

# STUDIES ON THE LIFE HISTORY OF SOME CESTODES (GENUS DIORCHIS CLERC, 1903) OF WATER BIRDS

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**Abstract.** The life cycles of the cestodes *D. inflata*, *D. nyrocae* and *D. ransomi* were studied. Larval development was divided into seven stages characterized by a complex of certain changes. It was found that the cyst wall of morphologically completely differentiated cysticercoids is composed of six layers. Cysticercoids of the cestode *D. inflata* were found in nature in *Eudiaptomus vulgaris*, *Acanthocyclops vernalis*, *Macrocyclus albidus* and *Heterocypris incongruens* (new intermediate hosts) and under experimental conditions in *H. incongruens*; those of *D. nyrocae* in natural conditions in *Acanthocyclops viridis*, *Cyclops strenuus*, *Mesocyclops leuckarti* (new intermediate hosts), and under experimental conditions in *C. strenuus*, *Dolerocypris fasciata*, and *Notodromus monacha*. Cysticercoids of *D. ransomi* were recovered in experimental infection only from *A. vernalis*, *A. viridis*, *C. strenuus* (new intermediate hosts) and in *D. fasciata*.

The larval development of cestodes of the genus *Diorchis* in crustaceans has been studied under both experimental and natural conditions by Rybicka (1957a, b), Jarecka (1958, 1960, 1961) and Ryšavý (1961, 1962). Of these authors only Rybicka (1957b) studied in detail changes occurring during the development of cysticercoids in the cestode *D. ransomi*. Votrubová (1965) studied experimental infection of *C. strenuus*. Zajíček (1961) found cysticercoids of *D. nyrocae* in the reservoir hosts *Lymnaea auricularia* (Linné).

Our work offers additional knowledge on the development of the oncosphere of the cysticercoids and on the structure of the cyst wall. The material and methods employed in this study and a general description of the larval development and structure of the cysticercoids are given in detail in an earlier paper (Neradová—Valkounová 1971).

## RESULTS

### 1) *Diorchis inflata* (Rudolphi, 1819)

Figs. 1, 2; Plate I\*), Fig. 2; Plate II

**Finding of cysticercoids:** A survey of the findings is given in Table I. The only instance of a mixed infection was registered in the body cavity of *Eudiaptomus vulgaris* (Schmeil) with the species *Sobolevicanthus gracilis* (Zeder, 1803).

**Experimental infection of intermediate hosts:** Cysticercoids of the cestode were bred from mature eggs of cestodes of domestic ducks from Vodňany. At both poles,

\*) The Plates I—II will be found at the end of this issue.

the eggs had long projections, they measured 130—180 by 22—30  $\mu$ , the oncosphere was oval, size 20—30 by 15—25  $\mu$ , and the embryonic hooks attained 18  $\mu$  in length. The eggs were added to the vessels containing crustaceans of the species *Eudiaptomus vulgaris*, *Acanthocyclops vernalis* (Fischer), *Cyclops vicinus* Uljanin, *Eucyclops serrulatus* (Fischer), *Macrocyclus albidus* (Jurine), *Mesocyclops crassus* (Fischer), *Dolerocypris*

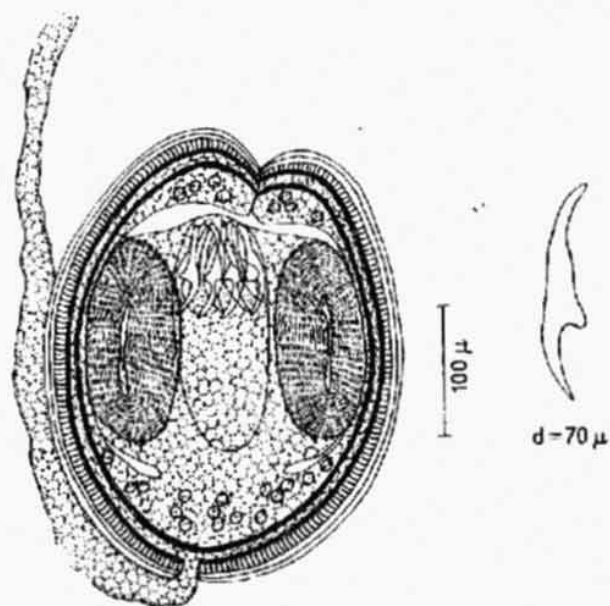


Fig. 1. Cysticercoid of *D. inflata* from the body cavity of *Eudiaptomus vulgaris*.

