombayensis No. 13*
20. Head gland present, excretory bladder 'V' shaped situated a little anterior to postterior end of body *C. sewatii*
 – Head gland absent, excretory bladder rectangular situated at posterior end of body *C. ocellata*
21. Two anterior pairs of penetrating gland cells boot-shaped *C. S. incognitum*
 – Two anterior pairs of penetrating gland cells flask-shaped 22
22. Intestinal caeca pear-shaped, cercariae developed in *Lymnea luteola*
 *C. indicae LXXIX*
 – Intestinal caeca bifid, cercariae developed in *Indoplanorbis exustus*
 *C. S. indicum*

1. *Cercaria ajmeri* Rozario
(Fig. 1. A-C.)

1939. *Cercaria ajmeri*, Rozario, *Parasit.*, XXXI (3) : 291-294.

Diagnosis : *Cercaria* swims with an intermittent motion, usually with tail end first, it lies either parallel to water level or with head downwards and furcae in a curve at right angles to main stem, on surface of slide it performs characteristic wriggling motions; cercaria capable of contraction and expansion considerably; body measures 0.29×0.13 ; tail-stem measures 0.67×0.06 ; furca measures 0.23×0.03 ; penetration organ measures 0.10×0.06 ; ventral sucker measures 0.04 in diameter; eye-spots measure 0.02 in diameter; caeca measure 0.04×0.01 ; cercaria roughly twice as long as broad; tail-stem about two and half times length of body covered with pointed piercing spines; penetrating organ protrusible pyriform structure, extending upto about one third body length, its posterior wall muscular; head gland prominent; ventral sucker small, situated a little behind middle of body, its wall muscular, opening

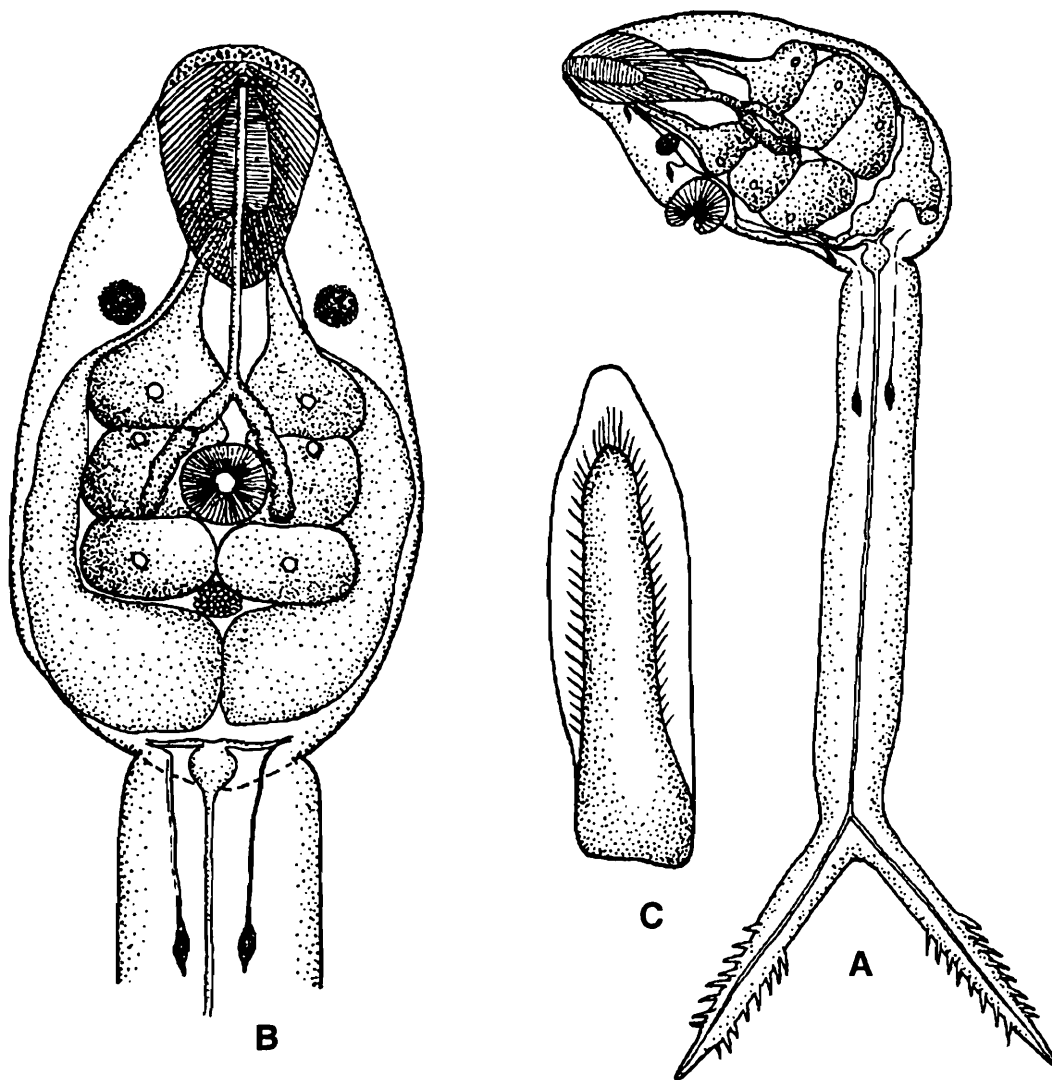


Fig. 1. A & B. *Cercaria ajmeri* D'Rozario, 1939. Furca of *C. ajmeri* D'Rozario, 1939. (After D'Rozario, 1939)

circular and armed with powerful spines; tail attached to body firmly, it attached with body ventrally a little anterior to posterior end of body, furcae thickest at point of attachment, needle-like processes present on body of furcae, activity of cercariae when slowed down cuticle becomes fluted and surrounds furcae giving appearance of a diphyercal tail fin of a fish with needle-like processes like ribs, processes at tip of furcae longest about 0.05 in length, fin fold present, in active condition fin fold lies in contact with tail and in this condition cercaria might mistakenly be thought not to possess a fin-fold; a pair of prominent eye-spots situated about one-third from anterior end, lateral in position, circular outline, diameter of eye-spots 0.02 and composed of a number of dark brown granules; small mouth situated on ventral surface of anterior organ; ducts of salivary glands enter on ventro-lateral aspect of anterior end of organ; oesophagus long and it bifurcates into a pair of caecae at about middle of first pair of penetration glands; caecae reach to posterior margin of ventral sucker; penetration cells five pairs, anterior three pairs coarsely granular and refractile in nature, large cells with prominent nuclei and form a rectangular table which encloses ventral sucker, other two ill defined pairs lying laterally and one behind other, occupying whole of posterior portion of body, nuclei of finely granular cells indistinct; germ mass lie in between posterior and last pair of anterior penetration gland cells; excretory vesicle lies at posterior end of body, main excretory tubes arising from antero-lateral margins and pass in a convoluted manner as far as posterior margin of ventral sucker, then they divide into anterior and posterior collecting tubules, each anterior collecting tubule divides into two capillaries tipped with flame cells, each posterior collecting tubule passes backward in a convoluted manner and receives a capillary from a flame cell in its course, while second capillary from posterior collecting tubule enters tail-stem and passes backward to end in a flame cell, lying in caudal region, caudal canal traverses tail-stem divides posteriorly and passes along rami to open at tips.

Sporocyst oval, sac-like with thin wall, measures 0.65×0.32 , brown in colour.

Snail Host : *Indoplanorbis exustus*.

Locality : Anasagar Tank, Ajmer, Rajasthan.

2. *Cercaria anasagari* Rozario

(Fig. 2. A.)

1939. *Cercaria anasagari*, Rozario, *Parasit.*, XXXI (3) : 294-298.

Diagnosis : Cercaria smaller in size, active, it swims with tail end first, tail lashes body while furcae work like a pair of flippers, float in water with tail end upwards and furcae in a curve at right angles to tail-stem, cercariae attach themselves by penetrating organ and vibrate their body, on slide they perform rapid wriggling motions, followed by leech-like creeping motion performed by alternate use of suckers; body measures 0.19×0.07 ; tail-stem measures 0.24×0.04 ; furca measures $0.09 \times$

0.01; oral organ measures 0.06×0.04 ; ventral sucker measures 0.02 in diameter; body shows considerable degree of contraction and expansion; anterior penetrating organ pyriform in shape, its posterior wall muscular, protrusible organ occupies about one-third of body; head gland prominent; body shorter than tail-stem, body broadest a little anterior to ventral sucker; tail-stem attached terminally in ventral side of body, furcae less than one half of length of tail-stem; ventral sucker small, protrusible, muscular structure with a circular opening, situated about one-fifth from posterior end of body; eye-spots absent; penetrating gland cells three pairs lying laterally, two pairs lie in front of ventral sucker and third behind it, each gland cell pyriform in shape with coarsely granular refractile protoplasm, ducts of penetrating gland cells pierce ventro-lateral aspect of penetrating organ and traverse through it to open at anterior tip; mouth situated anteriorly and ventrally; oesophagus passes backward and divides into caecae; caecae short, thick, globular, measuring 0.02×0.01 in dimension; spines on body absent; ducts of penetration glands capped with hollow cylindrical spines; excretory system simple, flame cells six pairs, two on each side empty into anterior and four into posterior collecting canals; germ cells lying ventral to ventral sucker.

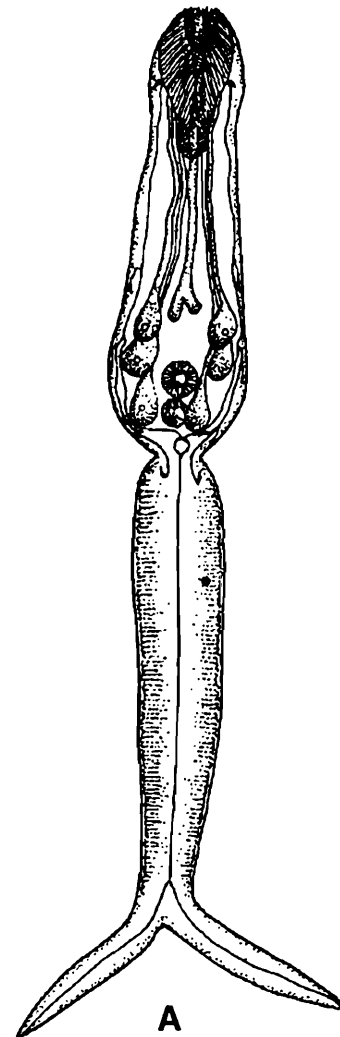


Fig. 2. A. *Cercaria anasagari* D'Rozario, 1939. (After D'Rozario, 1939)

Sporocyst short, oval, sac-like structure lying in liver mass of host; sporocyst thin wall, dirty brown in colour.

Snail Host : *Indoplanorbis exustus*

Location : Liver.

Locality : Anasagar Tank, Ajmer, Rajasthan.

3. *Cercaria bombayensis* No. 13 Soparkar (Fig. 3. A-C)

1921. *Cercaria bombayensis* No. 13 Soparkar, *Indian J. Med. Res.*, IX, 29-30.

Diagnosis : Body of cercaria when swimming doubled upon itself with bent tail; gradually sinks in water due to its own weight but suddenly it starts to swim again;

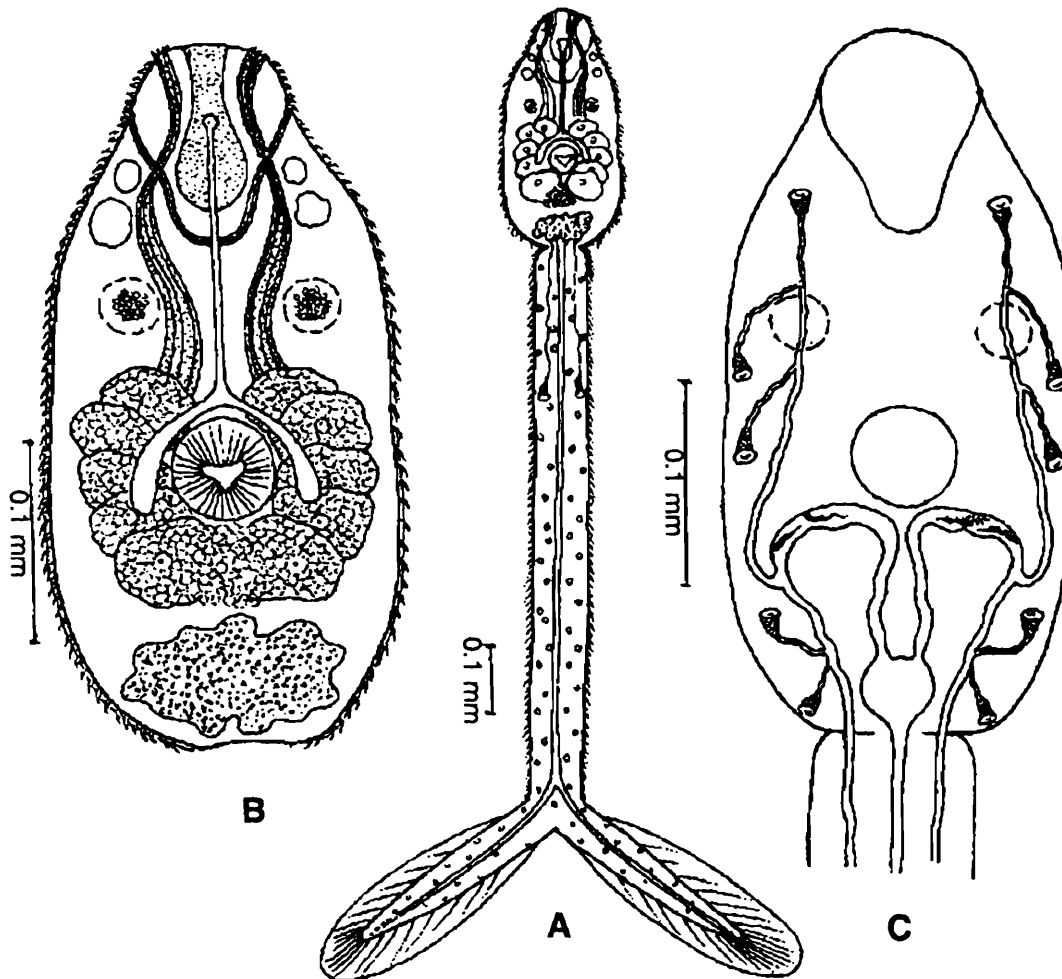


Fig. 3. A-C. *Cercaria bombayensis* No. 13 Soparkar, 1921 (After Soparkar, 1921)

cercaria pigmented type; body measures $350 \mu \times 185 \mu$ in living; tail trunk measures $850 \mu \times 80 \mu$ in living; furci measure 350μ long in living; whole larva measures more than 1.5 in length; body and tail covered with spines; furcal rami with thin membrane; ventral sucker prominent, situated behind middle of body, forms a marked projection when cercaria lies on its side, projection often reaching 35μ beyond general body surface; several mucin glands with finely granular protoplasmic contents surrounding ventral sucker, there appeared to be five pairs of mucin glands, ducts from these glands enter oral pouch and open externally, their tips being capped by hollow piercing spines; rudimentary genital system represented by a cluster of cells, situated behind ventral sucker, behind this a large irregular cell situated with coarse granules of unknown function; dorsal sucker measures $100 \times 50 \mu$ and divided into anterior and posterior portions; head gland situated in centre of oral sucker; on either side of head gland run ducts of mucin glands; a couple of large refractile cells of unknown significance situated between oral sucker and body wall on either side; mouth situated a little behind anterior end; narrow oesophagus passing through posterior portion of oral sucker continues backward upto anterior margin of ventral sucker and opens into caecum; caecum bifurcated, limbs of which curve round sides of ventral sucker; pharynx absent; two large pigmented eye-spots situated between ventral sucker and posterior

margin or oral sucker, pigments in form of dark granules and centre of this mass located a refractile lens; two branches of excretory trunk in tail open at tip of furcal rami; five pairs of flame cells present in body and one pair in tail, latter pair situated towards distal end, flame cells in this cercaria proportionately larger.

Sporocyst small, cylindrical, devoid of any movement.

Snail Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Andheri, Bombay.

4. *Cercaria hardayali* Dutt
(Fig. 4. A-C)

1970. *Cercaria hardayali* Dutt, *H.D. Srivastava Commen*, Vol., 313-316.

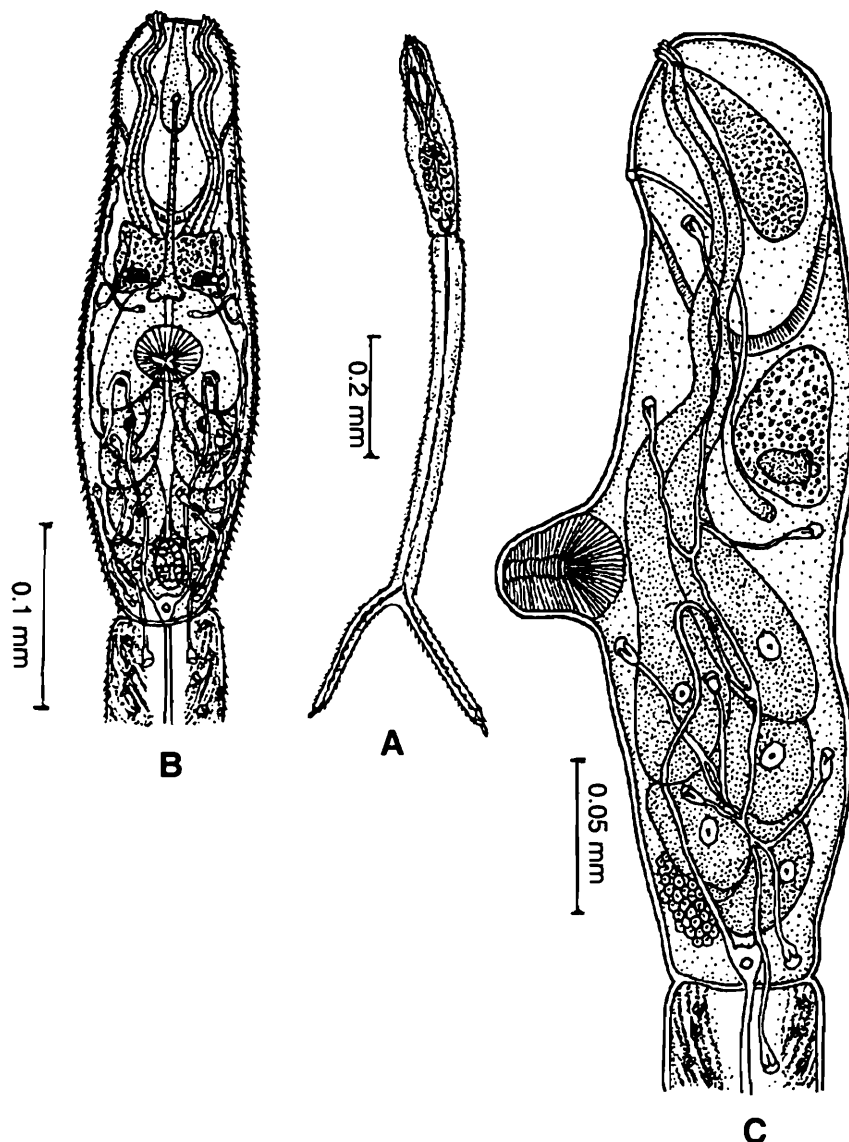


Fig. 4. A-C. *Cercaria hardayali* Dutt, 1970 (After Dutt, 1970)

Diagnosis : Cercariae emerge in morning, remain hanging in water with body and tail-stem held vertically with furcal rami spread obliquely, cercaria remains hanging or gradually sink downwards, after some time it becomes active again and swims tail foremost either vertically or obliquely, frequently it moves head foremost, on slide it shows creeping movements by means of both suckers, positive phototropic, concentrate near side of container towards light; eye-spots and fin-folds present; body measures 288-328 μ ($301.2 \pm 2.22 \mu$) \times 58-80 μ ($70.4 \pm 1.42 \mu$); anterior end to eye-spots measures 124-142 μ ($131.5 \pm 0.93 \mu$); anterior end to ventral sucker measures 133-160 μ ($146.3 \pm 1.68 \mu$); tail-stem measures 532-674 μ ($599.5 \pm 9.96 \mu$) \times 46-65 μ ($57.2 \pm 5.27 \mu$); furcal rami measure 195-299 μ ($241.9 \pm 6.27 \mu$) in length; head organ measures 100-121 μ ($109.8 \pm 1.43 \mu$) \times 46-62 μ ($50.4 \pm 5.2 \mu$); ventral sucker measures 24-34 μ ($29.5 \pm 0.56 \mu$); body widest at ventral sucker region; body, tail-stem and furcal rami spinose with a number of setae; furcal rami with dorsoventral fin-folds; mouth situated ventrally behind middle of anterior portion of head organ; oesophagus long, tubular; caeca short, situated near eye-spots not far from ventral sucker; nerve mass bilobed; a pair of pigmented eye-spot on dorsal side of nerve mass; head gland present; five pairs of penetration glands present-anterior two pairs coarsely granular and posterior three pairs finely granular and posterior to ventral sucker; nine pairs of flame cells present; flame cell formula $2[(3) + (5+1)] = 18$, two ciliary patches present in main lateral excretory tubes, "Island of Cort" present; genital rudiments represented by an elliptical mass of cells, situated at postero-ventral region of body.

Sporocyst cylindrical.

Host : *Indoplanorbis exustus*.

Locality : From a pool at Nilgaon, Sitapur and a tank at Rithaura, Bareilly, U.P.

5. *Cercariae indica* XXV Sewell

(Fig. 5. A-C)

1922. *Cercaria indicae* XXV Sewell, *Indian J. Med. Res.*, Suppl., (X) 260-262.

Diagnosis : Body capable of considerable degree of contraction and extension, in moderately extended condition it measures 0.33 in length and 0.05 in breadth, body pyriform in shape, posterior end broad; tail-stem nearly twice length of body, it measures 0.61 in length and furcal rami measure 0.03 in length; a pair of heavily pigmented eye-spots situated laterally at about 1/3 of body length from anterior end; anterior end occupied by a protrusible penetrating organ, pyriform in shape, narrow end pointing backwards, it measures 0.09 in length and 0.05 across its widest part, a distinct groove marks point of junction of organ and body wall proper, in front of this groove sides of organ armed with a number of small ante-verted spines, part of organ contained within body enclosed in a well-marked sheath within which a strong layer of circular muscle-fibres, main mass of penetrating organ traversed by ducts of salivary glands, these ducts enter organ on its ventro-lateral aspect and pass forward

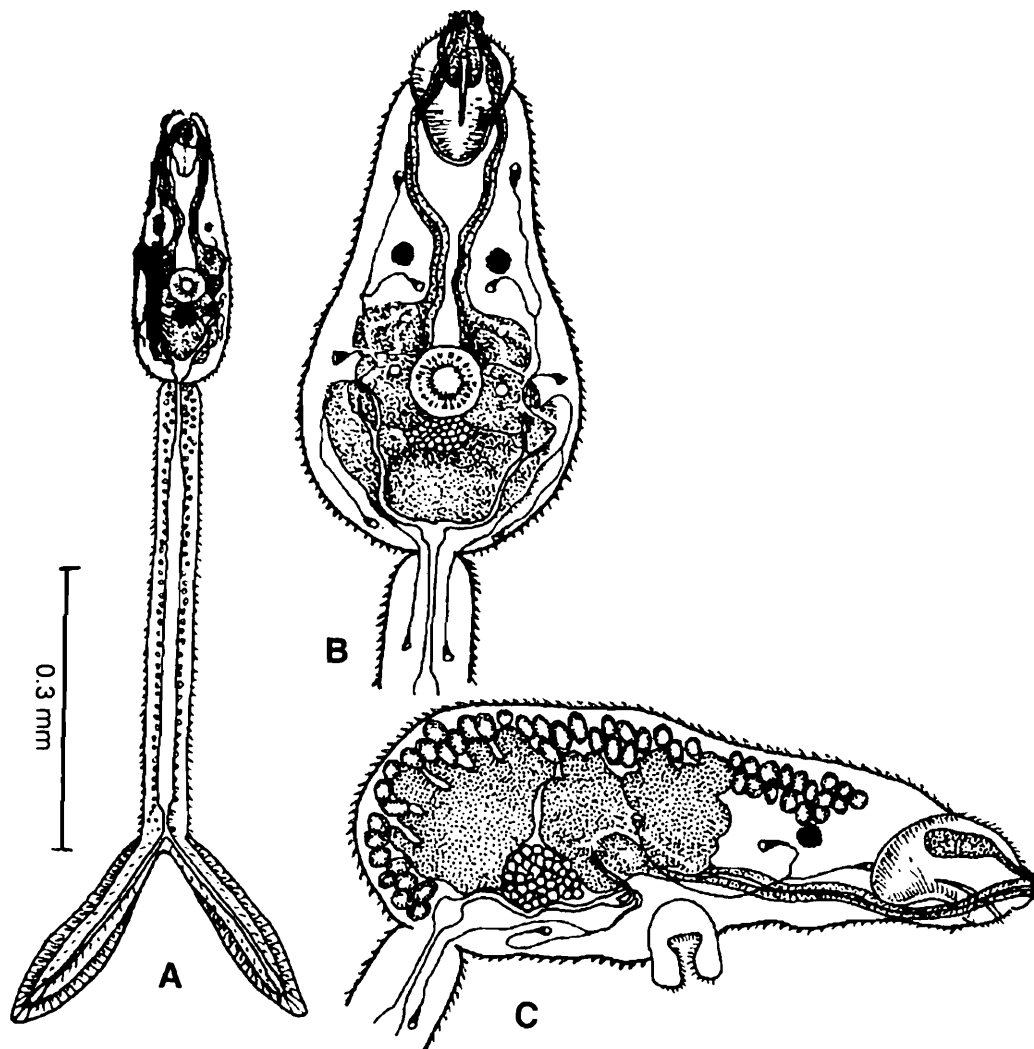


Fig. 5. A-C. *Cercariae indicae* XXV Sewell, 1922 (After Sewell, 1922)

to extreme anterior end where they appear to open on papillae instead of through hollow piercing spines as in closely-allied forms, dorsal portion of penetrating organ possesses of a pair of large pyriform refractile cells with large clear nuclei which lie close together on either side of middle line, ducts appear to pass forward from these cells and open on snout; posterior portion of organ occupied by a number of small pyriform cells; extreme tip or snout can be retracted slightly so that a pit-like depression sometimes formed at anterior end which can be mistaken at first sight a true oral sucker; behind level of anterior penetrating organ body wall armed with numerous small backwardly directed spines; ventral powerful sucker situated about $\frac{1}{3}$ of body length from posterior end, it forms a well marked projection on ventral surface, it measures 0.04 in diameter, its surface covered with a number of centrally directed spines, these spines larger than those of body wall; tail attached to ventral aspect a short distance in front of extreme posterior end of body and forms a distinct angle with it, tail armed throughout whole length with close set spines, well developed muscle fibres situated beneath cuticle, a number of large fibres follow a spiral course around proximal portion and further back numerous fibres can be seen running

longitudinally in tail substance, a marked groove constricts furcal rami from tail-stem, each ramus flattened from side to side, on dorsoventral margins runs a fine transparent fin-fold in which striae resembling fin-rays can be seen in contracted ramus, a number of fine spines scattered over surface and along margins of rami; mouth small, circular, subterminally; gut rhabdocoele which passes a short distance upwards and backwards within substance of anterior penetrating organ; mass of salivary gland cells occupied posterior half of body, anterior portion of this gland composed of two pairs of cells with finely granular protoplasm and large round nuclei, lie around ventral sucker, from these cells corresponding ducts pass forwards internally to eye-spots then diverging outwards reach to ventro-lateral aspect of anterior penetrating organ and enter into it, behind these cells lie a large and somewhat horse-shoe shaped mass of finely granular protoplasm which may be posterior part of salivary gland; small excretory bladder situated posterior end of body, a pair of main excretory tubes arise laterally from excretory bladder and pass forward to a point a little behind paired salivary gland cells, each duct divides into two branches-external branch passes forward and outward then again forward and inward and receives capillary tubes from three anterior pairs of flame cells, internal branch passes forward and outward crossing external branch then curves backward and receives capillary vessels from posterior two pairs of flame cells, flame cells five pairs of which four pairs occur in body and fifth pair situated at base of tail, caudal excretory canal arises from posterior end of bladder and passes back into tail-stem, narrow caudal canal soon dilates into a wide tube which continues just before point of division at distal end where it again becomes narrow, it finally divides into branches that pass along furcal rami to open at their extreme tips; genital organ represented by a compact mass of small round cells situated ventrally immediately behind ventral sucker and between paired salivary gland cells and horse-shoe shaped cell mass; central nervous system forms a somewhat irregular mass of tissue lying anterior to salivary gland cells and dorsal to their ducts, eye-spots in close contiguity with its anterior upper surface; all around margins of body numerous small, round or oval highly refractile cells present.

Sporocyst small, oval.

Snail Host : *Indoplanorbis exustus*.

Locality : Near Rambha Railway Station, Ganjam, Orissa.

6. *Cercariae indicae* XXX Sewell

(Fig. 6. A & B)

1919. *Cercariae indicae* XXX Sewell, *Rec. Indian Mus.*, XVI : 425-429.

1922. *Cercariae indicae* XXX Sewell, *Indian J. Med. Res., Suppl.*, (X) : 251-254.

Diagnosis : *Cercaria* small, feeble swimmer, first it moves tail through water then dragging body behind by means of vigorous lashing movements of tail; anterior organ

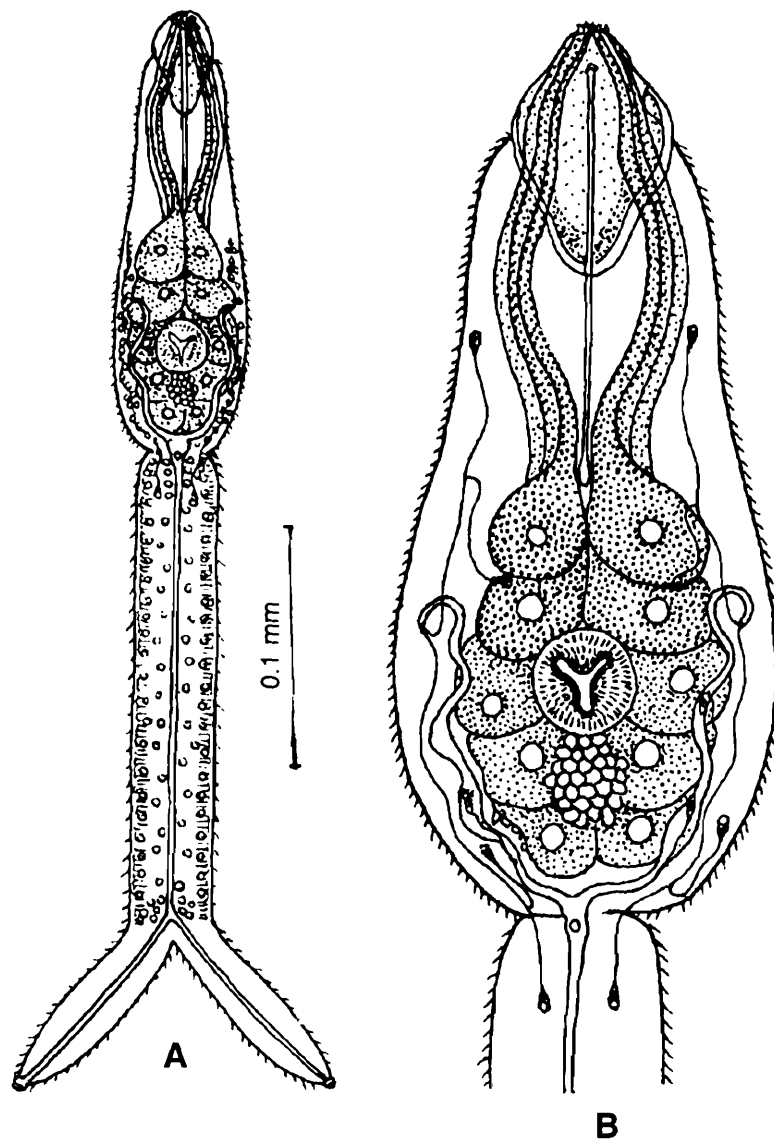


Fig. 6. A & B. *Cercariae indicae* XXX Sewell, 1922 (After Sewell, 1922)

not a true sucker but an organ for penetration into final host; body frequently bent from side to side, capable of considerable degree of extension and retraction; anterior end forms a protusible organ which might be mistaken as anterior sucker; cercaria can shed its tail; body measures 0.19-0.21 in length and 0.02 in breadth in extended conditions, body measures 0.09 in length and 0.05-0.07 in breadth in contracted conditions, in fixed condition body measures 0.17×0.05 ; length of tail varies from 0.14-0.26, furcal rami short and capable of extension and contraction, very in length from 0.07-0.10, tail and furcal rami measure 0.21×0.03 and 0.08 respectively in fixed condition; body surface covered with minute spines except sides of protrusible penetrating papilla, tail sparsely covered with large spines which appear to be slightly hook-shaped, furcal rami cover with spines along margins; anterior penetrating organ pyriform, measures 0.04×0.03 in retracted condition but in extension it becomes longer and narrower, posterior wall of organ thick with strong layer of circular muscle fibres, internally greater portion of

organ occupied by granular mass, laterally and posteriorly of head gland provided with small granular parenchymatous cells; salivary gland cells five on each side, ducts of salivary gland cells enter penetrating organ on ventro-lateral aspect, ducts pass forwards to open on tip of snout, each duct capped at orifice by a hollow conical spines, penetrating spines ten in number; small ventral sucker situated about $1/4$ distance from posterior end of body, its external opening 'Y' shaped, it measures 0.01 in diameter, external surface of sucker covered with number of fine spines, ventral sucker capable of protrusion and retraction, forms a slight projection on ventral aspect of body; salivary gland cells five pairs, occupy posterior $1/2$ to $2/3$ of body, pyriform in shape, each cell with wide conspicuous duct which runs forward to enter anterior penetrating organ, cells two kinds—anterior two pairs densely crowded with a number of coarse, irregular refractile granules within protoplasm while posterior three pairs sparsely arranged with more finely granular, each cell with large conspicuous nucleus, protoplasm of cell acidophilic, anterior and posterior group of cells show different protoplasmic structure, ducts of posterior cells large and lie ventrally in a 'U' shape while those of anterior cells situated side by side in opening of 'U' on dorsal side, all five ducts approximately of same calibre but in some cases anterior duct smaller than posterior; alimentary canal rudimentary, mouth opens by a small orifice, situated far forward on ventral aspect in front of junction of body wall with penetrating organ, narrow intestine passes backward as far as anterior pair of salivary gland cells, terminates in a small sac-like dilatation; pharynx absent; flame cells three pairs, anterior pair situated laterally external to duct of salivary glands about midway between anterior salivary gland cells and anterior penetrating organ, second pair lie in interval between coarsely-granular and finely granular gland cells towards outer side, posterior pair situated opposite posterior salivary gland cells, small excretory bladder situated at extreme posterior end of body from it two wide canals pass forward and outward as far as anterior margin of ventral sucker then they curve backward and divide into anterior and posterior collecting tubes, each canal dilates at two points and each dilatation provided with a flagellum, anterior and posterior collecting tubes each divide into two capillaries running to flame cells, second capillary from posterior collecting tubules leave body and enter tail passing backwards to a pair of flame cells that situated on either side of caudal excretory canal close to junction of tail and body; caudal canal arises from posterior end of bladder by a typical "Islet" aperture, posterior end of tail-stem caudal canal divides into two branches and each branch passing along each furcal ramus to open to exterior through a cup-like dilatation at extreme tip; genital gland forms a mass of small round cells situated ventrally and immediately behind posterior margin of ventral sucker, a series of five to six large round cells with clear protoplasm and small granular nucleus situated along each posterior and lateral margin, probably these lateral cells represent rudiments of testes while central mass of cells represent rudiment of ovary.

Cercariae develop in oval or sausage shaped sporocysts, each sporocyst contains two or three mature cercariae.

Snail Host : Indoplanorbis exustus and Lymnaea acuminata.

Location : Liver.

Locality : Swamp in Russa Road, Tollygunge, Calcutta and Wynaad, Madras.

7. *Cercariae indicae* XXXVI Sewell

(Fig. 7. A & B)

1922. *Cercariae indicae* XXXVI Sewell, *Indian J. Med. Res.*, Suppl., (X) : 263-265.

Diagnosis : Cercaria active, swims easily; body varies considerably in shape, length varies from 0.21 to 0.35 and breadth from 0.07 to 0.10; tail-stem measures 0.70 in length and 0.05 in diameter; furcal rami measure 0.14 in length; pyriform penetrating organ occupied anteriorly and crowded by papillae, it measures 0.05 in length and 0.04 in diameter in its widest part anteriorly, a well marked groove indicates junction of anterior penetrating organ and body proper, behind this groove organ surrounded and enclosed in a well developed sheath of circular muscle fibres; body surface covered

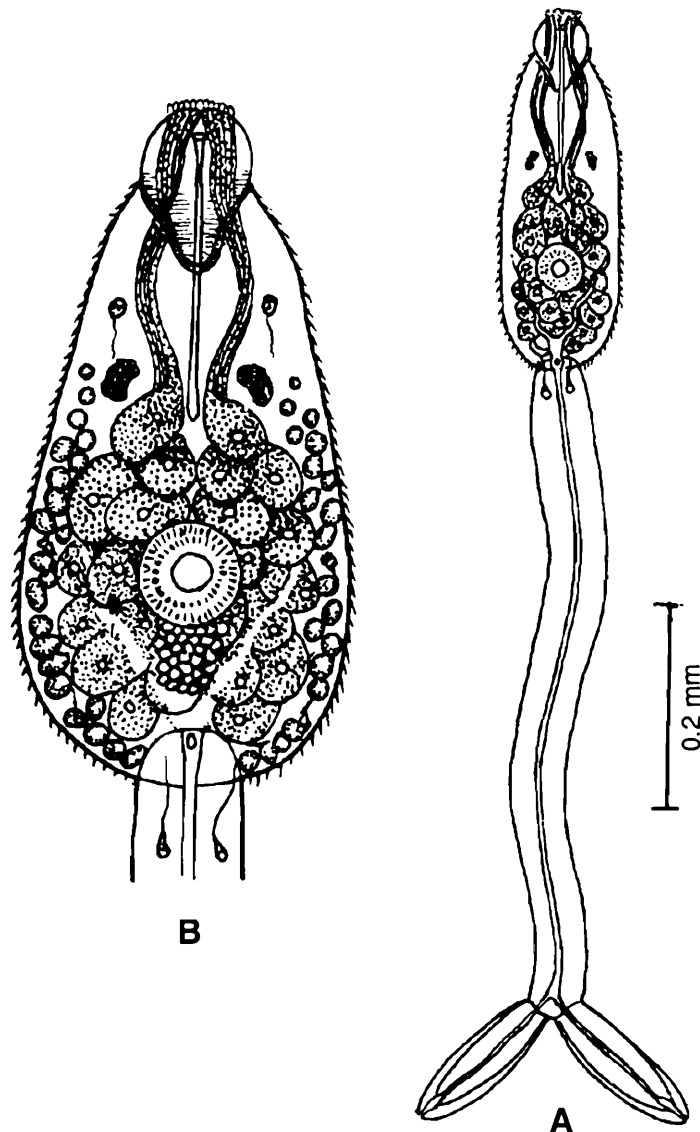


Fig. 7. A & B. *Cercariae indicae* XXXVI Sewell, 1922 (After Sewell, 1922)

with minute backwardly directed spines; a pair of circular heavily pigmented eye-spots situated at junction of anterior and middle third of body length; ventral sucker forms a well marked projection on ventral aspect about 1/3 of distance or a little more from posterior end, its surface armed with a number of minute centrally directed spines, it measures 0.04 in diameter; tail long, it forms a very distinct angle with body, well provided with muscle fibres, without spines, attached to ventral aspect of body a little distance in front of posterior end, furcal rami flattened bear along dorso-ventral margins a fin-fold with numerous striae resembling fin rays, tip of each ramus traversed by excretory pore; mouth small, situated subterminally, leads back into a narrow oesophagus; oesophagus passes backward through anterior penetrating organ and ends posteriorly at level of anterior pair of salivary gland cells; intestinal caeca absent; salivary gland forms a conspicuous mass occupying greater portion of posterior half of body, gland cells two kinds-anterior group consists of four pairs of coarsely granular cells situated in front of level of ventral sucker, granules of protoplasm irregular in shape and somewhat refractile, posterior group consists of eight pairs of gland cells with large clear nuclei and finely granular protoplasm, from each cell in both groups a duct passes forward, group of ducts from each side of body passes forward internal to eye-spot and sweeping forward and outward reach ventro-lateral aspect of anterior penetrating organ and passing through it to open on papillae; a small excretory bladder lies posteriorly and from it a pair of main excretory tubes pass formed in a wavy course to side of body at level of ventral sucker, three pairs of flame cells present in body probably fourth flame cell also present in body, anterior pair of flame cell lies midway between eye and penetrating organ, second pair occupy groove in lateral margin of salivary gland between anterior and posterior groups of gland cells, the posterior pair of flame cell situated opposite posterior end of salivary gland on either side of excretory bladder, a caudal canal arises from posterior aspect of excretory bladder and passes down whole length of tail-stem, it bifurcates at distal end and each branch passing along whole length of furcal ramus to open through a small bladder like cavity at tip, a single pair of flame cells situated near base of tail stem; genital organs represented by a somewhat diffuse mass of small round cells lying ventrally to salivary gland between ventral sucker and excretory bladder; along each side of body in lateral regions a number of oval or rounded refractile cells present.

Sporocyst elongate.

Snail Host : *Indoplanorbis exustus*.

Locality : Arapetta Tea Estate, Mepadi, Wynaad.

8. *Cercariae indicae* XLVII Sewell

(Fig. 8. A & B)

Diagnosis : Body armed in anterior two thirds of length with small closely set backwardly directed spines while posterior third appears to be devoid of armature; body of cercariae measures 0.27-0.28 × 0.09-0.10; tail-stem slightly shorter than body length, measures 0.18-0.25 in length with a uniform diameter of 0.04; furcal rami measure 0.09-0.14 in length, fin folds absent; anterior end occupied by a pyriform penetrating organ which measures 0.09 in length and breadth at its widest part measures 0.06, posterior portion of organ enclosed within body provided with a well marked sheath of circular muscle fibres; ducts of salivary glands enter on ventro-lateral aspect of narrow posterior end and pass forwards through substance of organ to anterior tip where they open through five pairs of hollow conical piercing spines; a well developed head gland present; a pair of eye-spots situated laterally at about 1/3 of body length from anterior end, circular in outline, composed of a number of granules

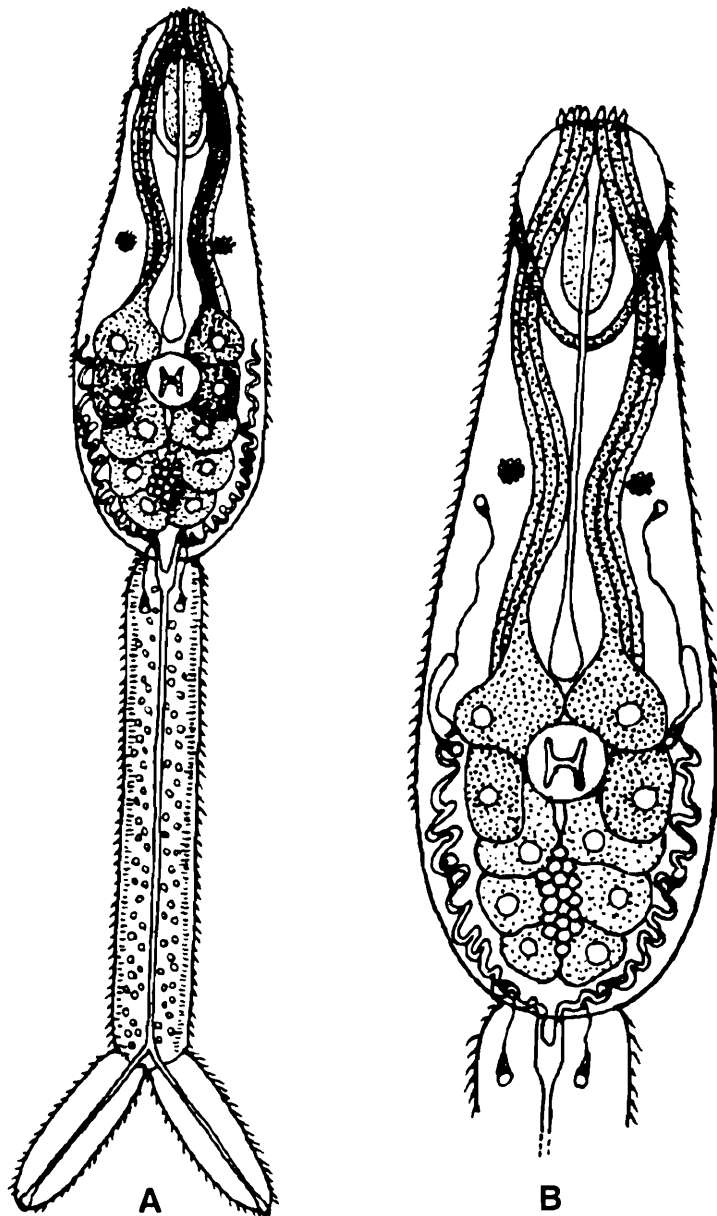


Fig. 8. A & B. *Cercariae indicae* XLVII Sewell, 1922 (After Sewell, 1922)

of light brown colour; ventral sucker forms a well marked projection on ventral aspect about 1/3 of body length from posterior end, powerful ventral sucker measures 0.03 in diameter, when viewed from ventral aspect its aperture looks like letter 'H'; tail attached to posterior end of body, tail armed with closely set spines rather than those present on body, spines appear to be slightly curved; beneath cuticle situated a layer of circular muscle fibres; furcal rami slightly more than half length of tail stem when fully extended but capable of very considerable contraction, constricted off from tail-stem and armed with five spines; mouth small, situated subterminally; oesophagus narrow, passes back as far as a short distance in front of ventral sucker where it terminates into a small pyriform dilatation; five pairs of salivary gland cells situated posterior half of body, anterior two pairs coarsely granular, granules irregular in shape and of a refractile character, posterior three pairs of cells finely granular, salivary cells possess round nuclei, five ducts pass forwards on each side of body, they pass forwards and inwards internal to eye-spot then bend outwards to reach ventro-lateral aspect of penetrating organ, they terminate in the hollow piercing spines; excretory vesicle situated in base of tail, a pair of main excretory tubes arise from antero-lateral angles and pass forwards into body, they diverge and follow a convoluted course around lateral aspect of salivary gland as far as level of anterior margin of ventral sucker and at this point main duct divides into anterior and posterior collecting tubes, anterior tube passes forward and divides into two capillaries each tipped with a single flame cell, two other flame cells situated in the posterior region of body, from posterior end of excretory vesicle a caudal canal passes down tail-stem and its distal end bifurcates into two branches which pass along each furcal ramus to open through a cup-shaped excretory pore at extreme tip, a single pair of flame cells situated at base of tail, flame cells formula represented by $2 \times 4 (+1) \times 1 = 8(\times 2)$; genital organs represented by a compact group of small round cells situated near ventral surface of body between ventral sucker and posterior end of body.

Sporocysts small, oval, measure 0.56–0.88 in length and 0.25 in breadth, each sporocyst contains three mature cercariae.

Snail Host : *Melanoides tuberculatus*.

Locality : Achur, Wynaad, Madras.

9. *Cercaria indicae* LXXIX Sultana

(Fig. 9. A.)

1980. *Cercaria indicae* LXXIX Sultana, *Proc. Indian Acad. Parasitol.*, 1(2) : 82-84.

Diagnosis : *Cercaria* belongs to non-ocellate, aphyeryngeate, brevifurcate group; body of cercaria measures 0.24×0.13 in living and 0.18×0.61 in fixed conditions; tail-stem measures 0.32×0.04 in living and 0.29×0.04 in fixed conditions; furcal rami measure 0.19×0.02 in living and 0.16×0.01 in fixed; oral organ measures 0.18×0.06 in living and 0.06×0.03 in fixed specimens; ventral sucker measures 0.02×0.03 in

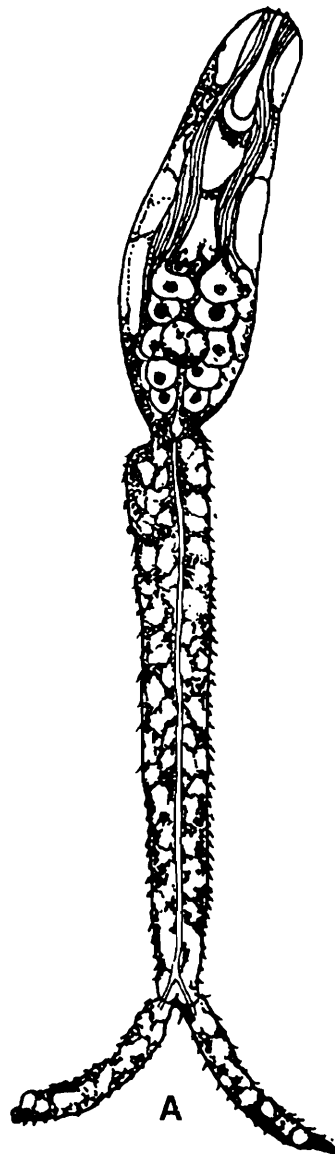


Fig. 9. A. *Cercariae indicae* LXXIX Sultana, 1980 (After Sultana, 1980)

living and 0.02×0.02 in fixed specimens; flame cell formula represented by $2 [(1+1) + (1+1) + (1)] = 10$.

Cercaria develop in sporocysts, each sporocyst contains a few cercariae.

Snail Host : *Lymnaea luteola*.

Locality : Kareemnagar district and Hyderabad (Tarnaka area).

Remarks : The cercaria is inadequately described.

10. *Cercaria manteri* Pandey and Agrawal
(Fig. 10. A & B)

1977. *Cercaria manteri* Pandey and Agrawal, *Indian J. Zoot.*, XVIII(1) : 35-37.

Diagnosis : Cercariae come out in large numbers during noon, positive phototropic, float in twisted state with body close to furcal rami, at intervals they turn downward

with body and furcal rami facing towards bottom and tail-stem on water surface, often cercarial body bents at an angle to tail-stem, under coverslip pressure they move in a circular manner around axis, they remain alive for more than two hours after their emergence; spinose body, narrow anterior and broad posterior ends; median dorsal fin fold present, appear as fin rays in contracted condition; eye spots kidney shaped present behind middle of body; anterior protrusible organ terminal, oval; oesophagus long followed by intestinal caeca; ventral sucker circular, situated in posterior half of body; body measures 0.07-0.08 (0.08) \times 0.03-0.05 (0.04) in living and 0.06-0.07 (0.07) \times 0.02-0.02 (0.02) in fixed conditions; tail-stem measures 0.19-0.21 (0.20) \times 0.02-0.02 (0.02) in living and 0.17-0.18 (0.18) \times 0.01-0.02 (0.01) in fixed conditions; furcal rami measure 0.04-0.07 (0.06) \times 0.01-0.02 (0.02) in living and 0.03-0.05 (0.04) \times 0.003-0.004 (0.003) in fixed conditions; anterior protrusible organ measures 0.02-0.02 (0.02) \times 0.01-0.02 (0.02) in living and 0.01-0.02 (0.01) \times 0.01-0.01 (0.01) in fixed conditions; ventral sucker measures 0.001-0.002 (0.001) in living and in fixed conditions; out of four pairs of penetration glands, two pairs situated anterior to ventral sucker, one pair at ventral sucker level and one pair posterior to ventral sucker, each gland oval in shape with a posteriorly placed nucleus and fine granules, opens at anterior protrusible organ; cystogenous glands and brown particles distributed all over body genital rudiment represented by cells, situated behind ventral sucker; spinose tail, narrow, more than twice length of body, furcal rami slightly smaller than body, caudal nuclei and striations present in tail, excretory bladder 'V' shaped, two main collecting canals-one on each side of body arise from cornua of excretory bladder and divide in anterior and posterior collecting canals, anterior canal with two fine

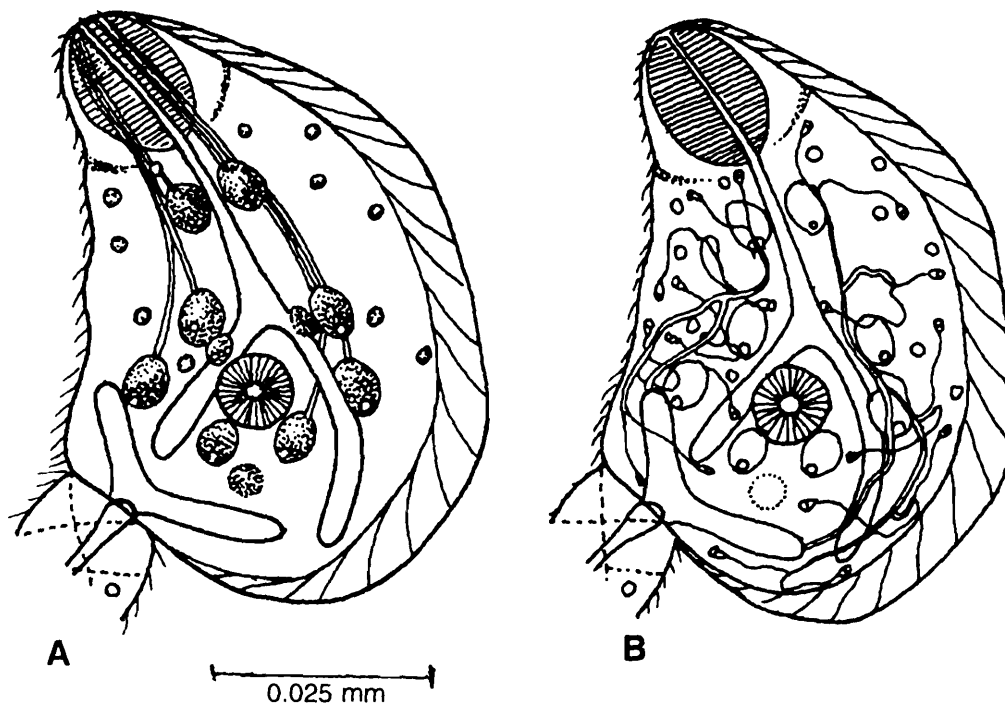


Fig. 10. A & B. *Cercaria manteri* Pandey and Agrawal, 1977 (After Pandey and Agrwal, 1977)

tubes each with two flame cells while posterior canal with three short branches each with capillaries from two flame cells, a caudal excretory canal runs upto caudal bifurcation where it ends as a bulbous swelling, flame cell formula can be represented by $2 [(2 + 2) + (2 + 2 + 2)] = 20$, flame cell in tail absent.

Sporocyst unknown.

Snail Host : *Indoplanorbis exustus*.

Location : Hepatopancreas.

Locality : Kathauta Tal, Lucknow.

11. *Cercaria ocellata* La Valette St. George (Fig. 11. A & B)

1855. *Cercaria ocellata* La Valette St. George, Symbolae ad Trematodum Evolutionis Historiam Berolini : 38.

1969. *Cercaria ocellata* Gupta and Taneja, *Res. Bull. Panj. Univ.*, 20(I-II) : 223-225.

Diagnosis : *Cercaria* large, swims with help of lashing and propelling movement of tail, it rests vertically with body points downward and tail upward, furcae place right angles to long axis of body, it sinks to bottom gradually when it rest, after rest tail beats rapidly and cercaria comes to motion again, on flat surface, cercaria exhibits caterpillar-like movements with help of suckers, positive heliotropic and swims towards light; body elongate and flattened, measures 0.35-0.42 in length in extended condition and 0.18-0.22 in length in contracted conditions; tail-stem measures 0.31-0.48 in length, short furcal rami and ramus measures 0.22-0.28 in length; anterior penetration organ measures 0.04×0.03 , situated at anterior end of body, it differentiated into two portions-a thin walled anterior portion and a muscular posterior portion, anterior part protrudes out; ventral sucker circular, measures 0.02-0.03 in diameter, situated 0.12-0.17 behind anterior end, it can protrude and retract and such movements brought by five sets of radiating muscle fibres of which two lie antero-laterally, two postero-laterally and one medially; mouth subterminal; oesophagus thin-walled, measures 0.09-0.13 in length; oesophagus bifurcates behind eye-spots into two short intestinal caeca which end blindly; pharynx absent; five pairs penetration glands lie close to ventral sucker, first two pairs large with coarse granular contents and remaining three pairs with fine granular contents, in live cercaria large glands appear yellow and remaining glands transparent, from these glands arise two ducts that run forward and open on either side of anterior penetration organ; penetration organ provided with a large number of fine delicate spines; genital organ represented by a mass of cells lying posterior to ventral sucker; eye-spots present one on either side of oesophagus, each eye-spot 0.01 in diameter and lies at a distance of 0.08-0.12 from anterior end, lens of eye directed antero-laterally; rectangular excretory vesicle lying at posterior end of body, main excretory canals arise from postero-lateral sides of

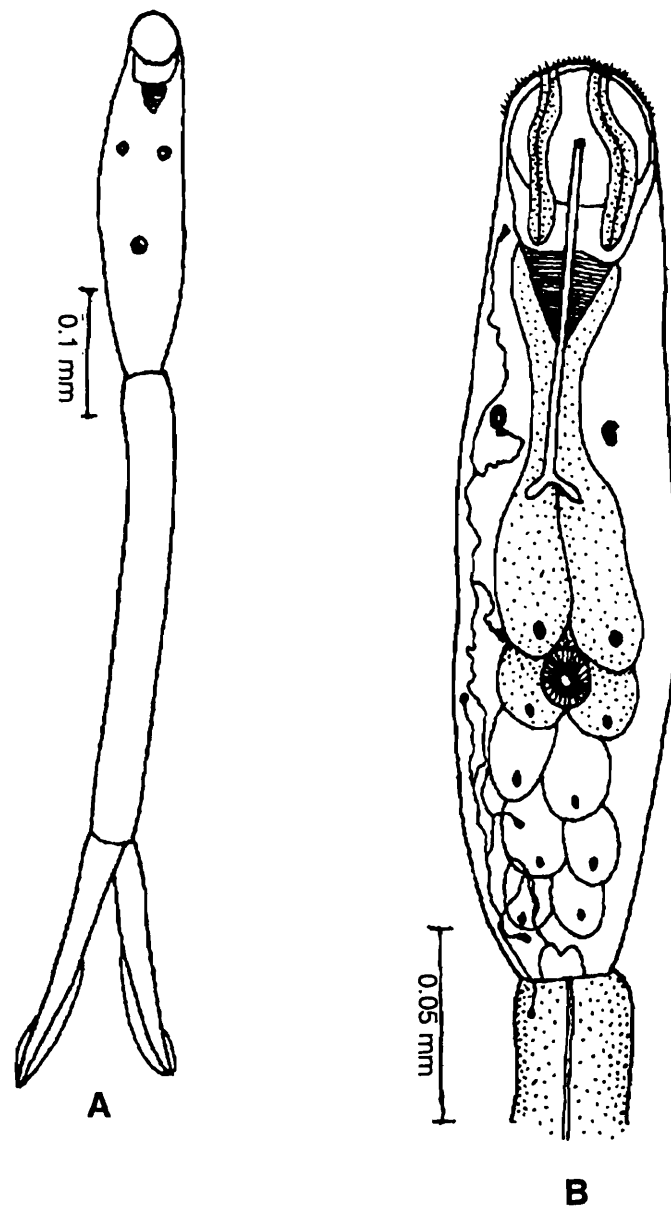


Fig. 11. A & B. *Cercaria ocellata* La Valette St. George, 1855, (After Gupta and Taneja, 1969)

vesicle run anteriorly for a short distance, each canal divides into two branches— anterior and posterior excretory canals, anterior excretory canal gives off three capillaries each terminating into a flame cell, posterior excretory canal also gives off three capillaries each capped with a flame cell, from either side of main excretory canal arises a duct that runs downward in tail and ends into a flame cell, posterior border of excretory vesicle gives off a caudal excretory canal that runs medially in tail-stem, caudal excretory canal near posterior end of tail-stem bifurcates into two branches, each branch runs into furcal ramus of its side and opens outside at tip of it, flame cell formula represented by $2 [(1 + 1 + 1) + (1 + 1 + 1) + (1)] = 14$.

