

LIFE-HISTORY OF PHILOMETRA OVATA
(ZEDER, 1803) AND PH. RISCHTA SKRJABIN, 1917

By

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Life-history studies on the nowadays numerous members of the genus *Philometra* have been conducted but fairly rarely. So far the developmental cycles of the following species are known: *Ph. sanguinea* (Rud.), *Ph. globiceps* (Rud.), *Ph. americana* Kuitunen-Ekbaum, *Ph. fujimotoi* Furuyama and, at least in part, of *Ph. ovata* (Zeder) and *Ph. lusiana* VISMAR (STRASSEN, 1906; NYBELIN, 1931; FURUYAMA, 1936; WIERZBICKI, 1960; VISMAR, 1964).

LINDBRO (1874) was the first to attempt elucidating the cycle of *Ph. ovata*. However, the status of *Ichthyonema sanguineum* had not been cleared up by that time. Thus, it seems uncertain whether the species dealt with really represented *Ph. ovata*. NYBELIN (1931) distinguished three species in the complex "*Ichthyonema sanguineum*" yet, his studies referred to only one of them, viz. probably *Ph. sanguinea*.

No data are at hand, so far, on the cycle of *Ph. rischta*. The present communication deals with the life cycle of *Ph. ovata* and *Ph. rischta*. The morphology of these species was described in detail in another paper (MOLNÁR, 1966).

Material and methods

During the past three years the biological characteristics of *Ph. ovata* and *Ph. rischta* were examined in this laboratory. *Ph. ovata* was collected from *Abramis brama* and *Rutilus rutilus* captured in the lake Balaton, while *Ph. rischta* specimens were obtained from *Alburnus alburnus* specimens originating from both the lake Balaton and the river Danube.

The examinations were carried out, with the exception of the wintry season, permanently. Worms were collected as a rule in saline, in which the worms, being freed from body tissues, moved very actively and could be preserved without injuries. All measurements of body size and examinations of morphological details were carried out partly on live specimens, partly with worms cleared in lactophenol.

The development of *Philometra ovata*

Ph. ovata runs a regular yearly life-cycle adjusted even to periods of days, like *Ph. sanguinea* a species also of common occurrence in Hungary. The development of the latter species had been studied in detail by several authors (NYBELIN, 1931; ČAKAY, 1957; WIERZBICKI, 1960).



Fig. 1. Full-grown females of *Ph. ovata* in the abdominal cavity of a fish host infested with *Ligula*

Adult females, about 9 to 12 cm in size and containing larvae, may be found only during the last days of May and the first days of June, in the abdominal cavity of those second-year and older breams and roaches which proved to be infected with plerocercoids of *Ligula intestinalis* L. and/or *Digamma interrupta* (Rud.) (Fig. 1). Male worms may be detected under the serosa of the posterior sac of the air-bladder (in the following referred to as air-bladder), more rarely also in the abdominal cavity (Figs 2, 3 and 4). Extensity of infestation in both breams and roaches was 100 per cent.

In *Ligula*-free breams more than one year of age male and female specimens of *Ph. ovata* may also be present in 100 per cent extensity during the whole year, but the number of worms is smaller than in *Ligula*-infected fishes, and only the males attain the size of mature worms. Both female and male specimens alike dwell in tissues of the air-bladder, i. e., migration of females into the abdominal cavity does not take place. These female specimens never attain 3 mm in length.

In less than one year old fish specimens an infestation with *Ph. ovata* could not be observed.

Since according to the present examinations in Lake Balaton *Ph. ovata* is able to reach maturity only in fish specimens infested simultaneously with plerocercoids (*Ligula*), the life-cycle of this species was traced up by examining *Ligula*-infested breams. A total of 500 two-year-old or older specimens of



