

**STUDIES ON MORPHOLOGY AND LIFE HISTORY OF  
ARTYFECHINOSTOMUM SUFRARTYFEX (LANE 1915)  
OF SWINE IN THAILAND**

*R. Dissamarn ; P. Chai-Anan*

*K. Thirapat ; P. Aranyakananda*

*P. Srivoranat ; P. Chitrakorn*

Parasitology Branch, Dept. of Livestock Development

*Artyfechinostomum sufrartyfex* or LANE'S fluke is an echinostome of man and swine in the Far East. It has been reported twice in man in India, once in Assam (LANE 1915) and the other in Madras (VERMAH & REDDY 1950). This fluke was first reported in pig in Bengal by Bhalerao (1931) and in Madras by RAMANUJACHARI and ALWAR (1954). It was Bhalerao (1931) who proposed the name of this parasite as *Paryphostomum sufrartyfex*. Then *P. sufrartyfex* appeared in the literature instead of *A. sufrartyfex*. In Thailand, DISSAMARN et al (1955) reported the first finding *A. sufrartyfex* (*P. sufrartyfex*) in pig in Bangkok and the role and possibility of the life history has been closely observed since that time.

In June, 1965, a pig farm in Rajaburi province of Thailand, about 65 miles south of Bangkok, was found that nearly 80% of the baby pigs of 3-4 months old were infected with *A. sufrartyfex*. The infected pigs were brought to Dept. of Livestock Development. Then the morphology & life history of *A. sufrartyfex* were studied in detail. The purpose of the present study was to get more information about this fluke in Thailand.

**Materials and Methods**

The eggs for study on life history were obtained from the infected pig of four months old from the mentioned pig farm. The pig was slaughtered and

the flukes from the small intestine were used for study on the morphology. Fifty four flukes were collected at random and put separately into a small plastic tray containing wells which were filled with normal saline. The eggs released from each fluke were counted and use for study on the size and shape as well as the larval development. Then each fluke was also studied on the morphology especially for the arrangement and size of collar spines by fixing in A.F.A. solution in flatten position and then clear with lactophenol. In the stained specimen the fluke were kept in saline in refrigerator over night (the flukes were still alive). The fixed in A.F.A. solution in the next morning and stained with Semichon's carmine and mounted in Canada balsam. The macreated flukes were those kept in the saline for days. After the fluke died then fixed and stained as the living specimens. The mentioned specimens were collected at random.

### Morphology

The living flukes are pinkish white and rather reddish in the uterine area and with two spots of white testes below. In saline or plain water they contract the body to and flow particularly the preacetabular region, changing the shape continuously. They are active in saline and in plain water for four to five hours but they remain alive for three to four days.

The fluke is elongated in shape with broaden toward the posterior end. When fixed in 5% hot formalin the unflattened flukes measure 8.0-11.0 X 2.2-3.5 mm. (based on thirty flukes and 9.5-13.5 × 2.5-4.5 mm. in concentrated acetic acid (based on fifty seven flukes). The maximum width is roughly located at the middle of the fluke. In the stained specimen the fluke measured 7.3-13.5 × 2.1-3.6 (based on non-macreated twenty four specimens). The broadest portion is at the anterior margin of the anterior testes for six of the body for four specimens and at the ovary region for three specimens. And only one of the specimen at the middle of the posterior part of the body.

In macreated stained specimens, most of the flukes are swollen. Few of collar spines were left. The size of corner spines and lateral spines could not measured due to broken off. The genital organs are swollen and elongated in shape. The ventral sucker remained in spape with longer than broad. The constrictions at the ventral sucker were slightly observed in some specimens, but the posterior end of the body were round and not indented.

The oral sucker is subterminal and ranged 165.1-317.4 × 207.0-303.6 u. The pharynx is 207.0-276 × 207.0-289.8 u. The oesophagas bifurcates infront of the

genital pore into two caeca which extended to the posterior end of the body. In old adult fluke the acetabulum is situated at the first  $\frac{1}{5}$  to  $\frac{1}{8}$  of the body and measured  $634.8-1098.2 \times 662.4-938.4$  u. It is usually longer than broad (based on twenty four stained specimens).

### Head collar and collar spines

The head collar is reniform and united ventrally by a narrow bridge in some specimens. The number of collar spines ranged from fourty to fourty eight (see detail in Table 1-111). The arrangement of the collar spines are also shown in the Table IV and Figure 10.

The size of the collar spines (based on fourty flattened specimens fixed in A.F.A. and clear with lactophenol) ranged  $74.1-101.4 \times 15.6-25.3$  u. for lateral aboral spines of the ventral group. The lateral spines of the lateral group range from  $74.2-89.7 \times 15.6-23.4$  u. Twenty of fourty flukes which L.A. spines larger than the lateral spines; eight flukes with L.A. spines equal to lateral spines and twelve flukes with L.A. spines smaller than lateral spines. So the L.A. spines is usually larger than the lateral spines. The smallest of the ventral group is usually ventro-oral spines ranged  $47.9-61.3 \times 9.7-15.6$  u.

### Body spines

They are conspicuous. Ventrally they extend from the anterior part to the posterior end of the body. Dorsally they extend to the the middle part of the pharynx and curved lateraly to the lateral size of the body at the acetabular level.

The size of ventral body spines in the region anterior of ventral sucker ranged  $27.30-40.9 \times 23.4-31.2$  with the average of  $36.65 \times 26.87$  u. At the ventral sucker area the spines ranged  $42.9-58.5 \times 23.4-29.7$  u. with the average of  $48.7 \times 26.88$  u. At the uterus area spines ranged  $50.7-62.4 \times 24.3-33.1$  u. with the average of  $53.61 \times 30.67$  u. The arrangement of the body spines is shown in Figure 11.

### Genital system

The anterior and posterior testes are deeply lobed and often broadly incised. They are usually situated in the posterior half of the body. In twenty

four stained specimens the anterior margin of the anterior testes is at the middle of the body or a little higher. The anterior testes ranged  $256-2932 \times 1090-1930$  u. and the posterior testes ranged  $1242-2139 \times 952-1893$  u. The cirrus sac is big and curves from the anterior margin to posterior border of the ventral sucker. The size of the cirrus sac is  $1242-1270 \times 165.6-427.8$  u. The seminal vesicle is large and filled with sperm cells. The prostate gland is un conspicuous. The cirrus is long and measured  $1.656-4.140$  mm. and has no spine.

