FOLIA PARASITOLOGICA (PRAHA) 23: 309—320, 1976.

OBSERVATIONS ON THE DEVELOPMENT OF RHABDOCHONA PHOXINI MORAVEC, 1968 (NEMATODA: RHABDOCHONIDAE)

F. MORAVEC

Institute of Parasitology, Czechoslovak Academy of Sciences, Prague

Abstract. The life-cycle of the nematode *Rhabdochona phoxini*, an intestinal parasite of the fish *Phoxinus phoxinus*, has been studied experimentally. The mayfly nymphs, *Habrophlebia lauta* Eaton and *H. fusca* (Curtis) were found to serve as experimental intermediate hosts. After the eggs of *R. phoxini* have been swallowed by the mayfly nymph, the toothed first-stage larvae of this parasite are released and penetrate through the intestinal wall into the body cavity of the mayfly. Before reaching the infective third stage, the larvae moult twice in the body of the invertebrate host (2 to 16 and 20 to 36 days after infection at water temperatures of 13—15 °C). However, the development of the encysted infective larvae does not cease in the intermediate host and the larvae may undergo one more moult. One or two moults then occur in the intestine of the definitive host (*Phoxinus phoxinus*) (depending on the fact whether it was infected with third- or fourth-stage larvae) before the larvae attain the maturity. The development of *R. phoxini* in the definitive host lasts about two months.

Rhabdochona phoxini is an intestinal parasite of the minnow, *Phoxinus phoxinus* (L.) of Europe. It has been reported from the basins of the Elbe and the Danube in Czechoslovakia (Moravec 1968, 1971, 1975), Hungary (Molnár 1970) and the Ukrainian S.S.R. (Ergens et al. 1975). Kazakov (1973) recorded this species from the Kola Peninsula (U.S.S.R.). *R. phoxini* is very abundant in some localities in Czechoslovakia. It may be supposed that in addition to *Ph. phoxinus* also other fish species, e.g. salmonids, are parasitized by this nematode. So far the life-cycle of *R. phoxini* has not been studied and also the data on other members of this genus are mostly fragmentary. With the exception of the paper by Linstow (1872) who recovered from mayflies and described spiruroid larvae *Filaria ephemeridarum*, most probably conspecific with some member of *Rhabdochona*, the larvae of this genus were recorded in the intermediate host only by Gustafson (1939, 1942) in the U.S.A., Shtein (1959) in the U.S.S.R. and Vojtková (1971) in Czechoslovakia. The records by Weller (1938) and Janiszewska (1960) from crustaceans and oligochaets are obviously erroneous (see Moravec and Arai 1971, Moravec 1972). According to the published data the intermediate hosts of *Rhabdochona* nematodes were mostly mayflies and less frequently also stone-flies and caddis-flies. The complete life-cycle of these nematodes has been described only recently with the species *R. ergensi* (Moravec 1972).

MATERIAL AND METHODS

Adult gravid females of *R. phoxini* were obtained from the intestine of *Ph. phoxinus* caught from the Rokytka Brook near Prague. Only the specimens containing mature eggs in the uterus were used in the experiment. The batches of 5 to 10 nematodes were placed in small petri dishes (⌀ 45 mm) filled with water. The nematode bodies were torn by fine mounted needles and the eggs were released from the uteri. A small amount of detritus, pieces of dry leaves and 20 to 50 mayfly nymphs were then added into each petri dish. The dishes were covered with a fine silon cloth fixed with a rubber ring and submerged into running water in large dishes. After 24—48 hours the nymphs were transferred to larger petri dishes with detritus and plant remnants without the eggs of the parasite and were kept at water temperatures of 13—15 °C. The mayfly nymphs were inspected first after 24 hours and then at intervals of 1 to 2 days. The experimental fishes were kept in the laboratory for one year previous to the experiment, in order to insure their sterility. They were fed with infected mayfly nymphs using a wide pipette. The fishes were kept in the aquaria containing 35 l of water of the temperature about 20 °C and they were fed with tubificids. The larval nematodes obtained from the mayfly nymphs and experimental fishes were fixed with hot 2 to 4% formalin and examined and measured without clearing in glycerine.

RESULTS

EXPERIMENTAL INFECTION OF INTERMEDIATE HOSTS

In our experiments, we used the isopods *Asellus aquaticus* L. (Crustacea) and nymphs of *Habrophlebia lauta* Eaton, *H. fusca* (Curtis), *Ecdyonurus* sp. and *Cloeon* sp. (Insecta, Ephemeroptera). Of them, only the two species of mayfly nymphs of the genus *Habrophlebia* were successfully infected with the larvae of *R. phoxini*.

The eggs of *R. phoxini* contain a fully formed first-stage larva already at the time of deposition. The mayfly nymph becomes infected when swallowing the nematode eggs together with the detritus. The larvae of the parasite hatch in the digestive tract of this host, with the help of their dorsal tooth penetrate through the intestinall wall into the body cavity and here they continue to develop. The larvae are located primarily in the abdomen, but partly also in the thorax of the intermediate host where they freely move. The larvae undergo two moults (the first 12 to 16 days after infection and the second 20 to 36 days after infection) before reaching the third stage, which is infective. After the second moult the third-stage larvae remain spirally coiled in the fat tissue of the intermediate host, most often in the dorsal part of the abdomen, without encystation. During the following days (most often 30 days after infection) a thin transparent cover appears around the coiled larvae, being apparently produced by the tissues of the intermediate host. The cysts are usually lens-shaped and contain mostly only 1 larva, but sometimes even larger number of infective larvae (up to 10). After the cysts have been transferred to water, some larvae actively leave the cyst envelope. The development of the third-stage larvae does not cease inside the cyst and during the following weeks the larvae undergo another (third) moult in the body of the intermediate host, reaching thus the fourth stage. The rates of the development are not alike in all larvae; at the same time, along with advanced fourth-stage larvae also young third-stage larvae and those undergoing the third moult were found in the mayflies 172 days after infection.

During our experiments the incidence was usually 100% in the nymphs of *Habrophlebia lauta* and *H. fusca* and each nymph contained 2 to 50 larvae of *R. phoxini*. Heavily infected nymphs losed their mobility, became languid and numerous gas bubbles appeared in their bodies. These nymphs soon died. It was found that up to 43 larvae may develop to the infective stage in the body of a single nymph. The body cavity of this intermediate host is almost completely filled with the cysts and the developing genital organs of the mayfly are strongly suppressed. However, the most frequent number of cysts was 2 to 15. The smallest nymph containing a cyst of *R. phoxini* was only 3 mm long.