Fig. 2. Head-end of a *Ph. ovata*

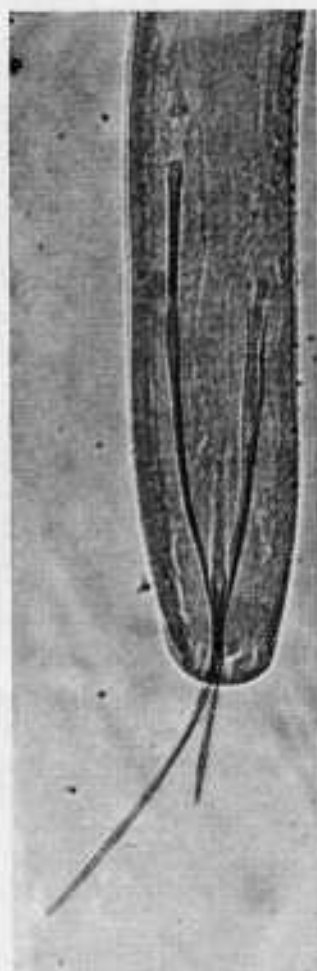


Fig. 3. Tail-end of a ♂ *Ph. ovata* seen in dorsoventral position

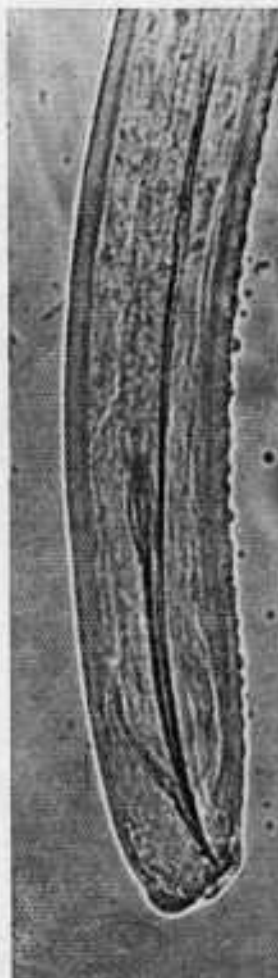


Fig. 4. Tail-end of a ♂ *Ph. ovata* seen in lateral position

Ligula-infested breams, 400 *Ligula*-free breams of the same ages, 100 one-year-old breams, 12 *Ligula*-infested and 20 *Ligula*-free roaches as well as 40 roach spawns were examined.

In order to determine the degree of infestation with *Ph. orata* as well as the exact stage of development, 6 to 10 specimens of the examined fish-material were selected monthly for permanent preparations. All worms collected from *Ligula*-infested roaches were treated similarly.

Observations

In the lake Balaton the infestation of breams and roaches takes place during the second half of June, at which time juvenile stages, viz., 0.96 to 1.91 mm long and 0.027 to 0.047 mm wide males, and 0.54 to 1.87 × 0.016 to 0.045



Fig. 5. Tail-end of a juvenile specimen of *Ph. orata*

mm-sized females could be detected. Among them there were smaller specimens from the abdominal cavity, representing larvae with tapering body end (Fig. 5). The larger specimens surpassing 1 mm in size had already lost their attenuated hind end characteristic of larvae, showing already either primordial spicules, or chitinized vaginal openings. The chitinized part of the spicules of these specimens never surpassed 0.040 mm in length and in males less than 1.4 mm in length these structures could not be detected at all. At the same period male worms 2.39 to 2.45 mm and females 2.00 to 2.19 mm in length, showing well-pronounced chitinized organs, were found on the air-bladder of some older fishes. (These are thought to be rudimentary specimens originating from the previous year's infection.)

During July growing specimens, both males and females, were found on the air-bladder only. The size of males attained 1.02 to 2.10 × 0.032 to 0.061, that of females 0.95 to 2.10 × 0.032 to 0.059 mm. (The average values for given dates is shown in Table I.)