Snail Host : *Lymnaea auricularia*.

Locality : Kharar (A town 10 miles from Chandigarh).

12. Cercaria of *Orientobilharzia dattai* Dutt and Srivastava
(Fig. 12. A-C)

1962. Cercaria of *Orientobilharzia dattai*, Dutt and Srivastava, *Indian J. Vet. Sci.*, 32(1) : 33-43.

Diagnosis : Cercariae remain uniformly distributed in water with head downward and furcal rami upward and spread out horizontally; in water they may remain motionless or make vertical movements by lashing movement of tail-stem and body being dragged behind; long axis generally remain vertical or occasionally oblique or horizontal; they also make looping movements by means of two suckers, ventral sucker acting as pivot; cercariae apharyngeal, brevifurcate, non-ocellate; body oval much longer than broad; tail-stem cylindrical, slightly tapering towards distal end; furcal rami without fin-folds, lanceolate and sharply delimited from tail-stem; cuticle spiny, body spines more closely set than those on tail-stem and furcal rami but

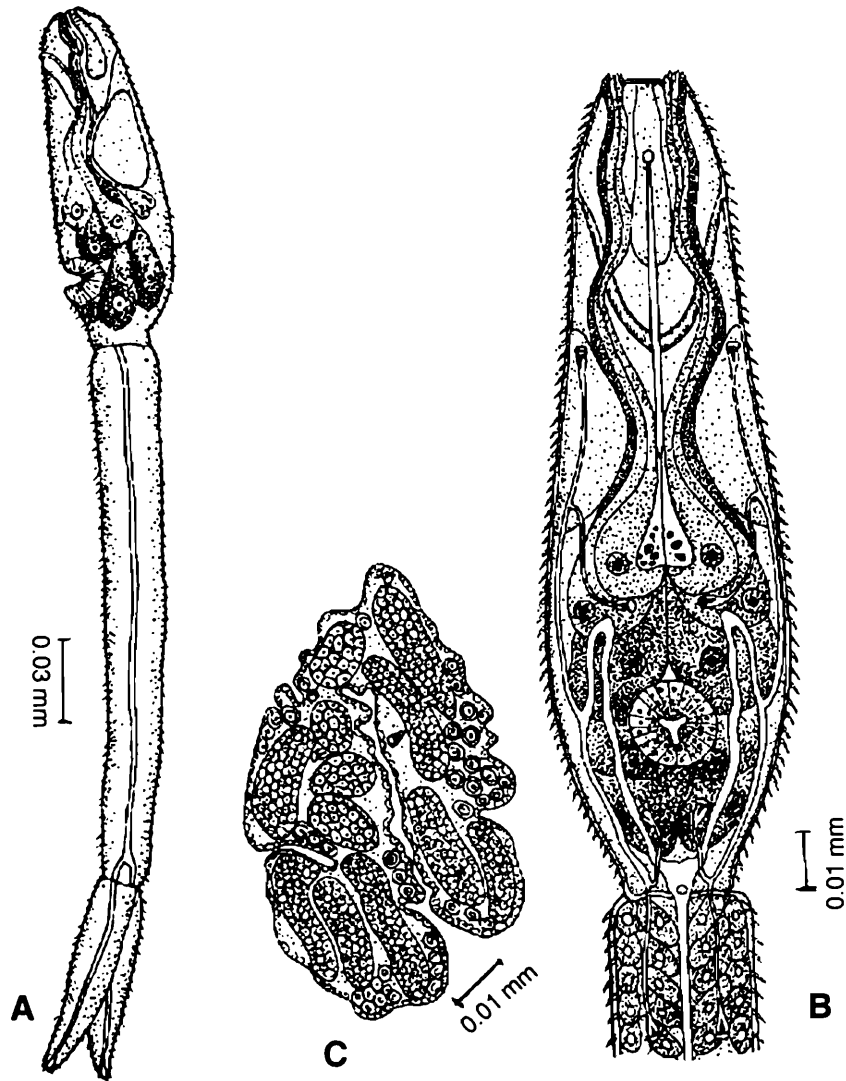


Fig. 12. A & B. Cercaria of *Orientobilharzia dattai* Dutta and Srivastava, 1962. C. Mother sporocyst of cercaia *O. dattai* Dutt and Srivastava, 1962 (After Dutt and Srivastava, 1962)

slightly smaller than latter; body when killed by heat measures 0.13-0.20 (0.17) × 0.04-0.06 (0.06); tail-stem measures in specimens killed by heat 0.21-0.31 (0.26) × 0.03-0.04 (0.03); furcal rami measure in specimens killed by heat 0.07-0.12 (0.10) in length; head organ highly muscular, pyriform, measures 0.05-0.80 (0.05) × 0.03-0.03 (0.03) and modified oral sucker occupies anterior third of body, consisting of anterior and posterior portions; head gland about three fourth as long as head organ and not very conspicuous; ventral sucker well developed, situated anterior region of last quarter of body, measures 0.02 in diameter, spinose, spines more prominent than those on surrounding cuticle, cavity 'Y' shaped; mouth situated ventrally at a distance of about 1/10th of body length from anterior end; oesophagus narrow; caecum situated dorsally behind nerve mass, a little posterior to middle of body, bilobed, measures 0.01 × 0.01, contains granules of various sizes; penetration glands five pairs-two anterior pairs slightly smaller in size, three posterior pairs larger, they fill up practically whole of interior of cercaria behind nerve mass, each gland gives out a duct from anterior end which passes anteriorly, two bundles of ducts of five glands of each side enter head organ through middle of its postero-lateral wall run in a wavy course and open at anterior most tip on either side of head gland, each gland with a swelling at its tip and capped by a prominent spine; escape glands lie in front of first pair of penetration glands, half size of penetration glands; nervous system consists of two thick, hemispherical nerve masses, situated in second quarter of body, connected by a thin median commissure lying dorsal to oesophagus and ducts of penetration glands; excretory system consists of four pairs of flame cells-a pair each of anterior collecting tubules, posterior collecting tubules and main lateral collecting tubes, an excretory vesicle, a caudal excretory tube and a pair of furcal excretory tubes opening at excretory pore situated at tip of rami, anterior flame cell of each side situated a little behind anterior border of nerve mass, second flame cell located at about level of anterior margin of second penetration gland, capillary tubules from flame cells unite to form anterior collecting tubule, third flame cell situated lateral to genital rudiments-sometimes further back, fourth flame cell located in tail-stem at a distance of about 1/8th of latter from proximal end, capillary tubules from third and fourth flame cells unite to form posterior collecting tubule which unites with anterior collecting tubule to form main lateral collecting tube, latter proceeds anteriorly upto level of second penetration gland then turns back and joins excretory vesicle, main lateral collecting tube bears two ciliary patches, excretory vesicle pear-shaped situated near posterior extremity of body, caudal excretory tube passes through tail-stem and divides into furcal excretory tubes passing through furcal rami and open through excretory pores situated at tip of rami; a group of cells lying posterior to ventral sucker form primordium of reproductive organs, it consists of large number of cells.

Sporocyst mostly found in mantle lobe, less frequently in digestive gland and rarely in head foot organ; mature mother sporocyst thin-walled, saccular, measures 0.2-0.59 × 0.02; sporocysts become folded and convoluted when occurring in mantle lobe and head-foot organ, forms occurring in peripheral spaces of digestive gland more

elongated and less convoluted; body wall thin lined internally by a cellular layer, this layer lining comparatively thicker at two ends; germinal elements consist of germinal cells, germinal balls, daughter sporocysts; germinal cells spherical, germinal balls spherical to oblong in shape, lie in cavity of mother sporocyst, mother sporocyst with three flame cells; daughter sporocyst more elongated, cylindrical, ends rounded, shows movement, found in digestive gland, measures $0.09-0.4 \times 0.02-0.05$, anterior end with spines and protrusible, body wall thick, germinal elements consist of germinal cells, with three flame cells, germinal cells give rise to germinal cells and balls, largest germinal ball 0.04 in diameter, cuticle thinner at birth pore, contains developing and mature cercariae.

Snail Host : *Lymnaea luteola*.

Locality : Bareilly.

Miracidium pyriform, posterior region narrower, greatest width lies at anterior end, terebratorium highly protrusible, while swimming body spindle shaped; size varies, measures $0.10-0.15 \times 0.04-0.06$, specimens killed by heat measure $0.10-0.15 \times 0.05-0.06$; body covered with cilia, cilia absent on terebratorium and inter-cellular space; epidermal cells 22 in number, arranged in four tiers, first tier consists of 6 cells, second of 9, third of 4 and last of 3 cells; sub-epithelium present beneath epidermal cells; apical gland or gut shorter than penetration glands, large sac like, contains coarse granules; penetration glands retort-shaped- one lying on each ventro lateral aspect of apical gland, glands thinner but longer than apical gland, ducts open at base of terebratorium-one on either side; central nervous system consists of thick mass of nervous tissue or brain situated approximately second quarter of length of miracidium, spherical in shape, bilobed in nature, a number of nerve fibres originate from nerve mass and terminate in sensory papillae; lateral papillae two in number, situated in space between first and second tiers of epidermal cells; anterior papillae six in number, form a ring round miracidium in region just anterior to lateral papillae, one papilla situated immediately external to middle of base of each epidermal cell of first tier; miracidium possess two sets of bristle patches-first set consists of two groups of six papillae each located laterally at base of terebratorium, second set located in intercellular space between first and second tiers of epidermal cells and consists of 14 to 17 bristle patches which form a girdle round miracidium; a small pore situated in intercellular space between dorsal and ventral epidermal cell of third tier; excretory system with two pairs of flame cells with ducts and excretory pores, two anterior flame cells situated near antero-lateral border of nerve mass and posterior ones situated a little anterior to posterior tier of cells, capillary tubules from anterior and posterior flame cells unite at level of posterior border of nerve mass, tube thus formed proceeds anteriorly then turns back and after reaching a little distance beyond second flame cell turns anteriorly again and opens into excretory vesicle and discharge through excretory pore; germinal cells occupy most of space of body behind nerve mass, cells large with prominent nuclei, cells number varies from 48-54.

13. Cercaria of *Orientobilharzia turkestanicum* Dutt and Srivastava

1964. Cercaria of *Orientobilharzia turkestanicum* Dutt and Srivastava, *Curr. Sci.*, **33**(24) : 752-753.

Diagnosis : Cercariae in shade congregate near surface of water; in strong sunlight they sink to bottom and in mild sunlight they remain uniformly distributed throughout water; cercaria apharyngeal, brevifurcate, non-ocellate; furcal rami without fin-folds; body measures 144-199 μ in length and 40-62 μ in maximum width; tail stem measures 165-248 μ in length and 23-39 μ in width; furcal rami measure 53-115 μ in length; head organ measures 44-58 μ in length and 29-35 μ in width; ventral sucker measures 21-25 μ in diameter; mouth situated ventrally; oesophagus narrow; caecum bilobed; penetration glands five pairs; flame cell formula represented by 2 [2 + 2 + (1)] = 10, excretory opening dilated and situated margin of tip of furcal ramus.

Snail Host : *Lymnaea auricularia* *Sensu stricto*.

Locality : Srinagar.

Miracidium measures 85-134 μ in length and 31-61 μ in maximum width; epidermal cell formula represented by 6 : 9 : 4 : 3; anterior papillae six; lateral papillae two pairs; bristle patches two sets - second set containing 15-18 (mostly 16) bristle patches; penetration glands one pair; an apical gland; a central nerve mass present; two lateral excretory canals each with a pair of flame cells; a number of germinal cells present.

14. *Cercaria pandei* Pandey and Agrawal
(Fig. 13. A & B)

1977. *Cercaria pandei*, Pandey and Agrawal, *Indian J. Zoot.*, XVIII (1) : 33-35.

Diagnosis : Cercariae hang in water with contracted body, tail-stem straight with diverged furcae, it gradually sink to bottom but come up again with quick movement, it moves at bottom of container by caterpillar movement; body elongated, aspinose, blunt rounded anterior and broad posterior end; protrusible organ oval; small ventral sucker located behind middle of body; prepharynx and pharynx absent; oesophagus long; intestinal caeca sinuous, extend upto hind end of body; body measures 0.13-0.16 (0.15) \times 0.11-0.09 (0.07) in living and 0.12-0.14 (0.13) \times 0.05-0.07 (0.06) in fixed conditions; tail stem measures 0.25-0.28 (0.27) \times 0.03-0.04 (0.04) in living and 0.21-0.25 (0.23) \times 0.02-0.04 (0.03) in fixed conditions; furcal rami measures 0.05-0.08 (0.06) \times 0.02-0.04 (0.03) in living and 0.04-0.06 (0.05) \times 0.02-0.04 (0.03) in fixed conditions; anterior protrusible organ measures 0.03-0.05 (0.04) \times 0.21-0.04 (0.03) in living and 0.03-0.04 (0.03) \times 0.02-0.03 (0.02) in fixed conditions; ventral sucker measures 0.01-0.02 (0.02) in living and 0.01-0.02 (0.01) in fixed conditions; penetration glands three pairs, located in ventral sucker region, one pair anterior to ventral sucker while other two pairs posterior to ventral sucker, each gland elongate-oval in shape with prominent nucleus and numerous granules, glands open anteriorly by separate pores close to anterior protrusible organ; cystogenous glands oval to round present in entire body;

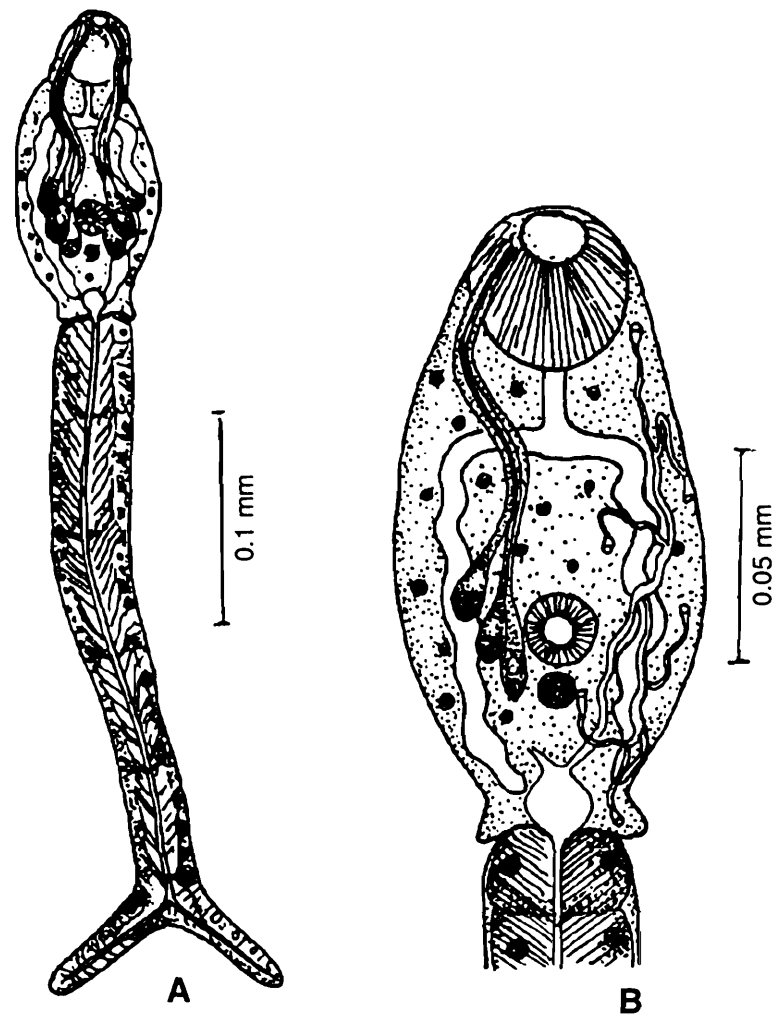


Fig. 13. A & B. *Cercaria pandei* Pandey and Agrawal, 1977. (After Pandey and Agrawal, 1977)

genital rudiments in form of a mass situated anterior to excretory bladder; aspinose tail longer than body, furcal rami aspinose without any fin-folds, smaller than tail, muscles of tail circular, longitudinal and oblique, caudal bodies well developed, a prominent notch present at union of tail and body; excretory bladder round to oval situated at hind end of body, two main collecting canals-one on each side present, canals arise from anterolateral part of excretory bladder and run laterally upto ventral sucker and divide into anterior and posterior collecting canals bearing three capillaries with flame cells, flame cells six pairs in body and flame cell formula represented by $2 [(1 + 1 + 1) + (1 + 1 + 1)] = 12$, a caudal excretory canal runs into tail-stem and divides into two branches which run through furcal rami to open outside by separate pores.

Sporocyst unknown.

Snail Host : *Indoplanorbis exustus*.

Location : Hepatopancreas.

Locality : Kathauta Tal, Lucknow

15. Cercaria of *Plasmiorchis orientalis* Singh
(Fig. 14. A-D)

1952. Cercaria of *Plasmiorchis orientalis* Singh, *Proc. Nat. Acad. Sci., India*, 22(B) I-V : 61-71.

Diagnosis : Cercaria large, transparent, white, emerges from snail hosts in large numbers, showing vigorous wriggling movements, swims horizontally or diagonally upwards and downwards by lashing movement of tail-stem and cercaria moves forward by dragging body behind, occasionally cercaria comes to rest for a while during which period it lies horizontally, it also lies with body downwards and tail-stem upwards with furcae widely separated, tail-stem and furcae also show contraction and expansion, crest in mid-dorsal line of body also contracts and expands; body lanceolate, anterior

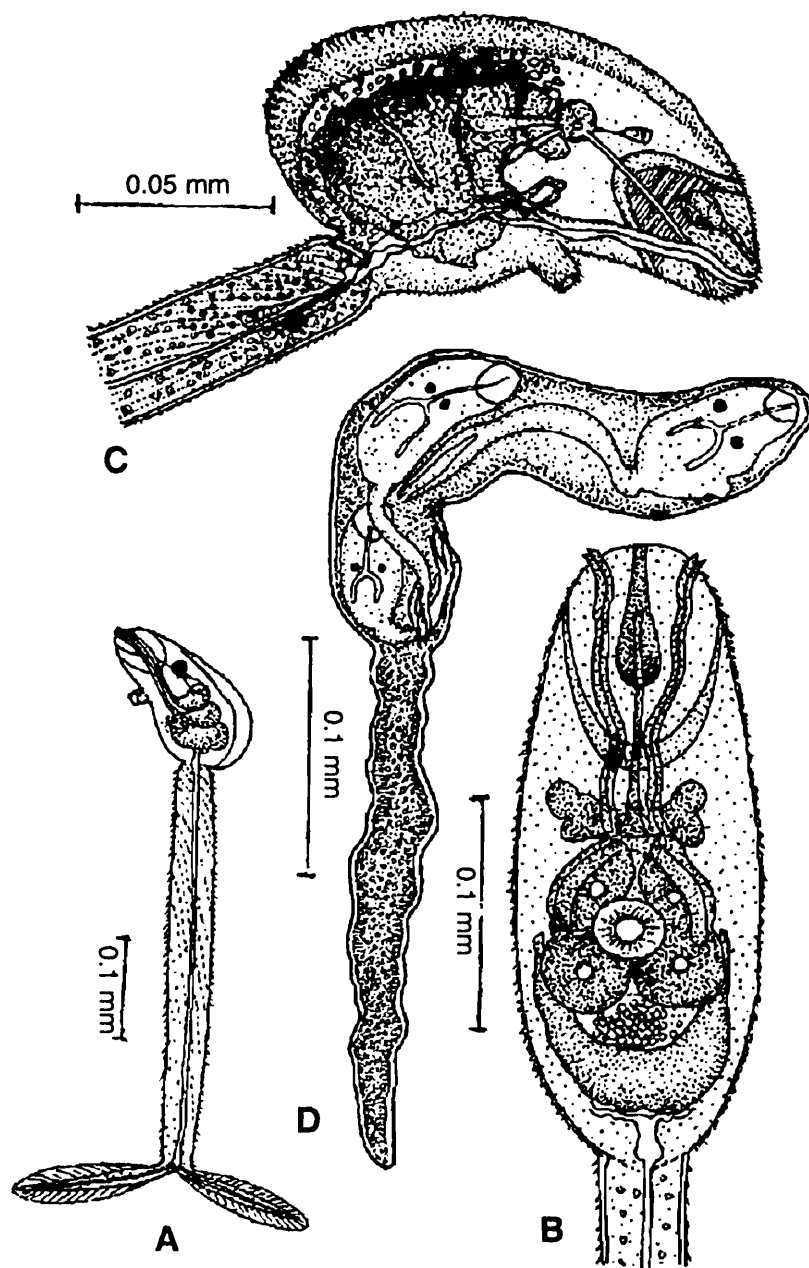


Fig. 14. A-C. Cercaria of *Plasmiorchis orientalis* Singh, 1952. D. Sporocyst of Cercaria *P. orientalis* Singh, 1952 (After Singh, 1952).

end rounded and posterior and more pointed; under coverslip pressure cercaria moves actively and when movements slowed down it lies on one side and moves slowly with aid of anterior penetration organ end ventral sucker; in partially contracted state body becomes pear-shaped, narrow anteriorly and broader posteriorly; body in living condition measures 0.26×0.06 in extended condition and 0.04×0.13 in contracted condition, in fixed specimen body measures $0.16-0.19 (0.17) \times 0.06-0.10 (0.08)$; tail-stem measures $0.23 (0.46) \times 0.04-0.05 (0.05)$; furcae measure $0.02 (0.03)$ long; anterior end of body provided with a protrusible penetration organ, its anterior end broad and posterior end narrow, narrow part of organ enclosed by a well developed sheath; anterior part of penetration organ armed with small anteriorly directed spines arranged densely in quinquinal; anterior tip of snout form a depression and in living condition it pulled in and pushed out; a large pear shaped head gland present in dorsomedian part of penetration gland and seems to open anteriorly on extreme tip of snout through a narrow duct; upto half level of anterior penetration organ body surface provided with numerous small, thick anteriorly directed spines but rest of body provided with sparsely distributed spines; tail-stem and furcae provided with spines; spines on ventral sucker larger than body spines and centrally directed; ventral sucker smaller, measures $0.01-0.01 (0.01) \times 0.01-0.02 (0.01)$, well developed, powerful, situated a little posterior to middle of body, it generally protrudes beyond general body surface; tail-stem more than twice length of body, covered with transparent cuticle, muscle fibres well developed, contracted condition it appears wrinkled furcae as long as body and less than half length of tail-stem, provided with thin transparent wide fin-folds, fin rays extend upto margin of fin-folds; dorsal median crest present; it extends from anterior to posterior end of body, rays of crest radiating like fin rays, margin of crest deeply serrated but serrations disappear during extension of body; eye spots pigmented, measure 0.01 in diameter, refractile lens present in centre of each eye; irregular mass of nervous tissue situated posterior to eye spot represent brain; nervous system represented by a dorsal bilobed ganglionic mass connected by a broad commissure posterior to head organ; posterior half of body occupied by a mass of gland cells, anterior mass composed of two pairs of large pyriform cells with clear rounded nuclei, their protoplasm coarsely granular, these two pairs of cells lie around ventral sucker and ducts pass forward in between eye-spots then diverging outward and reaching ventrolateral aspect of anterior penetration organ and open at tip of snout through short hollow conical spines, behind these gland cells lie a large horse-shoe shaped mass of finely granular cells, this represent posterior penetration gland cells but no duct could be traced; mouth ventral subterminal, a little behind anterior tip; oesophagus long, narrow; oesophagus bifurcates in region of eye spots into two long narrow intestinal caeca which extend a little behind posterior level of ventral sucker; excretory bladder 'V' shaped, posteriorly placed, bladder gives rise to a pair of primary collecting tubes which run anteriorly in a convoluted manner upto level of ventral sucker and at this point they take a turn first on outer side then run backward in a convoluted way upto second pair or penetration gland cells and give rise to anterior and posterior

collecting tubules, anterior collecting tubule receives capillaries from three flame cells-first situated by side of anterior organ, second behind eye spots and third in between margin of first and second pair of penetration gland cells, posterior collecting tubule passes in tail and receives capillaries from two flame cells-one situated between posterior margin of second pair of penetration gland cells and posterior glandular mass and other near bladder, in tail-stem tube ends in a single pair of flame cell, flame cell formula represented by $2 [(1 + 1 + 1) + (1 + 1 + 1)] = 12$, caudal excretory canal passes backward through middle of tail-stem and bifurcates to enter into each furca and opens at furcal tip through dilated excretory pore, each primary collecting tube with two ciliated areas; reproductive system represented by a prominent mass of germ cells, situated in ventral concavity of posterior glandular mass and posterior pair of penetration glands behind ventral sucker.

Sporocysts elongated, very irregularly constricted and their diameter never exceeds 0.13; length varies from 1.9-2.3; anterior end broader with tip produced into a snout; posterior half of body narrow and elongate and contains developing germ balls; body wall consists of single layer of cells covered by a very thin cuticle; body cavity large containing cercariae and germ balls; older sporocysts contain 3-4 mature cercariae and orange-yellow pigments throughout length of sporocyst.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Allahabad (U. P.).

16. Cercaria of *Schistosoma haematobium* Gadgil and Shah (Fig. 15. A & B)

1956. Cercaria of *Schistosoma haematobium* Gadgil and Shah, *Indian J. Med. Res.*, **44** : 577-580.

Diagnosis : Cercariae distributed more or less evenly through different strata of water; cercariae apharyngeal, brevifurcous, non-ocellate, spinose; body measures 0.14-0.24 × 0.06-0.10; tail-stem measure 0.17-0.25 × 0.03-0.05; furcal rami 0.06-0.10 long; oral organ pear-shaped to oval in outline, measures 0.06-0.07 × 0.04-0.06; ventral sucker smaller than oral organ, measures 0.02-0.03 in diameter; mouth opens on oral organ which communicates with oesophagus; oesophagus ends anterior to ventral sucker in two small cells; penetration glands consist of two pairs of large nucleated cells with granular acidophilic cytoplasm and three pairs with basophilic cytoplasm, in this respect cercariae show certain amount of polymorphism, penetration gland ducts moderately thick, opening at anterior end of oral organ and capped by five pairs of hollow piercing spines; germ cells, consisting of several large cells situated posterior to ventral sucker; excretory system with three pairs of flame cells in body and one pair of flame cell in tail stem.

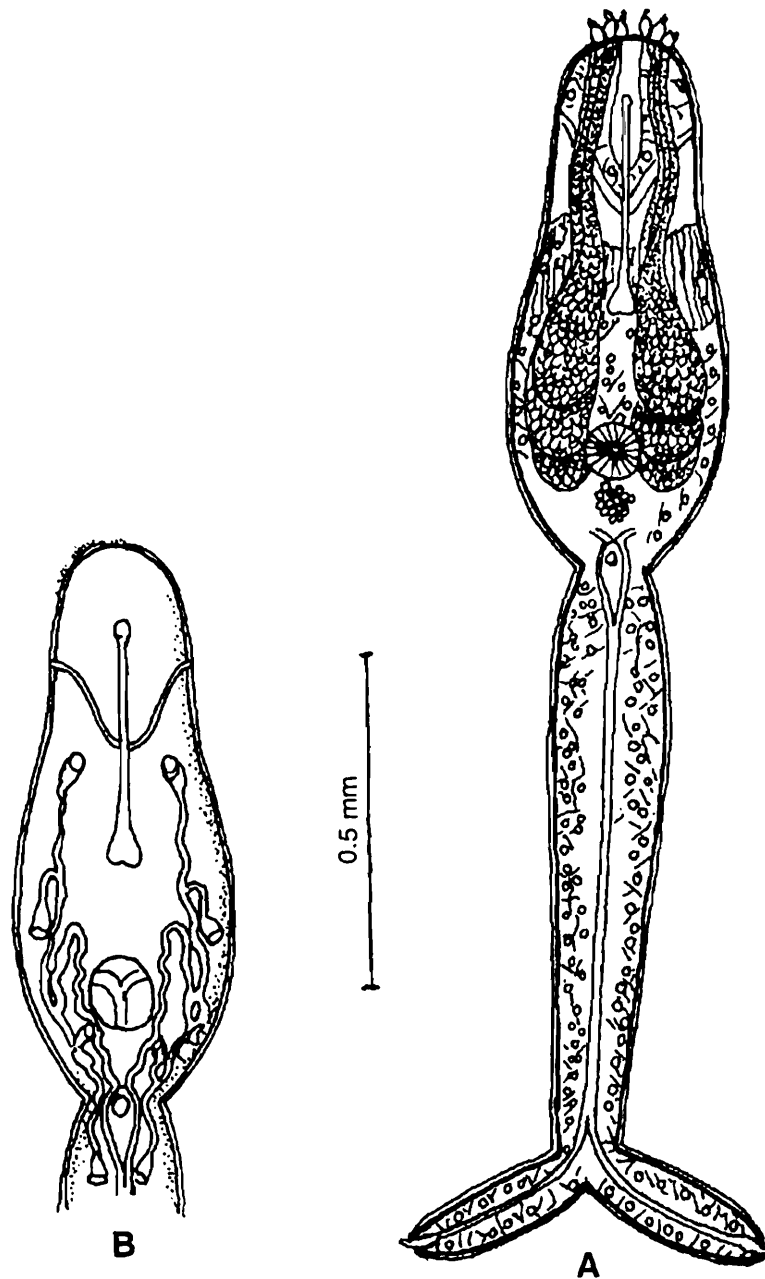


Fig. 15. A & B. Cercaria of *Schistosoma haematobium* Chauhan, Srivastava and Chauhan, 1973 (After Beutten Court and Borges, 1922)

Sporocyst elongate, sac-like, devoid of cilia, outer layer of cells enclosing a central cavity, primary sporocysts found relatively near sites of penetration of miracidia, sporocyst contains developing cercariae.

Snail host : *Ferrissia tenuis*.

Locality : Gimvi village, Ratnagiri district.

Remarks : Gadgil and Shah (1956) have neither illustrated nor gave the details of the various stages of its life cycle. Doubts were raised even about *Ferrissia tenuis* as its intermediate snail host in India. It is suggested that a fresh attempt should be

made to study the occurrence, distribution and life cycle of this important parasite in this country, if at all present.

17 Cercaria of *Schistosoma incognitum* Sinha and Srivastava
(Fig. 16. A-E)

1960. Cercaria of *Schistosoma incognitum* Sinha and Srivastava, *J. Parasit.*, **46**(5) : 629-641.

Diagnosis : Cercaria remains to top level of water, during progression furcal rami remain foremost and act as propeller, tail-stem undulated forming definite nodes and internodes, during movements body dragged behind, at rest cercariae remain hanging with spread out rami at right angles to tail, gradually cercariae sink but when disturbed they soon swim upto top layer; cercaria belongs to non ocellate, apharyngeate, brevifurcous; oval body much longer than broad; bifid tail much longer than body;

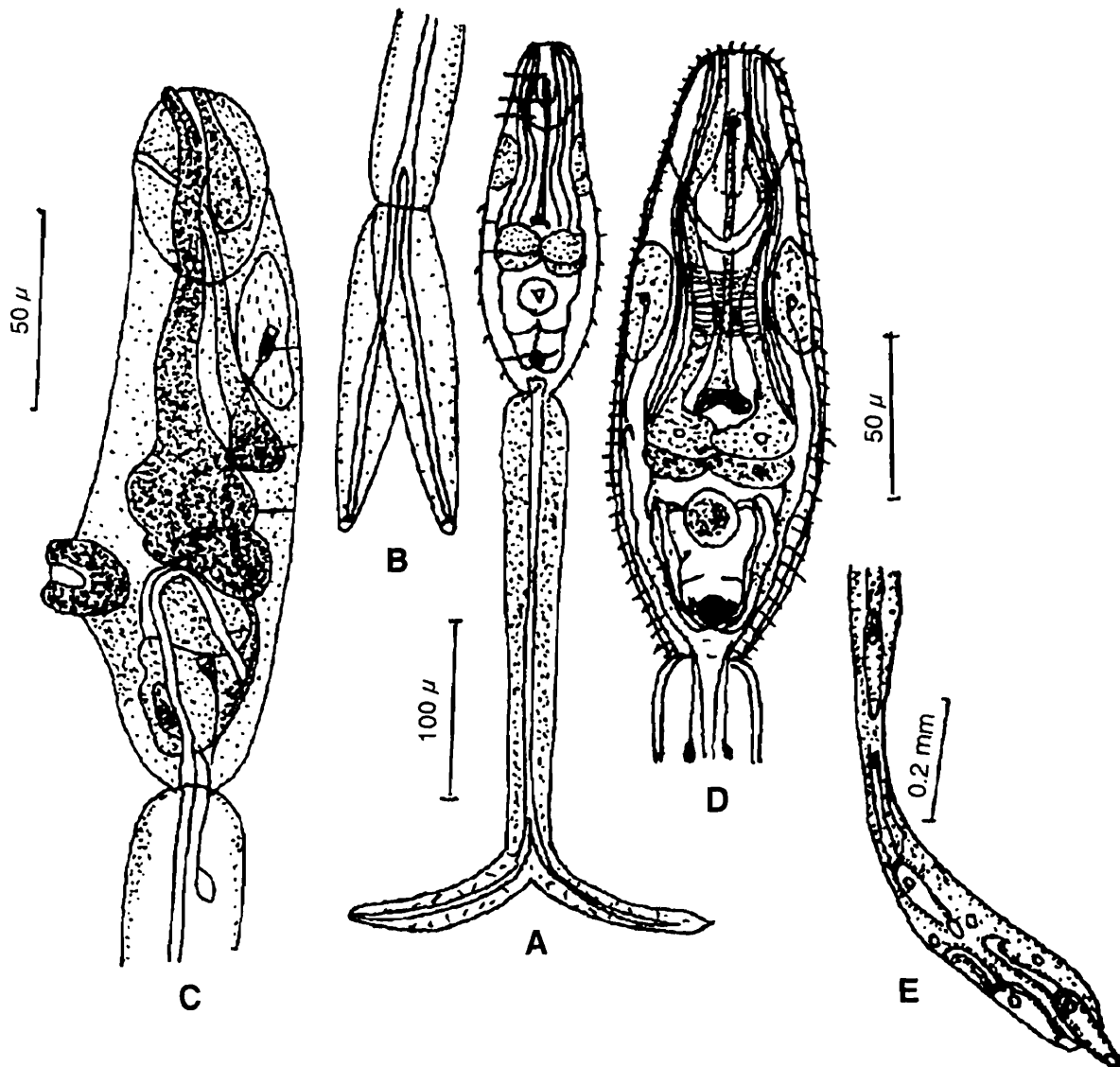


Fig. 16. A-D. Cercaria of *Schistosoma incognitum* Sinha and Srivastava, 1960; E. Sporocyst of Cercaria *S. incognitum* Sinha and Srivastava, 1960. (After Sinha and Srivastava, 1960).

body capable of extension and contraction, measures $0.16-0.21 \times 0.04-0.07$ (0.18×0.05) after killing by heat; tail weakly attached to body, tail-stem round and slightly tapering distally, measures $0.18-0.31$ (0.28) $\times 0.03-0.05$ (0.04), furcal rami distinctly constricted off from tail-stem, rami flat, much shorter than tail, measure $0.08-0.13$ (0.11) in length; body, tail and rami armed throughout with small retrorse spines, spines on body more closely set than those of tail and rami, spines on ventral sucker more dense, head organ free from spines; 5 hollow piercing spines situated on either side of anterior margin of head gland through which ducts of penetration glands open; head organ pyriform in shape, measures $0.05-0.07 \times 0.02-0.04$ (0.06×0.03), walls muscular, internally filled with parenchymatous cells; head gland fusiform in shape, finely granular and dorsally placed, indistinct and extends to three-fourths of length of head organ; ventral sucker situated in third quarter of body length at a distance varying from $0.11-0.14$ (0.12) from anterior end, strongly muscular, forms an elevation on ventral sides of body, measures 0.02 in diameter; mouth situated on ventral surface slightly anterior to junction of head organ and body wall; oesophagus narrow, straight tube; two small saccular, distinct caeca situated just above level of anterior penetration gland, pharynx absent; penetration glands 5 pairs quite conspicuous, situated in tandem slightly behind equator of body, unicellular, arranged in two bilateral groups, two anterior pairs distinct from three posterior pairs in their coarsely granular protoplasm, gland occupy almost posterior half of body, two anterior pairs boot-shaped and lie slightly anterior to ventral sucker, three posterior pairs occupy nearly all space between anterior penetration glands and excretory bladder, each gland with a thick duct which runs anteriorly, ducts on either side form two bundles which run in a zig-zag course in bilateral symmetry through body parenchyma and enter head organ near posterior margin and open at anterior end through hollow spines, ducts of anterior pairs of penetration glands lie medially to those of posterior pairs; excretory system with five pairs of flame cells—four pairs in body and fifth pair in tail, excretory vesicle situated near posterior end of body, from antero-lateral margins arise main excretory tubes, excretory tube of each side runs in an irregular wavy course upto anterior level of ventral sucker and then turns posteriorly to divide at about level of posterior margin of ventral sucker into anterior and posterior collecting tubules, backwardly directed portion of excretory tube dilated at two points bearing cilia on inner wall, anterior collecting tubule gives rise to two capillaries each ending in a flame cell, anterior flame cell situated at about level of middle of oesophagus while posterior invariably lies laterally in space between two anterior pairs of penetration glands, posterior collecting tubule gives rise to two capillaries— anterior ending in a flame cell while posterior divides further into two capillaries each terminating in a flame cell one in body and other in tail upto about one-eighth of length of tail stem, flame cells draining into posterior collecting tubule situated at level of first and second third of post ventral sucker distance respectively, excretory vesicle opens into a wide and straight tube which extends through tail to a little in front of origin of rami then divides into two branches which extend through rami to open at their tips with slightly projecting dilatation, flame cell formula represented by $2 [2 + 2 (+ 1)]$

= 10; nervous system consists of two suboval large masses lying symmetrically a little behind anterior quarter of body length in space between ducts of penetration glands and body wall, two nerve masses connected by a nerve commissure passing dorsally over gut.

Sporocyst shows slight movement; mother sporocyst tubular, very thin wall, measures $0.20-0.23 \times 0.02-0.03$, contains germ balls, germ cells, daughter sporocysts; daughter sporocyst found in digestive gland, motile and shows worm like movements, sausage shaped, measures $0.05-0.07 (0.06) \times 0.01-0.02$, size increases with maturity, body wall hyaline, refractile granules scattered throughout body, finally developed sporocysts of 21 days old measure $0.60-0.90 (0.80) \times 0.10-0.12$ and contain fully developed cercariae, birth pore at one end.

Snail Host : *Lymnaea luteola var australis*.

Location : Around oesophagus, digestive gland.

Locality : Bareilly.

Miracidium : Swimming activity increases with temperature and light, they move in straight course revolving counter-clockwise on their long axis; miracidium pyriform in shape, measures $0.12-0.17 \times 0.06-0.07$; outer surface of body covered with cilia arranged on epidermal cells, cilia absent on anterior papilla and intercellular space, cilia on an average measure 0.01 in length, epidermal cells 21 in number and arranged in 4 transverse rows, first row consists of 6 cells, second row with 8 cells, third row consists of 4 cells, fourth row with 3 cells; small lateral papillae—one on either side situated just above opening of ducts of lateral glands; primitive gut sac-like; a pair of cephalic glands situated one on each side of and ventral to gut, they open through wide ducts at base of apical papilla; lateral glands situated side by side ventral to nerve mass and behind cephalic glands, their ducts open at sides in space between first and second rows of epidermal cells; nervous system with a large central granular nerve mass situated anterior half of middle third of body length behind gut; excretory system with two pairs of flame cells arranged in bilateral symmetry; germ cells occupying posterior two third of body, round with large nucleus.

18. Cercaria of *Schistosoma indicum* Srivastava and Dutt (Fig. 17. A-C)

1962. Cercaria of *Schistosoma indicum* Srivastava and Dutt, *I. C. A. R. Res. Ser.*, **34** : 1-91.

Diagnosis : Cercariae remain uniformly distributed in water with head downward and furcal rami upward, cercariae may remain stationary for some time or gradually sink downward, suddenly they become very active and swim vertically upward by vigorous lashing movement of tail-stem, on slides cercaria also performs looping movement by means of both suckers, during this movement ventral sucker brought very close to oral sucker, cercaria occasionally makes vigorous lashing movements of tail-stem with ventral sucker serving as a pivot, under cover glass pressure cercaria

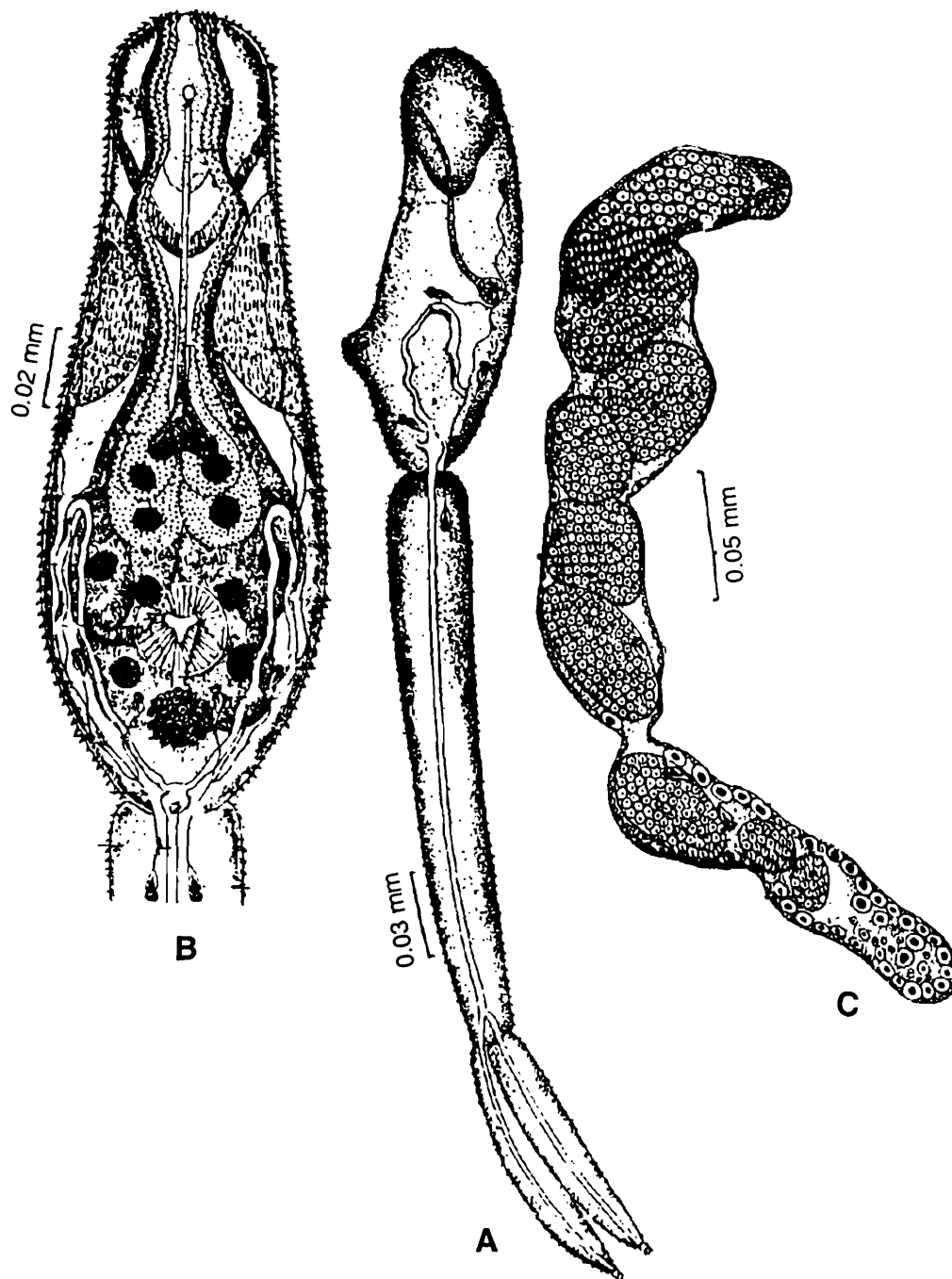


Fig. 17. A & B. Cercaria of *Schistosoma indicum* Srivastava and Dutt, 1962. C. Sporocyst of Cercaria *S. indicum* Srivastava and Dutt, 1962. (After Srivastava and Dutt, 1962).

makes creeping movements; cercaria apharyngeal, brevifurcate, non-ocellate; body fusiform being widest in front of ventral sucker and tapering towards both ends; cylindrical tail-stem much longer than body and terminally attached to body, broadest near its attachment with body and slightly tapers distally, muscular and muscle fibres arranged in four longitudinal bundles towards periphery while central region with large parenchyma cells, excretory tube passes through centre of tail-stem, furcal rami gradually taper towards distal ends, furcal rami oval to elliptical in cross section and armed with backwardly directed spines; spines more closely set on body especially on head organ and ventral sucker; spines on tail-stem and furcal rami slightly larger

and more sparsely arranged; body measures $145-171 \mu \times 43-60 \mu$ ($157 \mu \times 51 \mu$); tail-stem $177-250 \mu \times 23-32 \mu$ ($215 \mu \times 29 \mu$), furcal rami $68-103 \mu$ (86μ); in fixed cercaria body measures $110-153 \mu \times 30-50 \mu$ ($130 \mu \times 42 \mu$); tail-stem $153-233 \mu \times 23-27 \mu$ ($192 \mu \times 24 \mu$), rami $50-83 \mu$ (70μ); dimensions of cercariae vary to a certain extent according to method of killing; dimensions of cercaria irrespective of method of killing measure body length $110-171 \mu$, body width $30-60 \mu$; tail-stem length $153-250 \mu$, width $23-32 \mu$ and furcal rami length $50-103 \mu$; head organ highly developed, measures $58-63 \mu \times 27-35 \mu$, consists of an anterior and posterior portion, latter part with highly muscular wall, highly protrusible, contains anterior portion of penetration ducts, mouth and head gland; ventral sucker well developed, situated on anterior portion of last quarter of body, measures $16-21 \mu$ in diameter, cavity 'Y' shaped, it can be protruded, its surface covered with prominent spines; head gland situated dorsally, occupies three-fourths of head organ, it opens by a duct at anterior most tip in between opening of two sets of penetration ducts, densely covered with nuclei; ventral mouth subterminal and situated about $1/8$ th of body length from anterior end; oesophagus tubular, dilates distally into a conspicuous caecum placed dorsally behind middle of body length; caecum measures $13-19 \mu$, bilobed, contains granules of various sizes; penetration glands five pairs, flask-shaped, large, fill up space between caecum and posterior end of body, each contains large nucleus with distinct nucleolus, contents of anterior two pairs coarsely granular and those of posterior three pairs finely granular, ducts of glands run forward and open at extremity of head organ on either side of terminal portion of head gland; tip of each duct swollen and capped by a piercing spine; a pair of "escape glands" present in cercaria prior to its discharge from digestive gland of snail host, escape glands much smaller than penetration glands, situated anterior to first pair of penetration glands, ventral in position; nervous system consists of two hemispherical lobes situated in middle third of body length; length of each mass slightly less than a third of body length and maximum width about three fourths of width of region of body, two lobes joined in middle by a thin transverse connection; anterior most flame cell situated near anterior end of nerve mass, second flame cell situated near junction of first and second penetration glands, capillaries of two flame cells unite a little distance behind posterior border of nerve mass to form anterior collecting tubule which runs back and meets posterior collecting tubule near lateral margin of body at level of middle of ventral sucker, posterior collecting tubule formed by union of three flame cells—two in posterior region of body and one in tail-stem, capillary tubules of these three flame cells meet posterior collecting tubule at same point, caudal flame cell situated at a distance of one-eleventh of tail-stem from proximal end, main lateral collecting tube proceeds anteriorly upto second body flame cell and penetration gland turn back and proceeds backward to meet excretory vesicle situated near posterior end of body, lateral arm of main lateral collecting tube contains two ciliated areas, caudal excretory tube runs through middle of tail-stem and bifurcates at a distance of about $1/6$ th of length of tail-stem from distal extremity, each branch passes into a furcal ramus and opens by a terminal excretory pore, flame cell formula represented by $2 [2 + 2 + (1)] = 10$; genital rudiments represented by a ball of cells

situated behind acetabulum, cells ventral in position and almost size of a ventral sucker.

Sporocyst measures $0.35-0.47 \times 0.05-0.07$; elongated sac-like body covered with cuticle; germinal layer situated at end and consists of germinal cells attached to sporocyst wall, germ balls grow into daughter sporocysts; wall near birth pore comparatively thick and muscular; three flame cells present in mother sporocyst; daughter sporocyst measures $0.11-0.14 \times 0.03-0.05$, in daughter sporocyst anterior end armed with prominent spines, daughter sporocyst on reaching lymph space of digestive gland of snail undergoes rapid development and contains germinal cells, germinal masses, cercarial embryos and cercariae.

Snail Host : *Indoplanorbis exustus*.

Location : Mantle lobe, digestive gland.

Locality : Bareilly.

Egg : Egg measures $100-150 \mu \times 48-68 \mu$; spine length $3-13 \mu$; voided eggs contain mature miracidia and when come in contact with water they swell appreciably; swell egg measures $97-157 \mu \times 52-87 \mu$ with spine length $7-13 \mu$; eggs oval in shape but they vary in shape; shape of spine also showed variation.

Miracidium : Miracidium swims very actively in water, body rotates round its long axis during swimming; negative geotropic; positive phototropic pyriform in shape; measures $97-167 \mu \times 40-81 \mu$, fixed miracidium measures $100-145 \mu \times 58-81 \mu$ ($129 \times 67 \mu$); terebratorium situated at anterior most tip of body; body covered with cilia, covering of cilia interrupted at three places; epidermal cells 22 in numbers arranged in four transverse tiers, at times their number varies; a small papilla situated at middle of base line of each cell; at base of terebratorium and in space between first and second and second and third tiers situated some papillae; apical gland large in size measures $37-40 \mu$ long, occupying anterior quarter of miracidium, it terminates near tip of terebratorium, filled with coarse granules, it contains four nuclei; penetration glands two in number, retort-shaped, lying ventro-lateral to apical gland, one on each side, measuring $40-47 \mu$ long, each gland with a nucleus located posteriorly, each gland opens laterally at base of terebratorium through narrow pore; nerve mass situated immediately behind apical and penetration glands, spherical in shape, bilobed, nerve fibres arise from nerve mass and terminate in sensory papillae; between first and second tiers of epidermal cells situated two large papillae one on each lateral aspect; six small anterior papillae form a ring round in region just anterior to lateral papillae; three more sets of sensory structures-bristless patches present in miracidium; anterior flame cell of excretory system of each side situated near anterior-lateral border of nerve mass while posterior flame cells situated at level of posterior border of third row of epidermal cells, excretory pore of each side situated laterally in intercellular space between dorsal and ventral epidermal cells of third tier; germinal

cells situated in posterior half mostly behind nerve mass, their number varies from 45-60, arranged singly or in small groups.

19. Cercaria of *Schistosomum spindalis* Soparkar
(Fig. 18. A-C)

1921. Cercaria of *Schistosomum spindalis*, Soparkar, *Indian J. Med. Res.*, IX : 1-22.

Diagnosis : Cercariae hang in water with head down and tail turned upwards, they gradually sink when they begin to swim again; on substratum they move by rapid crawling movement with help of oral and ventral suckers; body measures in

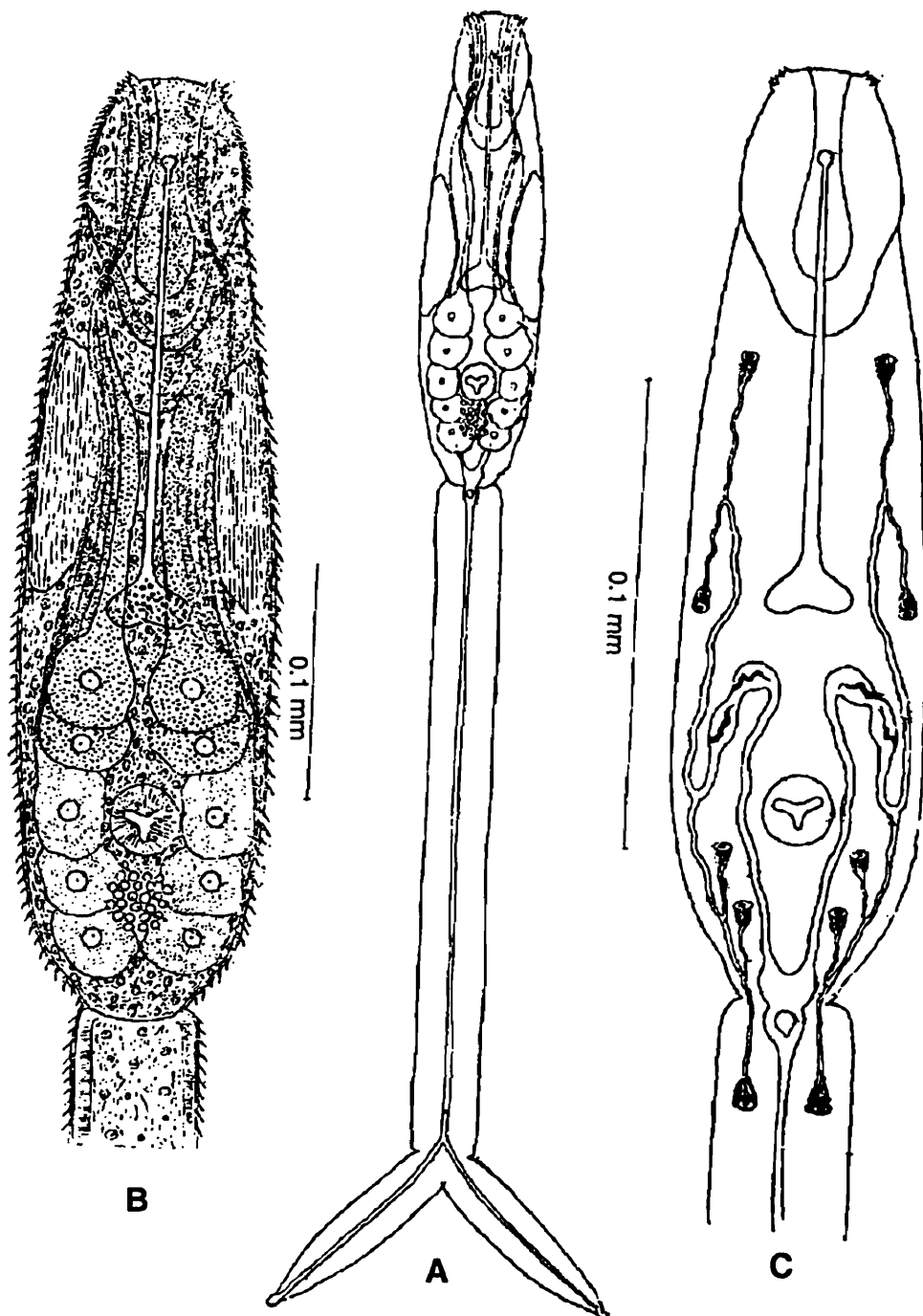


Fig. 18. A-C. Cercaria of *Schistosoma spindalis* Soparkar, 1921 (After Soparkar, 1921).

fixed condition $180-220 \mu$ (200μ) \times 50μ ; tail-stem measures $270-300\mu$ (290μ) \times 30μ , furcal rami measure $90-120\mu$ (100μ) in length; in living specimens body measures $250 \mu \times 35 \mu$ in fully extended condition and in contracted condition it measures $125\mu \times 70 \mu$; ventral sucker strong, muscular structure, situated $1/4$ th of body distance from anterior end, circular, opening triangular, measures 0.02 in diameter, surface covered with sharp cuticular spines, spines numerous on ventral sucker than on body in immediate neighbourhood; mouth opens on ventral surface, a short distance behind anterior tip, surrounded by a knob-like umbilicated thickening; narrow oesophagus passes backward extending a little behind middle of body; caecum kidney-shaped, containing granular material, surrounded posteriorly by mucin glands, some times constriction divides it into two chambers; pharynx absent; oral sucker thick, muscular, situated at anterior extremity of body, measures $64 \mu \times 45 \mu$, may be divided into an anterior and a posterior portion, centre of oral sucker situated head gland, head gland granular and opens externally in middle of head between two groups of mucin ducts; anterior end provided with protrusible snout, it forms a part of anterior portion of oral sucker; posterior half of body filled with a number of unicellular glands disposed around ventral sucker, five such gland present on each side, they may be divided into two groups—anterior and posterior, anterior group consists of two pairs of flask shaped glands measuring about 0.04×0.01 , situated in front of ventral sucker, protoplasm coarsely granular, posterior group consists of three pairs of glands, situated on either side and behind ventral sucker, these glands contain finely granular protoplasm, from these glands ducts pass forwards one from each gland along either side of middle line to enter oral sucker and open at anterior end, in middle of body course of these ducts deflected towards middle line in order to accommodate two large lobes of central nervous system between them and body wall on either side, these lobes connected by a median commissure, opening of ducts capped by hollow piercing spines; main excretory trunks of excretory system arise as anterior continuations of two cornua of bladder and taking a tortuous course pass forward on each side of ventral sucker to a point midway between it and caecum and at this point each trunk makes a bend and runs outward and backward for a short distance and at level of ventral sucker it divides into two branches—anterior and posterior collecting tubules, in main trunk between beginning of bend and its bifurcation situated two fusiform dilatations each containing a bunch of vibratile cilia, anterior collecting tubule passes forward and joined by two smaller tubules arising from flame cells situated in front of ventral sucker, most anterior flame cell located a little below lower border of oral sucker, second flame cell located at level of organ close to outer border of body, posterior collecting tubule passes backward and joined by smaller tubules arising from three flame cells—one in tail and other two situated in posterior part of body behind ventral sucker, flame cells in tail larger than those in body, excretory bladder situated at posterior end of body, thin walled, bicornuate in shape and joined backward by tubule in tail, caudal excretory duct runs as a single tubule to distal end where it bifurcates to enter furcal rami and opens externally in bulbous expansion; reproductive system represented by cluster of small round cells situated ventrally and just posterior to ventral sucker.

Sporocyst small, cylindrical, measures 1.2×0.15 , wall very thin, body elastic, contains 6 to 8 cercariae in various stages of development, firmly attached to tissues of digestive gland.

Snail Host : *Indoplanorbis exustus* rarely *Lymnaea acuminata*.

Location : Digestive gland.

Locality : Mahim, Bombay.

Remarks : This cercaria was designated as *Cercaria bombayensis* No. 4.

20. *Cercaria sewatii* Srivastava (Fig. 19. A & B)

1958. *Cercaria sewatii*, Srivastava, *Proc. Nat. Acad. Sci. India.*, **28** : 410-415.