The presence of a small number of cysts inside the body does not prevent the mayfly nymph from completing its metamorphosis and the infected imagoes are able to fly, as it was proved experimentally.

EXPERIMENTAL INFECTION OF FISHES

The mayfly nymphs containing various numbers of encysted infective larvae in their bodies were fed to experimental fishes, always one nymph per fish. We used 20 specimens of *Phoxinus phoxinus* (length of body 5 to 7 cm) and 1 young specimen of *Rutilus rutilus* (length of body 5.5 cm). The fishes were autopsied at various intervals. Only 5 specimens of *Ph. phoxinus* were found to be infected with the larvae of *R. phoxini*, the remaining fishes were negative. The relatively low percentage of infected fishes is probably due to the small number of infective nematode larvae in some mayfly nymphs used in the experiment.

As soon as the infected nymphs are swallowed by the fish, the infective larvae of *R. phoxini* are released by the digestive fluids, they attach to the mucosa of the intestine (at its anterior and middle portions) and continue to develop. If the fish was infected with the third-stage larvae, then as early as within 3 days these larvae undergo the moult (at body length 1.6—2.0 mm) and attain the fourth stage; in case that they attained the fourth stage in the intermediate host, they undergo only one more moult in the definitive host (fish). This occurs in the intestine of the fish after 22 to 38 or more days, at the length of larvae 3.0—3.5 mm. The following development could not be observed due to a limited number of suitable experimental fishes, but it may be assumed that the females attain maturity and start to produce eggs no sooner than two months after the infection.

DESCRIPTION OF DEVELOPMENTAL STAGES OF *R. PHOXINI*

a) Eggs — Figs. 1 A, B

The eggs are oval, relatively thin-shelled, with a smooth surface or more frequently with a very fine, irregular, almost transparent flock-like coating. The mature eggs measure 0.042—0.045 × 0.024—0.027 mm and contain a first-stage larva.

b) First-stage larva — Figs. 1 C-L

The larvae recovered from mayfly nymphs 1 to 2 days after infection are very fine, light and measure 0.210—0.219 mm in length and 0.012 mm in width. The cuticle is very thin and smooth. The anterior end of the body is provided with a small

Table 1. Growth of *R. phoxini* first-stage larvae in the intermediate host

	1—2 days p.i.	5 days p.i.	7 days p.i.	9 days p.i.	12 days p.i.
Length of body	0.210—0.219	0.210—0.233	0.255—0.300	0.294—0.339	0.336—0.408
Width of body	0.012	0.015—0.018	0.021—0.024	0.024—0.027	0.024—0.030
Length of vestibule			0.036—0.042	0.039—0.045	0.048—0.057
Length of oesophagus			0.069—0.084	0.078—0.087	0.084—0.105
Distance of nerve ring from anterior end		0.045—0.048	0.060—0.063	0.056—0.066	0.063—0.081
Distance of excret. pore from anterior end	0.075	0.063—0.069	0.072—0.084	0.069—0.087	0.081—0.102
Length of tail	0.042—0.045	0.045—0.048	0.057—0.063	0.060—0.063	0.060—0.063

sclerotized tooth measuring about 0.003 mm in length. The mouth is shifted slightly dorsally. The mouth tube begins with a small funnel, the anterior border of which is somewhat sclerotized. The mouth tube is indistinct, since it is covered with rather large cells. The anterior end of the larva is provided with several large elongated cells tapering towards the mouth opening (probably proteolytic glands). The internal organization of the body is obscure; the oesophageal and intestinal parts of the digestive tract are formed by large cells. The excretory cell is indistinct, but the excretory pore is visible in some larvae. The anus is distinct; the tail is conical and terminating in a sharp point. These larvae are rather vivid inside the mayfly body and do not burst after the transfer to the water.

