

LIFE HISTORY OF THE TAPEWORM *Khawia sinensis* HSÜ, 1935, A CARP PARASITE, IN THE POND DRAŽSKÝ SKALIČANY NEAR BLATNÁ, CZECHOSLOVAKIA

T. SCHOLZ, V. ŠPETA¹ and J. ZAJÍČEK²

Institute of Parasitology Czechoslovak Academy of Sciences, 370 05 České Budějovice

¹District Veterinary Administration, 386 01 Strakonice

²State Veterinary Administration — Regional Administration, 371 38 České Budějovice

Received November 11, 1988

Abstract

Scholz T., V. Špeta, J. Zajiček: *Life History of the Tapeworm Khawia sinensis Hsü, 1935, a Carp Parasite in the Pond Dražský Skaličany near Blatná, Czechoslovakia*. Acta vet. Brno, 59, 1990: 51—63.

The life cycle of the tapeworm *Khawia sinensis* was studied on the basis of examination of 280 stock carp (*Cyprinus carpio* — K 1—2) and 9 671 water oligochaetes of the families *Tubificidae* and *Naididae* from the pond Dražský Skaličany near Blatná from May 1987 to July 1988. The results showed the presence of the parasite in the pond throughout the year; the highest infestation of the carp was observed in late spring (May) and was followed by subsequent gradual departure particularly of gravid *K. sinensis* from the hosts at the end of June and at the beginning of July. Reinfestation of the fish began in mid July. *K. sinensis* with eggs were found throughout the observation period. After dehelminthization the number of infested carp decreased but rose again within a month in consequence of reinfections. The intermediate host of *K. sinensis* in Czechoslovakia was ascertained for the first time under natural conditions. In the locality under study it was *Tubifex tubifex* (probably the exclusive intermediate host of *K. sinensis* there) which is not the dominant species in the pond compared with members of the genus *Limnodrilus*. *K. sinensis* larval stages can survive in intermediate hosts over winter when the pond is drained and its bottom is exposed to frost. Disinfection of the bottom with quicklime produced a considerable decrease in the incidence of *T. tubifex*, but a small proportion of *K. sinensis* larvae survived in these intermediate hosts and became the source of infection for the new stock in spring 1988.

Tapeworm Khawia sinensis, carp, tubificids, life history, seasonal dynamics of incidence and maturation

The tapeworm *Khawia sinensis* Hsü, 1935 (*Cestoda: Caryophyllidea*), a carp parasite, has been spreading considerably in many ponds over a large area of Czechoslovakia during the last decade. A similar situation exists in a number of other countries where this originally non-European tapeworm species has become quite common. As the disease produced by *K. sinensis* has a major economic effect and may even result in death loss in carp (Kulakovskaya 1963, Shcherban 1965, Prouza and Tesarčík 1977 a. o.) this parasite has received considerable attention (Kulakovskaya and Krotas 1961, Kulakovskaya et al. 1965, Sapozhnikov 1970, 1971, 1972, Lozinska-Gabska 1981 a. o.). Most studies along this line recorded the incidence of *K. sinensis* in new localities and were focussed mainly on the possibilities of prophylaxis. Therefore some aspects of the biology and epizootiology of this tapeworm of major economic importance still remain undisclosed. No data at all are available on the biology of *K. sinensis* in Czechoslovak ponds because previous studies in this country by Tesarčík and Prouza (1977), Prouza and Tesarčík (1977) and Prouza (1982) were either concerned with the therapy of infected carp or were based on the results of mainly Soviet investigators.

For our study we chose the pond Dražský Skaličany because of the possibility of long-term collection of fish samples and because the infestation of carp with *K. sinensis* in this pond was rather high at the beginning of our observations. Thanks to the understanding of the personnel of the respective branch plant dehelminthization of the fish was carried out as late as one month before fishing. In the aforementioned pond we studied the occurrence of *K. sinensis* both in definitive hosts (carp) and in potential intermediate hosts — water oligochaets of the families *Tubificidae* and *Naididae*.

Materials and Methods

The pond Dražský Skaličany in which our investigations were conducted lies 437 metres above sea level about 3 kilometres north-east of Blatná (catchment area of the river Lomnice). Its area is 6.1 hectares and its maximum depth is 2 metres. At the time of our research the stock consisted of stock carp (35 000 K₁) originating from a fingerling pond, Dalina near Blatná. The fish were caught by means of cast nets, mostly after the fish were fed. In 1987 carp samples were obtained at approximately 2-week intervals from mid May to mid November (see Table 1). A total of 193 carp were examined. In October 1987 (23 Oct.) dehelminthization was carried out with Taenifugin carp in doses recommended by the manufacturer. In February 1988 the pond bottom was disinfected with quicklime in doses of 3 000 and 7 500 kg. In 1988 three further fish samples were taken: 30 carp were obtained upon fishing a fingerling pond, Stárka, the stock of which was transferred to the pond Dražský Skaličany and a total of 57 carp were obtained for examination from the pond Dražský Skaličany on two further occasions. The objective of these collections was to obtain information on the occurrence of *K. sinensis* in the locality after the pond was drained and disinfected and a new stock was planted.