The ovary is situated in front of the testes somewhat shifted to the right or to the left. The shape may be oval or elongated. In seventeen stained specimens the ovary measured  $386.4-690.0 \times 320.8-570.6$  u. There is no seminal receptacle in all specimen. The vitelline gland occupy the lateral part of the fluke reaching from the ventral sucker to the posterior end of the body. They fused together somewhat posterior to the testes. The uterus is coiled transversely into five to eight loops. They might contain few eggs to numerous eggs (see Table V.)

### Eggs

The eggs from infected pig range  $128.70-163.80 \times 70.20-81.90$  with an average size  $144.45 \times 76.61$  (based on one hundred eggs). The frequency class is  $144.30 \times 78.00$  u. The size of the egg for each fluke was studied and shown in Table VI. The size of eggs obtained from Swiss mice fed with the metacercaria from pig strain range of  $132.60-150.10 \times 58.5-76.05$  u. and average size  $140.08 \times 69.61$  (based on one hundred eggs). The frequency class is  $136.50 \times 66.30$  u.

### Life history

In our experimental studies it was found as follows:

1. The eggs hatch in nine to twelve days in water at room temperature (30 to 35 C)
2. The miracidium penetrated *Indoplanorbis exustus* but not *Lymnaea rubiginosa* in laboratory condition (for four experiments) as well as in nature (in infected area).
3. The miracidium fixed in hot 1% silver nitrate measured  $98.80-138.32 \times 44.46-69.0$  u. (based on twenty five specimens). There are two flame cells and two excretory pores (see also the detail of structure and size in Table VII and Figure 12).

4. Sporocysts were found mainly in the head within the tissue surrounding the mouth part of the snail. They are oval and yellowish brown in color when alive and measured  $170.0-240.0 \times 120-190$  u. (based on fifteen specimens). Usually they contain one redia and one germ ball and were found after three to five days post infection.

5. The first redia was found at four days after post infection. They are small about  $150 \times 40$  u. and colorless. When they grow bigger the color change into yellow.

6. Mother redia about twenty days old (based on twenty alive specimens)

Length	850-1350 u.
Width	190-400 u.
Pharynx	$140-200 \times 50-80$ u.
Locomotor appendages	650-1000 u.
Gut	250-480 u.
Collar (diameter)	200-350 u.

7. Daughter redia are colorless and gradually change into orange color. They are small when release from the mother redia. At two to three days of age they measured  $160-250 \times 50-90$  u. (based on fourty eight alive specimens) and usually found at fifteen days post infection.

8. Mature daughter redia at twenty eight days old (based on twenty five alive specimens).

Length	900-2100 u.
Width	200-410 u.
Pharynx	84-250 u.
Locomotor appendage	750-1000 u.
Gut	200-1000 u.
Collar	130-450 u.

The number of cercaria found in mature daughter redia are less than twenty.

9. The first cercaria are released twenty eight to thirty three days after exposure of the snail to miracidia (based on four experiments).

10. The cercaria swim easily and rapidly through the water while curling the body ventrally. They have seventeen sensory hairs on each side of the body

and nineteen pairs of flame cell. (see the detail of structure of cercaria in Table VIII and Figure 18).

11. The tail of cercaria has five finfolds as follows :

- a. Anterior dorsal fin and posterior dorsal fin.
- b. Ventral fin
- c. Two median fin

12. The metacercaria in *Indoplanorbis exustus* and *Lymnaea rubiginosa* are oval and flattened ventrally in fresh specimens they measured 125-165 × 106-145 u. The cyst wall is about 4.9 u. thick. The collar spines are slightly conspicuous but not could not count the number of spine exactly. The conspicuous body, distal to the oral sucker was found until the metacercaria are ten days of age.

13. Metacercaria developed to adult fluke, *A. sufrartyfex* when fed to pig, Swiss mice and eggs being reproduced in fourteen days. The maturation period of metacercaria is at twenty four hours (four experiments).

14. Metacercaria when fed to day old chick develops into immature *A. sufrartyfex* up to three days post infection. After three days all the immature flukes died.

### Discussion

Lie (1963 b) described the detail of morphology of adult *Echinostoma malayanum* (Leiper 1911) from pigs in Malaya and pointed that *A. sufrartyfex* reported by Lase in 1915 a new parasitic echinostome of man has all the features of disintegrated *E. malayanum*. Therefore *sufrartyfex* should be considered a synonym of *malayanum*. The life history of *E. malayanum* also worked out fully with descriptions of larval forms by Lie (1963 a). The fresh water snail *Indoplanorbis exustus* serves as a first intermediate host. The first cercaria are released 42-47 days after exposure of the snails to miracidium. *Lymnaea rubiginosa* is also found infected in nature but not in the experimental conditions. Second intermediate host include *Lymnaea rubiginosa*, *Indoplanorbis exustus*, *Pila scutata* and *Gyraulus convexiusculus*. The egg-laying stage of *E. malayanum* in rats, mice and hamsters is reached in 14-16 days after feeding them with metacercaria.

Bhaibulaya et al (1964) reported the human infection with *E. malayanum* in the North-Eastern part of Thailand and were also successfully in complete the life history in experimental conditions. The cercaria released from *Indoplanorbis* snails in 39-50 days Tad pole was found as one of the second intermediate host. The egg laying stage of this parasite on rats is reached in 21 days. *Lymnaea*

rubiginosa was not found in nature or experimental conditions to be served as a first intermediate host. According to the annual report (1965), school of Tropical Medicine in Bangkok, the number of flame cells of *E. malayanum* in experimental studies was nineteen.

In our present study, the detail of morphology and life history was slightly different from the work of Dr. Lie (1963 a,b) as follows.

1. The number of collar spines range from forty to forty eight. The corner spine in some specimen comprise of six to seven spines. *E. malayanum* as forty three to forty five spines only even in numerous specimens and have a corner spine of five in number.

2. The ventral sucker is situated extremely more anterior than *E. malayanum* and usually longer than broad.

3. The maximum size of lateral aboral spines is  $101.4 \times 25.4$  u. which is larger than the maximum size of *E. malayanum* that is  $93 \times 24$  u. and they are usually larger than the lateral spines.

4. The uterus coils into five to eight loops with numerous of eggs; while *E. malayanum* of pig as five loops and few eggs up to 25.

5. The cirrus pouch is rather big. The cirrus ranged 1.656 - 4.140 mm, *E. malayanum* has cirrus usually long measuring 6 mm. or more.

6. In stained specimen (fixed when alive) they show slightly constriction at the preacetabular region and also slightly indented at the caudal margin. The broadest part located about a little above the middle of the body.