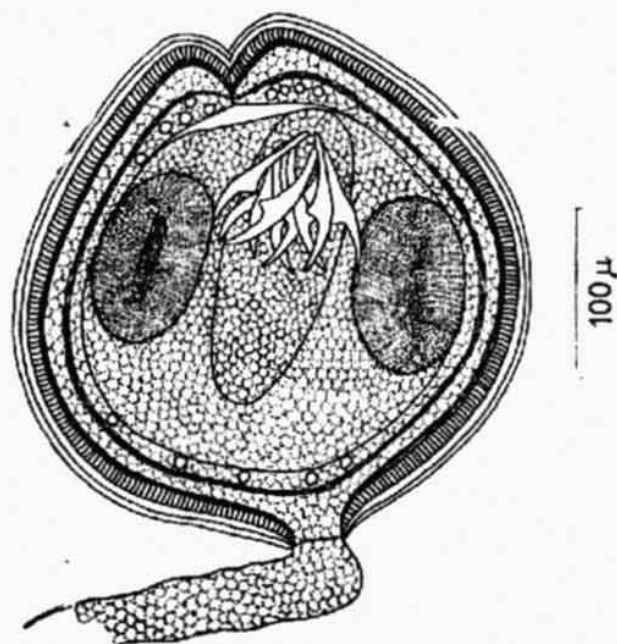


Fig. 2. Cysticercoid of *D. inflata* from the body cavity of *Heterocypris incongruens*.

Table 1. A survey of crustaceans infected by the cysticercoids of *D. inflata*

Locality (pond)	Date of collection	Intermediate host	Number of crustaceans examined	Positive findings	% of positive findings	Intensity of infection
Village pond at Radošovice near Vlašim	23. 9. 1963	<i>Eudiaptomus vulgaris</i>	3,600	1,400	38.9	1—2
Pond Hlohovec near Lednice	20. 10. 1964	<i>Heterocypris incongruens</i>	2,070	39	1.9	1—2
Pond Sv. Vit near Třeboň	17. 8. 1965	<i>E. vulgaris</i>	720	93	12.9	1—3
Pond Řod near Lomnice n./L.	5. 7. 1966	<i>E. vulgaris</i>	3,500	30	0.85	1—2
Pond Dobrá vůle near Lomnice n./L.	5. 6. 1968	<i>Macrocyclus albidus</i>	690	2	0.29	1
Pond Šeberov near Praha	16. 9. 1970	<i>Acanthocyclops vernalis</i>	1,200	6	0.5	1—2

*fasciata* (O. F. Müller), *Heterocypris incongruens* (Ramdohr), *Notodromas monacha* (O. F. Müller), *Daphnia hyalina* (Leydig), *D. longispina* O. F. Müller, *D. pulex* Leydig. Within five hours after adding the eggs to the vessels containing crustaceans, we observed the first oncospheres in the body cavities of *H. incongruens*, where their further development was proceeding as follows: mobile oncosphere—the first two days; growing oncosphere—from the 3rd day onward, size 64—81  $\mu$ ; differentiating larva—from the 7th day onward, length 493—539  $\mu$ , length of the tail 290—359  $\mu$ ; differentiated

**Table 2.** Measurements of the cysticercoids of *D. inflata* in the intermediate hosts

Sizes in $\mu$		Intermediate hosts	
		<i>Eudiaptomus vulgaris</i> <i>Acanthocyclops vernalis</i> <i>Macrocyclus albidus</i>	<i>Heterocypris incongruens</i>
Cysticercoid	l	232—322	260—298
	w	191—292	260—296
Hyaline layer	w	2—4	2—4
Homogeneous layer	w	2—4	2—4
Basal layer	w	4—9	5—10
Outer fibrous layer	w	2—4	2—4
Intormediary layer	w <sub>1</sub>	8—9	10—16
	w <sub>2,3</sub>	4—6	6—8
Inner fibrous layer	w	4—6	2—4
Neck	w <sub>1</sub>	18—20	10—20
	w <sub>2</sub>	3—6	6—8
	w <sub>3</sub>	6—25	6—8
Scolex	l	180—252	180—210
	w	159—226	180—228
Suckers	l	105—160	85—99
	w	60—90	50—66
Rostellum	l	120—172	135—170
	w	30—82	45—60
Hooks	l	66—77	69—72
Calcareous corpuscles	diameter	3—6	3—6
Tail	l	280—500	400—600