The catch was transported alive to the Institute of Parasitology Czechoslovak Academy of Sciences, České Budějovice, and dissected there mostly the same day or the next day at the latest. The location of *K. sinensis* in the gut was recorded and the parasites were then removed from the gut and transferred to water. After relaxation in a refrigerator they were fixed with 4 % formalin under pressure. For assessment of their sexual maturity the majority of *K. sinensis* recovered (281 specimens) were stained with Schuberg's carmine, dehydrated with increasing concentrations of alcohol, cleared with carbolxylol and mounted in Canada balsam. They were divided into the following four groups: Group I (juvenile tapeworms) — gonads, except genital primordium, not developed; Group II (maturing tapeworms) — gonads in the process of development; Group III (mature tapeworms) — gonads developed, without eggs; Group IV (gravid tapeworms) — eggs in uterus. In each fish sample the per cent proportions of *K. sinensis* in the four groups were calculated and seasonal dynamics of the maturation of the parasite was assessed. To obtain information on the location of the parasite in the gut of hosts and its seasonal changes the gut was divided into 4 parts: anterior part down to the first intestinal loop, henceforward referred to here as "widened gut", and the anterior, middle and posterior thirds of the remaining portion of the gut. Also in this case the per cent proportions of *K. sinensis* found in the aforementioned parts of the gut were calculated in each evaluated fish sample.

The degree of infestation of the fish was characterized using the following terms (Margolis et al. 1982): prevalence (per cents hosts infected out of total number of fish examined in the sample), mean intensity of infection (mean number of parasites per infected fish), minimal and maximal intensity of infection (the lowest and the highest number of parasites in a host).

Together with the fish, mud samples containing oligochaets were taken from the pond to find intermediate hosts of *K. sinensis*. The mud was obtained from the bottom with an Eckman-Birg grab over an area of 225 sq. cm. The samples were taken from depths of 180 to 200 cm at the site where the mud layer was highest (about 25 metres distant from the outlet). The number of mud collections during the observation period varied (mostly 5 collections in 1987 and 10 collections in 1988). The mud obtained was sifted through 0.50 to 0.75 mm mesh-nets directly on the spot and then examined for the presence of tubificids and naids with a microscope in the laboratory. Species of the genus *Limnodrilus* were determined only in adult specimens. The determination was carried out according to Hrabě (1981).

Results

Incidence of *K. sinensis* in the Definitive Host

In 78 out of the 193 carp examined in 1987 a total of 303 *K. sinensis* were found (prevalence, 40.4 %; mean intensity, 3.9). Values for the intensity of infection ranged from 1 to 36 parasites. A survey of the infestation of carp in 1987 together with the results of examination of three fish samples obtained in 1988 is shown in Table 1.

Table 1

Survey of carp (*Cyprinus carpio* - K_{1-2}) examined from the pond Dražský Skaličany and their infestation with the tapeworm *Khawia sinensis*

Date	Water temp. (°C)	No. of carp		Prevalence (%)	No. of tapeworms	Mean intensity (min. - max.)
		examined	infected			
1987						
13. 5.	15	1	1	—	7	—
26. 5.	16	8	5	—	56	11 (1-32)
17. 6.	17	15	6	40	16	3 (1-6)
29. 6.	23	18	0	—	—	—
16. 7.	26	16	8	50	70	9 (1-36)
30. 7.	18	15	8	53	17	2 (1-4)
11. 8.	17	16	8	50	36	5 (1-13)
25. 8.	22	16	9	56	32	4 (1-9)
8. 9.	17	14	8	57	22	3 (1-5)
22. 9.	20	18	13	72	26	2 (1-5)
7. 10.	14	5	2	—	3	— (1-2)
20. 10.	11	16	5	31	8	2 (1-3)
2. 11.	7	15	1	7	4	— (4)
16. 11.	3	20	4	20	6	2 (1-2)
Total	—	193	78	40	303	3,9 (1-36)
1988						
12. 4. *)	10	30	5	17	6	1 (1-2)
14. 6.	19	26	10	38	21	2 (1-4)
1. 7.	20	31	4	13	14	4 (1-9)

*) Carp from the fingerling pond Stárka before their release into the pond Dražský Skaličany

Food of Carp Examined

With the exception of two fish of 25 August 1987 the gut of all carp was filled with food. The gut contents consisted of feed, mud with benthos residues, mainly chironomid larvae or corixids, plankton crustaceans, particularly *Cladocera*, and in autumn also *Copepoda*, paste-like chyme or plant residues. Besides the food that was found in a large proportion of fish examined from mid June to the beginning of November a predominance of plankton crustaceans was detected in 1987 in the food of carp caught in spring, whereas benthos animal residues more or less prevailed in summer and autumn. Mud with benthos residues was found in the gut contents of carp most frequently in mid July, in August and the end of September. On the whole, benthos residues were found in the gut of 72 carp. i. e. in 37 % of the fish. *Tubificidae* were found only in the gut contents of a fish examined at the beginning of October. Examination of its gut contents detected about 50 specimens of the genus *Limnodrilus* (*L. helveticus*, *L. hoffmeisteri*, *L. claparedeanus*), most of which were still alive.