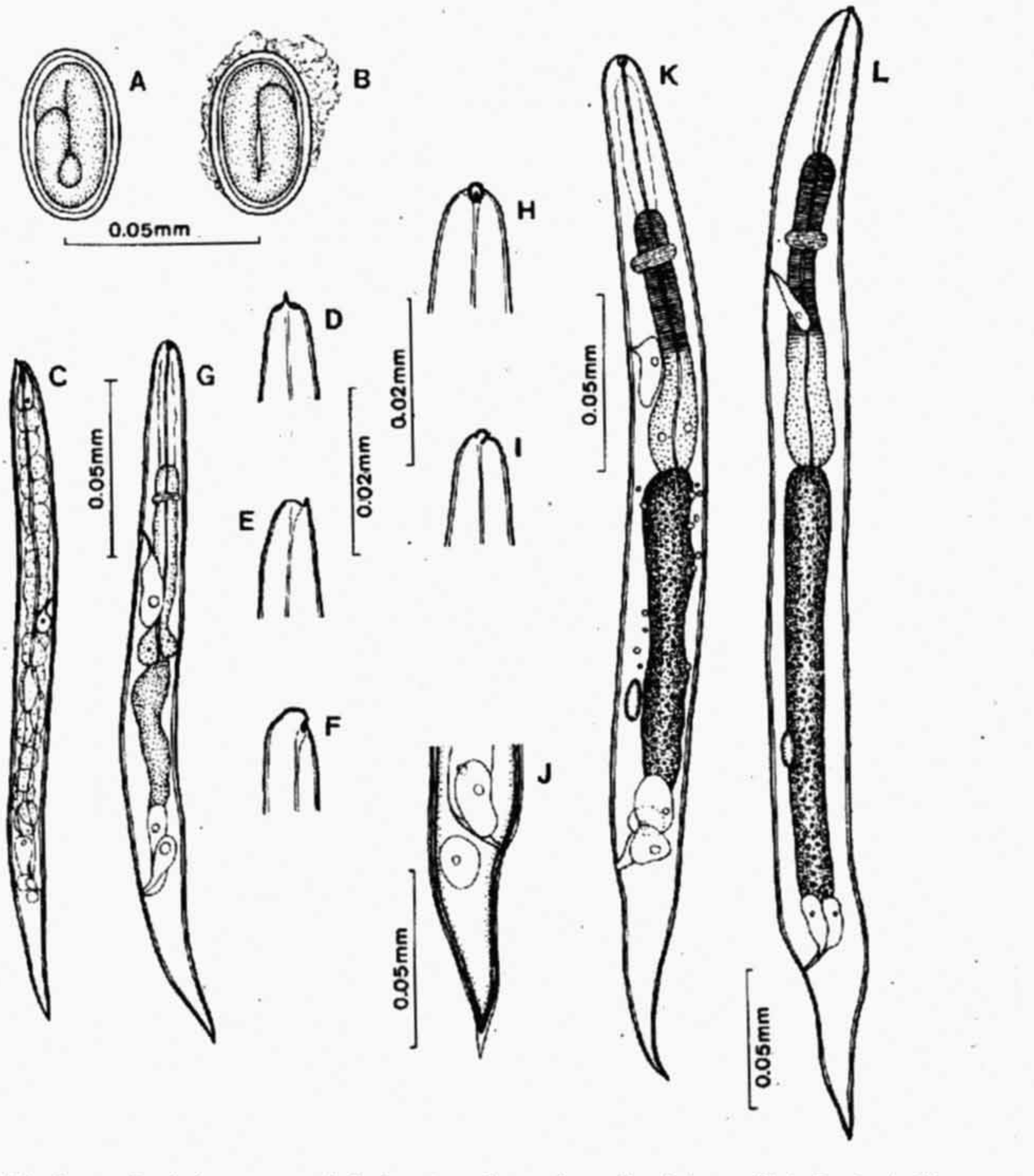

Fig. 1. *Rhabdochona phoxini* — egg and first-stage larva from the intermediate host. A, B — egg; C—F — larva 2 days p.i. (C — general view; D, E, F — anterior end; dorsal and lateral views); G — larva 7 days p.i.; K — advanced larva 7 days p.i.; H, I — anterior end of larva 9 days p.i. (dorsal and lateral views); J — tail of larva starting the first moult (9 days p.i.); L — larva 14 days p.i.

During the following three days the posterior part of the body somewhat widens and its internal organization is more distinct. In most larvae the mouth opening is distinctly subapical, shifted to the dorsal side and the thickened anterior border of the mouth funnel protrudes in form of a papilla-like formation. The dorsal tooth seems to be shorter. The excretory cell, nerve ring and rectal glands may already be distinguished. Seven-day-old larvae are more stout, less vivid and have a thicker cuticle. Their body is light, only the intestine is somewhat darker. The vestibulum is already visible and is surrounded with a layer of little distinct cells. The oesophagus is well visible and undivided; its widened end contains large cellular nuclei. The opening of the large excretory cell lies a short distance below the nerve ring. A small, oval genital primordium is distinct. The 12-day-old larvae are almost twice as long and their cuticle loosens at the end of the tail, indicating the onset of the first molt. During the following 4 days the first moult occurs. The larvae grow considerably, enlarge in length (Table 2) and turn to second-stage larvae. During the moult the larvae are very sensitive to the osmotic pressure and burst soon after the transfer to water.

Table 2. Growth of *R. phoxini* larvae in the intermediate host

	Transitory-stage larvae		Second-stage larvae		Transitory-stage larvae
	First moult				Second moult
	14 days p.i.	16 days p.i.	18 days p.i.	20 days p.i.	26 days p.i.
Length of body	0.423	0.735—0.816	0.885—1.095	1.292—1.332	1.168—1.297
Width of body	0.033	0.051—0.054	0.045—0.054	0.054—0.063	0.036
Length of vestibule	0.048	0.084—0.090	0.057—0.063	0.066—0.072	0.072—0.075
Length of muscular oesophagus				0.078—0.093	0.090
Length of glandular oesophagus	0.129	0.390	0.315—0.390	0.384—0.489	0.312—0.396
Distance of nerve ring from anterior end		0.132—0.171	0.090—0.108	0.108—0.111	0.102—0.112
Distance of excret. pore from anterior end		0.162	0.114—0.138	0.144	0.126—0.144
Distance of genital primordium from posterior end		0.296	0.315—0.333	0.384	
Length of tail	0.060	0.087—0.102	0.084—0.090	0.081—0.096	0.090—0.093

c) Second-stage larva — Fig. 2

The first larvae of the second stage were obtained on the 18th day after infection. These larvae are whitish, elongated (length of body 0.885—1.095 mm), with a smooth cuticle. The head end is rounded and provided with four subapical papillae. The vestibulum is straight, only in the most developed larvae a new vestibulum with a funnel-shaped widening at the anterior end can be observed (Fig. 2e). The oesophagus is well visible, but the boundary between the muscular and glandular portions is still indistinct. The small oval genital primordium lies in the posterior half of the body and grows on to the body wall. The short hyaline rectum is surrounded by large unicellular rectal glands. The tail is conical, terminanting in a sharp point; the posterior anal lip is markedly protruding in all larvae. During the following two days the larvae are growing, both portions of the oesophagus are more distinctly separated and the cuticle starts to loosen. The second moult of the larvae was observed 26 days after infection.

