

Nematodes Associated with Coleoptera Species in Egypt. I.

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I n t r o d u c t i o n

Nematodes invading insects as primary hosts are of great importance in biological control. The relation between insects and nematodes attracts the attention of many recent investigators attempting to use the nematodes as biological agents in controlling insect pests, as is the case with bacteria and viruses.

Records of insect-nematode association have been discussed and found in most orders of insects. ALI et al./1972/ discussed the infection of some coleopterous species with nematodes and found that nematodes were associated externally with those insects; they also discussed the relationships between those insects and their nematode parasites.

The interactions of nematodes and other notorious pests, especially insects, were recorded by certain investigators, e.g. BODENHEIMER /1923/, COBB /1927/, OLDHAM /1933/, THÉODORIDÉS /1950/ and WELCH /1958/. Other workers gave a list of insect - nematodes, as that of bark beetle - nematodes given by THÉODORIDÉS /1950/ and that of chrysomelids by JOLIVET /1950/. Three internal parasites in *Ips confusus* /Lec./ and a new nematode species, *Cylindrocorpus*, from *Scolytus multistriatus* March., were described by MASSEY /1960/. In the first contribution /ALI et al, in press/, we discussed and described the nematode species which

were found externally associated with some coleopterous hosts., and in this paper we propose to deal with nematodes found as internal parasites in some insect species, and also the symptoms of parasitism.

Material and Methods

Beetles examined in this investigation were collected from the farms of the Agricultural faculty at Mosttord, Abu-Rawash, and Giza. Certain insects live in the soil subsurface or in heaps of organic manure, either as adults or as immature stages.

Insect specimens were examined externally and internally by a stereomicroscope to verify their infection by nematodes. External examination involved testing the mouth parts, the areas underneath the elytra or wings, the leg parts, the abdomen and the genital segments. The nematode larvae isolated from the infested beetles were cultured on certain artificial media, such as nutrient agar /meat extract 5 g, bibtone 3 g, agar 20 g, dextrose 10 g and 1000 ml distilled water/, meat extract /meat infusion 10 ml, agar 20 g, and 70 ml distilled water/, and wet scrappings of potatoes.

Nematode cultures were incubated at 27-30°C in an incubator and examined daily to notice and follow development and generation period. The cultures lasted for one and half months. Renewals were made every 10 to 15 days.

To describe and measure the isolated nematode species, 10 males and females were placed in a drop of distilled water on a glass slide and killed by gradually heating. Small pieces of glass-wool rods were placed underneath the cover glass to avoid the crushing of nematodes. Measurements and drawing of nematodes were carried out by Camera - Lucida.

Drawing of adult females involved illustrations of the mouth cavity, vulva region and abdomen and in case of males illustra-

tions of the mouth cavity, oesophagus, abdomen and spicules and gubernaculum were made.

Dimensions, nomenclature and identification of the nematode species are given according to the system of FILIPJEV and STEKHOVEN /1959/, MEYL /1960/, THORNE /1961/, and GOODEY /1963/.

Permanent microscopic preparations of certain isolated nematode species were made by SEINHOREST's /1962/ method. Longitudinal sections through the body cavity of *Blaps polychresta* Forsk. were made by using Saphranine double staining method, and light green stains to verify the damage caused by the internal parasites.

Results and Discussion

Our results concerning insect infection with nematodes, and the description of their internal nematode parasites are as follows.

1. *Pimelia angulata* F.

A number of 171 beetles of *Pimelia angulata* F. /Col., Tenebrionidae/ were collected from sandy soils in various sites at Abu-Rawash. Only 10 beetles /5.85 %/ were found to be infested internally with nematodes invading the intestinal tract.

The extracted parasites were in the third larval stage. Many attempts were made to rear nematodes on artificial media or on insect tissues. Rearing succeeded on the meat extract medium. The nematode larvae reached the adult stage within about nine days. Culture examination showed that all adult nematodes were females; no males were noticed in the cultures continuing for three months.

The low percentage of infestation indicates that the propaga-

ABBREVIATIONS USED IN THE DESCRIPTIONS

an.	= Anus
cr.	= Corpus
ca.	= Caudal alae /Bursa/
ebe.	= End bulb of oesophagus
cp.	= Caudal papillae
gub.	= Gubernaculum
int.	= Intestine
li.	= Lip
mps.	= Median pseudobulb
nr.	= Nerve ring
ov.	= Ovary
pr.	= Pro-stome
r.	= Rectum
spi.	= Spicules
te.	= Telostome
ut.	= Uterus
veb.	= Valve of oesophagus end-bulb
vu.	= Vulva