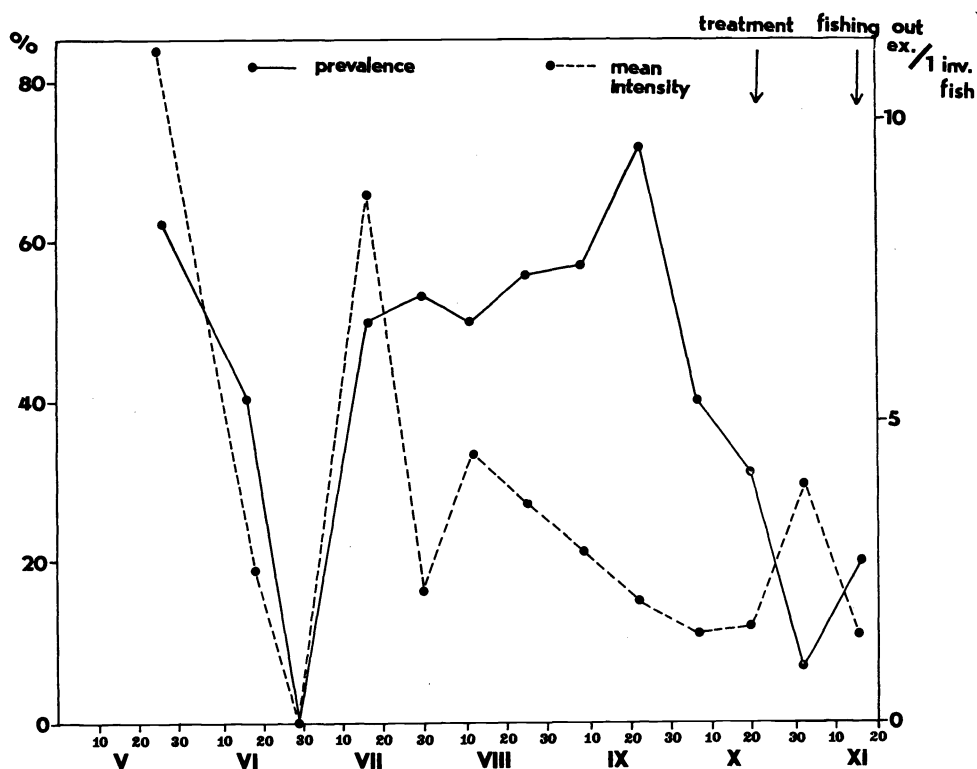


Fig. 1. Seasonal dynamics in the incidence of *Khawia sinensis* in stock carp (*Cyprinus carpio* — K₁₋₂) from the pond Dražský Skaličany near Blatná in 1987

Seasonal Dynamics of the Incidence of *K. sinensis*

Data on seasonal changes in the infestation of carp from the pond Dražský Skaličany in 1987 are shown in Table 1 and Fig. 1. In 1988 *K. sinensis* were found in all three fish samples (Table 1).

Seasonal Dynamics of *K. sinensis* Maturation

To assess the seasonal dynamics of *K. sinensis* maturation examined in 1987 a total of 281 *K. sinensis* were evaluated. Of these, 118 (42 %) specimens were juvenile tapeworms (Group I), 68 (24 %) were maturing tapeworms (Group II), 33 (12 %) were mature tapeworms (Group III) and 62 (22 %) were gravid tapeworms (Group IV). Per cent contributions of the four groups to the fish samples obtained during the period under study are shown in Fig. 2.

In the carp examined in 1988 all four groups were represented and the respective counts were as follows: 12 April (pond Stárka) — out of 6 *K. sinensis* recovered 5 were mature and 1 was gravid; 14 June (pond Dražský Skaličany) — out of 8 *K. sinensis* 6 were juvenile, 1 was maturing and 1 was gravid; 1 July (pond Dražský Skaličany) — out of 14 *K. sinensis* 2 were maturing, 4 were mature and 8 were gravid.

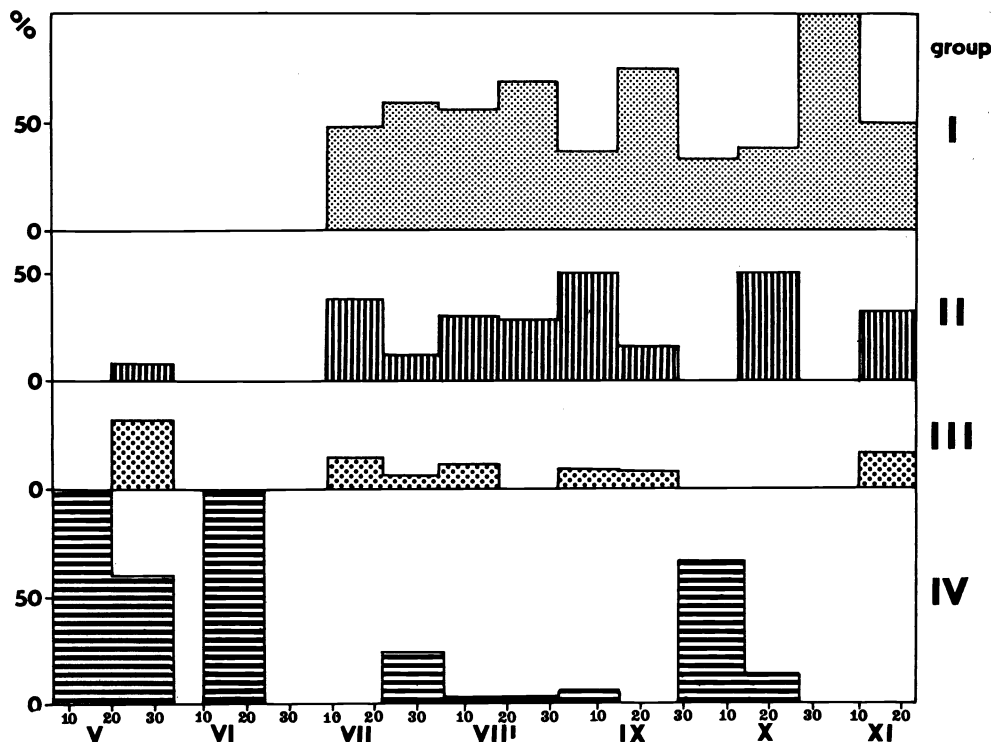


Fig. 2. Seasonal dynamics in the maturation of *Khawia sinensis* in stock carp (*Cyprinus carpio* — K_{1-2}) from the pond Dražský Skaličany near Blatná in 1987 (for division of *K. sinensis* into groups see Materials and Methods)

Location of *K. sinensis* in the Gut of Hosts

The parasite was found in all parts of the gut of carp but its distribution was uneven: 222 (73 %) *K. sinensis* were found in the "widened gut", particularly in its posterior portion before the first intestinal loop, 63 (21 %) *K. sinensis* in the anterior third, 13 (4 %) in the middle third and 5 (2 %) in the posterior third of the remaining part of the gut. Seasonal changes in the location of *K. sinensis* in the individual parts of the gut are shown in Fig. 3.