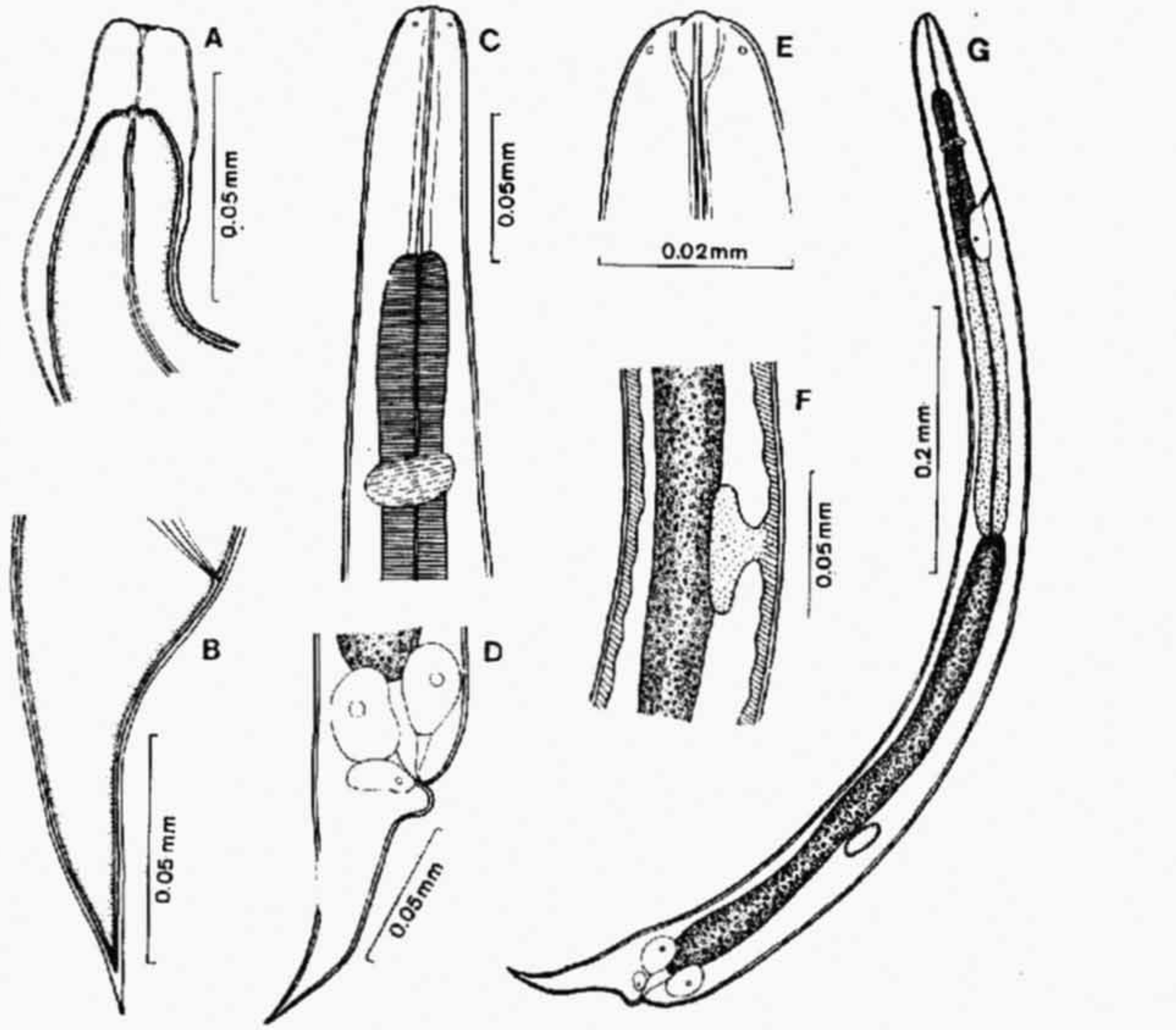

Fig. 2. *Rhabdochona phoxini* — second-stage larva from the intermediate host. A, B — head end and tail of larva undergoing the first moult; C — anterior portion of body; D — tail; E — anterior end of body; F — region of genital primordium; G — general viev. (A, B — 16 days p.i.; C—G — 18 days p.i.)

d) **Third-stage larva** Fig. 3

The third-stage larvae, already without the exuviae of the cuticle from the second moult, were recovered from the mayfly first on the 26th day after infection. These larvae, which measure 1.29—1.40 mm in length, already resemble the adult nematodes in their morphology. The cuticle is smooth. The head end is rounded, with four small subapical mouth papillae and two distinct lateral amphids. The mouth is oval. The sclerotized vestibulum is straight and narrow; it is widened at the anterior end and forms a funnel-shaped prostom. The walls of the prostom are strengthened by two longitudinal lateral thickenings, projecting in form of two small conical teeth at the anterior end of the prostom. The oesophagus is rather long (see Table 3), distinctly divided into anterior, shorter and narrower muscular portion and posterior, glandular portion. The nerve ring encircles the muscular oesophagus near its anterior end; the excretory pore is located in about midway between the nerve ring and the end of the