l = length      w = width

w<sub>1</sub> = width of the layer at the site of invagination

w<sub>2</sub> = width of the layer in the lateral parts

w<sub>3</sub> = width of the layer on the nether pole

larva before invagination—from the 12th day onward. The entire development lasted 14–16 days. From among the 100 ostracods *H. incongruens* employed for the experiment, 15 % were infected by 1–2 cysticeroids each.

Description of the cysticeroids: Cysticeroids identified in the body cavity of *E. vulgaris*, *A. vernalis* and *M. albidus* were oval (Fig. 1), those from *H. incongruens* were of a typical broadly pyriform to spherical shape (Fig. 2). For the most important sizes of cysticeroids in the individual host species see Table 2.

Feeding experiments: Cysticeroids were fed to seven ducklings. We found mature cestodes between 28–32 days.

## 2) *Diorchis nyrocae* Yamaguti, 1935

Fig. 3; Plate I, Fig. 1

Finding the cysticeroids in nature: A survey of the findings is given in Table 3.

**Table 3.** A survey of crustaceans infected by the cysticeroids of *D. nyrocae*

Locality (pond)	Date of collection	Intermediate host	Number of crustaceans examined	Positive findings	% of positive findings	Intensity of infection
Pond Sv. Vít near Třeboň	17. 8. 1965	<i>Cyclops strenuus</i>	600	40	6.7	1–2
Pond Baštýř near Třeboň	26. 5. 1970	<i>Acanthocyclops viridis</i>	260	8	3	1–4
Pond Mlýnský near Lednice	23. 9. 1970	<i>Mesocyclops leuckarti</i>	1100	5	0.4	1

Experimental infection of intermediate hosts: We succeeded twice in obtaining cysticeroids. The eggs employed for the experiment had an elongated shape, they measured 55–70 by 25–35  $\mu$ , the oncosphere 28–35 by 11–15  $\mu$ , and the embryonic hooks 8  $\mu$ . Both experiments were conducted with identical crustacean species—*Eudiaptomus vulgaris*, *Acanthocyclops viridis* (Jurine), *A. vernalis*, *Cyclops strenuus*, *Mesocyclops crassus*, *Dolerocypris fasciata*, *Heterocypris incongruens*, *Notodromas monacha*, *Daphnia pulex* and *Gammarus pulex* Koch. In the body cavity of crustaceans, the first oncospheres appeared three hours after adding the eggs to the vessels and were developing as follows: mobile oncosphere—the first two days; growing oncosphere—from the 3rd day onward, size 75–130  $\mu$ ; elongated larva—from the 5th day onward, length 206–260  $\mu$ ; differentiating larva—from the 7th day onward, length 260–560  $\mu$ , length of the tail 220–240  $\mu$ ; differentiated larva before invagination—from the 11th day onward. The entire development of cysticeroids lasted 13–17 days. Cysticeroids were found in the body cavity of *C. strenuus*, *D. fasciata* and *N. monacha*. For the most relevant data obtained in both experiments consult Table 4.

