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**TWO NEW SPECIES AND A NEW LOCALITY
RECORD OF A ZONOTIC CESTODE
(MATHEVOTAENIA) AMONG INTESTINAL
HELMINTHS OF RATS IN ASSIUT**
(With 4 Plates and Two Tables)

By

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نوعان جديدان وتسجيل مكان جديد لدودة شريطية معدية للإنسان
(من جنس الماثيفوتينيا)
بين الديدان المعوية للجرذان في أسيوط

مها سيد شاهين ، فاطمة جلال سيد ، أمانى إبراهيم حمزة
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تعد الجرذان من أهم الحيوانات الناقلة لأمراض الإنسان. وعند البحث عن الديدان ذات الأهمية الطبية بأمعاء الجرذان في أسيوط تم الكشف عن جنسين من الديدان الشريطية وهما الهمينوليس والماثيفوتينيا. كما وجد جنس من الديدان الأسطوانية وهو السيفيشيا بنوعيهما. وجد الباحثون ديدان الهمينوليس ديمنيوتا ووصفوا بعض العيوب الخلقية بها. كما وجدوا أربع أنواع من ديدان الماثيفوتينيا تم وصفها وتصنيفها ومقارنتها بالأبحاث السابقة وكانت كالآتي: (١) ماثيفوتينيا سيمتريكا، (٢) ماثيفوتينيا سكريابيني، (٣) ماثيفوتينيا ميكروكيفالا نوع جديد و(٤) ماثيفوتينيا أسيوطى نوع جديد. وهذا البحث هو الأول من نوعه الذي يشير إلى وجود طفيلي الماثيفوتينيا الذي لم يذكر في أبحاث سابقة في أسيوط. ووصف منه نوعين جديدين لم يسبق ذكرهما في أبحاث مماثلة. وتعد كل هذه الأنواع المذكورة ذات أهمية طبية بالنسبة للإنسان. كذلك يوصى الباحثون بتوخي الدقة أثناء فحص براز الإنسان نظراً لصغر حجم بويضات الماثيفوتينيا وخاصة في الأماكن ذات المستوى الصحي المنخفض والتي تنتشر بها الجرذان. ويوصى الباحثون أيضاً بإجراء أبحاث أخرى لفحص مختلف أنواع القوارض في مناطق أخرى نظراً لارتفاع نسبة الإصابة بالماثيفوتينيا في الجرذان التي تم فحصها.

SUMMARY

Rats are important reservoirs of zoonotic diseases. They constitute a source of morbidity to man. Searching for helminths of rats that have zoonotic importance in Assiut Governorate, the present work revealed two cestodes: *Hymenolepis diminuta*, which showed some congenital anomalies, and *Mathevotaenia*, which is a zoonotic cestode of the family *Anoplocephalidae*. Rats were also infected by a nematode *Syphacia* spp. The present work is the first record for the presence of *Mathevotaenia symmetrica* (Baylis, 1927), Akhumian, 1946 and *Mathevotaenia skrjabini* Spassky, 1949 in Assiut Governorate. It is also the first record for the presence of two new species of *Mathevotaenia* viz. *Mathevotaenia microcephala* sp. nov. and *Mathevotaenia assiuti* sp. nov., the two new species are described and their structural characters are discussed.

Key Words: Cestode, Helminths of Rats.

INTRODUCTION

Rats and mice play a role in human health and welfare (El-Gindy *et al.*, 1987). Previous studies have shown that they are reservoir hosts for many parasitic diseases (Morsy *et al.*, 1982). In Egypt previous studies dealing with rodent distribution clearly indicated that field and commensal rodent species have been found in association with man in houses and camping areas (Morsy *et al.*, 1986, 1987 and Shoukry *et al.*, 1986). Rodents have an important role in transmission and dissemination of serious pathogens to man and his animals (Shoukry *et al.*, 1986). The present work aims to study the intestinal helminths of rats that have zoonotic importance and may be a source of morbidity to human health.

MATERIALS and METHODS

Rats were trapped alive from houses in different districts using wire box traps with spring door and were transported to the laboratory. They were killed with chloroform. Their species were identified according to Osborn and Helmy (1980).

The gastrointestinal tract was removed, split open and was examined for helminthes. Recovered helminths were washed in water. Cestodes were compressed between two slides and were fixed in 10% formaline. They were stained in acid alum carmine and mounted in

Canada balsam. Nematodes were fixed in 70% alcohol and mounted in Glycerin gel (after Faust *et al.*, 1976).

Newly detected cestodes were measured using a ruler, drawn with the aid of *Camera lucida* and photographed.

RESULTS and DISCUSSION

The examined rats were:

1. *Rattus norvegicus* (52 rat, 30 of them had helminthic infections).
2. *Rattus rattus frugivorus* (35 rat, 12 of them were infected).
3. *Rattus alexandrinus* (28 rat, 3 of them were infected).

Out of the 115 examined rats, 45 had helminthic infections (39.1%). The recovered helminths were:

1. Phylum platyhelminthes

Class Cestoidea:

a- Family *Hymenolepididae* :

Hymenolepis diminuta (Rudolphi, 1819, Blanchard, 1891)
(17.3%).

b- Family *Anoplocephalidae*:

Subfamily Linstowiinae:

Mathevotaenia spp. (13.1%)

1. *Mathevotaenia symmetrica* (Baylis 1927),
Akhumian, 1946
2. *Mathevotaenia skrjabini*, Spassky, 1949
3. *Mathevotaenia microcephala* sp. nov.
4. *Mathevotaenia assiuti* sp. nov.

