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DYNAMICS OF *ANGUILLICOLA CRASSUS* (NEMATODA: DRACUNCULOIDEA) LARVAL INFECTION IN PARATENIC HOST FISHES OF LAKE BALATON, HUNGARY

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Anguillicola crassus, a nematode parasitizing the swimbladder of the European eel (*Anguilla anguilla*) caused substantial mortality among eels in Lake Balaton in the years 1991 and 1992. Parallel to a 3-year study of the infection dynamics of eels, *Anguillicola* larval infection of paratenic host fishes was also surveyed in the lake between 1991 and 1993. During that study, a total of 1,382 specimens of 22 paratenic host fish species were processed. The results showed that anguillicolosis had become a parasitosis widespread throughout the lake, and larval infection could be detected in practically all paratenic hosts examined. The prevalence and intensity values recorded in the paratenic hosts do not completely follow the dynamic change observed during the survey of eel infection. During the study of larval infection in paratenic hosts, only inter-species differences in the prevalence and intensity of infection could be found, rather than the expected course of infection spreading from the West to the East in both space and time. Marked differences existed between paratenic host species in the degree of host reaction to the larvae.

Key words: *Anguillicola crassus,* larval infection, paratenic hosts, dynamics, Lake Balaton

Since *Anguillicola crassus* was introduced into Europe at the end of the 1980's, numerous papers have dealt with its spread on the European continent (Paggi et al., 1982: Neumann, 1985; Sarti et al., 1985; Peters and Hartmann, 1986; Hartmann, 1987; Taraschewski et al., 1987; Dupont and Petter, 1988; Belpaire et al., 1989; Koops and Hartmann, 1989; Kennedy and Fitch, 1990; Køie, 1991; Székely et al., 1991; Moravec, 1992), its development (De Charleroy et al., 1990; Haenen and van Banning, 1991; Höglund and Thomas, 1992; Thomas and Ollevier, 1992), seasonal appearance (van Willigen and Dekker, 1989), pathogenic effect on the host (Boon et al., 1989; Haenen et al., 1989; Boon et al., 1990*a, b, c*; van Banning and Haenen, 1990; Molnár et al., 1991; Möller et al., 1991; Sprengel and Lüchtenberg, 1991; Höglund et al., 1992), mechanical injury caused in the swimbladder wall (Liewes and Schaminee-Main, 1987; Kamstra, 1990), and histopathological changes induced by it (Haenen et al., 1989; van Banning and

Haenen, 1990; Molnár et al., 1993). Several authors (Buchmann et al., 1991; Höglund and Pilström, 1994; Haenen, 1995) have suggested that eels develop immunological resistance against *A. crassus*. Although many of the above authors have referred to the dynamics of the parasite's occurrence, detailed data can be found only in the works of van Willigen and Dekker (1989), Thomas and Ollevier (1992), Höglund and Andersson (1993) and Molnár et al. (1994).

The paratenic hosts of *A. crassus* have been studied by Cannaerts (1989), De Charleroy et al. (1990), Haenen and van Banning (1990), Thomas and Ollevier (1992), Höglund and Thomas (1992), Székely (1994), and Pazooki and Székely (1994). Of the studies reported so far, however, only that of Thomas and Ollevier (1992) dealt with the seasonal dynamics of occurrence of larvae in paratenic hosts.

These data show that anguillicolosis is a parasitosis which has been studied in much detail. Still, the study reported here was justified by the mass mortality that *A. crassus* infection had caused among eel in Lake Balaton in 1991 and 1992: the epidemiological, ecological and environmental factors contributing to such a severe manifestation of the disease in that lake had to be explored. This was done by Molnár et al. (1994) who studied the dynamics of *A. crassus* infection in the eel population of Lake Balaton between 1991 and 1993. Parallel to that survey, the prevalence and intensity of *A. crassus* larval infection in paratenic hosts were also studied, and the results are reported in this paper.

Materials and methods

The studies were conducted throughout the period between September 1991 and November 1993. A total of 1,382 small fish belonging to 22 species (paratenic hosts) were collected, parallel to the eel catches, from three different habitats of the lake (Fig. 1): from the eutrophicated Western basin (Keszthely, Badacsony), from the less eutrophicated central basin (Udvardi, Tihany, Csopak), and from the oligotrophic Eastern region (Almádi, Kenese). All samples were taken from the littoral areas of the lake. The species distribution and the number of specimens of fish processed during the three-year period are shown in Table 1.

Some of the fish were collected with the help of the Balaton Limnological Research Institute of the Hungarian Academy of Sciences and the rest by ourselves, with the help of electrofishery equipment and a trawl-net. Although we always intended to catch fishes of the same species composition and specimen number, in the practice many times only low numbers of specimens could be collected, and the samples obtained were not always of the same species composition. The sample consisted of fish of a size suitable for eel food (max. 13 cm). Fish larger than that were thrown back into the water, with the exception of the pike, of which small specimens could not be caught; therefore, some 20 to 30 cm long pikes were also processed.

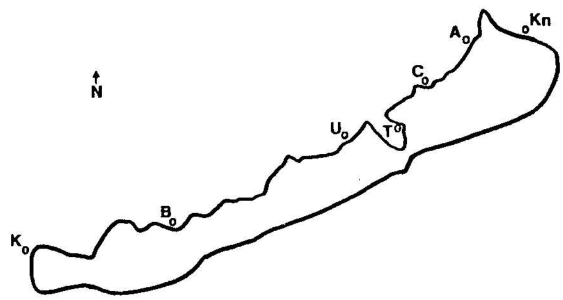


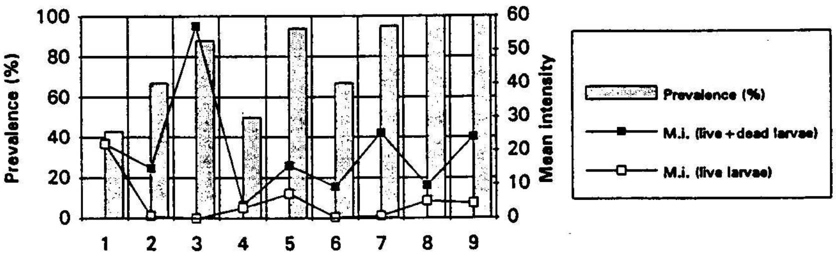
Fig. 1. Sampling places in Lake Balaton in the years 1991 through 1993 (Sampling places: Western basin: K = Keszthely, B = Badacsony; Central basin: U = Udvari, T = Tihany, C = Csopak; Eastern basin: A = Almádi, Kn = Kenese)

