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THE INFLUENCE OF TEMPERATURE ON THE DEVELOPMENT OF MONIEZIA EXPANSA (RUDOLPHI, 1810) IN ORIBATID MITES

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Dedicated to the memory of Academician K. I. Skryabin on the occasion of the centenary of his birthday

Abstract. The life cycle of *Moniezia expansa* was studied experimentally using 10 species of oribatid mites as intermediate hosts. Four of them became infected, namely *Scheloribates laevigatus* (76.2 %), *Sch. latipes* (70.8 %), *Liacarus coracinus* (20 %) and *Platynothrus peltifer* (1.1 %). The last was found for the first time to serve as intermediate host of *M. expansa* in Czechoslovakia. The development of the cysticercoid of *M. expansa* in the oribatid mites at 28 °C and 85 % relative humidity is completed within 27 days. At 18—20 °C and the same relative humidity the development lasts even 97 days.

This paper is a continuation of a previous one (Prokopič 1962) dealing with some species of oribatid mites living in Czechoslovakia and with the development of cysticercoids in susceptible mites.

MATERIAL AND METHODS

Oribatid mites were obtained by Tulgren thermoeclector from soil samples taken from meadows where no cattle had been pastured previously in order to avoid natural infection of mites. Nevertheless, even under these conditions the mites could have got into contact with *M. expansa,* since there are numerous deer living in free nature in Czechoslovakia. The soil samples were therefore carrefully selected to minimize the possibility of infection. The mites were kept in glass test tubes, measuring 5.5. cm in height and 2 cm in diameter, with a moistened filter paper. The tube was closed by a dense silon texture. The mites were fed with pieces of potatoes.

The experiments were carried out since January till April 1977. The suspension of cestode eggs (Plate I, Fig. 1) was prepared from mature proglottids of *M. expansa* recovered from cattle at Prague abattoir. The viability of oncospheres was controlled under the microscope. The mites were fid with food containing *M. expansa* egg suspension for 4 days. The dead mites were collected every day and examined unter the microscope for the presence of oncospheres. Living mites were transferred to pure breeding vessel.

The mites were then kept under constant laboratory conditions at 28 °C and 85 % relative humidity (experiments I—VI) and at 18—20 °C at the same relative humidity (experiments VII—X). Four days after infection the mites were again fed only with pieces of potatoes and sterile earth was added to the breeding vessels. The vessels were checked every day, dead specimens were examined and living mites were transferred to pure vessels.

The following 10 mite species were used: *Scheloribates laevigatus* (C. L. Koch, 1836), (77), *Sch. latipes* (C. L. Koch, 1841), (76), *Platynothrus peltifer* (C. L. Koch, 1839), (350), *Liacarus coracinus* (C. L. Koch, 1840), (42), *Trichoribates novus* (Sellnick, 1928), (7), *Galumna elimata* (C. L. Koch, 1841), (22), *Achipteria coleoptrata* (Linné, 1758), (6), *Eupelops occultus* (C. L. Koch, 1836), (1), *Ceratoppia bipilis* (Hermann, 1804), (1), *Adoristes ovatus* (C. L. Koch, 1840), (1). From these species only four were sensitive.

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RESULTS

Table 1 shows a survey of experiments I—VI carried out at the temperature of 28 °C, as described in Methods. Sensitive mites were *Scheloribates laevigatus* (76.2 %), *Sch. latipes* (70.8 %), *Liacarus coracinus* (20.0 %), *Platynothrus peltifer* (1.1 %), intensity of infection being 1—4 (Plate II, Fig. 1) cysticercoids per mites. Till day 16 after infections only oncospheres of the cestode were found in the body cavity of mites (Fig. 1A.). The oncospheres (Plate I, Fig. 2) were spherical, 27.5 μm in diameter and with three pairs of embryonal hooks. The hooks were 7.5 μm long.