2. Phylum Nemathelminthes

Class Nematoda:

Syphacia spp. (8.7%).

1. *Syphacia obvelata* (Rudolphi, 1802).
2. *Syphacia muris* (Yamaguti, 1958).

In the present work, the incidence of *H. diminuta* was higher in *R. norvegicus* (8%) than in *R. r. frugivorus* (7.3%) and *R. alexandrinus* (2%).

Some abnormalities in the arrangement of testes were observed in a number of mature segments (Plate I) in the form of:

1. Absence of poral testis and presence of 3 aporal testes in segments (a, b, d, e, g, h and j).
2. Presence of two aporal testes fused together in segment (c).

3. Presence of one poral and one aporal testis and a large ovary in segment (f).
4. Two aporal testes tandem in position in segment (i).

Mikhail (1967) and Sayed & Hassan (1994) reported similar congenital anomalies in *H. diminuta* recovered from *R. rattus*.

H. diminuta was detected by many workers in different species of rodents e.g. Meggit, (1927), Fahmy (1961), Mikhail (1967), Arafa (1968), El-Azzazy (1981), Morsy *et al.*, (1982) and Sayed & Hassan (1994). It was detected in all rodents examined by El-Shazly *et al.*, (1994) except in two types of rodents in all areas surveyed. They found that its incidence is higher in *R. r. frugivorus* than in *R. norvegicus*.

Human infections with *Hymenolepis diminuta* were reported by Clavo (1951), Ratcliff (1965) and Lee & Lee (1966). The infections have been recorded mostly from localities where populations live under low hygienic standard (Salem *et al.*, 1981). In Egypt, four cases of infection with *H. diminuta* were recorded by Nor Eldin and Baz (1949). Chandler and Read (1961) found 2% infection rate with *H. diminuta* among villagers. Youssef *et al.*, (1988) reported a prevalence 5.9% among primary school children. In Assiut, Shaheen (1992) found that the rate of infection among children was 0.23%.

The other cestodes found in the present work were four species of *Mathevotaenia*. They were identified according to the key constructed by Yamaguti (1959) as members of the Family *Anoplocephalidae*, Subfamily *Linstowiinae* because the uterus breaks down into egg capsules each contains one egg. They were identified as *Mathevotaenia* due to the absence of sucker like organ around the genital opening.

Description of the recovered species: -

1. *Mathevotaenia symmetrica* (Baylis, 1927), Akhumian 1946:

Body is composed of several hundred segments and measures 11 cm. Long. Segments are of craspedote type, i.e. having a narrow, straight edged velum extending over the adjacent proglottids.

Scolex is rounded anteriorly, measuring 400-460 x 660-700. It has a rudimentary rostellum (Pl. II, Fig. 1 a & Pl. IV, a, 1). Suckers are spherical measuring 120 x 120. They open into narrow slits surrounded by muscular margins. The neck is narrower than the scolex, measuring 900 x 600-700. Excretory stems are two pairs on lateral sides of segments near the boundaries. Mature segments (Pl. II, Fig. 1 b & Pl. IV, a, 2) are broader than long measuring 720-800x1320-1720. Testes are dispersed posterior and lateral to the

ovary. Their average number is 39-51 and they never overlap the ovary or cross the excretory stem. Cirrus is elongated and straight, cirrus pouch is transverse (80x50). Genital atrium is situated at the anterior fourth of the segment, it does not form a sucker-like organ and it is irregularly alternating on lateral margins. Ovary is bilobed or fan-shaped and central in position, measuring 700-860. Vitelline glands are median, post-ovarian and compact, measuring 300-400. The uterus is a transverse tube and it is transient. Vagina opens posterior to the cirrus by a separate opening. Gravid segments (PL. II, Fig. 1 c & PL. IV, a) are longer than broad, measuring 1620x1420, in which the uterus breaks down into egg capsules each contains one egg. Eggs are scattered through the medullary parenchyma of the gravid segments. They are oval in shape and measure 42x58. They have two coverings around the embryo. The embryo is dilated in its middle part and its hooks are long (PL. II).

According to the key constructed by Spassky, (1951) and Yamaguti (1959), and comparing the present material with that reported by Lamon and Greer (1986) in a human being – the authors can conclude that the already described tapeworm is:

Mathevotaenia symmetrica (Baylis 1927), Akhumian, 1946.

- Host: *Rattus norvegicus*, *Rattus r. frugivorus* and *R. alexandrinus*.
- Habitat: Small intestine.
- Locality: Assiut, Egypt.