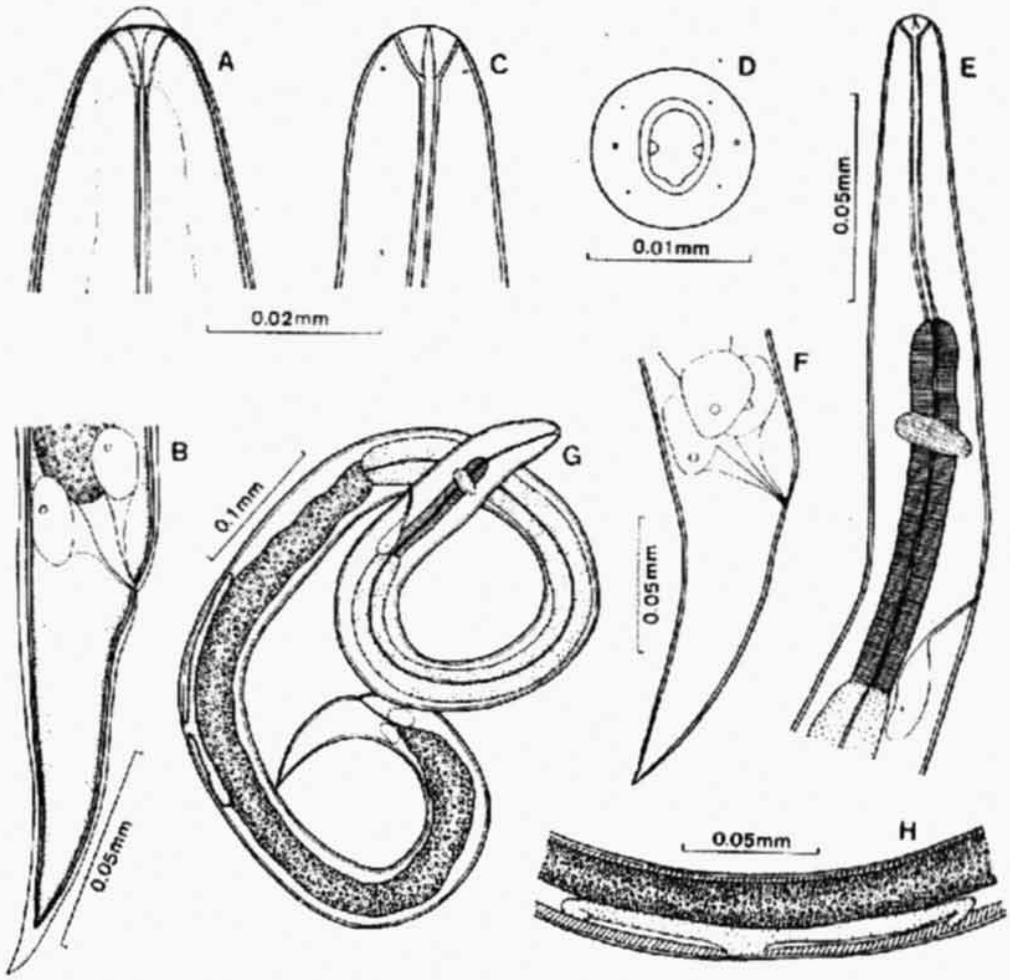

Fig. 3. *Rhabdochona phoxini* — third-stage larva from the intermediate host. A, B — head end and tail of larva undergoing the second moult; C, D — head end (lateral and apical views); E — anterior portion of body; F — tail; G — general view; H — vulva region in "female" larva. (A — 20 days p.i.; B—H — 26 days p.i.)

Table 3. Measurements of *R. phoxini* third- and fourth-stage larvae from the intermediate hosts

	Third-stage larvae	Transitory-stage larvae	Fourth-stage larvae	
		Third moult	"Male" larvae	"Female" larvae
	26 days p.i.	172 days p.i.	172 days p.i.	
Length of body	1.293—1.404	1.700	2.217—2.598	1.754—2.638
Width of body	0.039—0.042	0.042	0.045—0.054	0.042—0.057
Length of vestibule	0.072—0.084	0.093	0.099	0.093—0.102
Length of muscular oesophagus	0.090—0.099	0.144	0.144—0.156	0.159—0.180
Length of glandular oesophagus	0.441—0.450	0.694	0.952—1.061	0.639—1.020
Distance of nerve ring	0.105	0.144	0.129—0.132	0.120—0.135
Distance of excret. pore	0.144—0.153	0.171	0.177—0.189	0.180
Distance of deirids		0.045	0.045	0.039—0.042
Length of prostom	0.006—0.007	0.009	0.009	0.009—0.012
Width of prostom	0.006—0.007	0.006	0.008	0.008—0.009
Distance of vulva from posterior end				0.625—0.816
Length of larger spicule			0.066—0.120	
Length of smaller spicule			0.054—0.060	
Length of tail	0.084—0.090	0.120	0.135—0.150	0.096—0.111

muscular oesophagus. The intestine is rather wide; the rectal glands are large. The tail is conical and pointed at the tip. The genital primordium is tubular.

These larvae are spirally coiled and rest in the tissues of the intermediate host. After some days, a thin hyaline lense-shaped cyst, measuring 0.408—0.544 mm in diameter, forms around the larvae. They continue growing (see Table 3) and after several weeks or months they undergo further (third) moult in the body of the intermediate host. The length of their bodies is about 1.7 mm at that time. The larvae thus attain the fourth stage of development. Both the third- and fourth-stage larvae are infective for the definitive host (fish), which is confirmed by the presence of third-stage larvae in the experimental fishes (Table 4).

Table 4. Measurements of *R. phoxini* larvae from experimentally infected *Phoxinus phoxinus*

	Transitory-stage larvae	Fourth-stage larvae			Transitory-stage larvae ("female" larvae)	
	Third moult	"Male" larva	"Female" larvae		Fourth moult	
	3 days p.i.	3 days p.i.		10 days p.i.	22 days p.i.	38days p.i.
Length of body	1.632—2.054	2.448	2.244	2.176—2.761	3.046—3.372	3.468
Width of body	0.057—0.066	0.072	0.069	0.066—0.081	0.075	0.068
Length of prostom	0.006	0.009	0.012	0.009—0.012	0.009	0.015
Width of prostom	0.006	0.006	0.008	0.007—0.009	0.009	0.009
Length of vestibule including prostom	0.075—0.084	0.093	0.090	0.087—0.099	0.090	0.087
Length of muscular oesophagus	0.129—0.138	0.150	0.153	0.156—0.180	0.175	0.174
Length of glandular oesophagus	0.693—0.833	0.954	0.900	0.979—1.129	1.496	1.469
Distance of nerve ring	0.114—0.117	0.123	0.123	0.111—0.141	0.135	0.114
Distance of excret. pore	0.159—0.165	0.165		0.153—0.210	0.207	0.174
Distance of deirids	0.042—0.048	0.042		0.042—0.048	0.045—0.051	0.042
Distance of vulva from posterior end	0.483—0.603		0.765	0.707—0.816	1.224	1.088
Length of tail	0.096—0.111	0.129	0.105	0.111—0.126	0.129	0.117

e) Fourth-stage larva

Figs. 4,5

The larvae of this stage were recovered from experimentally infected mayflies 172 days after infection and from the intestine of the experimental fishes 3 to 38 days after infection.

The fourth-stage larvae encysted in the mayflies were 1.75—2.64 mm long. Their internal organization is similar to that of the third-stage larvae, but they differ from them in having slightly larger size of body and in the structure of the prostom. The prostom of these larvae is more elongated, with distinct basal teeth; its walls are strengthened with six longitudinal thickenings (1 dorsal, 1 ventral and 2 lateral on each side), which anteriorly protrude into the prostom to form small conical teeth. Small deirids are present. The tail is conical, with a sharp point at the tip. The future sex may be already distinguished in these larvae: the male larvae have feebly sclerotized, not fully developed spicules and the genital organs are visible under the old cuticle of more advanced larvae. In the female larvae, the following organs are already developed: vulva, covered with the old cuticle, vagina, uterus and ovary, reaching anteriorly almost to the end of the glandular oesophagus and posteriorly up to the rectum.

Very young larvae of this stage were obtained from experimental fishes on the 3rd day, more developed larvae on 10th day after infection (Table 4); their morphology was the same as in the larvae from mayflies. In the fourth-stage larvae obtained 22 and 38 days after infection the cuticle started to loosen on the tail, which indicates the onset of the last (fourth) moult, after which the larvae turn into young adults.