Diagnosis : Cercariae large, come out of snail in large numbers, they slowly sink in water with body downwards and furcae upwards, after sinking to a short depth cercaria darts all of a sudden and begins to swim, during swimming body or tail directed forwards; under cover glass they show looping movements and move with help of two suckers; cercaria transparent; spindle shaped body, anterior part tapering, posterior part bluntly rounded, body measures $0.35-0.45 \times 0.03-0.04$ in living condition and in extended stage, it measures $0.14-0.2 \times 0.07$ in living condition and in contracted stage, in fixed specimen it measures $0.34-0.41 \times 0.04-0.04$; in living specimen tail-stem measures $0.35-0.37 \times 0.02$ in extended condition and 0.25×0.05 in contracted condition, in fixed specimen it measures 0.33×0.03 ; in living specimen furcae measure 0.25 in length in extended condition and in contracted condition it measures 0.14, in fixed specimen it measures 0.18×0.21 ; spines present on body, tail-stem and furcae; width of tail-stem gradually diminishes towards its end; furcae laterally compressed, show light constrictions at base, fin folds present and it begin at 1/4th distance from its point of origin; anterior organ large, pyriform to elongated oval in shape, occupies anterior third part of body, measures 0.07×0.04 in fixed condition and 0.09×0.06 in living condition, anterior organ consists of two parts—larger anterior thinner part, measures 0.07×0.04 in size and smaller thicker muscular posterior triangular part, measures 0.03×0.03 ; head gland present with coarsely granular cytoplasm and measures 0.08 in length; ventral sucker invariably protruded out, measures 0.02 in diameter and lies at 0.12-0.17 from anterior end, provided with powerful muscle bands; eye-spots with dark brown pigments and lens, situated 0.09-0.12 from anterior end, measures 0.01 across; mouth opening small, subterminal, on ventral side; pharynx absent; oesophagus measures 0.08-0.10 in length, it bifurcates into two short caeca at about half distance between ventral sucker and eye-spots; caeca short, straight, not reaching to ventral sucker; nervous system form a bilobed mass lying anterior to eye-spots; penetration glands occupy almost entire region of body behind eye-spots, anterior one more prominent and consists of two pairs situated around ventral sucker, most anterior pair

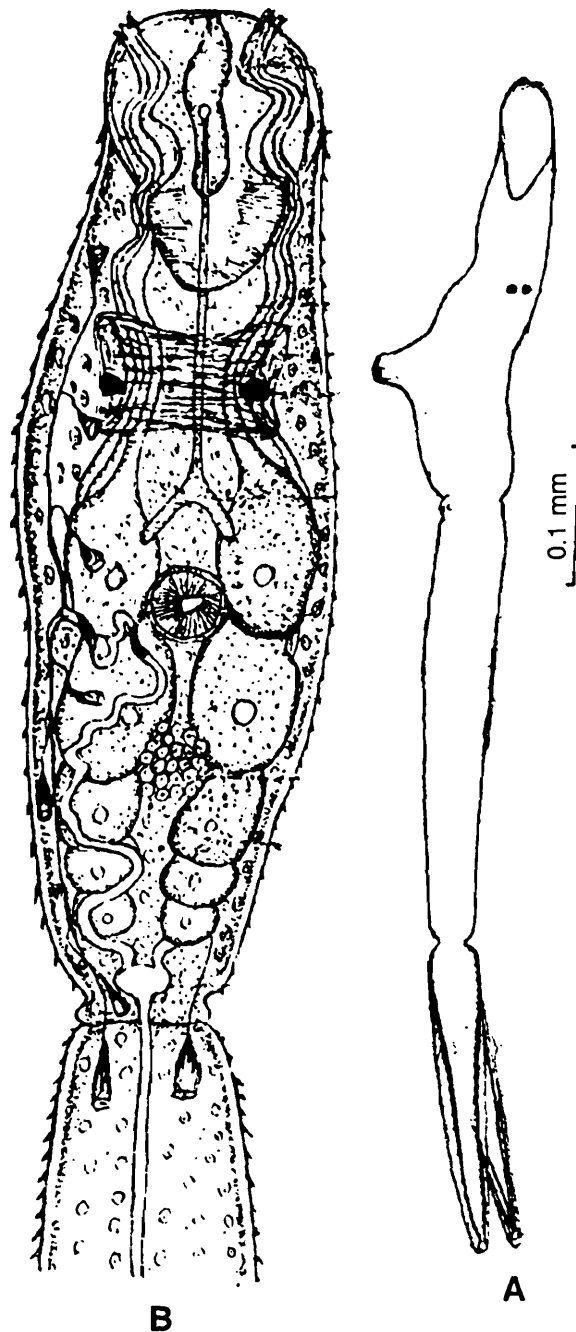


Fig. 19. A & B. *Cercaria sewatii* Srivastava, 1958 (After Srivastava, 1958).

of this set slightly larger than posterior pair, these cells contain granular contents and yellow brown in colour, posterior set of penetration glands comprising of three pairs of greyish coloured, these glands smaller, less granular, less prominent cells, ducts from these five pairs of glands run forward in a bundle on each side and enter into anterior organ and at point of entrance into anterior organ ducts become very thin and within organ ducts of two sides diverge away from each other before opening to exterior, at opening of these glands present a number of spines; six pairs of flame cells present in body, excretory bladder 'V' shaped, "Island of Cort" absent, primary excretory collecting tubes two in numbers which run anteriorly in a convoluted manner upto level of ventral sucker, it gives rise to anterior and posterior collecting tubes, cilia

present in tubes, tail-stem with a pair of flame cell, caudal excretory canal runs through middle of tail-stem, bifurcates and enters into each furca and open at its tip by a bulbous expansion which project beyond furcal tip; mass of cells located behind ventral sucker represent rudiment of reproductive system, it measures 0.03×0.04 .

Cercariae develop in aporocysts.

Host : *Lymnaea luteola*.

Location : Liver.

Locality : Allengunj, Sewait, Allahabad, U. P.

21. *Cercaria simhai* Pandey and Singh (Fig. 20. A-D)

1984. *Cercaria simhai* Pandey and Singh, *J. Zool. Soc. India.*, **35**(1 & 2) : 69-71 (1983).

Diagnosis : Cercariae liberated from snail host in small number, through day but more in bright day light, photopositive, larvae hang down with their head downward and tail upward, they swim with help of lashing movement of tail, they swim in backward direction, cercariae in stationary condition gradually sink to bottom of container; body elongated with narrow, blunt anterior and broad round posterior ends, body surface covered with minute, backwardly directed spines; body measures $0.32-0.44 \times 0.11-0.17$ in live and $0.16-0.24 \times 0.08-0.09$ in fixed conditions; tail spinose, broad, about two and half times longer than body, tail-stem measures $0.68-0.93 \times 0.06-0.08$ in live and $0.48-0.53 \times 0.03-0.05$ in fixed specimens, furcal rami small, measure $0.25-0.28 \times 0.04-0.05$ in live and $0.16-0.22 \times 0.02-0.03$ in fixed individuals, circular, longitudinal and oblique muscles present in tail, in furcal rami muscles absent, small, rounded caudal bodies irregularly distributed in tail parenchyma, fin fold present on furcal rami; terminal protrusible organ pear shaped, its surface covered with spines, measures $0.08-0.11 \times 0.05-0.08$ in live and $0.04-0.05 \times 0.02-0.03$ in fixed specimens; ventral sucker small, rounded, measures $0.04-0.05$ in live and $0.02-0.03$ in fixed specimens, located behind mid body, protrusible end when protruded concentric rings of minute spines on its surface can be seen; eye spots rounded, present anteriorly on lateral sides, measures $0.02-0.03$ in diameter; penetration glands six pairs, situated posterior half of body, anterior three pairs large, rectangular in shape, arranged in two tiers, each gland with prominent nucleus and finely granulated cytoplasm, posterior three pairs small and round to oval in shape, centrally located nucleus and coarsely granulated cytoplasm, each gland opens outside by a pore situated at tip of protrusible organ; entire body filled with rounded cystogenous cells; genital primordia represented by a cell mass located posterior region of body; excretory bladder small, rounded and situated posterior end of body, main excretory canal arises from anterior side of excretory bladder and runs for a short distance and divides into two canals, each canal runs upto posterior level of ventral sucker and divides into two branches— anterior and posterior collecting canals, anterior canal runs forward and gives rise three capillaries which tipped with flame cells, posterior canal runs backward and

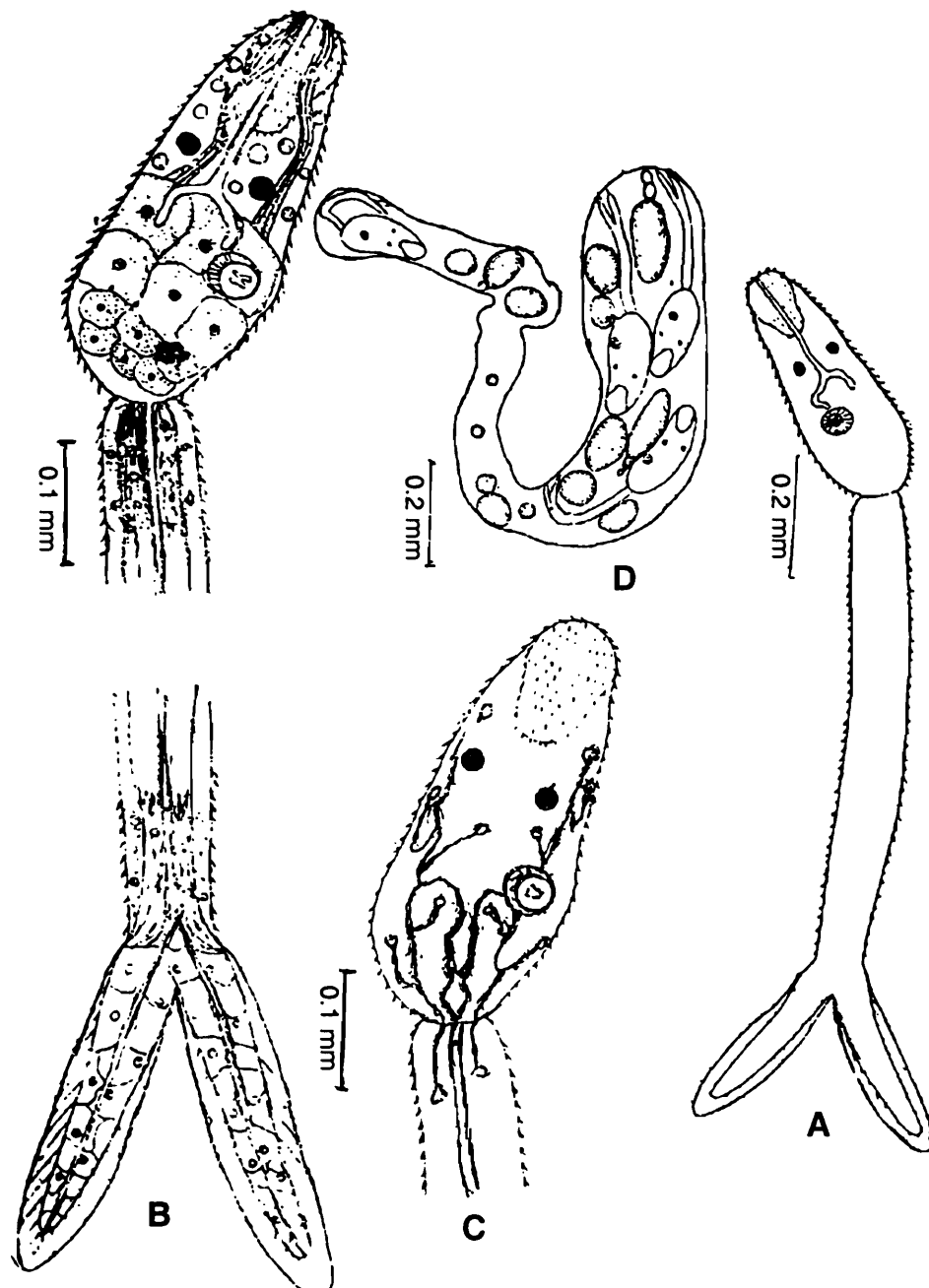


Fig. 20. A-C. *Cercaria simhai* Pandey and Singh, 1983 (After Pandey and Singh, 1983)
D. Sporocyst of *C. Simhai* Pandey and Singh, 1983.

gives rise two capillaries each tipped with a flame cell, posterior collecting canal runs down into tail stem and ends in a flame cell, flame cell formula represented by $2 [(1 + 1 + 1) + (1 + 1) + (1)] = 12$, caudal excretory duct arises from posterior side of excretory bladder and runs through tail-stem, at base of furcal rami it bifurcates and enters into furcal rami and opens outside through a pore situated at tip of furcal rami.

Sporocyst tubular, measures $0.90-1.62 \times 0.10-0.25$ in live and $0.54-0.96 \times 0.06-0.12$ in fixed specimens; brown pigment granules distributed throughout body and at places thickly pigmented; each sporocyst contains 4-8 mature cercariae, developing cercariae, germ balls.

Host : *Indoplanorbis exustus*.

Location : Hepatopancreas.

Locality : Priyadarshain Jheel, Nawabganj, Unnao, U. P.

22. *Cercaria sultanpurensis* nom. nov.
 Syn. *Cercaria sewelli* Pandey and Singh
 (Fig. 21. A-C)

1984. *Cercaria sewelli*, Pandey and Singh, *J. Zool. Soc. India.*, **35**(1 & 2) : 71-75 (1983).

Diagnosis : Cercariae come out of infected snails throughout day, photonegative, uniformly distributed in water, remain suspended vertically with head downward and tail upward, furcal rami stretched apart, swim with lashing movement of tail, while swimming cercariae move in backward direction, in stationary condition they sink gradually to bottom of container and after short period of rest they swim again; body elongated oval, ends rounded, covered with backwardly directed minute spines; it measures 0.23-0.27 × 0.09-0.10 in live and 0.12-0.19 × 0.04-0.06 in fixed specimens; tail long, beset with backwardly directed minute spines, about two times longer than body, tail-stem measures 0.27-0.29 × 0.04-0.07 in live and 0.22-0.26 × 0.02-0.03 in fixed conditions, two short laterally flattened rami, furcal rami measure 0.09-0.12 × 0.03-0.04 in live and 0.07-0.09 × 0.01-0.02 in fixed specimens, tail-stem with well developed oblique and longitudinal muscles and poorly developed circular muscle, rami contain parenchyma, rounded, small caudal bodies present, fin folds absent; protrusible organ pear shaped, situated anterior end of body, surface beset with minute spines arranged in circles, it measures 0.06-0.09 × 0.06-0.07 in live and 0.03-0.04 × 0.02-0.03 in fixed specimens, its cavity shallow; mouth and penetration glands open in cavity of protrusible organ; ventral sucker spheroidal, small, measures 0.02-0.04 in live and 0.01-0.02 in fixed specimens, located at posterior one third of body; pharynx absent; mouth leads into long oesophagus, measuring 0.05-0.06 in live and 0.03-0.04 in fixed individuals, oesophagus divides in middle of body into two short caeca; three pairs of penetration glands located at anterior to ventral sucker, penetration glands large, round to oval in shape, cytoplasm finely granulated, each gland with centrally placed prominent nucleus, ducts of penetration glands open into protrusible organ, openings arranged in a triangular manner, each opening with two prominent spines, spines larger than body spines, cystogenous cells fill entire body; genital rudiment represented by round cell mass, situated behind ventral sucker; excretory bladder small, triangular in shape, situated posterior end of body, main excretory canals arise from either sides of excretory bladder and run forward in a zig-zag manner, on reaching middle of body each canal turns back and runs posteriorly upto level of ventral sucker and divides into an anterior and posterior collecting canals, anterior canal runs forward and gives rise to three capillaries each ending in a flame cell, posterior canal runs backward and divides into two capillaries which end in flame cells, posterior collecting canal also runs into tail and ends in a flame cell,

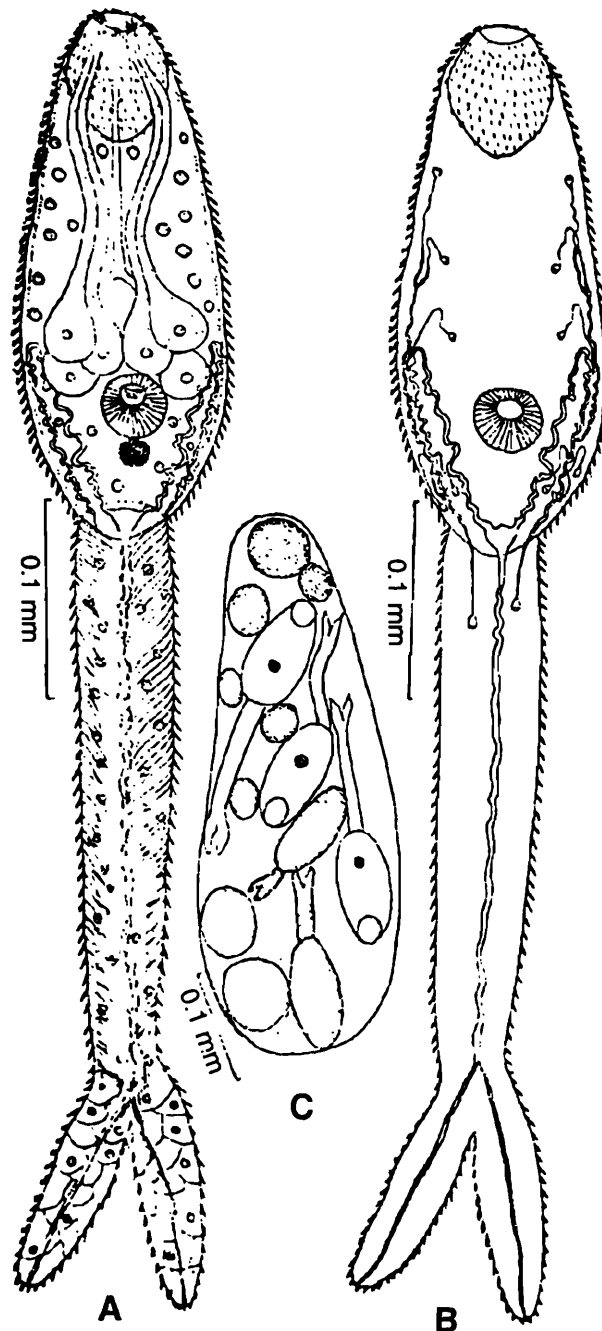


Fig. 21. A & B. *Cercaria sultanpurensis* nom. nov. (After Pandey and Singh, 1983). C. Sporocyst of *C. sultanpurensis* (After Pandey and Singh, 1983).

flame cell formula represented by $2 [(1 + 1 + 1) + (1 + 1) + (1)] = 12$, caudal excretory canal starts from posterior end of excretory bladder, runs entire length of caudal stem and divides at base of furcal rami into two branches which run along length of rami and each opens by a pore at tip of ramus.

Sporocyst thin walled, round to oval in shape, measures $0.30-0.56 \times 0.21-0.27$ in live and $0.20-0.40 \times 0.19-0.24$ in fixed specimens, contains one to three mature cercariae, developing cercariae and germ balls.

Host : *Lymnaea auricularia*.

Location : Hepatopancreas.

Locality : Nallah near Narindapur, Sultanpur district, U. P.

Remarks : Since *Cercaria sewelli* Pandey and Singh, 1984 is preoccupied, Pandey and Agrawal, 1977, so a new name is proposed for this cercaria.

23. *Cercaria tuberculatusi* Premvati

(Fig. 22. A-D)

1954. *Cercaria tuberculatusi* Premvati, *J. Zool. Soc. India.*, 6(1) : 43-45.

Diagnosis : Cercariae very active, swims rapidly with tail directed forwards; body measures 0.12-0.18 × 0.08; tail measures 0.34 × 0.03; furcal rami measure 0.11 in length; protrusible organ measures 0.03 × 0.02, present at anterior end; ventral sucker measures 0.02 in diameter, lies a little behind middle of body; eye spots oval, situated

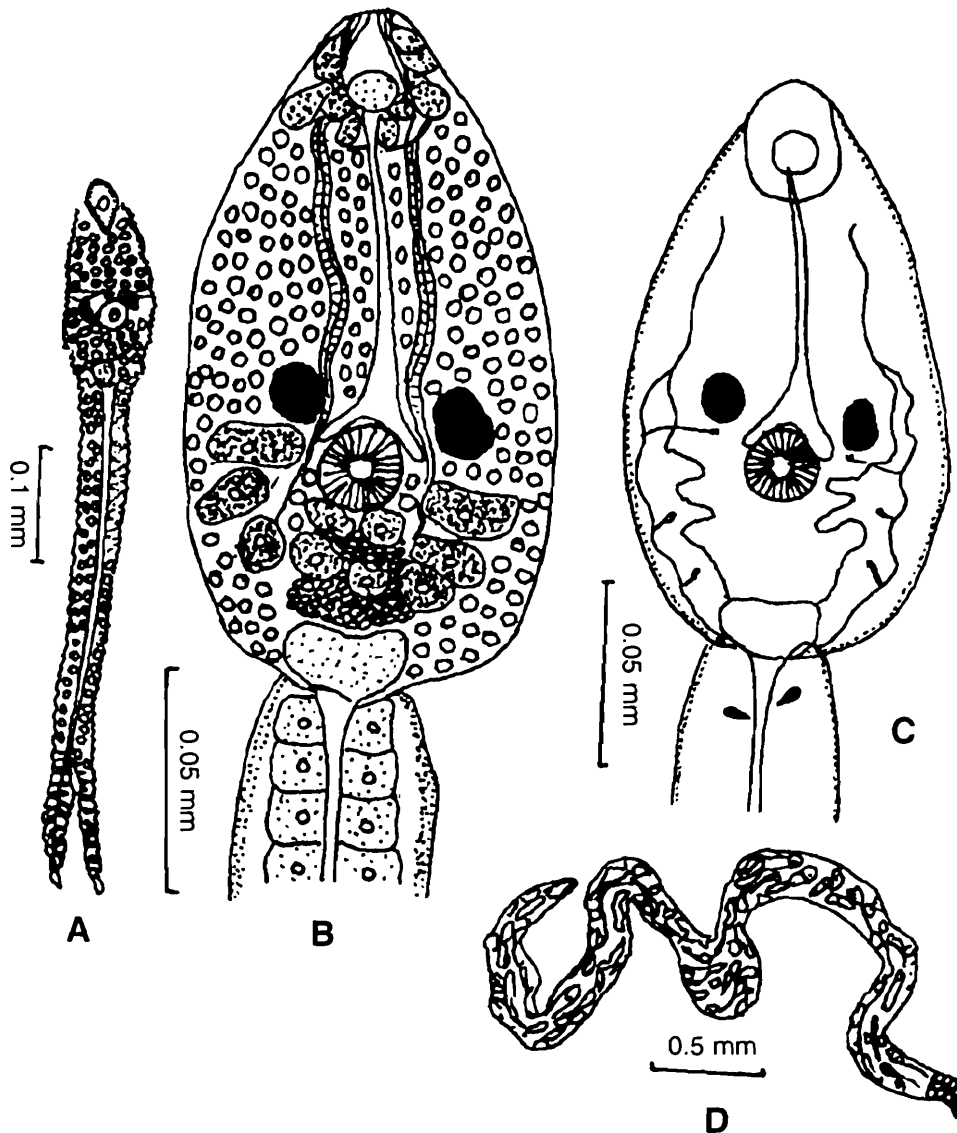


Fig. 22. A-C. *Cercaria tuberculatusi* Premvati, 1954. D. Sporocyst of *C. tuberculatusi* Premvati, 1954 (After Premvati, 1954).

just outer to and in front of ventral sucker in posterior half of body; body, tail and furcal rami covered with spines except in region of anterior protrusible organ; mouth small, situated ventrally; oesophagus narrow, extends upto anterior limit of ventral sucker; intestinal caeca short, end bluntly; pharynx absent; penetration glands five pairs, lie posterior to eye spots on postero-lateral sides of ventral sucker, three pairs of glands coarsely and two pairs with finely granular, thick and conspicuous ducts arise from these glands which run parallel to oesophagus and along ventro-lateral margin of anterior protrusible organ and open at its margin; four pairs of head glands lying in and around anterior protrusible organ and to open at margin of anterior protrusible organ; tail attached to posterior margin of body, on both sides of caudal excretory canal situated caudal cells, furcal rami constricted off from tail-stem, without fin folds, extreme posterior end of furcal rami lobe-like; excretory bladder large situated at posterior end of body; a pair of main excretory canals start from antero-posterior sides of bladder, main canal ends in middle level of oesophagus and receives anterior and posterior collecting canals slightly beyond level of eye, anterior collecting canal extends behind level of anterior protrusible organ where it ends in a flame cell, posterior collecting canal receives in its course four small capillaries each tipped with a flame cell, a pair of flame cells situated in base of tail, excretory bladder posteriorly opens into a caudal excretory canal which runs through length of tail-stem and bifurcates at its distal end, these branches run along length of furcal rami and open at extreme tips in between them and lobes situated at tips of furcal rami; rudiments of reproductive gonad situated in posterior region as a mass of cells just anterior to excretory bladder.

Sporocyst long, convoluted; measures 4.50×0.20 ; a birth pore present at anterior end of body; it contains 30-40 cercariae in various stages of development and number of germ balls.

Snail Host : *Melanoides tuberculatus*.

Location : Digestive gland and gonads.

Locality : Lucknow.

3. Longifurca Group

Diagnosis : Ventral sucker well developed, furcae more than half the length of tail-stem.

Key to Species

1. Fin fold on furcae present..... 2
- Fin fold on furcae absent 3
2. Pigmented eye-spots present..... 4
- Pigmented eye-spots absent 5

3. Flame cells in body 3 to 6 pairs 6
 - Flame cells in body more than 6 pairs 7
4. Penetrating gland cells 3 pairs, number of large cells on each side of body absent *C. saundesii*
 - Penetrating gland cells 5 pairs, number of large cells present on each side of body *C. srivastavai*
5. Short caeca represented by 4 cells, a muscular sucker like structure present near ventral sucker, caudal excretory branch opens at middle of each ramus *C. exusta*
 - Caeca long, muscular sucker like structure near ventral sucker absent, caudal excretory branch opens at tip of each ramus *C. kukrailensis*
6. Flame cells in body 3 pairs *C. rajai*
 - Flame cells in body more than 3 pairs 8
7. Flame cells in body 7 to 10 pairs 9
 - Flame cells in body 11 to 15 pairs 10
8. Flame cells in body 4 pairs 11
 - Flame cells in body more than 4 pairs 12
9. Flame cells in body 7 pairs 13
 - Flame cells in body more than 7 pairs 14
10. Unpigmented eye-spots present, short caeca consist of three cells on each side, hold fast organ absent, flame cells in body 11 pairs *C. dalibaghensis*
 - Eye-spots absent, caeca long, holdfast organ present, flame cells in body more than 11 pairs 15
11. Unpigmented eye-spots present, 2 pairs of penetrating glands situated on either side of body and anterior to ventral sucker *C. kotai*
 - Eye-spots absent, penetrating glands 4 in number and arranged in a group posterior to ventral sucker *C. soraonensis*
12. Flame cells in body 5 pairs 16
 - Flame cells in body 6 pairs 17
13. Tail-stem swollen *C. bithyniaea*
 - Tail-stem not swollen 18
14. Flame cells in body 8 to 9 pairs 19
 - Flame cells in body 10 pairs 20

15. Flame cells in body 12 pairs; sensory hairs and papillae on body absent; hairs, papillae and spines on tail-stem absent; spines absent on holdfast organ
..... *C. esplanadensis*
- Flame cells in body 15 pairs; hairs and papillae on body present; hairs, papillae and spines on tail-stem present; spines present on holdfast organ
..... *C. kumaunensis*
16. Eye-spots absent 21
- Eye-spots present 22
17. Penetrating glands arranged in groups of 4 cells situated anterior to ventral sucker 23
- Penetrating glands arranged in pairs situated anterior, lateral or posterior to ventral sucker 24
18. Eye-spots absent, single pair of flame cells present in tail-stem
..... *C. kadiramangalamensis*
- Non-pigmented eye-spots present, two pairs of flame cells present in tail-stem
..... *C. indicae LXXXI*
19. Flame cells in body 8 pairs, head gland absent 25
- Flame cells in body 9 pairs, two pairs of head gland present
..... *C. quadriglandula*
20. Eye spots absent, oesophagus represented by a round cell, caeca represented by four to five cells on each side *C. indicae II*
- Eye spots present and represented by pale yellow colour cells, oesophagus long lined by a row of rounded gland like cells on each side and ends in a bulbous caecum *C. bombayensis No. 9*
21. Caeca short well developed, pharynx present, one pair of flame cell in tail-stem
..... *C. indicae I*
- Caeca long, oesophagus shows a dilation just behind anterior penetration organ, two pairs of flame cells in tail-stem *C. indicae XXII*
22. Eye spots pigmented *C. hurleyi*
- Eye spots unpigmented 26
23. Caudal bodies in tail-stem absent 27
- Caudal bodies in tail-stem present *C. quadradena*
24. Penetrating glands 2 pairs 28
- Penetrating glands more than 2 pairs 29

25. Tail-stem bulbous 30
 – Tail-stem not bulbous 31
26. Penetrating glands 2 pairs 32
 – Penetrating glands 3 pairs 33
27. Head gland present, caudal canal gives off transverse branches forming annular loops which joined together by longitudinal ducts on each side
 *C. allahabadii*
 – Head gland absent, annular loops absent on caudal canal
 *C. delhupurensis*
28. Unpigmented eye spots present *C. rithainensis*
 – Eye spots absent 34
29. Penetrating glands 3 pairs 35
 – Penetrating glands more than 3 pairs 36
30. Eye spots absent, caeca consist of five cells, five pairs of penetrating glands present *C. kukrailensis I*
 – Eye spots unpigmented, caeca well developed and not composed of cells, four pairs of penetrating glands present *C. sphericauda*
31. Eye spots pale yellow in colour, prepharynx present, short oesophagus, spines present on whole body *C. mudaliari*
 – Eye spots absent, prepharynx absent, oesophagus long, body spines present almost upto middle level of ventral sucker *C. indicae LXIV*
32. Flame cells in tail stem one pair, excretory bladder tripartite *C. anuri*
 – Flame cells in tail stem 2 pairs, excretory bladder 'V' shaped
 *C. mathpurensis*
33. Caeca unbranched, globular *C. longicaudata*
 – Caeca branched, represented by four square cells on each side
 *C. bioculata*
34. Penetrating glands anterior to ventral sucker 37
 – Penetrating glands posterior to ventral sucker 38
35. Caeca short represented by a few cells on each side, eye-spots absent
 *C. chhailbehari*
 – Caeca long not represented by cells, eye-spots in form of browntinted mass
 *C. anantaramani*

36. Penetrating glands 4 pairs, long spines at tips of furcae absent
 *C. bombayensis* No. 19
- Penetrating glands 5 pairs, furcae provided with groups of long spines at tips
 *C. biocellata*
37. Head gland absent, short prepharynx *C. humkheri*
- Head gland present, long prepharynx *C. ahimanpurensis*
38. Body spines in 7 to 8 rows and anterior to ventral sucker, anterior half of body
 with orange-yellow pigmented patches *C. indicae* LXIII
- Body spines arranged in rows from anterior to posterior end of body, orange-
 yellow pigment absent in body *C. kumari*

24. *Cercaria ahimanpurensis* Singh

(Fig. 23. A & B)

1953. *Cercaria ahimanpurensis*, Singh, *Allahabad Univ. Stud.*, 59-64.

Diagnosis : Cercariae emerge in large numbers, swim in water but soon come to rest, they hang head downward and tail-stems turned upward and furcae widely separated, anterior part of body bent ventral in form of hook, they gradually settle down to bottom of container but suddely dart upward in wriggling movement to regain position, period of activety longer than period of resting, under coverslip pressure cercaria moves forward by help of anterior organ and ventral sucker and by flapping furcae, cercariae move with tail in advance and dragging body behind; body elongate with parallel sides, when fully extended it equals to length of tail-stem, annulations present in front of ventral sucker, body in living condition measures 0.12 in extended specimen and in contracted condition it measures 0.87 in length; tail-stem measures 0.12 and furcae measure 0.11; body in fixed specimen measures 0.14-0.19 (0.17) × 0.03-0.04 (0.03); tail-stem in fixed condition measures 0.18-0.19 (0.18) in length and an average width of 0.03, furcae length equal that of tail-stem and measure 0.10-0.19 (0.18); anterior part of body provided with a small protrusible snout which forms a part of anterior penetration organ and crowned with 2-3 rows of anteriorly directed spines, thickly distributed small spines arranged behind these rows and extend backward upto half length of anterior penetration organ, rest of body devoid of spines; anterior organ oval in shape, measures 0.03 × 0.02, thin wall and non-muscular; on dorsal aspect of penetration organ lies a pair of elongate, pyriform cells with finely granular protoplasm and small clear rounded nuclei near their basal ends (these cells may be considered as homologue of head glands of schistosome cercariae); eye-spots absent; ventral sucker situated a little behind middle of body, large, well developed, circular, provided with single row of about 50 hook like spines, smaller than anterior penetration organ and measures 0.01-0.02 (0.02) in diameter; tail-stem long, cylindrical, annulations present, with 10-12 large caudal glands arranged in pairs, 14-15 sensory

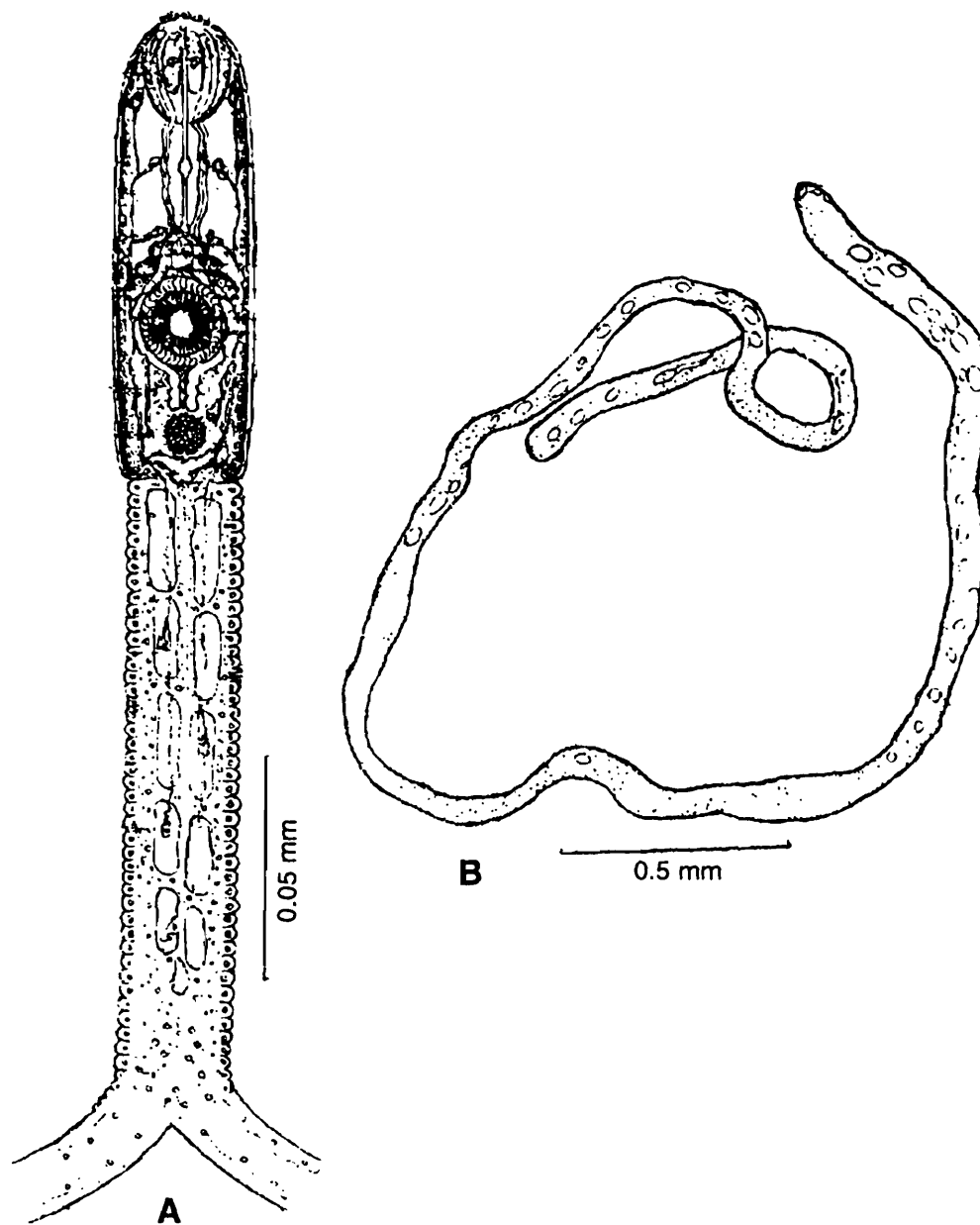


Fig. 23. A. *Cercaria ahimanpurensis* Singh, 1953. B. Sporocyst of *C. ahimanpurensis* Singh, 1953 (After Singh, 1953)

hairs present on either side, caudal glands move up and down due to contraction and elongation of tail-stem, number of these glands vary, in some these glands clearly defined while in others their outlines irregular, two rows of nuclei present on sides of tail-stem, furcae long, hornlike equal in length to that of tail-stem, in few spines present at base of furcae; mouth small, subterminal, lined by a thin layer of cuticle; prepharynx large; pharynx small, globular, poorly developed, situated at about middle of body; oesophagus divides into two intestinal caeca which encircle ventral sucker and end in two wide antiguous parts just in front of genital primordium; penetration glands in two pairs, lie in front of ventral sucker and over intestinal caeca, cells of first pair lie one behind other end that of second pair lie on antero lateral margins of ventral sucker with their inner margins in contact with one another, ventral

margin of each gland trilobed and nucleus lies on one of these lobes, ducts of these glands pass anteriorly and enter posterior margin on ventro lateral aspect of anterior organ, inside this organ ducts become wider before opening at snout; excretory bladder composed of a central vesicle and two large dilations of main lateral collecting ducts, main collecting ducts divide into anterior and posterior collecting tubules at level of ventral sucker, each anterior collecting duct connects three flame cells in anterior part of body, each posterior collecting tubule receives three flame cells in posterior region of body and end in two flame cells in tail-stem at about middle, caudal excretory canal extends along median dorsal side of tail-stem and divides at a point between two furcae, branches after entering furcae open outside at about middle; genital primordium consists of large mass of compact cells, situated posterior end of body and just anterior to excretory bladder.

Sporocysts long, slender, thread-like with about uniform width; anterior end with a snout; small birth pore situated a little distance from anterior end; brown and orange pigments present; sporocyst measures about 5.60×0.56 .

Host : *Indoplanorbis exustus*.

Locality : Tank near village Ahimanpur, Allahabad, U. P.

25. *Cercaria allahabadii* Chatterjee (Fig. 24. A & B)

1930. *Cercaria allahabadii* Chatterjee, *Allahabad Univ. Stud.*, 6(II) : 65-76.

Diagnosis : *Cercaria* swims rapidly in water by lashing movements of tail and body, it draws its body behind its tail by continuous flapping movements of furcal rami, rapid movements follow with a short rest, cercaria fixes itself on bottom of vessel by oral sucker, body shows considerable extension and contraction, cercaria progresses by its two suckers; body length in extended condition and tail-stem and furcal rami equal, each measuring 0.20; width of tail-stem uniform throughout and measures 0.03; greatest width of body in anterior region of ventral sucker, it measures 0.04; oral apparatus acts as a sucker and penetrating organ; protrusible snout crowned with a row of anteriorly directed solid spines; anterior end of body rounded, armed with several rows of solid spines extending as far back as level of oral apparatus; four salivary ducts situated on ventral aspect of oral apparatus open at tip of snout, on dorsal surface of oral apparatus two pyriform cells present with finely granular protoplasm and small clear rounded nuclei; body and tail-stem long and narrow; body tapers slightly towards anterior end, posterior region of body almost of same uniform breadth; tail-stem uniform breadth throughout, annulated, furcal rami horn-shaped and as long as tail-stem, ramus not constricted off from tail-stem; ventral sucker situated more towards region of body, occupies about half breadth of body, surface crowned with 50 well developed solid hook-like spines, ventral sucker with circular muscle fibres and powerful bands radiate from proximal region; penetration gland

cells four in number, lie anterior to ventral sucker, first two cells lie one behind other, second pair of cells on same level, each cell with clear nucleus and coarsely granular protoplasm, narrow duct from each cell passing forward to ventro lateral aspect of penetrating organ, first and third ducts open on one side and second and fourth ducts on other side; mouth small, terminal, leads into cavity of oral sucker; pharynx bulbous; oesophagus narrow, continues to anterior region of first salivary gland cell; oesophagus bifurcates into two narrow caeca, caeca enclose first two gland cells, run backward between second and third and second and fourth gland cells, pass around ventral sucker, terminating into two enlarged saccular structures, apparently divided into three chambers; excretory vesicle tripartite, narrow anterior arms form main lateral

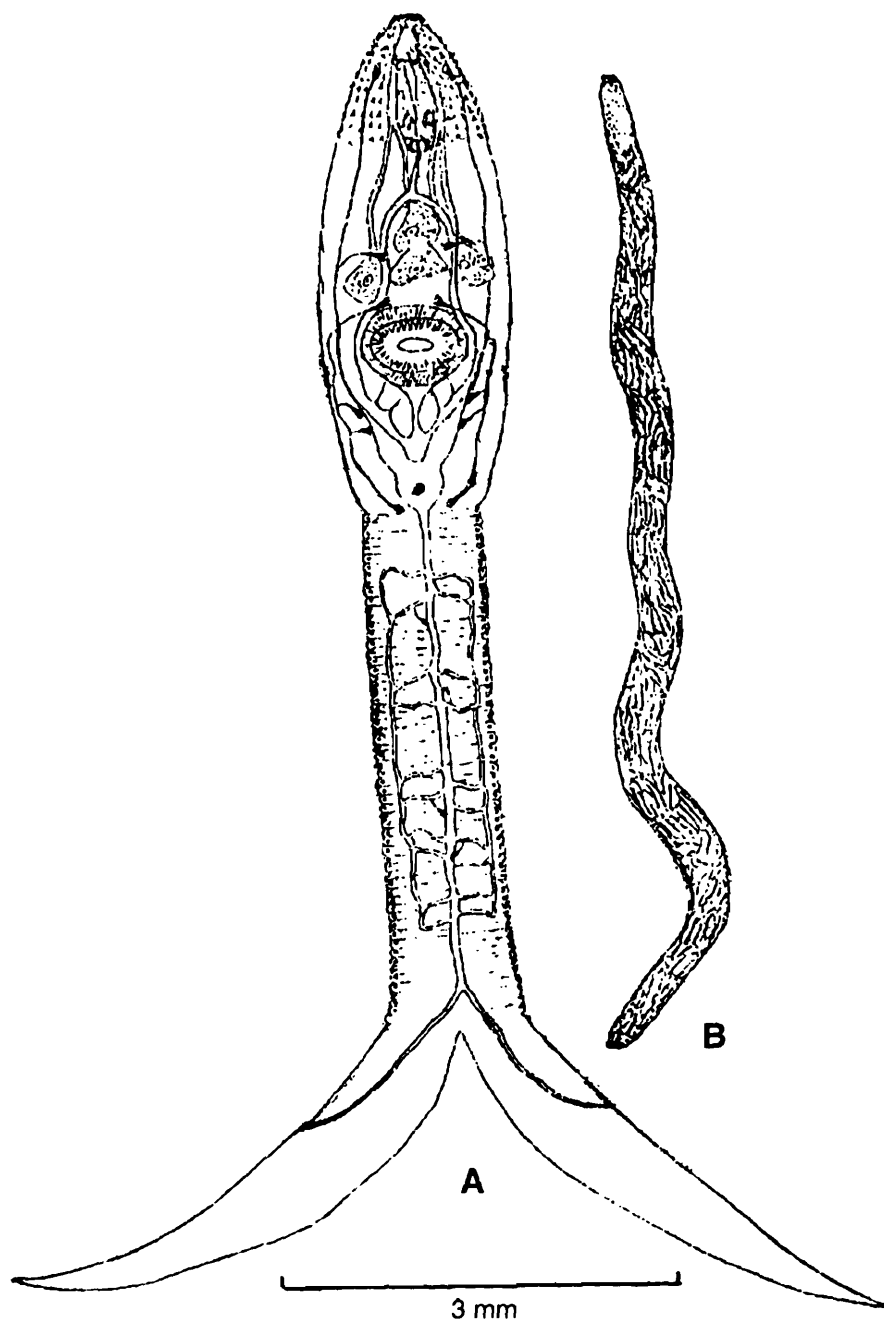


Fig. 24. A. *Cercaria allahabadii* Chatterjee, 1930. B. Sporocyst of *C. allahabadii* Chatterjee, 1930. (After Chatterjee, 1930).

collecting tubes which lie close against outer margin of caeca, middle of ventral sucker each tube divides into an anterior and posterior collecting tubules, anterior pair of collecting tubules passes forward and receives capillaries from three pairs of flame cells while posterior ones drain three pairs of cells lying at posterior region of which first and second pair lie very close to each other, main caudal tube arises from posterior end of bladder and passes along axis of tail-stem, it gives off a series of transverse branches forming annular loops usually five in number on each side which joined together by secondary ducts or longitudinal ducts—one on each side running close to inner margin of tail, main caudal canal at its distal end divides into two branches which pass along furcal rami about one third of their length and open to exterior on their outer margin, flame cells in tail four in number and more or less in regular line over main caudal canal at unequal distances, spaces between transverse ducts forming loops represent refractile bodies in tail.

Sporocyst thread like, free and exhibits independent movements; mature sporocyst more than one centimetre long, orange coloured; fixed end rounded and free end tapering; cercariae come out through its tapering end; contains cercariae at various stage of development.

Snail host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Allahabad, U. P.

26. *Cercaria anantaramani* Veerappan and Achuthan
(Fig. 25. A)

1992. *Cercaria anantaramani* Veerappan and Achuthan, *Rec. zool. Surv. India*, **91**(3-4) : 328-330.

Diagnosis : Cercariae large, swims rapidly by movements of tail, negative geotropic, floats motionless with body hanging downwards; protrusible organ prominent; pharynx small; pharynx followed by oesophagus; oesophagus bifurcates into intestinal caecae; at level of bifurcation present mass of browntinged structure, measuring 20-30 μ ; ventral sucker anterior to excretory bladder; penetration glands three pairs, two pairs anterior and one pair below and posterior to ventral sucker; excretory bladder oval in shape, seven pairs of flame cells present, three pairs each on anterior and posterior excretory tubule and a pair at base of tail; tail-stem continuous of body, longer than body, furcal rami as long as tail-stem, tail-stem broad, with numerous caudal gland cells, each ramus with 8 to 10 cuticular papillae like structure; caudal canal bifurcates into two and after entering furcal rami open laterally; body measures 410 μ \times 92 μ ; tail-stem measures 420 μ \times 87 μ ; furcal rami measures 390 μ in length; protrusible structure measure 42 μ ; ventral sucker measure 38 μ .

Snail host : *Indoplanorbis exustus*.

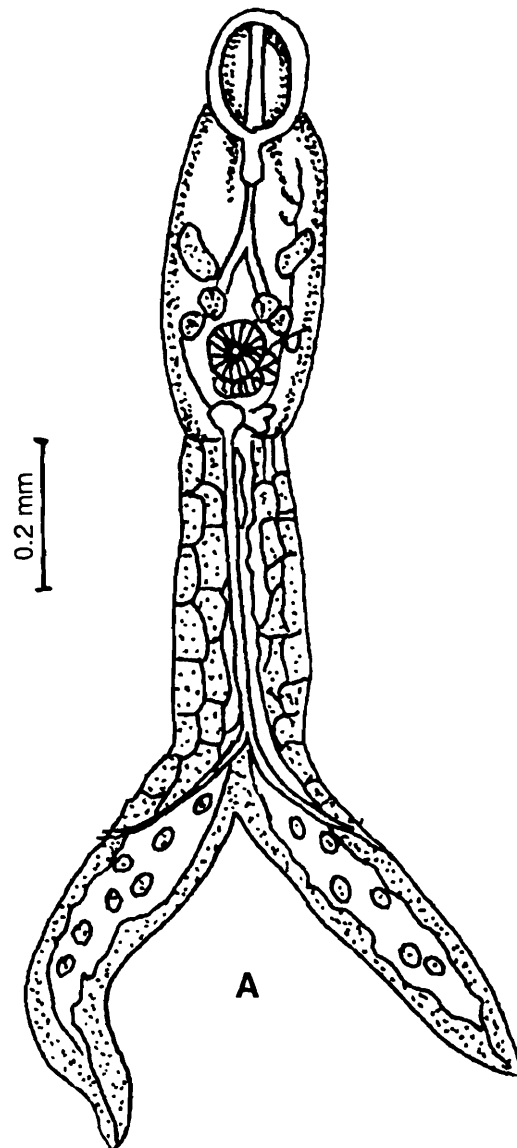


Fig. 25. A. *Cercaria anantaramani* Veerappan and Achuthan, 1992. (After Veerappan and Achuthan, 1992)

Locality : Keelapandi Pond, Thanjavur district, Tamil Nadu.

Remarks : Though the authors mentioned that the eye spots are absent but they are represented in the figure by two brown tinged mass, present on the two sides of the body at the level of oesophageal bifurcation.

27. *Cercaria anuri* Singh
(Fig. 26. A & B)

1951. *Cercaria anuri* Singh, *Allahabad Univ. Stud.*, 19-25.

Diagnosis : Cercariae emerge in large numbers, active swimmers, move back and forth in water with great speed, resting cercaria hangs down with head downwards and tail-stem turned upwards with furcae diverged at an angle of about sixty degrees,

in resting state it sinks downward when it suddenly becomes active and darts upward with characteristic spiral movement to regain its original position, under coverslip pressure cercaria moves with aid of its anterior penetration organ and ventral sucker, moving cercaria comes to rest for a few seconds after which it suddenly vibrates body and tail-stem in "8" shaped manner and moves away with tail in advance, after vigorous movements larva becomes sluggish and may lose its tail and body slowly creeps forward and dies after some time; cercaria small in size, body exhibits great power of contraction and extension in living state; it measures twice as long as in contracted state, body measures 0.13×0.03 in fixed condition; tail-stem measures 0.17×0.02 in fixed condition and long furcae measure 0.17 in length; in small specimen body measures 0.02, tail-stem measures 0.15 and furcae measure 0.14 in length while

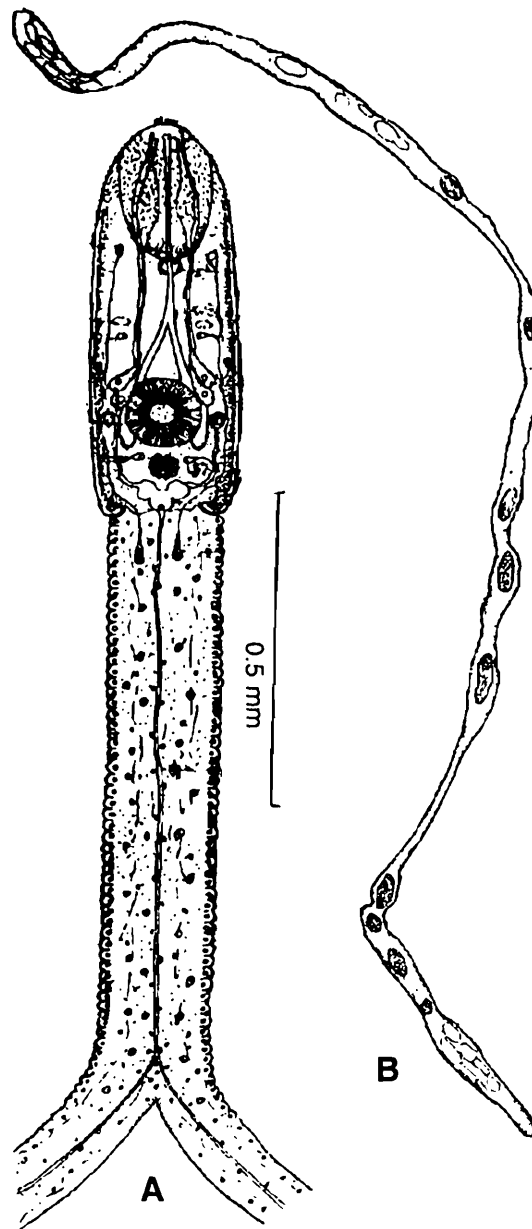


Fig. 26. A. *Cercaria anuri* Singh, 1951. B. Sporocyst of *C. anuri* Singh, 1951. (After Singh, 1951)

in large specimen body measures 0.16, tail-stem measures 0.19 and furcae measure 0.19; body elongate flattened structure with maximum width in region of ventral sucker; width of body and tail-stem equal; anterior penetration organ more or less like a sucker, circular in outline, average diameter 0.02; anterior end round, occupied by a small snout like structure—a part of anterior penetration organ which contains 10-12 forwardly pointing spines located dorsal to opening of mouth; small dense spines pointing backwards extend upto half level of anterior penetration organ, two rows of short conical spines present on margin of opening of ventral sucker, number of spines in each row about fifty; ventral sucker smaller than penetration organ, situated little behind middle of body, average diameter 0.02, provided with strong muscles, it helps cercaria also in locomotion; tail-stem elongate, annulated due to greatest contraction of muscle fibres, margins provided with rows of nuclei and central core contains fine strands of connective tissue; furcae long, horn like, equal in length of tail-stem; eye spots unpigmented, slightly greenish granule like appearance, located in front of penetration glands; penetration glands two pairs, smaller in size, located in front and on sides of ventral sucker, each gland contains a clearly defined nucleus, ducts of these glands before entering penetration organ become constricted but inside organ they become dilated before opening in circumoral spineless area; mouth small, subterminal; pharynx well developed, situated just behind posterior margin of penetration organ; oesophagus bifurcates into two intestinal caeca which end in level of posterior margin of ventral sucker; excretory bladder tripartite structure, situated at junction of body and tail-stem, from antero lateral lobe of bladder main excretory ducts pass forwards upto level of ventral sucker, at this point each duct makes one or two coils and divides into an anterior and posterior collecting tubule, anterior tubules receive capillaries from three pairs of flame cells posterior tubules pass backwards and after receiving two pairs of flame cells continue in tail-stem and each end in a single flame cell at base of tail-stem, caudal excretory canal originates from posterior end of bladder through an "Islet aperture" and runs back through middle of tail-stem and bifurcates at distal end, each branch passes into each ramus to open into middle on outer margin; genital primordia represented by a mass of small round cells, situated on ventral side in between bladder and ventral sucker; cercariae penetrate into tadpoles of frogs and develop into metacercariae.

Sporocysts elongate, thread like, unbranched, embedded in liver of snail host; anterior end tapering and bluntly round and capable of independent movement; posterior end round and lies embedded in liver of host; sporocysts measure $2.5-3.6 \times 0.02-0.05$; cercariae emerge through birth pore, situated a little distance from anterior end.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Ponds from Hundia and Sobatiabagh, Allahabad, U. P.

28. *Cercaria biocellata* Singh
(Fig. 27. A & B)

1955. *Cercaria biocellata* Singh, *Proc. Nat. Acad. Sci. India*, 25(B) I-II : 23-28.

Diagnosis : Cercariae swim vigorously in water, during swimming tail-stem oscillates from side to side and furcae remain at right angles to tail-stem, they swim upward and accumulate near surface of water where they lie motionless with tail well extended and in line with body and furcae being held at right angles to tail, they can attach to walls or bottom of container and also to inner surface of pipette; body in maximum extension measures 0.32×0.06 and 0.19×0.09 in greatest contraction; tail-stem measures 0.39 in extended and 0.28 in contracted condition; body of cercariae in fixed condition measure $0.20-0.24$ (0.22) \times $0.05-0.06$ (0.06); tail-stem in fixed condition measures $0.35-0.39$ (0.36) \times $0.03-0.04$, tail-stem tapering from base to tip, furcae measure $0.24-0.25$ (0.24) in length, provided with a group of long spines at tips; body, tail-stem, and furcae covered with short spines curved at their tips, spines uniformly

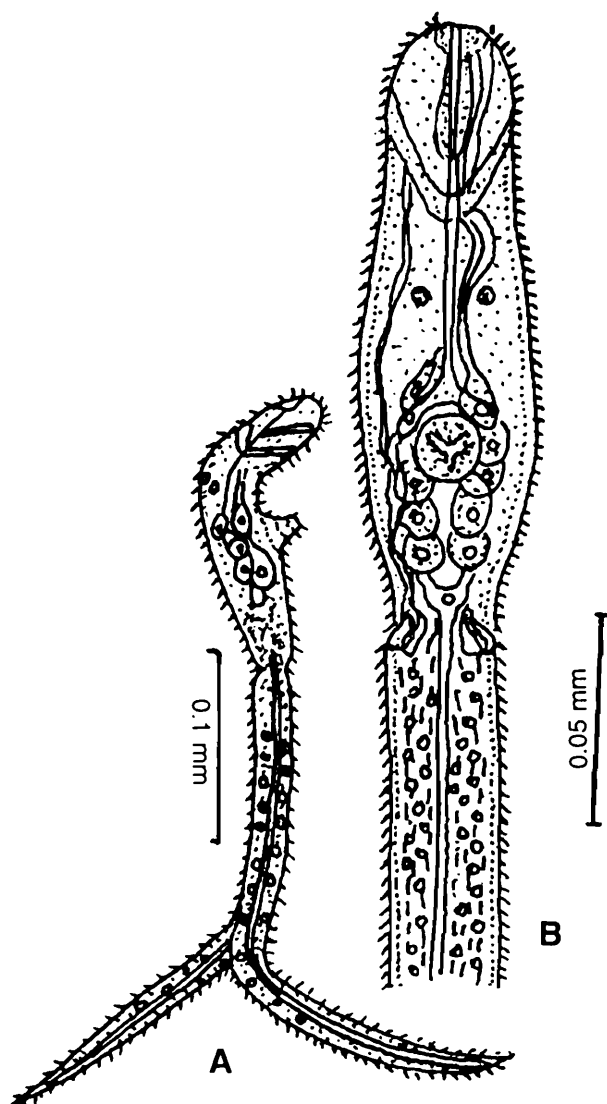


Fig. 27. A & B. *Cercaria biocellata* Singh, 1955. (After Singh, 1955).

distributed and pointed backward; anterior end of body provided with short, dense spines extending back upto half level of anterior penetration organ; dark pigmented eyes located over commissure of nervous system, centre concavity provided with lens; ventral sucker strong, muscular, protrusible, retractile, cavity 'Y' shaped and provided with two rows of short strong spines projecting from surface, it measures 0.04-0.06 (0.05) in diameter, located behind middle of body; anterior penetration organ 0.08-0.09 (0.08) × 0.05-0.06 (0.05), divided into an anterior and a posterior portion, latter being muscular, centre of anterior organ occupied by a head gland and on each side of this run penetration gland ducts; oesophagus narrow, extending prosteriorly upto level of eye spots; intestinal caeca diverging at level of first pair of penetration glands and terminating at level of ventral sucker; five pairs of penetration glands located behind eye spots, immature cercariae contained six pairs of penetration glands, first and second pairs lie anterior and dorsal to ventral sucker, fourth, fifth and sixth pairs located behind ventral sucker—fourth and sixth ventral and fifth dorsal to body, cytoplasm of anterior three pairs coarsely granular and posterior three pairs finely granular, ducts of these glands enter anterior organ ventral and anterior to muscular portion and open separately at its tip through hollow conical spines; six pairs of flame cells located in body and a pair at base of tail-stem, three anterior pairs of flame cells connected by capillaries to anterior collecting ducts, posterior collecting duct of either side after receiving capillaries from three flame cells in posterior region of body ends in a single flame cell in tail, two ciliary areas present in main ducts, excretory bladder small, located at junction of body and tail-stem, caudal excretory duct originates from posterior end of bladder through an 'Islet aperture' and after traversing tail-stem forks at distal end and resulting tubes open at tips of furcae through bladder-like enlargements surrounded by groups of large spines; genital primordium represented by a mass of small rounded cells with clear nuclei situated in front of excretory bladder and ventral to posterior pairs of penetration glands.