2. *Mathevotaenia skrjabini*, Spassky, 1949: -

The adult worm average measure was 12 cm. Scolex (Pl. II Fig. 2 a & Pl. IV, a, 2) is quadrate in shape and unarmed (420-480 x 680-700), bearing four spheroid suckers (120 x 130). Suckers have thick muscular margins and open into narrow slits. The neck measures 900 x 600-700. Segmentation is of craspedote type, with straight edges of the segments. Mature segments (Pl. II Fig. 2 b & Pl. IV, a, 2) are much broader than long and measure 440-470 x 2060-2160. The osmoregulatory canals lie on the lateral boundaries of the segments. Testes are rounded, 52-65 in number, posterior and lateral to female genitalia. In some segments they are discontinuous to form two lateral groups. Cirrus sac is long and narrow measuring 100 x 40. Cirrus is unarmed and vas deferens is slightly coiled. The circular genital pore alternates irregularly on the lateral margins of segments and is situated in the anterior fourth of the segment dividing the margin in a ratio 1: 3. The ovary is two-winged or bilobed, transverse and vitellaria behind it

are compact. The vagina opens into the genital atrium posterior to the cirrus sac, without vaginal sphincter. Gravid segments (Pl. II, Fig. 2 c& Pl. IV, a, 2) are longer than broad (1600 x 1520). Eggs are similar to previous species and measure 49 x 50.

The present material differs from that drawn before by Yamaguti (1959) in the number and distribution of the testes. Initial comparison of the number and distribution of testes is of great importance, this agrees with the opinion of Beveridge (1977). In the former illustration the number of testes was 51, and they were continuous postovarian. The cirrus pouch was wide while here it is narrow. The excretory canals are more laterally situated in the present material. Yamaguti (1959) reported the cestode from *Erinaceus auritus*, Central Asia, while it is recovered herein from *Rattus norvegicus* and *R. alexandrinus*. The similarity of the size and shape of mature segments, the nearly similar number of testes, the shape of the ovary, as well as changes that happen in the muscular organs- as the cirrus sac- during compression and fixation of helminths encourage the conclusion that the present material is:

***Mathevotaenia skrjabini* Spassky, 1949.**

- Host: *R. norvegicus* and *R. alexandrinus*.
- Habitat: Small intestine.
- Locality: Assiut, Egypt.

3. *Mathevotaenia microcephala*, sp. nov. :-

These are fragile cestodes of small size (7-8 cm.). The scolex (Pl. III, Fig. 3 a& Pl. IV, b, 3,a) is quadrate with a conical summit. It measures 280-300 x 240-260. There are four spheroidal suckers measuring 140 x 130. They open into narrow slits surrounded by muscular organs. They are relatively large in comparison to the scolex size. Neck is broader than the scolex and it is relatively long (1000 x 400 - 460). Segments are of craspedote type. Mature segments (Pl. III, Fig. 3 b & Pl. IV. b, 3,b) are fairly broader than long. They are small, deeply separated from each other and measure 500 x 1500. Testes are rounded, their number is 38-40. They are situated posterolateral to female genitalia, never overlap its level and they do not extend laterally beyond the osmoregulatory canals. Cirrus is transverse, cirrus sac is small, oval in shape measuring 50 x 60. Genital pores are small, irregularly alternating and situated just at the junction of the anterior and middle thirds of the lateral border of the segment. Ovary is median, bilobed and measures 500. Vitelline

glands are posterior to the ovary, composed of small compact lobules. The width of vitellaria is 220. Uterus is transient and could not be seen in most segments. Vagina opens posterior to the cirrus. Gravid segments (Pl. III Fig. 3 c & Pl. IV, b, 3,c) are sausage-shaped, with curved outline and deeply separated from each other. They are fairly longer than broad, length is more than twice the width (2800 x 1200). The uterus breaks down into egg capsules each contains one egg. Eggs are oval, with the embryo dilated in the middle, they measure 45 x 55.

After careful comparison with the previously described species it was found that the present description was not previously recorded, and the major differences are (1) Shape and size of the scolex. (2) Neck is broader than the scolex. (3) The fewer number of testes. (4) The deep separation of segments. (5) Gravid segments being sausage-shaped and more than twice the width. (6) Different egg size.

Thus the present material is suggested to be named:

***Mathevotaenia microcephala* sp. nov.**

- Host: *R. norvegicus*, *R.r. frugivorus* and *R. alexandrinus*.
- Habitat: small intestine.
- Locality: Assiut, Egypt.

4. *Mathevotaenia assiuti* sp. nov.

They are small-sized cestodes (8-9 cm). Body is composed of several hundred segments. The scolex (Pl. III, Fig. 4 a & Pl. IV, b, 4a) is entirely unarmed. It has a rounded summit measuring 350-360 x 500-520. The four suckers are oval (160 x 120), with thick muscular margin and open into narrow slits. Neck is exceptionally long, marked by a constriction posterior to the scolex and measures 1500-1600 x 300. Segmentation is distinct and of craspedote type, and the width of proglottids increases along the strobila. Excretory stems are situated close to the lateral boundaries of the cortex and genital ducts pass dorsal to them. Testes (Pl. III, Fig. 4 b & Pl. IV, b, 4,b) are of large number (100-120). They are distributed all over the segment and cross the excretory ducts laterally to reach near the boundaries. Cirrus sac is long and narrow (200 x 100) and crosses the osmoregulatory canals. Cirrus is unarmed and slightly coiled. Genital atrium is oval in shape and well developed, surrounded by a small genital papilla. Genital pores are irregularly alternating dividing the lateral border of the segment in a ratio 1: 2. Ovary is bilobed measuring 1400 x 1600. Its lobes extend transversely in the segment. Vitelline glands are compact, lobulated, and

postovarian structures and they measure 540-600. Uterus is transient, not observed clearly in most of the proglottids. Vagina opens independently posterior to the cirrus into the genital pore. Gravid segments (Pl. III. Fig. 4 c & Pl. IV, b, 4,c) are broader than long measuring 1500 x 2200. They are completely filled with eggs which measure 50 x 65. Eggs are oval and contain hexacanth embryo which is elongated and without a uniform width. The embryo is surrounded by an inner membrane and outer egg capsule, (Pl. III. Fig. 4 d).