7. The first redia was released in four days while *E. malayanum* in six days.

8. The number of cercaria in mature daughter redia is less than twenty while *E. malayanum* is about forty.

9. The first cercaria was released twenty eight to the thirty four days post infection while *E. malayanum* at forty.

10. The cercaria of *A. sufrartyfex* has nineteen pairs of flame cells and seventeen pairs of sensory hairs while *E. malayanum* has fourteen pairs of flame cells and has no sensory hair.

11. The finfold of cercaria of *A. sufrartyfex* consisted of dorsal ventral and medial and with a papillae near the tip of the posterior end of the tail. *E. malayanum* have only dorsal and ventral finfold.

12. The maturation period of the metacercaria is at twenty four hours while of *E. malayanum* is at five days.

13. The metacercaria of *A. sufrartyfex* can produce the immature fluke when fed to day old chick up to three days post infection. While *E. malayanum* could not produce immature fluke in day old chick.

14. *Lymnaea rubiginosa* did not serve as the intermediate host in nature and Laboratory for *A. sufrartyfex*.

In order to classify the confusion in taxonomic problem, the stained and fixed specimens of *A. sufrartyfex* including notes, photographs & [drawings of larval form were sent to Dr. Allen McIntosh of Beltsville Parasitological Laboratory USDA. for confirmed identification. Dr. McIntosh kindly examined the above materials and reviewed the papers by Dr. Lie. He convinced that the adult specimens of what Dr. Lie regards as *Echinostoma malayanum* Leiper, 1911 and the specimens of *A. sufrartyfex* Lane, 1915 sent by the senior author were the same species. Dr. McIntosh has also read the original papers by Leiper (1911 and 1913); Lane (1915); Odhner (1913); Bhalerao (1924); and Fain (1960) papers on the genus *Artyfechinostomum* Lane, 1915. and convinced that the following species are synonyms of Leiper and that Lane's genus *Artyfechinostomum* should be recognized as valid. The synonymy is as follows.

*Artyfechinostomum malayanum* (Leiper, 1911); *A. sufrartyfex* Lane 1915; *Testifroncosa cristata* Bhalerao, 1924; *A. mehrai* (Farugu, 1930) Jain, 1917; and *Testisaculus indicum* Bhalerao, 1927 is also probable a homonym.

### Summary

In June, 1965 a pig farm, in Rajaburi Province of Thailand, was found that about 80% of baby pigs of 3-4 months old were infected with *A. sufrartyfex* Lane, 1915. The infected pigs from this farm were used for the source of adult parasites & eggs of *A. sufrartyfex* in our experiment studies. The detail of morphology of adult *A. sufrartyfex* was described.

The life history of *A. sufrartyfex* was studied with the description of all stages of larval forms. The fresh water snails *Indoplanorbis exustus* serves as a first intermediate host. *Lymnaea rubiginosa* does not serve as a first intermediate host in nature or experimental conditions. Cercaria was released from *Indoplanorbis* snails within 28-33 days and *Indoplanorbis exustus*, *Lymnaea rubiginosa* were served as a second intermediate hosts. The metacercaria encysted & was infective after 24 hrs. The egg laying stage of *A. sufrartyfex* in pigs is reached 14 days after feeding with metacercaria.



To clarify the confusion in generic names **Paryphostomum sufrartyfex** should not consider as valid species. **Artyfechinostomum sufrartyfex** is the synonym of **A. malayanum** or **Echinostoma malayanum**, Leiper, 1911

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**Table I** Showing the number of Collar spines of the immature *A. sufrartyfex* specimens in 1955

No. of Specimen	No. of Collar Spines	Remark
2	40	Only 16 specimens were remained in our laboratory. The worms were cut off at the head and clear with lactophenol.
3	41	
4	42	
5	43	
1	44	
1	45	
Total : 16		

**Table II** Showing the number of Collar spines of adult *A. sufrartyfex* obtained from Bangkok slaughter house in 1965

No. of Specimen	No. of Collar Spines	Remark
4	40	The worms were cut off at the head and clear with lactophenol.
4	41	
5	42	
28	43	
10	44	
6	45	
3	46	
—	47	
1	48	
Total : 61		

**Table III** Showing the number of Collar spines of adult *A. sufrartyfex* of infected pig from the pig farm.

No. of Specimen	No. of Collar Spines	Remark
-	40	—
1	41	Eggs released and retained in uterus over 500
2	42	Eggs released and retained in uterus over 500
15	43	not examined
11	44	—do—
11	45	—do—
2	46	Eggs released and retained in uterus over 500
1	47	—do—
1	48	—do—
Total : 44		

**Table IV** Showing the number of Dorsal spines, Lateral spines & Corner spines of *A. sufrartyfex* in table III

No. of Collar spines	No. of Dorsal spines	Lateral spines	Corner spines
41	11 (6 Oral, 5 Aboral)	Lt. 10; Rt. 10	Lt. 5; Rt. 5
42	10 (5 Oral, 5 Aboral)	Lt. 11; Rt. 11	Lt. 5; Rt. 5
43	11 (6 Oral, 5 Aboral)	Lt. 11; Rt. 11	Lt. 5; Rt. 5
	for 13 spec.		
	11 (6 Oral, 5 Aboral)	Lt. 12; Rt. 10	Lt. 5; Rt. 5
	for 2 spec.		
44	12 (6 Oral, 6 Aboral)	Lt. 11; Rt. 11	Lt. 5; Rt. 5
	for 6 spec.		
	11 (6 Oral; 5 Aboral)	Lt. 12; Rt. 11	Lt. 5; Rt. 5
	for 5 spec.		
45	13 (7 Oral; 6 Aboral)	Lt. 11; Rt. 11	Lt. 5; Rt. 5
	for 5 spec.		
	11 (6 Oral; 5 Aboral)	Lt. 12; Rt. 12	Lt. 5; Rt. 5
	for 5 spec.		