Table I

Average size values measured during the life-cycle of *Ph. ovata*

Date of examination	Males		Females collected from Ligula-free fishes		Females from Ligula-beds fishes	
	length mm	width mm	length mm	width mm	length mm	width mm
June 29, 1964	1.39 (2.39)**	0.036			1.29 (2.09)**	0.029
July 7, 1964	1.71	0.048	1.68	0.042		
Aug. 14, 1964	1.96	0.047	1.91	0.049		
Aug. 18, 1964	2.02	0.045			3.86	0.105
Aug. 26, 1964	2.14	0.052			5.62	0.144
Sept. 10, 1964	1.95	0.037			9.39 (2.80)***	0.206 (0.060)***
Sept. 17, 1964	2.19	0.047	2.28	0.047		
Oct. 22, 1964	2.23	0.027			29.85	0.612
Nov. 8, 1964	1.83	0.047	1.95	0.042		
March 26, 1965	2.10	0.044	1.87	0.058	36.10	0.630
Apr. 27, 1965	1.69	0.052	2.41	0.054	52.00	0.800
May 6, 1965	2.03	0.046	2.94	0.085	78.00	0.850
June 5, 1965	1.94	0.041	6.42*	0.135*	105.00	1.05

* where the number of specimens was less than 10.

** Specimens originating from the previous year

*** Specimens not yet emigrated from the air-bladder

By August the males had attained their final size. Their chitinized organs did not change any more. The larger spiculum measured 0.246 to 0.325 (on the average, 0.284), the smaller one 0.136 to 0.204 (average, 0.165), the gubernaculum 0.053 to 0.078 (average, 0.066) mm in length. Beginning with this month the development of females in fish specimens harbouring plerocercoids and in those free of these parasites proceeded dissimilarly.

In non infested fishes the male worms having attained the size of 1.70 to 2.20 × 0.041 to 0.053, and the females with sizes of 1.66 to 2.36 × 0.039 to 0.053 mm do not grow any more and are located during their whole developmental cycle (*i. e.*, until June) under the serosa covering of the posterior

sac of the air-bladder. The chitinized part of the vagina attains in these females 0.080 to 0.100 mm in length (Fig. 6).

In fishes harbouring plerocercoids the males similarly do not grow any more, some of the females, however, continue to grow and begin to migrate from the air-bladder into the abdominal cavity. At that time their dimensions measure 1.50 to 11.50 \times 0.029 to 0.340 mm (Fig. 7). In their uteri there appear egg-primordia of the size 0.004 to 0.006 mm.

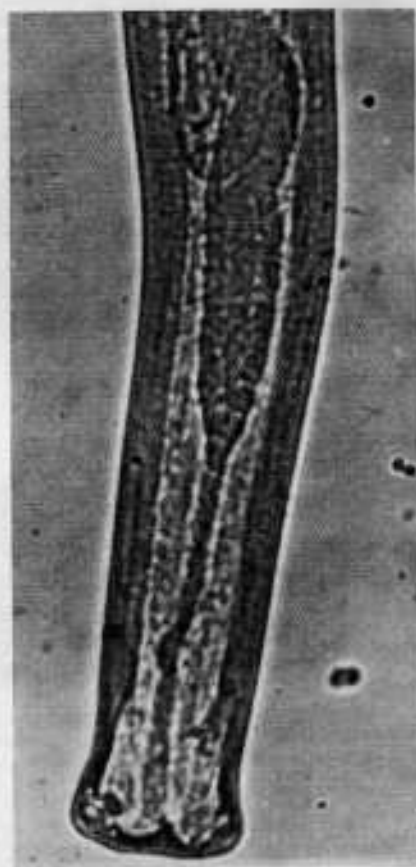


Fig. 6. The chitinized part of the vagina of ♀ *Ph. ovata* retarded in development

Fig. 7. Tail-end of a 2-month-old ♀ *Ph. ovata*

In fishes harbouring young plerocercoids, due supposedly to an infestation during the late autumnal or early spring months, *Philometra* specimens occurred, like in fishes containing no plerocercoids, only on the air-bladder. Here, apart from male worms, only females showing retarded development could be detected.

During September the size of females having migrated into the abdominal cavity attains 2.90 to 25.00 mm (Fig. 8), whereas that of males remaining on the air-bladder measures 1.8 to 2.0 mm. Together with males some smaller females may often be found, measuring 1.4 to 5.6 mm in size. Some of the latter supposedly emigrates at a later time whereas the smaller ones, like those present in Ligula-free fishes, fail to grow further. These females, attaining a size close to that of the males, may be found on the air-bladder even during spring time.