The exceptionally long neck, its deep constriction behind the scolex, the scattering of testes all over the mature segments and their large number (100-120), the great variation in dimensions from other species of *Mathevotaenia* and the gravid segments being broader than long – all these criteria are unique for the present material. Hence, it could be considered a new species and named:

***Mathevotaenia assiuti* sp. nov.**

- Host: *R. rattus frugivorus* and *R. norvegicus*
- Habitat: Small intestine.
- Locality: Assiut, Egypt.

Comparison of the presently detected *Mathevotaenia* spp. with previously described similar ones in Egypt and abroad is summarized in Table (1) and (2) respectively. Plates (II, III, IV a, b) show their different characters.

In the present study, Class Nematoda was represented by two species of genus *Syphacia* namely *S. obvelata* and *S. muris*. Both were detected in *R. norvegicus* and *R. r. frugivorus*. *R. alexandrinus* was infected by *S. obvelata* only.

S. obvelata is considered a zoonotic parasite, human infection results from accidental contamination with droppings of infected rodents (Riley, 1920). Fahmy et al., (1971) considered rodents as a source of human infection with *S. obvelata* especially in poor situations. In Egypt, *Syphacia* spp. were detected in different rodents. *S. obvelata* was detected in *Arvicantus niloticus* and *Mus musculus* by Meyers et al., (1962), while Mikhail (1967) recovered both *S. obvelata* and *S. muris* from *M. musculus*, *Ar. niloticus* and *R. rattus*. Rifaat et al., (1969) recovered *S. obvelata* from *Acomys cahirinus*. Fahmy et al., (1971) recovered *S. obvelata* from *Ar. Niloticus* and *S. muris* from *R. rattus*. El-Gindy et al., (1987) reported both species of *Syphacia* from *R. rattus* and *R. norvegicus*. El-Kady et al., (1998) recovered *S. obvelata* from *Acomys cahirinus dimidiatus* in South Sinai.

The final outcome of the present study is (1) The description of some abnormalities in *Hymenolepis diminuta*. (2) The recovery of four species of *Mathevotaenia*, all of them have a new locality record, and two are not previously described. (3) The recovery of *Syphacia* spp. from the examined rats. All the recovered helminths are of proven zoonotic importance. Human infections with *Hymenolepis diminuta* and *Syphacia* spp. were formerly discussed. As regards human infection with *Mathevotaenia* spp., Lamon and Greer (1986) first recorded it from a child. Transmission by ingestion of insect intermediate hosts probably accounts for the rarity of infection. They added that accidental swallowing of insects make it likely that other human cases will be discovered. Among Chinese, beetles are swallowed alive as a therapy for a number of ailments (Sullivan *et al.*, 1977). In Northern Thailand, a wide variety of beetles are regularly cooked and eaten for medicinal purpose (Kliks *et al.*, 1974).

It is noteworthy that the genus *Mathevotaenia* is considered a synonym of *Oochoristica* (Dellasanta, 1956), but previous reports in our locality denied the presence of these genera. Mikhael and Fahmy, (1968) issued the first record of the genus in Egypt. They recorded *M. ratti* from *Mus musculus* and *M. argyptica* n.s. from *Acomys cahirinus* and Laboratory hamster collected from Ismailia and Amria. Monib, (1980) studied the parasites of small mammals in Assiut and he didn't report their presence in rats. The presence of such prevalence of infection (13.6%) among rats in Assiut is astonishing, raising the question is it a recent outbreak of that parasite among rodent population in our community? If it is so, it could be an imported infection within several foodstuffs as grains that may contain infected beetles. Rendtroff (1948) found that several genera of grain beetles and moth could serve as intermediate hosts for *Mathevotaenia symmetrica*. Another explanation of introduction of the infection is that it could be introduced through rats aboard merchants' ships, since *Oochoristica ratti* was first reported by Yamaguti and Miyata (1937) in the same way.

The high prevalence of *Mathevotenia* infection among presently examined rats necessitates further examination of different rodents in other localities. Care should be taken for detection of such small fragile cestode or its eggs during examination of diarrhoeic stools especially in slum areas where zoonotic infections are common.

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LEGEND OF FIGURES

- Plate (I):** Photomicrographs of *Hymenolepis diminuta* showing the scolex and the abnormalities in mature segments (x 20).
- Plate (II):** Photomicrographs of *Mathevotaenia symmetrica* (1) and *M. skrjabini* (2) showing Scolex (a), Mature segment (b) and Gravid segment (c) for each species (x20), and egg capsule (d) of *Mathevotaenia symmetrica* (x 40)
- Plate (III):** Photomicrographs of *Mathevotaenia microcephala sp. nov* (3) and *M. asssiuti sp. nov.* (4) showing Scolex (a), Mature segment (b) and Gravid segment (c) for each species (x20). and egg capsule (d) (x 40)
- Plate (IV):** Camera lucida drawing of the presently recovered *Mathevotaenia spp.*

Table (8) Comparison between *Matheniaemia* in the present work and the previously detected spp.