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<i>No. of Collar spines</i>	<i>No. of Dorsal spines</i>	<i>Lateral spines</i>	<i>Corner spines</i>
	11 (6 Oral; 5 Aboral) for 1 spec.	Lt. 11; Rt. 12	<b>Lt. 5; Rt. 6</b>
46	15 (8 Oral; 7 Aboral) for 1 spec.	Lt. 11; Rt. 10	Lt. 5; Rt. 5
	13 (7 Oral; 6 Aboral) for 1 spec.	Lt. 11; Rt. 12	Lt. 5; Rt. 5
47	13 (7 Oral; 6 Aboral) for 1 spec.	Lt. 12; Rt. 12	Lt. 5; Rt. 5
48	15 (8 Oral; 7 Aboral) for 1 spec.	Lt. 11; Rt. 12	Lt. 5 Rt. 5

**Table V** Showing the number of eggs retained in the uterus and released in saline from each worm.

<i>No. of Eggs ranged</i>	<i>No. of worms</i>	<i>Characteristics of the worm</i>
60	—	—
60-75	1	Worm with 43 collar spines
75-80	1	Worm with 44 collar spines
81-90	—	Not studied
91-100	1	Worm with 45 collar spines
101-125	—	Not studied
125-200	4	Not studied
201-300	15	—do—
301-400	18	—do—
401-500	7	—do—
501-600	5	—do—
over 750	1	Worm with 45 collar spines

Total : 53

**Table VI** showing the size of eggs from each worm. Eggs were released after kept each worm in saline for 3-4 hrs.

<i>No. of worm</i>	<i>No. of Head Collar spines</i>	<i>size of eggs ranged</i> $\mu$	<i>average size</i> $\mu$	<i>Remarks</i>
1.	44	138.32-158.08 × 74.10-86.45	148.50 × 79.14	The eggs vary in size even from the worms with equal in number of collar spines.
2.	44	138.32-155.61 × 74.10-79.04	151.58 × 76.05	
3.	44	138.32-148.20 × 71.63-77.80	143.68 × 75.43	
4.	44	128.44-143.26 × 66.69-81.51	135.85 × 74.30	
5.	44	103.74-143.26 × 72.86-80.27	141.33 × 76.67	
6.	43	123.50-143.26 × 74.10-79.04	134.71 × 76.15	
7.	44	143.26-155.61 × 66.69-79.04	146.35 × 74.00	
8.	43	128.44-145.73 × 69.16-79.04	140.37 × 72.96	
9.	43	130.91-148.20 × 74.10-76.57	142.02 × 75.24	
10.	43	133.38-148.20 × 71.63-77.80	142.54 × 74.72	
11.	43	127.21-135.85 × 72.86-79.04	131.53 × 75.14	
12.	43	106.21-123.50 × 56.81-74.10	115.67 × 64.64	
13.	incomplete	133.38-143.26 × 71.63-80.27	137.23 × 74.52	
14.	-do-	125.97-150.67 × 74.10-79.04	131.43 × 76.25	
15.	-do-	135.85-150.67 × 72.86-76.57	140.17 × 74.72	
16.	45	130.91-143.26 × 74.10-76.57	137.70 × 75.24	
17.	incomplete	135.85-145.73 × 71.63-76.57	141.78 × 73.36	
18.	43	135.85-145.73 × 72.86-76.57	142.84 × 74.92	
19.	incomplete	140.70-150.67 × 74.10-70.04	145.31 × 75.95	
20.	44	143.26-153.14 × 71.63-83.98	148.30 × 76.05.	
21.	42	128.44-135.85 × 74.10-77.80	131.80 × 75.78	
22.	43	130.91-148.20 × 74.10-79.04	137.70 × 77.19	
23.	43	135.85-153.14 × 79.16-74.10	145.93 × 72.54	
24.	45	128.44-143.26 × 70.39-79.04	133.80 × 74.82	

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<i>No. of worm</i>	<i>No. of Head Collar spines</i>	<i>size of eggs ranged</i> $\mu$	<i>average size</i> $\mu$	<i>Remarks</i>
25.	incomplete	128.44-133.38 × 69.16-76.57	130.05 × 73.36	
26.	44	140.79-148.20 × 67.92-74.10	145.31 × 72.05	
27.	43	128.44-145.73 × 71.63-75.33	134.86 × 73.36	
28.	45	138.32-153.14 × 69.16-76.57	143.36 × 72.96	
29.	42	143.26-155.61 × 71.63-76.57	149.43 × 74.35	
30.	45	130.91-143.26 × 71.63-79.04	136.47 × 75.95	
31.	44	121.03-130.91 × 71.63-79.04	124.32 × 75.24	
32.	41	135.85-145.73 × 67.92-74.10	134.86 × 73.36	
33.	43	113.62-121.03 × 62.98-74.10	140.89 × 71.43	
45.	incomplete	135.85-150.67 × 74.10-79.04	142.32 × 75.85	
35.	45	123.50-134.71 × 69.16-74.10	130.29 × 70.64	
36.	44	133.38-150.67 × 69.16-74.10	143.88 × 71.31	
37.	45	128.44-145.73 × 69.16-76.57	137.08 × 73.16	
38.	43	140.79-148.20 × 69.16-74.10	144.49 × 73.68	
39.	45	128.44-143.26 × 64.22-71.63	137.90 × 68.34	
40.	46	128.44-140.79 × 74.10-80.27	134.81 × 77.19	
41.	44	138.32-148.20 × 74.10-79.04	143.75 × 75.33	
42.	44	130.91-140.79 × 74.10-79.04	135.43 × 76.25	
43.	47	133.38-140.79 × 71.63-76.57	136.15 × 73.90	
44.	43	140.79-157.08 × 74.10-79.04	147.76 × 75.68	
45.	45	125.97-148.20 × 71.63-79.04	136.27 × 74.00	
46.	43	133.38-145.73 × 72.86-79.04	139.43 × 76.00	
47.	45	130.91-148.20 × 51.87-86.45	140.79 × 69.60	
48.	48	135.85-143.26 × 71.63-75.33	138.12 × 74.10	
49.	incomplete	133.38-145.73 × 74.10-79.04	140.99 × 75.95	
50.	43	no egg	-	

<i>No. of worm</i>	<i>No. of Head Collar spines</i>	<i>size of eggs ranged μ</i>	<i>average size μ</i>	<i>Remarks</i>
51.	45	138.32-153.14 × 69.16-76.57	145.73 × 73.68	
52.	46	128.44-148.20 × 74.10-81.51	142.27 × 76.45	
53.	43	135.85-145.73 × 74.10-79.04	139.09 × 75.95	
54.	45	138.32-145.73 × 54.34-81.51	142.84 × 74.52	

**Table VII** Showing some characteristics of miracidium (based on 25 specimens fixed in hot 1% silver nitrate or 0.5 % neutral red in alive)

<i>Epidermal plates</i>	<i>Length μ</i>	<i>Ant. width μ</i>	<i>Post. width μ</i>
<b>First row</b> of 6 plates	11.11.-17.29	7.41-9.28	12.35-13.29
<b>Second row</b> of 6 plates	21.00-29.64	17.29-24.7	17.29-24.7
<b>Third row</b> of 4 plates	29.64-45.29	27.19-39.52	14.92-27.19
<b>Fourth row</b> of 2 plates	24.7-37.05	27.17-44.46	27.17-44.46

Cilia 12.35 μ long.

Apical papillae 3.7-4.9 μ long.

Excretory pores (2) each 4.9 μ in diameter.