Table 1

Fish species examined and number of specimens processed in the period 1991–1993

	Fish species	Number of specimens examined
Bleak	*Alburnus alburnus*	378
Pumpkinseed	*Lepomis gibbosus*	198
River goby	*Neogobius fluviatilis*	169
Roach	*Rutilus rutilus*	160
White bream	*Blicca bjoerkna*	78
Rudd	*Scardinius erythrophthalmus*	68
Bitterling	*Rhodeus sericeus amarus*	65
Chinese rasbora	*Pseudorasbora parva*	63
Pike perch	*Stizostedion lucioperca*	58
Bream	*Abramis brama*	38
Ruffe	*Gymnocephalus cernua*	25
Gibel carp	*Carassius auratus gibelio*	22
Gudgeon	*Gobio albipinnatus*	17
European catfish	*Silurus glanis*	14
Pike	*Esox lucius*	8
Asp	*Aspius aspius*	7
Perch	*Perca fluviatilis*	5
Common carp	*Cyprinus carpio*	3
Tench	*Tinca tinca* .	3
Crucian carp	*Carassius carassius*	1
Rain bleak	*Leucaspius delineatus*	1
Brown bullhead	*Ictalurus nebulosus*	1
Total:	22 species	1,382

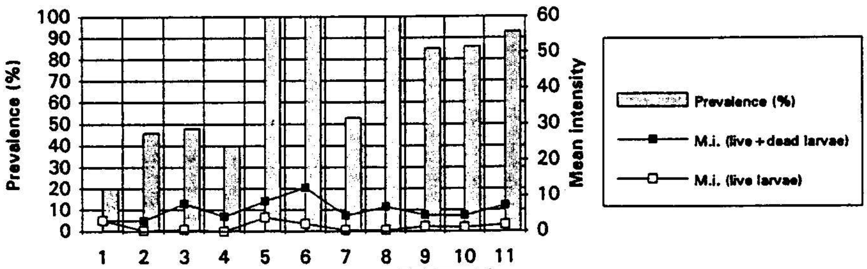
The fish were collected from the sampling places in the fishing period (from spring to autumn), possibly from every region in each season, and transported to the laboratory alive. The fish kept in our aquaria were processed within the shortest possible time in all cases; however, because of the time-consuming examinations the processing of a sample often took 1–2 weeks. The fish were killed, their abdominal cavity was opened, all internal organs were removed, and fresh squash preparations were made from them between two slides for light microscopic examination. Depending on the size of the internal organs, often as many as 10–15 squash preparations covering an entire slide were made. In order to recover all larvae present in the abdominal cavity the preparations were scanned by moving the microscopic field in a zigzag line. The dissection results were recorded: the records included the species and total body length of the fish and the number of live and dead larvae found in the abdominal cavity. The host reaction, if any, that developed around the larva in the paratenic host was also mentioned.



Samplings		Nr. of fish examined
1	17.09.1991.	7
2	11.03.1992.	27
3	21.04.1992.	8
4	24.06.1992.	2
5	25.08.1992.	17
6	19.04.1993.	15
7	09.06.1993	21
8	23.08.1993.	8
9	21.10.1993.	5
	Total examined	110

Chart 1.1. Prevalence and mean intensity of *Anguillicola crassus* larval infection of bleak (*Alburnus alburnus*) in the Western basin of Lake Balaton

On the basis of the records, the prevalence of infection by 3rd stage *A. crassus* larvae and the mean intensity of infection by live and dead larvae were calculated for the different fish species, and the obtained values were graphically illustrated using the Excel 4.0 programme. With the exception of one instance (Chart 10, which shows data collected in a 2-year period), the graphs (Charts 1–14) present data obtained during a 3-year period (1991–1993). In the case of some fish species of which a large number of specimens were examined (bleak, pumpkinseed, river goby, and roach) the dynamics of infection are illustrated separately for the three regions of the lake (Charts 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 4.1, 4.2 and 4.3), whereas the data obtained for those represented by a lower number of specimens are shown in a comprehensive chart each (Charts 5–12). Data of species represented in the sample only by a few specimens were summarized in two charts (Charts 13–14).



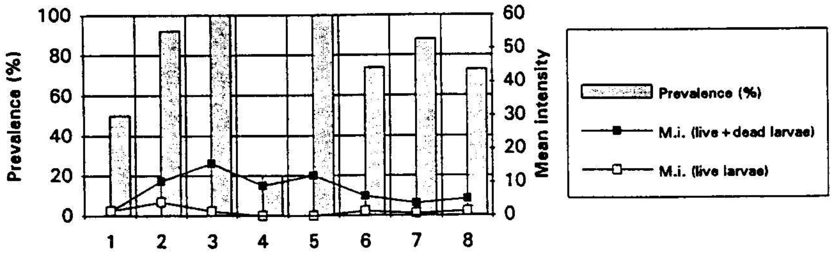
Samplings		Nr. of fish examined
1	05.09.1991. Tihany	10
2	31.03.1992. Csopak	11
3	31.03.1992. Tihany	21
4	20.05.1992. Tihany	15
5	03.08.1992. Tihany	9
6	10.08.1992. Csopak	9
7	06.04.1993. Csopak	28
8	27.05.1993. Tihany	3
9	05.07.1993. Tihany	13
10	09.08.1993. Csopak	22
11	12.10.1993. Tihany	29
	Total examined	170

Chart 1.2. Prevalence and mean intensity of *Anguillicola crassus* larval infection of bleak (*Alburnus alburnus*) in the Central basin of Lake Balaton