	<i>M. paraguayae</i> Schmidt & Martin 1978	<i>M. symmetrica</i> Lamon & Greer 1986	<i>M. symmetrica</i> Present material	<i>M. skyabini</i> Present material	<i>M. microcephala</i> , sp. nov. Present material	<i>M. assiuti</i> sp. nov. Present material
1- Host	Yellow armadillo	Human	<i>R. norvegicus</i> <i>R. r. frugivorus</i> <i>R. alexandrinus</i>	<i>R. norvegicus</i> <i>R. alexandrinus</i>	<i>R. norvegicus</i> <i>R. r. frugivorus</i> <i>R. alexandrinus</i>	<i>R. norvegicus</i> <i>R. r. frugivorus</i>
2- Scolex	Unarmed 21.5-280x37.5-46.5*	Unarmed scolex 270-290	Rounded summit 400-460x660-700	Quadrate 420-480x680-720	Conical summit 280-300x240-260	Rounded summit 350-360x500-520
3- Suckers	Oblong, deep embedded 120 x 120	Spherical 103-122 x 150	Spherical 120 x 120	Spheroid 129 x 130	Spheroid 140 x 130	Oval 160 x 120
4- Neck	Narrow Width 400	Narrow Width 220-270	Slightly narrow 900 x 600-700	Narrow 680 x 350	Broad 1000 x 400-460	Long and narrow 1500-1600x 300
5- Mature segment	Longer than broad Not mentioned	Broader than long 280-720x1050-1560	Same 720-800x1320-1720	Same 440-470x2060-2160	Same 500x1400-1500	Same 1100-1300x 2300-2500
6- Testes No.	16-25	38-51	39-51	52-83	38-40	100-120
Position	Posterior and somewhat lateral	Posterolateral to ovary	Postovarian	Postovarian mainly lateral	Postovarian	Allover the segment
7- Cirrus pouch	Transverse	Elongated, pyriform	Elongated, straight	Long, narrow	Small, oval shape	Long and narrow
Size	100-160 x 30-80	72-79 x 39-51	80 x 60	100 x 40	60 x 50	200 x 100
8- G. P. position	1/4 lateral border	Same	Same	Same	Same	Same
9- Ovary size	Median 90-120 x 220-280	Bilobed to fan-like 270-500	Bilobed 700-860	Bilobed, extended 1200-1300	Bilobed 500-550	Bilobed 1400-1600
10- Vit. Glands	Compact 40-50 x 90-110	Compact 110-145	Compact 300-340	Compact, lobular 320-450	Compact 220	Compact 540-600
11- Gravid Seg	Longer than broad Not mentioned	Longer than broad 200-3000x 1500	Same 1620 x 1420	Same 1600 x 1520	Same 2800 x 1200	Broader than long 1500 x 2200
12- Egg						
Onchosphere	22-35	26-31 x 17-22	Oval 28 x 20	Rounded 20 x 20	Ovoid 30 x 25	Oval 38 x 32
Hook length	16-18	Not mentioned	13-17	12-27	14-18	15-20
Outer capsule	60-80	Not mentioned	42 x 58	49 x 50	45 x 55	50 x 65

* All measurements are in μ .

Table (1) Comparison between *Mathewoventia* in the present work and the previously detected spp. in Egypt.

	<i>M. ratti</i> Mikhail & Fahmy, 1968	<i>M. angustica</i> Mikhail & Fahmy, 1968	<i>M. symmetrica</i>	<i>M. skryabinii</i>	<i>M. ratti</i>	<i>M. axiuti</i>
2- Host	<i>Mus musculus</i>	<i>Acomyx cabrinus</i> <i>Mesocricetus auratus</i> (lab. hamster)	<i>R. norvegicus</i> <i>R. r. frugivorus</i> <i>R. alexandrinus</i>	<i>R. norvegicus</i> <i>R. alexandrinus</i>	<i>R. norvegicus</i> <i>R. r. frugivorus</i> <i>R. alexandrinus</i>	<i>R. norvegicus</i> <i>R. r. frugivorus</i>
2- Scolex	Not mentioned 380 - 500	Unarmed scolex 380-430	Rounded summit 400-460x660-700	Quadrat 420-480x680-720	Conical summit 280-300x240-260	Rounded summit 350-360x500-520
3- Suckers	Not mentioned 120 - 150 (130)	Spherical 110-160 (150)	Spherical 120 x 120	Spheroid 120 x 130	Spheroid 140 x 130	Oval 160 x 120
4- Neck	Not mentioned	Not mentioned	Slightly narrow 900 x 600-700	Narrow 680 x 350	Broad 1000 x 400-460	Long and narrow 1500-1600x 300
5- Mature segment	Not mentioned 1066-1130 x 716-830	Broader than long 1040-1050x500-550	Same 720-800x1320-1720	Same 430-470x2060-2160	Same 500x1400-1500	Same 1100-1300x 2300-2500
6- Testes: No. Position	52 - 84 (62) Posterior to ovary and unequal in both sides	88-97 (90) distributed throughout the strobila	39-51 Postovarian	52-65 Postovarian mainly lateral	38-40 Postovarian	100-120 Allover the segment
7- Cirrus pouch	Not beyond excr. duct	Oval to pyriform 140-150 x 50-60	Elongated, straight 80 x 60	Long, narrow 100 x 40	Small, oval shape 60 x 50	Long and narrow 200 x 100
8- G. P. position	1/3 lateral border	Same	Same	Same	Same	Same
9- Ovary size	Median 310 x 460 (380)	Horse shoe-shaped 450-550	Bilobed 700-860	Bilobed, extended 1200-1300	Bilobed 500-550	Bilobed 1400-1600
10- Vit. Glands	Compact 166-316 (200)	Compact 208-250	Compact 300-340	Compact, lobular 320-450	Compact 220	Compact 540-600
11- Cravid Seg.	Longer than broad 1018-1028 x 1055-1083	Longer than broad 2500 x 1045	Same 1620 x 1420	Same 1600 x 1520	Same 2800 x 1200	Broader than long 1500 x 2200
12- Egg	Not mentioned	Spheroid	Oval	Rounded	Ovoid	Oval
Onchosphere	26	44	28 x 20	20 x 20	30 x 25	38 x 32
Hook length	Not mentioned	Not mentioned	13-17	12-27	14-18	15-20
Outer capsule	43	110-138 (125)	42 x 58	49 x 50	45 x 55	50 x 65