Eye-spots (2 pairs) Big pair 3.7 × 7.9 μ

Small pair 2.57 × 4.9 μ



**Table VIII** Showing some characteristics of cercaria emerged as free swimmer (based on 25 specimens fixed in hot 1 % silver nitrate or 0.5 % neutral red in alive)

**Body** Length 271-390  $\mu$

Width 139-210  $\mu$

**Tail** Length 390-546  $\mu$

Width 41.9-62.4  $\mu$

(1) Ant. dorsal fin 87-125 7.5  $\mu$

Post. dorsal fin 165-200  $\times$  15  $\mu$  and 200-300 from base of tail

(2) Ventral fin 75-87  $\times$  7.5-9.17, 210-225 from base of tail

(3) Median fin 75-87  $\times$  5  $\mu$  280-300 from base of tail

(4) Papillae 15  $\times$  5  $\mu$

Oral sucker 44.46-49.4  $\times$  44.46-62.4  $\mu$

Ventral sucker 46.80-61.70  $\times$  58.50-70.20  $\mu$

Pre-Pharynx 15.6-31.2  $\mu$

Pharynx 19.5-231.2  $\mu$

Oesophagus 74.1-117.0  $\mu$

Caeca 117.0-163.8  $\mu$

Cephalic cone 24.1-113  $\mu$

Excretory granules : Right side 7-9 granules

Left side 6-11 granules

Large 33.5  $\times$  15.6  $\mu$

Small 3.9  $\times$  3.9  $\mu$

Salivary gland 27.7-31.2-2  $\times$  19.5 - 27.3  $\mu$

Conspicuous body 11.70  $\times$  5.80  $\mu$

No. of Collar spines 41-45

Table. IX Showing the number of collar spines of *A. sufraryfex* obtained from 2 white mice infected with metacercaria of *A. sufraryfex* with 44 collar spines

<i>Animal</i>	<i>No. of intact worm recovered</i>	<i>Detail of worms</i>					
white mice No. 1	103	2 worms with 42 collar spines					
		49	„	„	43	„	„
		34	„	„	44	„	„
		14	„	„	45	„	„
		2	„	„	46	„	„
		2	„	„	47	„	„
white mice No. 2	26	2 worms with 42 collar spines					
		10	„	„	43	„	„
		10	„	„	44	„	„
		3	„	„	45	„	„
		1	„	„	47	„	„

## P. Sufartyfex

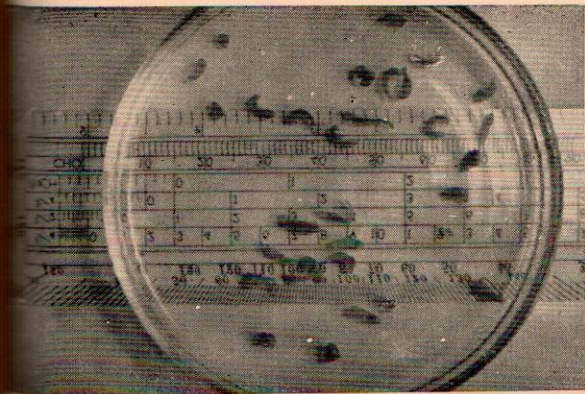


Figure 1 Photograph of *A. sufrartyfex* adult worm.



Figure 2 Photomicrograph of Anterior part of *A. sufrartyfex* showing Collar spines and Body spines.



Figure 3 Photomicrograph of eggs of *A. sufrartyfex* from natural infected pig.

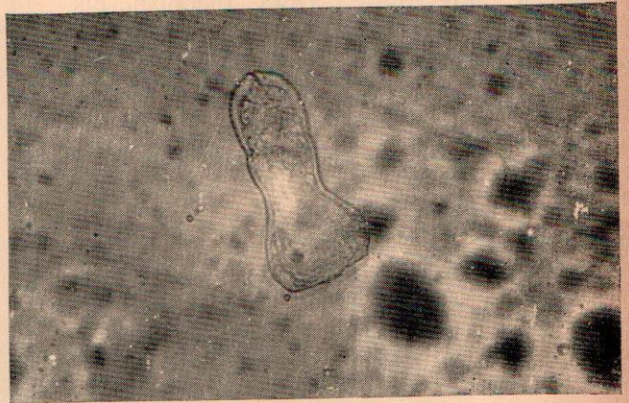


Figure 4 Photomicrograph of miracidium of *A. sufrartyfex* noting the eye spots.

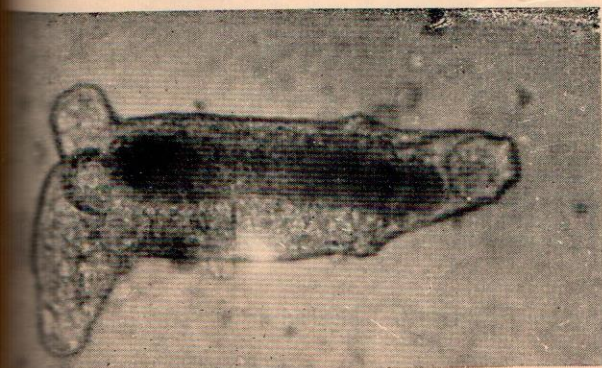


Figure 5 Photomicrograph of redia of *A. sufrartyfex* noting the position of lateral locomotor appendage. (15 days postinfection)

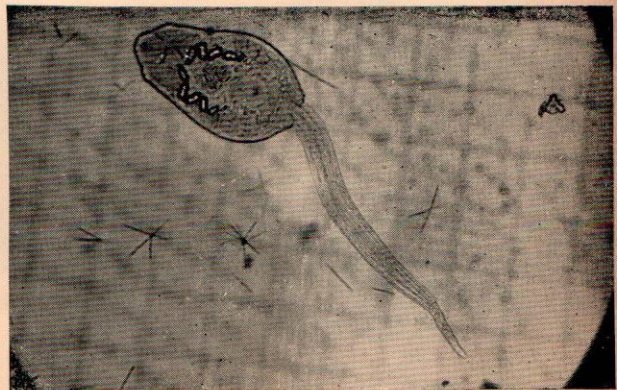


Figure 6 Photomicrograph of cercaria of *A. sufrartyfex* emerged from *Indoplanorbis exustus*.



Figure 7 Photomicrograph of metacercaria of *A. sufrartyfex* from *Indoplanorbis exustus*.



Figure 8 *Indoplanorbis exustus* served as first and second intermediate host.