Table 1. Development of cysticercoid of *Moniezia expansa* in oribatid mites

Species of oribatid mite	at 28 °C and 85 % RH			at 18 °C to 20 °C and 85 % RH		
	Examined	% positive	n	Examined	% positive	n
Scheloribates laevigatus	42/32*)	76.2	1	35/3	8.7	1
Scheloribates latipes	24/17	70.8	1.88	52/7	13.5	2.3
Platynothrus peltifer	278/3	1.1	1.66	80/0	—	—
Liacarus coracinus	35/7	20.0	1.14	7/0	—	—

*) — numerator — number of dissected, denominator — number of positive mites
n — average number of cysticercoids per infected mite

Twenty to 21 days after infection elongated, pyriform larvae were encountered in the mites (Plate I, Figs 2,3). They measured 262 μm in length, 140 μm in width in anterior portion and 114 μm in width in middle portion. Their bodies contained numerous oval calcareous bodies. The posterior portion of body measured 122 μm in length and 48 μm in width. The embryonal hooks were dispersed in this portion (Fig. 1C).

On day 24 after infection the mites contained larvae measuring 337.5 μm in length. This type of larvae (Fig. 4D) is distinctly divided into three portions. The anterior por-

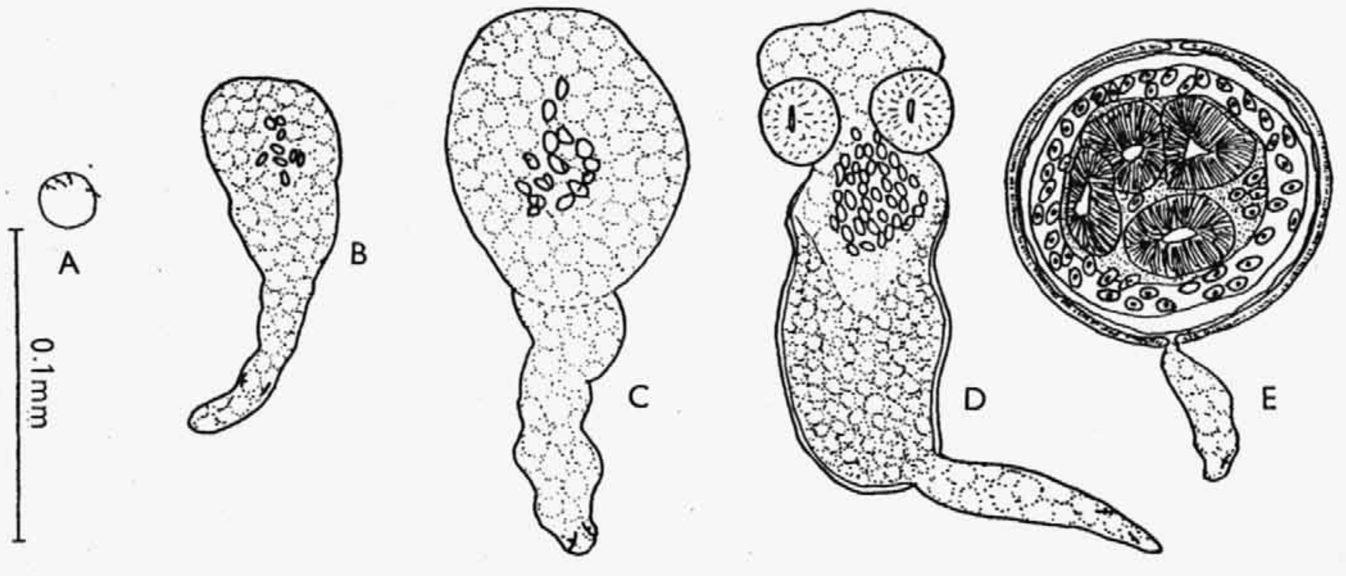

Fig. 1. Development of *M. expansa*. A- oncosphere, B- pyriform young larval stage of *M. expansa* after 16 days of development, C- differentiating larva after 20 days of development, D- advanced larval stage with developed scolex and suckers after 24 days of development, E- mature cysticercoid after 27 days of development.

tion has a form of scolex measuring 85×70 μm with four circular suckers. The middle portion is the future cyst in which the scolex invaginates. It measures 160×80 μm. A cavity with thick outer tissue is formed inside the cyst. The third portion is tail (cercomer) measuring 115×25 μm. At the site of the contact with the middle portion of the cyst it is markedly attenuated. The calcareous bodies are concentrated in the midle portion outside the scolex.

A fully formed cysticercoid of *M. expansa* (Plate II, Fig. 1) was observed on 27 day after infection (Fig. 1E), and from day 28 onwards only these cysticercoid were found. The cysticercoid (Plate I, Figs. 3,4) is spherical and measures 117—152 μm in diameter. The cyst wall is μm thick. The scolex measures 70—115 μm and the spherical suckers 35—52 μm in diameter. The scolex is surrounded by calcareous bodies. The tail is the same as in the previous stage.