All measurements are in microns, mean values in parentheses

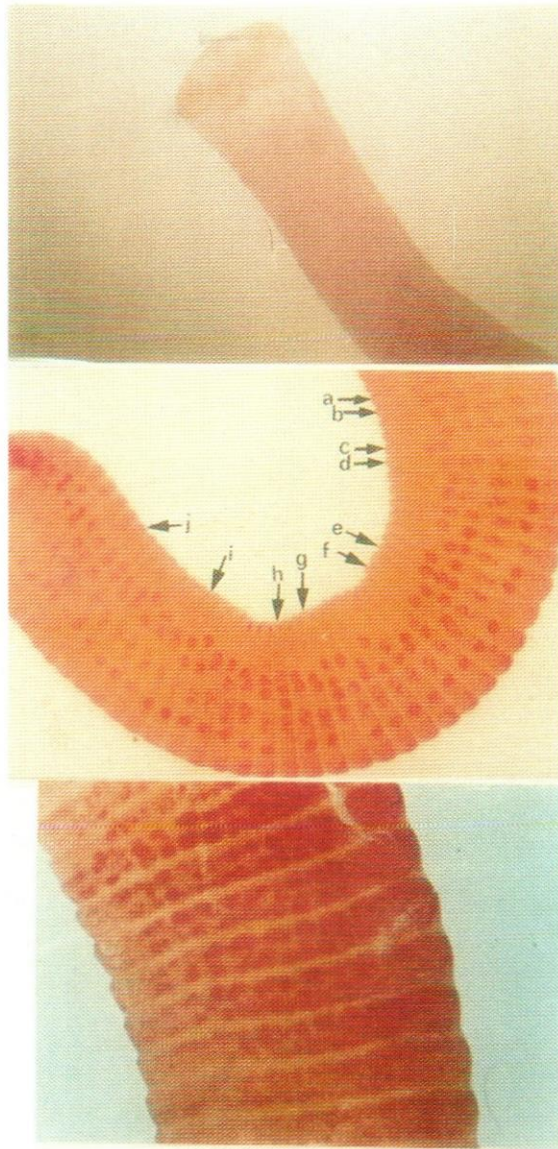


Plate (I)

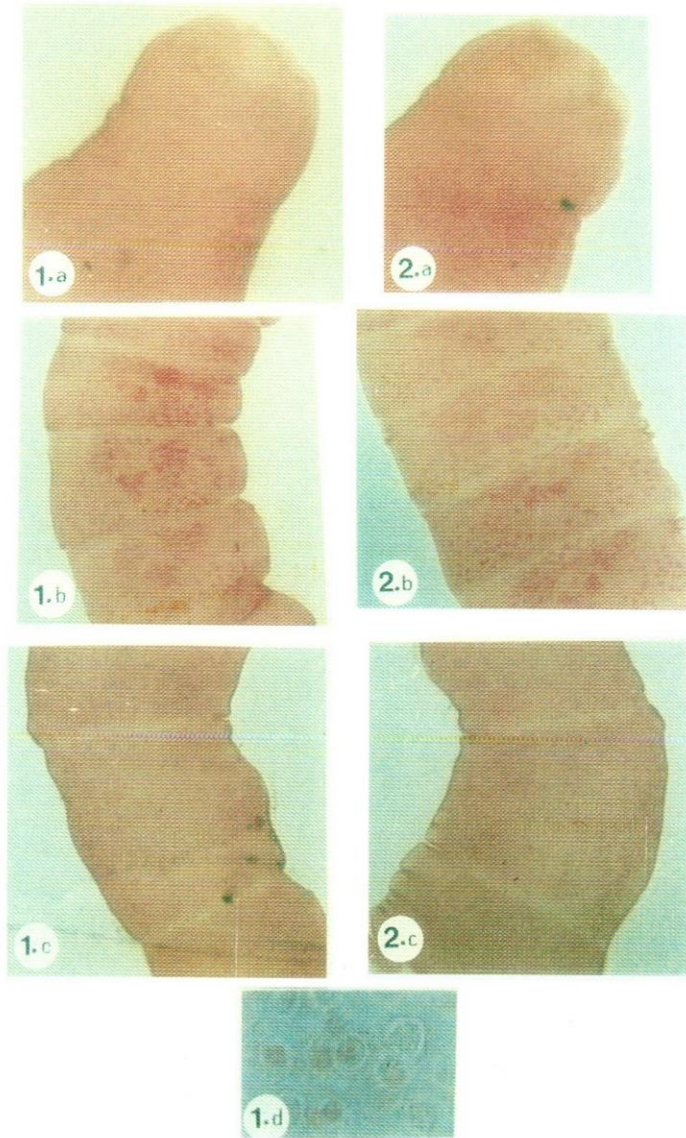


Plate (II)