Results

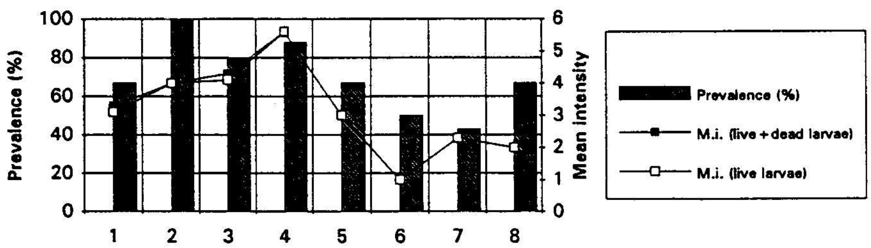
A surprisingly high proportion of the 1,382 fish collected from different areas of Lake Balaton and dissected in the laboratory was found to be infected by live or dead 3rd stage larvae of *A. crassus*.

For a higher degree of transparency and comparability, the results shown in the Charts were summarized in tables rather than having been evaluated in the text. Table 2 contains the data of infection (prevalence, intensity of infection by live larvae, intensity of infection by live and dead larvae combined, expressed as ranges of the mean calculated for each sampling) of the four fish species represented in the sample by the highest number of specimens (bleak, pumpkinseed, river goby and roach), separately for the three regions of Lake Balaton. Table 3 contains similar data on paratenic host fish species caught in a lower number of specimens (white bream, rudd, bitterling, Chinese rasbora, pike perch, bream, ruffe, gibel carp, European catfish, gudgeon, pike, asp, perch, common carp, tench, crucian carp, rain bleak, brown bullhead) for the entire area of the lake.



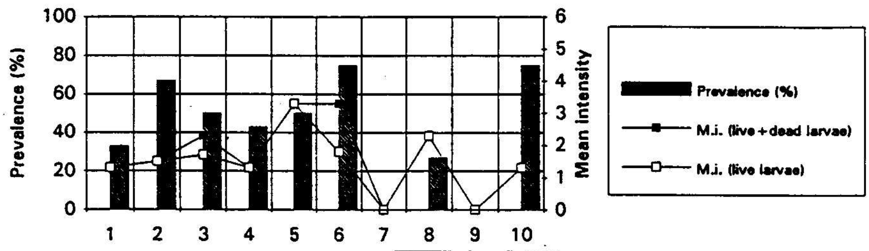
	Samplings	Nr. of fish examined
1	02.10.1991. Almádi	4
2	24.07.1992. Világos	12
3	09.09.1992. Szabadi	15
4	09.09.1992. Kenese	5
5	26.04.1993. Kenese	1
6	24.06.1993. Kenese	31
7	01.09.1993. Kenese	8
8	02.11.1993. Kenese	22
	Total examined	98

Chart 1.3. Prevalence and mean intensity of *Anguillicola crassus* larval infection of bleak (*Alburnus alburnus*) in the Eastern basin of Lake Balaton



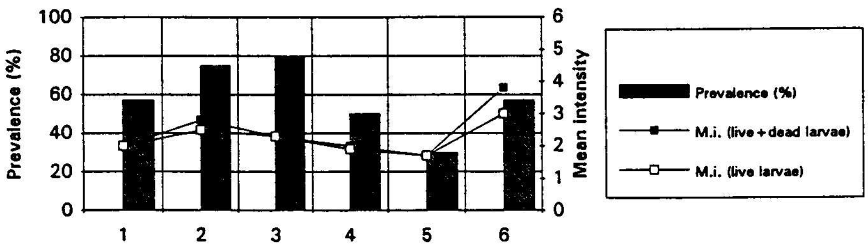
	Samplings	Nr. of fish examined
1	16.09.1991.Keszthely	21
2	11.03.1992. Keszthely	1
3	21.04.1992. Keszthely	10
4	24.06.1992. Keszthely	8
5	25.08.1992. Keszthely	3
6	19.04.1993. Keszthely	2
7	09.06.1993. Keszthely	7
8	21.10.1993. Keszthely	6
	Total examined	58

Chart 2.1. Prevalence and mean intensity of *Anguillicola crassus* larval infection of pumpkinseed (*Lepomis gibbosus*) in the Western basin of Lake Balaton



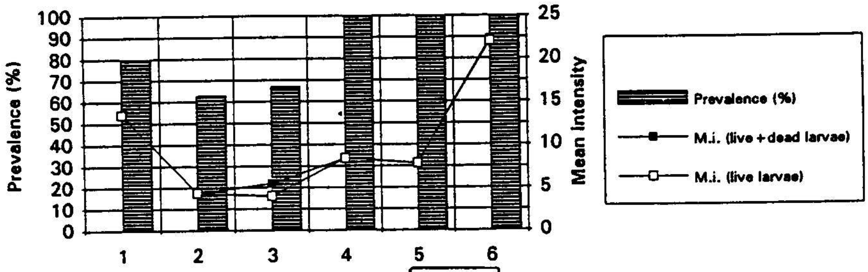
Samplings		Nr. of fish examined
1	05.09.1991. Tihany	9
2	07.11.1991. Csopak	3
3	31.03.1992. Csopak	6
4	20.05.1992. Tihany	14
5	03.08.1992. Tihany	6
6	10.08.1992. Csopak	8
7	06.04.1993. Csopak	1
8	27.05.1993. Tihany	11
9	09.08.1993. Csopak	3
10	12.10.1993. Tihany	4
	Total examined	65

Chart 2.2 Prevalence and mean intensity of *Anguillicola crassus* larval infection of pumpkinseed (*Lepomis gibbosus*) in the central basin of Lake Balaton