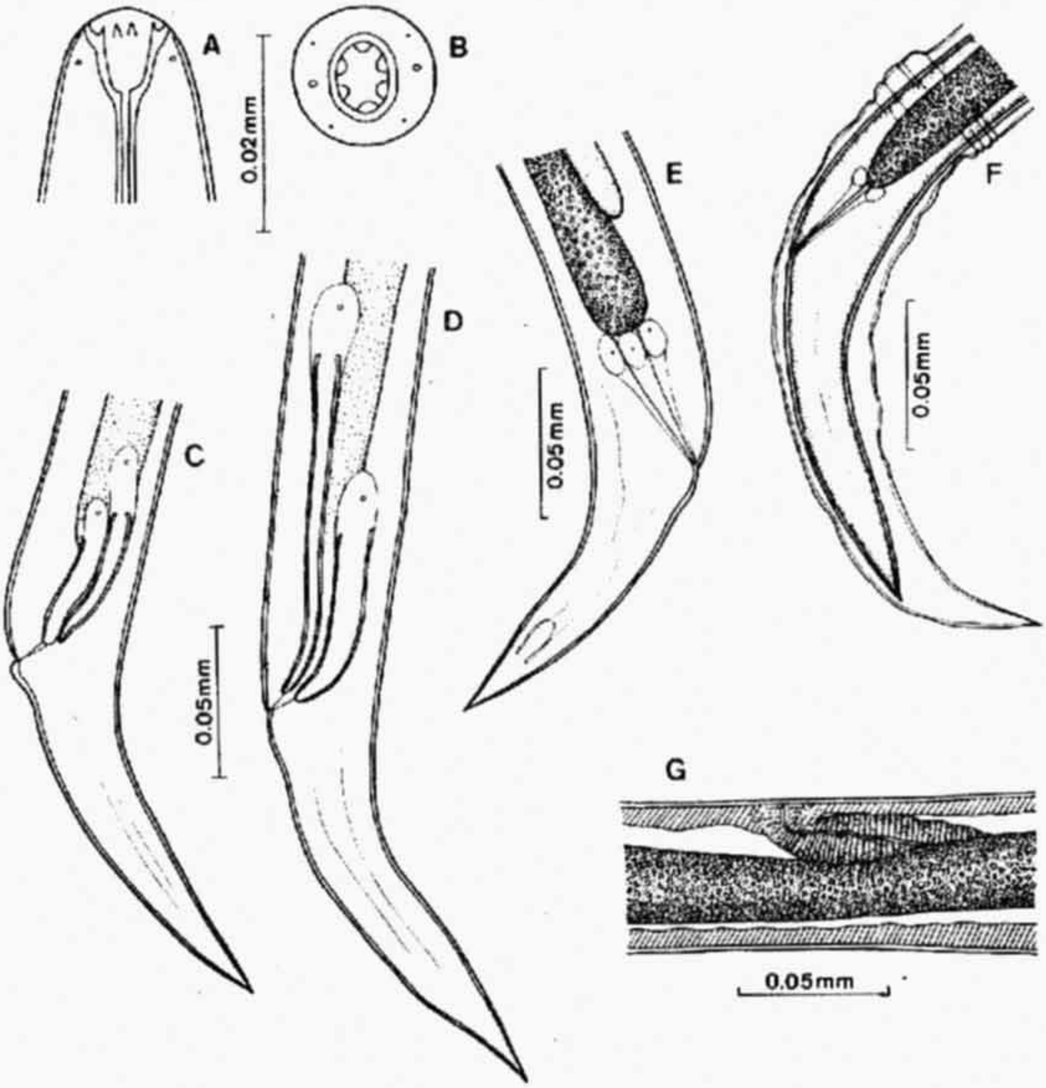

Fig. 4. *Rhabdochona phoxini* — advanced fourth-stage larvae from the intermediate host (172 days p.i.). A, B — prostom (lateral and apical views); C, D — posterior portion of body of "male" larvae with distinct spicules; E — tail of "female" larva; F — tail of "female" larva during the third moult; G — vulva region in "female" larva.

DISCUSSION

Although the nematodes of the genus *Rhabdochona* belong to the most common parasites of fishes and often infect the fishes of economic importance, little attention has been paid to the study of their life-cycles. Only Gustafson (1939, 1942) briefly mentioned the development of *Rhabdochona* spp. from North America in his experimental studies and Moravec (1972) described the complete development of the Palaearctic species *R. ergensi*. A brief review of the records of spiruroid larvae (including the members of *Rhabdochona*) in mayflies was published by Arvy and Peters (1973).