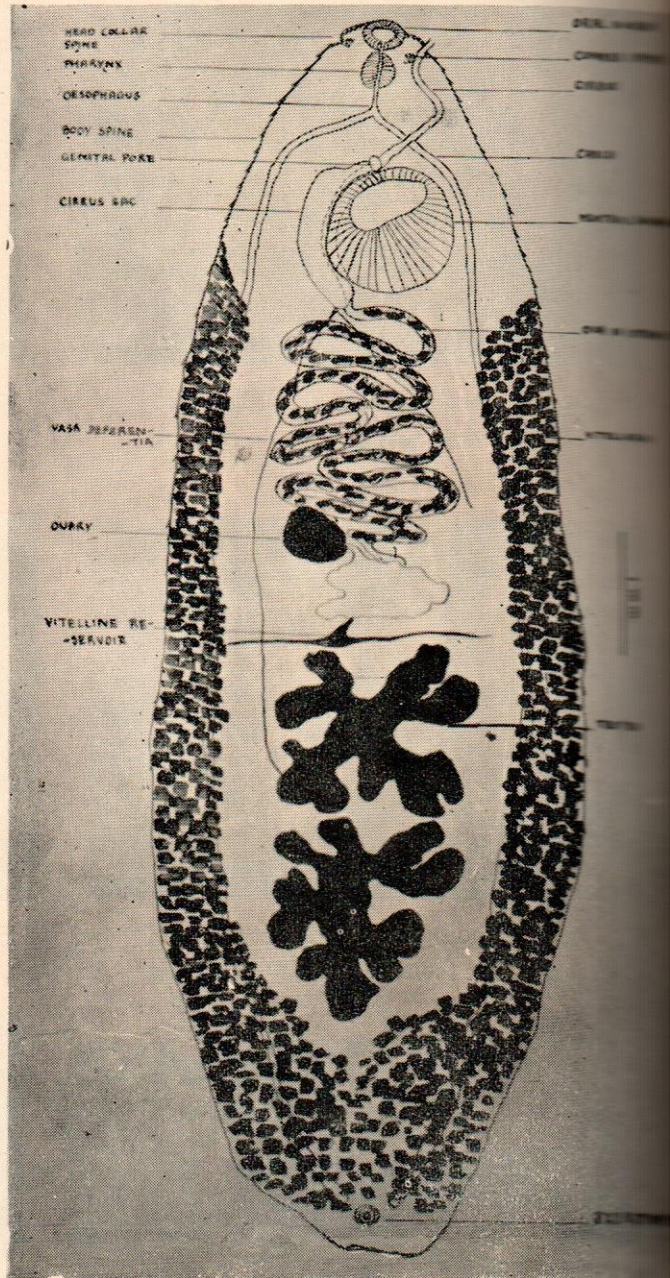


Figure 9 The adult *A. sufrartyfex* camera lucida drawing from stained specimen.

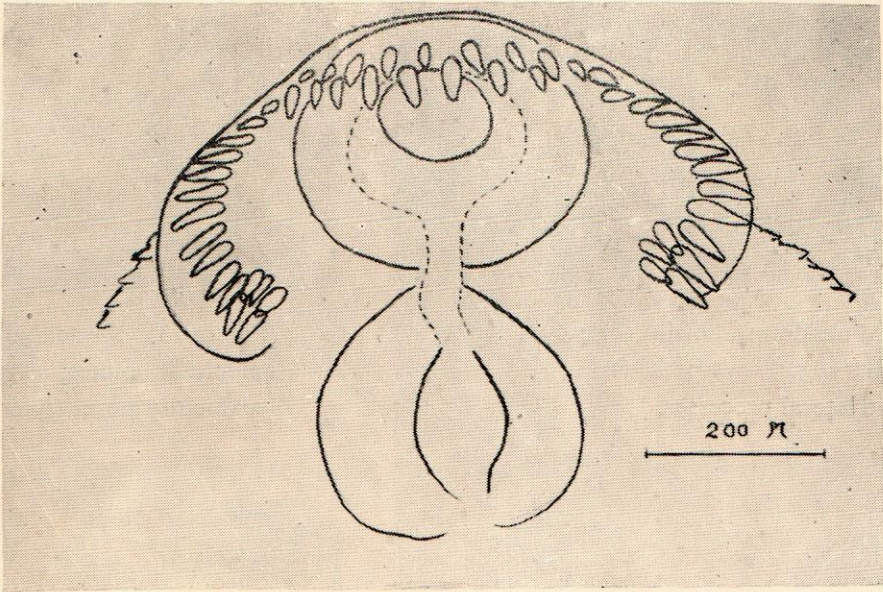


Figure 10 Head of worm showing 48 head collar spines.  
(ventral view)

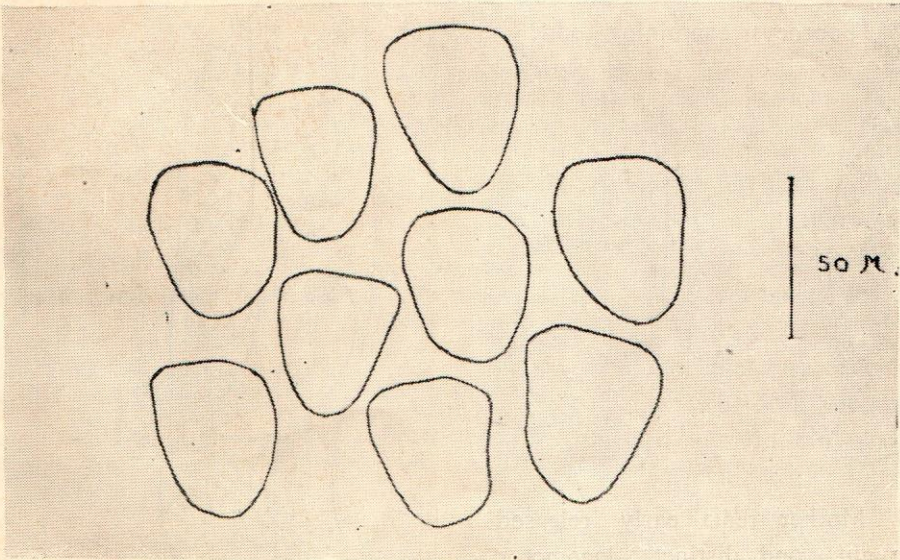


Figure 11 Ventral body spines.

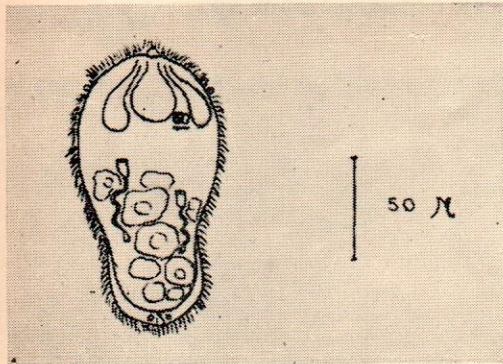


Figure 12 Miracidium showing apical papilla, primary gut, eyespots, flame cells and lateral processes.