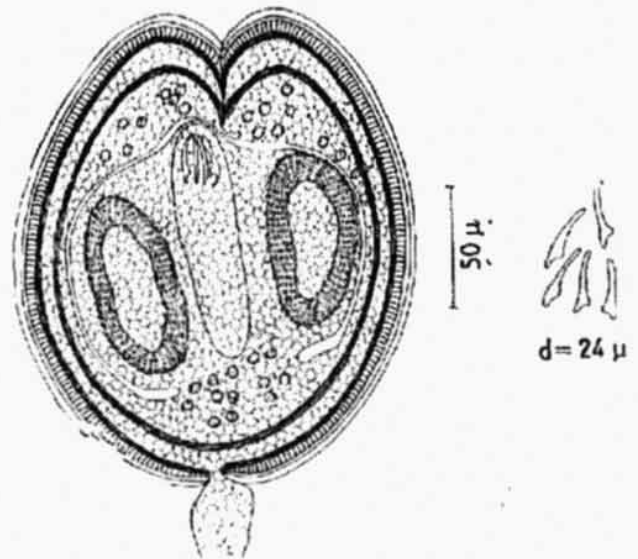
Description of the cysticeroids: The cysticeroids are spherical to oval, regardless of the host species of the crustacean; they attain 158–322  $\mu$ , the hyaline layer measures 3–4  $\mu$ , the homogeneous layer 1–4  $\mu$ , the basal layer 4–5  $\mu$ , sometimes even 20  $\mu$  at the sides. The outer fibrous layer attains 2–6  $\mu$ . The intermediary parenchymatous

**Table 4.** Experimental infection of the crustaceans with eggs of *D. nyrocae*

Start of experiment	Intermediate hosts	Number of crustaceans employed for the experiment	Number of crustaceans infected	% of crustaceans infected with cysticercoids	Intensity of infection	Duration of cysticercoid development (days)
22. 5. 1964	<i>Cyclops strenuus</i>	900	500	55.6	1—13	13—17
25. 10. 1965	<i>Dolerocypris fasciata</i>	120	10	8.3	1	14—15
	<i>Notodromas monacha</i>	80	20	25	1	14—15

layer attains 10–20  $\mu$  at the site of invagination, 4–10 $\mu$  on either side, and 4–7 $\mu$  on the nether pole. The inner fibrous layer measures 3–5  $\mu$ . The thickness of the neck at the site of invagination is 16–36  $\mu$ , 4–14  $\mu$  at the sides, and 4–29  $\mu$  on the nether pole. Calcareous corpuscles measure 2–4  $\mu$  in diameter. The scolex reaches 100–198 by 98–198  $\mu$ , the suckers covered with delicate spines measure 57–105 by 27–84  $\mu$ , rostellum 60–120 by 21–40  $\mu$ , and the ten hooks 21 and 24  $\mu$ . It was interesting to note that eggs of the cestodes, whose hooks measured 21  $\mu$ , produced cysticercoids with hooks measuring 24  $\mu$  and vice versa. The tail of the cysticercoids attained a maximum length of 460  $\mu$ , in one instance 1,806  $\mu$ .

Feeding experiments: Cysticercoids were fed to ten ducklings. We found the matured cestodes after four weeks.



**Fig. 3.** Cysticercoid of *D. nyrocae* from the body cavity of *Cyclops strenuus*.

### 3) *Diorchis ransomi* Schultz, 1940

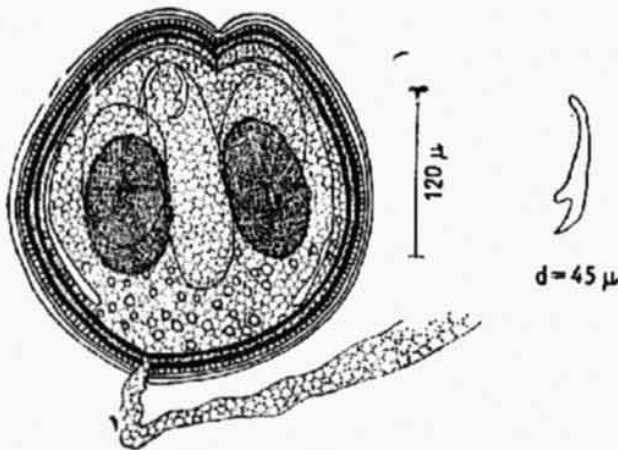
Fig. 4

Experimental infection of intermediate hosts: Crustaceans of the species *Acanthocyclops vernalis*, *A. viridis*, *Cyclops strenuus*, *C. vicinus*, *Dolerocypris fasciata*, *Eucyclops serrulatus*, *Macrocylops albidus*, *Mesocyclops crassus*, *Notodromas monacha* and *Paracyclops poppei* were used for the experiment. The eggs of the cestode are elongated, including the long filaments they reach 930–1,020 by 33–44  $\mu$ , the oncosphere measures 25–34 by 24–39  $\mu$ , embryonic hooks 10  $\mu$ . Within five hours after adding the eggs to the vessels with the crustaceans, we observed free oncosphere in their digestive tube, which appeared in their body cavities only after 12 hours. The development proceeded as follows: mobile oncosphere—the first 3 days; growing oncosphere—from the 4th day onwards, size 145–161 by 70–103  $\mu$ ; elongated larva—from the 7th day onwards,