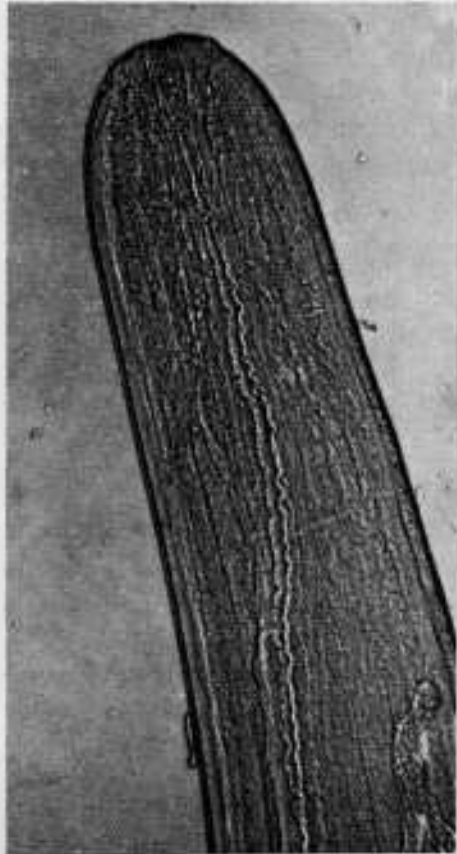


Fig. 8. Head-end of a 3-month-old growing ♀ *Ph. ovata*

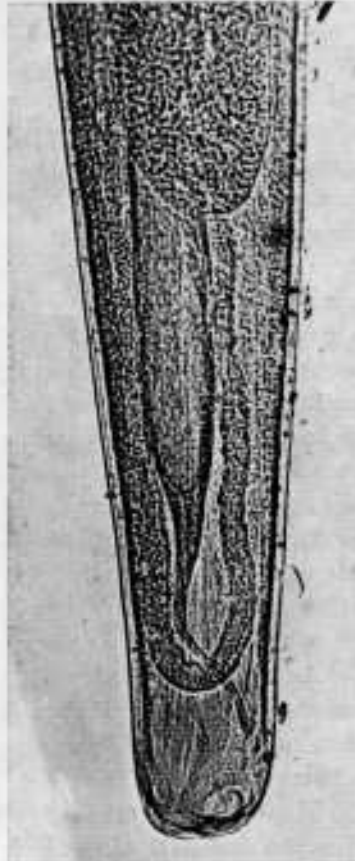


Fig. 9. Tail-end of a 3-month-old ♀ *Ph. ovata*

According to the above-described course of development, the copulation of sexes takes place in July or at the beginning of August. In females emigrated into the abdominal cavity late in August or in September, and moving there freely, the egg-primordia are usually well-visible. The females are now more or less transparent or of reddish-gray colour.

At the end of October the colour of worms present in the abdominal cavity is light red, their size varies between 24.2 and 37.5 mm in length and 0.46 and 0.76 mm in width. The diameter of the egg-primordia is 0.015 to 0.017 mm.

No particular change in size of the worms could be experienced during November.

Because of stop of fishing the research work could not be continued until the next spring. Examinations were continued in March. At this time yellowish-red or definitely red worms were found in the abdominal cavity of breams harbouring plerocercoids. They moved very actively and showed sizes of 13.7 to 51.2 \times 0.36 to 0.68 mm in diameter. The uterus of females was filled with roundish, unsegmented, thinn-walled eggs, 0.030 to 0.035 mm in diameter. Among the numerous (20 to 300 specimens) females found in plerocercoid-laden fishes sometimes 1 to 3 worm specimens could be detected which, while similar in size and shape to normal ones, were conspicuous by their milky white colour.

During April the colour of females varied between light and deep red. Their size attained 45 to 70 mm, their uterus contained eggs 0.035 to 0.040 mm in diameter, showing 8 to 32 blastomeres.

At the beginning of May, the thinn-walled, roundish eggs tended to become elongated, with diameters 0.040 \times 0.052 mm, showing a crescent-shaped primordium of the larvae. The size of females attained 70 to 90 mm. In some hosts there occurred a few smaller (40 to 50 mm long) and less-developed females, too, harbouring rounded eggs in the morula stage.