Daughter sporocysts occur in tangled masses and attached to each other by their thin walls; sporocysts may be cylindrical, pyriform or fusiform and measure 0.6-0.9 × 0.2-0.3; pointed at one end containing birth pore and birth canal.

Snail host : *Lymnaea luteola f. australis*.

Location : Liver.

Locality : Rithaian village, Allahabad, U. P.

29. *Cercaria bioculata* Singh (Fig. 28. A & B)

1953. *Cercaria bioculata* Singh, *Allahabad Univ. Studi.*, 47-52.

Diagnosis : Cercariae emerge in large numbers and water of container becomes almost dense with them, they remain suspended in water with head downwards and tail-stem turned upwards with furcae widely separated, in resting state anterior one-

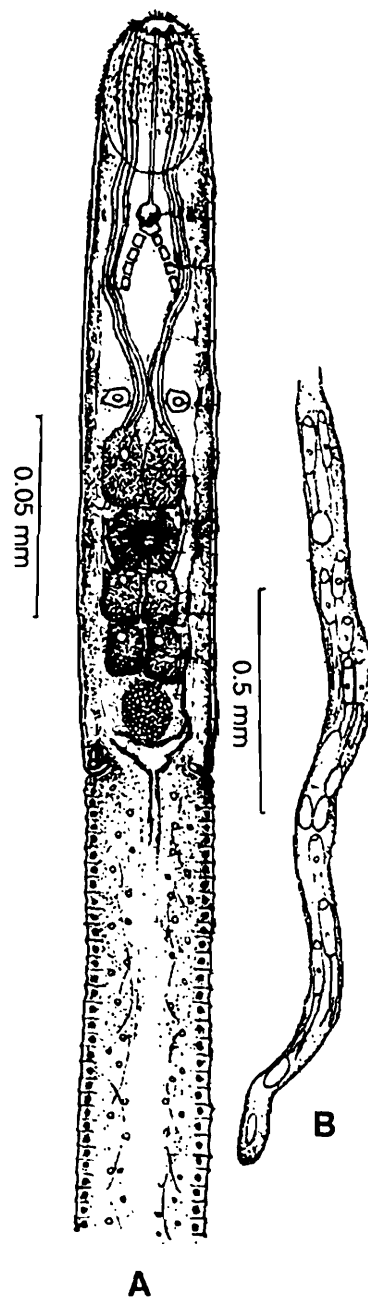


Fig. 28. A. *Cercaria bioculata* Singh, 1953. B. Sporocyst of *C. bioculata* Singh, 1953. (After Singh, 1953).

third of body bent ventrad in a hook like manner, cercaria gradually settles down to bottom of vessel, at times larva may dart upward with a characteristic wriggling movement to regain its original position, period of rest longer than period of active swimming, under coverslip pressure cercaria moves with tail foremost by lashing movement of tail-stem and furcae; in living condition colour of cercaria shows greenish yellow and body shows great contraction and elongation; body measures 0.20 long in contracted and 0.27 in fully extended conditions; proportion of body, tail-stem and furcae almost same; in extended condition anterior one-third of body in front of ventral sucker thrown into 6-7 annulations; body in fixed specimen measures 0.20-0.27 (0.23) \times 0.04; tail-stem measures 0.29-0.34 (0.32) long and width equal to that of

body, furcae nearly as long as tail-stem, measure 0.31-0.32 (0.31) in length; circumoral spineless area at anterior end contains a clump of 10-12 long forwardly pointing spines located on dorsal side of mouth; anterior portion of body contains small densely set spines extending backward upto half level of anterior penetration organ; rest of body, tail-stem and furcae without spines; tail-stem simple, firmly attached to posterior end of body, devoid of caudal bodies, rows of nuclei present along sides, very fine annulations present both in tail-stem and furcae; long sensory hairs 14-16 in numbers present on either side of tail-stem, furcae broadly lanceolate and end in sharp points; anterior penetration organ well developed and measures 0.03×0.02 ; oral cavity traceable to a short prepharynx beyond which a globular well developed pharynx present; gut represented by two diverging columns of four vacuolated square cells, caeca end in front of eye spots; eye spots a pair of closely set structures without any pigmentation with wavy outline with a darker greenish granule like central area, situated in front of penetration glands; penetration glands six in number arranged in rows of three, large, first pair lies in front of ventral sucker, second and third pairs lie behind it, ducts from these glands pass forward and enter into anterior penetration organ in which they somewhat dilated before opening at tip of snout in circumoral spineless area; ventral sucker well developed, diameter 0.01, smaller than anterior penetration organ, opening circular and surrounded by two rows of short conical spines; tripartite excretory bladder situated at junction of body and tail-stem, main excretory ducts arise as continuations of antero-lateral lobes of bladder and pass anteriorly upto level of ventral sucker, here they divide into anterior and posterior collecting tubules, each anterior collecting tubule joined with three flame cells located in anterior region of body, posterior collecting tubules receive capillaries from two flame cells in body and a pair at about middle of tail-stem, caudal excretory canal originates from posterior end of bladder through an 'Islet aperture' and after running upto distal end of tail divides to enter each furca, furcal branches open on outer margin at about middle; genital primordium large, composed of a compact mass of small round cells with clear nuclei and situated in front of bladder.

Sporocysts long, slender, thread like, show independent movement; anterior end free while rest of body embedded in host tissue; containing mature cercariae; width varies considerably on account of constriction in wall; contain germ balls; width varies from 0.04-0.09; wall thin and contains scattered yellowish brown pigments.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Sobatiabagh pond, Allahabad, U. P.

30. *Cercaria bithyniaea* Gupta and Sharma (Fig. 29. A-C)

1976. *Cercaria bithyniaea* Gupta and Sharma, *Res. Bull. Sci. Panj. Univ.*, 27(III-IV) 177-183.

Diagnosis : Cercaria comes out in early hours of day, fast swimmer; very small; furcal rami smaller or larger than body; tail-stem swollen, oval or rounded, during swimming it contracts and again extends with a jerk, it does not perform lashing movements, only furcal rami extend and contract alternately; under converslip pressure it exhibits caterpillar like movements with help of two suckers; body measures 0.12-0.15 × 0.08-0.11, body provided with fine spines; tail aspinose, swollen or bulbous, bifurcates into furcal rami at distal end measures 0.10-0.21 in length, furcal rami in some specimens larger than tail-stem, measure 0.19-0.29 in length, streaks present in tail-stem, which run diagonally from both sides and bisect one another in middle, nuclei present in tail-stem, from base of tail-stem arises two fibrous bands running on both sides of it and reaching tip of furcal rami; oral sucker protrusible and forms penetration organ, measures 0.02-0.05 in diameter; ventral sucker smaller than penetration organ, measures 0.02 × 0.02 in size, opening provided with spines; mouth with two lips, provided with spines, opens into pharynx; prepharynx small; oesophagus long, divides into two intestinal caeca; terminal portions of caeca dilated; penetration glands four pairs, situated lateral to ventral sucker, cytoplasm granular with conspicuous nuclei, ducts of these glands make a loop in anterior organ and open at anterior end of body; genital organ represented by a group of cells posterior to ventral sucker; excretory vesicle small, nine pairs of flame cells in body—four flame cells in anterior half join anterior collecting tubule through capillaries, similarly five flame cells—two in base of tail-stem and three in posterior half of body open into posterior

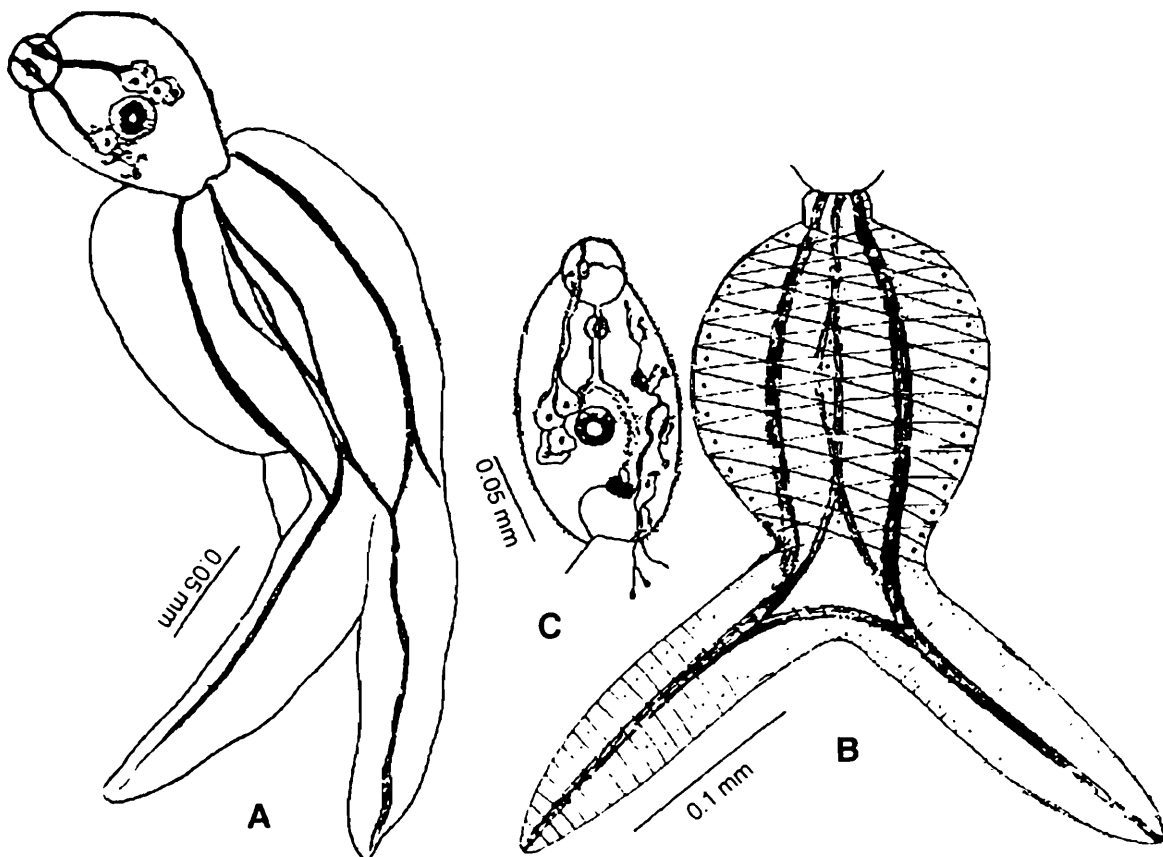


Fig. 29. A-C. *Cercaria bithyniaea* Gupta and Sharma, 1976. (After Gupta and Sharma, 1976).

collecting tubule through capillaries, anterior and posterior collecting tubules unite with each other at level of ventral sucker and form main excretory canal which runs backward and merges into excretory vesicle, flame cell formula can be represented by $2 [(1+1+1+1) + (1+1+1+1+1)] = 18$.

Snail Host : *Bithynia stenothyroides*.

Locality : Side of road to Mullanpur, a village near Chandigarh.

31. *Cercaria bombayensis* No. 9. Soparkar
(Fig. 30. A-D)

1921. *Cercaria bombayensis* No. 9 Soparkar, *Indian J. Med. Res.*, IX : 26-28.

Diagnosis : Cercaria large, at resting stage in water body of cercaria doubled up and prongs wide apart; it swims with great rapidity in all directions, movement not

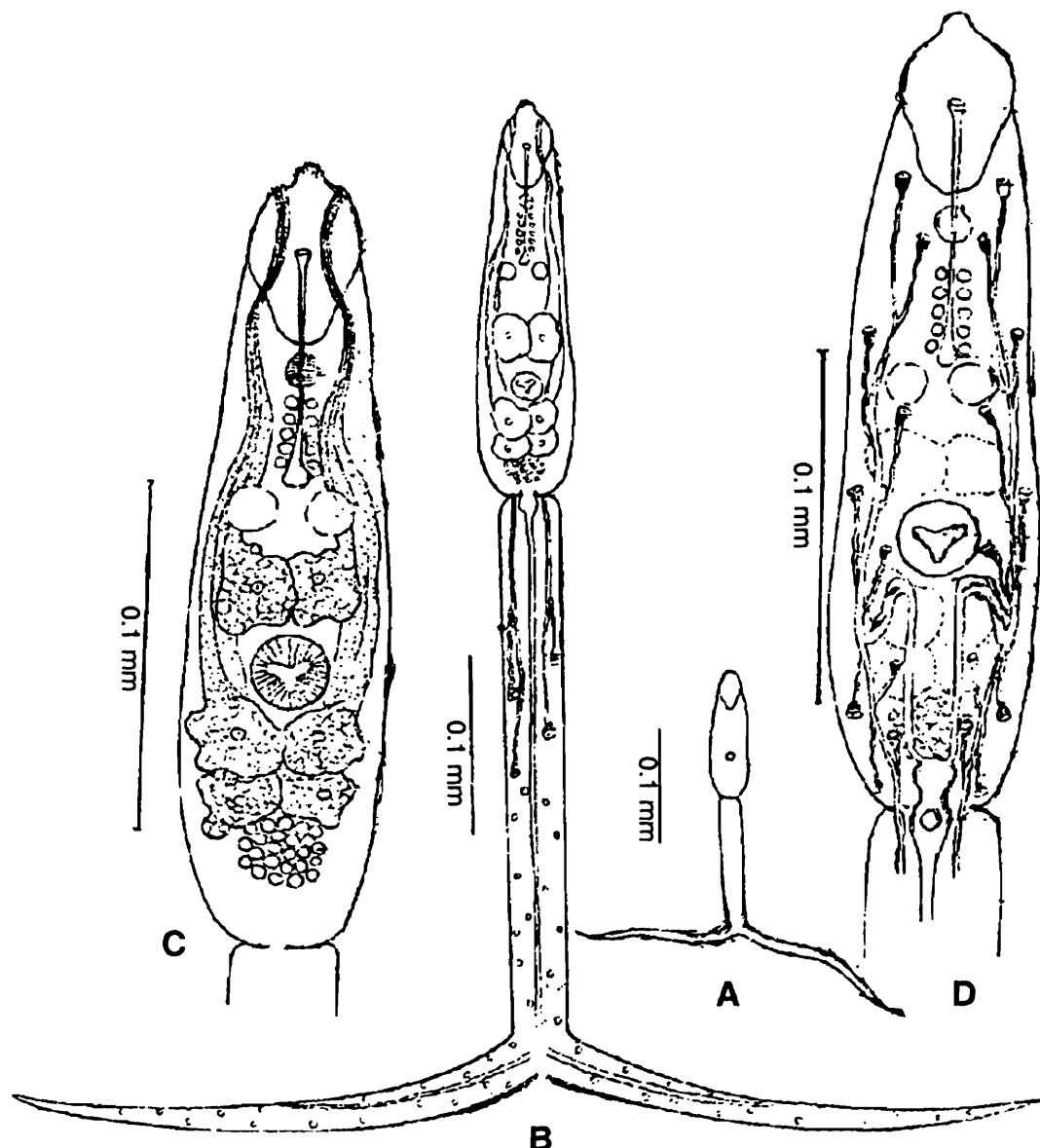


Fig. 30. A-D. *Cercaria bombayensis* No. 9 Soparkar, 1921. (After Soparkar, 1921).

continuous but intermittent; unable to crawl; body and tail capable of rapid vibration; occasionally this species found to be associated with other cercariae as mixed infection; body measures $225 \mu \times 52 \mu$ in fixed condition; tail measures $325 \mu \times 38 \mu$ in fixed condition, furcal rami measure 300μ in length, furcal rami long, sword like, held at right angles to stem of tail; integument covered with sharp spines, spines thickly set over anterior end; ventral sucker situated at junction of middle with posterior third of body, circular in outline, measure 20μ in diameter; around ventral sucker situated group of three pairs of mucin glands—one in front and two behind it, glands possess fine granular protoplasm and rounded nuclei, ducts from these glands pass forwards and enter oral sucker and open externally at anterior end, tips capped with hollow spines, ducts three pairs and three pairs of spines capping them; a pair of pale yellowish colour cells situated just in front of anterior pair of mucin glands, they may be vestigial eye-spots; oral sucker strong, muscular, measures $45 \times 30 \mu$, provided with protrusible snout, snout when pushed out seen to be covered with numerous large sharp spines; mouth located behind anterior end; oesophagus passes through oral sucker and opens in a bulbous caecum; caecum situated a little in front of vestigial yellowish eye spots; oesophagus surrounded by a muscular pharynx below posterior margin of oral sucker; beyond pharynx oesophagus and caecum lined by a row of rounded gland like structures; muscular excretory bladder at posterior end of body gives rise to two large trunks anteriorly, each trunk with two fusiform dilatations containing ciliated areas, excretory duct continues posteriorly into tail as a single trunk which bifurcates to enter furcal rami and opens in middle of furci and not at tip, islet anastomosis present, flame cells two pairs in tail, flame cells situated about middle of tail, body contains ten pairs of flame cells—first pair situated posterior margin of oral sucker, second pair situated on each side of pharynx, third pair situated on each side of caecum, fourth pair situated at posterior margin of vestigial eye spots, fifth pair located posterior margin of anterior pair of mucin glands, sixth pair located at anterior margin of middle pair of mucin glands, seventh pair situated at posterior margin of middle pair of mucin glands, eighth pair located at posterior margin of posterior pair of mucin glands, ninth pair located at level of middle of main excretory trunk and tenth pair situated on either side of excretory bladder; genital system represented by a mass of germ cells behind ventral sucker.

Sporocyst long, cylindrical, provided with club-shaped motile ends.

Snail host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Andheri, Bombay.

32. *Cercaria bombayensis* No. 19. Soparkar
(Fig. 31. A-C)

1921. *Cercaria bombayensis* Soparkar, *Indian J. Med. Res.*, **IX** : 30-32.

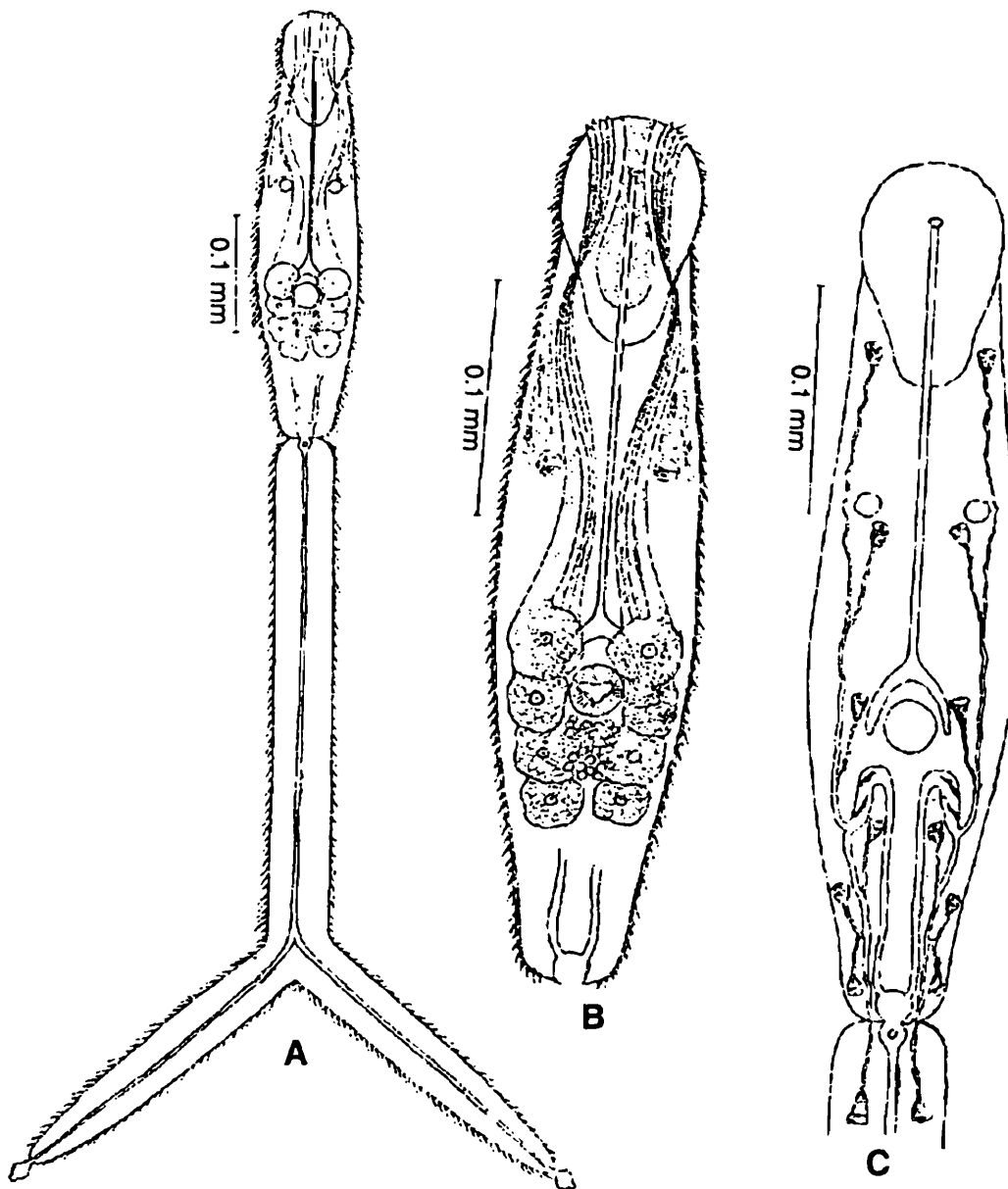


Fig. 31. A-C. *Cercaria bombayensis* No. 19 Soparkar, 1921. (After Soparkar, 1921).

Diagnosis : Cercaria hangs in water with head downward and swims backward, when crawls on a substratum it moves forward; during slow movement a constriction produced about middle of body; cercaria furcocercous with pigmented eye spots; body measures $300 \times 80\mu$ in fixed specimens; tail-trunk $435 \times 58 \mu$ in fixed specimens; furci measure $290 \times 28\mu$ and broadest at root; body when fully extended in living specimens measures 450μ in length and it contract down to 250μ ; tail and furci also show variation in size but not to extent shown by body; length of tail varied between $350-450\mu$ while furci varied between $220-300\mu$; body and tail covered with spines; ventral sucker situated about posterior third of body, ventral sucker strong, muscular, forms a marked projection, measures 20μ in diameter and 25μ in depth; four pairs of mucin glands surrounded ventral sucker, ducts of mucin glands pass forwards and enter oral sucker and open at anterior end on each side of middle line, their expanded ends capped by hollow piercing spines; oral sucker large, measures $105 \times 60 \mu$, divided into anterior portion and strongly muscular posterior portion; snout protrusible; centre of

oral sucker occupied by head gland and on each side of it run mucin duct; two pigmented eye spots situated between oral and ventral suckers, each eye spot composed of a cell containing a central lens surrounded by numerous small brownish black granules; mouth situated a little behind anterior end; oesophagus long; pharynx absent; caecum bifurcated, reaching on each side of ventral sucker; rudimentary genital system represented by a cluster of cells, situated behind ventral sucker and between mucin glands on either side; nervous system represented by two large lobes situated just in front of pigmented eye spots; body possesses six pairs of flame cells, tail contains one pair of flame cells, excretory pores open at tip of furcal rami, opening being dilated into bulbous expansions projecting beyond tips, islet anastomosis in bladder and two ciliated areas in main excretory trunks present.

Sporocyst elongate, without club-shaped motile ends; each sporocyst contains 6-8 cercariae in various stages of development; sporocysts not firmly attached to organ of host; it measures 1.5 in length and 0.15 in thickness; numerous dark granules embodied in walls.

Snail host : *Lymnaea acuminata*.

Location : Liver.

Locality : Andheri, Bombay.

33. *Cercaria chhailbeharii* Pandey and Singh (Fig. 32. A-C)

1984. *Cercaria chhailbeharii* Pandey and Singh, *J. Zool. Soc. India*, **35**(1 & 2) : 66-78 (1983).

Diagnosis : Cercariae emerge from snails throughout day in small number but they come out more in morning, they remain suspended in water with body downward and tail upward, they swim by lashing movements of tail, in resting phase they sink to bottom of container and after few seconds they again start to swim; body spinose, cylindrical, tapering rounded anterior and broad blunt posterior ends; it measures 0.31-0.40 × 0.07-0.10 in live and 0.19-0.22 × 0.02-0.04 in fixed specimens; tail with backwardly directed spines, forked distally into two long furcal rami, tail-stem as large as body and measures 0.28-0.32 × 0.05-0.08 in live and 0.20-0.30 × 0.02-0.04 in fixed conditions, furcal rami laterally flattended, broad, more or less equal to tail-stem and measure 0.27-0.29 × 0.04-0.05 in live and 0.18-0.20 × 0.01-0.02 in fixed individuals, circular, longitudinal and oblique muscles present in tail-stem, small and rounded caudal bodies present in tail parenchyma; protrusible organ pear shaped, located anterior end of body, surface provided with many minute spines arranged in circles, measures 0.05-0.07 × 0.03-0.05 in live and 0.03-0.04 × 0.01-0.02 in fixed specimens; small ventral sucker, spherical, situated behind equatorial line of body, measures 0.02-0.03 in diameter in living and 0.01-0.02 in fixed conditions; mouth leads into prepharynx which measures 0.02-0.03 in length; pharynx small, globular measures 0.01-0.02 in diameter; oesophagus divides immediate behind pharynx into

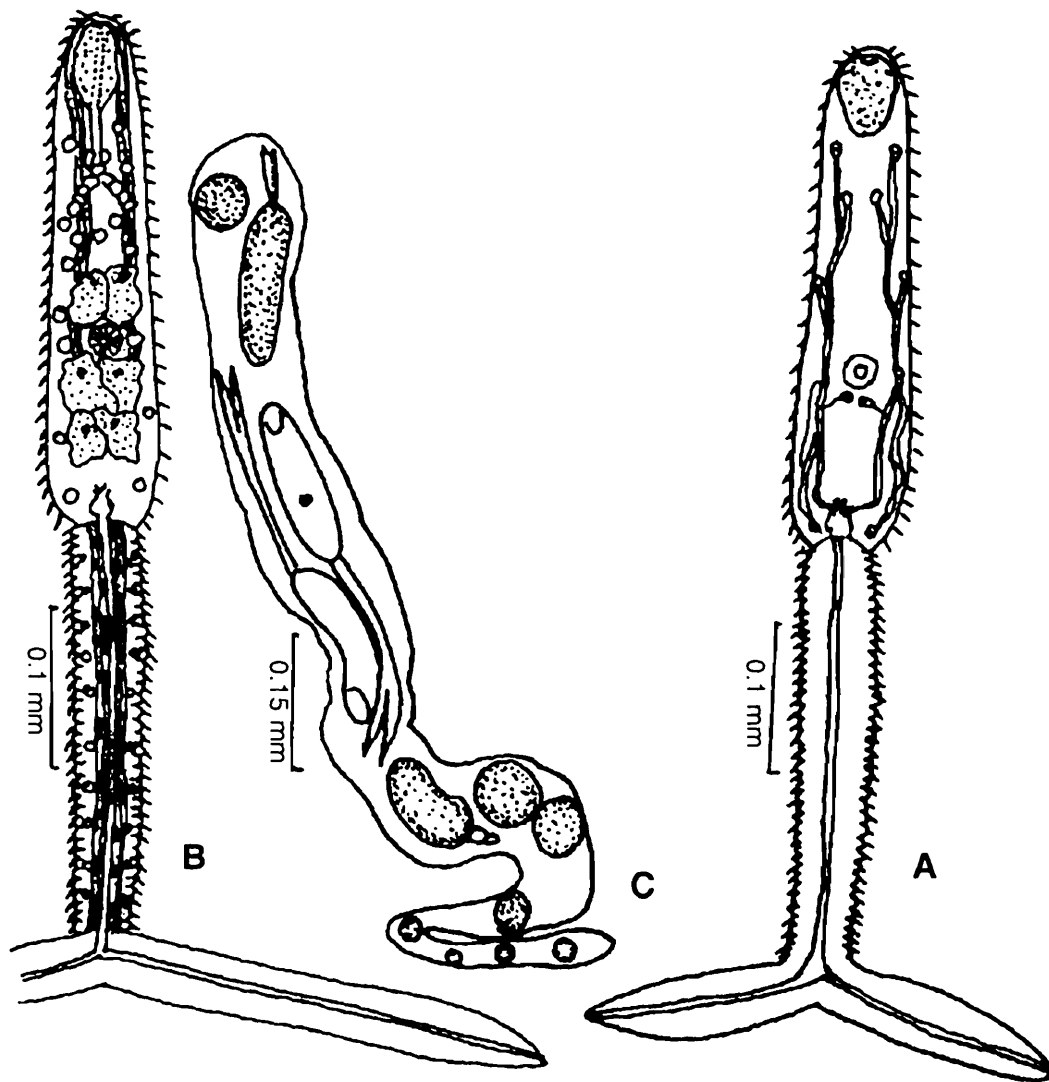


Fig. 32. A & B. *Cercaria chhailbeharii* Pandey and Singh, 1983. C. Sporocyst of *C. chhailbeharii* Pandey and Singh, 1983. (After Pandey and Singh, 1983)

two short four to five chambered intestinal caeca; penetration glands three pairs— anterior pair located in front of ventral sucker and posterior two pairs behind it, glands large, triangular in shape with fine granular cytoplasm and with anteriorly placed large nucleus, glands open outside by fine ducts; body of cercaria filled with round and small cystogenous cells; genital primordia represented by cell mass located in front of excretory bladder; excretory bladder rounded, situated posterior end of body, two main collecting canals start from anterior part of excretory bladder and run forward, main canals divide into anterior and posterior collecting canals behind ventral sucker, anterior canal runs forward and gives rise to three capillaries at different level and tipped with flame cells, posterior canal runs posteriorly and gives rise to three capillaries ending in flame cells, flame cell formula represented by $2 [(1+1+1) + (1+1+1)] = 12$, caudal excretory canal arises from posterior end of excretory bladder and runs through tail-stem, at base of furcal rami it divides into two branches which run through furcal rami and open outside by pores at tip of rami.

Sporocyst elongate, narrow thread like; measures $1.50-2.00 \times 0.10-0.14$ in live and $0.80-1.06 \times 0.03-0.05$ in fixed specimens; show slow movements by twisting body; brown pigmented granules present; each sporocyst with 4-6 mature cercariae, few developing cercariae and germ balls.

Host : *Indoplanorbis exustus*.

Location : Hepatopancreas.

Locality : Lucknow, U. P.

34. *Cercaria dalibaghensis* Pandey

(Fig. 33. A-C)

1967. *Cercaria dalibaghensis* Pandey, *Nat. Acad. Sci. India.*, **37**(B) IV : 341-344.

Diagnosis : Cercariae emerge in large number usually in morning but continue to come out during whole day, at rest cercariae hang down with tail-stem in vertical and furcal rami in horizontal position, cercariae while swimming show active movements of tails, at bottom of container they make movements by contracting and expansion of bodies; body leongale, spinose, bluntly rounded anterior and broad posterior ends, measures $0.23-0.27 \times 0.06-0.07$ in live and $0.14-0.16 \times 0.04-0.05$ in fixed specimens; tail aspinos, longer than body, measures $0.30-0.32 \times 0.04-0.05$ in live and $0.13-0.15 \times 0.02-0.02$ in fixed specimens; furcal rami aspinos, without fin-fold, a little smaller than tail-stem, measures $0.27-0.28$ in length in live and $0.11-0.12$ in fixed specimens; a large number of round nuclei present both in tail-stem and furcal rami, approximately 86 in tail-stem and 42 in each rami, nuclei arranged in longitudinal rows in tail-stem; anterior protrusible organ terminal, measures $0.05-0.05 \times 0.03-0.03$ in live and $0.02-0.03 \times 0.02-0.02$ in fixed specimens; ventral sucker smaller than anterior protrusible organ, measuring $0.02-0.02$ in diameter in live and $0.01-0.02$ in fixed specimens; a pair of unpigmented eye spots present a little anterior to anterior most pair of penetration glands, mouth leads into prepharynx long tubular; pharynx small, muscular, globular; oesophagus short, rectangular chamber; intestinal caeca short, consists of three cells on each side; three pairs of penetration glands, large, ovoid, one pair anterior to ventral sucker and other two pairs posterior to ventral sucker, each gland contains a nucleus and numerous granules, ducts of these glands run together anteriorly on each side and open to outside by separate pores close to anterior border of anterior protrusible organ; cystogenous gland cells oval to round, present in entire body of cercaria; rudiments of gonads represented by a small mass of cells, situated a little in front of excretory bladder; excretory bladder, round to oval, situated at hind end of body; two main collecting canals—one on each side, open into antero-lateral part of excretory bladder, each main collecting canal formed at level of anterior border of first pair of penetration glands by union of an anterior collecting canal and a posterior collecting canal, each anterior collecting canal arises near posterior border of anterior protrusible organ, four pair of flame cells present on each side and distributed along length of anterior collecting canals, posterior collecting canals formed

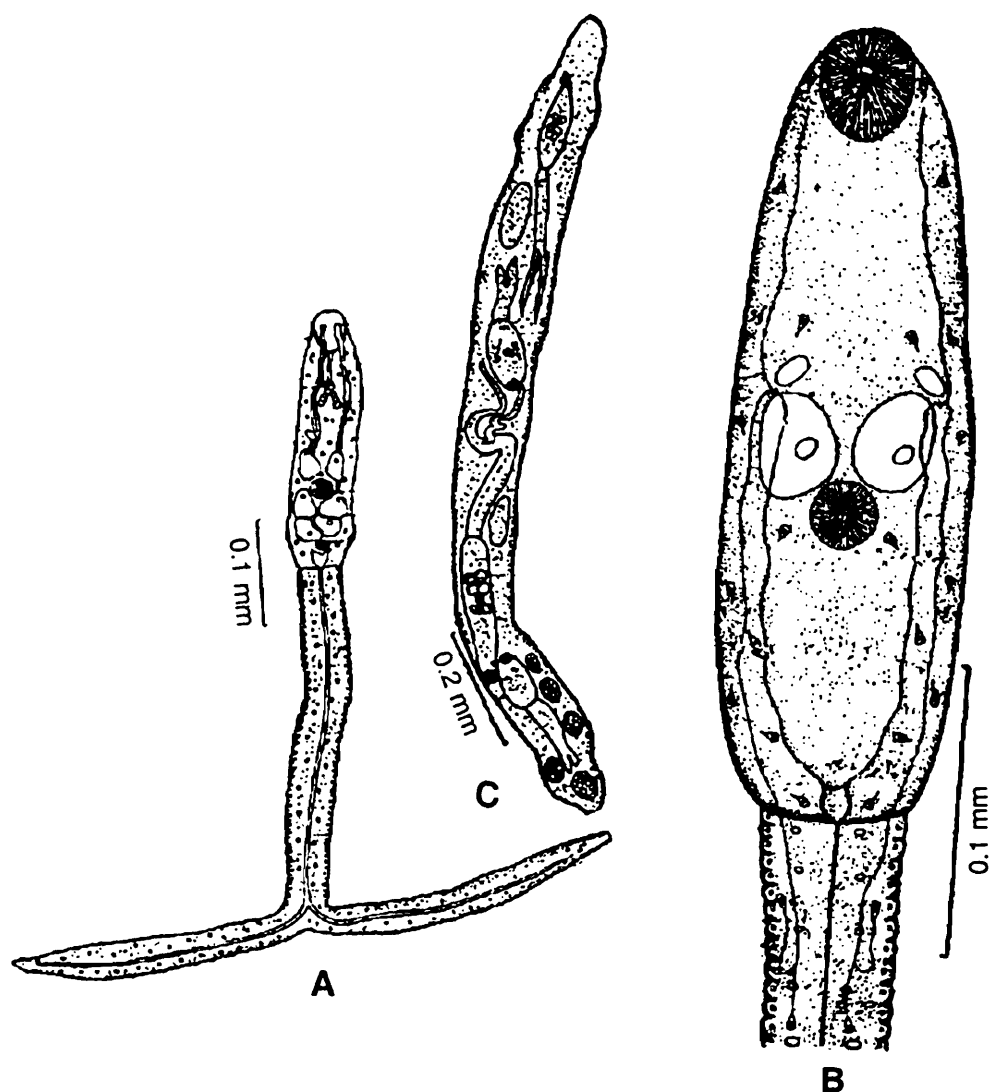


Fig. 33. A & B. *Cercaria dalibaghensis* Pandey, 1967. C. Sporocyst, of *C. dalibaghensis* Pandey, 1967. (After Pandey, 1967).

near middle region of tail-stem by union of two small capillaries, each with one flame cell, seven flame cells present on each side along length of posterior collecting canal, in all eleven pairs of flame cells present in body and two pairs in tail-stem, posterior collecting canals receive four transverse connections in region of penetration glands, a caudal excretory canal arises from posterior end of excretory bladder and it runs posteriorly into tail-stem and on reaching distal extremity of tail-stem divides into two branches which run through furcal rami and open a short distance in front of tips of rami.

Sporocysts elongated, narrow, thread-like, show contraction and expansion of body; measure $0.96-1.92 \times 0.13-0.16$; each sporocyst contains a birth pore, a number of germ balls, cercariae in various stages of development.

Snail Host : *Indoplanorbis exustus*.

Location : Hepatopancreas.

Locality : Dalibagh tank, Lucknow.

35. *Cercaria delhupurensis* Singh
(Fig. 34. A & B)

1953. *Cercaria delhupurensis* Singh, *Allahabad Univ. Stud.*, : 64-68.

Diagnosis : Cercariae swim actively in water but after some time assume a resting state and hang motionless with head downward then furcae suddenly flip rapidly and cercariae shoot upward, at rest anterior end of body bent downward like a hook, tail-stem remains extended with furcae diverged at an angle of about 45° to tail-stem, under cover glass pressure cercaria moves forward with help of anterior penetration organ and ventral sucker; larva capable of twisting its body; powerful ventral sucker remains protruded in extended conditions of body; cercaria can swim backward by jerking movements of tail; annulations present on anterior one-half or three fourths

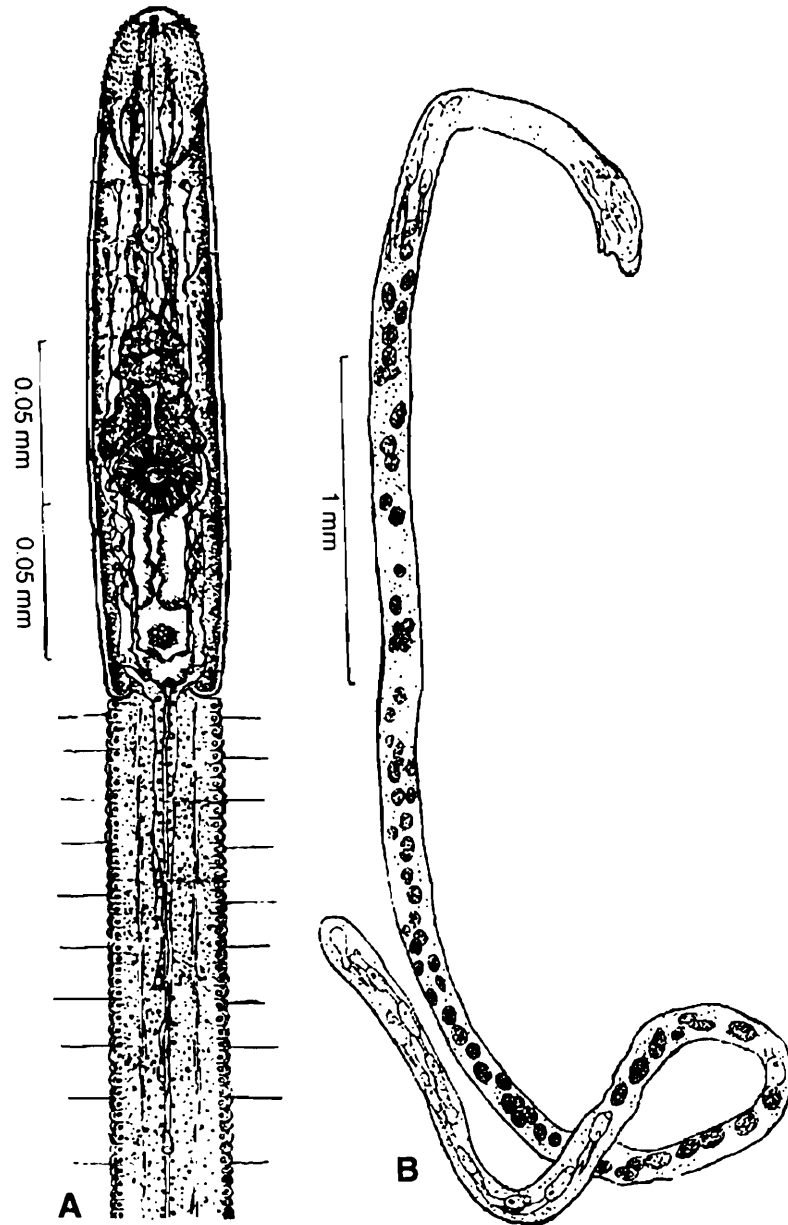


Fig. 34. A. *Cercaria delhupurensis* Singh, 1953. B. Sporocyst of *C. delhupurensis* Singh, 1953 (After Singh, 1953).

of body; body long, slender with parallel sides, square posterior end, anterior end bluntly rounded; in living condition body shows great extension and contraction; anterior end provided with protrusible snout and anteriorly directed spines, these spines form a crown and differ from body spines in being thick, stout and blunt; forwardly pointing spines absent; body under maximum elongation measures 0.27; tail-stem measures 0.23 and furcae also measure 0.23; in fixed condition body measures 0.14-0.20 (0.17) \times 0.02-0.04 (0.04); tail-stem measures 0.22-0.25 (0.23) \times 0.02-0.03 (0.02), furcae measure 0.22-0.23 (0.22); oval anterior penetration organ measures 0.02-0.03 (0.03) \times 0.02 (0.02), its wall thin and non-muscular; ventral sucker situated a little behind middle of body, circular, fairly muscular, can retract and protract, measures 0.02 in diameter, opening provided with 22-24 single row of short hooked spines; behind oral cap of spines anterior penetration organ provided with its half length small thick spines and behind this region spines distributed upto middle of body; tail-stem firmly attached to posterior end of body and in living specimens its width equal to that of body; fine annulations present beneath cuticle; two rows of nuclei present along two sides of tail and lumen occupied by parenchymatous cells, longitudinal muscles present, about 15 hair like projections present on either side, caudal bodies absent, furcae broadly lanceolate with sharp pointed ends; subterminal mouth opens into a long narrow prepharynx; pharynx small, globular; oesophagus small, bifurcates into two intestinal caeca which run parallel upto antero-lateral margins of ventral sucker and then pass around it and end into two very wide contiguous parts in front of genital primordium; eye spots absent; penetration glands four in number, pyriform, coarsely granular cytoplasm, nucleus prominent, cells of first pair lie one behind other in between and dorsal to intestinal caeca, each cell of posterior pair lies at antero-lateral margin of ventral sucker and external to intestinal caeca, ducts of these glands after entering anterior penetration organ dilated before opening on tip of snout; excretory bladder situated at distal end of body, consists of a central vesicle and two large dilations of main lateral collecting ducts, main lateral excretory ducts divide into anterior and posterior collecting ducts at level of ventral sucker, anterior collecting tubules receive three pairs of flame cells, posterior collecting tubules after receiving three pairs of flame cells in body and four flame cells in tail-stem, caudal excretory duct starts from "Islet aperture" and bifurcates at distal end of tail-stem and runs into each furca to open in middle on outer margin; genital primordium represented by a mass of compact small, rounded cells, situated in front of excretory bladder, with well defined nuclei.

Sporocysts long, motile, form a tangled mass; anterior end wide and tapers to form a snout at extreme tip; birth pore situated a little behind extreme tip, guarded by two lips; width of sporocyst uniform; sporocyst measures 5.70-7.00 \times 0.02-0.10.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Pond of Delhupur.

36. *Cercaria esplanadensis* Mukherjee and Ghosh
(Fig. 35. A-C)

1982. *Cercaria esplanadensis* Mukherjee and Ghosh, *Rec. zool. Surv. India*, **80** : 111-116.

Diagnosis : Cercariae white coloured, in resting stage they remain in suspended condition and uniformly distributed in water, they hang upside down with slightly bend tail pointing upward with stretched out furcal rami, in hanging condition they slowly drifted and gradually sinking when they began to swim again, they move vertically upwards, they can crawl on smooth surface with help of oral and ventral suckers; spoon shaped body, in fixed condition measures 0.37-0.41 (0.40) × 0.22-0.28 (0.24); tail measures 0.38-0.45 (0.42) × 0.07-0.10 (0.08), ramus measures 0.26-0.31 (0.29) × 0.05-0.06 (0.06); oral sucker well developed, muscular, measures 0.08-0.12 (0.10) × 0.05-0.09 (0.07); ventral sucker measures 0.03-0.03 (0.03) × 0.02-0.03 (0.03); pharynx muscular, measures 0.03-0.05 (0.03) × 0.02-0.03 (0.03); anterior end forms a conical, protrusible, retractile snout, provided with 7-8 rows of anteriorly directed

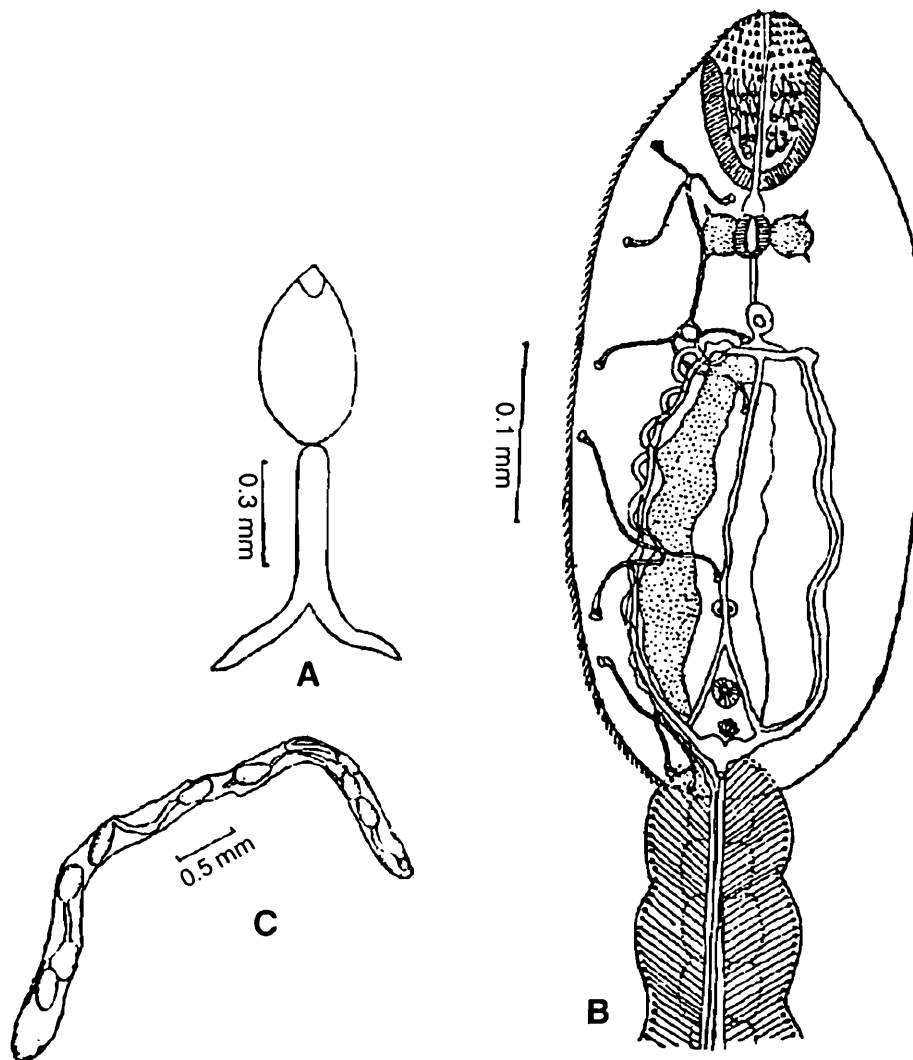


Fig. 35. A & B. *Cercaria esplanadensis* Mukherjee and Ghosh, 1982. C. Sporocyst of *C. esplanadensis* Mukherjee and Ghosh, 1982. (After Mukherjee and Ghosh, 1982).

small piercing spines, rest of spines small, posteriorly directed and arranged in transverse rows; body provided with posteriorly directed, small spines, papillae and sensory hairs absent; oral sucker with uninucleated gland cells; mouth terminal; prepharynx triangular, non-muscular; oesophagus long, forms a loop before bifurcation; intestinal caeca well developed, broad, muscular, sinuous, extend upto posterior part of body, terminate anterior to excretory vesicle; ventral sucker small, less muscular than oral sucker, oval in shape, situated anterior to excretory vesicle; holdfast organ located anterior to ventral sucker, slightly smaller in size than ventral sucker, unarmed; tail strong, muscular, provided with large number of uninucleate cells arranged laterally along length of tail-stem, stout tail-stem without spines, sensory hairs or papillae, furcal rami long, dorso-ventrally flat, unarmed; excretory bladder situated near posterior end; main excretory ducts four in numbers—two median, intercaecal which after running to short distance unite with each other at anterior to ventral sucker and form a median duct which runs forward upto level of oesophageal bifurcation where it joins with transverse connection, lateral sinuous ducts of two sides run close to outer wall of caeca upto oesophageal bifurcation where they join to form a transverse canal, lateral canals after reaching to level of oesophageal bifurcation descend again as sinuous tubes along length of ascending ducts, descending canals soon after leaving ascending ducts divide into anterior and posterior collecting ducts, anterior duct runs forward to short distance and gives off a small lateral duct which finally ends in three flame cells in region of oesophageal bifurcation, another long duct of anterior collecting duct runs forward and ends in three flame cells in region of pharynx, posterior collecting duct runs back and gives off small duct which ends in three flame cells in mid region of body, posterior collecting duct runs further downward and gives off another small duct which ends in three flame cells in posterior part of body, finally posterior collecting duct enters in tail-stem by passing close to lateral side of excretory bladder, it gives off three flame cells in each side of tail-stem—first pair of caudal flame cell situated near base of tail and directed anteriorly, second and third pairs of posteriorly directed caudal flame cells situated in middle and near of tail-stem, caudal flame cells of two sides not situated at same level, caudal excretory canal originates from posterior end of excretory bladder and runs through entire length of stem and divides distally into two ducts which pass through furcal rami and open at tip, flame cell formula represented by $2 [(3+3) + (3+3) + (3)] = 30$, out of these 30 flame cells, 12 pairs located in body and 3 pairs in tail-stem; genital rudiments dorsally placed, represented by a mass of cells, situated between ventral sucker and excretory bladder; nerve mass consists of a pair of ganglia, placed on either side of pharynx and connected by transverse band of nerve tissue, each ganglion gives off nerve bands anteriorly and posteriorly.

Sporocyst thin walled, transparent, elastic, long, cylindrical; contains 8-14 cercariae in various stages of development; birth pore at one end of body and encircled by two rows of minute anteriorly directed spines; posterior end also provided with one row of posteriorly directed spines; measures 1.10-4.10 (3.00) \times 0.15-0.21 (0.19); attached firmly with host tissue by posteriorly directed spines.

Snail Host : *Vivipara bengalensis*.

Location : Digestive gland.

Locality : Monohar Das Tank, Esplanade, Calcutta.

37. *Cercaria exusta* Thapar
(Fig. 36. A & B)

1969. *Cercaria exusta* Thapar, *Indian J. Helm.*, XXI(2) : 128-131.

Diagnosis : *Cercaria* swims actively by vigorous lashing movements of tail, while swimming tail moves in front and body dragged behind, active swimming period alternates with a period of rest when cercariae found drifting in water with body hanging downwards, on slide or dish cercariae also show looping caterpillar like movement; body elongated, cylindrical in shape, rounded at anterior end and broadly attenuated posteriorly; anterior half of body bears minute backwardly directed spines

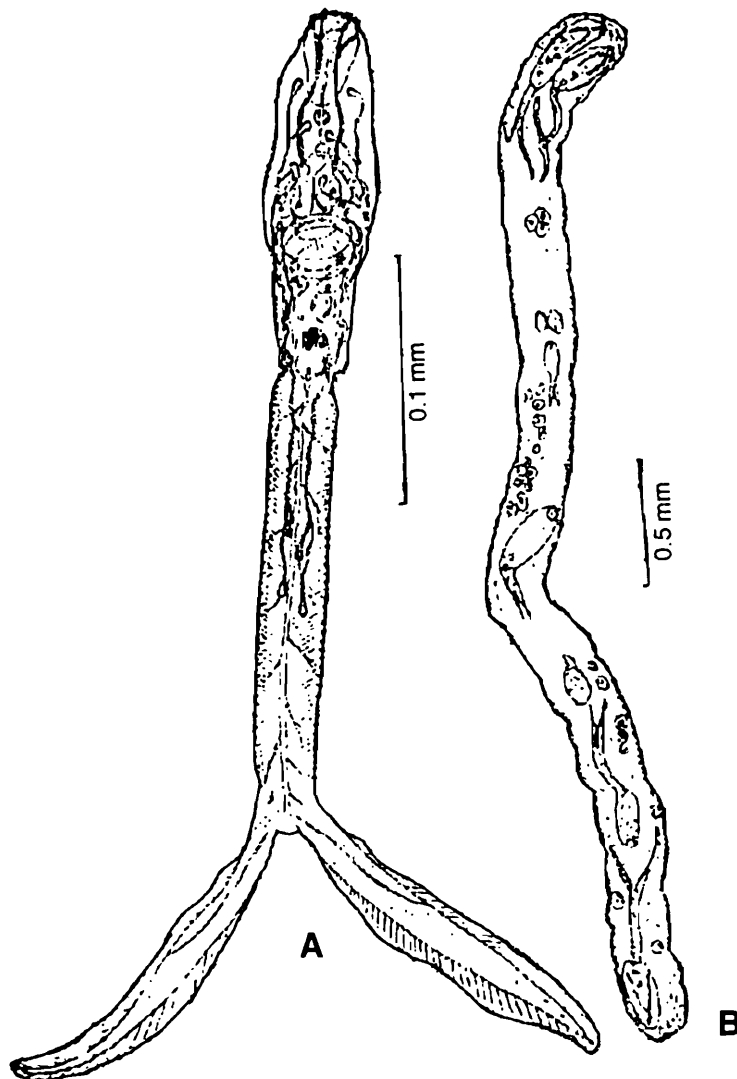


Fig. 36. A. *Cercaria exusta* Thapar, 1969. B. Sporocyst of *C. exusta* Thapar, 1969. (After Thapar, 1969).

and at extreme anterior end of body provided with large piercing spines; anterior end capable of protrusion in form of a snout; posterior end of body produced into a long tail, divided posteriorly into two furcal rami; tail longer than body; body measures 0.14-0.16 × 0.04-0.05 in fixed condition; tail-stem measures 0.17 in length, furcal rami 0.14-0.17 in length and bearing finfold running all along lateral margins; oral sucker large, oval or pyriform in shape, its long axis directed antero-posteriorly, measures 0.03 × 0.02 in size; ventral sucker much larger, situated 0.08 from anterior end, oval in shape, measures 0.03 × 0.02 in size, bears a row of mesially directed spines; another muscular sucker like structure almost size of ventral sucker present at about ventral sucker place or slightly behind it and oval in shape, this probably represent rudiments of holdfast organ; tail powerful organ; supplied with circular and longitudinal muscles; furcal rami flattened from side to side, not constricted off from tail, finfolds weak continuous round margin of rami and bear a few scattered spines on rami; mouth lies subterminally, leads thorough oral sucker into a small prepharynx; pharynx well developed; oesophagus moderately long which ends in a rounded dilatation behind; intestinal caeca represented by chains of four cells, terminating in front of ventral sucker; penetration glands four pairs—two pairs in front and two pairs behind ventral sucker, their ducts run forwards in a bundle on either side of oesophagus and pharynx, near oral sucker ducts pass over it and open at base of large piercing spines situated at anterior end; reproductive rudiments represented by a mass of small rounded cells situated at posterior end of body between posterior pairs of penetration glands and excretory bladder; excretory bladder trifoliate in appearance, excretory pore situated dorsally at junction of tail and body, excretory ducts arise from antero-lateral margins of bladder and pass forwards in a slight wavy course, at about level of ventral sucker main vessel divides into an anterior and posterior ducts, anterior duct runs forward and divides into three capillaries—each ending in a flame cell, situated at level of anterior pair of penetration glands, pharynx and oral sucker respectively, posterior duct runs backward and receives capillaries from two flame cells situated at level of posterior pair of penetration glands and excretory bladder respectively, further backwards posterior duct continued into tail for about half its length and receives capillaries of two more flame cells, thus a total of seven pairs of flame cells of which five pairs in body and two in tail, flame cell formula represented by 2 [(1+1+1) + (1+1) + (2)], a caudal excretory duct arises from bladder through an “Islet” at posterior end and runs throughout length of tail-stem giving out several fine ramifications throughout its course and ultimately divides into two branches—one for each ramus, at about middle of each ramus duct curves out to open to exterior.

Sporocyst elongated, thread like; developing cercariae crowded together end to end within sporocyst.

Host : *Indoplanorbis exustus*.

Locality : Aihari tank, Rae Bareli Road, Lucknow.

38. *Cercaria humkheri* Agrawal
(Fig. 37. A & B)

1956. *Cercaria humkheri* Agrawal, *Proc. Nat. Acad. Sci. India.*, **22(B)** : 283-286.

