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DIFFERENCES BETWEEN THE EUROPEAN CARP (*Cyprinus carpio carpio*) AND THE COLOURED CARP (*Cyprinus carpio haematopterus)* IN SUSCEPTIBILITY TO *Thelohanellus nikolskii* (MYXOSPOREA) INFECTION

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Thelohanellus nikolskii infection of the common carp (*Cyprinus carpio* L.) has been a common parasitosis in the Central European fish farms since the first detection of the parasite about 20 years ago. This parasite, introduced from the Far East, causes intensive infection on the fins of fingerlings of the carp subspecies cultured in Europe (European carp, *Cyprinus carpio carpio*). This infection of the common carp occurs in the Hungarian fish farms every year. Until the present study, this parasite had not been recorded from the fins of koi or coloured carp (*Cyprinus carpio haematopterus*), a carp of Far Eastern origin, which is cultured in Hungary as an ornamental fish. A recent survey conducted in common carp, koi and goldfish stocks demonstrated that *T. nikolskii* infection of low prevalence and intensity occurs also in koi populations, but its prevalence and intensity are markedly lower than in common carp kept in the same ponds. It is suggested that the observed differences are due to disparities in the susceptibility of the two carp subspecies to *T. nikolskii*, and that the koi is less susceptible to this infection. Other signs of susceptibility can also be observed in the European subspecies, since in 15% of the fish plasmodium development was arrested at an early stage. *Thelohanellus nikolskii* infection could not be demonstrated on goldfish (*Carassius auratus*).

Key words: Common carp, koi, goldfish, *Thelohanellus nikolskii*, susceptibility

Thelohanellus infection of the European carp *(Cyprinus carpio carpio)* was first reported in Hungary by Jeney (1979), who identified the plasmodia found on the fins of carp fingerlings and the spores located within the plasmodia with the species *Thelohanellus dogieli* Akhmerov. However, Molnár and Kovács-Gayer (1981–1982) held that the above parasite belonged to the species *Thelohanellus nikolskii* Akhmerov and, besides this typical fin parasite, detected the occurrence of a connective tissue parasite, *T. hovorkai* Akhmerov in the same

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fish species. They suggested that the two parasite species had probably been brought into Hungary with the Amur wild carp introduced into Europe, and they soon caused very intensive infection in the Hungarian carp stocks. The pathology of the infection caused by the parasite and its location associated with the cartilaginous tissue of the finrays were studied histologically by Molnár (1982) and electron microscopically by Desser et al. (1983). Since the first report of Jeney (1979), *Thelohanellus* infection, and particularly *T. nikolskii* infection well visible even with the unaided eye, has been a permanent and important parasitosis of cultured common carp fingerlings in Hungary, and it rates as one of the commonest carp diseases also in the neighbouring countries (Čirković, 1986; Dyková and Lom, 1988). Moshu and Molnár (1997) have pointed out that the occurrence of *T. nikolskii* infection is not restricted to fingerlings, as in Moldova it is quite often detected in older wild carp populations living in natural waters. However, in the latter the plasmodia of the parasite develop at the tip of the scales, in the cartilage of collagenic origin which is composed of the same substance as the finrays, rather than in the cartilaginous substance of the finrays. The above authors supposed that older fish infected in this way are responsible for the infection of fingerlings, which occurs regularly each year. Regarding the source of infection, Székely et al. (1998) conducted investigations and found the aurantiactinomyxon stages of *T. nikolskii* and *T. hovorkai,* responsible for causing infection in fish, in common *Tubifex* and *Branchiura* worms in fish farms.

This paper reports the results of a survey which revealed substantial differences between common carp and koi specimens of the same age and reared in the same pond with respect to the prevalence and intensity of *T. nikolskii* infection.

Materials and methods

Since the first occurrence of *T. nikolskii* in Hungary in 1979, during routine examinations of other purpose (pathological observations, life-cycle experiments, molecular biological studies) the author collected unpublished data on *T. nikolskii* infection of several hundred carp fingerlings every year. Most of these studies were conducted in the Warm-water Fish Farm of Százhalombatta, where fingerlings are produced, and the fingerlings of common carp *(Cyprinus carpio carpio),* coloured carp (koi, *Cyprinus carpio haematopterus*) and goldfish (*Carassius auratus* L.) are reared in the ponds. The survey reported in this paper was conducted in 2001 in fish ponds of the farm populated with the above three species.