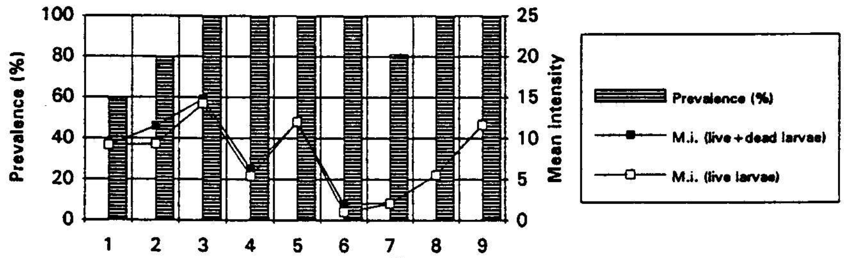
Samplings		Nr. of fish examined
1	02.10.1991. Almádi	7
2	09.09.1992. Kenese	20
3	26.04.1993. Kenese	15
4	24.06.1993. Kenese	16
5	01.09.1993. Kenese	10
6	02.11.1993. Kenese	7
	Total examined	75

Chart 2.3. Prevalence and mean intensity of *Anguillicola crassus* larval infection of pumpkinseed (*Lepomis gibbosus*) in the Eastern basin of Lake Balaton



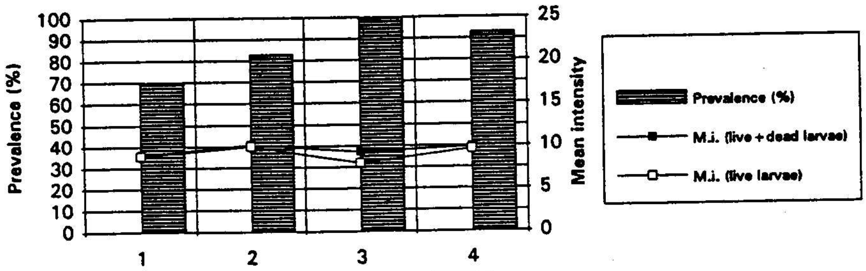
Samplings		Nr. of fish examined
1	17.09.1991.	5
2	24.10.1991.	8
3	21.04.1992.	3
4	25.08.1992.	8
5	09.06.1993.	4
6	23.08.1993.	21
	Total examined	49

Chart 3.1. Prevalence and mean intensity of *Anguillicola crassus* larval infection of river goby (*Neogobius fluviatilis*) in the Western basin of Lake Balaton



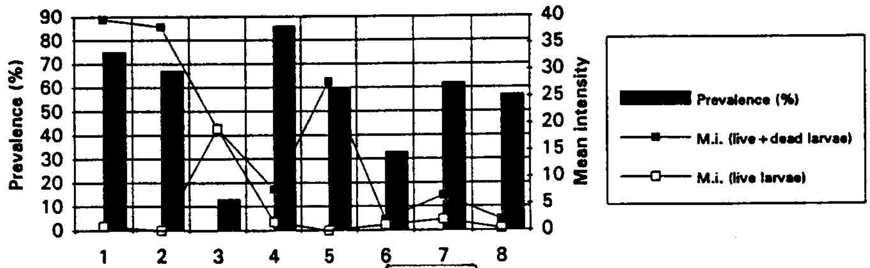
Samplings		Nr. of fish examined
1	05.09.1991. Tihany	10
2	07.11.1991. Csopak	5
3	20.05.1992. Tihany	10
4	03.08.1992. Tihany	9
5	10.08.1992. Csopak	1
6	27.05.1993. Tihany	1
7	05.07.1993. Tihany	21
8	09.08.1993. Csopak	8
9	12.10.1993. Tihany	18
	Total examined	83

Chart 3.2. Prevalence and mean intensity of *Anguillicola crassus* larval infection of river goby (*Neogobius fluviatilis*) in the central basin of Lake Balaton



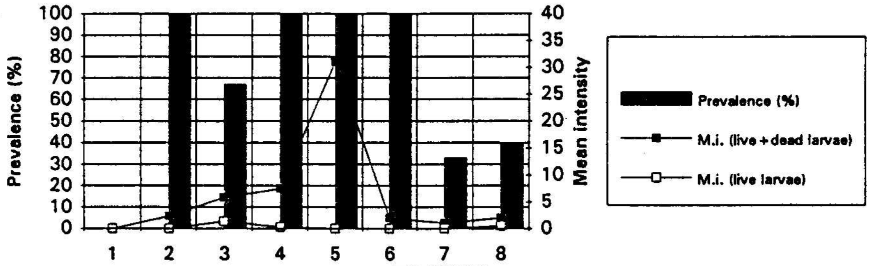
Samplings		Nr. of fish examined
1	02.10.1991. Almádi	10
2	09.09.1991. Szabadi	6
3	09.09.1992. Kenese	6
4	24.06.1993. Kenese	15
	Total examined	37

Chart 3.3. Prevalence and mean intensity of *Anguillicola crassus* larval infection of river goby (*Neogobius fluviatilis*) in the Eastern basin of Lake Balaton



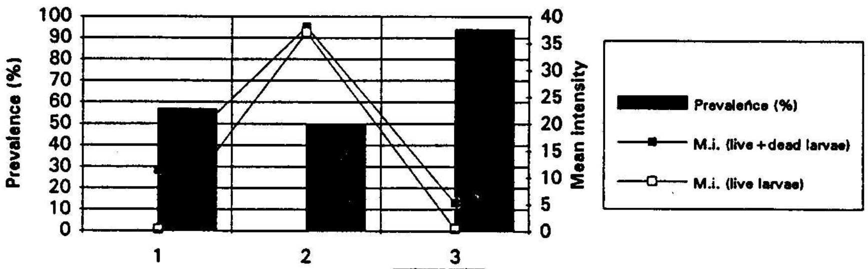
Samplings		Nr. of fish examined
1	16.09.1991. Keszthely	8
2	11.03.1992. Keszthely	15
3	24.06.1992. Keszthely	8
4	25.08.1992. Keszthely	21
5	19.04.1993. Keszthely	10
6	09.06.1993. Keszthely	3
7	23.08.1993. Keszthely	13
8	21.10.1993. Keszthely	7
	Total examined	85

Chart 4.1. Prevalence and mean intensity of *Anguillicola crassus* larval infection of roach (*Rutilus rutilus*) in the Western basin of Lake Balaton