Diagnosis : Cercariae move very actively and hang themselves with their anterior one third end bent ventrally in form of a hook when at rest; under a coverslip pressure larvae continued to move with alternate use of anterior organ and ventral sucker; when active larvae move with their tail in advance and dragging body behind; body elongated when fully extended, a number of annulations present anterior to ventral sucker, body measures 0.16-0.18 (0.16) \times 0.03-0.05 (0.04) in living condition and 0.10-0.18 (0.13) \times 0.03-0.06 (0.04) in fixed condition; anterior organ present in anterior part of body containing spineless area with openings of penetration glands and gut, anterior organ oval in shape, measures 0.04 \times 0.02 in living and 0.03 \times 0.02 in fixed conditions, short cuticular spines pointing backward extend upto half of anterior organ and a group of forwardly pointing spines located dorsal to mouth;

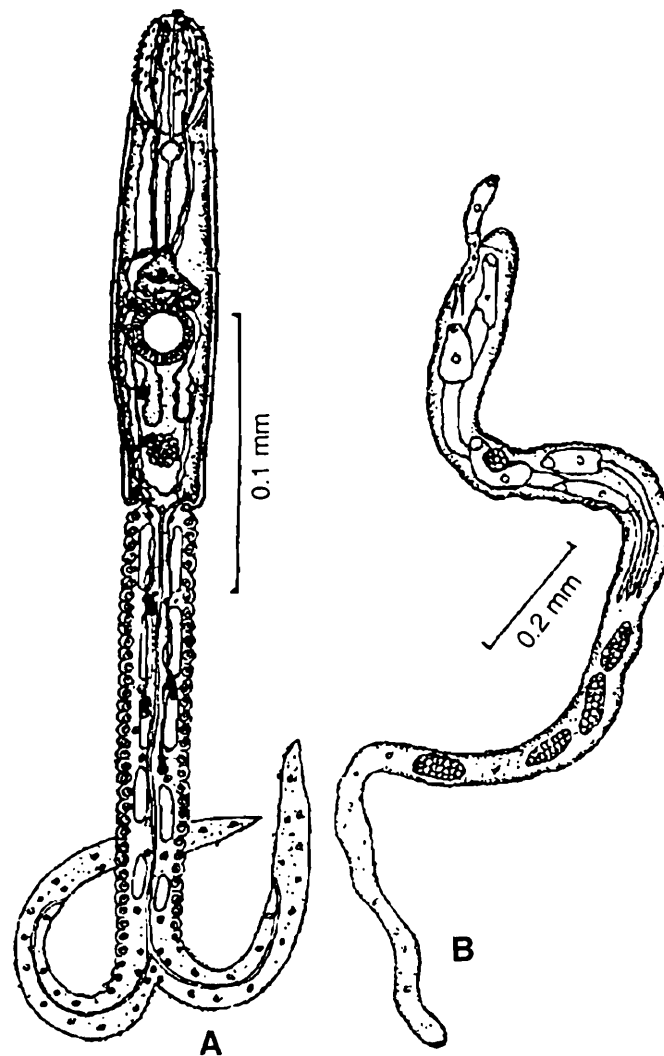


Fig. 37. A. *Cercaria humkheri* Agrawal, 1956. B. Sporocyst of *C. humkheri* Agrawal, 1956. (After Agrawal, 1956).

pigmented eye spots absent; ventral sucker situated at about middle of body, large, circular with wide cavity, provided with a single row of stout spines, ventral sucker smaller than anterior organ, measures 0.02×0.03 in fixed condition; tail-stem slightly longer than body, measures $0.16-0.19$ (0.18) \times $0.03-0.04$ (0.03) in living and $0.10-0.16$ (0.14) \times $0.02-0.03$ (0.02) in fixed specimens, central core provided with five pairs of small narrow caudal bodies and remaining part contains scattered rounded nucleated cells, margin provided with a row of similar cells on either side, eight hair like processes present on either side, furcae slightly longer than tail-stem, measure $0.02-0.2$ (0.18) \times $0.02-0.02$ (0.02) in living and $0.12-0.17$ (0.15) \times $0.01-0.02$ (0.01) in fixed conditions, short spines present at base of furcae; small mouth leads into a prepharynx; pharynx large anterior to penetration glands; oesophagus long bifurcates into two intestinal caeca just above ventral sucker; caeca continue back around sides of ventral sucker and end in three wide sacculations in front of genital primordium; penetration glands two pairs, located anterior to ventral sucker and on point of bifurcation of intestinal caeca, members of first pair arranged one behind other in middle line, anterior one with three lobes on its ventral aspect, posterior one seems to be five lobed, glands of second pair antero-lateral to ventral sucker with their margins entire and separated from each other, ducts of these glands swell in anterior organ; excretory bladder bicornuate, each cornua continues into a main collecting duct which divides into an anterior and a posterior at level of ventral sucker, three pairs of flame cells open in each factor of body and two pairs in tail-stem, posterior end of bladder extends as a caudal excretory duct to bifurcate at distal end of tail-stem where each branch enters a furca and to open at about its middle, 'Island of Cort' present in bladder; genital primordium consists of a number of cells present between arms of bladder.

Sporocyst long, thread like, forming an entangled mass in liver of snail host; free ends perform worm like movements; white in colour; in some sporocysts extreme anterior end seems to contain a number of very short spines; birth pore present a little behind extreme anterior tip; sporocyst measures $0.68-3.65 \times 0.06-0.09$.

Snail Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Humkhera tank, Jabalpur.

39. *Cercaria hurleyi* Rao

(Fig. 38. A)

1933. *Cercaria hurleyi* Rao, *Indian J. Vet. Sci. Anim. Husb.*, 3(3) : 237-239.

Diagnosis : *Cercaria* small, powerful swimmer, negative phototropic; body elongate, cylindrical measures 1.00×0.04 ; tail-stem 0.08×0.02 , furcal ramus measures 0.15 in length; body tail spinose; two pale eye spots present in front of ventral sucker; in body four setae present on each side, on tail-stem setae six in number on each side,

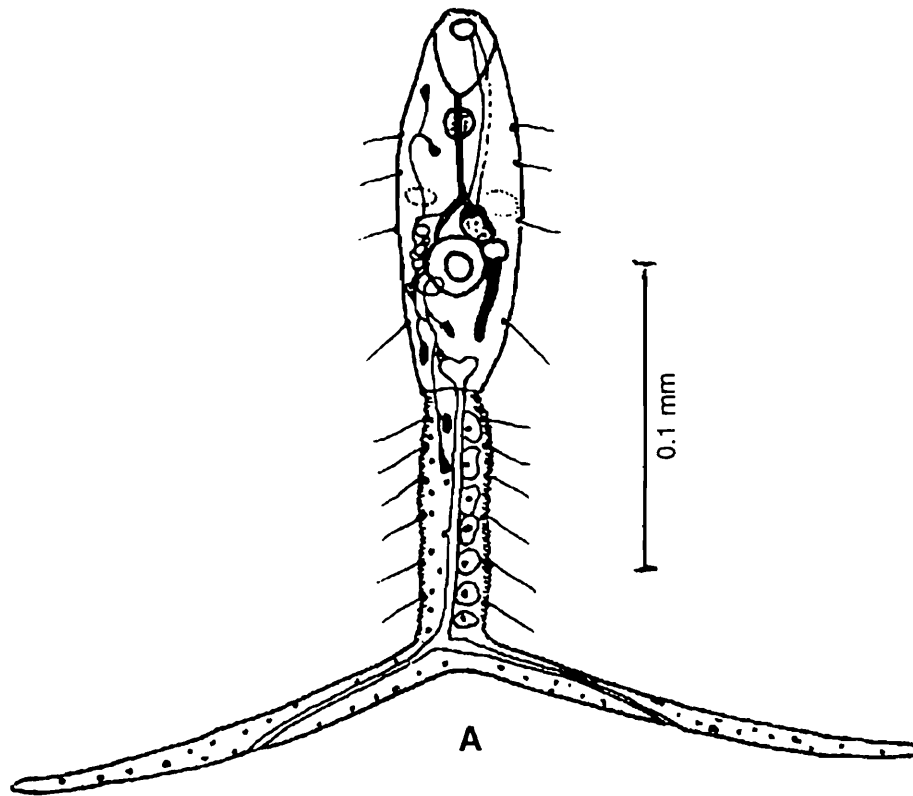


Fig. 38. A. *Cercaria hurleyi* Rao, 1933 (After Rao, 1933).

setae originate from refractile granules; oral sucker with circular muscles; protrusible anterior penetrating organ present; ventral sucker a little wider in diameter, situated a little behind middle of body, well developed, circular lining armed with three alimentary canal well developed; prepharynx short; pharynx bulb muscular, small; oesophagus long, with a thin calibre, bifurcates in front of ventral sucker into two intestinal caeca; caeca reach almost to posterior end of body; a pair of small penetration glands present on either side of ventral sucker on anterior aspects, anterior gland larger and contains coarsely granular oxyphylic contents whereas posterior gland contains granules of basophylic in nature, ducts from both these glands pass forwards and open on margin of oral opening, duct of large gland appears to be a little wider; five pairs of flame cells present in body and two in tail, excretory bladder bilobed, two collecting canals pass forwards from excretory bladder, each tube forms a tangle on either side of ventral sucker and at tangle a cross connection between two main tubes present, this connection present anterior to ventral sucker, each tube divides into anterior and posterior collecting tubules, anterior tubule divides into two branches—each ending a flame cell, posterior tubule divides into two branches—one of which bifurcates soon and ends in two flame cells, other branch bifurcates at level of excretory bladder and one branch ends in a flame cell near bladder and other branch passes into tail-stem where it divides into two divisions and each surmounted by a flame cell, flame cell formula represented by $2 [(2) + (2+1) + 2]$; caudal excretory canal originates from excretory bladder and runs whole length of tail-stem, it bifurcates into furcal

rami and each after entering into each furca opens in a midfurcal pore; caudal glands six pairs, arranged along caudal canal; genital rudiments represented by a mass of cells, situated between ventral sucker and bladder.

Sporocyst long, slender, its wall bulging in places in which large number of cercariae present.

Snail host : *Lymnaea leuteola*.

Location : Digestive gland.

Locality : Spur tank, Egmore.

40. *Cercaria indicae* I Sewell (Fig. 39. A & B)

1922. *Cercaria indicae* I Sewell, *Indian J. Med. Res., Suppl.*, (X) : 268-270.

Diagnosis : *Cercaria* swims easily by vigorous lashing movements of tail and furca, it also able to progress by looping method, it can attach to glass slide by means of ventral sucker and can extend and retract anterior end of body as well as bend from side to side; body in extended condition measures 0.18 in length and 0.05 in breadth; tail-stem measures 0.16-0.18 in length and 0.03 in diameter, furcal rami of almost as long as tail-stem and measure 0.16 in length; body elongate, cylindrical shape, anterior end rounded, produced terminally in a small conical snout which crowned by a number of small anteriorly directed solid piercing spines; anterior rounded end occupied by a weak oral sucker, oval in shape, long axis in antero-posterior, measure 0.02×0.02 ; surface of body armed in its anterior two-thirds with numerous small backwardly directed spines; ventral sucker smaller than oral sucker, measures 0.02 in diameter, situated between $\frac{1}{3}$ and $\frac{1}{4}$ of body length from posterior end and armed with double row of small centrally directed spines; tail-stem as wide as body and attached to its posterior aspect, beneath cuticle a layer of transverse muscle fibres present and internal to this bulk of tail appears to consist of parenchymatous tissue in which faint longitudinal striae indicate presence of longitudinal muscle fibres, a row of rounded nuclei lie along each side of central canal, furcal rami long, not constricted off from tail-stem, lancet-shaped outline and along each margin a row of small backwardly directed spines present, spines on tail-stem absent; mouth small, subterminal, leads back through oral sucker to a short prepharynx; pharynx rounded, measures 0.01 in diameter; oesophagus passes backward in middle line almost to anterior margin of ventral sucker where it terminates in a pair of short wide caeca; a pair of pyriform salivary cells lie in front and outside of ventral sucker with coarsely granular protoplasm and rounded nuclei, ducts pass forward from these gland cells on each side of body and before reaching oral sucker they dilate and continued on round sucker on its dorsal aspect and open on tip of snout; excretory vesicle trilobed, lies at extreme posterior end of body, from each antero-lateral lobe a main excretory tube

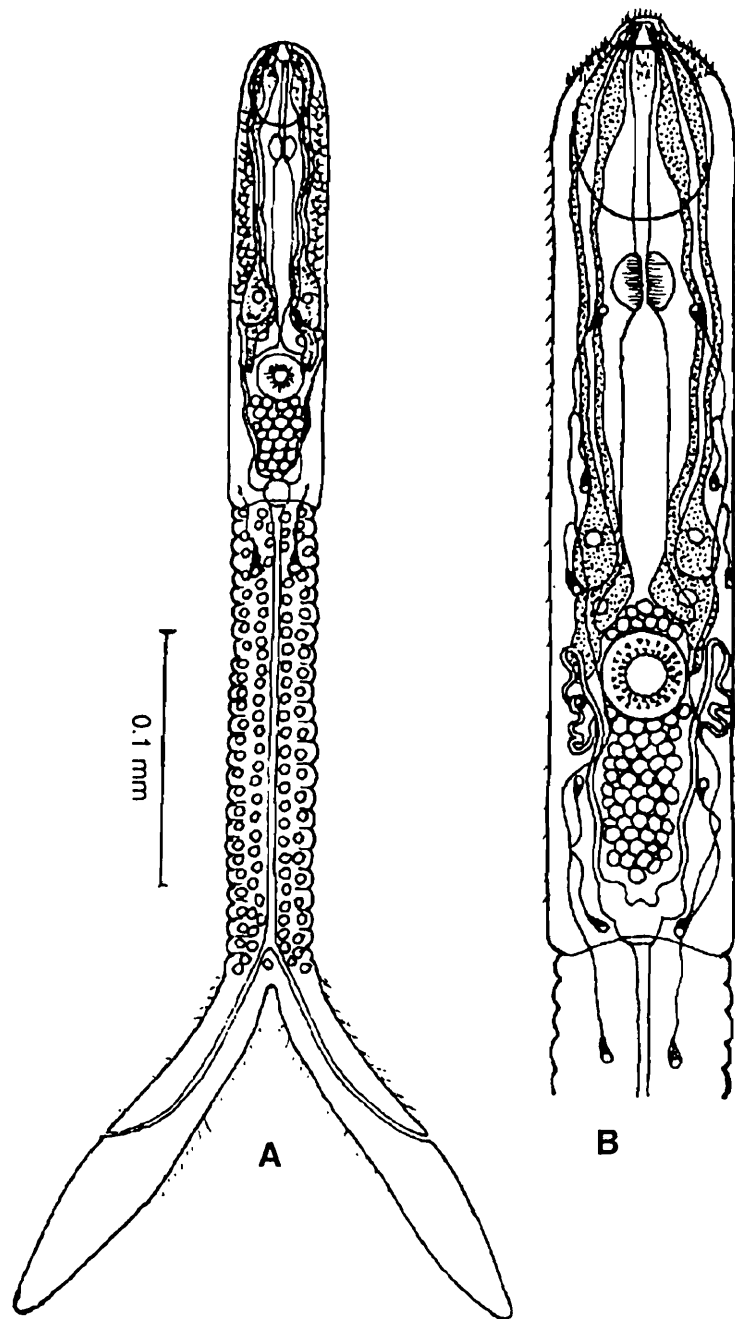


Fig. 39. A & B. *Cercaria indicae* I Sewell, 1922 (After Sewell, 1922).

passes forward to level of anterior margin of ventral sucker, it then turns backward in a coil to a point on a level with posterior margin where it divides into anterior and posterior collecting tubes, anterior collecting tube passes forward and receives capillary vessels from anterior three pairs of flame cells, posterior collecting tube passes back in body and after receiving capillary vessels from posterior two flame cells in body continued on into tail to flame cell situated close to its proximal end, from posterior end of excretory vesicle a caudal excretory tube arises and passes into tail-stem, at distal end caudal canal divides into branches which pass along furcal rami for about half their length and open to exterior on margin, an excretory pore appears to open out of bladder at point of attachment of tail to body on dorsal aspect; body composed

of small parenchymatous cells; genital organs represented by a mass of small round cells extending ventrally in middle line from anterior wall of bladder forward to posterior margin of ventral sucker and bounded laterally by two main excretory tubes.

Sporocysts elongate, thread like, capable of considerable movement; free end tapering and bluntly rounded.

Snail Host : *Indoplanorbis exustus*.

Locality : Swamp, Russa Road, Calcutta.

41. *Cercariae indicae II* Sewell

(Fig. 40. A & B)

1922. *Cercariae indicae II* Sewell, *Indian J. Med. Res., Suppl.*, (X) : 271-274.

Diagnosis : *Cercaria* large, swims rapidly and easily through water by means of vibrations of tail, when swimming it appears to progress tail first and body being dragged behind, negative geotropic, swims upward towards surface of water, active swimming alternate with period of rest during which cercaria floats, body downward, motionless in water, when floating furcal rami extended to full length at right angles to tail-stem and anterior end of body curved ventral wards in a 'Pot hook', under cover slip pressure it progresses rapidly by looping movement; body, tail-stem and furcal rami all of approximately same length; body measures 0.21-0.26 in length and 0.03-0.06 in breadth; tail-stem measures 0.26 and its diameter slightly greater than of fully extended body, furcal rami 0.26 in length; body elongated, cylindrical, anterior end rounded, posterior end abruptly truncated, anterior tip of body produced in a rounded snout and armed with a number of anteriorly directed solid piercing spines, anterior 1/4 of body armed with a number of smaller spines arranged in transverse rows; oral sucker at anterior end, oval in shape, long axis being antero-posterior, measures 0.04 in length and 0.03 in breadth, bulk of organ composed of rounded parenchymatous cells; ventral sucker smaller than oral sucker, situated about 1/3 of body length from posterior end, measures 0.02 in diameter, armed with a number of short centrally directed spines arranged in double row around margin; tail-stem attached to extreme posterior end of body and in a straight line with it, muscular and powerful, beneath delicate cuticle lies a layer of circular muscle fibres which when contracted give an annulated appearance to tail, internally to circular layer lie a number of longitudinal muscle fibres which appear as fine striae in general parenchyma, furcal rami long, lanceolate, not constricted off from tail-stem, base of each ramus annulated and armed with numerous backwardly directed spines on dorso-ventral margins, other spines scattered along margins of rami and occur in longitudinal rows on both median and lateral aspects, extreme edges of rami clear and give a spurious appearance of fin-folds; mouth situated subterminally; prepharynx long; pharynx small spindle shaped dilatation surrounded by a compact mass of small

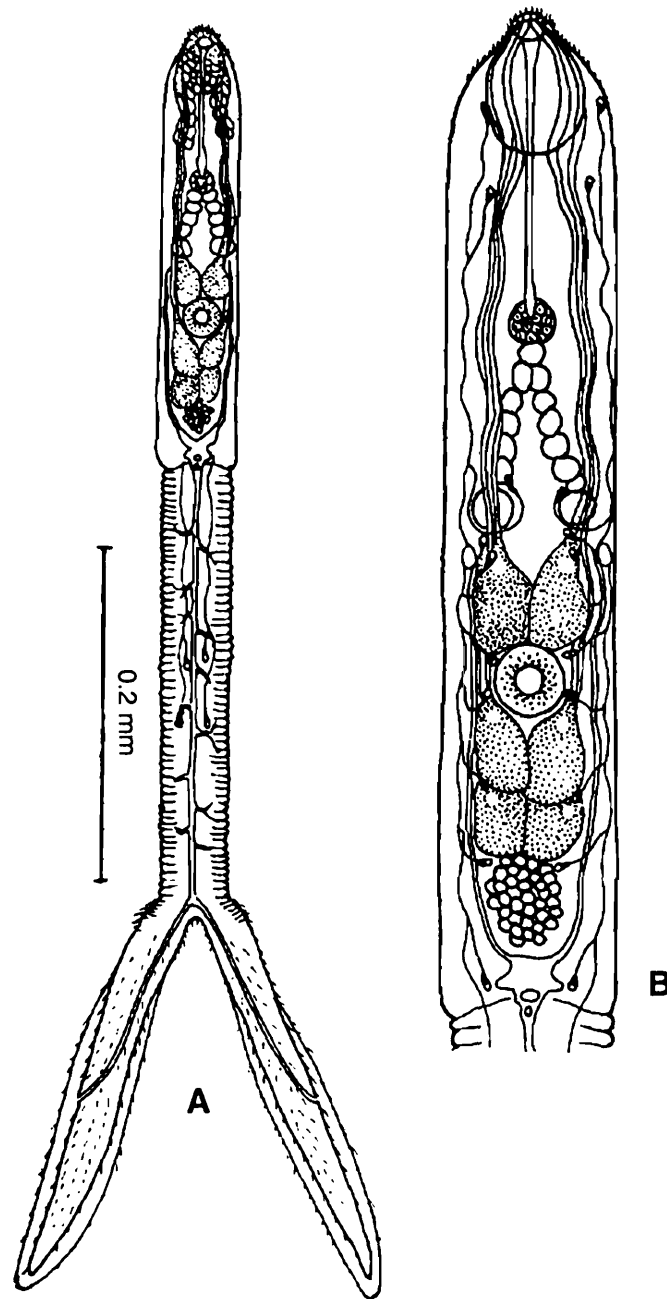


Fig. 40. A & B. *Cercaria indicae II* Sewell, 1922. (After Sewell, 1922).

round cells which represents a rudimentary pharynx; oesophagus represented by a singly round vacuolated cell; intestinal caeca represented by two diverging columns of four or five similar cells, each caecum terminates posteriorly in a single round cell of plae brown colour lying immediately in front and little to outer side of anterior pair of salivary gland cells; salivary gland consists of three large pyriform cells with coarsely granular protoplasm and round nuclei, anterior pair of salivary gland cells lie in front of ventral sucker and two posterior pairs behind it, occasionally three cells lie in front of and three behind ventral sucker, each gland cell a duct passes forward, ducts on each side of body pass forward together in a bundle and on reaching side of oral sucker appear to pass around it on its dorsal aspect and finally open on tip of

snout among penetrating spines, a second group of what appears to be gland cells situated just behind sucker on either side of body in front and to outer side of pharynx, each group consists of ten or more small pyriform cells; at posterior end of body lies a small trilobed excretory vesicle from which an excretory pore opens to exterior on dorsal aspect of junction of body and tail, antero-lateral regions of vesicle a pair of main excretory tubes arise, each main tube passes forward following a slightly wavy course to anterior margin of salivary gland where it divides into anterior and posterior collecting tubes, anterior collecting tube passes forward and receives capillaries from three flame cells, posterior collecting tube passes backward to posterior end of body receiving capillaries from seven more flame cells in body and then continued on into tail where it joined by capillaries from two flame cells of same side, excretory formula represented by $2 \times 10 (+2) \times 1 = 20 (+4)$, from posterior end of bladder a caudal excretory tube arises by a typical 'Islet aperture' and passes along tail-stem receiving numerous short lateral branches and at distal end divides into branches which pass along furcal rami for about half their length and open to exterior near lateral margin; genital organs represented by a compact mass of small round cells situated between posterior pair of salivary gland cells and in front of excretory vesicle and towards ventral aspect of body.

Sporocyst elongated, thread like with narrow calibre; free ends of sporocyst actively motile, constantly extending and contracting exhibiting writhing movements; extreme tip composed of solid mass of parenchymatous tissue and immediately behind this a definite birth pore with protruberant lips; sporocyst provided with a definite excretory system; a few large flame cells could be seen in body wall.

Snail Host : *Indoplanorbis exustus*.

Locality : Tank of Indian Museum; a swamp in Russa Road South, Tollygunge and a tank in Maidan, Calcutta.

42. *Cercariae indicae* XXII Sewell

(Fig. 41. A & B)

1922. *Cercariae indicae* XII Sewell, *Indian J. Med. Res., Suppl.*, (X) : 276-278.

Diagnosis : *Cercaria* active swimmers, under cover slip pressure it progresses by alternate use of its two suckers though anterior organ feebly prehensile, it shows looping movement, anterior organ takes hold by retraction of protrusible snout within rest of anterior organ thus converting it temporarily into a sucker, it fixes itself by ventral sucker and turns from side to side extending and retracting its anterior end; body measures 0.16 in length and 0.02 in breadth; tail-stem measures 0.14 in length and 0.02 in uniform diameter, furcal rami measure 0.14 in length; body shows considerable degree of extension and contraction, when fully extended sides of body tend to become crenated owing to extreme contraction of circular muscle fibres, these fibres situated beneath cuticle, sides of body normally parallel, anterior end rounded, posterior end abruptly truncated, extreme tip produced in a small inversible papilla

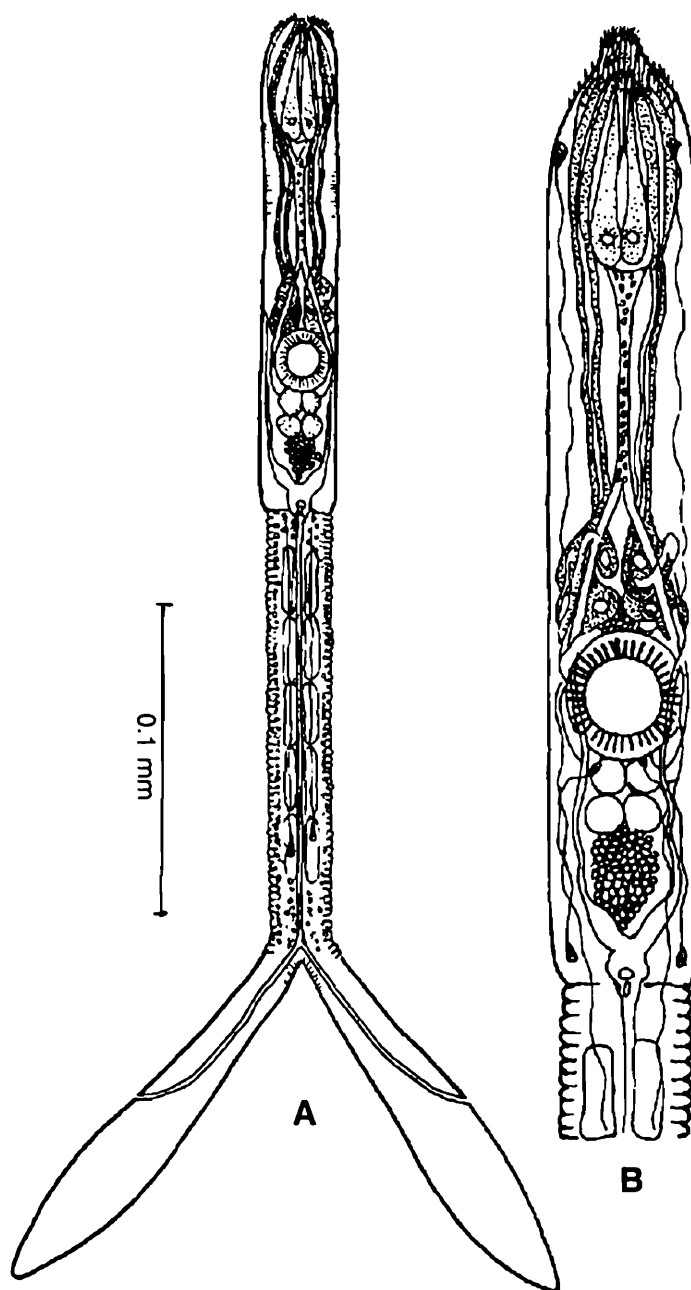


Fig. 41. A & B. *Cercariae indicae* XXII Sewell, 1922 (After Sewell, 1922).

crowned with anteriorly directed piercing spines, rounded anterior end armed with several transverse rows of small anteriorly directed spines, remainder body unarmed; anterior end occupied by protrusible oval shape penetrating organ, its long axis being antero-posterior, it measures 0.04 in length and 0.02 in its transverse diameter, snout like projection at extreme anterior end can be retracted within penetrating organ and to give rise to a secondary sucker, ducts of salivary cells pierce penetrating organ in ventro-lateral aspect, ducts pass forward to reach to tip of snout, a pair of elongate pyriform cells with finely granular protoplasm and small round nuclei near basal ends situated on dorsal aspect of organ, these two cells lie close together near middle line and may possibly be homologue of head gland of Schistosome cercariae; ventral

sucker situated a little behind junction of middle and posterior third of body, pre-sucker and post-sucker regions being in proportion to 68 : 32, ventral sucker, large, well-developed, measures 0.02 in diameter, surface armed with a single row of hook like spines; powerful tail attached to posterior end of body, its lateral margins present an annulated appearance owing to contraction of sub-cuticular circular muscle fibres, on either side of central canal a row of five rectangular refractile masses probably parenchymatous cells present, between these cells and layer of circular muscle fibres a mass of small parenchymatous cells among which longitudinal striae indicating presence of longitudinal muscle fibres, furcal rami long, lancet-shaped with margins finely annulated at base; small mouth subterminally, leads back into a narrow tube that passes through anterior penetrating organ; oesophagus narrow which shows small triangular dilatation immediately behind posterior margin of penetrating organ, lumen contains numerous oval or rounded refractile granules; middle of body length oesophagus divides into a pair of intestinal caeca, caeca pass around ventral sucker and continuous with two pairs of rounded globular masses of refractile material situated close together near middle line immediately posterior margin of sucker, these structures be dilated ends of caeca; two large pyriform salivary glands with rounded nuclei and coarsely granularⁿ protoplasm situated on either side of middle line in front of ventral sucker, from each cell a narrow duct passes forward to ventro-lateral aspect of penetrating organ and after entering into it traverses to reach tip of protrusible snout where it opens to exterior; excretory bladder bicornuate, from its posterior end an excretory pore opens to exterior on dorsal side of point of attachment of tail, from each cornu a main excretory tube starts and follows a wavy course and moves forward to sides of ventral sucker where it divides into anterior and posterior collecting tubes, anterior tube passes forward and receives capillaries from three flame cells while posterior tube passes backward and after receiving capillaries from two flame cells in body continued on into tail where it receives capillaries from two flame cells situated near extremities of tail-stem, from posterior end of bladder a caudal excretory tube arises and passes backward along tail-stem to its distal end where it divides into two branches which pass along furcal rami for about half their length and open to exterior on margin; a compact mass of small rounded cells represent genital organs, situated ventral side of body between posterior margin of ventral sucker and ends of intestinal caeca in front and cornua of excretory bladder behind and to outer side, probably it represents ovary, another small mass of cells situated triangular space in front of ventral sucker and between two posterior salivary cells.

Sporocysts elongated, sausage shaped; bright orange colour; show a considerable degree of extension and contraction, also show active bending movement, waving free end from side to side.

Snail Host : *Lymnaea ovalis*.

Location : Liver.

Locality : A tank in Zoological Garden, Alipore, Calcutta.

43. *Cercariae indicae* LXIII Murty
(Fig. 42. A-C)

1975. *Cercariae indicae* LXIII Murty, *Proc. Indian Acad. Sci.*, 82(B) : 118-120.

Diagnosis : Cercariae emerge throughout day, periods of swimming alternate with periods of passive sinking and rest, cercariae distributed at all levels in water of container, while at rest tail-stem bent at an angle one-fourth distance from base; body fusiform, broader than tail, maximum width of body anterior to ventral sucker, body spinose; spines at tip of anterior organ more prominent and directed forward; circumoral spineless region present; oral cap with 6-8 rows of concentrically arranged spines decreasing in size posteriad, extending upto two-fifths of length of anterior organ; oral cap spines followed by spineless region; body anterior to ventral sucker with spines arranged in 7-8 rows; orange yellow pigment patches present lateral to pharynx as well as anterior to ventral sucker; tail longifurcate, cuticle of tail-stem thrown into concentric rings, eleven pairs of lateral bristles present on tail-stem; small caudal bodies surrounding caudal excretory tubule and connected to cuticle by strands, furcal

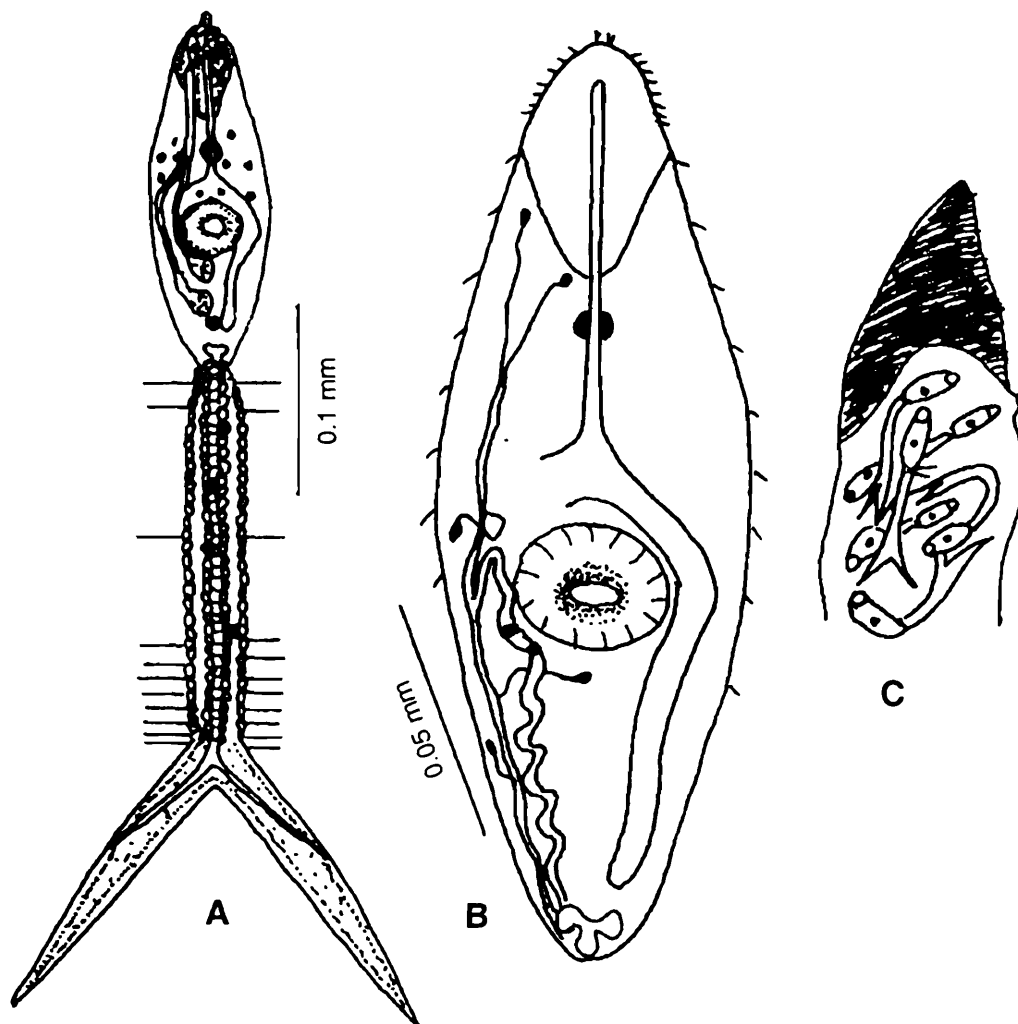


Fig. 42. A & B. *Cercariae indicae* LXIII Murty, 1975. C. Sporocyst of *C. indicae* LXIII Murty, 1975. (After Murty, 1975).

rami covered with spinulets; ventral sucker post-equatorial, three alternating rows of spines present around opening of ventral sucker; mouth subterminal; prepharynx small; pharynx muscular; oesophagus bifurcates anterior to ventral sucker; caeca undulating, extending upto excretory bladder; penetration glands two pairs, intercaecal, posterior to ventral sucker, contain finely granular protoplasm; excretory system mesostomate, excretory bladder tripartite, two ciliated patches present in main tubules, anterior and posterior collecting excretory canals each ends in three flame cells, caudal excretory canal bifurcates and opens laterally half way down to ramus, two pairs of flame cells in tail-stem and arranged asymmetrically; a mass of cells represented genital rudiments situated between penetration glands and bladder; body measures $164\mu\text{-}200\mu \times 52\mu\text{-}68\mu$ ($180\mu \times 58\mu$); tail-stem measures $192\mu\text{-}208\mu \times 32\mu\text{-}36\mu$ ($203\mu \times 33\mu$), ramus measures $168\mu\text{-}184\mu$ (176μ) $\times 20\mu$; anterior organ measures $32\mu\text{-}60\mu \times 32\mu\text{-}36\mu$ ($53\mu \times 33\mu$); ventral sucker measures $28\mu\text{-}32\mu \times 32\mu\text{-}36\mu$ ($31\mu \times 33\mu$); pharynx measures $12\mu \times 12\mu$.

Sporocyst motile; orange yellow in colour; measure $492\mu \times 130\mu$; birth pore a little behind blunt end of sporocyst, guarded by a muscular sphincter; cercariae in various stages of development present; cercarial development completed within sporocyst.

Snail Host : *Lymnaea acuminata*.

Location : Liver and viscera.

Locality : Kondakarla lake, Andhra Pradesh.

44. *Cercariae indicae* LXIV Murty

(Fig. 43. A & B)

1975. *Cercariae indicae* LXIV Murty, *Proc. Indian Acad. Sci.*, 82(B) : 120-122.

Diagnosis : Cercariae emerge throughout daytime, cercaria looks like an oscillating rod with nodes at body-tail stem and tail stem-rami junction, freshly liberated cercariae very active and hardly rest but as time passes they frequently rest and hanging upside down with spread out rami at right angles to tail-stem; body cylindrical or fusiform with maximum width near ventral sucker; body spinose, orange yellow pigment granules distributed uniformly all over body; two pairs of lateral bristles on body situated anterior to excretory bladder; tail longifurcate, cuticle of tail-stem thrown into concentric rings; eighteen pairs of uniformly spaced lateral bristles on tail-stem, caudal bodies absent; ventral sucker subequatorial, with 3-4 rows of spines around opening; mouth subterminal, leads into pharynx; oesophagus slender, bifurcates into two caeca; caeca reaching half way between ventral sucker and excretory bladder; penetration glands two pairs situated antero-lateral to ventral sucker, first pair almost touch each other, glands contain finely granular protoplasm, ducts of glands small and open lateral to mouth; excretory system mesostomate, excretory bladder tripartite, flame cell formula represented by $2 [(2+2) + (2+2) + 2] = 20$, flame cells of tail-stem situated very close to body, caudal excretory canal bifurcates and opens laterally half

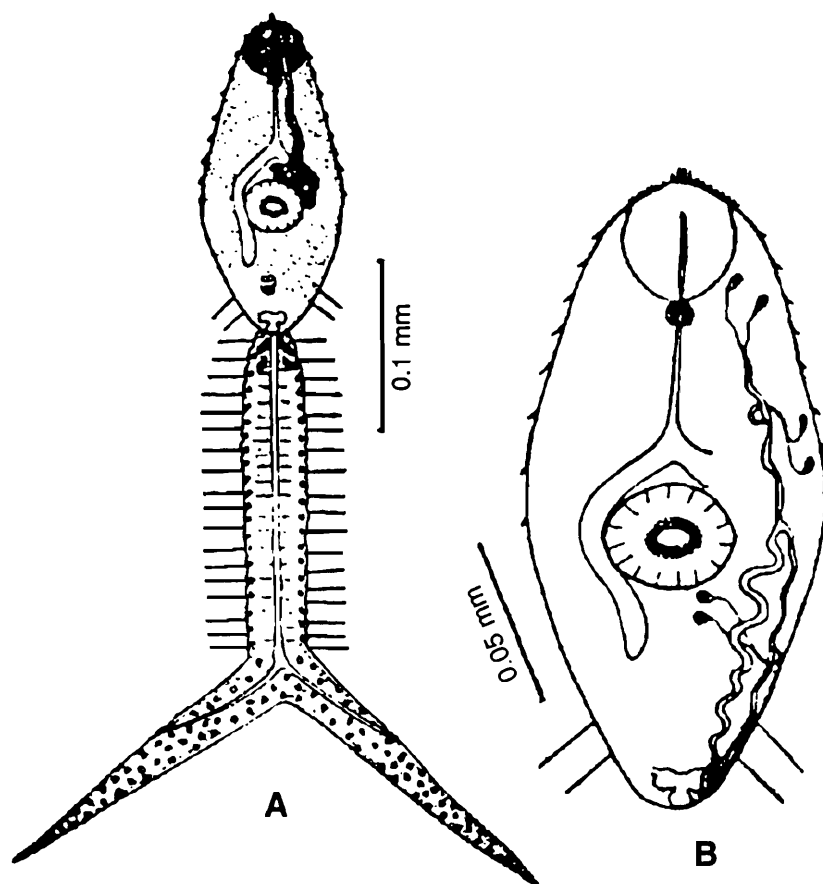


Fig. 43. A & B. *Cercariae indicae* LXIV Murty, 1975. (After Murty, 1975).

way down to rami; genital rudiments represented by a mass of cells located between ventral sucker and excretory bladder; body measures $176\mu-210\mu \times 62\mu-80\mu$ ($198\mu \times 75\mu$); tail-stem measures $176\mu-200\mu \times 32\mu-40\mu$ ($186\mu \times 34\mu$); ramus measures $200\mu-240\mu \times 16\mu-24\mu$ ($212\mu \times 20\mu$); anterior organ measures $32\mu-40\mu \times 24\mu-40\mu$ ($35\mu \times 30\mu$); ventral sucker measures $32\mu-36\mu \times 28\mu-36\mu$ ($33\mu \times 30\mu$); pharynx measures $16\mu-22\mu$ ($19\mu \times 19\mu$).

Sporocyst measures $5000\mu \times 100\mu-150\mu$; younger generation measures $1800\mu \times 50\mu-115\mu$; two generations of sporocyst; sporocyst containing developing embryos.

Snail Host : *Lymnaea acuminata*.

Locality : Kondakarla lake, Andhra Pradesh.

45. *Cercaria indicae* LXXXI Sultana
(Fig. 44. A & B)

1982. *Cercaria indicae* LXXXI Sultana, *Proc. Indian Acad. Parasitol.*, 3(1 & 2) : 93-95.

Diagnosis : Body slightly larger than tail-stem, elongated and cylindrical in shape, anterior end rounded; terminal conical snout present, crowned with 12 thick solid piercing spines; oral sucker not powerful, oval in shape; anterior half of anterior

penetrating organ covered with numerous thick small backwardly directed spines; small circum-oral aspinous area present; body uniformly spinose; ventral sucker large, a little smaller than oral sucker, situated between $1/3$ to $1/4$ of body length from posterior end, armed with a single whorl of 46 hook like longer and shorter spines, alternately arranged; tail-stem broad, attached to posterior aspect of body, provided with 11 pairs of flagella, two rows of bipolar cells situated beneath cuticle on either side of excretory canal and more towards periphery; a row of small round nuclei located along each side of tail-shaft; tail-stem and furcae provided with dense minute backwardly directed spines; mouth small, sub-terminally; prepharynx short; muscular pharynx, oval in shape; short and wide oesophagus; two intestinal caeca slightly increasing in diameter, undulate in posterior regions; penetrating glands four in number, situated anterior to ventral sucker, protoplasmic content granular, two of these glands central, transversely elongate, anterior to ventral sucker, overlying pre-equatorial region of ventral sucker, other two glands beneath these two glands, slightly antero-lateral to ventral sucker; penetration ducts paired pass forwards on each side of body, dilated just before reaching oral sucker; a pair of non-pigmented eye spots present on anterolateral sides of ventral sucker; excretory bladder trilobed, lie at extreme posterior end of body, from each anterolateral lobe a main collecting excretory tube passes forward to level of anterior margin of ventral sucker then it turns backward in a coil to a point at level with posterior margin of ventral sucker and divides into anterior and posterior collecting tubes, anterior collecting tubule passes forward receiving capillaries from four flame cells, posterior collecting tubule passes back in body and after receiving capillary vessels from posterior three flame cells passes back

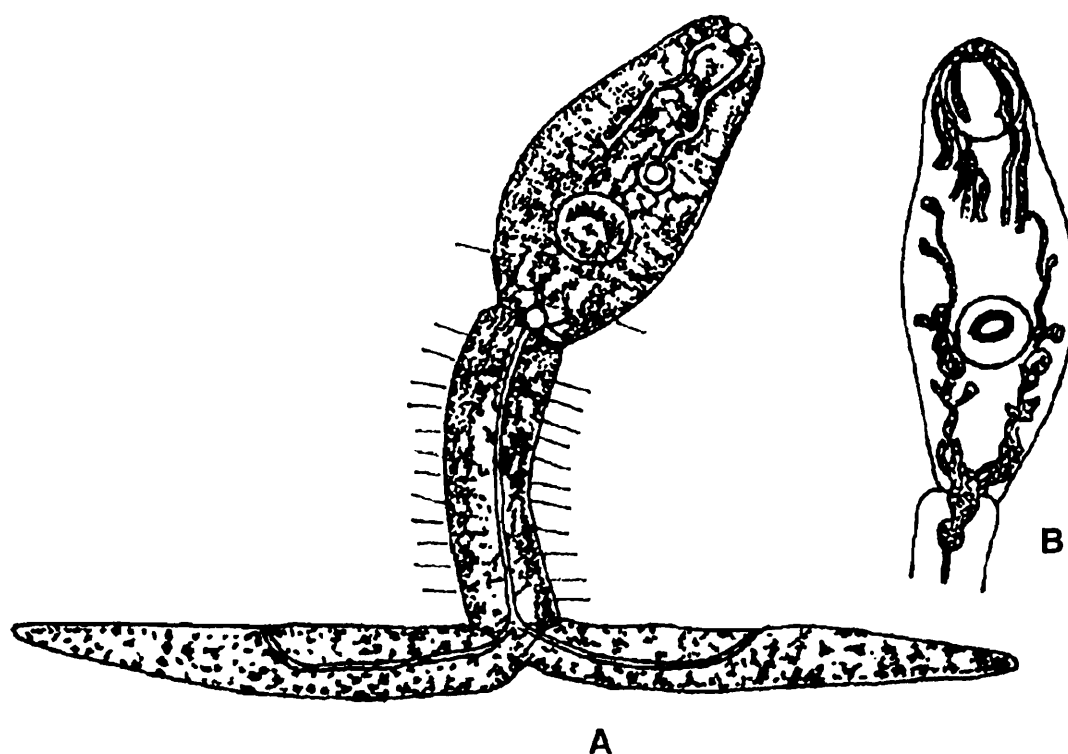


Fig. 44. A & B. *Cercaria indicae* LXXXI Sultana, 1982. (After Sultana, 1982).

into tail-stem to flame cells situated in proximal region of tail, caudal excretory tube arises from posterior end of excretory vesicle which passes into tail-stem and divides at bifurcation of tail, each tube opens on inner margin of furcal rami about half its length, flame cell formula represented by $2 [(2+2) + (2+1) + (2)] = 18$; genital system represented by a cluster of small cells occupying position in median line anterior to excretory bladder.

Sporocyst elongated, thread like structure.

Snail Host : *Lymnaea luteola*.

Locality : Musi river, Hyderabad.

46. *Cercaria kadiramangalamensis* Veerappan and Achuthan
(Fig. 45. A)

1992. *Cercaria kadiramangalamensis* Veerppan and Achuthan, *Rec. zool. Surv. India*, **91**(3-4) : 325-328.

Diagnosis : *Cercaria* active swimmer, showing considerable degree of contraction and extension; pyriform penetrating organ situated anterior; furcal rami sword like, tail-stem longer than body; oral sucker circular in shape, measures 30μ across;

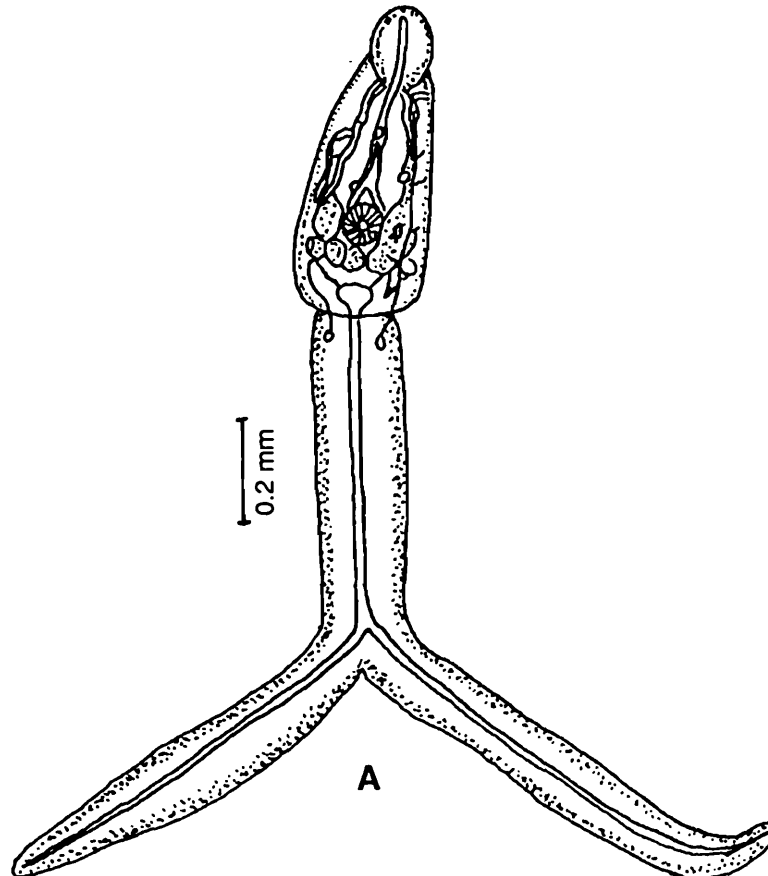


Fig. 45. A. *Cercaria kadiramangalamensis* Veerappan and Achuthan, 1992. (After Veerappan and Achuthan, 1992).

penetrating glands three pairs, present around and below ventral sucker; eye spots absent; small bulbous pharynx present; oesophagus short, oesophagus divides into two caeca near ventral sucker; ventral sucker measures 22μ in diameter; body measures $345\mu \times 72\mu$; tail-stem measures $410\mu \times 39\mu$, furcal rami measures $398\mu \times 22\mu$; lateral excretory tubes divide into anterior and posterior branches, anterior tube provided with four pairs of flame cells and posterior tube with three pairs, a single pair of flame cells present in tail-stem, caudal excretory tube divides into two branches and each branch travels through each furca and opens at its tip.

Snail Host : *Indoplanorbis exustus*.

Locality : Kadiramangalam pond, Thanjavur district, Tamil Nadu.

47. *Cercaria kotai* Shrivastava
(Fig. 46. A & B)

1958. *Cercaria kotai* Shrivastava, *Indian J. Helm.*, X(2) : 82-87.

Diagnosis : *Cercaria* fairly small, longifurcate, pharyngeate, moves constantly in water, swims to and fro by vibrating their body and tail, hangs with head downwards and tail-stem upwards with furcae diverged apart, they gradually sink to bottom of container, under coverslip pressure cercaria progresses by means of anterior organ and ventral sucker, annulations on anterior half of body surface appear when cercaria contracts; small body, flexible, filled with granular cells, body measures 0.11-0.11 (0.11) \times 0.04-0.05 (0.04) in living condition; tail-stem measures 0.11-0.12 (0.12) \times 0.03-0.15 (0.04) in living condition, furcae measure 0.12-0.15 (0.13) \times 0.01 in living condition; in fixed specimen body measures 0.12-0.13 (0.11) \times 0.04-0.06 (0.05); tail-stem measures in fixed condition 0.10-0.11 (0.11) \times 0.03-0.03 (0.03), in fixed condition furcal rami measure 0.13-0.13 (0.13) in length; anterior organ or oral sucker oval in shape, measures 0.05-0.06 \times 0.03-0.04; ventral sucker large, muscular, circular in outline, measures 0.02 in diameter, surface armed with single row of spines; anterior half of anterior penetration organ covered with thick spines; body spines on posterior thinner at level of ventral sucker and beyond that practically no spines on body; on extreme tip of snout and dorsal to mouth a group of 8 to 10 anteriorly pointing spines present; penetration glands four in number, small, coarsely granular present at intestinal fork, ducts of these glands run anteriorly and open on either side of oral opening in circumoral spineless area; a pair of very small rounded unpigmented eye spots lies in front of ventral sucker and on either side of penetration glandular mass; mouth subterminal; prepharynx narrow; pharynx globular; oesophagus long divides into two intestinal caeca in front of ventral sucker; caeca extend a little beyond posterior margin of ventral sucker with enlarged terminal portions; excretory bladder small, lying posterior end of body where tail attached with body; from bladder a single median canal runs posteriorly along longitudinal axis of tail-stem and divides near tail fork, small 'Island of Cort' present, each branch of tubule extends through one half of furca and opens to exterior at its lateral border, anteriorly each main arm of

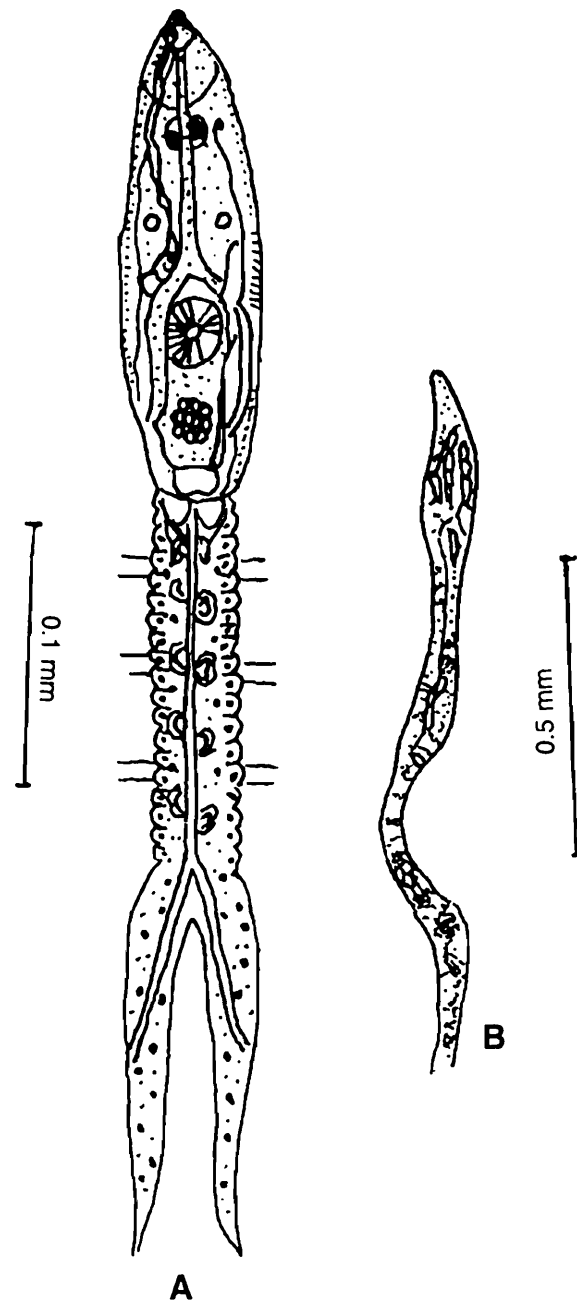


Fig. 46. A. *Cercaria kotai* Shrivastava, 1958. B. Sporocyst of *C. Kotai* Shrivastava, 1958. (After Shrivastava, 1958).

bladder divides into an anterior and posterior branch near equator of ventral sucker, anterior branch ends in two capillaries each with flame cell and posterior branch ends with three flame cells—two in body and one in tail-stem; genital primordia represented by a small mass of rounded cells situated in front of bladder; tail-stem long, cylindrical, attached terminally with body, it bears six sensory hairs in groups of two on each side, it bears five pairs of caudal bodies, tail with many nuclei, loose muscle bands extend throughout tail-stem length and terminate in furcae, tail shows a number of annulations on its surface, furcae larger than tail-stem and body, leaf like furcae end in sharp points, furcae with few scattered spines at base.

Sporocyst long, thread like; about 2.50-3.00 long; walls constricted in between masses of germ cells; shows worm like movements; anterior end produced into a snout which bears a birth pore guarded by two lips; unmaturred sporocyst whitish in colour and when matured yellowish in colour.

Snail Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Kota, Raipur (M. P.).

48. *Cercaria kukrailensis* Thapar (Fig. 47. A-C)

1969. *Cercaria kukrailensis* Thapar, *Indian J. Helm.*, **XXI**(2) : 131-135.

Diagnosis : Cercariae active, move in water by lashing movement of tail, they can move backward, at bottom of container they show looping caterpillar like movement; body highly contractile, in fixed conditon it measures 0.26-0.3 × 0.13-0.15; tail-stem measures 0.26-0.35 in length, furcal rami nearly as long as tail-stem and measure 0.26-0.29 in length; body oval to pyriform, flattened dorsoventrally; tail-stem provided with circular and longitudinal muscles and made up of parenchymatous tissue, cells with rounded nuclei, furcal rami flattended from side to side and bear finfolds which appear to possess finrays, at distal ends of rami finfolds become continuous and join each other, rami not distinctly constricted off from tail-stem; oral sucker situated at anterior end of body, rounded in shape, measures 0.06-0.04 in diameter, protrusible, anterior surface armed with a few circular rows of small spines; ventral sucker present on ventral surface of body at about 2/3 body length from anterior end; mouth opening small, subterminal; prepharynx small; pharynx well developed; oesophagus wide bifurcates into two caeca at about third body length; caeca well developed, conspicuous, developed into a number of loops in their course, terminate in front of excretory bladder; penetration glands three pairs present within anterior sucker, two other sets present behind oral sucker, one set consists of mass of gland cells situated on posterolateral sides of anterior sucker and may extend upto ventral sucker, second set consists of 2-4 pairs of cells situated on either side of pharynx, ducts of all sets pass forwards laterally to anterior sucker and open at snout, piercing spines absent; genital rudiments represented by a mass of cells situated in front of excretory bladder and between terminal portions of caeca, pyramidal in shape; excretory bladder trifoliate, situated at posterior end of body, antero-lateral margin of bladder four main excretory vessels—two on each side—arise and pass forwards, outer pair runs on outer lateral side of caeca while inner pair lies on inner side of caeca, inner pair of excretory ducts join each other in front of ventral sucker and then a common duct runs forward upto level of bifurcation just behind oesophagus then it again divides into two transverse ducts—one on each side which join outer pair of vessels by transverse loops, outer pair of excretory ducts run outside caeca upto bifurcation of oesophagus and then divides

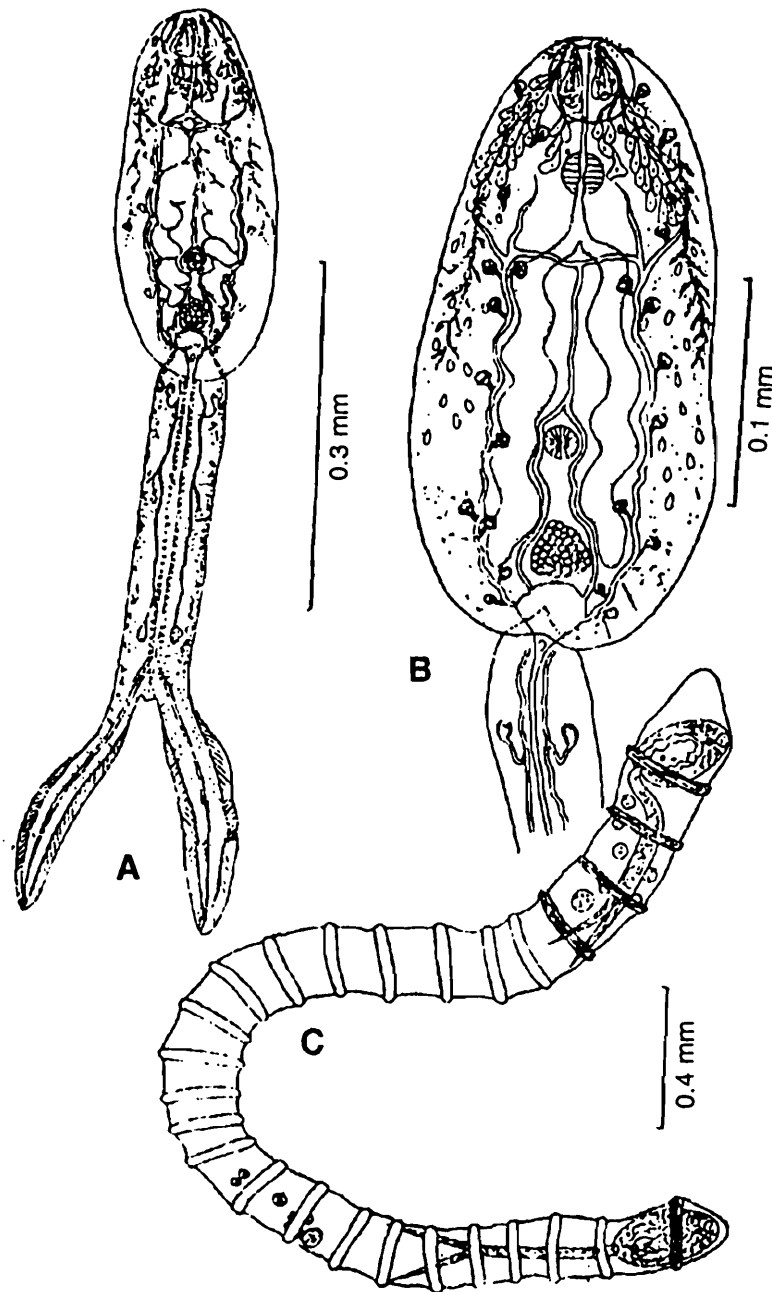


Fig. 47. A & B. *Cercaria kukrailensis* Thapar, 1969. C. Sporocyst of *C. Kukrailensis* Thapar, 1969 (After Thaper, 1969).

again into two branches that run forwards as far as penetration gland cells, twelve flame cells present on either side of body along lateral excretory ducts, a pair of narrow tubules passing down into tail-stem and bear three pairs of flame cells along their course, first pair of flame cells situated near base of tail-stem, second pair at about middle of tail-stem and third pair posterior end of stem, flame cell formula represented by $2 [12 + (3)] = 30$, anterior flame cell in tail-stem directed forwards and posterior two pairs directed backwards, a caudal excretory canal arises from posterior end of bladder and runs through entire length of tail-stem and divides distally into two branches each going into furcal ramus and to open at its tip.