Incidence of *K. sinensis* in the Intermediate Host

A total of 9 671 oligochaetopods of the families *Tubificidae* and *Naididae* from 27 collections were examined for the possible presence of *K. sinensis* larval stages between May 1987 and June 1988. A survey of the results is presented in Table 2. *K. sinensis* larvae were found only in tubificids of the species *Tubifex tubifex* (Müll.). A survey of infestation of these tubificids together with the dimensions and location of *K. sinensis* larvae is shown in Table 3. The degree of their development as recorded during the period under study was as follows: the smallest larvae were found at the beginning of the sampling program (May and June 1987) and

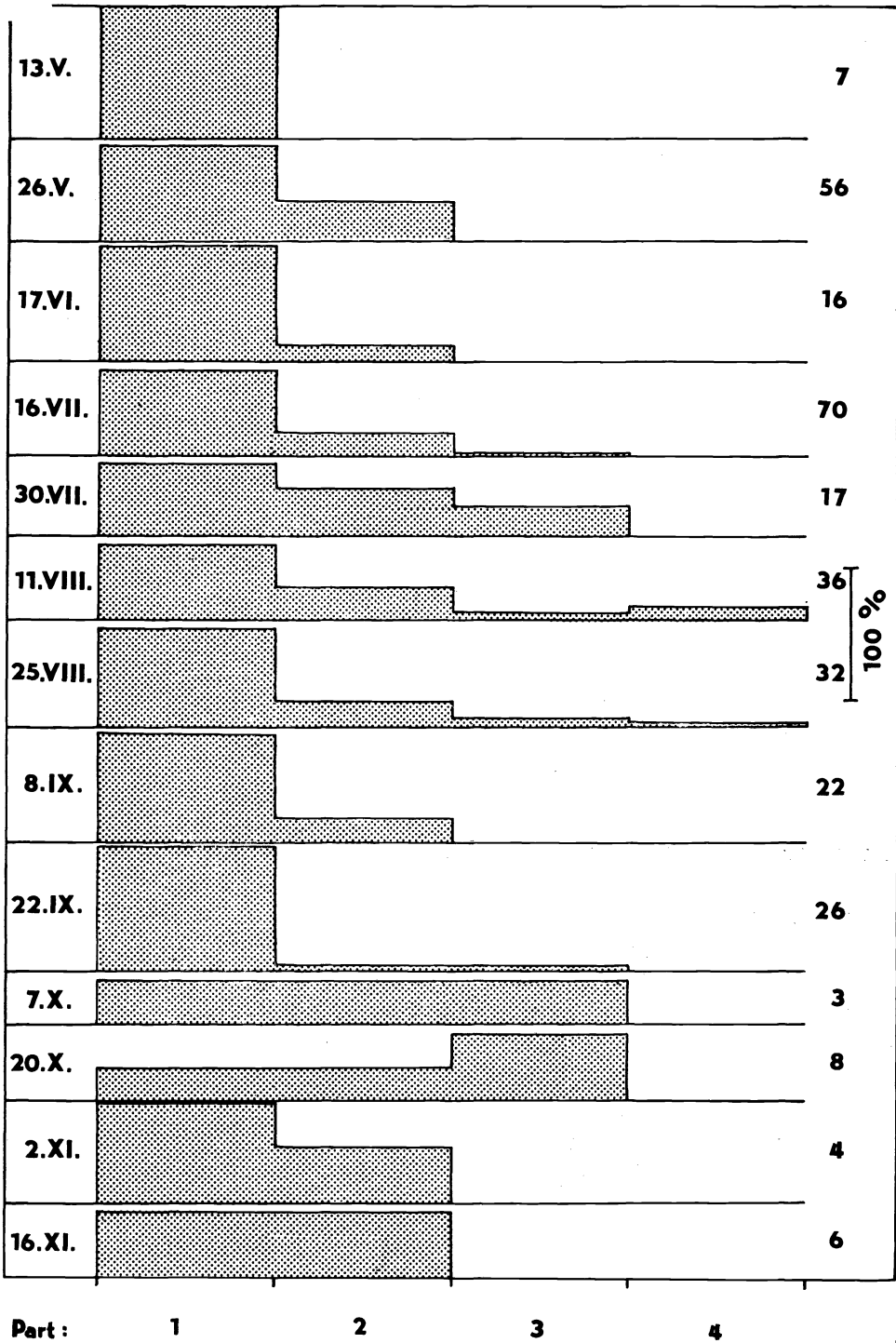


Table 2
Survey of oligochaets examined from the pond Dražský Skaličany

Date	Tubificidae				Total	Naididae		Total
	1*)	2	3	4		5	6	
1987								
13. 5.	5	1	6	31	43	—	—	—
26. 5.	17	1	7	27	52	—	—	—
17. 6.	13	—	9	30	52	—	—	—
29. 6.	10	—	4	57	71	—	—	—
16. 7.	4	—	19	26	49	—	—	—
30. 7.	7	—	5	14	26	—	—	—
11. 8.	20	1	2	102	125	2	—	2
25. 8.	38	—	18	268	324	—	—	—
8. 9.	52	—	10	407	469	—	—	—
22. 9.	95	2	6	474	577	—	—	—
7. 10.	101	1	8	364	474	1	—	1
20. 10.	117	1	5	460	583	86	60	146
2. 11.	97	—	21	399	517	3	—	3
16. 11. ¹⁾	6	—	13	63	82	—	—	—
8. 12.	13	1	87	314	415	—	—	—
1988								
7. 1.	62	1	423	764	1 250	—	—	—
19. 1.	19	—	193	416	628	—	—	—
2. 2.	23	1	204	281	509	—	—	—
16. 2. ²⁾	41	—	132	280	453	—	—	—
1. 3.	2	—	27	117	146	—	—	—
14. 3.	11	—	76	281	368	—	—	—
29. 3.	84	—	140	575	799	—	—	—
12. 4. ³⁾	1	—	105	113	219	—	—	—
26. 4.	11	—	130	340	481	—	—	—
10. 5.	—	—	47	203	250	—	—	—
24. 5.	5	2	57	236	300	—	—	—
14. 6.	4	—	28	225	257	—	—	—
Total	858	12	1 782	6 867	9 519	92	60	152