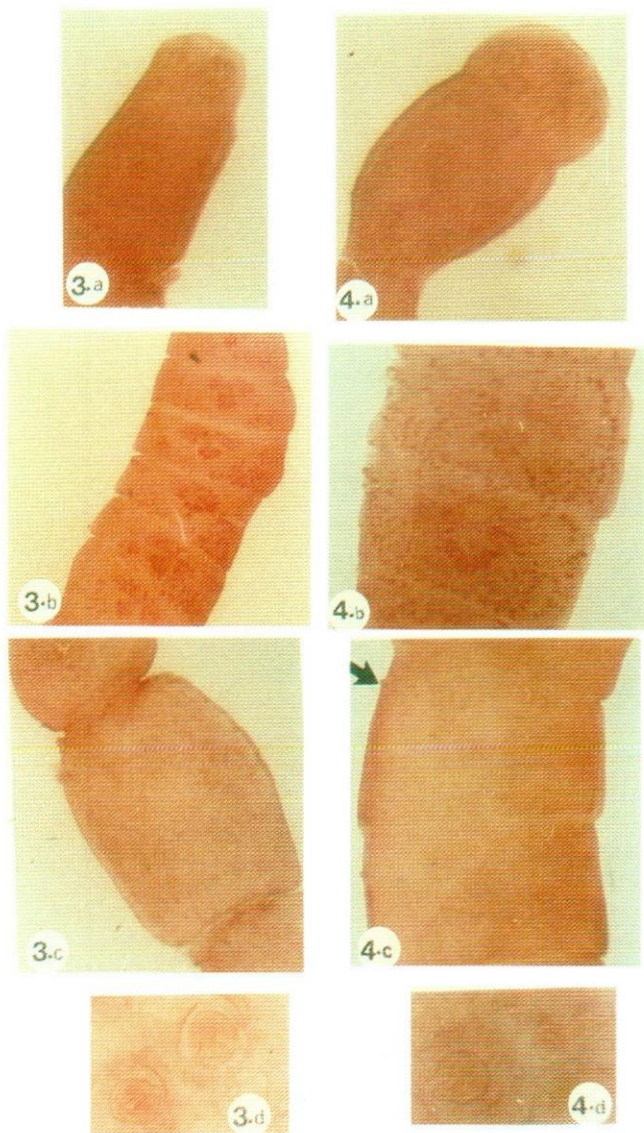


Plate (III)