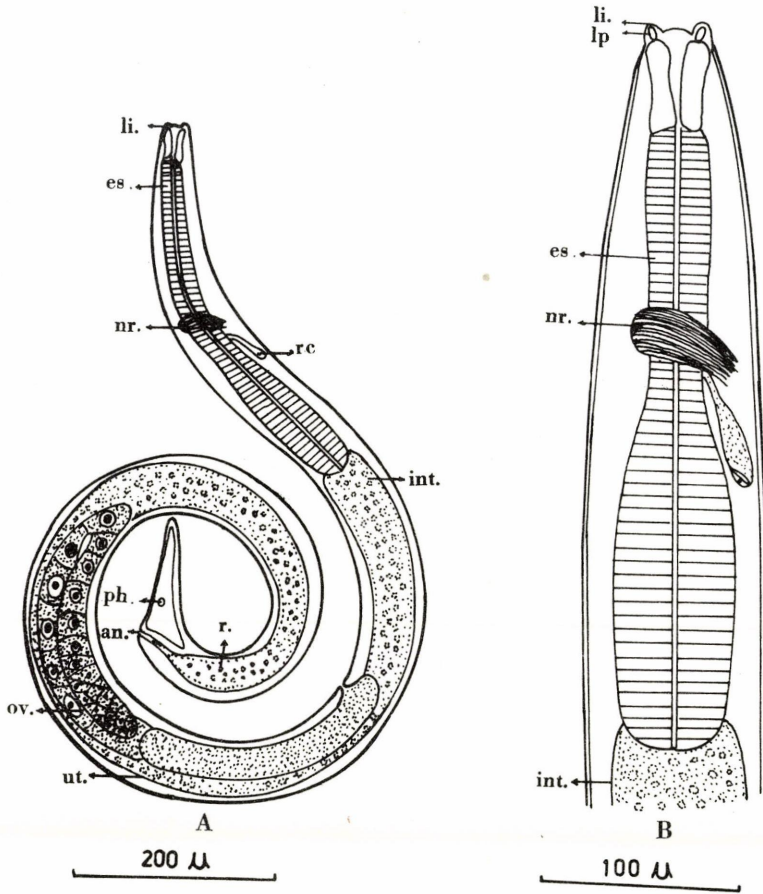


Fig. 1.:
 Internal parasitic nematode species, Alaimus primitivus
 De Man, 1880
 A. - Pre-adult female
 B. - Female front end with oesophagus

tion of parasitic nematodes by the insect in dry sandy soils is limited. The morphological description of extracted internal parasitic nematode species is as follows:

1. - 1. Alaimus primitivus De Man, 1880

Females /n = 10/:

L = 1.985 - 3.080 mm; a = 18.7 - 27.5; b = 10.1 - 14.3;

c = 24.8 - 36.4; v = 39 - 41 %

Males: not found

Adult female with a slender body, tapering anteriorly and posteriorly. Cuticle smooth, head papillae very obscure, visible only in very favourable conditions; no special stomatal structures, but mouth in form of a minute cup leading into a narrow tube traversing oesophagus /Fig. 1-b/. Oesophagus clavately swelling terminally. Oesophago-intestinal valve thin and disciform. Adult female with one gonad, ovary reflexed about half - way to vulva. Female tail long and slightly conoid.

Host: *Pimelia angulata* F.

Locality: Abu-Rawash, Cairo, EGYPT

2.- *Blaps polychresta* Forsk.

Specimens of *Blaps polychresta* Forsk. /Coleoptera: Tenebrionidae/ were collected on various occasions from manure heaps at Abu-Rawash, Kerdasa, and Mosttord.

Only 455 individuals of 755 dissected beetles /60.26 %/ were found to be infested with nematodes. The beetles were infested externally and internally. The extracted nematodes represented three nematode species, found to be infesting the beetles at different ratios /Table 2/.

The nematode species Alaimus primitivus occurred in the intestinal region and represents a comparative percentage of 2.324 %.

Physocephalus sexalatus was noticed as cysts invading in large numbers the insect haemocoel and particularly the internal genital organs; this species represented 93.181 %. Rhabditis axei was found externally on the abdominal segments, especially on the ventral side of the genital ones. Beetles collected in Mosttord during February and March, 1967, were mostly infested by this nematode, in a comparative percentage of 4.495 %. Most beetles gathered in Mosttord were infested also by Physocephalus sexalatus, while the beetles collected in Kerdasa and Abu-Rawash were free of this nematode species. Several unsuccessful attempts were used to rear Alaimus primitivus and Physocephalus sexalatus on artificial cultures.

Table 1.

Infection of *Blaps polychresta* Forsk.

Number of beetles examined	% of infestation	Number of extracted nematodes	Nematode species	% of nematode infested beetles
300	Nil	-	-	-
79 "intestinal"	10.5	106	<u>Alaimus primitivus</u>	2.3
339 "haemocoel"	44.9	4250	<u>Physocephalus sexalatus</u>	93.2
37 "external"	4.9	205	<u>Rhabditis axei</u>	4.5
Total: 755	60.3	4561	3 Nematode species	100.0

The larvae of Rhabditis axei flourished well in meat extract, potato scrappings, neutral insect tissues, and nutrient agar media. The cultures were incubated at 27°C. Potato scrappings was less suitable for the growth of this nematode species. Continuous examination of beetles collected at various seasons re-

vealed that the infestation with nematodes was higher in the warm months.

The description of Alaimus primitivus was given above while the morphological diagrams of Physocephalus sexalatus and Rhabditis axei are as follows:

2. - 1. Physocephalus sexalatus Molin, 1916

Females /n = 10/:

L = 3.3 - 3.325 mm; a = 26.6 - 28.7; b = 2.6 - 2.7;

c = 33 - 41.7; V = ?

This nematode species may be easily distinguished by the well developed oesophagus. Oesophagus /Fig.3-A/ without median bulb. Head broad, but lips conspicuous and labial papillae present. Stoma long and narrow. Excretory system consisting of rectal cells, extending to surround anterior part of oesophagus. Cuticular with longitudinal and transverse striations. Female tail nearly conoid, with pointed appendage.

Host: *Blaps polychresta* Forsk.

Locality: Mosttord and Abu-Rawash, Cairo, EGYPT

2. - 2. Rhabditis axei /Cobbold, 1884/, Dougherty, 1955

Females /n = 10/:

L = 0.815 - 1.394 mm; a = 13 - 19.4; b = 3.6 - 5.7; c = 2.2 - 3.7

V = 50 - 79,5 %

Males /n = 10/:

L = 0.944 - 1.232 mm; a = 31.6 - 35.5; b = 3.3 - 5.3; c = 4.2 - 5

This nematode species is characterized by the broad conical lips /Fig. 4-D/, each with a fine apical papilla. Body cuticle finely but obscurely striated. Stoma long and narrow. Chelo-

rhabdions absent or blended with thin and weak protorhabdions. Oesophageal collar enveloping about 2/3 of stoma. Oesophagus /Fig. 4-C/ with a swollen median bulb; oesophago-intestinal valve short and conical, protruding into intestine. Oesophagus with a valvate bulb.