Two types of studies were performed. In the first type of investigations, the characteristics of infection of carp fingerlings with *Thelohanellus* plasmodia were studied on 100 fish specimens collected from an intensively infected pond of the farm. The occurrence of plasmodia on the fins, the intensity of infection, and the stage of development of the individual plasmodia were determined.

In the second survey, 100 specimens each of 7-week-old and 9-week-old fingerlings of carp, koi and goldfish stocks (a total of 600 specimens) were examined for *T. nikolskii* infection. In that study, carp and koi fingerlings were collected from a pond with a mixed population, while goldfish specimens from several small ponds located next to the former. Most of the examinations were performed under stereomicroscope, on live fish narcotised with MS-222 solution, but on 20 fish specimens of each category postmortem examinations were also carried out. In the latter case, the fish were killed, then their fins were cut off and examined at 10-fold magnification under stereomicroscope.

Some of the infected fins were fixed in Bouin's solution for histology, embedded in paraffin wax, cut to 5 μm thin sections and stained with haematoxylin and eosin.

Results

According to the results of the present author's surveys spanning several years, *Thelohanellus* infection of the fins occurs regularly, every year, with almost 100% prevalence on 6- to 9-week-old carp in different fish farms of Hungary, including the warm-water fish farm. In some cases the intensity of this infection was very high, and the development of 30–50 plasmodia per fish could be considered typical. It was striking that during the regular veterinary inspections by external examination no *Thelohanellus* plasmodia could be detected on the koi fingerlings kept in the same ponds.

In the first survey, plasmodia containing spores of mostly the same developmental stage, or emptied plasmodia, occurred on the finrays, primarily on the tail fins, of 75 common carp specimens. The number of these plasmodia varied between 8 and 35 (average: 27) per fish (Fig. 1). In the finrays of the same fish bright areas of cartilage deformation were seen, which could be regarded as traces of abortive development. In histological sections this abortive development was indicated by small nodules containing broken pieces of the fin cartilage (Fig. 2). Fifteen fish exhibited only areas of cartilage deformation indicative of arrested development, while ten fish proved to be free of infection. Carp that showed only cartilage deformation considered to represent arrested parasite development were examined repeatedly after keeping them in aquaria for one month; however, they did not show signs of plasmodium development.

In the second survey, an examination involving 200 carp and 200 koi fingerlings (Table 1) showed that by more thorough, primarily stereomicroscopic, inspection *Thelohanellus* plasmodia can be found also on the fins of koi fingerlings; however, such plasmodia can be collected from much fewer fish, the intensity of infection is far lower than in carp fingerlings, and the plasmodia are of smaller size. While out of one hundred 7-week-old and 9-week-old carp 73 and 84 specimens, respectively, proved to be infected and the mean intensity of in-

fection reached 22–24 plasmodia per fish, in koi the prevalence of infection was only 18–20% and none of the fish had more than 3 plasmodia. *Thelohanellus* infection did not occur on the 200 goldfish specimens collected from the neighbouring ponds of the farm; however, it was interesting to note that in the goldfish a *Myxobolus* infection could be observed in the same finray location.

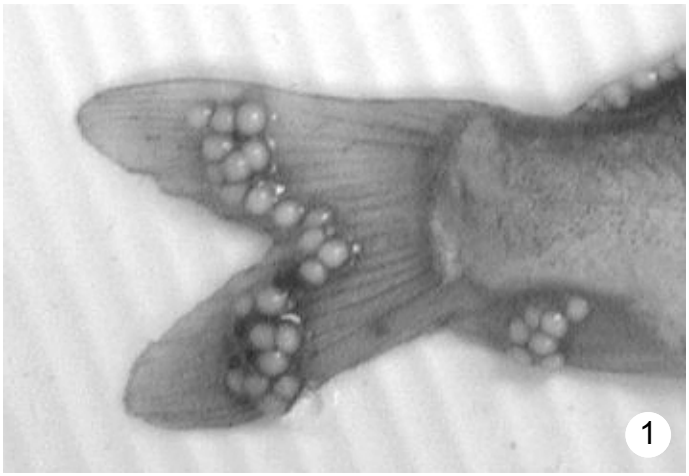

Fig. 1. Tail end of a common carp fingerling with *Thelohanellus nikolskii* plasmodia in the cartilaginous finrays. Magnification × 1.5