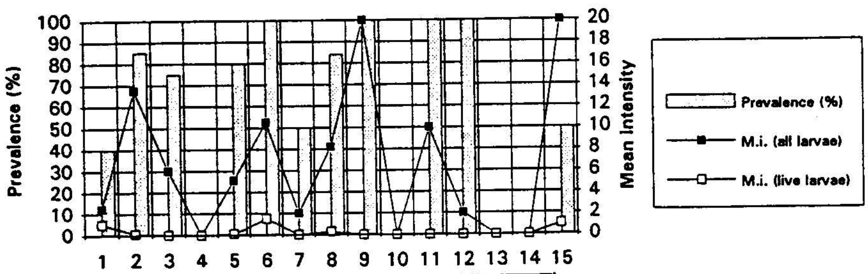
Samplings		Nr. of fish examined
1	05.09.1991. Tihany	4
2	20.05.1992. Tihany	3
3	03.08.1992. Tihany	9
4	10.08.1992. Csopak	5
5	06.04.1993. Csopak	4
6	27.05.1993. Tihany	1
7	05.07.1993. Tihany	3
8	09.08.1993. Csopak	20
	Total examined	49

Chart 4.2. Prevalence and mean intensity of *Anguillicola crassus* larval infection of roach (*Rutilus rutilus*) in the central basin of Lake Balaton



Samplings		Nr. of fish examined
1	09.09.1992. Kenese	7
2	24.06.1993. Kenese	2
3	01.09.1993. Kenese	17
	Total examined	26

Chart 4.3. Prevalence and mean intensity of *Anguillicola crassus* larval infection of roach (*Rutilus rutilus*) in the Eastern basin of Lake Balaton



	Samplings	Nr. of fish examined
1	17.09.1991. Keszthely	5
2	11.03.1992. Keszthely	13
3	21.04.1992. Keszthely	4
4	24.07.1992. Világos	1
5	03.08.1992. Tihany	10
6	10.08.1992. Csopak	11
7	25.08.1992. Keszthely	4
8	09.09.1992. Kenese	19
9	06.04.1993. Csopak	1
10	26.04.1993. Kenese	1
11	24.06.1993. Kenese	1
12	05.07.1993. Tihany	1
13	09.08.1993. Csopak	1
14	23.08.1993. Keszthely	2
15	01.09.1993. Kenese	4
	Total examined	78

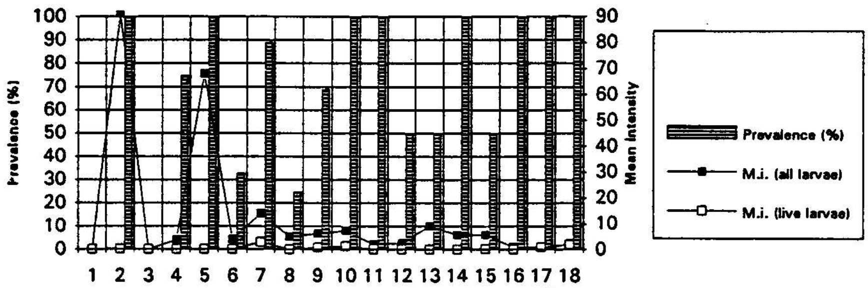
Chart 5. Prevalence and mean intensity of *Anguillicola crassus* larval infection of white bream (*Blicca bjoerkna*) in Lake Balaton

Discussion

The results presented here support the finding of Molnár et al. (1994), namely that at the time of the study anguillicolosis was a parasitosis widespread in the entire area of Lake Balaton and it caused infection not only in eels but also in practically all paratenic host fish species examined (in the form of larval infection). The prevalence and intensity of larval infection found in paratenic hosts do not completely follow the dynamic changes found by Molnár et al. (1994) during the study of eel infection. Thus, during the study of larval infection in paratenic hosts, only inter-species differences in the prevalence and primarily in the intensity of infection could be found, rather than the expected course of infection spreading in the three regions from the West towards the East in both space and time.

The biggest differences between paratenic host species occurred in the degree of host reaction to the larvae, which has already been reported by Székely (1994). As a consequence, in some species — first of all in cyprinids (Charts 1.1–1.3, 4.1–4.3, 5, 6, 7, 8 and 10) — the number of dead larvae as compared to that of live larvae was high, while in other species — primarily in percids and in the river goby (Charts 2.1–2.3, 3.1–3.3, 9, 11) live larvae were dominant as a result of the weak host reaction. Because of the weak host reaction, in one species, the pike perch (Chart 9) no dead larvae were found.

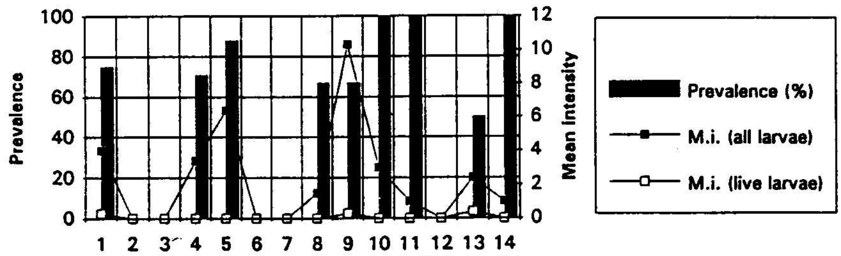
According to the assumption of Molnár et al. (1994), the parasite first appeared in the Western part of Lake Balaton. Its rapid propagation was potentiated by the high eel density that developed as a result of the eutrophication of that region. The large number of paratenic hosts (small fishes) living in the region and in other areas of the lake also contributed to the rapid spread of infection.