size 260—360 by 130—155  $\mu$ ; differentiating larva — from the 11th day onwards, size 480—550 by 180—240  $\mu$ ; the tail 250—350  $\mu$ ; differentiated larva before invagination — from the 15th day onwards. Cysticeroids were identified in crustaceans of the species *A. vernalis*, *A. viridis*, *C. strenuus* and *D. fasciata*. The entire development was completed in 14—24 days (Table 5).

**Table 5.** Experimental infection of the crustaceans with eggs of *D. ransomi*

Start of experiment	Intermediate hosts	Number of crustaceans employed for the experiment	Number of crustaceans infected	% of crustaceans infected with cysticeroids	Intensity of infection	Duration of cysticeroid development (days)
6. 6. 1968	<i>Acanthocyclops vernalis</i>	30	5	17	1—2	18—20
	<i>A. viridis</i>	30	8	27	1	18—20
	<i>Cyclops strenuus</i>	50	10	20	1	20—24
	<i>Dolerocypris fasciata</i>	20	2	10	1	18—24



**Fig. 4.** Cysticeroid of *D. ransomi* from the body cavity of *Dolerocypris fasciata*.

scolex attains 168—208 by 102—240  $\mu$ , the suckers covered with fine spines 75—111 by 57—90  $\mu$ , the rostellum 80—140 by 25—40  $\mu$ . The hooks measure 39—45  $\mu$ , the tail length is 250—400  $\mu$ .

**Feeding experiment:** Cysticeroids were fed to one duckling. After six weeks, one sexually mature cestode was identified in autopsy.

**Description of the cysticeroids:** Cysticeroids are oval, sometimes spherical, those from the intermediate host *D. fasciata* are pyriform. In size they do not differ from each other. They attain 210—294 by 150—259  $\mu$ , the hyaline layer is 3—12  $\mu$  thick, the homogeneous layer measures 1.5—2  $\mu$ , the basal layer 3—8  $\mu$ , the outer fibrous layer 2—3  $\mu$ , the intermediary parenchymatous layer 3—6  $\mu$ , the inner fibrous layer 2—3  $\mu$ . The neck attains a width of 9—15  $\mu$  at the poles of the cysticeroid and 6—12  $\mu$  on the sides. Calcareous corpuscles are relatively large, they measure 6—9  $\mu$  in diameter. The