In the second half of May all females attained 9 to 12 cm in length. Their colour was light red. The uterus was filled with great numbers of free first-stage larvae, showing see-saw motion maintained by a red-coloured fluid of the contracting uterus.

At the end of May and at the beginning of June the full-grown females evacuated the host's body via the tissues around the anus and, passing into the water, soon ruptured due to its hypotonic effect. Finally the larvae sank to the bottom.

The free first-stage larva is 0.350 to 0.510 (average, 0.410) mm in length and in the mid-part of the body 0.012 to 0.022 (average 0.017) mm in width. Their head-end is rounded off, the tail-end is tapering.

At the time of the full-grown worms' emigration, males and females may be found in about equal numbers on the air-bladder, more rarely in the abdominal cavity. After the evacuation of females the number of males diminishes gradually; by the end of July usually several males and, occasionally, undergrown females similar in size may be found on the air-bladder of the hosts.

The same occurs in *Ligula*-free hosts, with the only difference that the ratio of undergrown females to males is greater than in *Ligula*-laden hosts.

in which the number of females was smaller even originally. It is probably due to the above conditions that at the period of fresh infestations, viz., late in June, males averaging 2.39 mm and females 2.09 mm in length occur togeth-



Fig. 10. Larvae of *Ph. ovata* in the body cavity of *Cyclops*

er with males attaining an average length of 1.39 and young females averaging 1.29 mm in length.

It seems worthwhile to note that in June I had the opportunity to find a female *Philometra* 6.42 in size and a male 1.94 mm in size in the abdominal cavity of a young, Ligula-laden bream specimen. This finding supports the view that some females retarded in their development may continue developing under favourable conditions at the beginning of the next cycle.

Being known from the work of certain authors (STRASSEN, NYBELIN, FURUYAMA, WIERZBICKI) that *Philometra* first-stage larvae reach their infective stage in the body of *Cyclops* species, attempts were made to infest some *Cyclops* species common in the lake Balaton with first-stage larvae of *Ph. ovata*. It was found that the three species of the Cyclopids, viz. *C. strenuus*, *Macrocyclops albidus* and *Acanthocyclops viridis* are equally able to swallow the worm larvae offered in water. The larvae of *Ph. ovata* pass the intestinal wall of the intermediary host and may be observed moving until the 15th day in its body cavity (Fig. 10). On the 15th day the death of the *Cyclops* checked further observation.

The life-cycle of *Ph. ovata* runs an almost identical course in the second host, viz., in the roach. Scarcity of *Philometra*-infested roach material prevented us from obtaining data sufficient for any conclusion.

Trials of the demonstration of *Ph. ovata* in fishes from the lake Balaton were successful in two fish species, viz., the bream (*Abramis brama*) and the roach (*Rutilus rutilus*). However, the character of philometrosis differs in some respects even in these two hosts. Depending on age and infestation with pleurocercoids, the following features seem to be characteristic in breams and roaches.

1. In breams and roaches under one year of age *Ph. ovata* was never found.

2. In *Ligula*-laden breams 20 to 300 full-grown female worms, approximately the same number of males and usually 2 or 3 undergrown females were found. Extensity of infestation equalled 100 per cent.

3. In *Ligula*-laden roaches 1 to 14 adult females and the same number of males occurred. Extensity of infestation was 100 per cent.

4. In breams free of *Ligula* 2 to 30 undergrown females and males were found. Extensity of infestation was 100 per cent.

5. Roaches free of *Ligula* proved infested in 50 per cent with 1 to 10 undergrown *Philometra* females and/or males each.

The development of *Philometra rischta*

Philometra rischta Skrjabin 1917 occurs in Hungary as parasite of numerous species of Cyprinidae. So far it has been collected from *Alburnus alburnus*, *Aspius aspius*, *Abramis brama*, *A. ballerus*, *A. sapa*, *Blicca björkna* and *Scardinius erythrophthalmus*. It is most frequent in *Alburnus alburnus*. Practically every third specimen of this host, if older than one year, harbours this *Philometra* species.