Table 1 (experiments VII—X) gives a survey of experiments carried out at the temperatures of 18—20 °C. Of the 8 species of mites only two, *Scheloribates laevigatus* (8.7 %) and *Sch. latipes* (13.5 %) were infected. The intensity of infection was 1—3 cysticercoids per mite.

Compared with the previous experiments (I—VI) at higher temperatures, the greater activity of mites at higher temperatures seems to result in greater voracity and the incidence of infection is therefore almost tenfold. At higher temperature, there occurred also more mite species (4) sensitive to *M. expansa*. In contrast to experiments (I—VI) at high temperatures, at lower temperatures (VII—X) the development lasted 97 days, i.e. three times longer than at 28 °C.

DISCUSSION

The cysticercoids of *Moniezia expansa* were found in 56 mite species. Table 2 shows literature data on the time of development of cysticercoids of *M. expansa*. According to Rao and Choquette (1955) the development of cysticercoid of *M. expansa* in *Sch. laevigatus* lasted 75 days, according to Orekhov (1960) 94 days. Prokopič (1962, 1967) found that the development of this parasite under natural conditions in Šumava Mountains at variable temperature lasted 150 days. The same period was observed by Jurášek (1962) at 18—20 °C. The longest developmental period, 11 months, was reported by Alkov (1971) and the shortest, 28 days, by Narsapur (1976) at the temperatures of 29—32 °C.

It is evident that the temperature has a great influence on the time of development of cysticercoids in oribatid mites. This fact has already been mentioned by Kuznetsov (1965) and Nazarova (1970) who reported that at higher temperatures the time of development of cysticercoid is shorter and vice versa. This is confirmed also by our experiments where the development of cysticercoid occurring at 28 °C takes one month, whereas at 18—22 °C up to three months or 97 days.

Also the results obtained by Prokopič (1962) show that under natural conditions when the temperature ranges both during the day and during the season, the development of the cysticercoid takes five or even more months.

The mortality of infected mites was very high (60—70 %) during the first five days. This fact has also been pointed out by Potemkina (1948) and Prokopič (1962). We assume, however, that in nature, the infections of mites are not so massive and consequently no mortality occurs. Kassai and Mahunka (1965) who examined mites naturally infected by *M. expansa* in the pastureland reported that the susceptiblity of mites to *M. expansa* is much related with the size of the mite and of its mouth pore, i.e., whether it is able to swallow an undamaged oncosphere. Prokopič (1962) stated that it depends on the character of the pastureland and on the composition of oribatid mites which species will serve as intermediate hosts in the given environment. A host susceptible in the experiment need not occur in the studied pastureland or in a small number only. This is confirmed also by our recent experiments. According to Prokopič (1962), the dominant species of mites was *Achipteria coleoptrata* in Šumava Mountains, whereas in the localities in the vicinity of Prague, where the mites used in our experiments we collected, this species occurred only rarely.

Table 2. The literature data on the development time of cysticercoid of *Moniezia expansa*