ИЗУЧЕНИЕ ЖИЗНЕННОГО ЦИКЛА НЕКОТОРЫХ ЦЕСТОД РОДА  
*DIORCHIS* CLERC, 1903 У ВОДОПЛАВАЮЩИХ ПТИЦ

И. Валкоунова

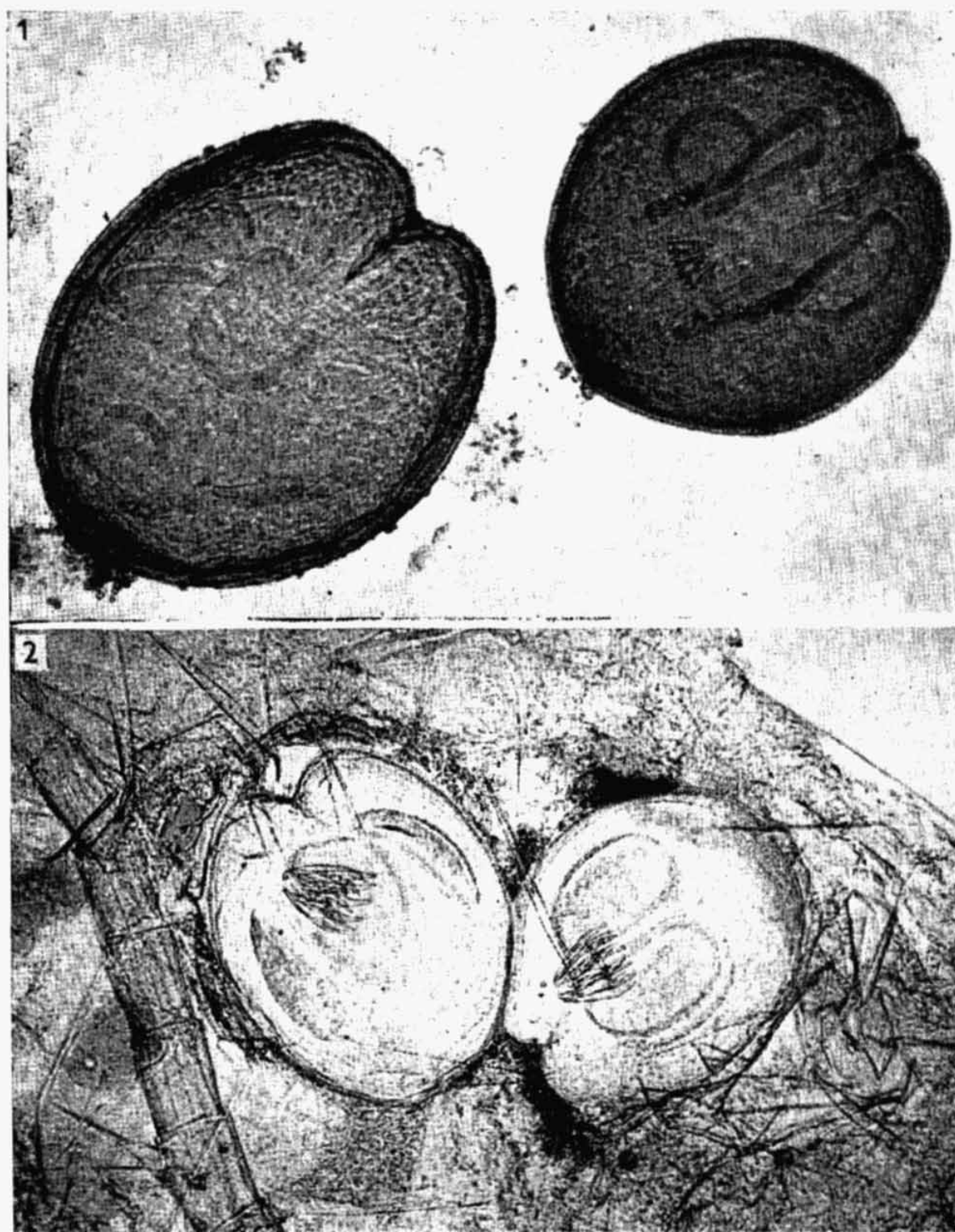
**Резюме.** Мы изучали жизненный цикл цестод видов *D. inflata*, *D. nyrocae* и *D. ransomi*. Развитие личинок разделили на семь стадий, для которых характерен комплекс определенных изменений. Мы нашли, что стена кисты у морфологически совсем различных цистицеркоидов состоит из шести слоев. Цистицеркоидов цестоды вида *D. inflata* находили в природе у *Eudiptomus vulgaris*, *Acanthocyclops vernalis*, *Macrocyclops albidus* и *Heterocypris incongruens* (новые промежуточные хозяева) и в условиях опыта у *H. incongruens*; цистицеркоидов вида *D. nyrocae* находили в природе у *Acanthocyclops viridis*, *Cyclops strenuus*, *Mesocyclops leuckarti* (новые промежуточные хозяева) и в условиях опыта у *C. strenuus*, *Dolerocypris fasciata* и *Notodromas monacha*. Цистицеркоиды вида *D. ransomi* обнаружены в условиях экспериментального заражения лишь у *A. vernalis*, *A. viridis*, *C. strenuus* (новые промежуточные хозяева) и у *D. fasciata*.