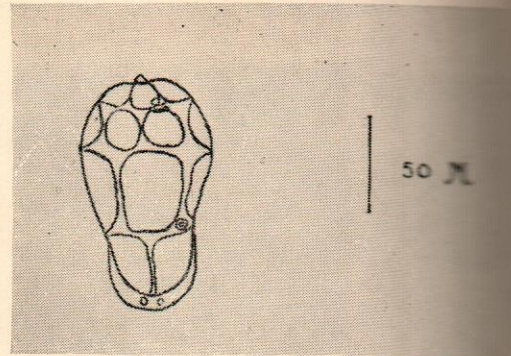


Figure 13 Miracidium showing epidermal plates, eyespots, and excretory pore. (lateral view)

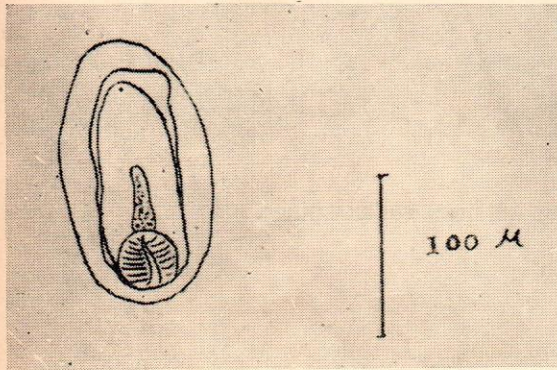


Figure 14 Sporocyst containing redia.

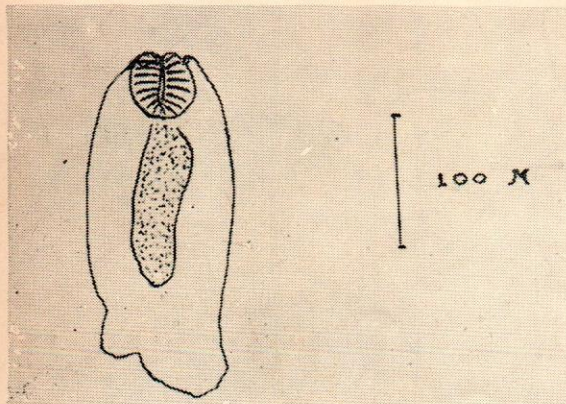
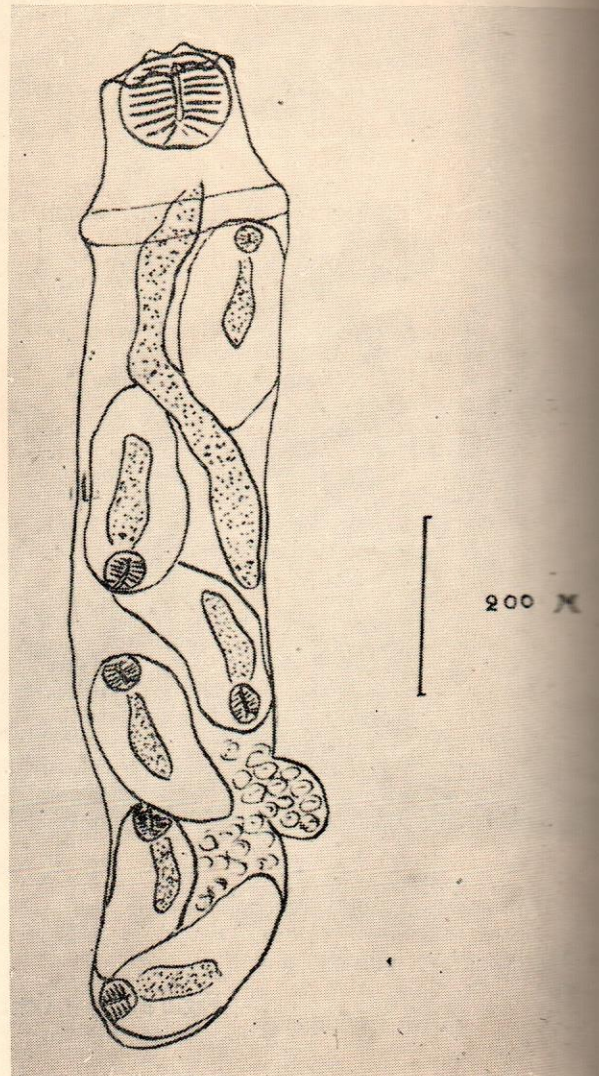


Figure 15 Mother redia early released with long gut and distinct locomotor appendage.

Figure 16 Mother redia, twenty days postinfection, with many daughter rediae and very long gut.



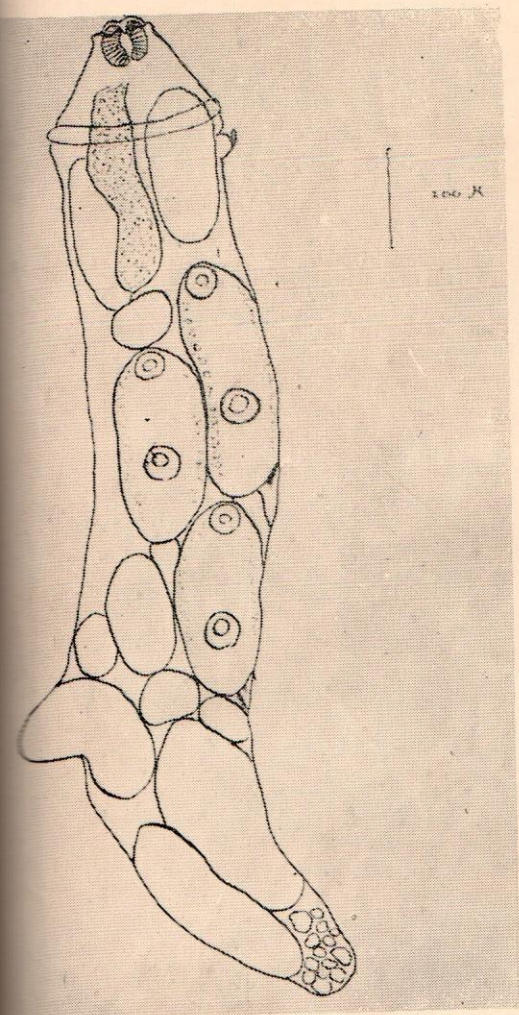


Figure 17 Mature daughter redia, about 30 days postinfection, with several cercariae and germ balls