Intermediate host	Authors	Period for formation of cysticercoid	Temperature or season
Scheloribates laevigatus	Rao and Choquette (1951)	75 days	
	Orekhov (1960)	94 days	
	Prokopič (1962, 1967)	150 days	
	Jurášek (1962)	150 days	18—20 °C
	Kuznetsov (1970)	8 months	November
		64—65 days	June
	Alkov (1971)	11 months	
	Narsapur (1976)	28 days	29—32 °C
Scheloribates latipes	Orekhov (1960)	94 days	
	Prokopič (1962)	150 days	
	Nazarova (1970)	77—79 days	27 °C
		85—98 days	23 °C
	Alkov (1971)	11 months	
Scheloribates madrasensis	Anantaraman (1951)	5—7 weeks	
Scheloribates fimbriatus	Narsapur (1976)	29 days	29—32 °C
Scheloribates semidesertus	Nazarova (1970)	77—79 days	27 °C
Galumna sp.	Stunkard (1937, 1939)	15—16 weeks	
	Stoll (1938)	6—7 weeks	
	Jurášek (1962)	150 days	18—20 °C
	Alkov (1971)	11 months	
Galumna obvia	Alkov (1971)	11 months	
Galumna virginiensis	Edney and Kelly (1935)	55 days	
Galumna flagellata	Orekhov (1960)	94 days	
Galumna type *minor*	Orekhov (1960)	94 days	
Galumna elimata	Prokopič (1922, 1967)	150 days	
Trichoribates trimaculatus	Prokopič (1962), 1967)	150 days	
	Alkov (1971)	11 months	
Trichoribates incisellus	Alkov (1971)	11 months	
Punctoribates punctum	Alkov (1971)	11 months	
Achipteria sp.	Jurášek (1962)	150 days	18—20 °C
Achipteria coleoptrata	Prokokopič (1962, 1967)	150 days	
Platynothrus peltifer	Alkov (1971)	11 months	
Spatiodamaeus subverticillipes	Alkov (1971)	11 months	
Liacarus sp.	Jurášek (1962)	150 days	18—20 °C
Liacarus coracinus	Prokopič (1967)	4—5 months	
Oribatid mites (unspecified)	Mehra and Srivastava (1955)	9—12 weeks	
	Kuznetsov (1955)	109—114 days	16—18 °C

ВЛИЯНИЕ ТЕМПЕРАТУРЫ НА РАЗВИТИЕ *MONIEZIA EXPANSA* (RUDOLPHI, 1810) В ОРИБАТИДНЫХ КЛЕЩАХ

В. С. Нарсапур и Я. Прокопич

Резюме. Для экспериментального исследования жизненного цикла *Moniezia expansa* использовали 10 видов орибатидных клещей в качестве промежуточных хозяев. Четыре из них удалось заразить, именно *Scheloribates laevigatus* (76,2 %). *Sch. latipes* (70.8 %), *Liacarus coracinus* (20 %) и *Platynothrus peltifer* (1.1 %). Последний был в первый раз зарегистрирован в Чехословакии как промежуточный хозяин *M. expansa*. Развитие цистицеркоида *M. expansa* в орибатидных клещах при 28 °C и 85 % относительной влажности совершилось через 27 дней, тогда как при температуре 18—20 °C и той же относительной влажности развитие продолжалось 97 дней.