Samplings		Nr. of fish examined
1	05.09.1991. Tihany	1
2	24.10.1991. Keszthely	3
3	02.10.1991. Almádi	1
4	11.03.1992. Keszthely	4
5	21.04.1992. Keszthely	4
6	20.05.1992. Tihany	3
7	24.06.1992. Keszthely	9
8	03.08.1992. Tihany	4
9	10.08.1992. Csopak	13
10	09.09.1992. Kenese	3
11	06.04.1993. Csopak	1
12	19.04.1993. Keszthely	4
13	09.06.1993. Keszthely	6
14	05.07.1993. Keszthely	3
15	09.08.1993. Csopak	6
16	01.09.1993. Kenese	1
17	12.10.1993. Keszthely	1
18	02.11.1993. Kenese	1
	Total examined	68

Chart 6. Prevalence and mean intensity of *Anguillicola crassus* larval infection of rudd (*Scardinius erythrophthalmus*) in Lake Balaton

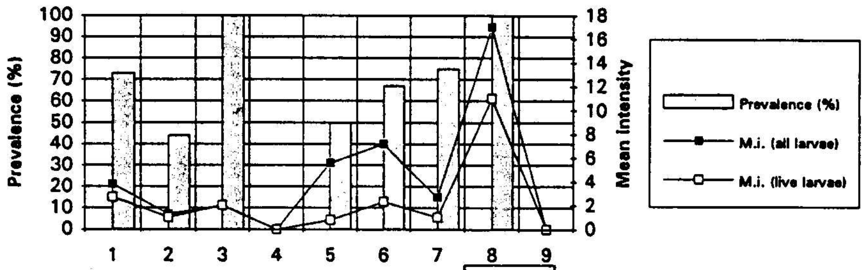
Molnár et al. (1994) found that larger eels of Lake Balaton were colonized by more helminths than those of smaller size. The dissimilar number of helminths found in eels of different size can partially be explained by the fact that smaller eels consume lower numbers of infected intermediate hosts (e.g. cyclops) or paratenic hosts (small fish). The number of helminths colonizing eels can be markedly influenced by the degree of host reaction developing in the paratenic hosts.



	Samplings	Nr. of fish examined
1	24.09.1991. Keszthely	4
2	02.10.1991. Almádi	3
3	07.11.1991. Csopak	1
4	11.03.1992. Keszthely	14
5	21.04.1992. Keszthely	8
6	20.05.1992. Tihany	1
7	24.06.1992. Keszthely	3
8	03.08.1992. Tihany	6
9	10.08.1992. Csopak	3
10	19.04.1993. Keszthely	1
11	05.07.1993. Tihany	1
12	09.08.1993. Csopak	3
13	01.09.1993. Kenese	16
14	21.10.1993. Keszthely	1
	Total examined	65

Chart 7. Prevalence and mean intensity of *Anguillicola crassus* larval infection of bitterling (*Rhodeus sericeus*) in Lake Balaton

A survey of the dynamics of infection during a 6-year period has already been conducted in The Netherlands as well (Haenen et al., 1994). In that study, however, the only paratenic host monitored was the smelt (*Osmerus eperlanus*), and exclusively the larvae occurring in the swimbladder were examined. Although the prevalence of infection of the smelt dropped below 40% after the first two years of the study and remained on that level thereafter, that set of data is not comparable with data from the 3-year study of larval infection of paratenic hosts from Lake Balaton, as the latter study involved an examination of the entire abdominal content of the fish. In addition, only a minority of larvae occurred in the swimbladder, while the majority were present in the principal predilection site, on the outer surface of the intestinal wall. The low mean intensity values (1.2–2.16) recorded in smelt by Haenen et al. (1994) also indicate that they found only part of the larvae occurring in a given fish specimen. In contrast to the present study, however, in some cases Haenen et al. (1994) detected also 4th stage larvae (L4), a stage which occurs exclusively in the swimbladder. Like in cyprinids of Lake Balaton, in some instances the death of larvae following encapsulation by the host organism was observed also in smelt.

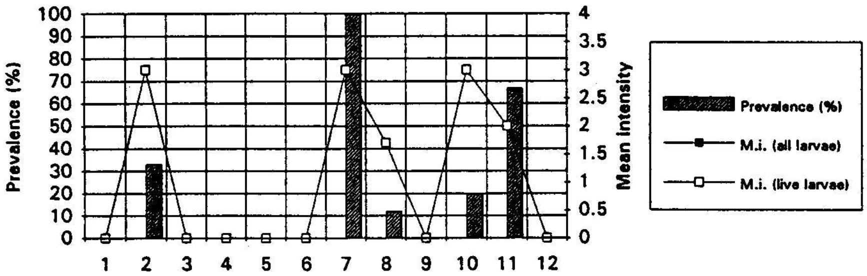


Samplings		Nr. of fish examined
1	16.09.1991. Keszthely	15
2	24.10.1991. Keszthely	9
3	02.10.1991. Almádi	2
4	07.11.1991. Csopak	1
5	11.03.1992. Keszthely	20
6	21.04.1992. Keszthely	9
7	24.06.1992. Keszthely	4
8	09.09.1992. Kenese	2
9	21.10.1993. Keszthely	1
	Total examined	63

Chart 8. Prevalence and mean intensity of *Anguillicola crassus* larval infection of Chinese rasbora (*Pseudorasbora parva*) in Lake Balaton

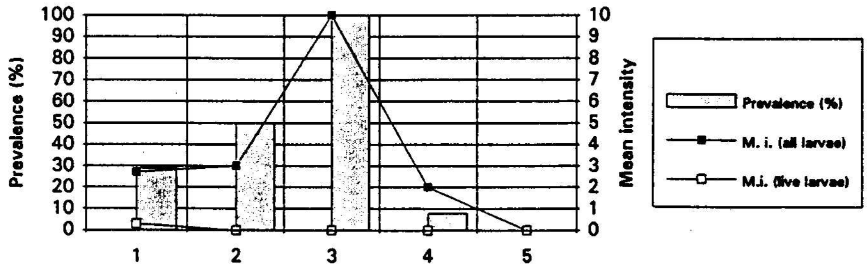
In an earlier study involving the examination of the swimbladder and the intestine, Haenen and van Banning (1990) found larvae exclusively in the swimbladder. Interestingly, 4th stage larvae occurred in the swimbladder of smelt, ruffe, perch and three-spined stickleback on several occasions, and in the ruffe, perch and three-spined stickleback even infection by pre-adult larval stages was recorded. In our 3-year study (which involved much higher numbers of species and specimens), L4 or pre-adult larvae could never be detected in paratenic hosts. The larvae detected always proved to be L3. In the same way, during their studies on fish from Lake Velence, a lake situated close to Lake Balaton, Pazooki and Székely (1994) could detect exclusively L3 in the paratenic hosts.