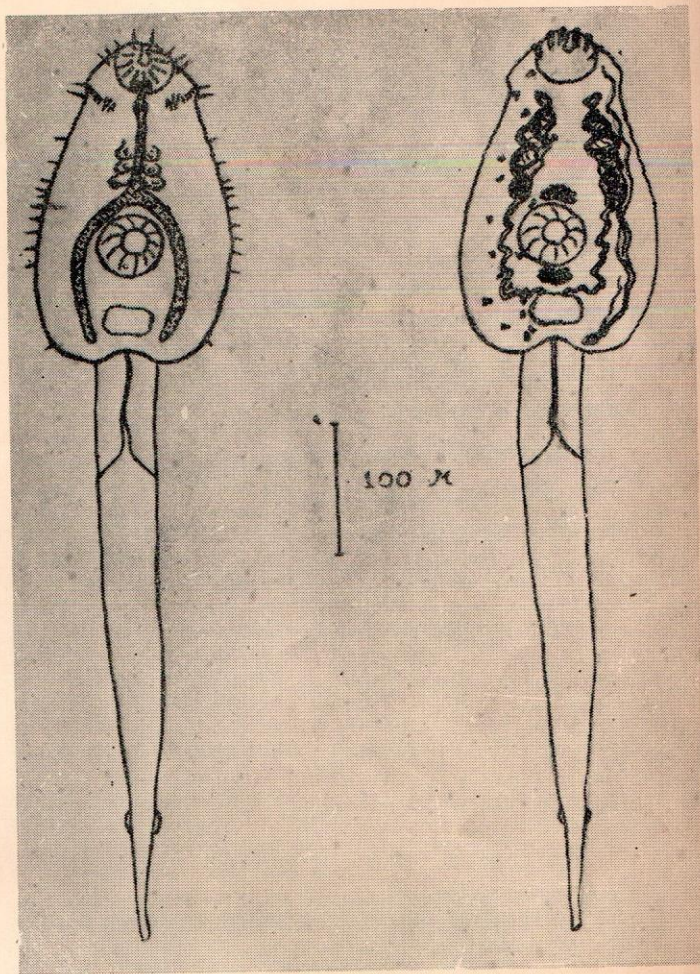


Figure 18 Cercaria a) Showing collar spines, conspicuous body, salivary glands, digestive system and seventeen pairs of sensory hair.  
b) Showing excretory system: bladder, excretory granules and tubules, salivary ducts, nineteen pair of flame cells and two genital anlagen.

Figure 19 Cercaria showing anterior dorsal and posterior dorsal ventral and medial fin fold and three caudal papillae (lateral view)

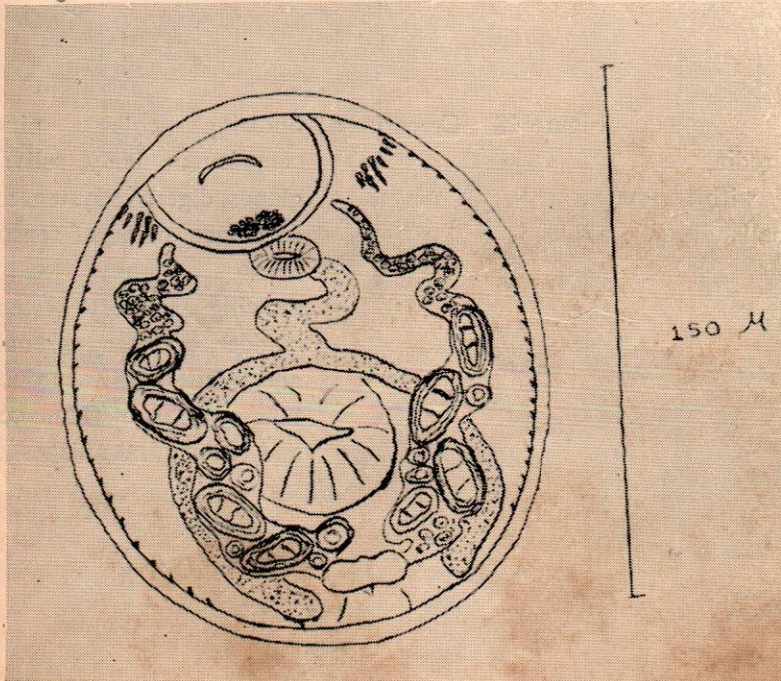
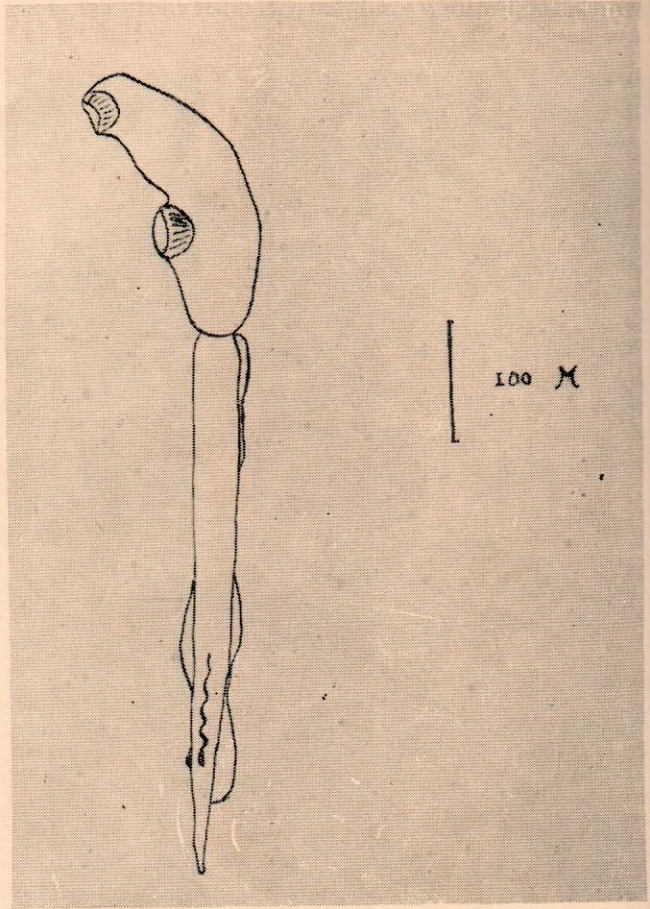


Figure 20 Metacercaria showing collar spines, body spines, digestive system and excretory system.

Figures 10-20 Drawings made with aid of camera lucida