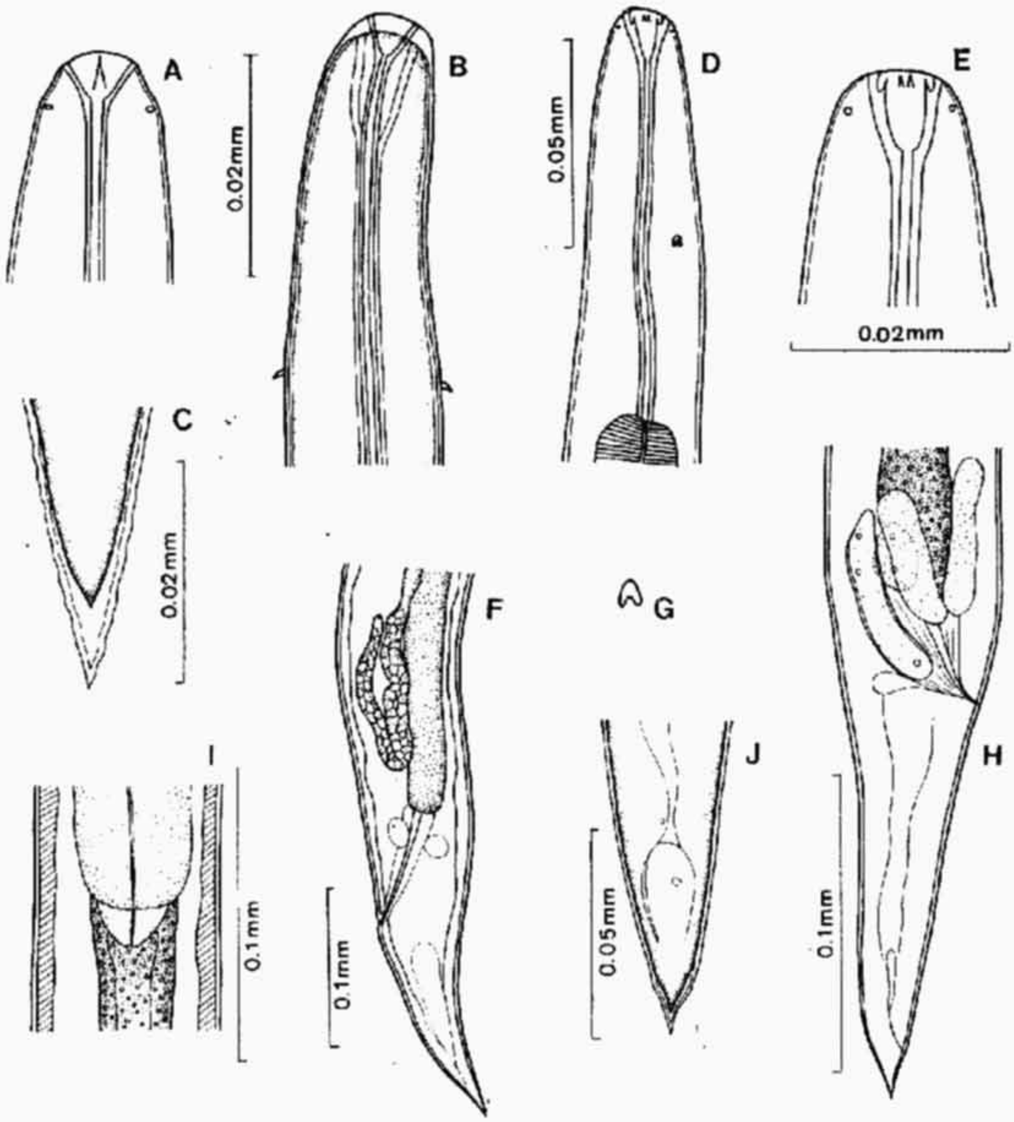

Fig. 5. *Rhabdochona phoxini* — third- and fourth-stage larvae from the intestine of *Phoxinus phoxinus*. A — head end of third-stage larva; B, C — head end and tail of larva undergoing the third moult; D—J — fourth-stage larva (D — anterior end, E — anterior end of body, F — posterior end of body of "female" larva, G — deirid, H — posterior end of body of "male" larva, I — region of oesophagus end); J — tail tip of larva undergoing the last (fourth) moult. (A—C, H — 3 days p.i.; D—G, I — 10 days p.i.; J — 22 days p.i.)

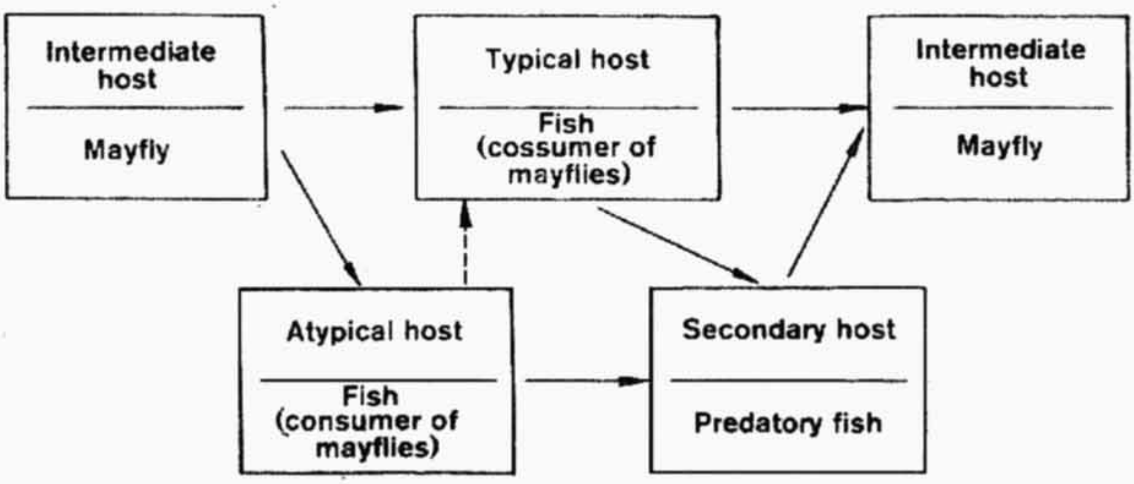

Fig. 6. Simplified scheme of circulation of *Rhabdochona* nematodes in nature.

Gustafson (1942) states that in some North-American members of *Rhabdochona* the development of larvae in the intermediate host does not cease when the infective stage is reached, but that these larvae may almost attain the maturity in the body of the mayfly. The same results were obtained in our experiments with *R. phoxini*, where sclerotized spicules and genital papillae were found in the male fourth-stage larvae from mayflies 172 days after infection. It may be assumed that not only the third stage, but in nature also the fourth stage or even young adults of this parasite occurring in the mayflies may be infective for the definitive host (fish). This is an important fact elucidating why the adult nematodes of the genus *Rhabdochona* are often encountered in atypical hosts, in which they cannot develop. It should be considered, however, that some predatory fishes may be infected by adult *Rhabdochona* when feeding on an infected typical host (fish) and that the nematodes can survive for some time in the gut of this secondary host after the primary one has been digested (Fig. 6). The ability of third-stage larvae to continue their development already in the body of the intermediate host seems to be more common in nematodes than it has so far been supposed. Some adult forms of spirurids and ascarids, described as independent species from invertebrates, are apparently only progenetic forms of species parasitizing vertebrate hosts.

НАБЛЮДЕНИЯ НАД РАЗВИТИЕМ *RHABDOCHONA PHOXINI* MORAVEC, 1968 (NEMATODA: RHABDOCHONIDAE)

Ф. Моравец

Резюме. Изучено развитие нематоды *Rhabdochona phoxini*, паразита кишечника рыбы *Phoxinus phoxinus*. Было обнаружено, что экспериментальными промежуточными хозяевами могут служить нимфы поденок *Habrophlebia lauta* Eaton и *H. fusca* (Curtis). После поглощения яиц *R. phoxini* личинкой поденки освобождаются личинки первой стадии этого паразита, проникающие стенкой кишечника в полость тела поденки, в которой происходят две линьки (на 12—16-й и 20—36-й день после заражения, при температуре воды 13—15°) прежде чем личинки достигнут 3-й, инвазионной стадии. Но развитие инцистированных инвазионных личинок не останавливается в промежуточном хозяине, а происходит еще одна линька. В кишечнике окончательного хозяина (*Phoxinus phoxinus*) личинки линяют еще один или два раза (в зависимости от того, если хозяин был заражен личинками 3-й или 4-й стадии) прежде чем достигнут половой зрелости. Развитие *R. phoxini* в дефинитивном хозяине продолжается около 2 месяцев.