Sporocyst measures 3.5-3.9 in length; shows movements; body wall shows a series of annular thickenings; minute birth pore present at one end; body full of cercariae and with a few masses of parenchymatous cells.

Host : *Melanoides tuberculatus*.

Locality : Kukrail stream, Lucknow.

49. *Cercaria kukrailensis* I Bhatnagar and Saxena
(Fig. 48. A-C)

1982. *Cercaria kukrailensis* I Bhatnagar and Saxena, *Helminth.*, **19** : 219-225.

Diagnosis : Cercariae emerge in forenoon, maximum liberate in morning hours, cercaria swims actively with its folded caudal furcae directed forward, occasionally it comes to rest either at surface of water and hangs vertically down with diverged furcal rami or sink at bottom of container where it crawls with help of fore part of its body and ventral sucker, when exhausted it settles down at bottom and tail gets detached and finally it dies; cercaria positive phototropic; body spinose; spoon-shaped, narrow anterior end and broad posterior end; body measures 0.24-0.28 × 0.11-0.15; body spines minute and gradually decrease in size posteriorly; oral organ dome shaped, posteriorly bounded by thick sheath, measures 0.06-0.07 × 0.06-0.06, it protrudes and retracts within its sheath, when well-protruded it demarcated by a basal constriction from body proper; anterior third of oral organ besets with several circlets of spines, these spines more prominent and larger than of body spines; ventral sucker discoid with a ring of about 48 spines, arranged around its central cavity; tail longifurcate with spinose furcal rami; tail-stem about double length of body with a bulbous enlargement at its middle, measures 0.35-0.50 × 0.14-0.23, furcae measure 0.26-0.35 × 0.06-0.08, distal halves of furcae lanceolate with a pair of minute filaments at tips; mouth terminal; prepharynx long and narrow, traversing through oral organ and emerges as a short tube; pharynx measures 0.01-0.01 in diameter; oesophagus long, measures 0.04-0.05 in length, bifurcates into caeca in middle third of body shortly in front of ventral sucker; caeca extend back upto a short distance of excretory bladder, each caecum with five tandemly arranged elongated cells, each of which contains a mass of finely granular cytoplasm and a nucleus located at distal end; penetration glands five pairs, pear shaped, cytoplasm coarsely granular with a nucleus, glands located in intercaecal field in middle third of body, of five pairs—one pair anterior to another pair lateral to and remaining three pairs postero-lateral and posterior to ventral sucker, ducts of these glands run together anteriorly on each side in a bundle, these ducts on reaching to pharyngeal level curve around pharynx and enter into oral organ through sheath of oral organ wherein components dilate and appear bow-shaped, individual ducts of each bundle separate and open by orifices at sides of mouth on surface of oral organ; excretory bladder bicornuate, each cornu continued anteriorly into main excretory canal, caudal excretory canal originates from hind part of excretory bladder, main excretory canals run anteriorly as ascending limbs almost

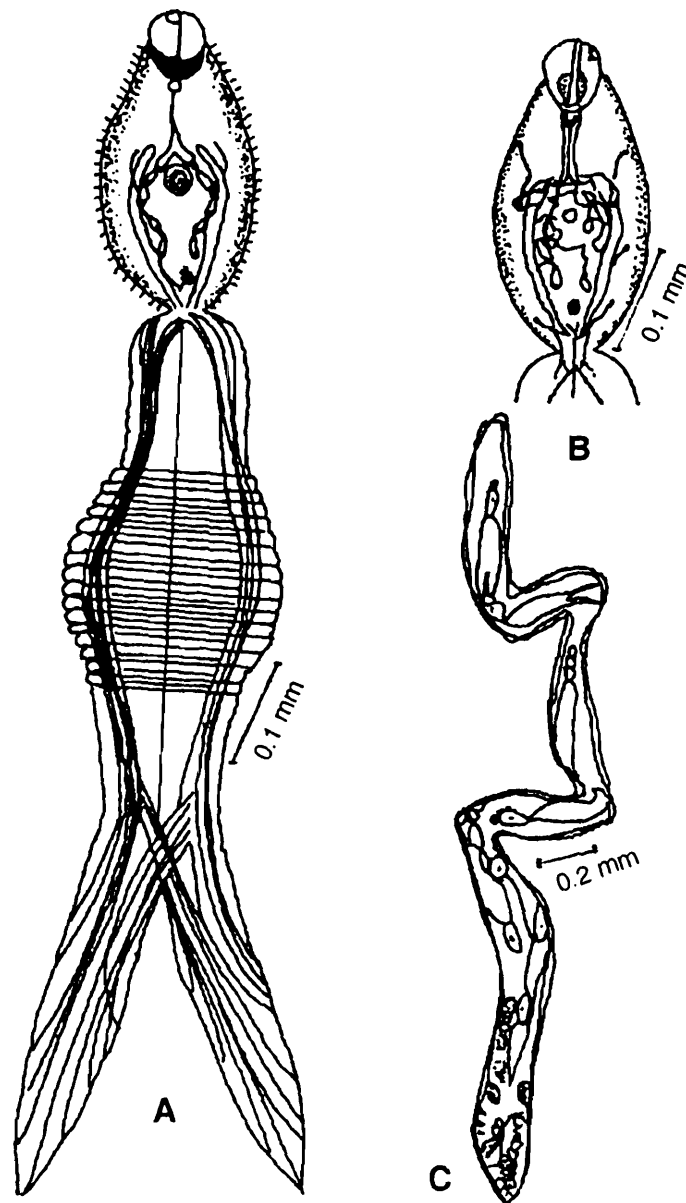


Fig. 48. A & B. *Cercaria kukrailensis* I Bhatnagar and Sakena, 1982. C. Sporocyst of *C. kukrailensis* I Bhatnagar and Sakena, 1982. (After Bhatnagar and Sakena, 1982).

upto oesophageal bifurcation from where they recurve and run backwards as descending limbs upto level of ventral sucker where each bifurcates into an anterior and posterior collecting canals, anterior collecting canal short and terminates near about oesophageal bifurcation while posterior collecting canal long and runs backward along outer border of main excretory canal of its side upto hind end of body where from it enters tail-stem and terminates at its basal part, flame cells 10 in numbers, bilaterally arranged on each side of body, two pairs of flame cells communicate with anterior collecting canal and three pairs with posterior collecting canal, one pair of the posterior canal located in basal part of tail-stem, flame cell formula represented by $2 [(2+2) + (2+2) + 2] = 20$, main excretory canals interconnected by transverse commissures at two points—one in front of and other behind ventral sucker and termed as anterior and

posterior transverse commisures, caudal excretory canal runs down through middle of tail-stem and terminally subdivided at distal end of tail-stem, they enter into caudal furcae and run to about middle distance of furcae and open outside by excretory pores located dorsally; a mass of cells representing genital rudiment located between caecal terminations and excretory bladder; in tail-stem two thick bundles of muscle fibres run lengthwise—one on each side from base to distal end of tail-stem where dorsal and ventral moieties of each bundle separate, one moiety runs down furca of same side while second one crosses over to and runs through other furca thus two half bundles of muscle fibres run through each furca and some run upto furcal end while others stop short and terminates at lateral borders of furca, fibres of each bundle elongated and bipolar and with a nucleus, cuticle of tail-stem and furcae provided with series of uniformly spaced annular striations and striations of tail-stem more widely spaced than those of caudal furcae, another series of equally spaced bundles of circular muscle fibres confined to field between bundles of longitudinal muscle fibres located in tail-stem.

Sporocyst long, columnar; measures $3.43-4.50 \times 0.08-0.25$; cuticle thin; germ cells located at hind end and may form clusters or found as individual, germ balls and cercariae indifferent stages of development also exist; well formed cercariae varies from 6-11.

Snail Host : *Indoplanorbis exustus*.

Location : Digestive gland.

Locality : Kukrail river, Lucknow (U. P.).

50. *Cercaria kumari* Singh (Fig. 49. A-C)

1955. *Cercaria kumari* Singh, *Proc. Nat. Acad. Sci. India*, 25(B) I-II : 18-22.

Diagnosis : Cercariae emerge in large numbers, they remain suspended for some time but soon they start swimming, during period of rest tail-stem bent so that body and first fourth tail-stem form an angle with rest of tail while furcae held at about 60° to tail-stem, cercariae swim both backward and forward with vibration of body and tail, they swim on their long axis so they take a spiral course and can swim in any direction; in living body of cercaria exhibits six annulations beginning from behind oral sucker and extending upto anterior margin of ventral sucker; small posterior directed spines cover anterior portions of body upto half level of anterior penetration organ except at extreme tip which covered with circumoral spineless area; behind these body spines arranged in definite rows extending upto posterior end, terminal row being at level of excretory bladder, each row composed of smaller spines than those of anterior end; in fixed specimens body measures $0.23-0.26$ (0.25) \times $0.05-0.06$ (0.06); tail-stem measures $0.30-0.33$ (0.32) \times $0.03-0.04$ (0.03), furcae measure $0.30-0.33$ (0.32); anterior organ oval, larger than ventral sucker, measures $0.06-0.07$ (0.06) \times

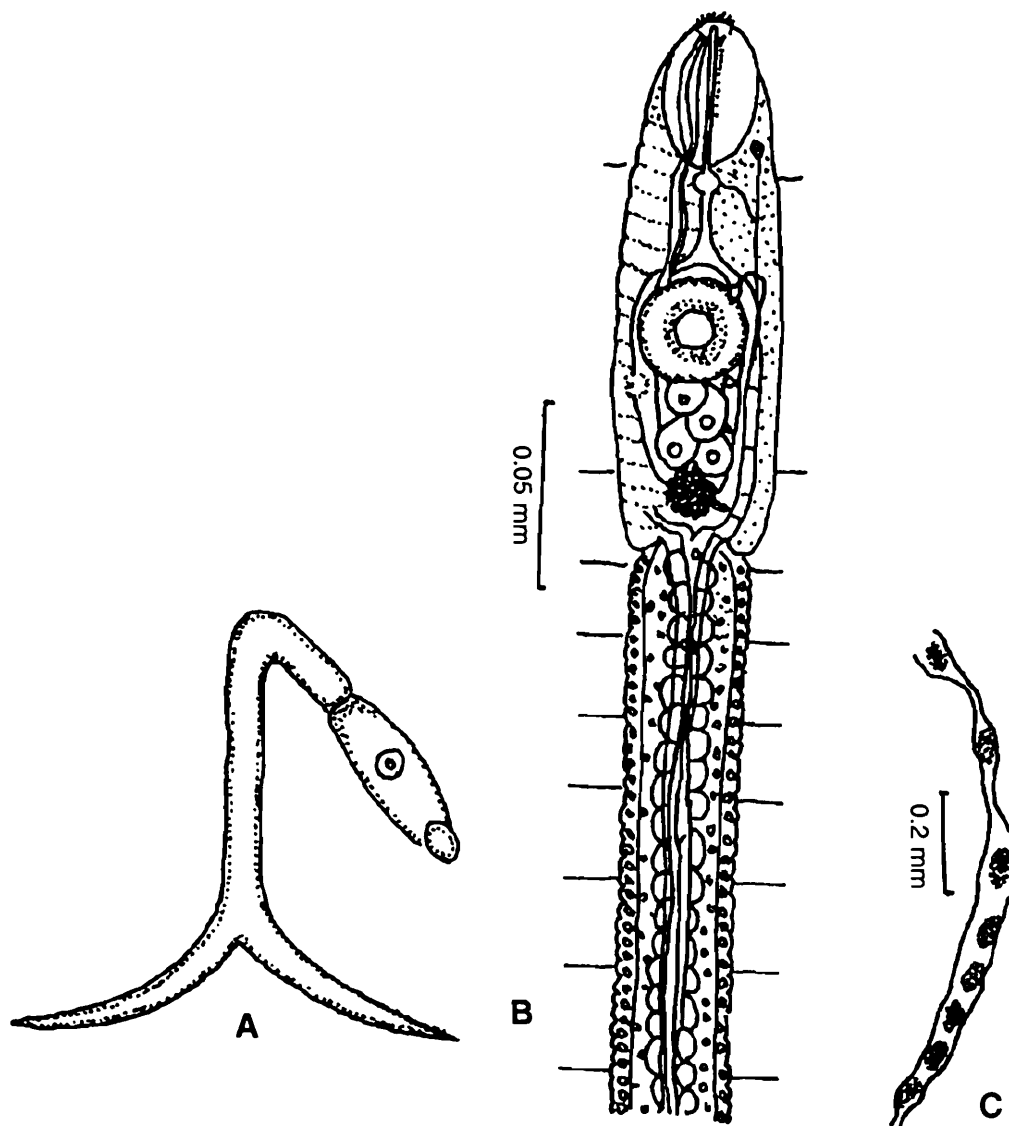


Fig. 49. A & B. *Cercaria kumari* Singh, 1955. C. Sporocyst of *C. kumari* Singh, 1955. (After Singh, 1955).

0.03-0.05 (0.04); digestive system well developed; pharynx well developed, globular; oesophagus long; intestinal caeca prominent, reaching almost to posterior end of body; ventral sucker with circular opening, three rows of spines present on its surface, measures 0.05-0.05 (0.05) in diameter; penetration glands four in number, situated posterior to ventral sucker, ducts pass anteriorly through oral sucker and to open in groups of two at each lateral margin of circumoral spineless area; a compact mass of small cells representing genital rudiments situated posterior to penetration glands; tail longer and slightly narrower than body, provided with 20 pairs of small caudal bodies attached to its central core by fine strands of tissue; surface of tail-stem very finely annulated and bears 7-8 sensory hairs; such hairs two on each side present on body also; furcae as long as tail and bear fine spines at their base; bipartite excretory bladder with an 'Island of cort' present at most posterior part of body, body with six

pairs of flame cells—three pairs in anterior and three pairs in posterior part, two flame cells present well back in tail-stem and situated on each side of caudal excretory duct, caudal excretory duct originates from bladder and runs through centre of tail-stem and bifurcates at level of furcae and each branch runs through each furca to open by a minute pore in middle of furca.

Sporocyst long, slender, thread-like; about uniform in width; anterior end with a snout; birth pore located a little behind snout; brown and orange pigments present.

Snail Host : *Lymnaea luteola* f. *australis*.

Locality : Rithaian village, Allahabad.

51. *Cercaria kumaunensis* Singh and Malaki
(Fig. 50. A-C)

1963. *Cercaria kumaunensis* Singh and Malaki, *Indian J. Helm.*, XV(1) : 62-68.

Diagnosis : Cercariae hang in water with anterior end down and tail slightly curved and turned upwards with furcal rami stretched out, cercariae gradually sink, they swim actively, move in a straight line either vertically upwards or at an angle, on substratum cercaria moves by crawling movement by means of oral sucker and hold fast organ, ventral sucker acts as pivot; cercaria flat, spoon-shaped, translucent; body measures 0.23-0.47 (0.29) × 0.12-0.24 (0.17); oral sucker measures 0.04-0.07 (0.05) in diameter; pharynx measures 0.02-0.04 (0.02) in diameter; ventral sucker measures 0.02-0.03 (0.02) in diameter; tail-stem measures 0.35-0.42 (0.39) × 0.06-0.10 (0.07), ramus measures 0.21-0.36 (0.30) × 0.03-0.07 (0.04), tail-stem stout, longer than body, furcal rami long, lancet-shaped, dorso-ventrally flat, tail-stem show considerable contraction and extension, rami provided with small spines; penetration organ formed by well developed and muscular oral sucker; oral sucker with large number of uninucleated gland cells; anterior end with conical, protrusible, refractile snout which bears a crown of small piercing spines at tip, spines in 7-8 rows, hollow, directed anteriorly or posteriorly, rest of spines present in transverse rows, solid and small in size, directed posteriorly; whole body and caudal stem covered with numerous small, backwardly directed spines, set in transverse rows, provided with large number of sensory hairs inserted into papillae distributed all over body surface; mouth opens terminally; pharynx well developed, muscular; oesophagus short, forms coil in living specimen; caeca muscular, extend upto posterior end of body; ventral sucker oval, situated in posterior mid-part of body anterior to excretory vesicle; holdfast organ present in front of ventral sucker, smaller than ventral sucker, transversely elongated, beset with numerous small spines; excretory vesicle trilobed, main anterior ducts four in numbers—two median ones between caeca uniting anterior to ventral sucker to form a median duct which connects with lateral ducts by short ducts at level of oesophagus, lateral main ducts run anteriorly as sinuous tubes and lateral to caeca and in region of oesophagus bifurcation receive ducts from median longitudinal duct,

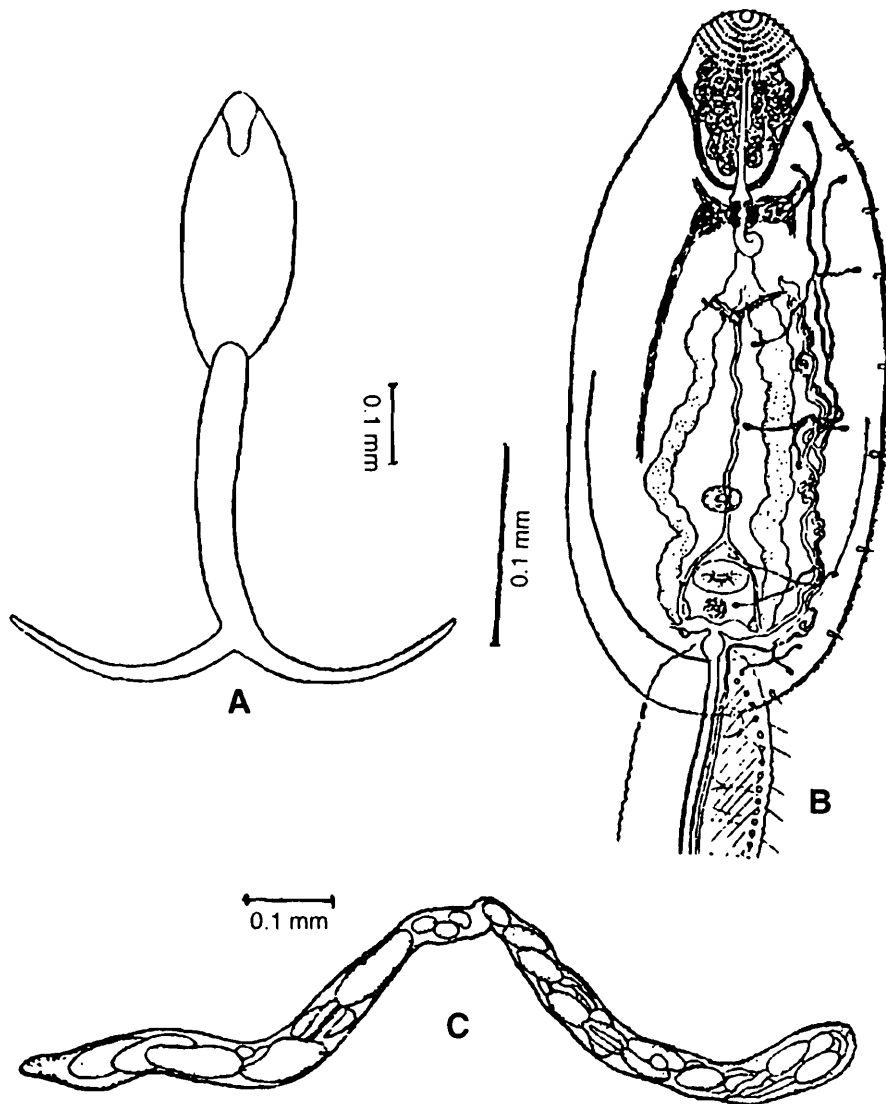


Fig. 50. A & B. *Cercaria kumaunensis* Singh and Malaki, 1963. C. Sporocyst of *C. kumaunensis* Singh and Malaki, 1963. (After Singh and Malaki, 1963).

ducts then descend as sinuous tubes along length of ascending limbs till reach mid body where they divide into anterior and posterior collecting ducts, anterior collecting duct runs forward for a short distance when it gives off a small duct which ends in three flame cells in mid body, after a short distance duct divides into two equally wide duct—one ending in three flame cells present in oesophageal area and other running forward to end in three flame cells in pharyngeal area, posterior collecting duct runs posteriorly along length of ascending limb and gives off a small duct which ends in three flame cells in region of ventral sucker and then runs for a short distance to give off another small duct which ends in three flame cells in posterior part of body by side of tail attachment, posterior collecting ducts enter tail-stem and passing close to excretory vesicle, duct then gives off a flame cell which directed anteriorly and two flame cells which directed posteriorly, caudal flame cells present in mid region and flame cells of two sides never present at same level, caudal duct runs through stem

and divides into two ducts passing through tip, flame cell formula represented by 2 [(3+3+3) + (3+3) + (3)] = 36, 15 pairs in body and 3 pairs in tail; genital primordium situated behind ventral sucker and dorsally placed; nervous system with a pair of ganglia, situated laterally on either side of pharynx, connected by transverse band of nervous tissue, each ganglion gives off nerve bands anteriorly and posteriorly extending as far back as level of hold-fast organ; tail-stem muscular, with a large number of uninucleate cells arranged laterally along sides of caudal stem, sensory hair like processes present.

Sporocyst long, cylindrical, thin wall; birth pore at one end; measures 2.14-4.49 (3.25) × 0.12-0.24 (0.18); contains 10-12 cercariae in various stages of development; some times show brood chambers; numerous germ cells present.

Snail Host : *Viviparus bengalensis*.

Location : Digestive gland and body space.

Locality : Garur and Baijnath villages, Almora district, U. P.

52. *Cercaria longicaudata* Singh

(Fig. 51. A-C)

1953. *Cercaria longicaudata* Singh, *Allahabad Univ. Stud.*, : 56-59.

Diagnosis : Cercariae hang in water with anterior part of body bent ventral in form of hook, tail-stem performs an active part in locomotion, sinking cercariae shoot upwards with wriggling movement to regain original position, under coverslip pressure larva occasionally opens furcae with extension of body, body contracts and expands regularly; body elongate, cylindrical; tail-stem and furcae of about equal length; body, tail-stem and furcae measures 0.13, 0.24 and 0.22 respectively; body annulations present; body in fixed specimen measures 0.12-0.17 (0.14) × 0.04-0.05 (0.05); tail-stem measures 0.21-0.23 (0.22) × 0.04-0.05 (0.04), furcae measure 0.21-0.23 (0.22) in length; anterior penetration organ oval in shape, measures 0.03-0.04 × 0.02-0.03, anterior end with circumoral spineless area with a clump of 10-12 forwardly pointing spines; body spines limited, extend back upto half level of penetration organ, spines absent from rest of body, tail-stem and furcae; tail-stem long, uniformly wide, fine annulation present, rows of nuclei present along margins, central part consists of parenchymatous cells and stands of longitudinal muscle fibres, sensory hairs about 14 in number present on either side; furcae as long as tail-stem and not constricted at base; bucal cavity followed by short, narrow prepharynx; globular, poorly developed pharynx; caecum unbranched, short; a pair of unpigmented eye spots present at about middle of body, located in front of penetration gland cells; penetration glands six in number, arranged in rows of three, anterior pair separated from posterior two pairs by ventral sucker, ducts of these glands run anteriorly in between eye spots and enter penetration organ; inside organ ducts become wide and open on sides of oral opening; ventral sucker small than anterior organ, situated a little behind middle of body and between anterior pair and posterior two pairs of penetration gland cells, circular in shape and measures 0.02 in diameter

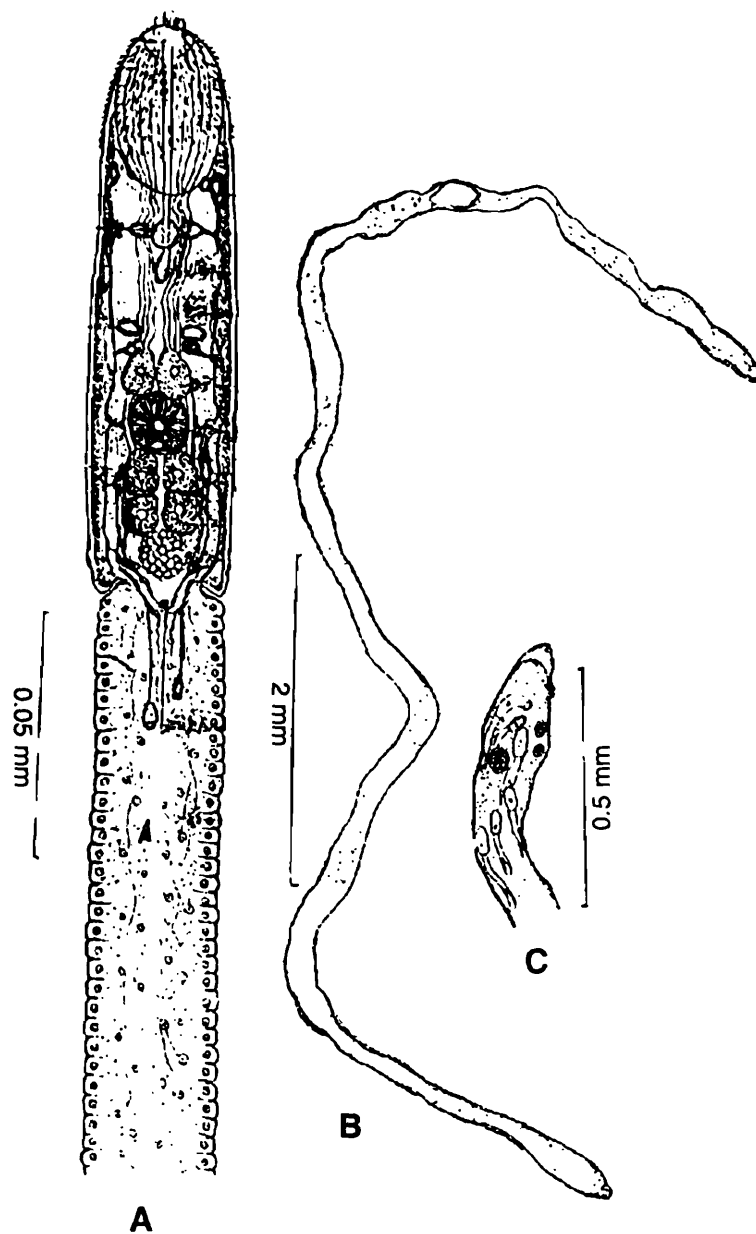


Fig. 51. A. *Cercaria longicaudata* Singh, 1953. B & C. Sporocyst of *C. longicaudata* Singh, 1953. (After Singh, 1953).

in fixed condition, excretory bladder tripartite, from its antero-lateral lobes arise two main collecting ducts, these ducts divide into anterior and posterior collecting tubules at level of ventral sucker, anterior collecting tubule receives three pairs of flame cells and posterior tubule after receiving two pairs of flame cells end in two flame cells in tail-stem, flame cells in tail-stem situated at about middle level and larger than those in body, caudal excretory canal originates from posterior end of bladder through an 'Islet aperture' and runs upto distal end of tail-stem to bifurcate into two branches which run to furcae and open in middle on outer margin of each furca; small mass of rounded cells situated in front of excretory bladder in between arms of main excretory collecting ducts represent genital primordium.

Sporocysts long, thread like; remain entangled in tissue of snail host; anterior end projects outside host tissue and shows worm-like movements; body shows constrictions in between groups of germ balls; birth pore situated at anterior end and guarded by two lips; sporocyst measures 2.50-4.70 in length.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Sobatiabagh tank, Allahabad, U. P.

53. *Cercaria mathpurensis* Shrivastava
(Fig. 52. A & B)

1958. *Cercaria mathpurensis* Shrivastava, *Indian J. Helm.*, X(2) : 91-96.

Diagnosis : Cercariae come out from snail host in large numbers, swim actively by lashing movement of tail and furcae, during resting stage larva hangs motionless with head downwards, period of rest longer than period of swimming, after rest furcae suddenly flip rapidly and larva shoots upwards in water, at rest tail-stem

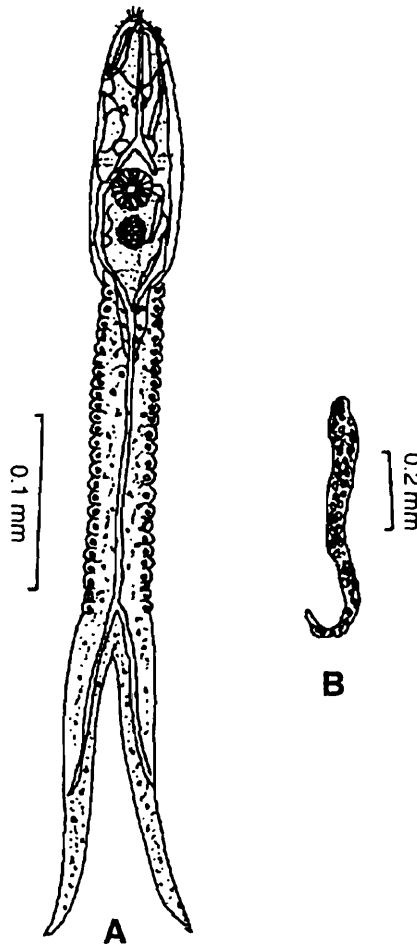


Fig. 52. A. *Cercaria mathpurensis* Shrivastava, 1958. B. Sporocyst of *C. mathpurensis* Shrivastava, 1958. (After Shrivastava, 1958).

remains extended and furcae diverged at an angle of about 60 degrees of tail-stem, under cover glass pressure cercaria progresses forward by alternate use of ventral sucker and anterior penetration organ; small body filled with numerous granular parenchymatous cells, body showing a great degree of extension and contraction, body larger than tail-stem; tail-stem equal to length of furcae; body measures 0.08-0.10 (0.10) × 0.05-0.06 (0.05) in living and 0.08-0.10 (0.08) × 0.02-0.05 (0.04) in fixed conditions; tail-stem measures 0.14-0.16 (0.15) × 0.03-0.03 (0.03) in living and 0.13-0.14 (0.14) × 0.02-0.03 (0.03) in fixed conditions, furcae measure 0.15-0.16 (0.15) × 0.01 in living and in fixed condition measure 0.13-0.15 (0.14) in length; anterior penetration organ measures 0.03 in breadth, anterior half covered with thick spines, posteriorly spines gradually thin out and beyond level of ventral sucker only few spines present; ventral sucker smaller than anterior organ, muscular, circular in outline, measures 0.02 in diameter, surface covered with two rows of spines pointing centrally; tail-stem long, cylindrical without caudal bodies, capable of expanding and contracting, furcae leaf like almost equal in length to tail-stem and end in sharp points, more transparent than body and tail-stem, few scattered spines on bases; coarsely granular penetration glands four in number, situated in front of ventral sucker and intestinal fork and proportionately smaller, ducts of these glands open on either side of oral opening in a circumoral spineless area; in front of ventral sucker lies a pair of small unpigmented oval eye spots; mouth subterminal and lined by a cuticular thickening; prepharynx small; pharynx globular; oesophagus long which divides into two intestinal caeca; caeca extend upto level of genital primordium; excretory system consists of small 'V' shaped bladder lying at junction of body and tail-stem, anterior aspect of bladder arises a pair of main collecting tubules which run anteriorly upto level of ventral sucker, each arm of bladder receives one anterior and one posterior collecting tubule, anterior collecting tubule of each side receives three capillaries each capped with a flame cell, posterior branch connected with four capillaries from four flame cells—two in posterior region of body and two in tail, flame cell formula represented by 2 [(3+2+ (2))] = 14; genital primordium represented by a mass of small rounded cells, situated between excretory bladder and ventral sucker.

Sporocyst long, filiform; shows worm like movements; filled with cercariae in various stages of development and germ balls; wall consists of a single layer of epithelial cells covered by a very thin transparent cuticle; measures 1.23-2.19 × 0.05-0.06.

Snail Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Mathpurena tank, Raipur (M.P.).

54. *Cercaria mudaliari* Peter

(Fig. 53. A)

Diagnosis : Cercariae negative phototropic, move upwards with tail in advance and body being pulled behind in short dashes, remain suspended in water with tail up and furcal rami spread out, acting as a float, on slides they crawl with help of ventral sucker, they remain suspended in water with relaxed body and tail; shape of body variable depending on amount of contraction and extension, in relaxed condition

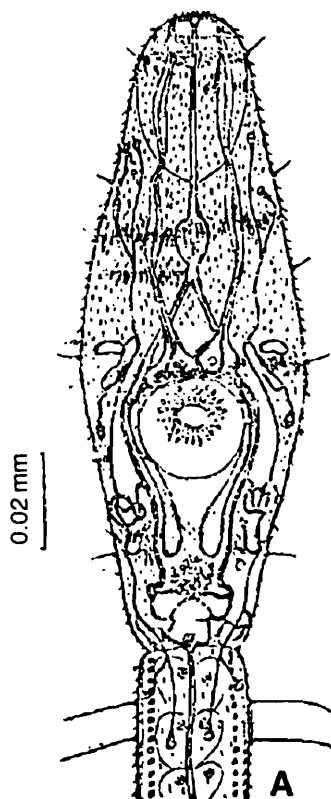


Fig. 53. A. *Cercaria mudaliari* Peter, 1955. (After Peter, 1955)

body spindle shaped with greatest width at anterior to ventral sucker and two narrow extremities, anterior end bluntly rounded and posterior truncated, body in fully elongated acquiring a width almost that of tail-stem, during contraction it assumes an oval or globular shape; anterior end with protrusible snout capable of being pushed out and drawn in; tail-stem attached to posterior end of body, cylindrical and when contracted its cuticle thrown into a number of wrinkles, rami not delimited from tail-stem, rami broadly lanceolate in shape and end in sharp points, eight clear and thin walled caudal gland each a nucleus situated on either side of caudal excretory vessel, in live relaxed specimens furci nearly twice as long as tail-stem and tail-stem about two-thirds of length of body; in living condition body measures $130\mu \times 30\mu$ and when killed it measures $157\mu \times 38\mu$; tail-stem in living condition measures $95\mu \times 23\mu$ and when killed it measures $109\mu \times 25\mu$, furca measures 173μ in living condition and 183μ in fixed condition; body

and tail spinose, body spines slightly larger and curved than those present on tail-stem and rami, spination heavy in region of anterior penetrating organ and arranged in transverse rows and closely set giving appearance of an oral hood or cap; dorsal border of mouth opening armed with two alternate rows of stumpy spines—eight anterior row of piercing spines and nine posterior spines; spineless area located between these and oral spinous cap; spines absent near ventral sucker; inner free margin of ventral sucker bordered with a fringe of spines arranged in two or three irregularly alternating rows, their shape and size differ from those of body spines, each spine with a triangular basal plate or handle on the base of which mounted a needle like terminal portion directed towards centre of cavity of sucker; fine bristle like hairs or setae present on body and tail-stem, those on body being shorter and lesser in number; five setae present on either side of body and each measuring 6.5μ in length while on tail-stem ten setae present on either side and arranged in pairs and each measures 16.5μ ; rami devoid of any setae; two pale yellow eye-spots situated on dorsal surface of body lateral to anterior limit of penetration glands, eye spots elliptical in shape with small notch on posterior border and measure about 7.5μ in horizontal plane; oral

sucker oval, not differentiated into an anterior and posterior region; mouth opening guarded by anterior piercing spines, mouth opening measures 10μ across; anterior organ measures $36\mu \times 24\mu$; ventral sucker highly muscular, situated at junction of middle and posterior third of body, measures 25μ in diameter, free edge provided with two to three rows of spines; narrow prepharynx traverses anterior penetrating organ; pharynx well developed, muscular, measures $6.5 \times 4.5\mu$; oesophagus short, divides at a point midway between two suckers; two intestinal caeca run outwards and backwards and dorsal to penetration glands, encircle lateral borders of ventral sucker, slightly converge behind sucker and then turn outwards and run posterior to end just a little beyond halfway between ventral sucker and excretory vesicle, caeca gradually become broader as they run backwards; penetration glands four in number, arranged in pairs on either side of median line in front of ventral sucker and bounded laterally by intestinal forks, in each pair outer one situated posterior and inner anterior, glands same size, contain finely granular protoplasm, ducts run in pairs on either side, at about level of caecal bifurcation duct of inner gland crosses outer one and comes to lie lateral to it, thereafter lumen of duct increases slightly, on reaching posterior border of anterior penetrating organ ducts get again constricted and then run as dilated tubes in anterior organ, open through paired pores situated lateral to mouth opening; excretory bladder situated at posterior extremity, globular in shape, slight constriction in middle, bladder opens out dorsally through a minute pore located at point of attachment of tail to body, on either side from antero-lateral aspect of bladder originates main excretory trunk with a bulbous origin, basal dilatations together with bladder assume a shape of triglobular—a characteristic of this cercaria, each main canal runs forward lateral to distal portion of caecum and forms at postero-lateral angle of ventral sucker a tangle from which arise anterior and posterior collecting tubules, transverse excretory tube or commissure connecting main canals situated anterior to ventral sucker, anterior collecting tubule runs forward and divides at level of eye spots into two branches, short branch traces its course backwards for a short distance to divide into two capillaries each capped with flame cell and located anterior and lateral to ventral sucker, other branch continues its course cephalad and divides into capillaries capped with two flame cells present at anterior region of body behind penetrating organ, posterior collecting tubule runs backwards and gives off two branches—one receiving capillaries from two flame cells situated behind tangled mass of main vessels and other from two cells located at posterior end of body near excretory bladder, backward continuation of posterior collecting tubule enters tail-stem and finally divides into two capillaries which end in flame cells in proximal part of tail, flame cells formula represented by $2 [(2+2) + (2+2) + 2] = 20$, caudal tube passes from excretory vesicle down tail-stem and divides at bifurcation of tail into two and after entering into furcal ramus open on inner margin about half of its length, 'Island of Cort' absent; a cluster of small cells occupying a position in median line anterior to bladder represents rudimentary genital organ.

Sporocyst white in colour, elongated in shape, slender in structure and appear as a mass of cotton wool; it measures 6.3 in length; bulges out at varying intervals

throughout its length and lumen varies from 0.08-0.50; bulgings caused by assemblage of number of mature cercariae which come out by bursting open extended sporocyst wall.

Snail Host : *Lymnaea luteola* f. *succinea*.

Location : Digestive gland.

Locality : Madras city.

55. *Cercaria quadradena* Singh
(Fig. 54. A-C)

1956. *Cercaria quadradena* Singh, *Proc. Nat. Acad. Sci. India.*, 26(B) : 239-242.

Diagnosis : Cercariae come out at any time of day, uniformly distributed and remain suspended in water, furcae held at 60° angles to tail-stem, body and tail hang

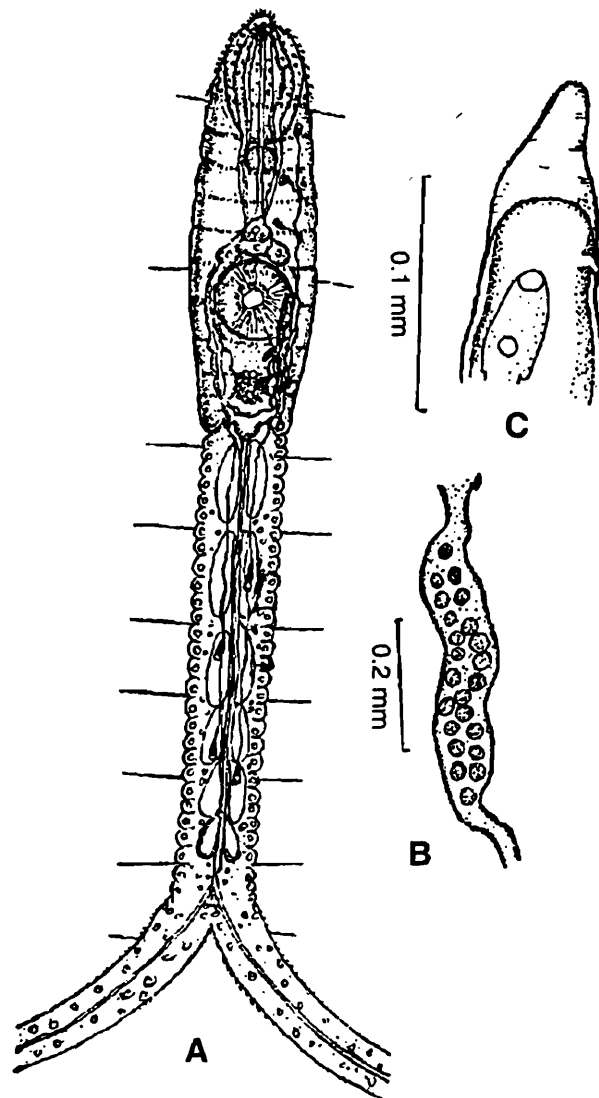


Fig. 54. A. *Cercaria quadradena* Singh, 1956. B & C. Sporocyst of *C. quadradena* Singh, 1956 (After Singh, 1956)

vertically, they swim with tail foremost and generally upward to regain position, cercariae often attach by ventral sucker to bottom of container and move by alternate use of anterior organ and ventral sucker aided by movement of tail; cercaria longifurcate, pharyngeal, distome; body of fixed cercaria measures 0.18-0.24 (0.23) × 0.03-0.05 (0.03); tail-stem measures 0.27-0.30 (0.27) × 0.03, furca measures 0.26-0.28 (0.26) in length; oral sucker measures 0.05-0.06 (0.06) × 0.03; ventral sucker measures 0.03; living cercariae vary greatly in size due to contraction and expansion of body; body elongate, widest in region of ventral sucker, tapering slightly at ends; oral sucker oval to pyriform in shape; pharynx small, globular, placed at posterior margin of oral sucker; oesophagus long, narrow; intestinal caeca wide, terminate behind ventral sucker in three antequous parts; eye spots absent; ventral sucker slightly posterior to middle of body, bears two rows of short spines on its surface; spines in circumoral spineless area absent; body spines in definite rows except at anterior end; tail-stem contains six pairs of elongate, oval caudal bodies supported by strands of connective tissue; seven long hair like processes present on each side of tail, fine spines present at base of each furca; penetration glands four in number, smaller in size, located in front of ventral sucker above bifurcation of caeca, glands of first pair situated one behind other and those of second pair placed laterally to ventral sucker; excretory bladder located posteriorly, body contains six pairs of flame cells and tail two pairs; genital primordium situated posterior end of body and just anterior to excretory bladder and consists of large mass of cells.

Sporocyst long, nearly uniform in diameter; constrictions present at long intervals; filled with germ balls and cercariae; anterior end with snout and bears a birth pore guarded by two lips; sporocyst measures about 3-5 × 0.02-0.10.

Snail Host : *Lymnaea luteola*.

Locality : Rithaian village, Allahabad.

56. *Cercaria quadriglandula* Premvati (Fig. 55. A-C)

1953. *Cercaria quadriglandula* Premvati, *Proc. Nat. Acad. Sci. India.*, 23,B (I-III) : 34-38.

Diagnosis : Cercaria active, moving rapidly in water with its tail bent and placed parallel to body, it also shows round and round movements, during rest body remains suspended with its tail directed upwards; cercaria elliptical, tapering anterior end and broad truncated posterior end; body measures 0.15-0.30 × 0.06-0.08; tail-stem measures 0.22 in length, furcal rami measures 0.17-0.25 in length; body covered with transverse rows of backwardly directed spines; anterior pear-shaped protrusible organ measures 0.37 × 0.02; ventral sucker lies little behind middle of body, smaller than anterior protrusible organ, measures 0.02 in diameter, surface armed with double row of spines; eye spots absent; penetration glands two pairs with clear nuclei, glands slightly lobed, granular, surround ventral sucker, one pair lying anterior and other pair posterior to

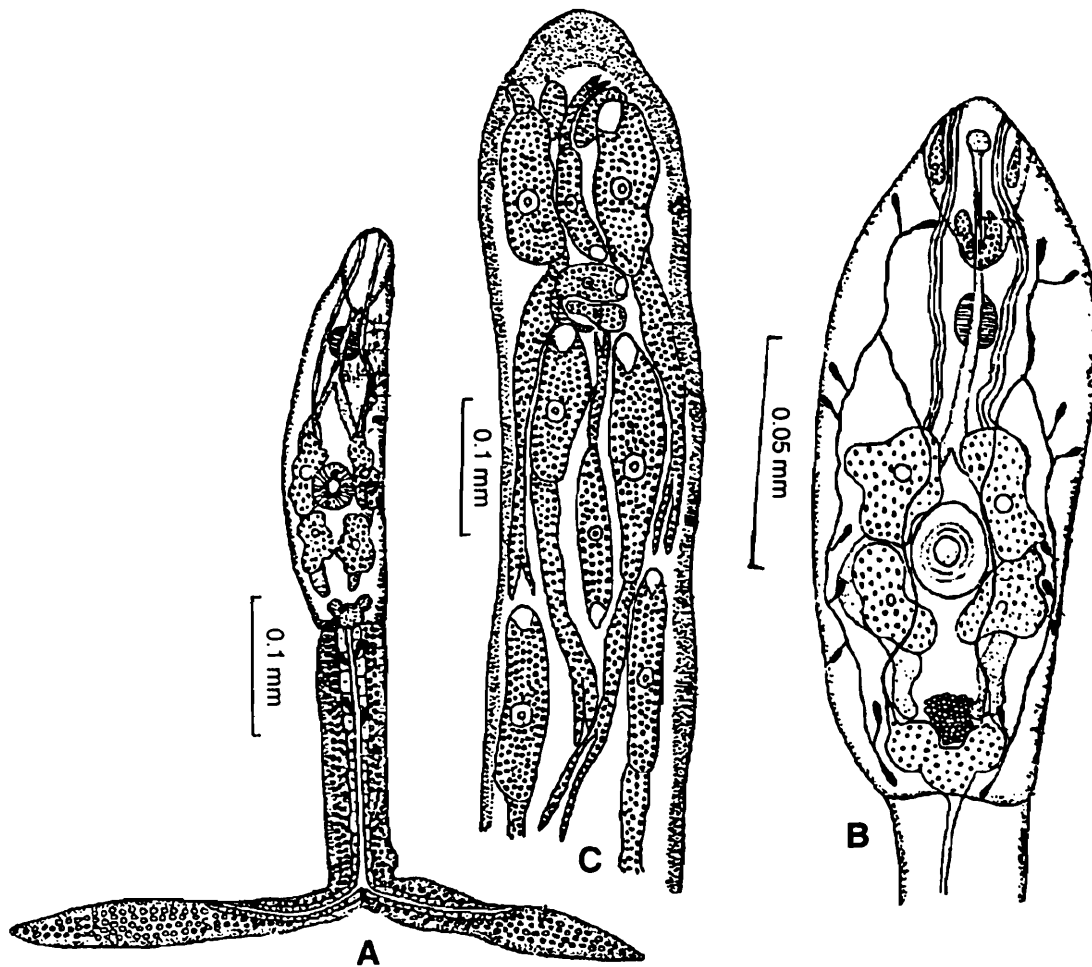


Fig. 55. A & B. *Cercaria quadriglandula* Premvati, 1953. C. Sporocyst of *C. quadriglandula* Premvati, 1953 (After Premvati, 1953).

ventral sucker, a duct arises from each gland and ducts run forward in convoluted manner over anterior protrusible organ to open separately on each side at anterior part of body; within protrusible organ lies two pairs of granular head glands, one pair situated at anterior lateral margin and other pair at posterior conical end of protrusible organ; mouth opening subterminally; prepharynx narrow greatly elongated; pharynx globular and muscular; oesophagus elongated, extending posteriorly upto level of anterior pair of penetration glands, it bifurcates into two intestinal caeca; caeca extend posteriorly and terminate in front of excretory bladder; tail-stem attached to posterior margin of body, a row of caudal cells present on each side along caudal excretory canal, lanceolate shape long furcal rami without fin-folds, tail-stem and furcal rami covered with spines; excretory bladder at posterior end of body, it appears as three large rounded lobes in extended condition, middle lobe opens posteriorly into caudal excretory canal, each anterior lateral lobe gives out a main excretory canal and extends up to level of oesophagus where it receives two collecting canals—an anterior and a posterior, anterior collecting canal of each side receives two small capillaries each tipped with a flame cell at level of anterior protrusible organ, posterior collecting canal of each side receives

seven small capillaries each tipped with a flame cell, tail-stem shows two pairs of flame cells, caudal excretory canal passes along tail-stem up to beginning of furcal bifurcation where it divides into two branches which run to furcal rami for about half their length and open to exterior on outer lateral margin; rudimentary reproductive cells situated in front of excretory bladder.

Sporocyst tubular, measures 3.00 in length and 0.12 in diameter; birth pore lies just by side of anterior end; each sporocyst contains mass of germ balls at posterior end and a large number of cercariae in various stages of development.

Snail host : *Melanoides tuberculatus*.

Locality : Lucknow.

57. *Cercaria rajai* Shrivastava
(Fig. 56. A & B)

1958. *Cercaria rajai* Shrivastava, *Indian J. Helm.*, X(2) : 87-91.

Diagnosis : *Cercaria* small, longifurcate, pharyngeate, swim freely in water by lashing movements of tail-stem and flapping of furcae, during rest cercariae hang with head downwards and furcae diverged apart and they gradually sink to bottom of container, under cover slip pressure cercariae crawl with help of ventral sucker and protrusible organ; small flexible body filled with parenchymatous cells, shows considerable degree of extension and contraction; body measures 0.11-0.12 (0.11) × 0.02-0.05 (0.05) in living condition and 0.09-0.10 (0.10) × 0.04-0.05 (0.05) in fixed condition; tail-stem measures 0.14-0.16 (0.15) × 0.03-0.03 (0.03) in living and 0.14-0.15 (0.14) × 0.02-0.03 (0.03) in fixed conditions, furcal length measures 0.15-0.16 (0.16) in living and 0.14-0.16 (0.15) in fixed conditions; body elongated with round narrow anterior end and subquadrate posterior end; anterior end covered with conspicuously large spines, posteriorly body spines thinner and smaller upto level of ventral sucker and beyond that only few spines present; eye spots small, unpigmented, situated in front of penetration glands; anterior penetration organ measures 0.02-0.03 (0.02) × 0.02, oval in shape, ventral sucker large, muscular, circular in shape, measures 0.02 in diameter, surface of ventral sucker armed with spines, ventral sucker spines larger than those of body and arranged in a single row encircling cavity; mouth subterminal; prepharynx short; pharynx well developed muscular, 0.02 in length; oesophagus short divides into two intestinal caeca which extend beyond ventral sucker; four nucleated coarsely granular penetration gland cells, two on each side, lie between ventral sucker and intestinal bifurcation, these glands open to exterior through ducts which run anteriorly and open near mouth, under coverslip pressure a mass of slimy liquid comes out from these glands; a mass of cells represent germinal cells situated posterior to ventral sucker and in front of excretory bladder; tail-stem attached to terminal part of body, surface nuclei present in tail-stem and furcae, caudal bodies absent loose muscle bands extend throughout length of tail and furcae; furcae bear minute spines

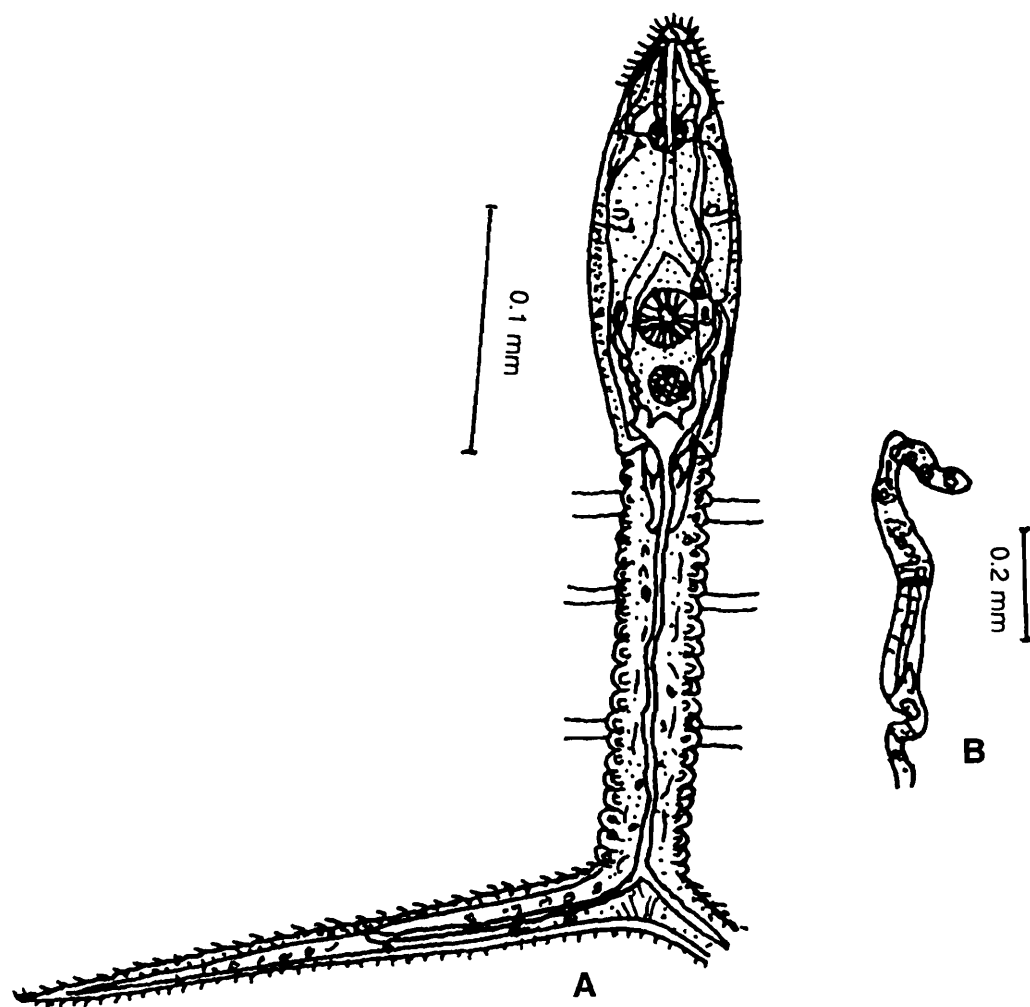


Fig. 56. A. *Cercaria rajai* Shrivastava, 1958. B. Sporocyst of *C. rajai*, Shrivastava 1958 (after Shrivastava, 1958);

at base and end in sharp points, excretory bladder 'V' shape with three chambers, a small 'Island of Cort' present, main excretory ducts originate as elongations of antero-lateral arms of bladder, each arm runs anteriorly upto level of ventral sucker and then divides into two—one running anteriorly and other posteriorly, anterior duct of each side ends in two capillaries each capped with flame cell, branches of posterior tubule end in three flame cells one in posterior region of body and two in tail-stem, a single median canal originates from posterior end of bladder runs along longitudinal axis of tail-stem and divides near tail fork, each branch extends through half distance of furca before opening at its lateral border.

Sporocysts yellow, thread like; filled with germ balls and cercariae in different stages of development.

Snail Host : *Lymnaea luteola*.

Location : Liver.

Locality : Raja Talab, Raipur (M.P.).

58. *Cercaria rithaianensis* Singh
(Fig. 57. A & B)

1955. *Cercaria rithaianensis* Singh, *Proc. Nat. Acad. Sci. India.*, 25(B) III-IV : 40-45.

Diagnosis : Cercariae after escaping from snail host remain active and swim back and forth by vibrating movement of body and tail, rarely they come to rest and in condition of rest body hangs downward, tail-stem turned upward and furcae remain diverged at an angle of about 60° to tail-stem; under cover glass pressure cercariae move by means of anterior organ and ventral sucker; body small, granular, flexible, extending upto 0.24 in length, when contracted it becomes almost globular, measuring 0.18×0.06 , body of fixed specimen measures 0.14×0.04 ; tail-stem measures 0.17-0.04 in fixed condition, furcae measure 0.16×0.02 in fixed condition; smallest specimen measures 0.14×0.41 in body size; 0.16×0.03 in tail-stem size and 0.16×0.02 in size of furcae; largest specimen measures 0.15×0.04 in body size; 0.17×0.04 in tail-stem

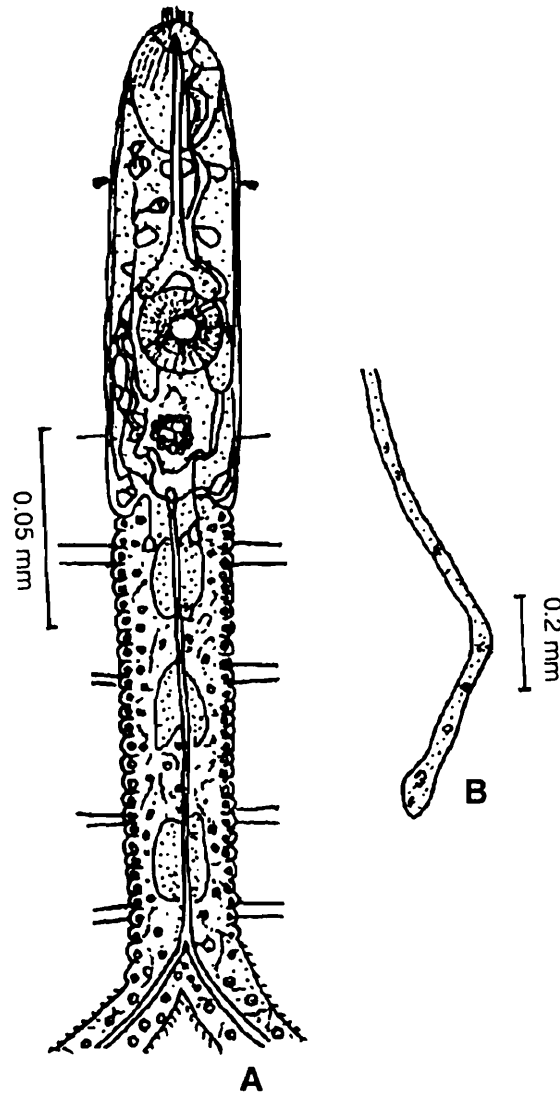


Fig. 57. A. *Cercaria rithaianensis* Singh, 1955. B. Sporocyst of *C. rithaianensis*, Singh, 1955 (After Singh, 1955).

size and 0.17×0.01 in size of furcae; anterior organ oval, measures $0.07-0.08 \times 0.04-0.06$; ventral sucker large, muscular circular in outline, measures $0.03-0.04$ in diameter, surface with three rows of spines; upto half level of penetration organ body spines thickly arranged but thin out posteriorly and at level of ventral sucker body spines disappeared; in circumoral spineless area forwardly pointing spines present at extreme tip of snout and dorsal to opening of mouth and 10-12 in number; tail-stem long, cylindrical, usually with three pairs of caudal bodies, lateral rows of nuclei, long sensory hairs eight in number on each side and arranged in groups of two; furcae equal in length to that of tail-stem, leaf like, end in sharp points, more transparent with few scattered spines at their bases; penetration glands four in number, situated anterior to ventral sucker, small in size, coarsely granular, ducts open on either side of oral opening in circumoral spineless area; a pair of small, rounded eye spots present in front of penetration glands; oral opening lined by a cuticular thickening; prepharynx short; pharynx small, globular; intestinal caeca with enlarged terminal portions, end in level of genital primordium; excretory bladder small, lying at junction of body and tail-stem, 'Island of Cort' present from where caudal excretory duct arises and runs back in tail-stem, flame cells six pairs present in body and a pair at base of tail-stem; genital primordia represented by a mass of small, rounded cells located in front of excretory bladder.

Sporocyst long, thread like; about 3 in length; wall constricted in between masses of germ balls; perform worm-like movements; anterior end produced into a snout which bears a birth pore and it guarded by two lips.

Snail Host : *Lymnaea luteola f. australis*.

Location : Rithaian village, Allahabad.

59. *Cercaria saundersi* Rao (Fig. 58. A)

1932. *Cercaria saundersi* Rao, *Indian J. Sci. Anim. Husb.*, 2(3) : 255-258.

