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RESEARCH NOTE

CO-OCCURRENCE OF METACESTODES OF *ECHINOCOCCUS MULTILOCULARIS* AND *TAENIA TAENIAEFORMIS* (CESTODA) IN *ARVICOLA TERRESTRIS* (RODENTIA) IN FRANCE

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In western Europe, the natural life cycle of *Echinococcus multilocularis* (Leuckart, 1863) involves mostly foxes, dogs and cats as definitive hosts and voles (Arvicolidae) as intermediate hosts. Studies on this topic are often restricted to data on prevalence of this tapeworm. However, until now, an association of *E. multilocularis* with larvae of another cestode species has only been reported from *Rattus norvegicus* in Japan (Okamoto M., Fujita O., Arikawa J., Kurosawa T., Oku Y., Kamiya M. 1992: Int. J. Parasitol. 22: 681–684).

This paper reports our results of necropsy of 1807 voles belonging to 3 species, *Arvicola terrestris* (Linnaeus), *Microtus arvalis* (Pallas), *Clethrionomys glareolus* (Schreber) and 22 *Apodemus sylvaticus* (Linnaeus) (Table 1) trapped in a mountainous region of Central France between 1980 and 1990 and in 1995. They were captured alive, killed under anaesthesia and dissected. The livers were examined macroscopically for the presence of metacestodes of *E. multilocularis* and other cestode larval stages. Livers without macroscopical metacestodes were sectioned by hand (the thickness of sections: 1.5 mm) and observed under the dissecting microscope. All liver metacestodes were fixed in a 5% neutral formaldehyde solution. *Echinococcus multilocularis* metacestodes were studied by traditional histological methods. Other metacestodes were cleared or examined histologically for the presence of the hooks. The species determination of the Taeniidae was performed according to Abuladze (Abuladze K.I. 1964: Taeniata of Animals and Man and Diseases Caused by Them. Essentials of Cestodology IV. Nauka, Moscow, 530 pp.), Verster (Verster A. 1969: Onderstepoort J. Vet. Res. 36: 3–58) and Loos-Frank (Loos-Frank B. 2000: Syst. Parasitol. 45: 155–183).

The species of rodents and the number of rodents infected by *E. multilocularis* are shown in Table 1. Larval stages of other cestodes found in voles and *A. sylvaticus* are summarized in Table 2. *Echinococcus multilocularis* and *Taenia taeniaeformis* (Batsch, 1786) were found three times co-occurring in the same liver (Fig. 1). *Taenia taeniaeformis* showed macroscopically visible cysts of whitish to yellow colour and 4–9 mm in size (Fig. 1); a scolex and larval strobila 4–4.5 cm long were always found inside the cyst. Two crowns of hooks were observed on the scolex. The total number of hooks was 36 and their size was 0.36–0.44 mm for the anterior crown and 0.25–0.27 mm for the posterior one. Their shape was typical of *T. taeniaeformis*.

Table 1. Rodents found infected by *Echinococcus multilocularis* metacestodes only in the liver (EML) and rodents infected simultaneously with *E. multilocularis* metacestodes and *Taenia taeniaeformis* metacestodes in the liver (EMTTL).

	Number of animals dissected	EML	EMTTL
Arvicola terrestris	1730	60	3
Microtus arvalis	66	2	0
Clethrionomys glareolus	11	2	0
Apodemus sylvaticus	22	0	0

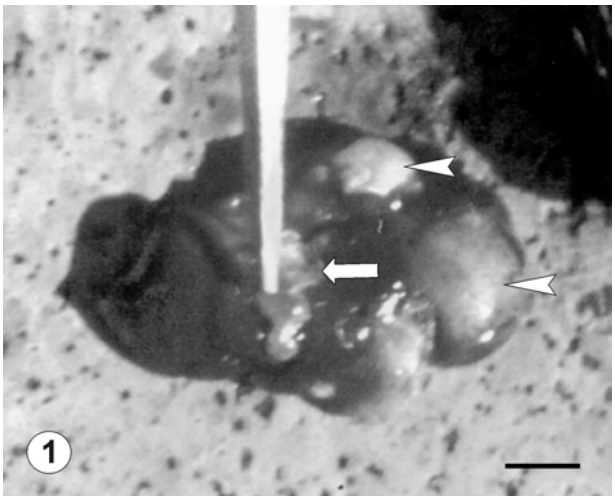

Fig. 1. Co-occurrence of *Echinococcus multilocularis* metacestodes (arrow) and *Taenia taeniaeformis* metacestodes (arrowheads) in the liver of *Arvicola terrestris*. Scale bar = 5 mm.