Considering the frequency of this worm species in *Alburnus alburnus*, the life-history studies presented in this paper refer to specimens collected from this host.

Depending on possibilities of purchase, fishes from the lake Balaton and the river Danube were examined parallelly. As, however, while studying the development of *Philometra ovata* no biological differences were experienced in details according to the origin of the parasite, it was found reasonable to treat them together.

During the different periods of the year 200 host specimens (*Alburnus*) were examined from the lake Balaton and 250 from the Danube.



Fig. 11. Females of *Ph. rischta* on the gill-flap of *Alburnus alburnus*

The full-grown females of *Ph. rischta*, measuring 35 to 42 mm in length and 0.80 to 1.00 mm in width were found at the end of May and in early June on the inner surface of the gill-flap (Fig. 11), occasionally under the skin of the head, in the orbit, rarely at the base of the anterior fins. Usually 1 to 35 females were found in a single host.

Males occurred during summer only. In an individual host usually at most two specimens were found under the serosa of the air-bladder's hind sac (Fig. 12 and 13). On September 2, when no males were detectable any more on the air-bladder, a single male was found on the tail fin. Thereafter no more males were found in *Alburnus*. In contrast to *Ph. rischta*, a single male was found on the air-bladder of *Aspius aspius* in May. However, no females were detectable in this specimen.

The infestation of *Alburnus* specimens of two or more years of age with larvae of *Ph. rischta* takes place at the end of June.



Fig. 12. Head-end of a ♂
Ph. rishta



Fig. 13. Tail-end of a ♂
Ph. rishta



Fig. 14. Head-end of a 3-month-old ♀ of *Ph. rishta*

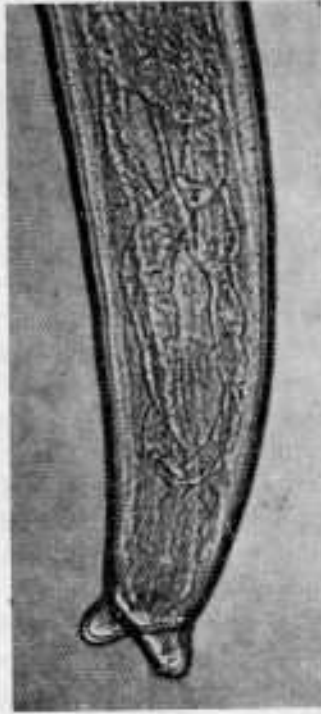


Fig. 15. Tail-end of a 3-month-old ♀ of *Ph. rishta*

Males measuring 1.53 to 1.92×0.024 to 0.031 mm and females of 1.04 to 1.37×0.031 to 0.037 mm in size were first found on the air-bladder early in July. (The average metric values are summarized in Table II.)

Table II

The average size values of males and females of *Philometra rischta* as well as the average size values of sex organs during the life-cycle

Date of examination	Females		Males				
	length mm	width mm	length mm	width mm	epiosolium I. mm	epiosolium II. mm	gubernaculum mm
July 7	1.20	0.034	1.70	0.027	0.049	0.045	0.31
July 16			1.92	0.033	0.045	0.045	0.039
Aug. 16	1.06	0.069					
Sept. 2			1.78*	0.033*	0.057*	0.053*	0.041*
Sept. 21	4.82	0.167					
Oct. 17	6.02	0.225					
Apr. 1-2	13.65	0.367					
May 5	28.10	0.465					
May 17	37.5	0.900					

On the air-bladder of the few *Alburnus* specimens collected in middle of July only males were found. These measured 1.78 to 2.05×0.029 to 0.037 mm in size.

By the middle of August the females and males had disappeared from the air-bladder and some young females, 1.30 to 2.73×0.033 to 0.105 mm in size, were already found in the inner surface of the gill-flap or other portions of the head.