Fig. 2.:

Larva of *Physocephalus sexalatus* as shown in the haemocoel of the host, *Blaps polychresta* Forsk.

- A. - Larva in its cyst in the insect haemocoel
- B, D. - Larva leaving its cyst
- C. - Free nematode larva.

Female 1.394 mm long and 45 μ in maximum breadth. Oesophageal portion 223 - 245 μ long. Two well developed gonads present, ovaries reflexed towards vulva. Female tail /Fig. 4-A/ filiform and very long.

Male 1.232 mm long, 45 μ broad. Male tail about 0.374 - 0.381 mm long, filiform and supported with nine pairs of caudal papillae; three pairs pre-anal position. A small bursa present /Fig. 4-E/. Spicules 48 - 53 μ long, separate, knobbed anteriorly and with strong dorsal prong; gubernaculum 24 - 26 μ long, about half as long as spicules.

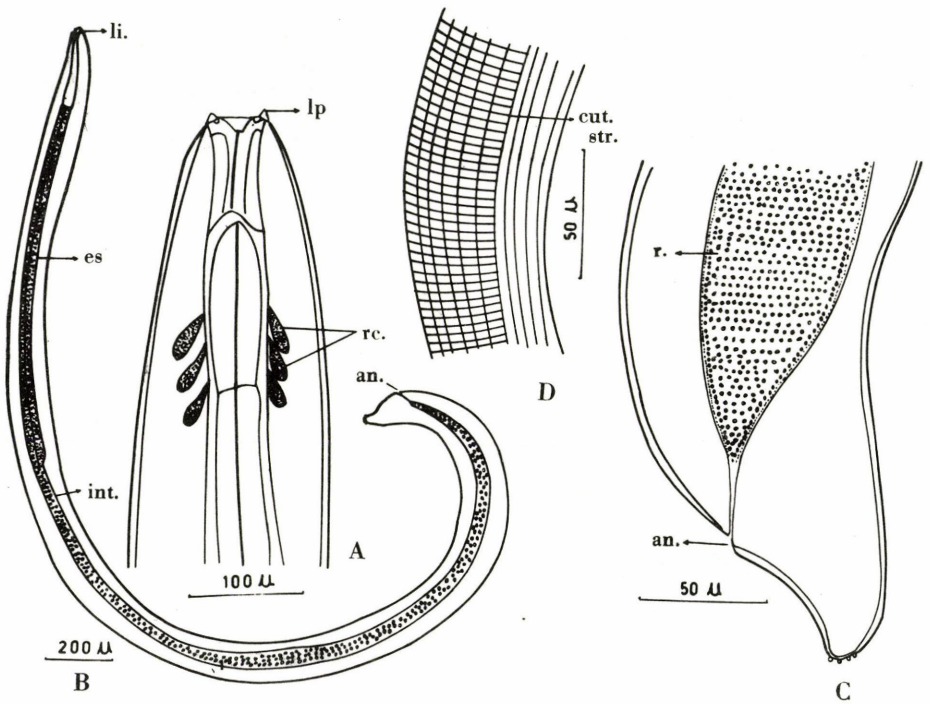


Fig. 3.:

Physocephalus sexalatus /after Seurat, 1916/

A.- Female front end with part of oesophagus

B.- Third stage larva, lateral view

C.- Larval tail, lateral view

D.- Cuticular striations

Host: *Blaps polychresta* Forsk.

Locality: Mosttord and Abu-Rawash, Cairo, EGYPT

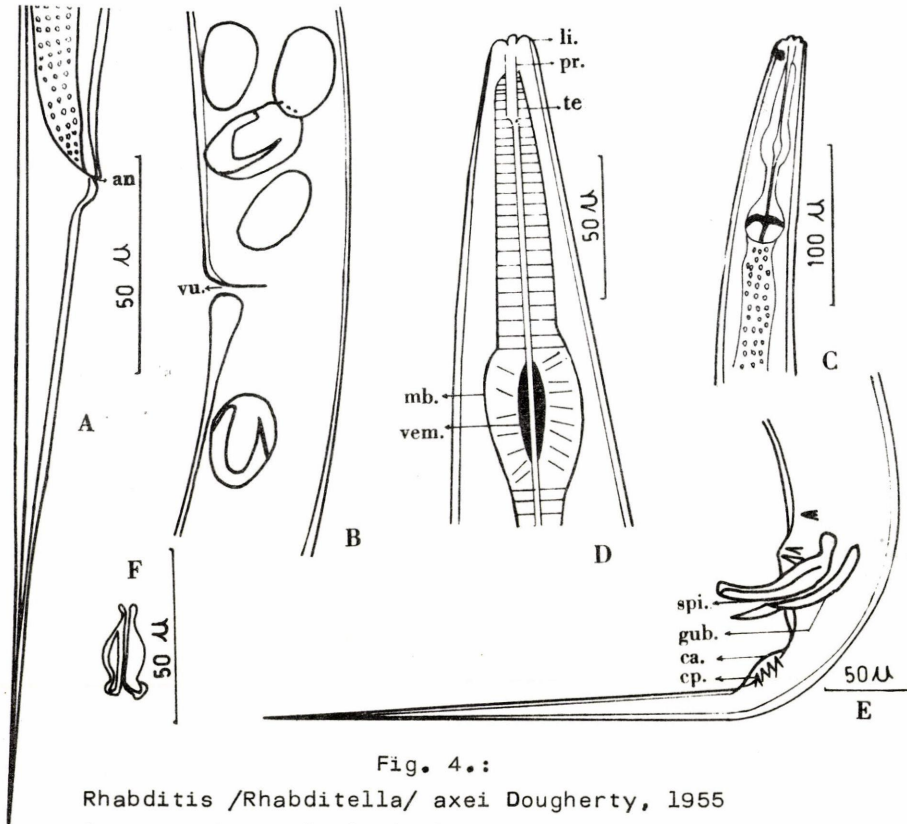


Fig. 4.:

Rhabditis /*Rhabditella*/ *axei* Dougherty, 1955

- A. - Female tail, lateral view
- B. - Female vulva region with some eggs, lateral view
- C. - Female front end with oesophagus
- D. - Male stoma
- E. - Male tail, lateral view
- F. - Male spicules

3. - *Scarabaeus sacer* L.

Specimens of *Scarabaeus sacer* L. /Coleoptera: Scarabaeidae/ were collected in various sites at Abu-Rawash on different occasions. The specimens were found in the subsurface sandy soils at

a depth ranging from 60 to 100 cm. A ball of organic matter was always attached to the insect body.

Examination of 210 beetles showed that only 112 specimens were infested externally and internally by nematodes /53.33%/. About 42.86 % of the total were infected externally, the rest internally. The exoparasites were found beneath the elytra and on the membranous wings. The endoparasites were found either as cysts between the internal organs /especially the reproductive organs/ or as larvae wandering free in the haemocoel and feeding on the surrounding tissues.

A number of 1742 external larval parasites were extracted from 90 externally infested beetles. They were reared on several artificial media, where they developed well. After reaching the adult stage, they identified as Cephalobus persegnis, Mesorhabditis spiculigera, Panagrolaimus wichmanni and Rhabditolaimus crassus /Table 3/.

From 22 beetles /10.47 % of the total/, 513 endoparasitic larvae were extracted. They represented Physocephalus sexalatus Molin /after Seurat, 1916/.

This species was described above. The external parasitic nematodes reported above are described hereafter.

3. - 1. Cephalobus persegnis Bastian, 1865

Females /n = 10/:

L = 1.288 - 1.4 mm; a = 12.5 - 15.3; b = 5.6 - 6.5;

c = 16.7 - 26.3; V = 72 - 74 %

Males /n = 10/:

L = 0.924 - 1.148 mm; a = 13.2 - 13.6; b = 4.8 - 5.1;

c = 14.5 - 18.5

Table 2.

Infection of *Scarabaeus sacer* L.

Number of beetles examined	% of infestation	No. of extracted nematodes	Type of infestation	Nematode species	% of nematode-infested beetles
98	Nil	-	external	-	-
34	16.2	600		<i>Cephalobus persegnis</i>	26.6
28	13.3	503		<i>Mesorhabditis spiculigera</i>	22.3
9	4.3	240		<i>Panagrolaimus wichmanni</i>	10.6
19	9.0	399		<i>Rhabditolaimus crassus</i>	17.7
22	10.5	513	internal	<i>Physocephalus sexalatus</i>	22.8
Total: 210	53.33%	2255		5 Nematode species	100.0

Adults characterized by fine transverse striations on cuticle, apparently at posterior part of tail. Lips low, rounded, obscurely duplex, median lip asymmetrical.

Oesophagus /Fig. 5-A/ almost cylindrical except in the basal fifth, there tapering to isthmus but separated it by only a break in musculature. Nerve ring present, apparently surrounding isthmus.

Female with a single gonad, prodelphic, reflexed, ovary with double flexure in posterior part. Female tail 49 - 84 μ long generally uniformly conoid to blunt terminus. Vulva posterior.

Male shorter than female, 1.184 mm /maximum/ long and 84 μ broad. Male tail /Fig. 5-D/ shorter than that of female more

tapering, arcuate, with six pairs of caudal papillae; three in preanal and three in postanal positions, about 50 mm long. Gubernaculum 38 - 41 μ long.

Host: *Scarabaeus sacer* L.

Locality: Abu-Rawash, Cairo, EGYPT

3. - 2. *Mesorhabditis spiculigera* /Steiner, 1936/,
Dougherty, 1953

Females /n = 10/;

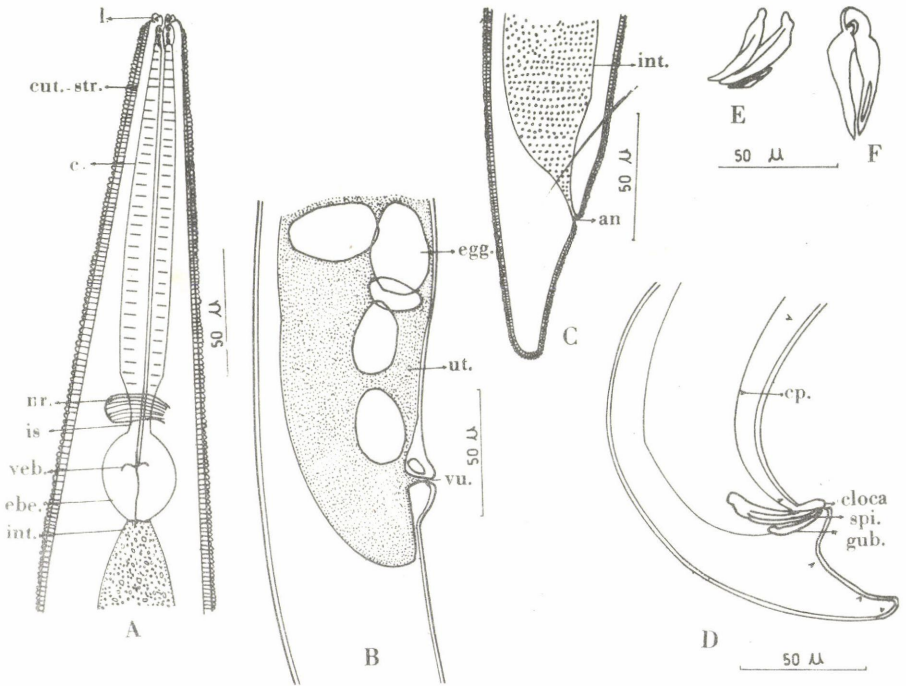


Fig. 5.:

Cephalobus persegnsis Bastian, 1865

- A. - Anterior end with complete oesophagus
- B. - Female vulva region with eggs, lateral view
- C. - Female tail, lateral view
- D. - Male tail with caudal papillae, lateral view
- E. - Male spicules, dorsal view

Table 3
3. táblázat

Insect Species Infested with Nematodes
Bogárfajok fonálféreg-fertőzöttsége

No. Insect species examined Vizsgált rovar- fajok	Number of ins- ects examined Vizsgált boga- rak száma	Number of infes- ted beetles Fertőzött boga- rak száma	% of insect in- festation Fertőzött boga- rak %-a	Nematode species Fonálféreg-fajok	% of extensity Extenzitás %-a
Order: Coleoptera 1. <i>Pimelia angulata</i> F. 2. <i>Blaps polychresta</i> Forsk. 3. <i>Scarabaeus sacer</i> L.	171 755 210	10 455 112	5,8 60,3 53,4	<i>Alaimus primitivus</i> <i>Alaimus primitivus</i> <i>Physocephalus sexala-</i> <i>tus</i> <i>Rhabditis axei</i> <i>Cephalobolus perseg-</i> <i>nis</i> <i>Mesorhabditis spicu-</i> <i>ligera</i> <i>Panagrolaimus wich-</i> <i>manni</i> <i>Rhabditolaimus crassus</i> <i>Physocephalus sexala-</i> <i>tus</i>	100,0 2,3 93,2 4,5 26,6 22,3 10,7 17,7 22,7

L = 1.371 - 1.637 mm; a = 19 - 23.1; b = 6.8 - 6.9;
c = 14.5 - 14.6; V = 87 - 89 %

Males /n = 10/:

L = 1.171 - 1.188 mm; a = 17.7 - 18.6; b = 5.5 - 5.6;
c = 37.1 - 68.9

Cuticle slightly striated. Six spherical lips present well offset and every lip with a single setox papilla /Fig. 6-B/. Mouth cavity four to five times as long as wide, mouth cavity 28μ long, body narrowing immediately behind vulva.

Oesophagus /Fig. 6-A/ consisting of corpus, median bulb, isthmus and basal bulb; basal bulb with strongly sclerotized valve. Excretory pore opposite basal bulb. Nerve ring clear and surrounding isthmus.

Female tail /Fig. 6-C/ shorter than that of male, pointed, conical. Adult female with a single ovary, prodelphic, not reflexed. Vulva posterior. Few eggs present in uterus. Means of deposited eggs: 51μ long and 25μ broad. Larva after its third moult reaching 1.056 mm in length and 0.048 mm in breadth.

Male tail /Fig. 6-D, E, F, G, and H/ peloderan, short and pointed conical. Bursa present, peloderan, open and about 101μ long, supported by 10 pairs of caudal papillae: two pairs in preanal position, five pairs in middle region, and three pairs close to tip of tail.

Fig. 6.:

Mesorhabditis spiculigera /Steiner, 1936/, Dougherty, 1953

- A. - Female front end with complete oesophagus
- B. - Female mouth cavity, side view
- C. - Female vulva and anal region, lateral view
- D., E. - Male tail, lateral view
- F. - Male tail, ventro - lateral view
- G. - Male tail, ventral view
- H. - Male spicules and gubernaculum