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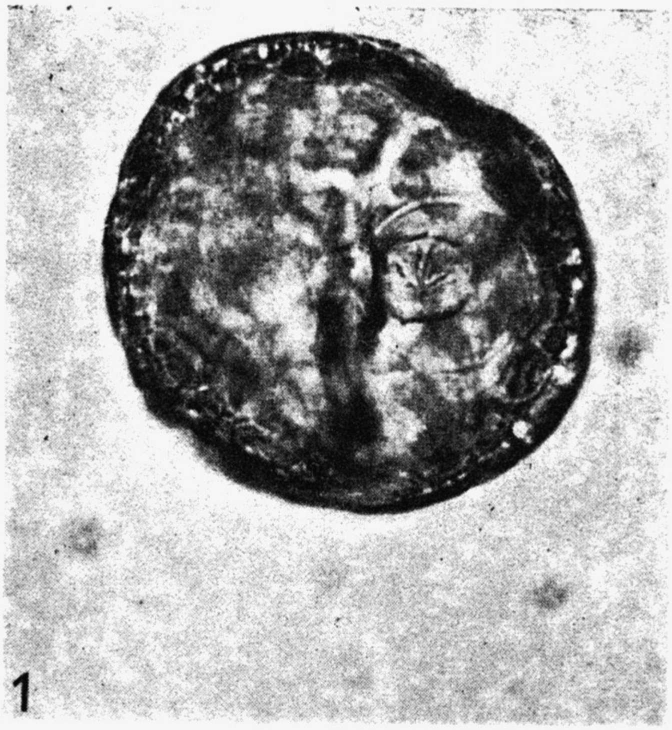
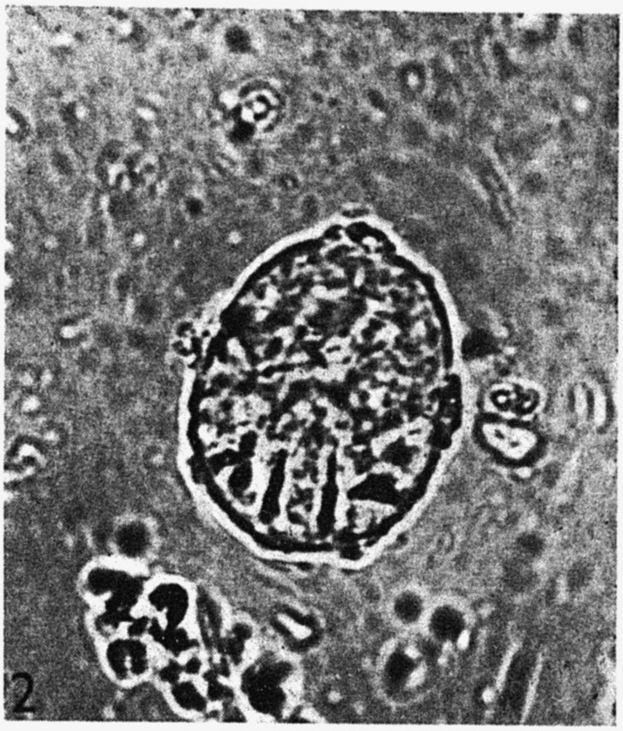
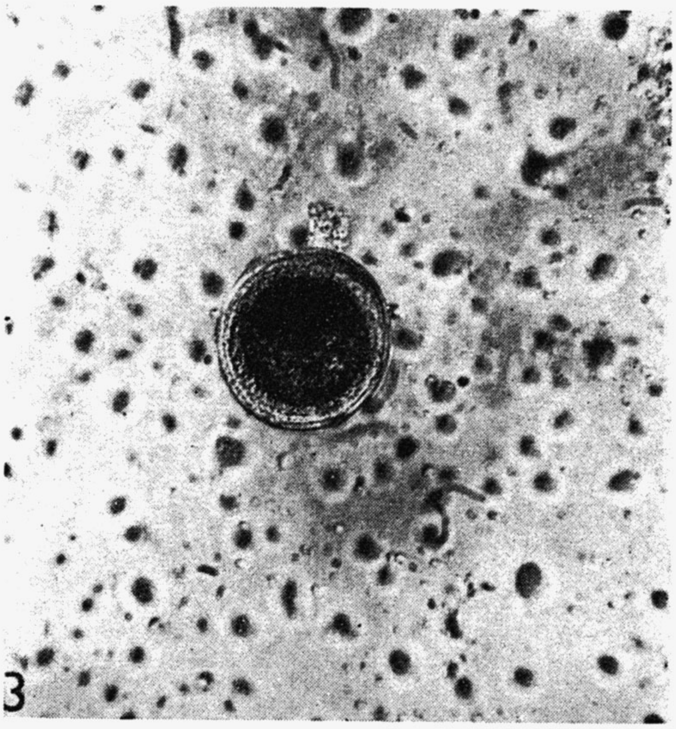