Explanations: *) 1 — *Tubifex tubifex*, 2 — *Limnodrilus udekemianus*, 3 — adult *Limnodrilus* spp., 4 — juvenile *Limnodrilus* spp., 5 — *Dero* spp., 6 — *Nais pseudoobtusata*; ¹⁾ — fishing out, ²⁾ — bottom liming, ³⁾ — plantation of new stock carp.

infective proceroids were first recovered in July. After the pond bottom was disinfected with quicklime in mid February no *K. sinensis* larval stages, except 4 specimens at the end of March, were found till the end of the observation period (June 1988). In these samples, however, *T. tubifex* counts were very low (11 specimens at the highest).

Discussion

The results of observations on the incidence of *K. sinensis* in intermediate and definitive hosts from the pond Dražský Skaličany enable us to reconstruct the life history of this parasite in the pond under study in 1987. The high level of infestation of the carp in spring shortly after their transference from the fingerling pond Dalina was probably the result of their infection contracted in the fingerling pond in autumn of the previous year. After the carp were transferred to the pond Dražský Skaličany *K. sinensis* became sexually mature in spring and began to produce

Fig. 3. Seasonal changes in the location of *Khawia sinensis* in the gut of stock carp (*Cyprinus carpio* — K₁₋₂) from the pond Dražský Skaličany near Blatná in 1987. Portions of the gut: (1) "widened gut", (2) anterior third, (3) mid third, (4) posterior third of the remaining gut portion (see Materials and Methods)

Table 3
Survey of the infestation of *Tubifex tubifex* with *Khawia sinensis* larvae

Date	No. tubificids			No. of larvae ¹⁾	Mean intensity (min. - max.)	Location ²⁾	Dimensions of larvae (mm)
	exam-ined	infected	(%)				
1987							
13. 5.	5	0	—	—	—	—	—
26. 5.	17	1	6	2 (—)	2 (2)	13.-14. ³⁾	0.8-0.9 × 0.10-0.20
17. 6.	13	1	8	2 (—)	2 (2)	14.	0.1-1.3 × 0.04-0.16
29. 6.	10	1	10	2 (—)	2 (2)	9.-40.	0.2-0.5 × 0.04-0.06
16. 7.	4	3	—	10 (2)	3.3 (3-4)	9.-20.	0.5-3.4 × 0.07-0.37
30. 7.	7	2	—	7 (3)	3.5 (2-5)	9.-15.	Not measured ³⁾
11. 8.	20	1	5	2 (—)	2 (2)	11.-15.	0.8-1.4 × 0.16-0.23
25. 8.	38	9	24	26 (6)	2.9 (2-5)	10.-15.	0.2-7.8 × 0.06-0.43
8. 9.	52	5	10	9 (2)	1.8 (1-3)	11.-15.	0.5-2.2 × 0.17-0.25 ³⁾
22. 9.	95	5	5	14 (3)	2.8 (1-5)	9.-17.	0.3-2.5 × 0.07-0.46 ³⁾
7. 10.	101	5	5	15 (5)	3 (2-5)	9.-17.	0.7-2.0 × 0.14-0.40 ³⁾
20. 10.	117	7	6	20 (8)	3.3 (1-6)	8.-16.	1.0-1.6 × 0.14-0.20 ³⁾
2. 11.	97	3	3	13 (1)	4.3 (2-7)	8.-19.	0.2-2.2 × 0.06-0.57
16. 11.	6	2	—	4 (2)	2 (+-4)	8.-14.	Not measured ³⁾
8. 12.	13	2	15	4 (3)	2 (1-3)	8.-13.	2.6-3.0 × 0.35
1988							
7. 1.	62	10	16	32 (10)	3.2 (1-7)	7.-17.	0.2-3.5 × 0.05-0.67
19. 1.	19	2	11	6 (1)	3.0 (1-5)	9.-33.	0.9-2.6 × 0.26-0.46
2. 2.	23	4	17	11 (4)	3.7 (3-4)	9.-28.	0.2-0.4 × 0.04-0.06 ³⁾
16. 2.	41	6	15	15 (6)	2.5 (2-3)	8.-22.	2.2-3.0 × 0.46-0.55 ³⁾
1. 3.	2	0	—	—	—	—	—
14. 3.	11	0	—	—	—	—	—
29. 3.	84	2	2	4 (3)	2 (1-3)	8.-13.	Not measured ³⁾
12. 4.	1	0	—	—	—	—	—
26. 4.	11	0	—	—	—	—	—
10. 5.	0	—	—	—	—	—	—
24. 5.	5	0	—	—	—	—	—
14. 6.	4	0	—	—	—	—	—
Total	858	71	8.3	198 (59)	2.8 (1-7)	8.-40.	0.1-7.8 × 0.04-0.67

Explanations: 1) — No. of proceroids in brackets; 2) body segments of tubificids; 3) — proceroids used for experimental infection of fish (Scholz 1988)

eggs. This appears from the high proportion of gravid tapeworms in samples collected during this period.

In eggs released by *K. sinensis* in late spring and at the beginning of June oncospheres developed in the bottom of the pond within 3 to 4 weeks. After ingestion of these oncospheres-containing eggs by *Tubifex tubifex* infective proceroids developed in the intermediate hosts during a few (about 6 to 8) weeks, i. e. at the turn June-July. New infections of the carp with these proceroids occurred from the beginning of July to the autumn 1987. This appears from the fact that during this period tubificids were found to contain fully developed proceroids and juvenile tapeworms were first recovered from the gut of the carp. These young tapeworms originated presumably from a very recent infection, judging from our previously published data on the development of *K. sinensis* in the definitive host within 1 to 2 weeks of infection (Scholz 1988).