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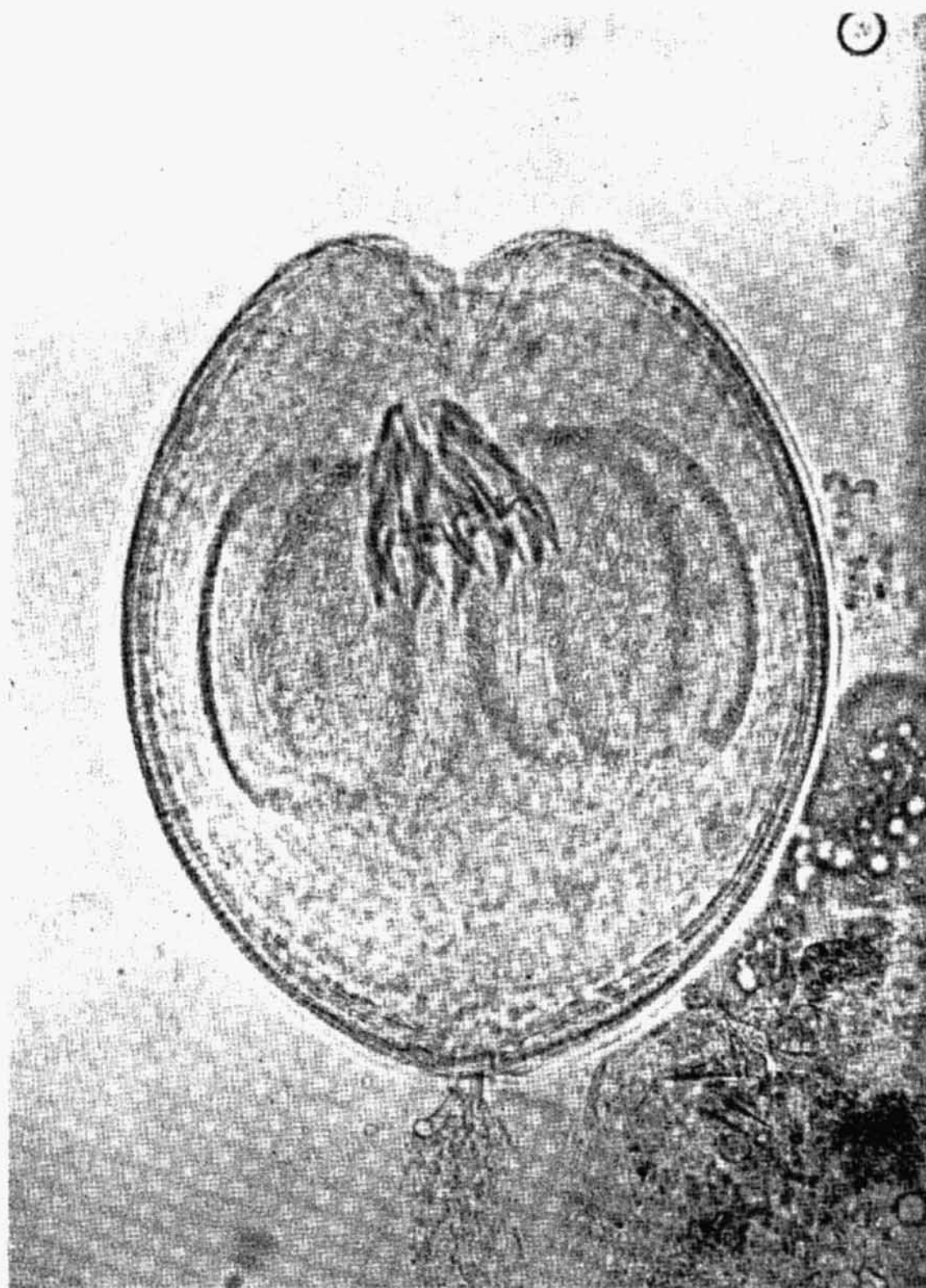
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**Fig. 1.** Cysticercoids of *D. nyrocae* from the body cavity of *Cyclops strenuus*, fixed in ammonium glycerol picrate, ( $\times 200$ ), photo by Wanner.

**Fig. 2.** Cysticercoids of *D. inflata* in the body cavity of *Eudiaptomus vulgaris*, fresh preparation, ( $\times 180$ ).



**Fig. 1.** Cysticercoid of *D. inflata* from the body cavity of *E. vulgaris*, a distinct hyaline layer on the surface of the cyst, fresh preparation, ( $\times 350$ ).