In fishes showing a heavy infestation (with more than 25 specimens) some worms fail to attain the connective tissues of the head, but occasionally start development on the trunc. This is evidenced by finding fairly advanced female worms 3.56 to 6.57×0.114 to 0.217 mm in size during September in the musculature adjacent to the anterior fins (Figs. 14 and 15).

In the autumn females continue developing and may attain the size of 5.4 to 6.8×0.20 to 0.26 mm by the end of October. In the spring our research work was resumed in the early April days. Females 8.21 to 22.50×0.26 to 0.47 mm in size showed eggs 0.014 to 0.019 in size. These were scarcely or not at all segmented.

Early in May the segmentation proceeds and reaches the morula stage. The the slightly elliptical eggs measure 0.038×0.042 mm in diameter. From 10th to 20th May the elongated primordia of larvae are visible and at the end of May the uterus is filled with actively-moving first-stage larvae.

The full-grown females are 35 to 42 mm in length. They leave the body of the host at the end of May or early in June. In fish specimens examined after 10th June only the tissue lesions caused by *Ph. rischta* could be detected.

If full-grown females of *Ph. rischta* are brought into hypotonic medium, e. g., water, they, similarly to *Ph. ovata*, will soon burst and the freed first-stage larvae swarm out. The larvae measure now 0.280 to 0.430 mm, they are similar in shape to those of *Ph. ovata*. Out of the Cyclops species available *C. strenuus*, *Macrocylops albidus* and *Acanthocyclops viridis* proved to be easily infested. A 100 per cent infestation could be attained with a young Cyclops population only. Out of grown Cyclops specimens only every third proved infested.

Discussion

Assessing the course of development of *Ph. rischta* and *Ph. ovata* described in this paper it seems clear that both species run a regular, periodically well-determinable, year-long cycle. According to the observations and results of experimental proof, the cycle comes about only in fish hosts more than one year of age.

In the case of *Ph. ovata* we found that the females are able to complete the cycle but in breams and roaches which are simultaneously infested with plerocercoids of *Ligula intestinalis* or *Digamma interrupta*. Our view appears to be in agreement with the observation of CREPLIN (1825), who found *Filaria cyprini rutili*, which was most probably identical with *Ph. ovata* in roaches harbouring simultaneously *Ligula intestinalis*.

Considering other sources of literature, there is no possibility to conclude whether mature females of *Ph. ovata* had been found simultaneously in *Ligula*-laden hosts or not. The elucidation of this question is impeded by the fact that descriptions known from literature, including those of NYBELIN (1931), refer solely to easily appreciable females and form mostly a part of a paper which is more or less faunistic in character. It is, therefore, impossible to identify the species of mature females occasionally described from a given fish host and identified once with *Ph. ovata* Zeder, in another case or by another author with *Ph. abdominalis* Nybelin.

The question, therefore, whether *Ph. ovata* is able to complete development in other fish species, or under certain conditions in breams and roaches not infested simultaneously with *Ligula*, remains to be cleared up by means of further concrete observations or, possibly, by investigations extending to the problem of the resistance of fishes. One conclusion, however, seems to be clearly admissible, viz., that in the lake Balaton the surprisingly high frequency of *Ph. ovata* is principally maintained by breams and roaches showing a simultaneous infestation with *Ligula*, while the possible infestation of other fish species plays an unimportant role.

SUMMARY

The life-history of the Nematode species *Philometra ovata* Zeder, a parasite of the abdominal cavity of the bream (*Abramis brama*) and roach (*Rutilus rutilus*) as well as that of *Philometra rischta* living on the gill-flaps and in the abdominal cavity of *Alburnus alburnus* was studied.

Philometra ovata could be demonstrated in all of the examined 900 specimens of breams and in the majority of 32 roaches.

Females of *Philometra ovata* attained their maturity but in hosts over one year of age showing simultaneously an infestation with plerocercoids of *Ligula* or *Digamma*. In hosts free of plerocercoids the development of *Philometra* stops at an early stage.

Females of *Philometra rischta* migrate from the abdominal cavity, where their fecundation takes place, to tissues of the anterior part of body, most frequently to the gill-flaps, where they attain maturity.

Both species run a yearly, regular cycle adjusted even to a couple of days.

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