Certain Belgian (Thomas and Ollevier, 1992) and Dutch (Haenen, 1995) authors observed in several cases that *Anguillicola* larvae can develop and reach the L4 stage in some fish species other than the eel. These fish species, however, cannot be considered paratenic hosts, as larval development has taken place in them; nor can they be regarded as hosts as the helminths developing in them have failed to reach the imago stage. They can be designated "inadequate hosts". During this study, exclusively L3 were found in all fish examined; therefore, these species can consistently be regarded as paratenic hosts.



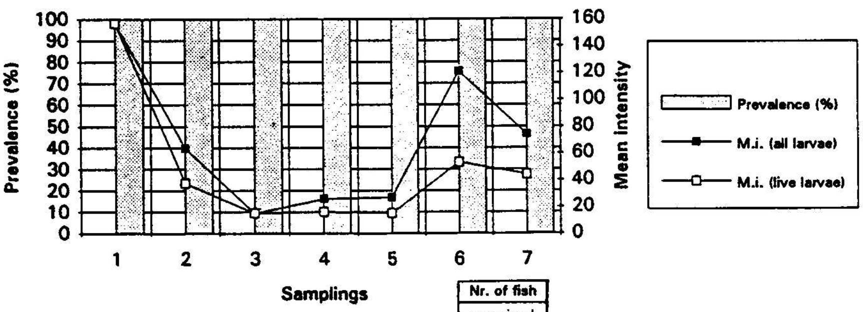
Samplings		Nr. of fish examined
1	05.09.1991. Tihany	1
2	07.11.1991. Csopak	3
3	24.06.1992. Keszthely	5
4	03.08.1992. Tihany	1
5	25.08.1992. Keszthely	4
6	09.09.1992. Kenese	4
7	19.04.1993. Keszthely	1
8	24.06.1993. Kenese	26
9	25.06.1993. Szabadi	4
10	05.07.1993. Tihany	5
11	23.08.1993. Keszthely	3
12	01.09.1993. Kenese	1
	Total examined	58

Chart 9. Prevalence and mean intensity of *Anguillicola crassus* larval infection of pike perch (*Stizostedion lucioperca*) in Lake Balaton



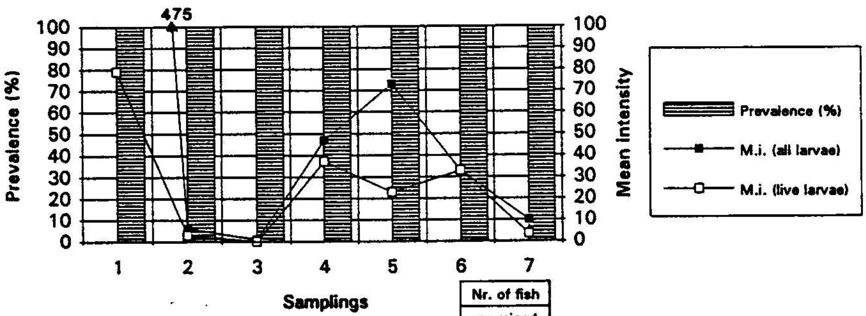
Samplings		Nr. of fish examined
1	11.03.1992. Keszthely	21
2	09.09.1992. Kenese	2
3	19.04.1993. Keszthely	1
4	23.08.1993. Keszthely	13
5	12.10.1993. Tihany	1
	Total examined	38

Chart 10. Prevalence and mean intensity of *Anguillicola crassus* larval infection of bream (*Abramis brama*) in Lake Balaton (1992–1993)



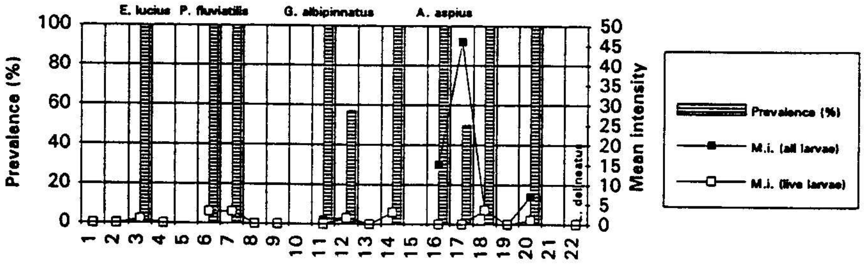
		Nr. of fish examined
1	24.10.1991. Keszthely	1
2	07.11.1991. Csopak	13
3	31.03.1992. Tihany	1
4	20.05.1992. Tihany	1
5	09.09.1992. Kenese	1
6	26.04.1993. Kenese	3
7	01.09.1993. Kenese	5
	Total examined	25

Chart 11. Prevalence and mean intensity of *Anguillicola crassus* larval infection of ruffe (*Gymnocephalus cernua*) in Lake Balaton



		Nr. of fish examined
1	16.09.1991. Keszthely	5
2	07.11.1991. Csopak	1
3	31.03.1992. Csopak	1
4	09.09.1992. Kenese	4
5	06.04.1993. Csopak	1
6	09.06.1993. Keszthely	1
7	01.09.1993. Kenese	2
	Total examined	15

Chart 12. Prevalence and mean intensity of *Anguillicola crassus* larval infection of catfishes (*Silurus glanis* and *Ictalurus nebulosus*) in Lake Balaton