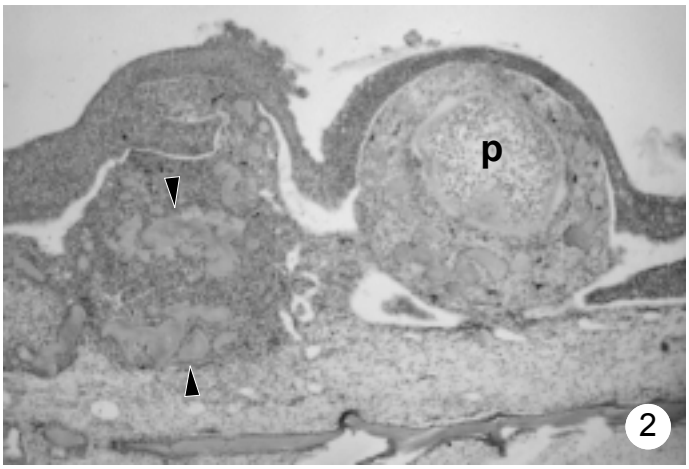

Fig. 2. Developing plasmodium (p) and an abortive nodule of *Thelohanellus nikolskii* in the fin of a common carp fry. Broken pieces of the cartilage (arrows) indicate the abortive development. Histological section. Haematoxylin and eosin (H.-E.), × 60

Table 1

Infection of the fins of carp and koi fingerlings with *Thelohanellus nikolskii* plasmodia

	No. of fish	Prevalence (%)	Intensity (plasmodia/fish)
Carp (7 weeks old)	100	73	1–35 (22)
Koi (7 weeks old)	100	20	1–3 (1.3)
Carp (9 weeks old)	100	84	8–30 (24)
Koi (9 weeks old)	100	18	1–3 (1.4)

Discussion

Today *Thelohanellus* infection introduced from the Far East can be considered a common parasitosis in Europe. The fact that the detection of this infection has been limited to Central Europe can primarily be explained by the lesser importance of carp in Western Europe; however, the infection has been documented to occur also in other European countries where carp breeding is conducted. While the disease caused by the parasite is sometimes alarming, infection is rarely diagnosed because it takes place in a period of fry rearing when there is no fishing off. Infection passes off relatively quickly, and the fins undergo rapid regeneration.

The prevalence and high intensity of carp thelohanellosis caused by *T. nikolskii* in Hungary were first reported by Molnár (1982) and by Molnár and Kovács-Gayer (1981–1982). The present survey reveals that this high prevalence and intensity of infection have not changed in the 20 years that have elapsed since that first report. At the same time, it is remarkable that, besides the developing or spore-containing mature plasmodia, not infrequently plasmodia of arrested development can also be found on the infected fins. These latter plasmodia have already produced the cartilage deformation described by Molnár (1982), but their development was arrested at an early stage. Some of the examined carp fingerlings showed such infection manifested in clinical signs but not resulting in spore formation, indicating that in some fish the parasite failed to reach the stage of sporogenesis despite the actual presence of infection. Carp collected from a given pond showed the same stage of infection and, disregarding cases of infection resulting in mild cartilage deformation, on fish of the same age plasmodia of identical developmental stage could only be found. The aquarium experiment performed in this study disproved the hypothesis that cartilage deformations would correspond to a delayed development or a secondary infection; namely, the abortive forms did not start to develop even after prolonged keeping in aquaria.

Until the present study, Hungarian specialists had commonly held the view that the koi was completely resistant to *T. nikolskii*, and that apart from its original host, the Amur wild carp, *T. nikolskii* caused infection in the European carp only. That view was supported by the lack of reliable data on this parasite

from Japan and China, while the species *T. hovorkai,* which is much more difficult to diagnose, had been studied thoroughly in both countries (Yokoyama et al., 1998; Chen and Ma, 1998). In the light of the present studies the supposed absolute resistance of the koi to *Thelohanellus* infection requires revision; however, it can be proved beyond doubt that the Asian carp subspecies is much less susceptible to infection than the European variant. Obviously, *T. nikolskii* recorded from the river Amur has much wider distribution in Asia, but it is difficult to diagnose this infection because of its low prevalence and intensity. The species described in Japan by Hoshina and Hosoda (1957) under the name of *Thelohanellus cyprini* presumably corresponds to *T. nikolskii*, and it is not impossible that one of the 11 *Thelohanellus* species described from carp in China is synonymous with *T. nikolskii* (Chen and Ma, 1998). The lower prevalence of infection in Asia, and the low susceptibility of Far Eastern carp subspecies to this parasite typically adapted to the species *Cyprinus carpio* are supported by the fact that the koi, the coloured carp introduced from Asia, develops an infection of lower prevalence and intensity even in the Hungarian fish ponds, while the European carp, which had been free from this parasite before the 1970s, shows highly prevalent infection. The studies revealed signs of a developing resistance also in the European carp; namely, one-fifth of the fish proved to be infection free, and even the infected fish included specimens exhibiting signs of an abortive infection. The cartilaginous thickenings of the fin, which is indicative of abortive development, were observed already by Molnár (1982) who, however, regarded these changes as signs of a passed-off infection. The present studies, which included long-term controlled laboratory experiments, undoubtedly prove that the changes indicating disruption of the finrays are the result of an abortive development.