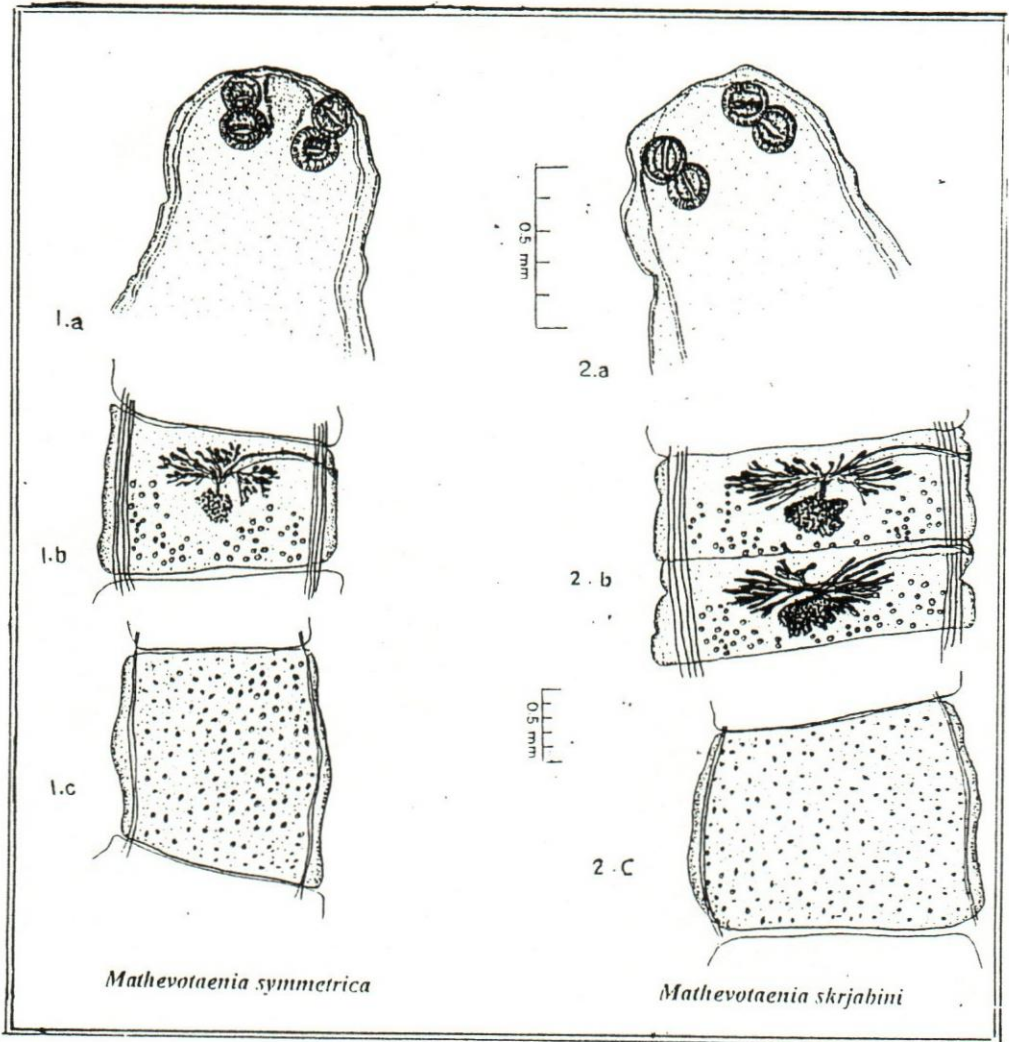


Plate (IV, a)

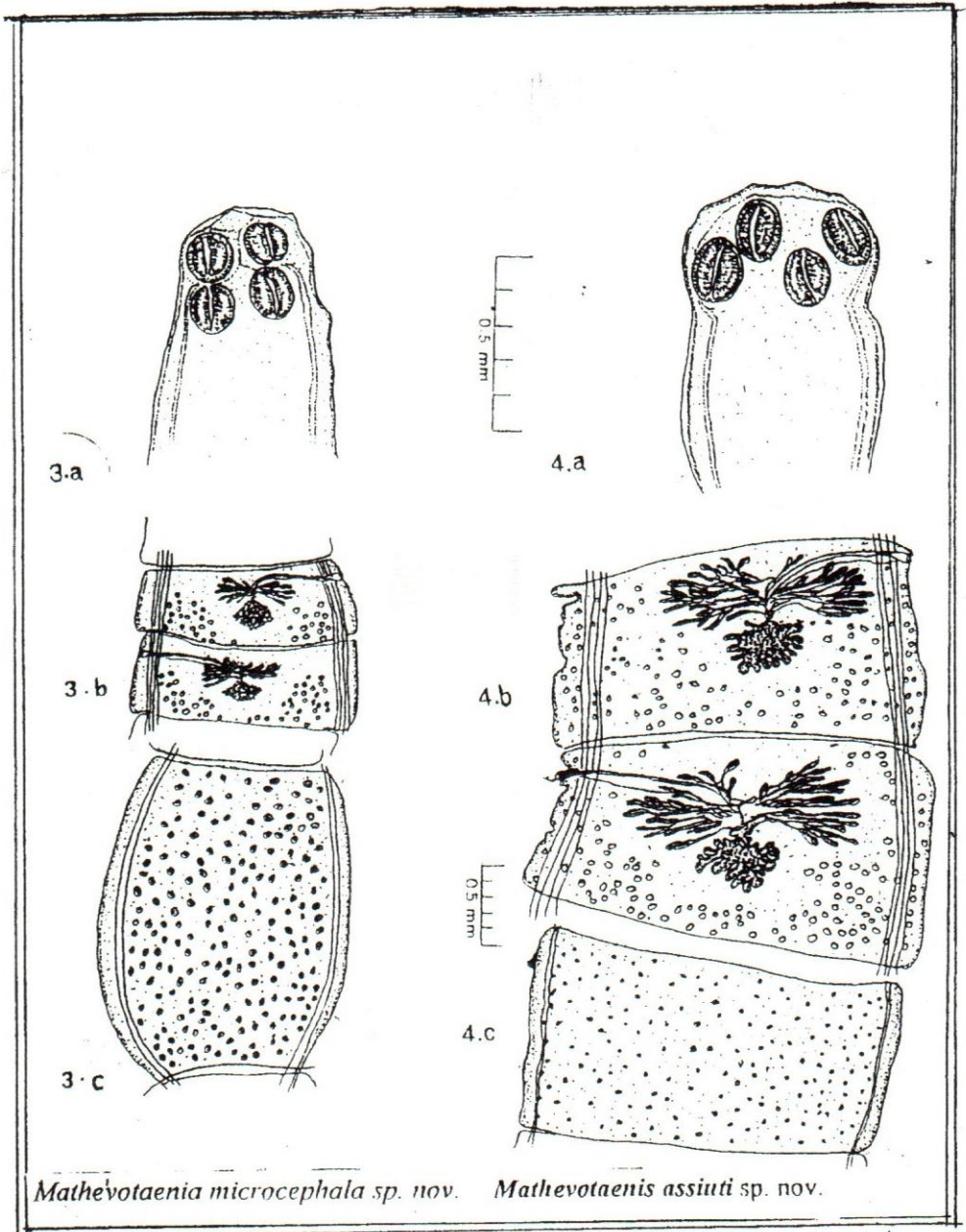


Plate (IV, b)