REFERENCES

ARVY L., PETERS W. L., Phorésies, biocoenoses et thanatocoenoses chez les Éphéméroptères. Proc. First Inter. Congr. on Ephemeroptora, 1970, Tallahassee, pp. 254—312, 1973.

ERGENS R., GUSSEV V. A., IZYUMOVA N. A., MOLNÁR K., Parasite fauna of fishes of the Tisa River basin. Prague, 117 pp., 1975.

GUSTAFSON P. V., Life cycle studies on *Spinitectus gracilis* and *Rhabdochona* sp. (Nematoda: Thelaziidae). J. Parasitol. 25: 12—13, Suppl., 1939.

—, A peculiar larval development of *Rhabdochona* spp. (Nematoda: Spiruroidea). J. Parasitol. 28: p. 30, Suppl., 1942.

JANISZEWSKA J., Studies on larval nematodes in Tubificidae (A hypothesis on the life-cycle of Rhabdochonidae). Acta Paras. Polon. 8: 419—425, 1960.

KAZAKOV B. E., The helminth fauna of freshwater fishes of the Kola Peninsula. Tr. GELAN 23: 64—70, 1973. (In Russian.)

LINSTOW O., Beobachtungen an Helminthenlarven. Arch. Mikr. Anat. 39: 325—343, 1872.

MOLNÁR K., Beiträge zur Kenntnis der Fischparasiten Ungarns VI. Cestoda, Nematoda, Acanthocephala, Hirudinea. Parasitol. Hung. 3: 51—76, 1970.

MORAVEC F., Species of the genus *Rhabdochona* Railliet, 1916 (Nematoda: Rhabdochonidae) from fishes of Czechoslovakia. Folia parasit. (Praha) 15: 29—40, 1968.

—, Nematodes of fishes in Czechoslovakia. Acta Sci. Nat. Brno 5: 1—49, 1971.

—, Studies on the development of the nematode *Rhabdochona* (*Filochona*) *ergensi* Moravec, 1968. Folia parasit. (Praha) 19: 321—333, 1972.

—, Reconstruction of the nematode genus *Rhabdochona* Railliet, 1916 with a review of the species parasitic in fishes of Europe and Asia. Prague, 104 pp., 1975.

—, ARAI H. P., The North and Central American species of *Rhabdochona* Railliet, 1916, (Nematoda: Rhabdochonidae) of fishes, including *Rhabdochona canadensis* sp. nov. J. Fish. Res. Bd. Canada 28: 1645—1662, 1971.

SHTEIN G. A., On the question of the life history and living conditions of the nematode *Rhabdochona denudata* (Dujardin, 1845). Dokl. AN SSSR 127: 1320—1321, 1959. (In Russian.)

VOJTKOVÁ L., Beitrag zur Kenntnis der Helmintofauna der Wasserwirbellosen III. Cestoda, Nematoda, Acanthocephala. Věst. Čs. spol. zool. 35: 146—155, 1971.

WELLER T. H., Description of *Rhabdochona ovifilamenta* n.sp. (Nematoda: Thelaziidae) with a note on the life history. J. Parasitol. 24: 403—408, 1938.

Received 11 November 1975.

F. M., Parasitologický ústav ČSAV,
Flemingovo n. 2, 166 32 Praha 6,
ČSSR

FOLIA PARASITOLOGICA (PRAHA) 23: 320, 1976.

F. Moravec: Reconstruction of the nematode genus Rhabdochona Railliet, 1916 with a review of the species parasitic in fishes of Europe and Asia

Studie ČSAV (Studies of the Czechoslovak Academy of Sciences), No. 8. Publishing House Academia, Prague, 1975 104 pp. 26. -Kčs.

Dr. F. Moravec from the Institute of Parasitology of the Czechoslovak Academy of Sciences, Prague, ichthyoparasitologist well known to the world scientific public, presents in this monograph the results of his studies of the morphology, taxonomy and systematics of nematodes of the genus *Rhabdochona*, which are important parasites of fishes. A series of original scientific papers dealing with this genus from fishes of South, Central and North America and Africa, which were published in the last years, is thus complemented with another part to form a complete survey of these helminths from all parts of the world.

The introductory section of the book (pp. 8—19) offers an analysis of the position of *Rhabdochona* in the family Rhabdochonidae (a key to genera is attached), a reconstruction of this genus and key to Eurasian species. The subfamily Rhabdochoninae includes 5 valid genera and the genus *Rhabdochona* is divided into 4 subgenera (*Rhabdochona* Railliet, 1916; *Globochona* Moravec, 1972; *Globochonoides* Moravec, 1975 and *Sinonema* Moravec, 1975). In the subgenera *Rhabdochona* and *Globochona* the author used also a non-systematic division into morphological groups (based on eggs). In this case it is an auxiliary classification of great practical and theoretical significance.

The major part of the work is a revision of Eurasian species (pp. 20—88). The author recognizes 25 taxons as valid and other two as "species inquirenda". He himself has studied 20 of these species using either type material from many museums or his own material. The main morphological and metrical characters of the remaining species are commented on the basis of their original descriptions. The redescriptions of the revised species are made with a scientific exactitude and documented with 24 detailed original figures. The geographic distribution and range of definitive hosts is given for each species and in many cases also a detailed historical analysis and critical evaluation of the synonymy are added. The main metrical characters of some species are summarized in 10 tables for better comparison. On the basis of this revision the author excluded 8 species from the genus *Rhabdochona* and transferred them to other genera. The complete list of references dealing with this subject comprises 187 original scientific papers which are cited and analyzed in the text.

The present monograph should be appreciated as a work of high scientific level. The taxonomical analysis in form of a revision is exact and makes possible a perfect differentiation of Eurasian species of the genus *Rhabdochona*. The published results suggest that the author has attained a qualitatively higher degree in the taxonomy of species belonging to this genus. The book is of great value to all ichthyoparasitologists, but it will be successfully applied on a larger scale also in the taxonomy and zoogeography of parasitic nematodes.

Dr. V. Baruš, D.Sc.