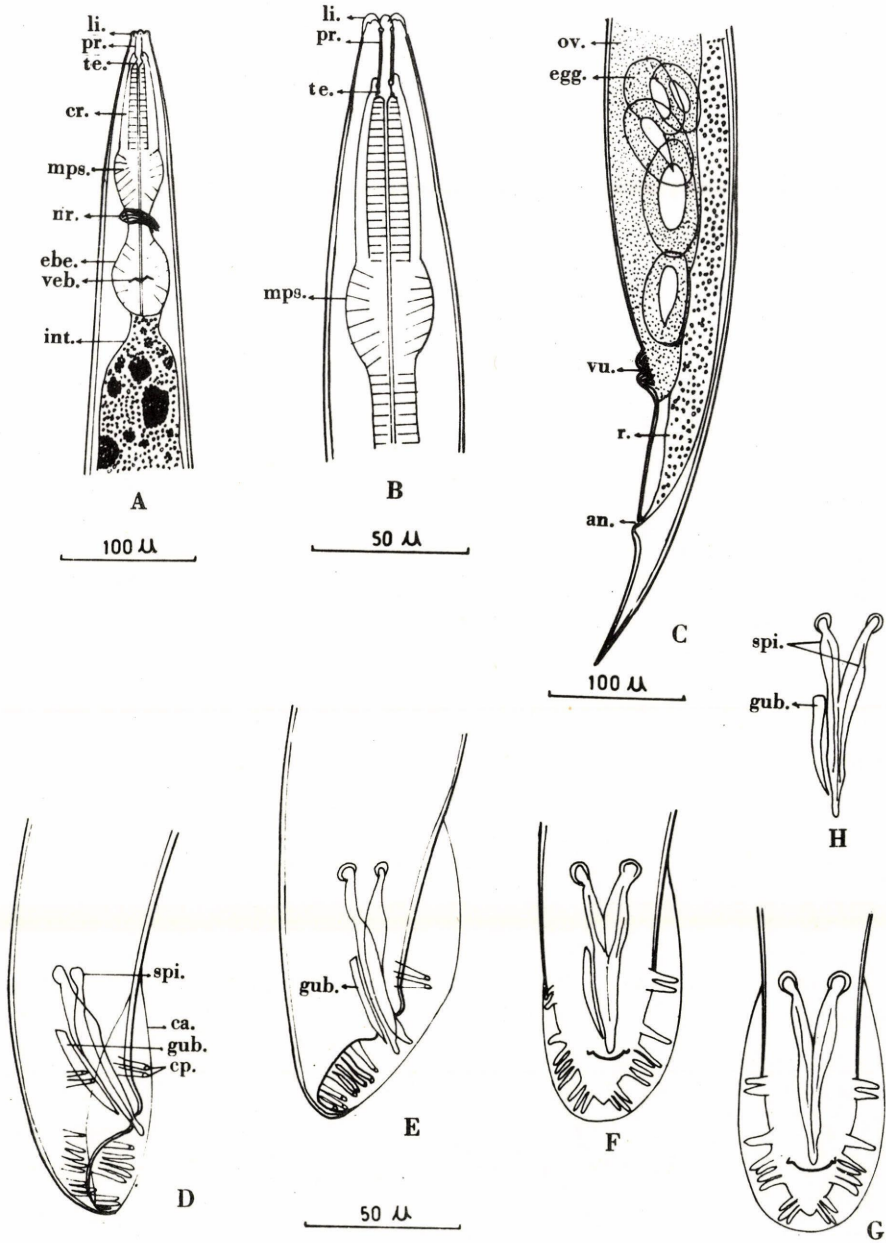


Fig. 6.

Spicules paired, narrow, long, brownish and about four times as wide as anal body width; anteriorly knobbed. Gubernaculum 24-32 μ long, spicules 61-72 μ long.

Host: *Scarabaeus sacer* L.

Locality: Abu-Rawash, Cairo, EGYPT

3. - 3. *Panagrolaimus wichmanni* Rühm, 1956.

Females /n = 10/:

L = 1.220 - 1.265 mm; a = 13.6 - 14.2; b = 4.2 - 4.3;

c = 12.7 - 12.8; V = 68 %

Males /n = 10/:

L = 0.99 - 1.03 mm; a = 11.4 - 11.6; b = 3.8 - 3.9;

c = 17.4 - 18.

Two circlets of lip papillae present. Cheilostoma rounded, triangular, 42 - 44 μ long. Protorhabdion longer than mesorhabdion. Oesophagus /Fig. 7-B/ panagrolaimoid; anterior part cylindrical, isthmus shorter than its anterior part and leading to a basal, valvate bulb.

Adult female 1.265 mm long and 93 μ broad. A single gonad present, ovary tip reflexed, post-vulva almost as far as anus. Post-vulva sac about body-width in length; vulva posterior and uterus containing several eggs at a time /Fig. 7-C/. Female tail /Fig. 7-D/ conoid, more tapering towards end.

Male tail /Fig. 7-E/ conical, short, supported by six pairs of caudal papillae; three pairs in pre-anal position, three pairs arranged at base of conical tail. Spicules 44 μ long, paired, fused and knobbed at their anterior ends. Gubernaculum 14 μ long.

Host: *Scarabaeus sacer* L.

Locality: Abu-Rawash, Cairo, EGYPT

3. - 4. Rhabditolaimus crassus /Körner, 1954/

Females /n = 10/:

L = 0.925 - 1.145 mm; a = 14.2 - 16.9; b = 5.8 - 6.8;

c = 13.4 - 16.6; V = 81.5 - 87 %.

Males /n = 10/:

L = 0.656 - 0.928 mm; a = 15.6 - 17.4; b = 4.2 - 6;

c = 14.3 - 17.

Body relatively thick. Cuticle with long striations. Lips closed with six very small papillae. Mouth cavity narrow, small, 18 μ long. Cheilostoma consisting of prostoma and mesostoma. Oeso-

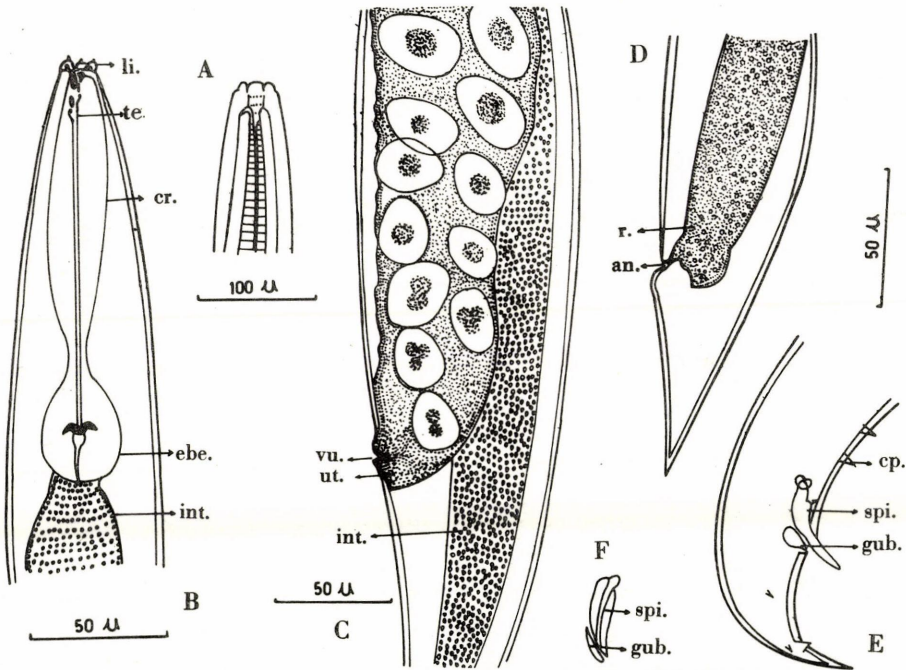


Fig. 7.:

Panagrolaimus wichmanni Rühm, 1956

- A. - Female front end showing stoma
- B. - Female anterior part of body with oesophagus
- C. - Female vulva region, lateral view
- D. - Female tail, lateral view
- E. - Male tail, side view
- F. - Male spicules and gubernaculum, side view

phagus narrow, long consisting of procorpus, median bulb, isthmus and basal bulb. Nerve ring conspicuous and present. Excretory pore at level of basal bulb of oesophagus.

Female tail conical, tapering towards the posterior end. Female with a single gonad, prodelphic, uterus sac not existing. Uterus containing many eggs and embryos. Vulva posterior.

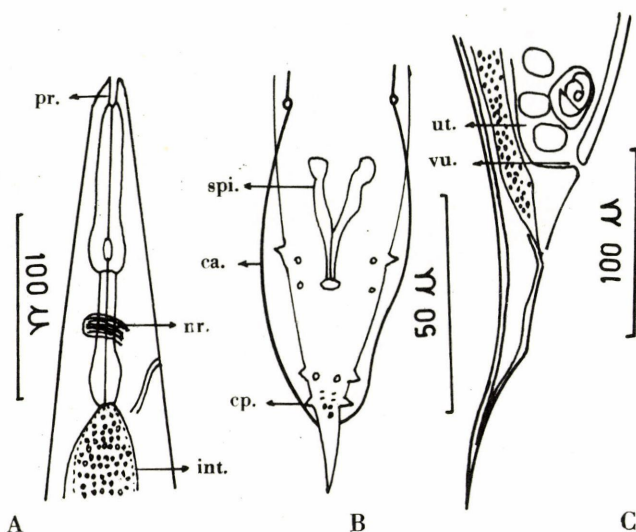


Fig. 8.:

- Rhabditolaimus crassus* /Körner, 1954/
 A. - Front end, lateral view
 B. - Male tail, ventral view
 C. - Female vulva and anal region, lateral view

Male tail /Fig. 8-B/ leptoderic. Bursa present but not encircling tail end and supported by ten pairs of caudal papillae; one pair in pre-anal, three pairs in adanal position, six pairs typically arranged at tail end. Male tail 46 - 55 μ long. Spicules paired, 36 - 42 μ long, strong, proximally knobbed and curved.

Host: *Scarabaeus sacer*

Locality: Abu-Rawash, Cairo, EGYPT

SYMPTOMS OF PARASITISM ON HOST

Parasitism by nematodes occurred generally by the larval stages. Ectoparasitism apparently failed to affect the host, used only as carrier and distributor. In some cases the larval ectoparasites were noticed to cause traces of damage to the intersegmental or cervical membranes of certain insects, eg. *Ocnera hispida* Forsk., *Oniticellus pallens* Oliv. and *Saprinus semipunctatus* F. /ALI et al, 1971/.

Intestinal endoparasites caused damage to their insect hosts when infestation was intense. Haemocoelicolous or wandering endoparasites often caused damage to the gonads, preventing females from ovipositing, often ending in death of host; these observations were proved histologically and experimentally. Longitudinal sections of the infested beetles /Plate I-A, B and C/ show the parasitic nematodes wandering in the host haemocoel and damaging the gonads. Plate I-D shows the same section of an uninfested beetle with the gonads undamaged.

In the experiments 25 artificially infested specimens of *Blaps polychresta* Forsk. were kept in a glass jar with sterilized wet sand and kept at 28 °C. The beetles were normally fed. Infestation was transmitted by haemocoel endoparasites extracted from naturally infested beetles. As a result, all individuals died within 22 days. Examination of the dead beetles by dissection showed the damage outlined above. The sand in the jar also contained the parasitic nematodes, proved by sifting. In fact the haemocoel endoparasites can be used in biological control.

SUMMARY

The beetle species examined, *Pimelia angulata* F., *Blaps polychresta* Forsk. and *Scarabaeus sacer* L., were collected at Most-torod and Abu-Rawash, Egypt, at various dates. The specimens

were examined externally and internally to detect their infection with nematodes.

Of 1136 beetles, 577 specimens /50.8 %/ "Table 3" were found to be infested by nematodes. Nematode larvae extracted from the infested beetles were reared on various artificial media; the methods of rearing, drawing, measuring and description of the nematodes are described.

Nematodes associated with the infested beetles were classified into ectoparasitic and endoparasitic groups. The ectoparasites were Rhabditis axei, Cephalobus persegnis, Mesorhabditis spiculigera /Fam. Rhabditidae/, Panagrolaimus wichmanni /Fam. Panagrolaimidae/ and Rhabditolaimus crassus /Fam. Diplogasteridae/ and the endoparasites Alaimus primitivus /Fam. Alaimidae/, parasiting the host intestine, and Physocephalus sexalatus /Fam. Physalopteridae/, parasiting the host haemocoel.

Infection with nematodes occurred either externally and internally in one species /one and the same specimen/ or externally only. The effects of nematodes on their hosts were discussed histologically and experimentally.