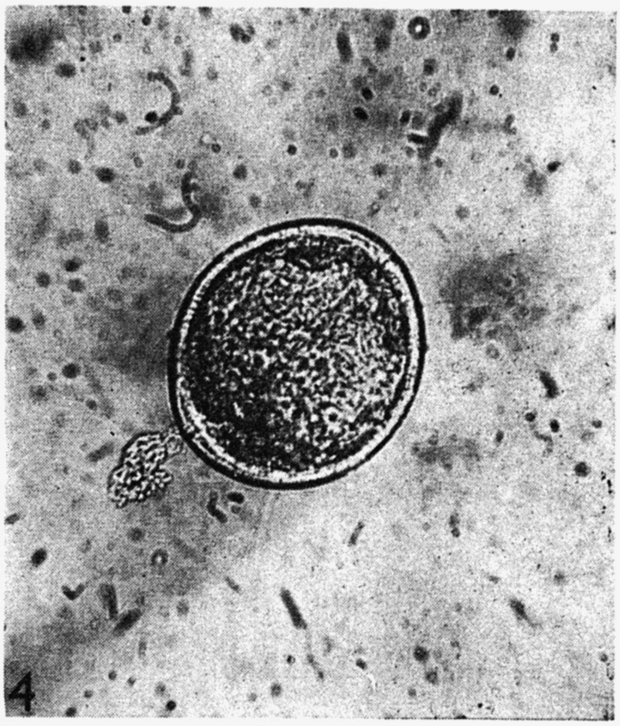
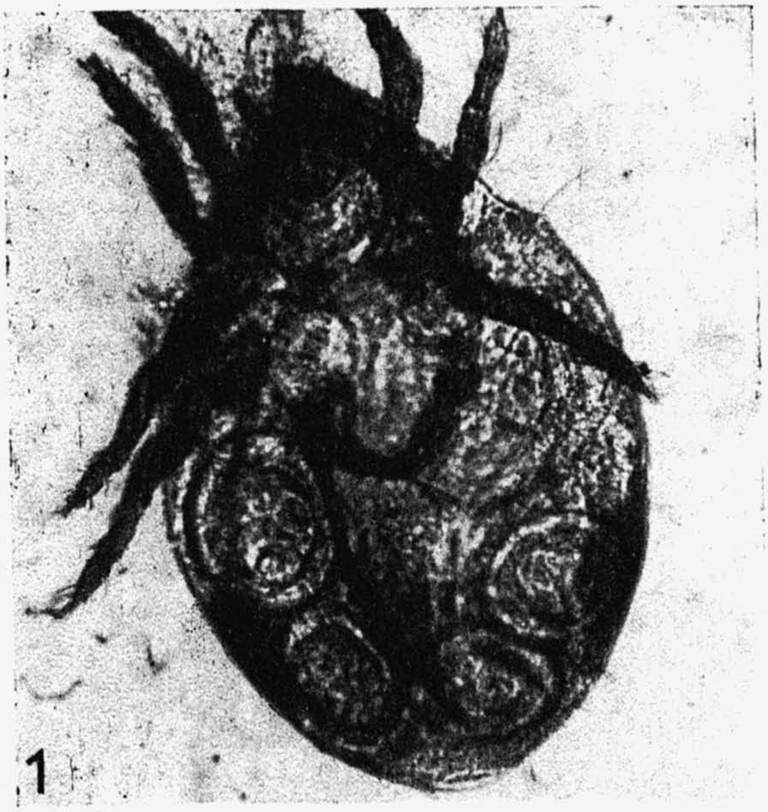
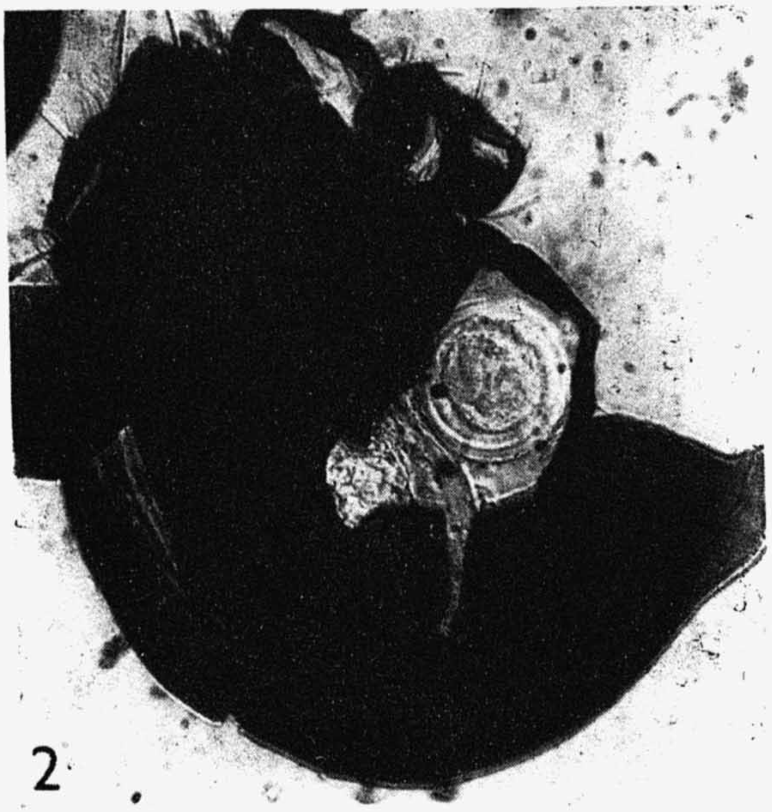
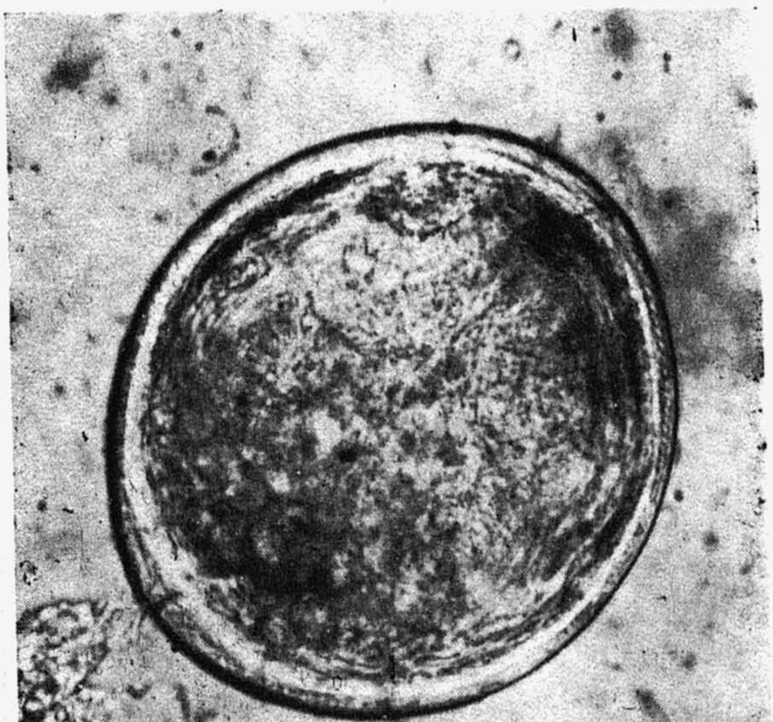