No juvenile *K. sinensis*, however, were recovered in spring and early summer 1987. Two explanations of this absence of young tapeworms can be offered: (1) The parasite was introduced in the pond Dražský Skaličany with the planting of the fish in spring 1987. Regular veterinary inspections had previously detected the incidence of *K. sinensis* in this pond for the last time in spring 1985. Upon transference of the fish from the fingerling pond Dalina in spring 1987, on the other hand, *K. sinensis* were recovered from 33 % of the carp examined at an intensity of 1 to 3 specimens. These facts together with the findings of gravid parasites shortly after the fish were planted (in May) and the absence of proceroids from

tubificids at this time support the afore-mentioned hypothesis. (2) Another possible explanation of the absence of juvenile tapeworms in late spring and in June might be the composition of carp food. In spring stock carp feed mainly, and occasionally even exclusively, on plankton and it is only in late spring that the fish begin gradually to consume benthos, i. e. also tubificids. This hypothesis is supported by the finding of a small number of carp (4 out of 42) with benthos residues in the gut upon examination in May and June and by the fact that the first findings of juvenile tapeworms in the fish from mid July were accompanied by an increased proportion of carp (11 out of 16 carp examined) having benthos residues in the gut. Also in the carp examined in summer and early autumn, i. e. at the time that juvenile tapeworm counts were high, the findings of benthos residues in the gut were very frequent. The solitary finding of tubificids in the gut can be accounted for by the fact that these oligochaets are decomposed in the fish gut very rapidly (within a few hours) and afterwards can be detected only under a microscope (Kennedy 1969). However, the presence of chironomid larvae and possibly the residues of other benthic animals provide indirect evidence for the consumption of tubificids because the contribution of tubificids to benthos in the pond Dražský Skaličany is high (the ratio of tubificids to chironomid larvae in the mud samples was 3.9 : 1).

The highest infestation of the carp was recorded in May, similarly to our previous observations on two-year-old fish from the pond Naděje near Lomnice nad Lužnicí (Scholz 1988). Likewise Sapozhnikov (1970) reported the highest infestation of stock carp in May and June. This investigator also found a marked decrease in the numbers of both infested fish and tapeworms in July, which is in keeping with our observations. Kulakovskaya (1963), on the other hand, reported that the incidence of *K. sinensis* in stock carp peaked in autumn. Presumably these differences reflect the differences in ecological conditions in different localities. Moreover, treatments such as supplementary feeding pond fertilization and liming, and fish dehelminthization exert major effects on the life cycle of the parasite in each locality.

At the end of June 1987 no *K. sinensis* were recovered from any of the fish examined. One of possible explanations, the hypothesis of a direct effect of increased water temperature on premature departure of tapeworms from the gut of hosts, is refuted by our findings of a total of 70 *K. sinensis* in 50 % of the carp from the pond Dražský Skaličany examined in mid July 1987, at which time the water temperature 30 cm below the level reached 26 °C. Also the findings of *K. sinensis* in the carp examined at the beginning of July and the results of an experiment with *K. sinensis* survival in fish at 21 °C to 22°C (Scholz 1988) provide further evidence against the afore-mentioned hypothesis. In our view, the departure of *K. sinensis* from fish in late spring is influenced by high water temperature only indirectly in that higher temperatures accelerate sexual development of the parasite culminating in egg production and subsequent departure of gravid tapeworms from the body of hosts. The sample of *K. sinensis* found in the carp in mid June consisted entirely of gravid tapeworms.

Before fishing out the pond Dražský Skaličany in 1987 the fish were dehelminthized prior to their transfer to a storage pond. In consequence, the infestation of the carp decreased but it was as early as one month after the medication that the parasite was found in the gut of 20 % of the fish examined. This suggests that the fish may have become reingested soon after their dehelminthization. This hypothesis is fully supported by the findings of juvenile *K. sinensis* in November.

The afore-mentioned reinfections are made possible by the presence of infective *K. sinensis* procercoids in tubificids at the bottom of the pond, a view confirmed also by our observations of the incidence of *K. sinensis* larval stages in the intermediate hosts.

Our examination of water oligochaets from the bottom of the pond under study revealed the parasite only in tubificids of the species *Tubifex tubifex*. The identity of these larvae was confirmed by successful experimental infection of carp (Scholz 1988). Our attempts to detect *K. sinensis* larvae in members of the genus *Limnodrilus* yielded negative results in spite of the large number (8 661) of the specimens examined. Likewise Ilyushina (1987) examining tubificids from Byelorussian ponds found *K. sinensis* larval stages only in *T. tubifex* but not in the second dominant species, *Limnodrilus hoffmeisteri*. In her study, however, *T. tubifex* was the most frequently found species, whereas in the pond Dražský Skaličany *T. tubifex* is relatively rare. Thus our results are at variance with the conclusions of Kuchinská (1972) according to whom the intermediate host of *K. sinensis* is generally one of the dominant tubificid species in the respective locality.