Acknowledgement

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Plate I.

L.S. of adult *Blaps polychresta* Forsk., showing haemocoel endoparasites /Physocephalus sexalatus/ either as larva or cyst.

A, B, C: Longitudinal sections of body cavity of infested *Blaps polychresta* Forsk.

D: L.S. of uninfested beetle

Cys. = cyst; Ins. Tis. = Insect tissue;

Nem. = Nematode;

Ov. = Ovary

ALI, M. — WAHAB, A. — EL-KIFEL, A.: Élősködő fonálférgék
(Nematoda) egyiptomi bogaraktól

A szerzők vizsgálatokat végeztek a fonálférgéknek a rovarok elleni biológiai védekezésben történő felhasználására. Egyiptomban hasonló vizsgálatok eddig nem folytak.

Vizsgált bogárfajok: *Pimelia angulata* F., *Blaps polychresta* Forsk. és *Scarabaeus sacer* L. E fajokat Mosttord és Abu-Rawash /Kairó/ helységekben gyűjtötték, a talaj felszine alatti szerves anyagban vagy homokban. A begyűjtött 1136 bogár közül 577 /50.8 %/ fertőzött volt fonálférgel /3. táblázat/.

Említésre méltó, hogy a *Pimelia angulata* és *Scarabaeus sacer* példányok többsége Abu-Rawash környékéről, homokos talajból származik. Az első fajt közvetlen a talaj felszine alatt gyűjtötték, ahol a talaj csaknem száraz volt /a bogarak fertőzöttsége 5,8 %-os/, míg a másik fajt 60-100 cm mélységben a talajban találták. Ebben a mélységben a talaj nedvessége viszonylag magas, szervesanyag-tartalma nagy. Többek között ez az oka annak, hogy a *Scarabaeus sacer* fonálféreg-fertőzöttsége nagyobb /53,4 %/.

Az Egyiptomban gyűjtött bogarakkal együttélő fonálférgeket két csoportba oszthatjuk:

1. Ektoparaziták: *Rhabditis axei*, *Cephalobus persegnis*, *Mesorhabditis spiculigera* /Fam.: Rhabditidae/, *Rhabditolaimus crassus* /Fam.: Diplogasteridae/ és *Panagrolaimus wichmanni* /Fam.: Panagrolaimidae/.

2. Endoparaziták: *Alaimus primitivus* /Fam.: Alaimidae/ és *Physocephalus sexalatus* /Fam.: Physalopteridae/.

A szerzők megkísérelték az endoparazitákat mesterséges táptalajon felnevelni, de ez nem sikerült. Az ektoparaziták huskivo-

natból, burgonyakaparékból és agarból készült táptalajon jól fejlődtek.

A bogarak fertőzöttsége a nyári hónapokban volt a legintenzívebb. Elsősorban az istállótrágyában és a rothadó szervesanyagban élő bogarak fertőződtek. Az ekto- és endoparazita fonálférgesek lárvaállapotukban fertőzik a gazdarovart. A bélcsatornában élősködő fonálférgesek csak akkor okoznak kárt a gazdarovarban, ha a fertőzés erős. Az enyhe fertőzést az epithelium tolerálja. A haemolymphában élő vagy vándorló endoparaziták a gazdarovar ivarmirigyait károsítják, ezzel megakadályozzák a nőstények tojásrakását. Gyakran elpusztul a gazdarovar a nagyszámu élősködő hatására. Ezeket a megfigyeléseket szövettani metszetekkel bizonyítják a szerzők.

A fonálférgesekkel végzendő biológiai védekezési kísérletek során e megfigyeléseket figyelembe kell venni.

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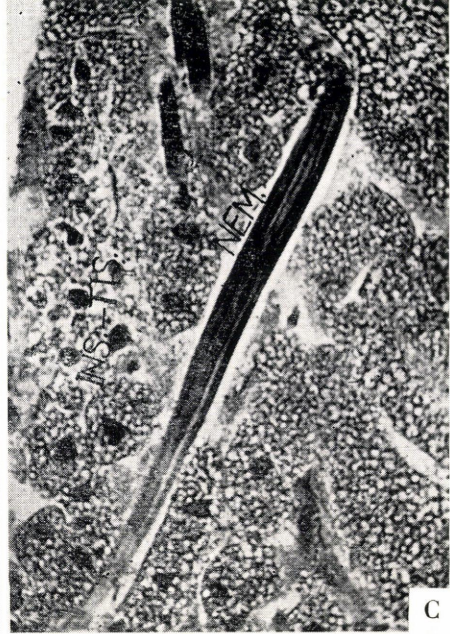
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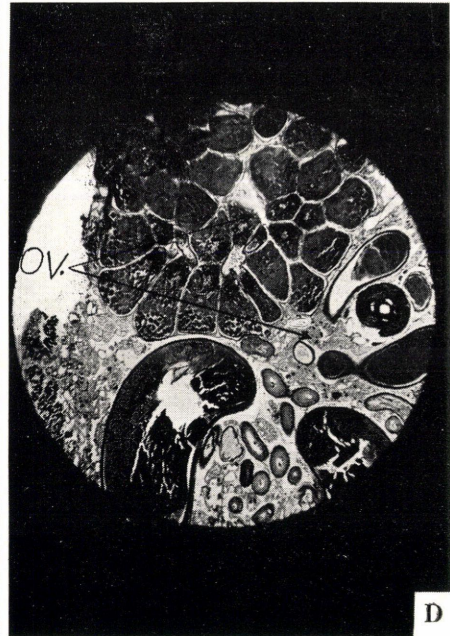
A



C



B



D