Fig. 1. Egg of *Moniezia expansa* from mite intestine. (1000 ×). **Fig. 2.** Oncosphere of *M. expansa* from mite body cavity (1500 ×). **Fig. 3.** Young stage of cysticercoid of *M. expansa* from mite body cavity (60 ×). **Fig. 4.** Developed cysticercoid of *M. expansa* from mite body cavity. (75 ×).







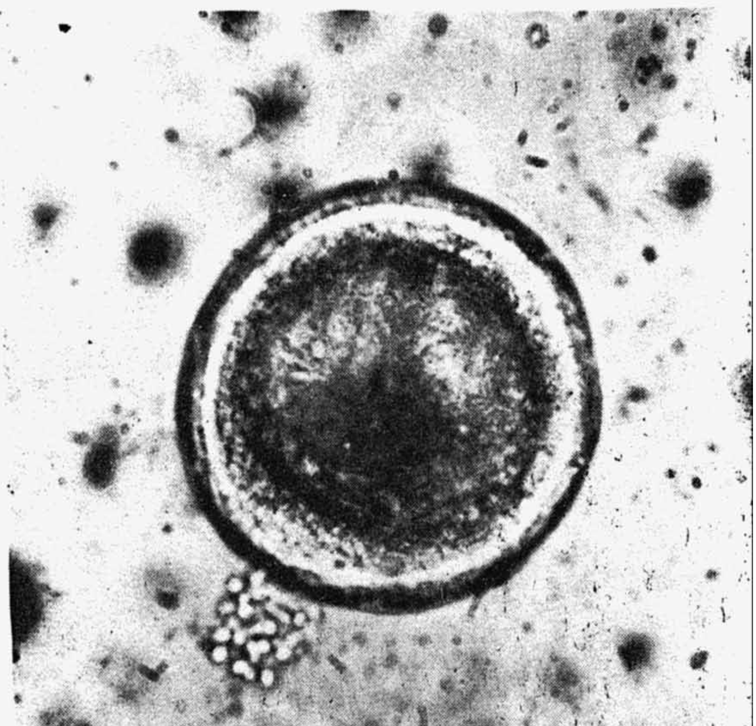


Fig. 1. Four mature cysticercoids of *Moniezia expansa* in *Scheloribates laevigatus* (100 ×). **Fig. 2.** Cysticercoid of *M. expansa* in the body of *Galumna elimata* (100 ×). **Fig. 3.** Mature cysticercoid of *M. expansa* from body cavity of *Sch. latipes* (150 ×). **Fig. 4.** Mature cysticercoid of *M. expansa* from body cavity of *G. elimata*. (80 ×).