T. tubifex has been described as a suitable intermediate host of *K. sinensis* under both experimental and natural conditions (Kulakovskaya 1963, Sapozhnikov 1972, Demshin and Dvoryadkin 1980). Of interest is the absence of *K. sinensis* larvae from *L. udekemianus* and *L. hoffmeisteri* in the pond Dražský Skaličany considering that the two species have been reported as experimental intermediate hosts of *K. sinensis* (Kulakovskaya 1963). In the present study, however, only very few specimens of *L. udekemianus* were examined. Considering this fact and the results of our previous experiments (Scholz 1988) where this species appeared to be a suitable intermediate host of *K. sinensis* its possible, though presumably only minor, role in the circulation of *K. sinensis* in the locality under study cannot be entirely excluded. As to species *Limnodrilus* (*L. hoffmeisteri*, *L. helveticus* and *L. clapardeanus*), however, the numbers of the specimens examined in our study were sufficient to allow us to exclude them, with reasonable probability, as intermediate hosts of *K. sinensis* in the pond Dražský Skaličany. Moreover, neither of these species became infected in our previous attempts at experimental infection with *K. sinensis* oncospheres (Scholz 1988). However, the resolution of the question of the species specificity of *K. sinensis* to the species of intermediate host in our conditions requires besides experiments further observations on larval stages from the field. In the present study tubificids of the species *T. tubifex* and members of the genus *Limnodrilus* were found throughout the observation period (from May 1987 to June 1988), i. e., also in mud samples collected from the bottom of the pond Dražský Skaličany after it was drained, i. e., from November 1987 to mid February 1988. Whereas the number of tubificids of the genus *Limnodrilus* was large after the pond was drained, the number of *T. tubifex* specimens showed a distinct decrease during this period. However, the percentage of infected *T. tubifex* as well as the number of *K. sinensis* larvae including infective procercoids during the afore mentioned period were considerable (11 to 17 %; 68 larvae from 5 collections). Our findings therefore confirm the hypothesis of Kulakovskaya et al. (1955) that *K. sinensis* larval stages can overwinter in tubificids even in mud at the bottom of drained ponds.

The liming of the pond Dražský Skaličany with quicklime in mid February 1988 had a very marked effect: all mud samples collected from the bottom of the pond contained lime residues and remnants of dead chironomid and tubificid larvae till the end of spring. In spite of their survival in deeper layers of the bottom

chironomid larvae and particularly tubificid larvae of the species *T. tubifex* decreased markedly in number during this period. It is primarily this considerable decrease in *T. tubifex* numbers in the samples that can account for the fact that except 4 *K. sinensis* larvae found in 2 tubificids at the end of March no other larvae of the parasite were recovered from the intermediate hosts. The aforementioned solitary finding of *K. sinensis* larvae originated from a collection containing 82 *T. tubifex*, whereas in the other samples collected from February to June the numbers of *T. tubifex* did not exceed 11 specimens. In spite of the marked decrease in intermediate hosts after the pond bottom was limed at least a small of *K. sinensis* larvae survived till the spring months and became the source of infection for new stock fish in the following year. This view is supported by the findings of juvenile *K. sinensis* in the carp examined in June and July 1988.

Although *K. sinensis* were found in all portions of the carp gut examined the pattern of their distribution was far from uniform. The predilection site of *K. sinensis* location was the proximal half of the gut, particularly its anterior "widened" portion. These observations are in keeping with our previous findings in most carp examined in other localities (Scholz 1988) and are also in harmony, except one report (Jara and Szerow 1981), with the bulk of published evidence (Murai and Monár 1975, Prouza 1981, a. o.).

Our results confirmed the important role of tubificids as intermediate hosts of *K. sinensis* and particularly as a source of infection for new stock fish because of their capability to overwinter at the bottom of drained ponds and survive, though to a limited extent, the disinfection of the bottom with quicklime. The findings reported here also showed the value of veterinary measures preventing the spread of *K. sinensis* to new localities.

Životní cyklus tasemnice *Khawia sinensis* Hsü, 1935, parazita kapra, v rybníce Dražský Skaličany u Blatné

Na základě vyšetření 280 kusů násady kapra (*Cyprinus carpio* — K_{1-2}) a 9 671 jedince vodních máloštětináčů (*Oligochaeta: Tubificidae* a *Naididae*) z rybníka Dražský Skaličany u Blatné byl od května 1987 do července 1988 sledován životní cyklus tasemnice *Khawia sinensis*. Výsledky ukázaly celoroční výskyt parazita s nejvyšším napadením kaprů na konci jara (květen) následovaný postupným odchodem především gravidních jedinců z hostitelů na konci června a začátku července. Od poloviny července docházelo k reinvazím ryb. Tasemnice s vajíčky byly nalézány po celou dobu sledování. Provedení dehelmintizace sice vedlo ke snížení počtu napadených kaprů, ale v důsledku reinvazí se jejich počet již během měsíce opět zvýšil. Poprvé v Československu byl v přírodních podmínkách zjištěn mezihostitel tasemnice *K. sinensis*. Na sledované lokalitě je jím (pravděpodobně výhradně) nitěnka *Tubifex tubifex*, která v rybníce nepředstavuje dominantní druh ve srovnání se zástupci rodu *Limnodrilus*. Larvální stadia parazita jsou schopna přežít v mezihostitelích i přes zimní období v době vypuštění rybníka a vymrznutí jeho dna. Provedení dezinfekce dna rybníka páleným vápnem po jeho napuštění sice velmi silně snížilo početnost nitěnek *T. tubifex*, ale malá část populace larev tasemnice v těchto mezihostitelích přežila a na jaře se stala zdrojem nákazy pro novou rybí obsádku.