The high host specificity of *Thelohanellus* species and the special affinity of individual species to different organs have already been pointed out by Akhmerov (1955). The results of this study confirm Akhmerov's statement concerning host specificity. On the basis of the studies on goldfish, and according to the findings of a survey conducted by Székely and Molnár (1996–1997) on gibel carp (*Carassius auratus gibelio* Bloch) in the Kis-Balaton water reservoir it seems to be likely that *Thelohanellus* species cannot colonise even the members of the genus *Carassius*, which is most closely related to the common carp.

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References

Akhmerov, A. Kh. (1955): Ways of the origin of Myxosporidia species of the genus *Thelohanellus* Kudo from Amur wild carp (in Russian). Dokl. Akad. Nauk USSR **105,** 1129–1132.

Chen, C. and Ma, C. (1998): Myxozoa, Myxosporea. Fauna sinica. Ed. Committee of Fauna Sinica. Science Press, Beijing.

Čirković, M. (1986): Myxosporidiosis of the one year old common carp fry (in Serbian). Doctoral Thesis of the Veterinary University, Beograd, Yugoslavia.

Desser, S. S., Molnár, K. and Weller, I. (1983): Ultrastructure of sporogenesis of *Thelohanellus nikolskii* Akhmerov, 1955 (Myxozoa: Myxosporea) from the common carp, *Cyprinus carpio*. J. Parasitol. **69,** 504–518.

Dyková, I. and Lom, J. (1988): Review of pathogenic myxosporeans in intensive culture of carp (*Cyprinus carpio*) in Europe. Folia Parasitol. **35,** 289–307.

Jeney, G. (1979): The occurrence of *Thelohanellus dogieli* Achmerov, 1955 (Myxosporidia) on carp (*Cyprinus carpio*) in fish ponds in Hungary. Parasit. Hung. **12,** 19–20.

Hoshina, T. and Hosoda, S. (1957): On a new myxosporidian species, *Thelohanellus cyprini* n. sp., parasitic in the fins of *Cyprinus carpio*. J. Tokyo Univ. Fish. **43,** 71–73.

Molnár, K. (1982): Biology and histopathology of *Thelohanellus nikolskii* Achmerov, 1955 (Myxosporea, Myxozoa), a protozoan parasite of the common carp (*Cyprinus carpio*). Z. Parasitenkde **68,** 269–277.

Molnár, K. and Kovács-Gayer, É. (1981–1982): Occurrence of two species of *Thelohanellus* (Myxosporea: Myxozoa) of Far-East origin in common carp populations of the Hungarian fish farms. Parasit. Hung. **14,** 51–55.

Moshu, A. and Molnár, K. (1997): *Thelohanellus* (Myxozoa: Myxosporea) infection of the scales in the European wild carp *Cyprinus carpio carpio*. Dis. Aquat. Org. **28,** 115–123.

Székely, Cs. and Molnár, K. (1996–1997): Preliminary survey of the parasite fauna of some important fish species in the Upper Reservoir of the Kis-Balaton system. Parasit. Hung. **29–30,** 45–54.

Székely, Cs., El-Mansy, A., Molnár, K. and Baska, F. (1998): Development of *Thelohanellus hovorkai* and *Thelohanellus nikolskii* (Myxosporea: Myxozoa) in oligochaete alternate hosts. Fish Pathol. **33,** 107–114.

Yokoyama, H., Liyanage, Y. S., Sugai, A. and Wakabayashi, H. (1998): Haemorrhagic thelohanellosis of the common carp caused by *Thelohanellus hovorkai* (Myxozoa: Myxosporea). Fish Pathol. **33,** 85–89.