Diagnosis : *Cercaria* adheres to sides of tube firmly with its powerful ventral sucker, occasionally swims tail foremost and often in spasmodic jerks, cercaria remains resting in vicinity of host snail and not a powerful swimmers, positive phototropic; cercaria with two black vestigial eyes with transparent convex lenses directed upwards and outwards; whole length of living cercaria varies from 0.80-1.00; in fixed body measures $300\mu \times 75\mu$; tail-stem measures $400\mu \times 35\mu$, furcal ramus measures 225μ ; body and tail covered with fine spines, spines more on body than on tail; ventral sucker armed with spines; anterior organ measures 90μ in length and posterior portion muscular; head gland single; mouth terminal or slightly sub-terminal; mouth connected with a delicate tube or oesophagus which runs down and followed by a fine tube in anterior portion of body without apparent dilatation or bifurcation and this constitutes a simple alimentary canal; situated terminally on snout six hollow spines, three on each side; three pairs of mucin glands open by means of stout ducts into these hollow

spines; two anterior mucin glands surrounded ventral sucker contain coarse granules and two posterior pairs which almost fill posterior region of body contain fine granules; two masses of nervous system situated laterally between eyes and snout; a few granules in a mass situated behind ventral sucker represent rudimentary reproductive organ; anterior and posterior lateral excretory ducts unite to form two main ducts which open into a small rounded excretory vesicle situated at hind end of body, each main excretory tube with two patches of cilia located behind union of anterior and posterior collecting tubes, seven flame cells including one in tail situated on each side of body, on each half of body in anterior portion one flame cell situated postero-lateral to snout, one cell behind eye and another antero-lateral to ventral sucker, in posterior portion, one flame cell situated postero-lateral to ventral sucker, one lateral to eyelet aperture and another midway between these two, eyelet aperture opening into excretory canal of tail-stem and a little behind this opening situated flame cells of tail-stem; ventral sucker muscular, protrusible, provided with six bands of muscles which run from it and attached dorsally and laterally to body wall; tail-stem longer than body with a wide canal running through length of tail-stem, furcal rami narrow, delicate finfolds running about two-thirds of their length; a constriction present at junction of rami with tail-stem, canal in furcal ramus opens to outside at its tip in a barrel-like extremity.

Sporocysts long; lightly yellow in colour; contain large number of dark granules; shows peristaltic movements.

Snail Host : *Lymnaea accuminata*.

Locality : Spur tank, Egmore.

60. *Cercaria soraonensis* Singh
(Fig. 59. A & B)

1955. *Cercaria soraonensis* Singh, *Proc. Nat. Acad. Sci. India.*, 25(B) I-II : 15-18.

Diagnosis : Cercariae emerge from snail host continuously but more in day than in night, they hang motionless with body downward and furcae forming an angle of

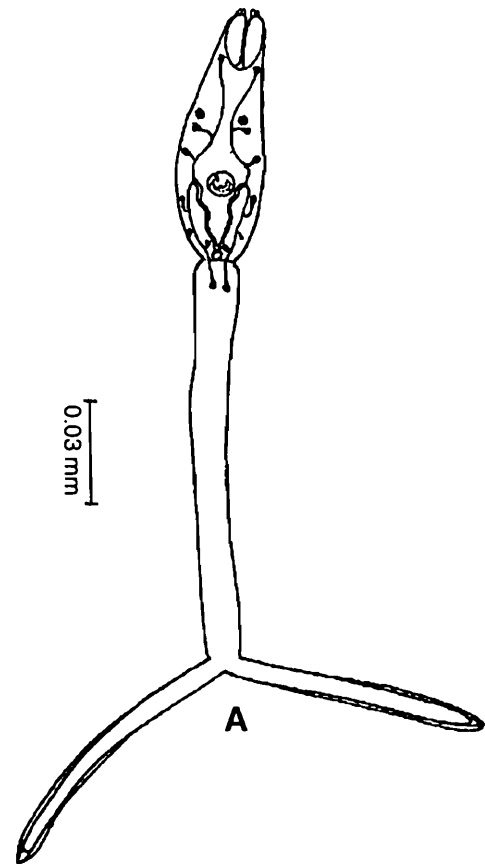


Fig. 58. A. *Cercaria saundersi*, Rao, 1932
(After Rao, 1932).

about 90° to tail-stem, from time to time they gradually sink when they shoot upward with a wriggling movement, period of rest longer than period of activity, after a short free existences they settle down to bottom of vessel and move on bottom by aid of anterior organ and ventral sucker; body flattened posteriorly and narrow anteriorly and very flexible in living condition, constriction of body appear in anterior part of ventral sucker when cercaria subjected to cover glass pressure; body measures 0.16-0.16 (0.16) × 0.05-0.05 (0.05) in fixed condition; tail-stem measures 0.18-0.21 (0.19) × 0.03-0.04 (0.03) in fixed specimen, furcae measure 0.16-0.19 (0.18) × 0.01-0.02 (0.01) in fixed condition; anterior penetration organ pyriform to oval in shape, measures 0.03-0.04 (0.04) × 0.02-0.03 (0.02), anterior tip of anterior organ produced into a refractile snout provided with 3-4 rows of thick, shining spines directed anteriorly; behind these rows of spines cuticle of body provided with five spines arranged in transverse rows upto level of ventral sucker, behind ventral sucker body contains sparsely and irregularly distributed spines extending upto posterior end; ventral sucker large, muscular, situated at about middle of body with circular opening in centre, it measures 0.03-0.04 in diameter and bears 3-4 rows of spines; mouth terminal; pharynx

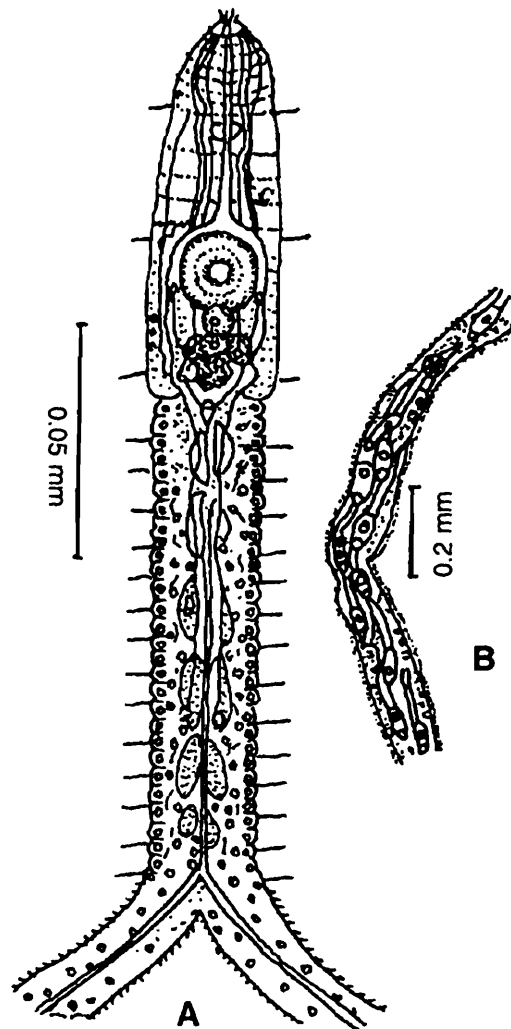


Fig. 59. A. *Cercaria soraonensis* Singh, 1955. B. Sporocyst of *C. soraonensis*, Singh, 1955. (After Singh, 1955).

globular, placed just behind posterior margin of anterior penetration organ; oesophagus large, narrow, bifurcates anterior to ventral sucker; large and wide intestinal caeca end in level to second pair of penetration glands; tail-stem contains six pairs of caudal bodies supported by strands of connective tissue, two rows of nuclei on either side of tail-stem and about 14 long sensory hair present, furcae as long as tail-stem with fine spines at their base; penetration glands four in number, situated posterior to ventral sucker, each cell rounded and provided with nucleus in centre, glands of first pair in a line whereas other two lying opposite each other, ducts of these glands open to each side of mouth; two arms of excretory bladder divide into anterior and posterior collecting ducts, each anterior collecting duct join by two flame cells whereas each posterior duct after receiving capillaries from two flame cells in posterior region of body extend in tail to end in two flame cells, caudal excretory duct originates from posterior end of bladder through an 'Islet aperture' and forks at distal end of tail and enters into furcae and finally open at about half length of furcae; genital primordium lies in front of excretory bladder and behind last pair of penetration glands, composed of small rounded cells with clear nuclei.

Sporocysts perform independent worm-like movements; they show uniform width with few constrictions at places; they measure $0.50-0.60 \times 0.05-0.1$; anterior end produced into a snout like structure and contains birth pore and birth canal.

Snail Host : *Lymnaea luteola f. australis*.

Location : Liver.

Locality : Rithaian village, Allahabad.

61. *Cercaria sphericauda* Singh

(Fig. 60. A-D)

1952. *Cercaria sphericauda* Singh, *Proc. Nat. Acad. Sci. India.*, **22(B)** VI : 12-21.

Diagnosis : Cercariae distributed uniformly throughout container, they held with body contracted, tail-stem straight and furcae diverged, at an angle of about 60° , they in this position sink gradually to bottom of vessel but from time to time they again rise upwards with slow motion, they propelled upwards with vibratory motion, lashing of tail-stem induced by alternate contraction of longitudinal muscle bands present on either side in tail-stem, most characteristic and striking feature of cercaria of its unusual expansion of tail-stem into a spherical ballon like structure; body measures $0.07-0.10$ (0.09) \times $0.03-0.04$ (0.04) in fixed condition; tail-stem measures $0.12-0.16$ (0.14) \times $0.07-0.10$ (0.06) in fixed condition, furca measures $0.06-0.12$ (0.10) in length and 0.02 in average breadth in fixed specimen; body in living condition varies in shape and size depending upon degree of contraction and extension, in more extended condition it looks elongated measuring about 0.26×0.03 , in extreme contracted condition it becomes more or less pear shaped and measures 0.09×0.06 ; anterior

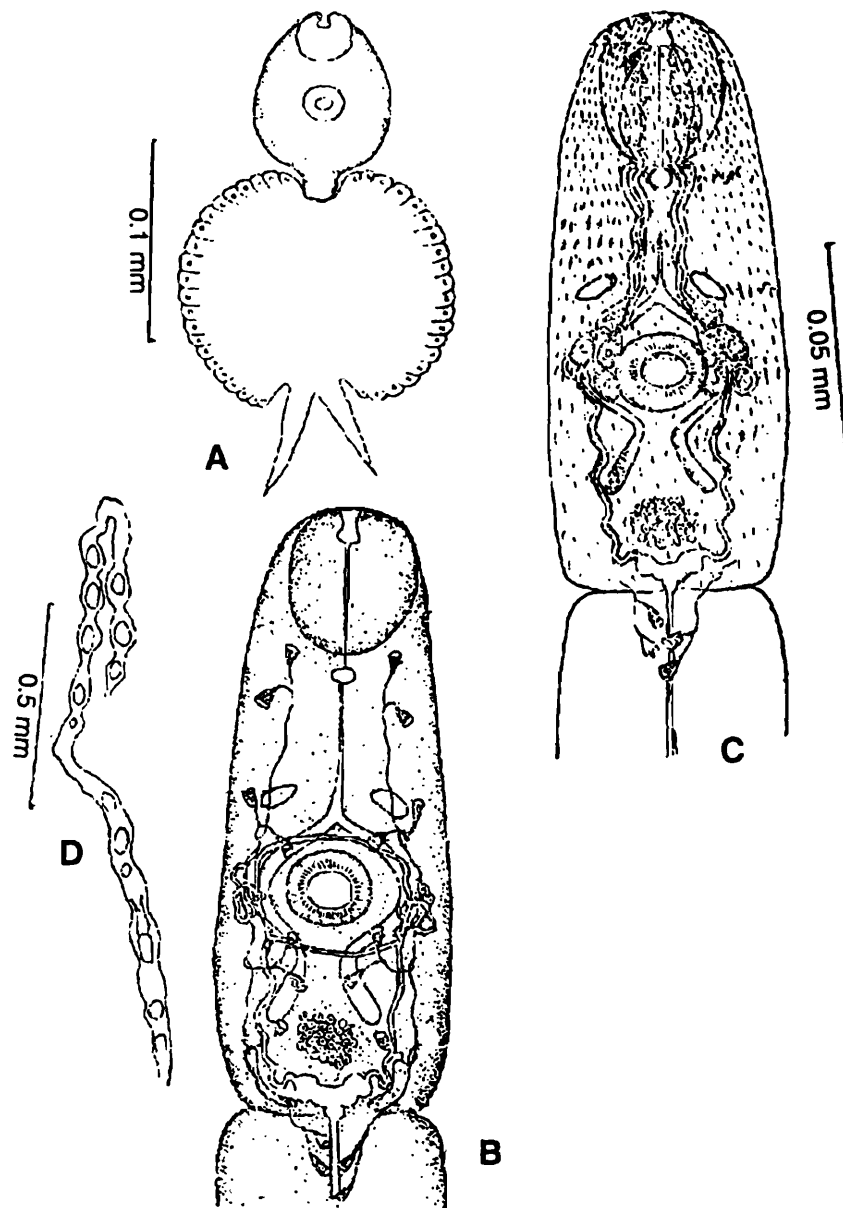


Fig. 60. A-C. *Cercaria sphericauda* Singh, 1952. D. Sporocyst of *C. sphericauda* Singh, 1952. (After Singh, 1952).

penetration organ measures 0.03-0.04 (0.03) \times 0.02-0.02 (0.02) in fixed specimens, extreme anterior tip produced into a small snout like structure which regularly pushed in and pulled out, when pushed in it forms a cup shaped depression, 10 spines forming irregular rows surround a circumoral spineless area on snout and behind this situated thick densely scattered spines extend back as far as upto half level of anterior penetration organ; body contains small scattered spines; fine scattered spines present on tail-stem and furcae; ventral sucker lies a little behind middle of body, circular in shape, measures 0.01-0.02 (0.02) in diameter, margin furnished with a single row of spines; a pair of unpigmented eye spots present anterior to group of penetration gland cells; tail-stem broad and contractile, buldging in middle with a large cavity filled with fluid, in living cercaria tail-stem appears thick in middle and tapering towards

either end, in contracted condition of tail-stem circular muscle fibres form regular annulations, two longitudinal rows of cells extend along mid-dorsal and mid-ventral lines of tail-stem, four groups of longitudinal muscle bands situated in tail-stem, small rounded cells with clear nuclei present along margins of tail-stem and rest of lumen filled with clear watery fluid, caudal bodies four pairs, furcae broad, flat, pointed ends and contractile; prepharynx short; pharynx small, globular; oesophagus long, reaching about half of body length and bifurcates into two intestinal caeca; caeca extend upto level of genital primordium, encircle ventral sucker; penetration glands four pairs each with a clear nucleus, they grouped around ventral sucker, first two pairs lie in front of ventral sucker on outer side of caeca, second two pairs located between intestinal caeca and lateral to ventral sucker, gland ducts on each side run forward and enter anterior penetration organ where they dilated and finally open at snout lateral to oral opening; small bipartite excretory bladder situated at junction of body and tail-stem and gives rise to two main collecting ducts, at level of ventral sucker each main duct divides into an anterior and a posterior collecting tubule, two pairs of flame cells connected with each anterior collecting tubule while with each posterior collecting tubule two pairs of flame cells connected in body and a pair in tail-stem, two transverse commissures—one behind pharynx and parallel to arch formed by intestinal caeca and other posterior to ventral sucker connect main collecting ducts, caudal excretory duct passes backward from bladder and at distal end of tail-stem bifurcates into two branches which enter furcae and open to exterior in middle of their outer margins; genital primordium large and represented by a mass of small rounded cells located in front of excretory bladder.

Sporocyst long, thread like; anterior end of sporocyst capable of independent movement; birth pore protruded, birth canal short situated a little behind extreme tip which projects like snout; it measures 3.50-5.60 in length; width not uniform; constriction in wall present; these constrictions separate areas where germ balls developed; diameter varies from 0.03 and 0.07 in region of constrictions and parts of sporocysts between them respectively.

Snail Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Ahimanpur, Allahabad.

62. *Cercaria srivastavai* Dutt

(Fig. 61. A-C)

1957. *Cercaria srivastavai* n. sp. Dutt, *Proc. Indian Sci. Cong.*, **3** : 349.

1970. *Cercaria srivastavai* Dutt, *H. D. Srivastava Commen. Vol.* : 311-313.

Diagnosis : *Cercaria* emerge in early morning, positive phototropic, attached by means of ventral sucker to side of glass container towards light, during attachment

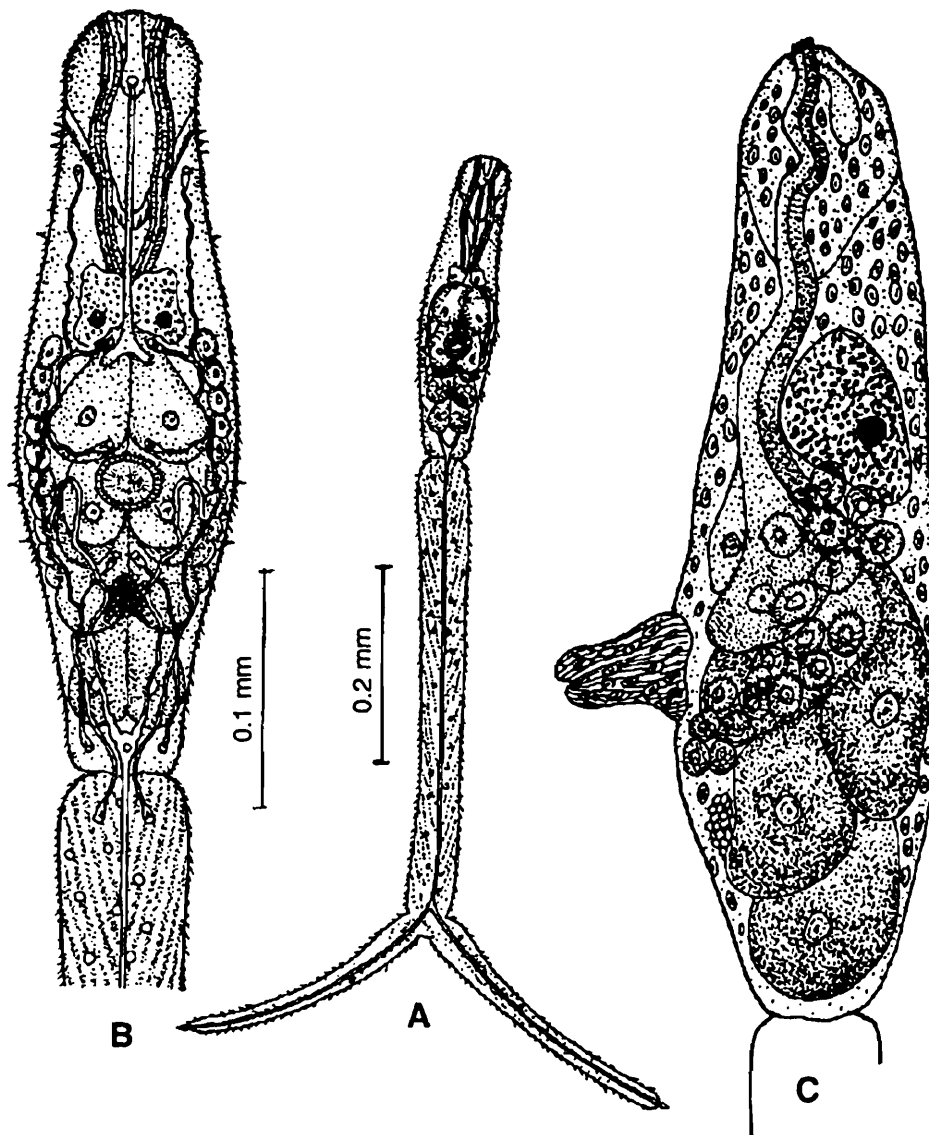


Fig. 61. A-C. *Cercaria srivastavai* Dutt, 1970. (After Dutt, 1970)

anterior part of body reflexed and made parallel to tail-stem which generally remains perpendicular to surface of attachment and in this position tips of furcal rami generally cross each other, cercariae congregate near top and only a few remaining distributed throughout water, they remain suspended when floating with tail upward and body slightly curved dorsally, they swim erratically with either head or tail foremost; pigmented eye spots present; with furcal fin-folds; body measures $204-319\mu$ ($254 \pm 8.65\mu$) \times $51-73\mu$ ($63 \pm 1.35\mu$); tail-stem measures $448-510\mu$ ($482 \pm 3.69\mu$) \times $34-46\mu$ ($41 \pm 0.63\mu$), furcal rami measure $250-291\mu$ ($273 \pm 2.18\mu$) in length; head organ measures $69-111\mu$ ($87 \pm 2.49\mu$) \times $38-50\mu$ ($46 \pm 0.30\mu$); ventral sucker measures $23-31\mu$ ($27 \pm 0.43\mu$) in diameter; anterior end to eye spots measures $100-154\mu$ ($125 \pm 4.30\mu$); anterior end to ventral sucker measures $112-196\mu$ ($136 \pm 5.36\mu$); body, tail-stem and furcal rami spinose with a number of setae; furcal rami with dorso-ventral fin-folds; mouth situated ventrally at middle of anterior portion of head organ; oesophagus long, tubular; caeca short, situated far anterior to ventral sucker and posterior to eye-spots; nerve mass

supra-oesophageal, bilobed; a pair of pigmented eye-spots; head gland present; penetration glands five pair; in unemerged cercaria a pair of escape glands present; a number of large cells present on each side of body between nerve mass and genital rudiments; excretory system with flame cell formula $2 [(3) + 3 + (1)] = 14$; two ciliary patches in each main lateral excretory tube present; 'Island of Cort' present, terminal portion of furcal excretory vessel tubular; genital rudiments represented by cluster of closely packed cells, lying ventral to fourth pair of penetration glands.

Sporocyst cylindrical.

Host : *Lymnaea acuminata* (= *L. auricularia rufescens*).

Locality : From a tank of Rithaura, Bareilly, U.P.

Vivax Group

Diagnosis : Ventral sucker rudimentary, represented by cell mass or indistinct and poorly developed.

Key to Species

1. Fin fold present 2
- Fin fold absent 3
2. Fin fold present only on furcal rami *C. indicae* XV
- Fin fold present on furcal rami and on dorsal side of body or present only on dorsal side of body 4
3. Flame cells in body 30 in number 5
- Flame cells in body less than 30 in number 6
4. Fin fold present on furcal rami and on dorsal side of body *C. hunterii*
- Fin fold present on dorsal side of body 7
5. Flame cell in tail-stem absent *C. milleri*
- Flame cell in tail-stem present 8
6. Eye spots present 9
- Eye spots absent 10
7. Rudimentary pharynx present, penetration ducts open by small papillae
..... *C. of Clinostomum giganticum*
- Pharynx absent, penetration glands open by piercing spines 11
8. Flame cells in furcal rami present *C. udaipurensis*
- Flame cells in furcal rami absent 12

9. Eye spots pigmented, penetration glands 6 in number *C. kaniharii*
 – Eye spots unpigmented, penetrating glands 4 in number *C. hornifurca*
10. Intestinal caeca very well developed, penetrating glands in two sets of 18 in number *C. shikarii*
 – Post pharyngeal digestive system not developed, penetrating glands one set of 4 in number *C. indicae LXV*
11. Head gland present in centre of protrusible organ, filamentous hairs absent on tail-stem *C. bombayensis No. 8*
 – Head gland absent in protrusible organ, filamentous hairs present on tail-stem *C. clinostomum piscidium*
12. Body aspinose, protrusible organ with spines, prepharynx present, penetrating glands 8 pairs *C. singhi*
 – Body spinose 13
13. Tail aspinose, penetrating glands 18 in number located on either side of anterior protrusible organ *C. sewelli*
 – Tail spinose, penetrating glands less than 18 in number and arranged in two sets 14
14. Caeca long, oesophagus makes a knot, digestive duct without brownish granules, genital sucker present *C. indicae LXXXII*
 – Caeca short, oesophagus without knot, digestive duct with brownish granules, genital sucker absent *C. indicae LXXXIII*

63. *Cercaria bombayensis* No. 8 Soparkar
 (Fig. 62. A-D)

1921. *Cercaria bombayensis* No. 8 Soparkar, *Indian J. Med. Res.*, **IX** : 24-26.

Diagnosis : *Cercaria* pigmented, apharyngeal, furcocercous, small, with pigmented eye spots, in water it always seen with body bent on one side and tail turned upwards; body of cercaria in fixed condition measures $130\mu \times 35\mu$; tail-trunk measures $240\mu \times 24\mu$; furcal rami measure 65μ in length; pigmented eye spots situated 55μ from anterior end, composed of refractile lens and granular brownish black pigment; body, tail, furci covered with sharp spines, spines quite prominent over conical anterior end; posterior half of dorsal aspect of body attached a thin narrow membrane; alimentary system simple, mouth opens a little behind anterior end; long oesophagus passing through oral sucker; caecum dilated, situated about 80μ from anterior end; pharynx absent; ventral sucker not well formed and represented by a mass of cells and appears as a rudimentary sucker; genital system represented by a cluster of small round cells situated behind rudimentary sucker; oral sucker situated at anterior

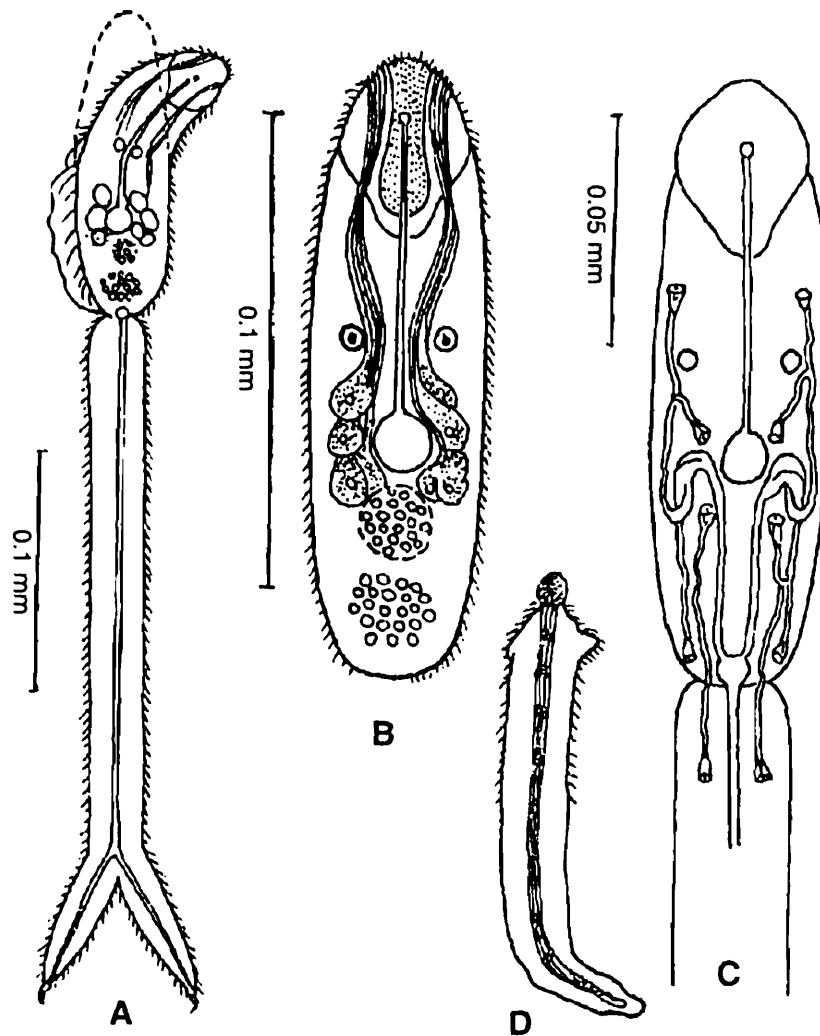


Fig. 62. A-C. *Cercaria bombayensis* No. 8 Soparkar, 1921. D. Redia of *C. bombayensis* No. 8 Soparkar, 1921. (After Soparkar, 1921)

end, measures 35μ long and provided with a protrusible snout, covered with papillae, in centre of it situated head gland; mucin glands four pairs, located around caecum, ducts from these glands pass forwards and enter oral sucker, open at anterior end on either side of opening of head gland in middle, opening capped by hollow piercing spine; it possesses five pairs of flame cells including one in tail, out of four pairs of body flame cells one pair located behind posterior margin of oral sucker, second pair on each side of caecum, third on each side of rudimentary ventral sucker, fourth at posterior end of body, ciliated areas in main excretory canals present, caudal canal present, opening of branches of caudal canal at end of furcal rami capped with curved spines; cercaria develops in sporocyst and redia.

Sporocyst small, no. club-shaped muscular ends; redia small, anterior half covered with spines; prominent muscular pharynx long intestine reaches whole length of structure.

Snail Host : *Lymnaea acuminata*, *Indoplanorbis exustus*.

Location : Liver.

Locality : Mahim & Bandra, Bombay.

64. Cercaria of *Clinostomum giganticum* Agarwal
(Fig. 63. A-D)

1959. *Clinostomum giganticum* Agarwal, *Indian J. Helm.*, **XI**(2) : 75-115.

Diagnosis : Cercariae discharged from infected snails in large numbers during day time, they float in water with body downwards and tail-stem and furcae straight up, body bent at an angle so that fin fold always remains dorsally and anterior tip of body comes in line with base of body, while swimming they remain stationary at a point for some time and then suddenly show brusque movement by vibrations of tail-stem and furcae and dart through water almost like an arrow, when at rest body always bent at a characteristic angle; body measures 0.11-0.16 (0.13) × 0.04-0.06 (0.05) in living and 0.08-0.11 (0.09) × 0.03-0.04 (0.04) in fixed conditions; tail-stem measures 0.22-0.30 (0.28) × 0.02-0.03 in living and 0.18-0.32 (0.26) × 0.02-0.03 (0.02) in fixed conditions, furcae measure 0.08-0.12 (0.10) × 0.01-0.02 (0.02) in living and 0.07- 0.13 (0.10) × 0.01-0.02 (0.01) in fixed specimens; body small with minute spines at its anterior end and arranged in a number of rows and extending to about level of middle of anterior organ, spines present on general surface of body; tail-stem long, slender, more than twice length of body and firmly attached to body, small, conical row of spines present on its sides, spines on tail-stem bent backwards at their tips, centre of tail runs caudal excretory canal on either side of it located empty spaces with scattered nucleated cells, circular muscles of tail situated beneath cuticle and longitudinal muscles run obliquely in dorso-ventral direction in anterior region of tail while in posterior region they tend to become parallel to long axis of tail, furcae shorter in length than tail-stem and approximately as long as body, on lateral margin furcae bear minute spines with a group of spines at tip of each furca of which one spine comparatively larger than rest, at base of this opens excretory pore in each furca; body with dorsal median finfold with 16-19 spines, spines disappear in fixed specimens; oral sucker in form of penetration organ, penetration organ narrow in front and broader behind, it measures 0.03-0.04 (0.04) × 0.02-0.02 (0.02) in living and 0.03-0.04 (0.04) × 0.01-0.02 (0.01) in fixed specimens; one pair of pigmented eye spots measure 0.01; ventral sucker in form of loosely arranged cells, not well defined; mouth ventral situated on level with posterior border of penetration organ and laterally on one side of body; prepharynx long, tubular, dilated at base to form a bulbous rudimentary pharynx; intestinal caeca undivided, caecum located at distance of 0.08-0.10 from anterior end of body in living condition; penetration glands four pairs, situated lateral to intestinal caecum, penetration ducts run forward on either side of prepharynx and pass laterally to penetration organ where ducts of each side form a plate like structure, penetration ducts run through penetration organ to open finally at its anterior tip by small papillae, each penetration gland characterised by presence

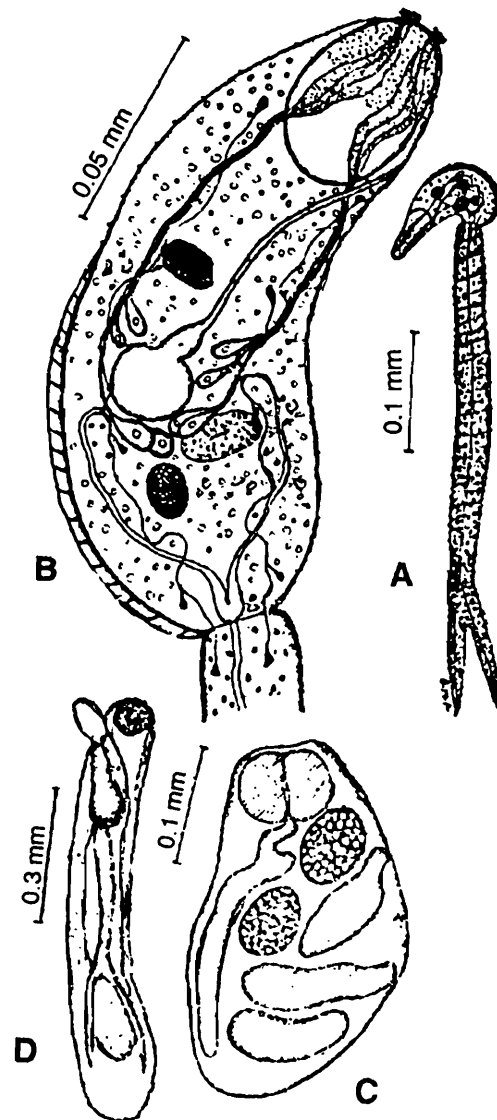


Fig. 63. A & B. Cercaria of *Clinostomum giganticum* Agarwal, 1959. C & D. Redia of cercaria *C. giganticum* Agarwal, 1959 (After Agarwal, 1959).

of a prominent nucleus; body space filled up with numerous small nucleated cells; excretory bladder situated at posterior end of body 'V' shaped, prolonged backwards into tail as a median caudal excretory canal, running through centre of tail, from arms of excretory bladder arise main excretory ducts, each duct runs forward to a little above intestinal caecum, bends upon itself to a loop and then divides into two excretory tubes, anterior tube runs forward while posterior runs backward and passes into proximal part of tail, two flame cells open in each anterior tube and two flame cells open in each posterior excretory tube and one flame cell opens in caudal part of each posterior excretory tube, flame cells in tail present just a little below attachment of tail with body, flame cell formula can be represented by $2 [(1+1) + (1+1)(1)] = 10$.

Encysted metacercariae found attached to tissue beneath operculum of *Ophiocephalus punctatus*; cysts rounded, yellowish, long, slender bodied, lateral

margins almost parallel to one another, measures 7.70-13.35 (10.66) × 2.70-3.75 (3.15), without any cuticular spines; oral sucker measures 0.30-0.45 (0.38) × 0.45-0.60 (0.50); ventral sucker measures 1.20-1.95 (1.50) × 1.35-2.55 (1.69); mouth leads into prepharynx which dilates at its base to form a bulbous rudimentary pharynx; intestinal caeca bifurcates at pharynx, caeca long, sinuous, reach upto posterior border of ventral sucker and give rise to closely set pouches beyond ventral sucker, terminate blindly in front of two arms of excretory bladder; gonads situated posterior two fifth of body; testes strongly digitate—each divides into six lobes, anterior testis measures 0.75-1.2 (0.96) × 0.75-1.00 (0.88), posterior testis measures 0.45-1.05 (0.73) × 1.20-1.35 (1.24), cirrus-sac situated just above ovary, it measures 0.50 long and contains a bilobed vesicula seminalis, pars-prostatica and a circus; genital pore situated at about level of equator of anterior testis; ovary intertesticular, situated on right side of body just beneath cirrus-sac, measures 0.30-0.45 (0.34) × 0.05-0.03 (0.17), oviduct, without any lobes, from inner side of ovary springs oviduct which after forming a loop just at point of origin runs transversely in intertesticular space meets duct from vitelline reservoir in centre of intertesticular space and finally opens in ootype, it gives out pouch like receptaculum seminis; uterine sac long, tubular structure, measures 2.10-3.45 × 0.15-0.45, extends from little beneath ventral sucker to middle of anterior testis where it opens in genital atrium and finally opens outside through genital pore situated about level of middle of anterior testis, vitelline follicles indistinct, extend from a little beneath ventral sucker, extending laterally, overlapping intestinal caeca on two sides coalesce in post-testicular region and finally reach to tips of intestinal caeca, vitelline reservoir indistinct; excretory bladder 'V' shaped with a small posterior opening, excretory pore situated a little above posterior tip of body, from two arms of bladder arises main excretory ducts—one on each side, excretory ducts run a coiled course upto level of oral sucker where each duct bends upon itself to follow a descending course, details of main excretory duct completely obscured by presence of prominent ladder like system of vessels.

Mother rediae measure 0.18-0.82 (0.58) × 0.05-0.18 (0.13); pharynx measures 0.02-0.05 (0.03) broad; mother rediae elongated, tubular, gut well developed and consists of pharynx and long tubular intestine extending to a little above posterior end of body; germ balls varying from three to thirteen in number; mother rediae show difference in body size, size of pharynx and number of germ balls in different stages of development.

Daughter rediae measure 0.40-1.15 (0.69) × 0.06-0.17 (0.12); pharynx measures 0.04-0.07 (0.05) × 0.04-0.06 (0.05); number of cercarial germ balls in rediae vary from one to thirteen; number of mature cercariae inside a redia vary; pharynx rounded, long; intestine straight with three to four chambers filled with a yellowish substance, extends upto posterior tip of body; birth pore prominent situated beneath pharynx on one side; anterior end with cuticular ridges which regularly contract and expand and bring about movement of rediae and ridges look like spines; daughter rediae differ from mother rediae in presence of birth pore and cuticular ridges.

Sporocyst ovoid in shape, with thin cuticle and a layer of cells beneath cuticle; measures 0.17×0.24 with a minimum width of 0.10; germ ball measures 0.08×0.05 .

Miracidia minute, rod like, moving vertically up and down and also in a characteristic spiral way; measure $0.14-0.16$ (0.14) \times $0.04-0.08$ (0.05), broadest in region of eyes, narrower and rounded at posterior end while tapering towards anterior end; body covered with long cilia; epidermal plates arranged in four transverse rows and twenty-one in number, arranged in groups of six, eight, four and three plates respectively in four tiers, epidermal plates of first tier measure about $0.02-0.04$ long, plates of second tier longest, measure 0.03 , plates of third tier measures $0.01-0.02$ and plates of fourth tier measure 0.02 , knobbed stylet like protrusible papilla situated at anterior end of body, knob measures $0.004-0.008$ in diameter, entire stylet measures 0.02 in length; sac like primitive gut or apical gland opens into apical papilla, it contains small granules but no nucleus; penetration glands one pair, extending proximally from posterior level of eye to anterior end, penetration glands sac-like with slender penetration ducts, ducts open to apical papilla, each gland with a prominent nucleus; two lateral papillae situated between first and second rows of epidermal plates, one of which conical and tapering while second globular in structure, minute droplets come out from lateral papillae; composite eye made up of three units—two dorso-lateral and third medio-ventral, situated middle of body about $0.02-0.03$ from anterior end, arranged in intimate association with each other, medio-ventral unit smallest; brain prominent, oval and smooth situated on a level with eye; distinct, well defined germ ball situated at posterior part of body, it measures $0.05-0.06$ (0.05) \times $0.02-0.04$ (0.03); numerous small nucleated cells and 15 to 16 refractile bodies filled up space in anterior two-thirds of body above germ ball; flame cells two pairs, excretory pore situated between second and third rows of epidermal plates, excretory vesicle situated just above excretory pore, common excretory duct ascends upto level of eye spot where it bends upon itself and descends and during its descent it crosses ascending limb two to three times and finally it bifurcates into an anterior and posterior ducts a little above germ ball, anterior duct runs anteriorly and ends in a flame cell at level of brain, posterior duct spirally coils round main excretory duct and ultimately ends in a flame cell on anterior and lateral border of germ ball.

Eggs arranged in strings with three rows of eggs in each string; eggs non-embryonated when laid; white in colour, elliptical in shape, operculate, measure $0.11-0.12$ (0.11) \times $0.07-0.08$ (0.08); a shell membrane 0.002 in thickness; operculum measures 0.004 in thickness; number of yolk cells packed up space inside; egg increases in size during development and egg a day before hatching measures $0.12-0.13$ (0.13) \times $0.08-0.10$ (0.08), increase in size of egg may be due to absorption of water; brisk movement of larva starts before hatching.

Snail Host : *Lymnaea luteola*, *L. accuminata*.

Location : Liver.

65. Cercaria of *Clinostomum piscidium* Singh
 (= Cercaria *Clinostomum microstomum* Singh)
 (Fig. 64. A-C)

1959. *Clinostomum piscidium* Singh, *Proc. Nat. Acad. Sci. India.*, **29(B)** : 12-23.

1955. *Clinostomum microstomum* Singh, *Proc. Nat. Acad. Sci. India.*, **25** : 15-22.

Diagnosis : Cercariae remain suspended in water with body hanging down and tail-stem turned upward in a straight line with furcae held relatively together; body curved ventral so that anterior organ takes a position close to base of tail-stem, when disturbed cercariae regain their original position by lashing movement of tail and propelling actions of furcae; cercariae short lived, delicate, measures 0.08-0.10 (0.10) × 0.04, elongated, pear shaped, narrow anteriorly, broad and massive posteriorly, convex dorsally and concave ventrally; anterior part covered with thick backwardly pointing spines extending postrod for 1/3 to 1/4 length of penetration organ; dorsal median finfold delicate 6-7 μ wide and extends from level of eye-spots to posterior end of body, when thrown into folds its cuticular thickenings apparently giving appearance of finrays; eye-spots pigmented, measure 0.02 in diameter, lie at a distance of about 0.05 from extreme anterior end; tail-stem narrower than body, measures 0.22-0.26 (0.25) × 0.02-0.03, furcae measure 0.07-0.08 (0.07) long, provided with spines, tail-stem spines curve at tips; long filamentous hairs present on tail-stem; penetration organ long, narrow, measures 0.04 (0.04) × 0.02 (0.01); mouth median, ventral, slightly posterior to middle of penetration organ; oesophagus long, conspicuous; pharynx absent; caecum sac like, undivided, situated behind eye-spots; ventral sucker in form of a mass of cells, smaller than penetration organ; penetration glands small, four pairs, located around caecum, fine ducts open at extreme tip of anterior penetration organ and capped with hollow piercing spines; excretory bladder 'V' shaped, located at posterior end of body, two arms of bladder receive an anterior and a posterior collecting duct on either side, two pairs of flame cells connected with anterior tubules and three pairs to posterior tubules, two in body and one in tail giving a total of eight flame cells in body and two in tail, caudal excretory canal runs through middle of tail-stem and bifurcates at furca, each furca contains extension of caudal excretory canal which opens at tip through bladder like enlargements amongst group of large spines.

Metacercariae nonencysted, move freely in body cavity of piscine hosts, yellowish white in colour, relatively small, thin, slender; body measures 3.31-3.42 (3.80) × 0.97-1.3 (1.16); body provided with spines, spines broader at base; musculature well developed; oral sucker subterminal smaller than ventral sucker, measures 0.13-0.19 (0.14) × 0.16-0.29 (0.20); ventral sucker situated at a distance of 0.31-0.48 from oral sucker measures 0.42-0.75 (0.54) × 0.42-0.71 (0.52); mouth leads into a small prepharynx a slight saccular dilation which gives impression of pharynx; intestinal caeca occupy large part of body with small lateral diverticula, filled with yellowish granular contents; excretory system consists of 'V' shaped bladder located at posterior end; reproductive

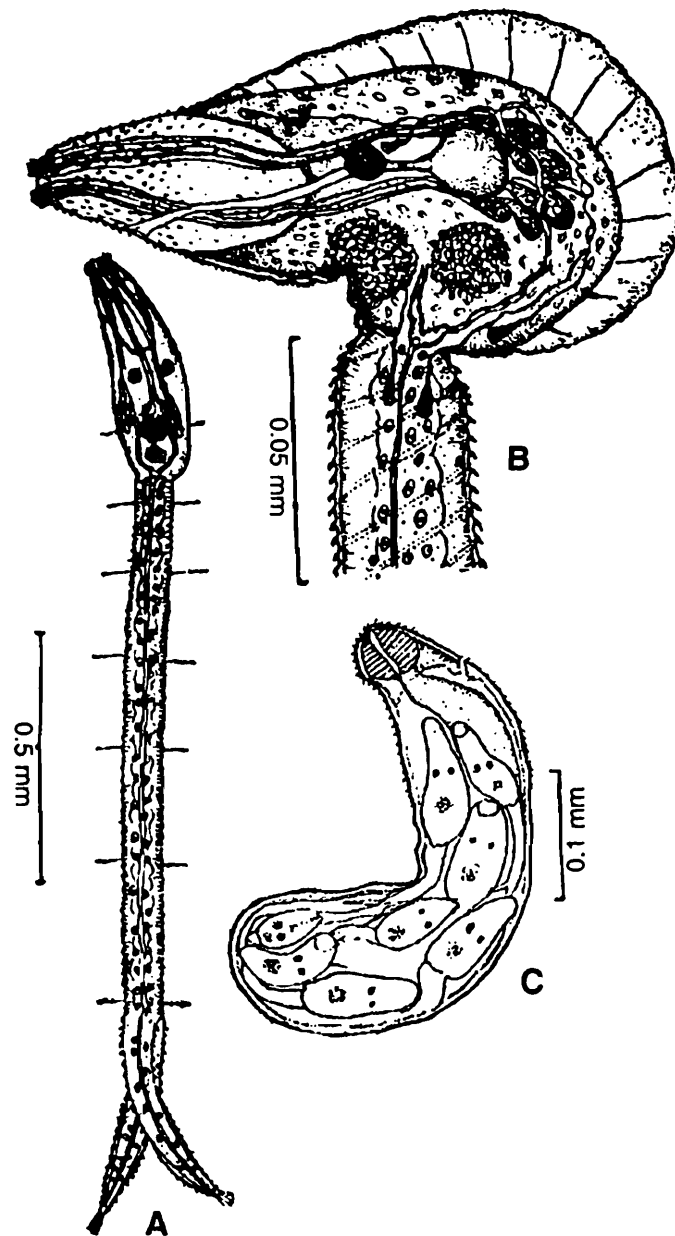


Fig. 64. A & B. Carcaria of *Clinostomum piscidium* Singh, 1959. C. Redia of a cercaria *C. piscidium* Singh, 1959 (After Singh, 1959).

organs in a primary stage and fully represented, finger like processes present in testes, uterus with a cellular coating along its entire length, cirrus inserted into metraterm, ovary small, vitellaria undifferentiated.

Mother mature redia oval, sac-like, large wide gut almost reaching to posterior end; measures $0.31-0.42 \times 0.11-0.21$; pharynx measures $0.02-0.06 \times 0.03-0.06$; daughter rediae present, daughter rediae with cercariae measure $0.39-0.49 \times 0.10-0.14$; pharynx measures 0.03 in diameter; second generation of rediae distinguished from first generation by spines covering anterior third of body; mass of developing cercariae and a birth pore near anterior end lateral and posterior to pharynx.

Miracidium pyriform in shape, broad anteriorly and narrow posteriorly, able to swim rapidly by means of cilia; body measures 0.13-0.16 (0.14) \times 0.04-0.06 (0.06); positive phototropic and negative geotropic; first tier of ciliated epidermal plates consists of six cells, second of eight, third of four and fourth of three plates, cilia range between 0.01-0.02 in length; apical gland or primitive gut sac like, filled with granules, extends back upto anterior margin of nerve mass, bears an apical papilla which carries a stylet about 0.02 long; a single penetration gland situated on either side of apical gland which opens at base of apical papilla through very fine ducts; three prominent eye-spots present and located in median line over brain mass at about 0.05 from anterior end, cupshaped, darkly pigmented; brain or nerve mass located posterior to apical gland and extends from level of lateral processes to posterior margin of second row of epidermal plates, slightly bilobed, roughly rectangular; excretory system with two pairs of flame cells—one anterior and other posterior, each cell of anterior pair located antero-lateral to brain in level with lateral processes, cells of posterior pair lie in hinder region of body in level with posterior half of third row of epidermal plates and antero-lateral to germ ball, capillaries from flame cells unite to form a common collecting duct on either side which open through excretory pores located in groove of second and third tiers of epidermal plates; germ cells in form of a compact mass, large, oval and occupies posterior fourth of body.

Remarks : Singh (1959) considered *Clinostomum microstomum* Singh (1955) as a synonym of *Clinostomum piscidium* Southwell and Prashad (1918).

66. *Cercaria hornifurca* Singh (Fig. 65. A-C)

1953. *Cercaria hornifurca* Singh, *Allahabad Univ. Stud.*, : 52-56.

Diagnosis : Cercariae swim for sometime after escaping from snail host before coming to rest, when at rest cercaria hangs in water with its body downwards and tail-stem turned upwards and with furcae widely separated, anterior end of body bend ventrad in form of hook, hanging cercariae gradually sink towards bottom of container and they dart upwards with wriggling movement to regain their original positions, periods of rest shorter than periods of swimming, under cover slip pressure cercariae move with tail in advance with extended body and furcae remain right angles to tail-stem; body in extended condition measures 0.22 \times 0.04, in contracted condition it measures 0.09 \times 0.05; tail-stem measures 0.22 in length, furcae measure 0.21 in length; in fixed condition body measures 0.08-0.12 (0.10) \times 0.01-0.02 (0.02); tail-stem measures in fixed condition 0.13-0.16 (0.15) \times 0.01-0.02 (0.02), furcae in fixed condition measure 0.12-0.13 (0.12) long; body elongated with parallel sides; anterior end occupied by penetration organ which varies in shape from oval to pyriform and measures 0.03 \times 0.02 in living condition, in fixed condition it looks more or less oval and measures 0.02-0.03 \times 0.01-0.02; anterior part of body in front of penetration

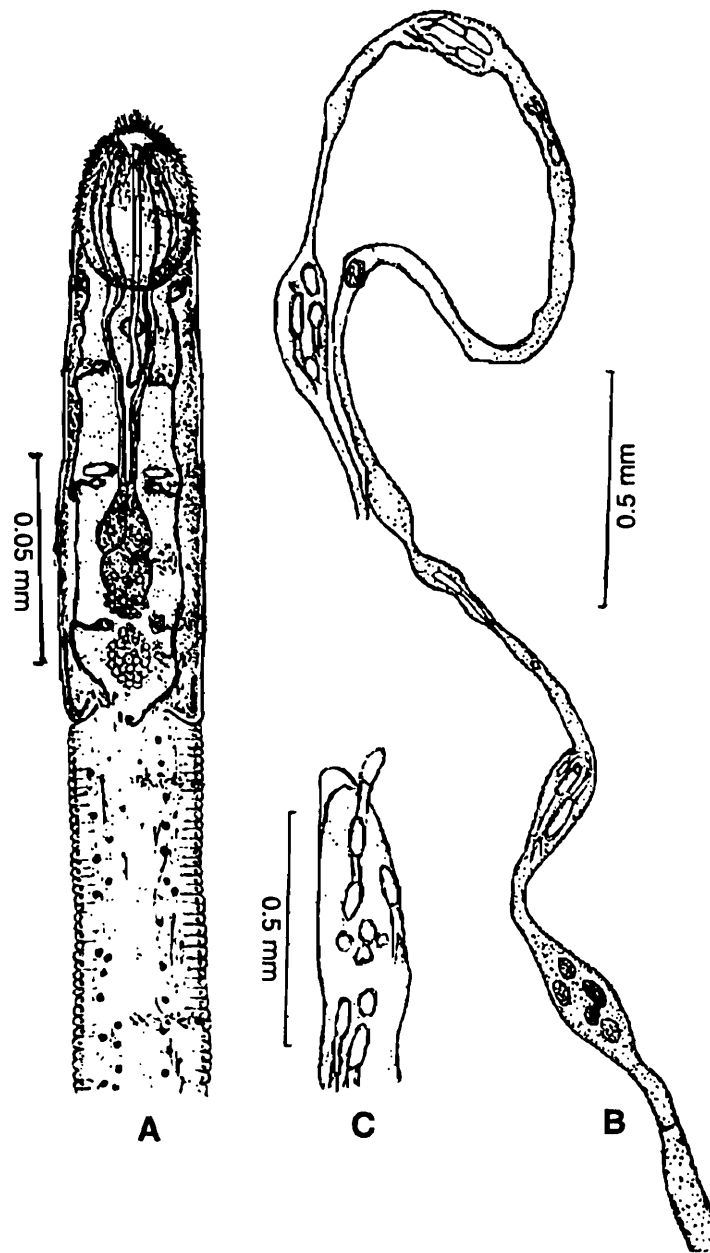


Fig. 65. A. *Cercaria hornifurca* Singh, 1953. B & C. Sporocyst of *C. hornifurca* Singh, 1953 (After Singh, 1953)

glands present 6-7 annulations; anterior end armed with thick backwardly pointing spines which extend upto half level of anterior penetration organ; at tip of anterior organ in circumoral spineless area present a clump of 10-12 forwardly pointing spines; tail-stem long, cylindrical, equal in width to that of body, nuclei present on either side and lumen occupied by parenchymatous cells and longitudinal muscles, annulations present, furcae long, horn like, nearly as long as tail-stem and not constricted off from their base, about 15 long sensory hairs present on each side of tail; a pair of simple unpigmented eye spots present at about middle of body; penetration glands two pairs, small, occupy middle region of body, ducts of these glands run together in a bundle upto level of caecum where ducts of respective pairs separate and run upto posterior

margin of anterior penetration organ and run through it and open on snout, these ducts become narrow before entering penetration organ and then expand; mouth subterminal; prepharynx long, narrow; pharynx small, globular, distinct; caecum as long as prepharynx and blind; excretory bladder tripartite, situated posterior end of body, from each antero-lateral lobe arises main lateral collecting duct which extends upto level of posterior pair of penetration glands and divide into anterior and posterior collecting tubules, anterior collecting tubules receives capillaries from three pairs of flame cells in anterior region of body whereas posterior collecting tubule receives two pairs of flame cells in posterior region of body, two pairs of flame cells present at about middle of tail-stem, caudal excretory duct runs through middle of tail-stem and after bifurcating into two branches at distal end enters each furca and open to middle of outer margin; true ventral sucker absent, small cell mass attached to posterior pair of penetration glands and slightly overlapped by them represents rudiment of ventral sucker; another more pronounced cell mass situated further back in between arms of main excretory collecting ducts and round compact body represents rudiment of reproductive organ.

Sporocysts long thread like, form and entangled mass; anterior end produced into snout; birth pore situated a little back from extreme anterior tip and guarded by two lips; cercariae and germ balls separated by constrictions; sporocysts show an independent worm like movement; they measure $2.0-4.0 \times 0.03-0.11$ in size.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Sobatiabagh tank, Allahabad, U.P.

67. *Cercaria hunterii* Singh (Fig. 66. A-C)

1952. *Cercaria hunterii* Singh, *Proc. Nat. Acad. Sci., India*, 22(B) : VI : 1-11.

Diagnosis : In fully extended cercaria anterior end draw near base of tail-stem; body in extreme contracted condition become globular; contraction and expansion of dorso-median fin-fold correlate with contraction and expansion of body; cercaria remains for a few seconds at one place and afterward moves away with tail in advance; furcae may contract one at a time but both may contract simultaneously, a furca contracts about half of its length; tail-stem usually remains well extended but it may contract along with furcae; body measures 0.09×0.04 in living condition; tail-stem measures 0.29×0.03 in living condition; furcae measure 0.10×0.03 in living condition; in fixed specimens body measures $0.07-0.09$ (0.08) \times $0.03-0.04$ (0.03); tail-stem measures $0.16-0.25$ (0.23) \times $0.01-0.02$ (0.02) in fixed condition; furcae measure $0.07-0.10$ (0.96) \times $0.01-0.01$ (0.01) in fixed condition; body small; tail-stem long and narrow; furcae less than half length of tail-stem and not sharply constricted at bases but pointed and bear very small finfolds at their tips; dorso-median fin-fold on body causes cercaria to lie on one

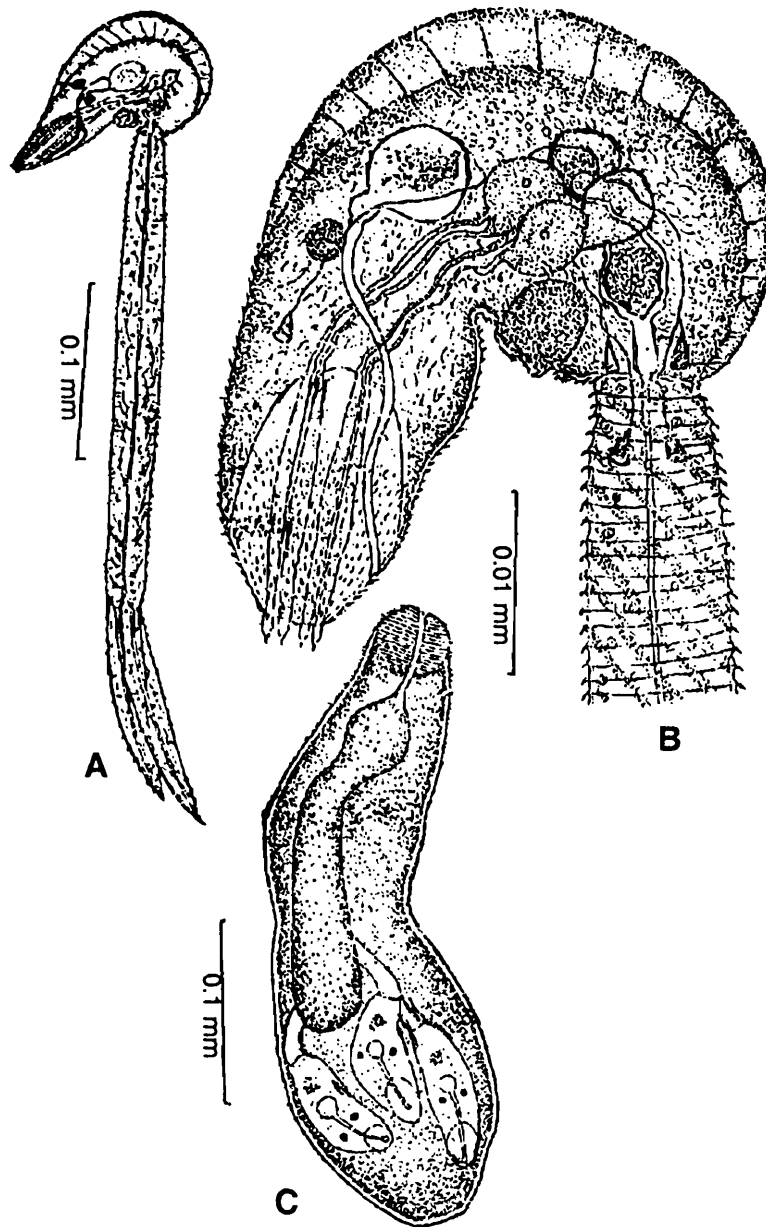


Fig. 66. A & B. *Cercaria hunterii* Singh, 1952. C. Redia of *C. hunterii* Singh, 1952 (After Singh, 1952).

side when placed under a cover slip; anterior end of body provided with a protrusible penetration organ, penetration organ narrow anteriorly and broader posteriorly, cercaria provided with a protrusible snout at extreme tip of penetration gland on which open ducts of penetration glands capped with hollow conical spines, penetration organ measures $0.02-0.03 \times 0.01-0.01$, penetration organ simple and devoid of any muscular sheath separating its posterior region from rest of body proper; anterior end of body with thick, dense, small staggered spines extending backwards upto half level of anterior penetration organ; rest of body surface sparsely covered with sharp, conical spines, curved at their tips; tail-stem and furcae provided with fine backwardly pointed and curved tips spines; body transparent with light greenish colour in living cercaria;

numerous parenchymatous cells present in body and more in posterior region than in anterior part; body pyriform in shape, anterior part narrow and elongate, posterior part broad and thick, body in maximum extension measures 0.01×0.05 and under maximum contraction measures 0.06×0.05 ; dorsomedian crest extends from level of eye spots to posterior end of body, crest when thrown into folds seems to possess cuticular fin rays which vary from 22-24 in number, crest may obliterated when body expands, in fixed specimens crest generally disappears; tail-stem forms an angle with body, tail-stem long, narrow, armed with sharp backwardly directed spines, spines curved at tips, tail-stem capable of contraction and expansion, it measures 0.29 in contracted state and 0.32 in fully extend condition, fine annulations and circular and longitudinal muscles present, round cells with nuclei present in tail-stem; conical furcae not sharply set off from tail-stem contain large scattered spines, excretory pore situated on tip of each furca; a pair of pigmented eye spots present dorso-laterally at about 0.04 from anterior end of body, in optical section eye spots appear crescentic with their concavities directed forwards and upwards; ventral sucker indistinct, represented by a mass of small rounded cells located a little in front of base of tail-stem in ventral surface, it measures about 0.01-0.02 in diameter; an irregular mass of cells representing genital primordium lies near posterior end dorsal to ventral sucker and ventral to penetration glands; mouth opening small, median, ventral, slightly posterior to middle of anterior penetration organ and at about 0.02 from anterior end; oesophagus long, narrow, runs in a curved manner upto posterior margin of eye spots, it narrow anteriorly and widens posteriorly, behind eye spots it ends into a large delicate thin walled, spherical, undivided sac like caecum; caecum filled with granular food material; penetration glands small, indistinct, in two pairs, situated ventrally just behind caecum, ducts from these glands run forwards, enter penetration organ laterally and open at tip of snout through hollow conical spines, inside penetration organ ducts become thick and rod like; excretory system consists of a small "V" shaped bladder situated at junction of body and tail-stem, main collecting tubes coil anteriorly from excretory bladder and about middle of body divide into anterior and posterior excretory ducts, anterior duct connects capillaries from two flame cells in anterior region of body—one located antero-lateral to eye spot and other latero-postero-dorsal to caecum, posterior tubule collects from a single flame cell located at level of excretory bladder by its side and then passes into tail-stem to end in a single flame cell at base, excretory formula can be represented by $2[(1+1) + (1+ [1])] = 8$.