**Жизненный цикл цестоды *Khawia sinensis* Hsü, 1935,
паразита карпа, в пруду Дrajски-Скаличани близ Блатной**

Исходя из исследования 280 посадочных карпов (*Cyprinus carpio* — K₁₋₂) и 9671 особи малоцетинковых червей (*Oligochaeta: Tubificidae* и *Naididae*) пруда Дrajански-Скаличани близ Блатной, с мая 1987 г. по июль 1988 г., проводили наблюдения жизненного цикла цестоды *Khawia sinensis*. Результаты выявили круглогодичное наличие паразита с максимальным заражением карпов в конце весны (май) с последующим постепенным выходом прежде всего осемененных особей из хозяев в конце июня и в начале июля. С половины июля наблюдалась реинвазия рыб. Цестод с яичками находили в течение всего наблюдаемого периода. Хотя и выполненная дегельментизация привела к понижению численности зараженных карпов, однако в результате реинвазии их численность вновь увеличилась уже в течение одного месяца. В Чехословакии был в естественных условиях впервые выявлен промежуточный хозяин цестоды *K. sinensis*. В исследуемом пруду упомянутым промежуточным хозяином является (по всей вероятности исключительно) *Tubifex tubifex*, не представляющий доминирующий вид по сравнению с представителями рода *Limnodrilus*. Личинки паразита в состоянии выживать в промежуточных хозяевах в течение зимнего периода, т. е. в период, когда выпускают воду из пруда и его дно вымерзает. Дезинфекция дна пруда женой известью после его наполнения водой хотя и существенно понизила численность *T. tubifex*, однако небольшая часть популяции личинок солитера в упомянутых промежуточных хозяевах выжила, став весной источником заражения нового рыбопосадочного материала.

Acknowledgements

We wish to thank Mr. Hajn, director of the branch plant of the State Fishery, and Mr. Kalousek, head of the centre Blatná, for allowing us to carry out the research. Thanks are also due to Mr. Nušl and Mr. Bláha for technical assistance.

References

- DEMSHIN, N. I. — DVORYADKIN, V. A.: *Biologiya Khawia sinensis* Hsü, 1935 (Caryophyllidea, Cestoda) — parazitа amurskogo sazana. *Gidrobiol. zhurn.*, **16**, 1980: 77—82.
- HRABĚ, S.: Vodní máloštětnatci (Oligochaeta) Československa. *Acta Univ. Carol.—Biol.*, Vol. 1979 (1—2), 1981: 1—167.
- ILYUSHINA, T. L.: Sezonnye izmeneniya czislennosti i zarazhennosti oligochet procerkoidami kaviy v prudakh razlicznogo biotekhnicheskogo naznacheniya. *Trudy GELAN*, **35**, 1987: 38—41.
- JARA, Z. — SZEROW, D.: Zmiany histopatologiczne i lokalizacja tasiemca *Khawia sinensis* w jelicie karpi (*Cyprinus carpio* L.). *Wiad. Parazytol.*, **27**, 1981: 693—703.
- KENNEDY, C. R.: Tubificid oligochaetes as food of coarse fish. *Proc. IV British Course Fish Conf.*, Liverpool Univ., 27—28th March, 1969.
- KULAKOVSKAYA, O. P.: K biologii i rasprostraneniu gvozdicznika *Khawia sinensis* Hsü, 1935. *Problemy parazitologii*, **2**, 1963: 200—205.
- KULAKOVSKAYA, O. P. — KROTAS, R. A.: O *Khawia sinensis* Hsü (Caryophyllaeidae, Cestoda) — parazite, zavezenom s Dalnego Vostoka v karpovye khozyaystva zapadnykh oblastey SSSR. *Doklady AN SSSR*, **137**, 1961: 1 253—1 255.
- KULAKOVSKAYA, O. P. — KUPCZINSKAYA, O. S. — YALINSKAYA, N. S.: Faktory opredelyayushchie zarazhennost ryb gvozdicznikami v rybnых khozyaystvach Lvovskoy oblasti. *Parazyty i parazitozы cheloveka i zhivotnykh*, Naukova Dumka, Kijev, 1965: 256—263.

- KUPCZINSKAYA, O. S.: Oligokhety zapadnykh oblastey Ukrainy i ikh rol v razvitii nekotorykh cestod. Tr. Vsesoyuz. Hidrobiol. obshcz., **17**, 1972: 125–133. (Cited after Iluyshina 1987).
- LOZINSKA-GABSKA, M.: Biologia i dzialane patogenne *Bothriocephalus gowkongensis* Yeh, 1955 i *Khawia sinensis* Hsü, 1935. Wiad. Parazytol., **27**, 1981: 685–694.
- MARGOLIS, L.—ESCH, G. W.—HOLMES, J. C.—KURIS, A. M.—SCHAD, G. A.: The use of ecological terms in parasitology (report of an HOC committee of the American Society of Parasitologist). J. Parasitol., **68**, 1982: 131–133
- MURAI, É.—MOLNÁR, K.: *Caryophyllaeus fimbriceps* Annenkova-Chlopina, 1919 and *Khawia sinensis* Hsü, 1935: Occurrence in Hungary and Morphology. Parasitol. Hung., **8**, 1975: 63–70.
- PROUZA, A.: Khawióza kaprů. Veterinářství, **32**, 1982: 470–472.
- PROUZA, A.—TESARČÍK, J.: Khawióza kaprů. Čs. rybníkářství, **1**, 1977: 11–13.
- SAPOZHNIKOV, G. I.: Sezonnaya i vzroastnaya dinamika kavióza karpov v Moskovskoy oblasti. Byul. VIGIS, **4**, 1970: 117–119.
- SAPOZHNIKOV, G. I.: Vliyanie kaviy na rost i upitannost karpov. Byul. VIGIS, **5**, 1971: 89–94.
- SAPOZHNIKOV, G. I.: K biologii vzbuditele kavióza karpov. Byul. VIGIS, **7**, 1972: 31–35.
- SCHOLZ, T.: Tasemnice ryb Československa a biologie některých druhů. PhDr. Thesis. Parazitologický ústav ČSAV, České Budějovice, 1988.
- SHCZERBAN, N. I.: Cestodozy karpov. Urozhay, Kijev, 1965, 80 pp.
- TESARČÍK, J.—PROUZA, A.: Úspěšná léčba kaviózy Taenifuginem. Bul. VÚRH Vodňany, **4**, 1977: 26–31.