When the metacestodes of *E. multilocularis* were associated with *T. taeniaeformis*, the metacestodes were 3–9 mm in size, showing a cluster of small lucent vesicles without protoscoleces. The histological finding (Fig. 2) was the same as earlier described (Yamashita J.R., Ohbayashi M., Sakamoto T. 1960: Jpn. J. Vet. Res. 8: 315–323; Deblock S., Pétavy A.F. 1983: Ann. Parasitol. Hum. Comp. 58: 423–437; Yagi K., Takahashi K., Hattori K., Ishige M. 1986: Rep. Hokkaido Inst. Public Health 36: 30–42; Martínek K., Kolářová L., Červený J., Andreas M. 1998: Folia Parasitol. 45: 332–333).

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Table 2. Metacestodes identified in the examined rodents (*Echinococcus multilocularis* excluded).

	Liver	Pleural cavity	Peritoneal cavity
Arvicola Terrestris	*Taenia taeniaeformis*		
Microtus arvalis	*Taenia taeniaeformis*	*Taenia crassiceps*	*Taenia crassiceps* *Taenia polyacantha*
Clethrionomys glareolus	*Taenia mustelae*		
Apodemus sylvaticus	*Cladotaenia* sp.		

Fig. 2. Cross-section of *Echinococcus multilocularis* metacestode. Peripheral cyst in which the typical wall is absent. Scale bar = 100 µm.

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In Europe, the association of *E. multilocularis* metacestode with other metacestodes in the same host and the same organ has not previously been mentioned. Only in Japan, a single paper reports the association of the metacestodes of *E. multilocularis* and of *T. taeniaeformis* in the liver of a wild *Rattus norvegicus* (Okamoto et al. 1992, op. cit.). In our material, up to 4 metacestodes of *T. taeniaeformis* and 1–2 metacestodes of *E. multilocularis* were simultaneously found in the liver of *Arvicola terrestris*. *Echinococcus multilocularis* cysts were sterile, protoscoleces were absent. However, numerous protoscoleces are sometimes present in *E. multilocularis* cysts in naturally infected *A. terrestris* (Deblock and Pétavy 1983, op. cit.). This phenomenon was never observed when *E. multilocularis* was associated with *T. taeniaeformis* in the liver. *Arvicola terrestris* is not considered to be a suitable intermediate host for *E. multilocularis* (Deblock and Pétavy 1983, op. cit.). Some recent observations show that, at certain conditions, *A. terrestris* can be an intermediate host of primary importance for the transmission of *E. multilocularis* (Hofer S., Gloor S., Müller U., Mathis A., Hegglin D., Deplazes P. 2000: Parasitology 120: 135–142).

The simultaneous records of larvae belonging to different cestode species in one specimen of rodent are very rare. Tenora (Tenora F. 1967: Acta Sci. Nat. Brno 1: 161–207) examined 1043 rodents. A simultaneous infection by *Taenia crassiceps* (Zeder, 1800) and *T. polyacantha* Leuckart, 1856 was identified in two cases in the body cavity, that by *T. mustelae* Gmelin, 1790 and *T. taeniaeformis* in one case in the body cavity, and that by *T. mustelae* in the liver with *T. polyacantha* in the body cavity in one case. In our material (1807 voles and 22 *A. sylvaticus* dissected), 6 larval stages of cestodes (Tables 1, 2) were found. Only *E. multilocularis* and *T. taeniaeformis* were found in the same organ of the same individual, and only *T. crassiceps* was found in the pleural and peritoneal cavities of the same individual.

In a review by Rickard (Rickard M.D. 1983: Immunity. In: C. Arme and P.W. Pappas [Eds.], Biology of Eucestoda. Academic Press, London, pp. 549–564), the author mentioned that larval stages of *T. taeniaeformis* and *Taenia pisiformis* had evoked high levels of concomitant immunity in their intermediate hosts. This mechanism seems not to be involved in our material but it is possible that the co-parasitism influences the development of one or the other species by a reduction of the susceptibility to *E. multilocularis* or by the enhanced development of *T. taeniaeformis*. Further investigations are needed to clarify the effect of co-parasitism on immunity and to estimate the eco-epidemiological role of the association.

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