Redia measures 0.07×0.02 ; pharynx opens into a small oesophagus; intestine wide, filled with black and brown substance, extends upto posterior end of body; body wall with a single layer of cells; small cuticular spines present anterior one third of body and rest of body surface devoid of spines; each redia with several cercariae; birth pore situated laterally behind pharynx.

Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Ahimanpur, Allahabad.

68. *Cercariae indicae* XV Sewell
(Fig. 67. A & B)

1922. *Cercariae indicae* Sewell, *Indian J. Med. Res.*, Suppl (X) : 280-290.

Diagnosis : *Cercaria* very active, swims rapidly by lashing of tail from side to side, it moves through water tail first body being dragged behind; body shows considerable degree of extension and contraction, body measures 0.32-0.37 in length and 0.07-0.16 in breadth; tail-stem capable of marked elongation and contraction, measures 0.21-0.37 in length and 0.05-0.07 in diameter furcal rami measure 0.26-0.32 in length; in semi-contracted condition body appears pyriform, anterior end being tapered somewhat sharply rounded, markedly flattened from above downwards, tissues of body show a pale brownish tinge; tail-stem attached to ventral aspect of posterior end of body, well developed layer of circular muscle-fibres situated beneath cuticle and more internally a well marked layer of oblique muscle-fibres which run backward and inward and rounded to oval nuclei still more internally and surrounding central excretory canal a mass of parenchymatous cells of a pale brown tinge with rounded nuclei, furcal rami flattened from side to side, along each margin runs a fin-fold which exhibits a faint striation resembling a series of delicate hair-like fin rays, at distal end of ramus two fin-folds become continuous and fold joint thickened to form a pyriform mass, furcae arise from distal end of tail-stem and not constricted off from it; anterior sucker not a true sucker but nature of a protrusible penetrating organ, rounded or pyriform in shape, extended condition it measures 0.06 in length and 0.05 in greatest breadth, its free anterior surface armed with a number of circular rows of fine refractile recurved spines and portion enclosed within body surrounded by a layer of circular muscle fibres; body and tail devoid of any spines; a very minute sucker like pit (not a true sucker) present on ventral surface about 1/3 body length from posterior end, on pressure form cover-slip this pit entirely disappears and position seen to be occupied by a mass of small round parenchymatous cells; mouth small, subterminal; prepharynx short; pharynx small and well developed, circular in outline and measures 0.02 in diameter; oesophagus long, anterior half usually somewhat constricted and of small calibre, posterior part wide dilated tube which after a short course divides at about 1/3 body length from anterior end into two wide intestinal caeca; caeca extend back as far as level of excretory bladder, clear wide intestinal caeca a very characteristic feature of body, tissues of body give a pale brownish tinge so caeca show up very clearly as white spaces; salivary glands four sets on each side of body—first set of three pairs of finely-granular cells contained within muscular capsule of anterior penetrating organ, form a more or less pyriform mass and ducts of which pass forward to open on tip of snout, second set of three or four finely granular cells situated behind and to outer side of sucker, ducts of these cells pass forwards laterally to open on snout, third set of a pair of pyriform granular cells lie on each side of and immediately behind pharynx their ducts pass forward between first and second sets of salivary gland cells, fourth set of elongated mass of small granular cells situated laterally and extending backward along sides of body to level of or somewhat behind

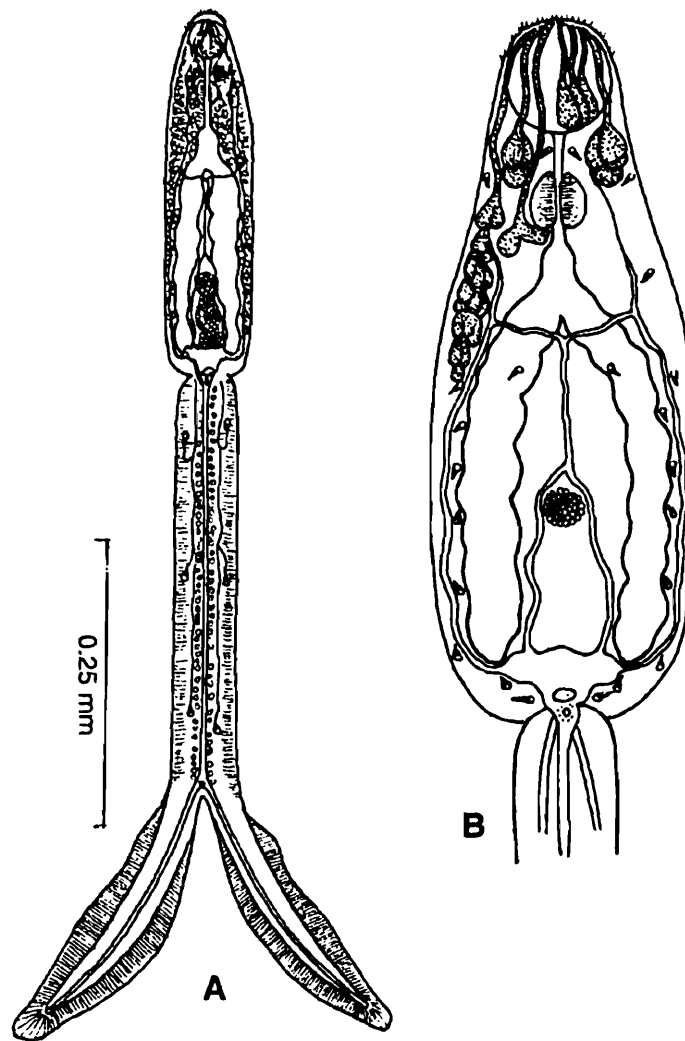


Fig. 67. A & B. *Cercariae indicae* XV Sewell, 1922. (After Sewell, 1922).

point of bifurcation of intestine, ducts from these gland cells pass forward laterally and also appear to open on snout; excretory system highly developed, trifoliate excretory bladder situated posteriorly, excretory pore opens from posterior lobe of bladder on dorsal aspect of point of attachment of tail, four main canals—two on each side of body leave anterolateral lobes of bladder, a pair of ducts arise laterally and pass forward in body lying to outer side of wide intestinal caeca as far as level of bifurcation of oesophagus, at this point they divide and one branch passes forward to side of pharynx while other passes inward and backward crossing intestinal caecum near its origin to unite with its fellow and form an anastomosis across middle line, from anterior region of bladder and somewhat internal to origin of first pair of canals a second pair of ducts arise which pass forward internal to intestinal caeca and about middle of body-length these latter unite to form a single median canal which continued forward to join cross-connection between lateral canals, with exception of median pair of excretory canals all remaining tubes contain a number of small scattered refractile globules composed of excretory material, a caudal excretory canal arises from posterior end of bladder by a typical 'Islet' aperture and after passing backward to distal end of tail-

stem divides into two branches each of which passes along corresponding furcal ramus to its extreme tip, twelve pairs of flame-cells present in body and three pairs in tail-stem, connections of flame-cells in tail-stem appear to be somewhat unusual, all three flame-cells on each side connect with a single longitudinal lateral capillary vessel which passes forward and apparently joins caudal canal close to its origin from bladder opposite islet; genital organs represented by an oval or hour-glass shaped mass of small rounded cells situated towards ventral aspect of body between two intestinal caeca and extending forwards from excretory vesicle to region of so-called ventral sucker.

Sporocysts long sausage-shaped; measure 4.38-4.91 in length and 0.26-0.35 in breadth; fully developed sporocyst contains 40 to 50 cercariae; sporocyst quite active, exhibiting elongation and contraction as well as writhing movements, outline shows a series of transverse rings which give it to a segmented appearance, rings caused by circular bands of transverse muscle-fibres; body wall thick and well developed; one end of sporocyst situated a solid mass of parenchyma, large body cavity communicates by a terminal orifice with exterior, orifice act as a birth pore; these sporocysts developed within still large parent sporocysts which found living free in cavity of rectum or in tissues at upper end of branchial chamber of mollusc host, infected mollusc host contains several of these parent sporocysts; these parent sporocysts measure 9.60 in length; in immature and small sporocysts transverse muscular bands in body-wall appear to be regular in distribution occasionally with a well marked transverse constrictions which may be due to localised muscular contraction; in larger sporocysts terminal birth pores situated at one end and at both ends incomplete and irregular transverse muscle bands giving rise to a number of irregular ridges and projections on surface.

Snail Host : *Melanoides tuberculatus*, *Melanoides lineatus*.

Localities : A tank in Zoological Garden, Alipore, a tank in Indian Museum, Calcutta.

Remarks : The sporocysts of this cercaria are capable to produce not only cercariae but miracidia. A brief account of the structure of the miracidia is given below :

Miracidium measure 0.17 in length; anterior end produced into a bluntly pointed apex devoid of cilia and can be retracted within body thus forming a small apical pit, external surface covered with cilia which arise from roughly hexagonal cells; a pattern of fine double lines can be made out over anterior half of body this indicate boundaries of ciliated epithelial cells; anterior pole composed of six cells and behind this a second ring of six cells; two circular vessels surround body-anterior circular canal situated at level of anterior ducts and from it six canals be traced out running forward towards anterior end, opposite to origin of these canals six posteriorly directed canals pass backward to join second circular canal surrounding middle of body this latter produced backward in a series of loops, a pair of anterior ducts situated laterally between cephalic region and body proper, each duct forms a pyriform vesicle blunt ends of

which form a slight bulge on surface and devoid of cilia, narrow ends produced inward and backward into a tube that runs backward in body as far as region of anterior flame-cell of same side, these tubules surrounded by a mass of small round parenchymatous cells; rudiment of alimentary canal passes backward as an elongate sausage-shaped cavity from extreme anterior tip, it constricted in its middle third where it passes ventrally to large central nervous mass; either side of stomach and extending backward for about 1/3 of body-length along lateral margins of body situated a pair of salivary glands, connected anteriorly with apical papilla and composed of a number of pyriform finely-granular cells; central nervous system composed of a rounded mass with crenated margins situated about 1/3 of body length from anterior end and dorsal to stomach, bluntly rounded end projects somewhat behind it; excretory system possesses two pairs of flame cells, both pairs work in an anterior direction, flame cells large in proportion to size of body, each flame cell provided with a fine capillary tube, capillary from anterior flame cell passes forward as far as posterior end of salivary gland and then turns backward, it joined a short distance behind middle of body by capillary from posterior flame cell of same side, excretory tube thus formed passes backward and forms a figure-of-eight loop, it then turns back again and forms a spiral coil just behind figure-of-eight loop, finally passing outward to open on surface of body near lateral margin; a wide 'V' shaped space in body cavity of which each limb of 'V' running forward and outward and conjoined apex being posterior and near extreme end of body, each limb of cavity contained several large germ cells.

69. *Cercariae indicae* LXV Murty

(Fig. 68. A-C)

1975. *Cercariae indicae* LXV Murty, *Proc. Indian. Acad. Sci.*, **82**(B) : 122-123.

Diagnosis : *Cercariae* shed during all hours of day, maximum number emerge in morning, cercaria hangs upside down when in rest with rami spread out and body bent in middle resembling a hook; body cylindrical sides almost parallel to each other, when contracted 6-8 annulations appear on body between anterior organ and penetration glands, body spinulate with a circumoral spineless area; lateral bristles three pairs present on body; tail-stem aspinose, longer than but as wide as body, tail-stem with twenty pairs of uniformly distributed lateral bristles, cuticle annulated, rami as long as stem; anterior organ well developed; ventral sucker weakly developed, posterior to penetration glands; mouth subterminal, small; prepharynx distinct; pharynx distinct; post-pharyngeal digestive system not developed; penetration glands two pairs, postequatorial, glands not very conspicuous, ducts run lateral to pharynx and open lateral to mouth, coarsely granular contents; excretory system mesostomate, excretory bladder almost quadrangular with slight median constriction, ciliated patches in main ducts as well as anterior and posterior tubules present, flame cell formula represented by $2 [(2+2) + (2+2) + 2] = 20$, flame cells in tail asymmetrically arranged, an "Island of Cort" discernible at origin of caudal tube, lateral forks of caudal canal

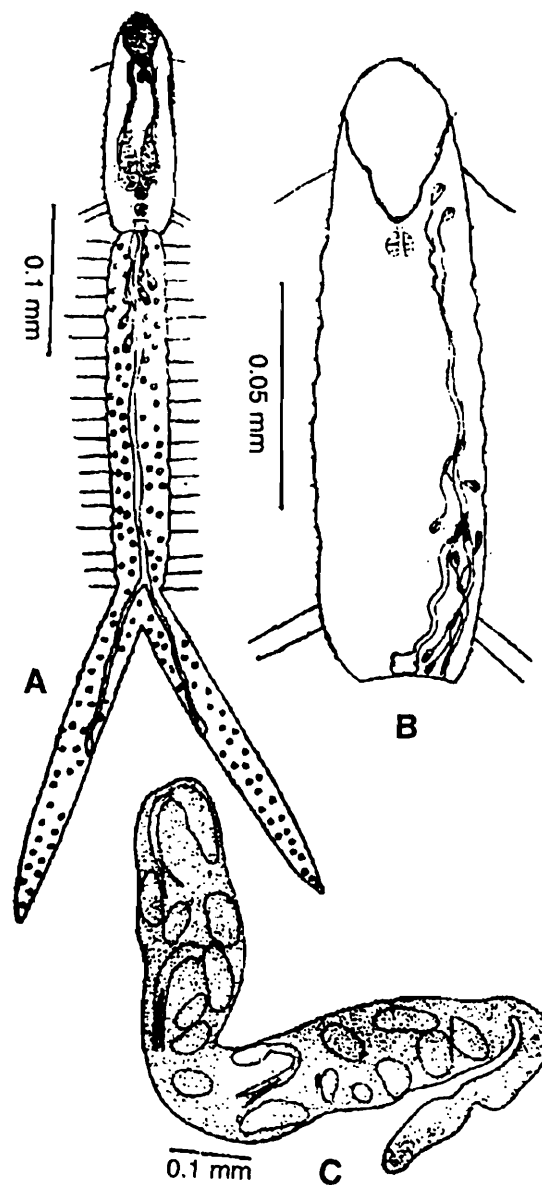


Fig. 68. A & B. *Cercariae indicae* LXV Murty, 1975. C. Sporocyst of *C. indicae* LXV Murty, 1975. (After Murty, 1975).

open laterally half way down on rami through flask-shaped dilations; genital rudiments represented by cells situated anterior to excretory bladder; body measures 125μ - $156\mu \times 34\mu$ - 45μ ($137\mu \times 38\mu$); tail-stem measures 184μ - $240\mu \times 28\mu$ - 36μ ($207\mu \times 32\mu$), rami measure 192μ - $240\mu \times 16\mu$ - 24μ ($208\mu \times 18\mu$); anterior organ measures 26μ - $36\mu \times 16\mu$ - 24μ ($31\mu \times 21\mu$).

Sporocyst pigmented, forms a tangled mass; longest sporocyst measures $5,080\mu$, smallest measures $1066\mu \times 108\mu$.

Snail Host : *Indoplanorbis exustus*

Location : Liver.

Locality : Kondakarla lake, Andhra Pradesh.

70. *Cercaria indicae* LXXXII Sultana
(Fig. 69. A)

1982. *Cercaria indicae* LXXXII, Sultana, *Proc. Indian Acad. Parasit.*, 3(1 & 2) : 95-96.

Diagnosis : Body pyriform, flattened, tapering, rounded anterior part, covered with minute spines directed backward, large spines present antero-ventral part around circum oral region; moderate size oral organ occupies anterior part of body, surrounded by circle of cilia which can be protruded and retracted; tail-stem attached dorsally at posterior extremity of body immediate behind excretory bladder, furcal rami laterally flattened, arise from distal extremity of cylindrical tail-stem, fin-folds absent, tail-stem and furcal rami with minute spines, a number of sensory hairs present in pairs on tail-stem and furci at irregular intervals sensory papillae present at base of each sensory hairs, longer ciliary hairs present at tip of each ramus; mouth sub-terminal; pharynx globular; prepharynx long narrow; oesophagus short, it makes a knot before bifurcation into two caecae; caecae thin walled, broad, tortuous, extend to level of

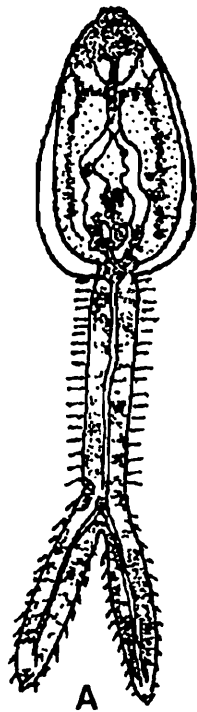


Fig. 69. A. *Cercaria indicae* LXXXII
Sultana, 1982. (After Sultana,
1982)

excretory bladder; penetration glands two sets— an anterior set of 5 cells lying on either sides of anterior organ and a posterior set of 4 cells lying on either side of pharynx, ducts of these gland cells open at anterior tip of body; another type of glandular cells located at dorso-lateral sides of body, these elongated cells open by short duct at body surface; ventral sucker rudimentary; excretory system Vivax type, excretory bladder roughly triangular in shape, it receives 4 ascending trunks—two median and two lateral, median trunks run forward separately for short distance anterior to genital sucker before joining each other to form a common median trunk which extends anteriorly almost upto oesophagus where it divides into two lateral horizontal branches across intestinal caecae and join lateral ascending trunks, one pair of collecting tubes arise from lateral ascending trunk slightly posterior to above mentioned junctions, each anterior collecting tubule receives capillaries from three groups of three flame cells and each posterior collecting tubule originates in tail-stem where it receives three flame cells and runs forward close to caudal excretory canal, posterior collecting tubule receives two groups of three flame cells, flame cell formula represented by $2 [(3+3+3) + (3+3+ (3))] = 36$, caudal excretory tube arises from posterior end of bladder and after making 2 to 3 loops at proximal end passes backward to distal end of tail-stem, divides into two branches each of which

excretory bladder; penetration glands two sets— an anterior set of 5 cells lying on either sides of anterior organ and a posterior set of 4 cells lying on either side of pharynx, ducts of these gland cells open at anterior tip of body; another type of glandular cells located at dorso-lateral sides of body, these elongated cells open by short duct at body surface; ventral sucker rudimentary; excretory system Vivax type, excretory bladder roughly triangular in shape, it receives 4 ascending trunks—two median and two lateral, median trunks run forward separately for short distance anterior to genital sucker before joining each other to form a common median trunk which extends anteriorly almost upto oesophagus where it divides into two lateral horizontal branches across intestinal caecae and join lateral ascending trunks, one pair of collecting tubes arise from lateral ascending trunk slightly posterior to above mentioned junctions, each anterior collecting tubule receives capillaries

passes along each furcal ramus and opens at excretory pore at a short distance, "Island of Cort" present; nervous commisure present across oesophagus, it divides into anterior and median and posterior nerve cord; rudiments of gonads represented by bean-shaped mass of cells, lies in front of excretory bladder; genital sucker distinct at anterior end of germinal primordium.

Snail Host : *Vivipara bengalensis*.

Locality : Hussain Sagar Lake, Hyderabad.

71. *Cercaria indicae* LXXXIII Sultana
(Fig. 70. A)

1982. *Cercaria indicae* LXXXIII, Sultana, *Proc. Indian Acad. Parasitol.*, 3(1 & 2) : 96-97.

Diagnosis : This cercaria resembles strongly with *Cercaria indicae* LXXXII, basic morphological details and systems same in both these cercariae. This species differs from *C. indicae* LXXXII chiefly in smaller size; anterior extremity of anterior oral organ provided with two pairs of cilia; oesophagus long; intestinal caeca short, slightly tortuous, not reaching upto excretory bladder; digestive system filled with brownish granules; tail-stem with caudal bodies arranged in 4 rows—two median and two dorso-lateral; ventral sucker and genital sucker indistinct, union of median ascending excretory canals near bifurcation point of oesophagus.

Snail Host : *Vivipara bengalensis*.

Locality : Ramappa Lake, Warangal district.

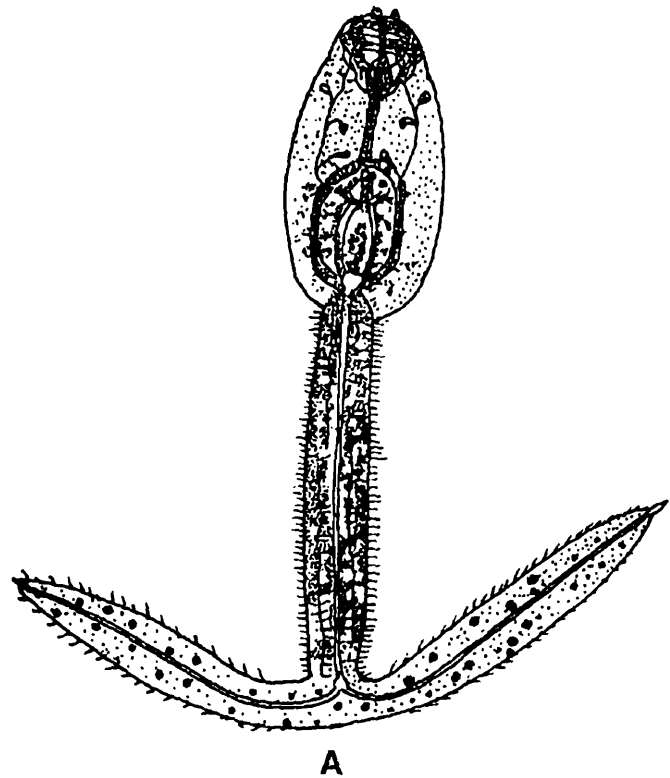


Fig. 70. A. *Cercaria indicae* LXXXIII Sultana, 1982 (After Sultana, 1982)

72. *Cercaria kaniharii* Singh
(Fig. 71. A & B)

1955. *Cercaria kaniharii* Singh, *Proc. Nat. Acad. Sci. India*. 25(B) III-IV : 37-40.

Diagnosis : Cercariae after emerging from snail host hang in water, anterior end bent ventrally to form a characteristic hook, tail remains well extended and furcae diverging at an angle of about 90° to tail-stem, cercaria remains hanging motionless

for sometime when furcae suddenly flip and cercaria shoots upward, cercaria moves forward with tail advance dragging body behind; annulations of about seven in number present in anterior half of body when cercaria elongates its body but they disappear with contraction of body, body smaller and tail and furcae of almost same length; under cover glass pressure body, tail and furcae measure 0.19, 0.26, 0.25 in length respectively; body and tail-stem measures 0.03 and 0.04 in width respectively; furcae measure 0.02 in width at base; body of fixed specimen measures 0.23-0.31 (0.28) × 0.03-0.03 (0.03); tail-stem in fixed specimen measures 0.33-0.38 (0.30) in length and width equal to that of body; furcae in fixed condition measure 0.33-0.36 (0.35) long and uniform width of about 0.02; body elongated with round, narrow anterior end and a sub-quadrate posterior end; large anterior penetration organ elongated in shape, it empties into a very narrow prepharynx; pharynx tiny and globular; gut rhabdocele,

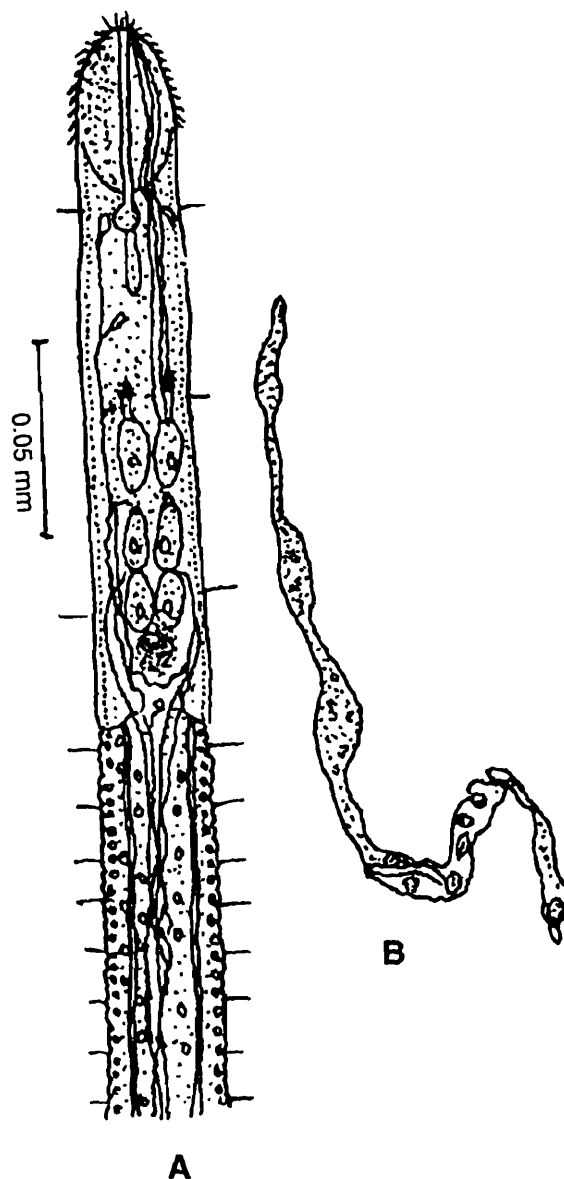


Fig. 71. A. *Cercaria kaniharii* Singh, 1955. B. Sporocyst or *C. kanihari* Singh, 1955 (After Singh, 1955).

located posterior to pharynx; anterior penetration organ measures $0.05-0.06 \times 0.026$ in fixed specimens; ventral sucker represented by a mass of small rounded cells, situated between anterior and posterior pairs of penetration glands; penetration glands six in number, large, clearly nucleated, lie posterior region of body, three glands of each side arranged in linear fashion and their ducts run anteriorly to enter into anterior penetration organ where they become greatly swollen and open at anterior end in association with large spines located dorsal to opening of mouth in a circumoral spineless area; germinal cells represented by a mass, situated posterior to penetration glands and anterior to excretory bladder; body with scattered small nuclei and with a few long sensory hairs; tail-stem with sensory hairs of about 15 in number on each side, surface nuclei present along either side of tail-stem and also to furcae; in contracted specimens fine annulations can be seen in tail and furcae; furcae bear minute spines at bases and end in sharp points; anterior end of oral apparatus covered with small thick spines but they thin out posteriorly reaching only to a point about mid-way between anterior organ and eye spots; small pigmented eyes present almost to middle of body; excretory bladder small, lies at posterior end of body and constricted in its middle and appears as double bladder, "Island of Cort" present, main excretory ducts originate from antero-lateral arms of bladder, each main collecting duct anteriorly divides into an anterior and posterior branches, three capillaries each with flame cell join anterior branch of main duct whereas branches of posterior duct end in five flame cells of which three situated inside body and two in tail, a single median tube extending from posterior end of bladder runs along longitudinal axis of tail-stem and divides near furcae, branch of this tube extends to one half of each furca and opens at its lateral border.

Daughter sporocyst yellow in colour; thread-like, tangled in liver mass of host; filled with germ balls and developing cercariae; anterior ends with birth pore; wall constricted at places.

Snail Host : *Indoplanorbis exustus*.

Location : Liver.

Locality : Ahimanpur Village, Allahabad.

73. *Cercaria milleri* Pandey and Agrawal
(Fig. 72. A-C)

1977. *Cercaria milleri* Pandey and Agrawal, *Indian J. Zoot.*, XVIII(1) : 27-30.

Diagnosis : Cercariae come out of snails throughout whole day but come out in large numbers during morning hours, swim rapidly by lashing movement of their tail, while swimming they rest for a while with their body downwards and with stretched furcae; cercaria spinose, elongate oval body with blunt ends; protrusible organ terminal, rounded; ventral sucker poorly developed, represented by an oval mass of cells, located in posterior half of body; prepharynx absent; pharynx muscular, rounded; oesophagus

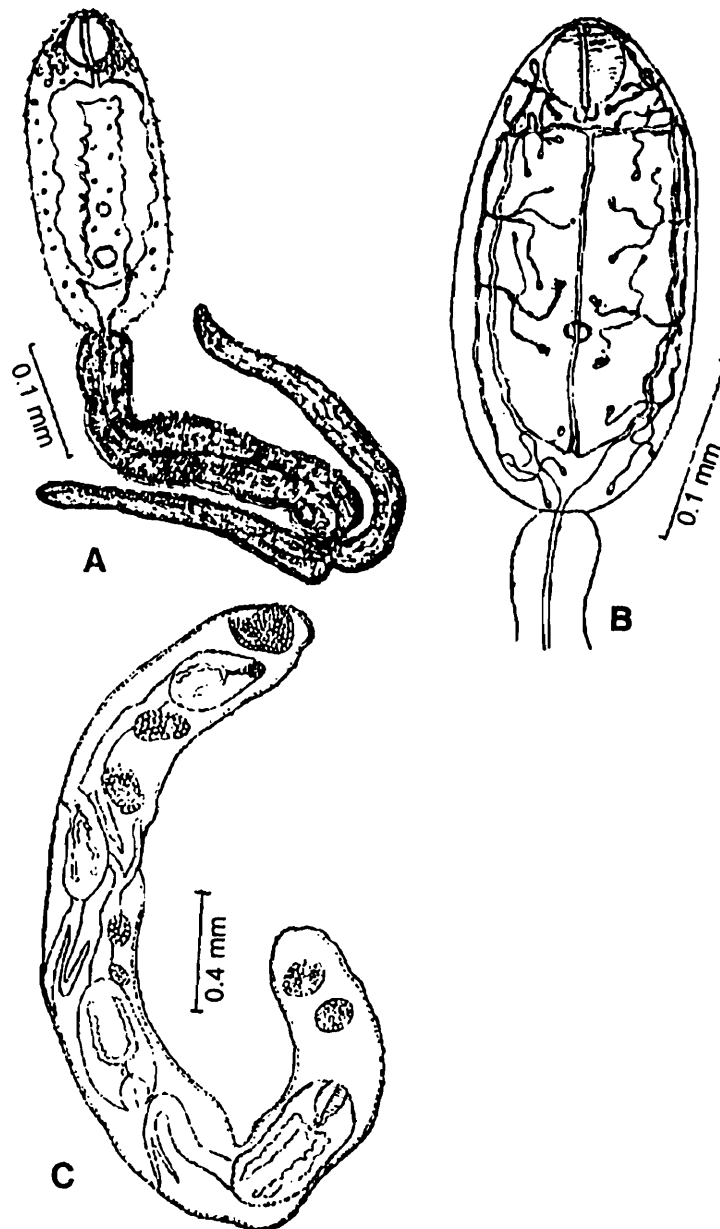


Fig. 72. A & B. *Cercaria milleri* Pandey and Agrawal, 1977. C. Sporocyst or *C. milleri* Pandey and Agrawal, 1977. (After Pandey and Agrawal, 1977).

short; intestinal caeca crenated, broad, extend almost upto excretory vesicle; in living condition body measures 0.22-0.29 (0.25) \times 0.09-0.15 (0.12) and in fixed condition it measures 0.15-0.17 (0.16) \times 0.06-0.08 (0.07); tail-stem in living condition measures 0.29-0.32 (0.30) \times 0.05-0.06 (0.59) and in fixed condition it measures 0.21-0.23 (0.22) \times 0.04-0.06 (0.05); furcal rami measures 0.25-0.27 (0.26) \times 0.04-0.04 (0.04) in living and 0.14-0.16 (0.15) \times 0.02-0.02 (0.02) in fixed conditions; anterior protrusible organ measures 0.04-0.06 (0.05) \times 0.03-0.05 (0.04) in living and 0.02-0.03 (0.02) \times 0.02-0.04 (0.03) in fixed conditions; pharynx measures 0.04-0.05 (0.04) \times 0.08-0.04 (0.03) in living and 0.01-0.01 (0.01) \times 0.01-0.01 (0.01) in fixed conditions; penetration glands nine pairs, located around anterior protrusible organ, each opens outside through a

small pore, gorged with fine granulas, prominent basal nuclei, appears to be acidophilic in reaction; cystogenous glands irregular, contain fine granules, distributed all over body; a rounded mass located anterior to excretory bladder represents ganital rudiments; tail aspinose, longer than body, small furcal rami; well developed circular, longitudinal, oblique muscles and caudal bodies; excretory bladder 'V' shaped, two main collecting canals one on each side of body originate from excretory bladder and run anteriorly upto level of pharynx and join together by a short transverse canal, each main collecting canal divides in pharyngeal region into an anterior and posterior collecting canals, anterior collecting canal gives out two short branches each with 3 capillaries from flame cells, posterior collecting canal bears 3 short branches and each trifurcates into capillaries ending in flame cells, from transverse canal originates a median longitudinal canal which runs posteriorly in middle region of body to open at excretory bladder, flame cell formula can be represented by $2 [(3+3) + (3+3+3)] = 30$, caudal canal runs to tail-stem and bifurcates to open outside through excretory pores at tip of furcal rami.

Sporocysts elongated, yellowish in colour; contain 3-7 mature cercariae, developing cercariae and germ balls; body measures $3.00-3.80 (3.38) \times 0.29-0.32 (0.30)$ in living condition and $2.87-2.98 (2.92) \times 0.22-0.25 (0.23)$ in fixed condition.

Snail Host : *Vivipara bengalensis*.

Location : Hepatopancreas.

Locality : Kathauta Tal, Lucknow.

74. *Cercaria sewelli* Pandey and Agrawal (Fig. 73. A-C)

1977. *Cercaria sewelli* Pandey and Agrawal, *Indian J. Zoot.*, XVIII(1) : 31-33.

Diagnosis : Cercariae emerge mostly in morning but continue to shed during day, swim by lashing movement of their tail, it hangs down in a flexed condition during rest with body downwards and with stretched furcal rami; body spinose, pear shaped, blunt anterior and round posterior ends; anterior protrusible organ smooth, weakly muscular, rounded shape protudes from body; ventral sucker poorly developed, located in middle region of body; mouth leads to an oval pharynx; prepharynx absent; oesophagus short; intestinal caeca sinuous, broad, extend posteriorly upto level of excretory bladder; body measures $0.39-0.50 (0.44) \times 0.19-0.28 (0.23)$ in living and $0.17-0.22 (0.21) \times 0.08-0.10 (0.09)$ in fixed conditions; tail-stem measures $0.37-0.46 (0.41) \times 0.02-0.03 (0.03)$ in living and $0.19-0.27 (0.23) \times 0.01-0.03 (0.02)$ in fixed conditions; furcal rami measure $0.26-0.29 (0.27) \times 0.04-0.05 (0.04)$ in living and $0.13-0.22 (0.17) \times 0.01-0.02 (0.02)$ in fixed conditions; anterior sucker measures $0.05-0.07 (0.06) \times 0.06-0.08 (0.07)$ in living and $0.03-0.03 (0.03) \times 0.02-0.03 (0.03)$ in fixed conditions; pharynx measures $0.02-0.03 (0.03) \times 0.03-0.05 (0.04)$ in living and $0.01-0.01 (0.01) \times 0.01-0.01 (0.01)$ in fixed conditions; ventral sucker measures $0.03-0.04 (0.04) \times 0.02-0.04 (0.03)$

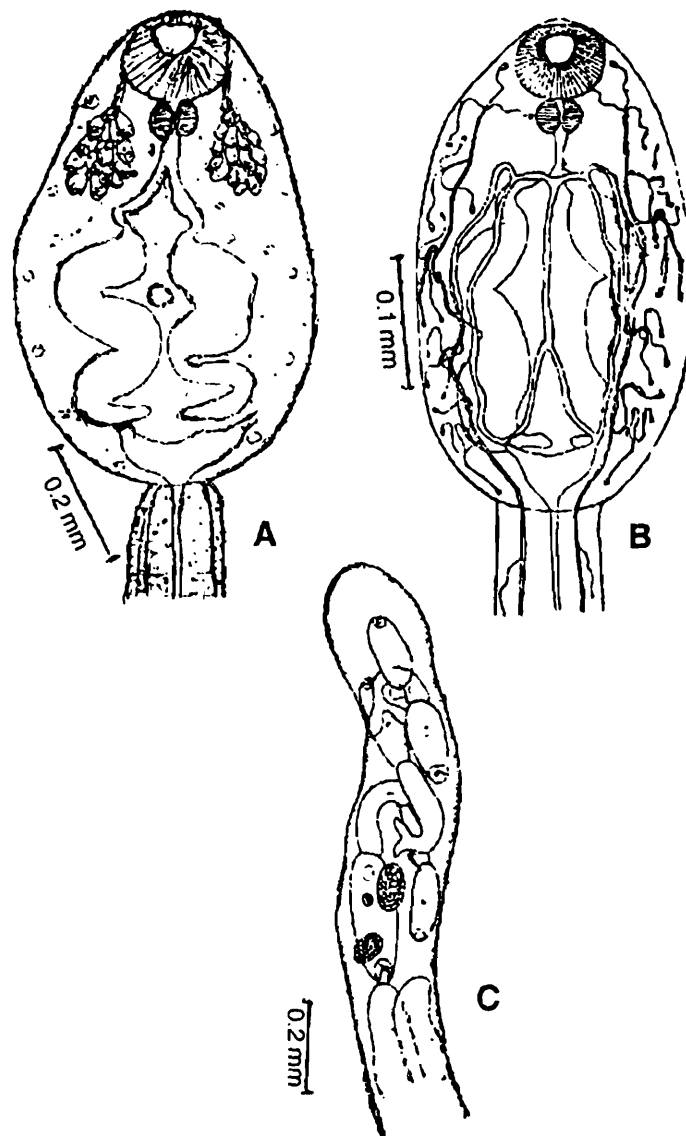


Fig. 73. A & B. *Cercaria sewelli* Pandey and Agrawal, 1977. C. Sporocyst of *C. sewelli* Pandey and Agrawal, 1977. (After Pandey and Agrawal, 1977).

in living and 0.01-0.01 (0.01) × 0.01-0.01 (0.01) in fixed conditions; penetration glands 18 in number located on either sides of anterior protrusible organ, each gland small, oval, with short duct, opens at tip of anterior protrusible organ, gorged with fine granules, centrally placed nucleus; cystogenous glands oval in shape with finely granular cytoplasm; small brown particles also distributed all over body; genital rudiment represented by a rounded mass, located anterior to excretory bladder; aspinose tail larger than body while furcal rami small not sharply marked off from tail-stem, a large number of caudal, bodies, irregularly arranged within well develop circular longitudinal and oblique muscles present; excretory bladder 'V' shaped, medially situated at hind end of body, main collecting canal one on each side of body originates from anterolateral cornua upto region of intestinal bifurcation and divides into an outer and inner branches, inner branch runs transversely for a short distance,

unites with opposite side branch in median region of body to form a transverse canal, outer branch turns downward and runs roughly upto middle of body, divides into two fine branches—an anterior collecting canal and a posterior collecting canal, former runs upto region of pharynx and divides into 3 short branches each with 3 capillaries capped with flame cells while posterior canal runs posteriorly, divides into 2 fine branches each with 3 capillaries capped with flame cells, further it runs upto tail-stem and gives 3 more capillaries on its way each capped with a flame cell, a median longitudinal canal originates from transverse canal, runs upto ventral sucker where it divides into two short branches each opening into cornua of excretory bladder of its side, flame cell formula can be represented by $2 [(3+3+3) + (3+3)] = 30$ in body and $2 (1+1+1) = 6$ in tail-stem.

Sporocyst long, tubular, thin walled; measures $0.15-4.27 (3.21) \times 0.12-0.21 (0.17)$ in living and $1.95-2.99 (2.47) \times 0.09-0.13 (0.11)$ in fixed condition.

Snail Host : *Vivipara bengalensis*.

Location : Digestive glands.

Locality : Kathauta Tal, Lucknow.

75. *Cercaria shikarii* Singh

(Fig. 74. A-C)

1966. *Cercaria shikarii*, Singh, *Proc. 2nd All-India Conor. Zool.*, Pt. 2 : 382-391.

Diagnosis : *Cercaria* shows a short period of rest and vigorous swimming, in resting state body hangs downward with tail turned upwards and furcae diverged at an angle, swimming intermitent and unless disturbed larvae remain suspended; body elongate pyriform, bluntly pointed anterior end; tail attached dorsally at posterior end of body immediately behind excretory bladder; furcal rami flattened, devoid of finlets, not constricted off from tail-stem, tail-stem without caudal bodies but with powerful muscles and lateral rows of nuclei; minute spines present on body, tail-stem and furcae; spines on oral cap small, stout, arranged in transverse rows; twelve pairs of long hairs present on body and twenty pairs on tail; body measures $0.50-0.56 (0.54) \times 0.22-0.28 (0.25)$; tail-stem measures $0.49-0.54 (0.51) \times 0.08-0.09 (0.08)$; furcal rami measure $0.40-0.44 (0.42) \times 0.05-0.05 (0.05)$; anterior penetration organ oval to circular in shape, measures $0.09-0.10 (0.09) \times 0.08-0.09 (0.08)$; ventral sucker represented by a mass of small rounded cells lying a little behind equator of body; mouth subterminal, anteriorly located; prepharynx present, measures 0.10 long; pharynx present, globular, muscular, measures $0.24-0.03 \times 0.02-0.03 (0.03 \times 0.02)$; oesophagus measures $0.06-0.07 (0.06)$ in length and ends in two intestinal caeca; intestinal caeca long, prominent structures, wide, sinuous with crenated margins, extend posteriorly upto anterior margin of excretory bladder; penetration glands coarsely granular, divided into anterior and posterior sets, anterior set consists of two small nucleated cells on each side of median line in anterior penetration organ, posterior set composed of seven

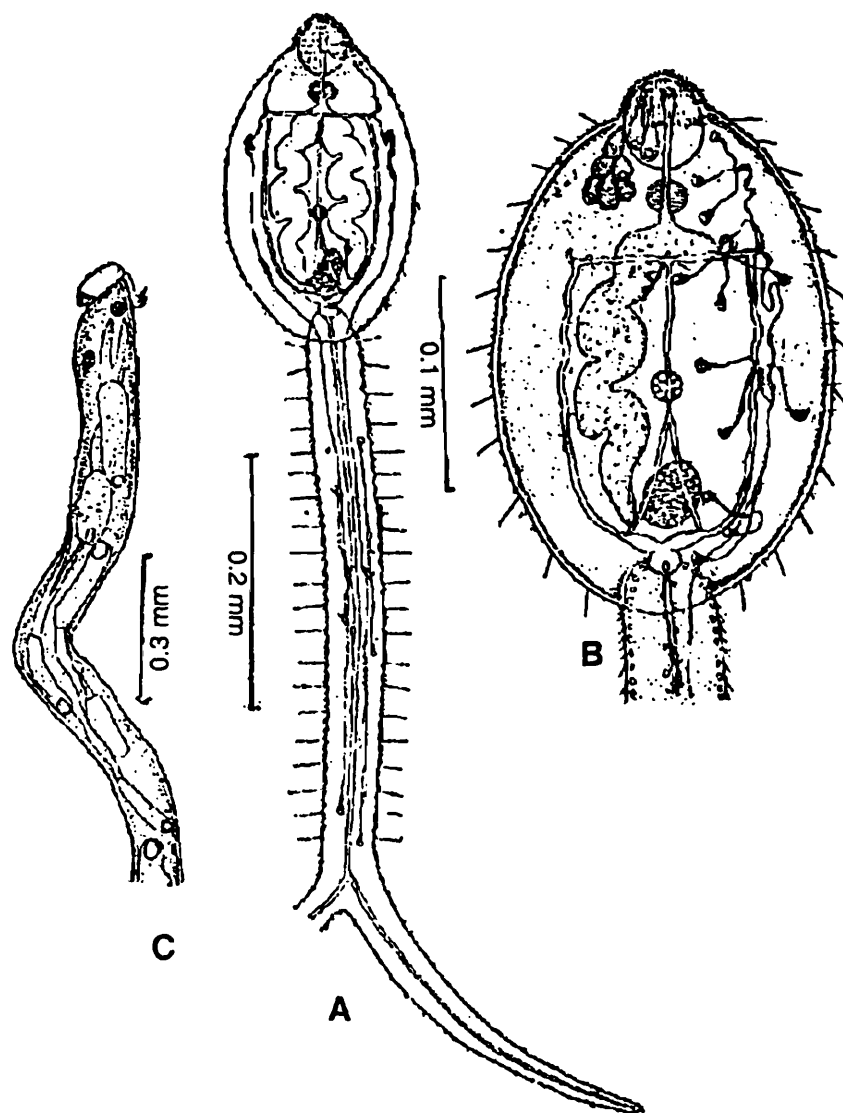


Fig. 74. A & B. *Cercaria shikarii* Singh, 1966. C. Sporocyst of *C. shikarii*, Singh, 1966 (After Singh, 1966).

comparatively larger cells than cells of anterior set and lie on either side of pharynx, ducts of these glands open in vicinity of oral opening; excretory bladder trifoliate, situated in median line at posterior end of body, excretory canals four in number—two median and two lateral and open into excretory bladder at its anterolateral aspects, caudal excretory canal opens posteriorly, lateral excretory canal of each side formed by union of an anterior and a posterior collecting tubule, each anterior collecting tubule receives capillaries from two groups of three flame cells, posterior collecting tubule on each side connected to three groups of three flame cells including a group of three cells of tail, flame cells 30 in numbers—24 in body and 6 in tail and can be represented by a formula $2 [(3+3) + (3+3) + (3)] = 30$, two lateral excretory canals joined by a transverse excretory canal at level of intestinal bifurcation, two median excretory canals join anteriorly to form a common median excretory canal which opens in transverse excretory canal in median line, caudal excretory canal arises from

posterior end of bladder through an 'Islet aperture', it runs posteriorly through tail-stem and on reaching distal extremity divides into two branches which run through furcal rami to open at tips; rudiments of gonads represented by small rounded mass of cells, it lies in front of excretory bladder between two median excretory canals.

Sporocyst long, sausage shaped; birth pore located at one end.

Snail host : *Vivipara bengalensis*.

Location : Uterus and rectum.

Locality : Shikara, M. P.

76. *Cercaria singhi* Pandey and Singh
(Fig. 75. A-C)

1984. *Cercaria singhi*, Pandey and Singh, *J. Zool. Soc. India*. 35(1&2) : 66-69. (1983)

Diagnosis : Cercariae come out through day, photonegative, hang down in water with tail upward and head downward, with tail and body bent larva appears 'C' shaped, swim by vigorous movement of body and tail, during swimming larva moves in backward direction, after a short period it sinks to bottom, it creeps like caterpillar; body aspinose, oval, blunt anterior and broad posterior ends, measures 0.39-0.45 × 0.28-0.32 in live and 0.17-0.22 × 0.08-0.11 in fixed specimens; tail aspinose, longer than body, tail-stem measures 0.47-0.50 × 0.10-0.14 in live and 0.22-0.32 × 0.03-0.05 in fixed specimens, furcal rami about half length of tail stem, laterally flattened furcal rami equal, without fin fold, measure 0.32-0.40 × 0.06-0.07 in live and 0.17-0.24 × 0.02 in fixed conditions, tail with circular, longitudinal and oblique muscles, caudal bodies irregularly distributed in tail, anterior protrusible organ terminal, pear shaped, its surface beset with minute spines, measures 0.08-0.09 × 0.05-0.07 in live and 0.03-0.04 × 0.03 in fixed specimens; ventral sucker poorly developed and represented by mass of cells, situated behind middle of body; mouth opens at anterior extremity of protrusible organ; prepharynx short; pharynx circular, measures 0.02-0.03 in live and 0.02 in fixed specimens; intestinal caeca broad, spacious, run posteriorly upto excretory bladder; penetration glands 8 pairs, located on either side of protrusible organ, small and oval in shape, nucleus of gland centrally placed, cytoplasm fine granular, open to outside by separate ducts at tip of protrusible organ; cystogenous cells oval to round and distributed throughout body; genital rudiment represented by small mass of cells, situated in front of excretory bladder; excretory bladder 'V' shaped, situated at hind end of body, open outside by a terminal excretory pore, from each cornua arises a main collecting canal and runs anteriorly, at level of intestinal bifurcation main collecting canals connected together by transverse canal, two protrubance present on both outer ends of transverse canal, from outer protrubance of each side a duct arises and runs posteriorly as descending canal along outer margin of main collecting canal, at about middle of body it divides into two branches anterior and posterior, anterior collecting canal runs anteriorly and divides into three branches,

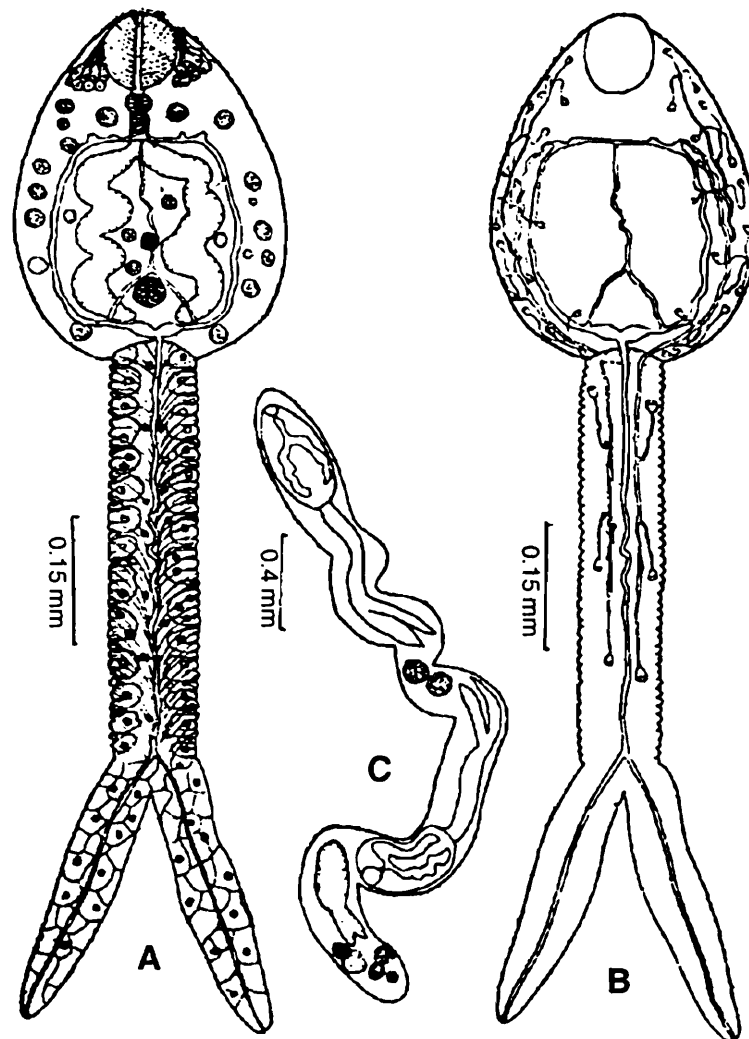


Fig. 75. A & B. *Cercaria singhi* Pandey and Singh, 1983. C. Sporocyst of *C. singhi* Pandey and Singh, 1983 (After Pandey and Singh, 1983).

each branch gives rise to three capillaries each ending in a flame cell, posterior collecting canal gives rise to two branches and each dividing into three capillaries which end in flame cells, further posterior collecting canals of both sides run into tail and giving rise to three capillaries at different levels, each ending in a flame cell, flame cell formula can be represented by $2 [(3+3+3) + (3+3) + (1+1+1)] = 36$, a median longitudinal canal originates from transverse duct runs posteriorly and at level of ventral sucker it divides into two branches which open into main collecting canal near its origin, caudal excretory duct arises from posterior side of excretory bladder and runs through length of tail-stem, it divides into two branches at base of furcal rami, each branch passes into each furca and opens outside by minute pore situated at tip of furcal rami.

Sporocyst long, tubular, shows slow movement; measures $3.20-4.05 \times 0.18-0.27$ in live and $1.28-2.08 \times 0.08-0.16$ in fixed conditions; each contains 4-8 mature cercariae, developing cercariae and germ balls.

Snail Host : *Belamya bengalensis*.

Location : Hepatopancreas.

Locality : Nayagaon, Barabanki, U. P.

77. *Cercaria udaipuriensis* Sharma and Choubisa
(Fig. 76. A-C)

1983. *Cercaria udaipuriensis* Sharma and Choubisa, *Indian J. Parasit.*, 7(2) : 209-212.

Diagnosis : Cercariae emerge in large numbers during morning hours, swim rapidly by lashing movement of tail, hang up side down with stretched furcae when at rest; cercaria elongated, oval, spinose body; anterior protrusible organ weakly developed, provided with large number of minute spines arranged in transverse rows; body measures 0.15-0.24 × 0.07-0.12; ventral sucker poorly developed, located in mid-ventral

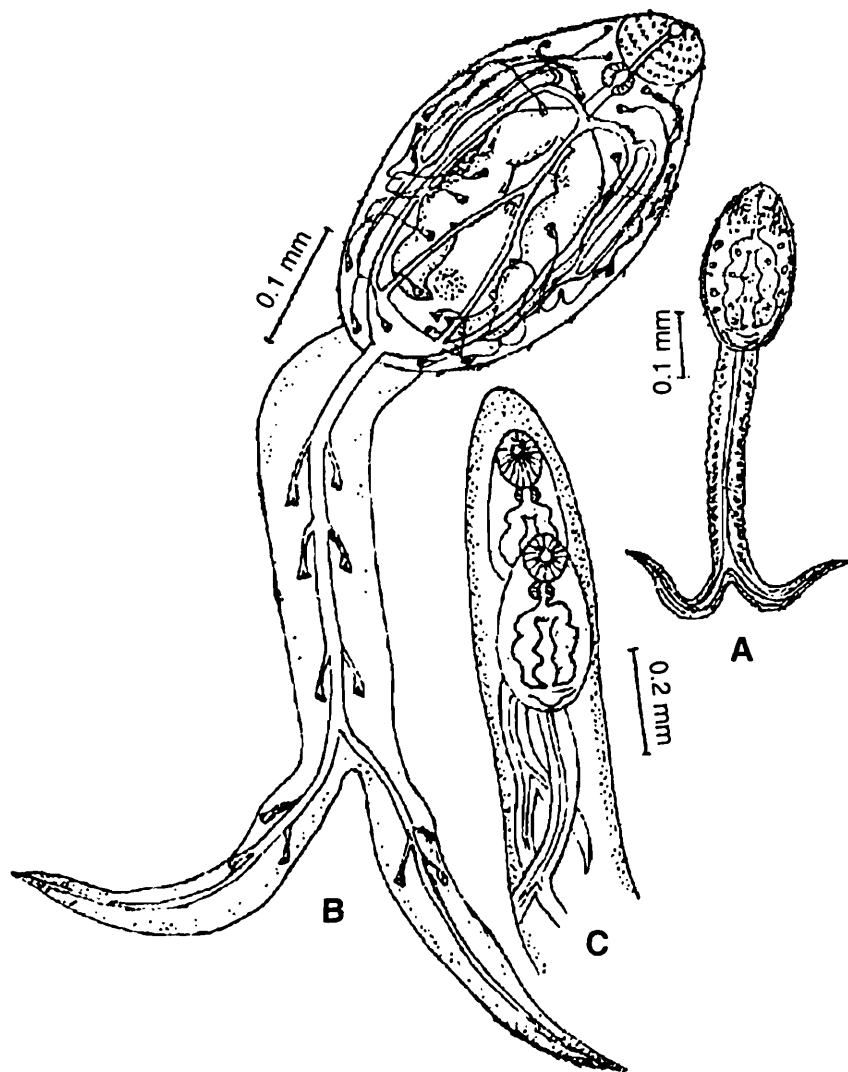


Fig. 76. A & B. *Cercaria udaipuriensis* Sharma and Choubisa, 1983. C. Sporocyst of *C. udaipuriensis*, Sharma and Choubisa, 1983 (After Sharma and Choubisa, 1983).

of body, measures 0.01×0.01 ; mouth leads into pharynx; pharynx muscular, round measures 0.01×0.01 ; prepharynx absent; oesophagus short; intestinal caeca sinuous, broad, extend posteriorly upto excretory bladder; uninucleate penetration glands nine pairs, small, ovoid, located around anterior, protrusible organ, each opens to out side through a small pore each gland with nucleus and numerous granules; cystogenous glands irregular, contain fine granules, distributed all over body; rudimentary reproductive organ located front of excretory bladder; tail aspinose, longer than body, measures $0.19-0.23 \times 0.01-0.03$, furcal rami measure $0.13-0.23 \times 0.01-0.02$; excretory bladder 'V' shaped, situated posterior end of body, main collecting canal one on each side, originates from anterolateral cornua and running upto intestinal bifurcation, it divides into outer and inner branches, latter running transversely for a short distance uniting with branch of opposite side in median region of body and form a transverse canal, outer branch turns downward and runs upto middle of body and again divides into two fine branches anterior and posterior collecting canals, former runs upto region of pharynx and divides into two branches each with three capillaries capped with flame cells, posterior canal runs posteriorly and divides into three branches and each with three capillaries capped with flame cells, a median longitudinal canal originates from transverse canal which runs upto ventral sucker where it divides into two branches which open into cornua of excretory bladder, flame cell formula can be expressed by $2 [(3+3) + (3+3+3)] = 30$, caudal excretory canal originates from posterior end of excretory bladder, runs medially along tail-stem and bifurcates to open outside through excretory pore situated at tip of two furcal rami, three pairs of flame cells located in tail-stem and three flame cells in each furca, flame cells in tail-stem and furcal rami can be represented by $2 [(1+1+1) + (1+1+1)] = 12$.

Sporocyst whitish, branched; measures $1.98-3.12 \times 0.01-0.15$; shows contraction and expansion; each contains 8-12 mature cercariae, developing cercariae and germ balls.

Snail Host : *Vivipara bengalensis*.

Location : Digestive gland.

Locality : Fateh Sagar Lake, Udaipur, Rajasthan.

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