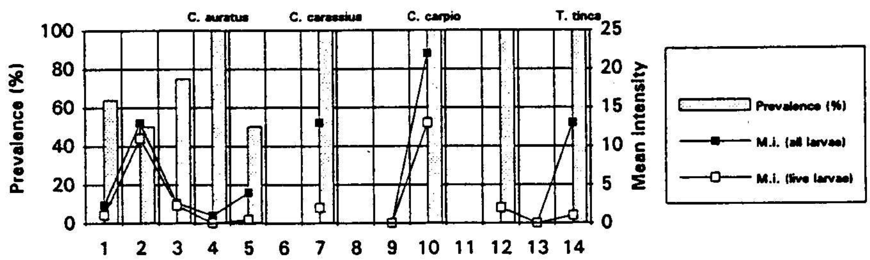


	Samplings	Nr. of fish
	Esox lucius	examined
1	07.11.1991. Csopak	4
2	03.08.1992. Tihany	2
3	10.08.1992. Csopak	1
4	05.07.1993. Tihany	1
	Total examined	8
	Perca fluviatilis	
6	17.10.1991. Keszthely	1
7	11.03.1992. Keszthely	1
8	21.04.1992. Keszthely	1
9	05.07.1993. Tihany	2
	Total examined	5
	Gobio albipinnatus	
11	17.09.1991. Keszthely	1
12	25.06.1993. Szabadi	14
13	05.07.1993. Tihany	1
14	01.09.1993. Kenese	1
	Total examined	17
	Aspius aspius	
16	11.03.1992. Keszthely	1
17	21.04.1992. Keszthely	2
18	24.06.1992. Keszthely	2
19	05.07.1993. Keszthely	1
20	21.10.1993. Keszthely	1
	Total examined	7
	Leucaspius delineatus	
22	11.03.1992. Keszthely	1

Chart 13. Prevalence and mean intensity of *Anguillicola crassus* larval infection in paratenic host fishes (*Esox lucius, Perca fluviatilis, Gobio albipinnatus, Aspius aspius, Leucaspius delineatus*) in Lake Balaton

Thomas and Ollevier (1992) studied the *Anguillicola* larval infection of paratenic host fish species in a Belgian channel over a one-year period. They found that in the warm period (from May to October) the prevalence of infection was in most species higher than in the cold season. From this fact they infer that fish contract the infection primarily in the summer. Although this hypothesis may seem logical, during our 3-year study of Lake Balaton fishes no seasonal fluctuation was found in the prevalence of infection.

The results of this study indicate that the L3 of *A. crassus* are extremely widespread in Lake Balaton, and most fish species of the lake serve as their paratenic hosts. The study also calls attention to the dissimilar nature of the host reaction in the different paratenic hosts. From the examinations the injury caused to the paratenic hosts by the pathological lesions observed cannot be assessed; at the same time, highly intensive infection of the European catfish may occasionally be of fatal outcome.



	Samplings	Nr. of fish
	Carassius auratus gibelio	examined
1	02.10.1991. Almádi	11
2	07.11.1991. Csopak	2
3	24.06.1992. Keszthely	4
4	09.09.1992. Szabadi	1
5	09.09.1992.Kenese	4
	Total examined	22
6	*Carassius carassius*	
7	21.10.1993. Keszthely	1
8	*Cyprinus carpio*	
9	21.04.1992. Keszthely	1
10	24.10.1991. Keszthely	2
	Total examined	3
11	*Tinca tinca*	
12	02.10. 1991. Almádi	1
13	07.11.1991. Csopak	1
14	24.06.1992. Keszthely	1
	Total examined	3

Chart 14. Prevalence and mean intensity of *Anguillicola crassus* larval infection of carps (*Carassius auratus, Carassius auratus gibelio, Cyprinus carpio, Tinca tinca*) in Lake Balaton

Table 2

***Anguillicola* larval infection of paratenic host fish species caught in a large number of specimens in the three regions of Lake Balaton between 1991 and 1993 (ranges of the means calculated for each sampling)**

Fish species	Number examined	Larvae recovered		
		prevalence, ranges	live larvae, ranges	all larvae, ranges
Western basin				
Alburnus alburnus	110	43–100	0–22	4–25.3
Lepomis gibbosus	58	43–100	1–5.6	1–5.6
Neogobius fluviatilis	49	63–100	4.0–22	5.5–22.3
Rutilus rutilus	85	13–86	0–19	2–39.5
Central basin				
Alburnus alburnus	170	20–100	0.2–3.9	3–12.3
Lepomis gibbosus	65	0–75	0–3.3	0–3.3
Neogobius fluviatilis	83	60–100	1–14.2	2–14.8
Rutilus rutilus	49	0–100	0–1.3	0–31
Eastern basin				
Alburnus alburnus	98	20–100	0–1.5	3.6–15.6
Lepomis gibbosus	75	30–80	1.7–3.0	1.7–3.8
Neogobius fluviatilis	37	70–100	8–9.6	9–10.2
Rutilus rutilus	26	50–94	0.3–37	5.2–38

Table 3

Anguillicola larval infection of paratenic host fish species caught in a small number of specimens in Lake Balaton between 1991 and 1993 (ranges of the means calculated for each sampling)

Fish species	Number examined	Larvae recovered		
		prevalence, ranges	live larvae, ranges	all larvae, ranges
Blicca bjoerkna	78	0–100	0–1.5	0–20
Scardinius erythrophthalmus	68	0–100	0–2.8	0–68
Rhodeus sericeus amarus	65	0–100	0–0.4	0–10.3
Pseudorasbora parva	63	0–100	0–11	0–17
Stizostedion lucioperca	58	0–100	0–3	0–3
Abramis brama	38	0–100	0–0.3	0–10
Gymnocephalus cernua	25	100	15–157	15–157
Silurus glanis	14	100	0–79	1–475
Ictalurus nebulosus	1	100	32	32
Esox lucius	8	0–100	0–1	0–1
Perca fluviatilis	5	0–100	0–3	0–3
Gobio albipinnatus	17	0–100	0–3	0–3
Aspius aspius	7	0–100	0–3.5	0–6
Leucaspius delineatus	1	0	0	0
Carassius carassius	1	100	2	13
Carassius auratus gibelio	22	50–100	0–11	1.0–13
Cyprinus carpio	3	0–100	0–13	0–22
Tinca tinca	3	0–100	0–2	0–13

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