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Taxonomic review of cestodes of the genus *Catenotaenia* Janicki, 1904 in Eurasia and molecular phylogeny of the Catenotaeniidae (Cyclophyllidea)

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Abstract

This study reviews the taxonomy of cestodes of the genus *Catenotaenia* Janicki, 1904 (Cyclophyllidea: Catenotaeniidae) in Eurasia and presents the first molecular phylogenetic hypothesis of *Catenotaenia*, *Skrjabinotaenia* Ahumyan, 1946 and *Meggittina* Lynsdale, 1953, all parasites of rodents. The phylogenetic data are based on sequences of 28S ribosomal RNA. The analysis does not support the proposed subfamilial classification of the Catenotaeniidae into Catenotaeniinae Spasskii, 1949 and Skrjabinotaeniinae Genov & Tenora, 1979. Instead, the main division appears to be between Eurasian species and a basal Nearctic species. The results support the monophyly of the Skrjabinotaeniinae but not that of the Catenotaeniinae or *Catenotaenia* as traditionally understood. It is suggested that the Old World catenotaeniid cestodes appeared in murid rodents and diverged subsequently as *Skrjabinotaenia* and *Meggittina* (Skrjabinotaeniinae) in Africa. According to the molecular phylogeny, Eurasian *Catenotaenia* codiverged with their hosts, with the exception of *Catenotaenia dendritica* that originated via a host shift from murid rodents to squirrels. The crown clade of Eurasian *Catenotaenia* consists only of species found in cricetid rodents and the three terminal species only in the Arvicolinae (voles). Phylogenetic structure within the Eurasian *Catenotaenia* clade suggests seven distinct lineages, three of which are described as new: *C. apodemi* **n. sp.** from *Apodemus peninsulae* (type host) from the Republic of Buryatia and from *Apodemus uralensis* from the Lower Tunguska River, North-Central Siberia (Russian Federation); *C. cricetuli* **n. sp.** from *Cricetulus barabensis* from the Republic of Buryatia and *C. microti* **n. sp.** from *Microtus socialis* from Kazakhstan. A new genus (*Catenotaenioides* **n. g.**) is proposed for *C. kirgizica* Tokobaev, 1959, a basal species within the Old World clade. Of the various morphological features, proglottid form (short acraspedote proglottids widest at middle vs. elongated craspedote proglottids widest posteriorly) is consistent with the phylogenetic pattern exhibited by catenotaeniid cestodes.

Key words: Parasites, tapeworms, Cestoda, 28S rRNA, *Skrjabinotaenia*, *Meggittina*, *Catenotaenioides* **n. g.**, *Catenotaenia apodemi* **n. sp.**, *Catenotaenia cricetuli* **n. sp.**, *Catenotaenia microti* **n. sp.,** rodents

Introduction

Cestodes of the genus *Catenotaenia* Janicki, 1904 (Cyclophyllidea, Catenotaeniidae) exclusively parasitize rodents. They occur in three of the five rodent suborders, i.e., Myomorpha, Sciuromorpha and Castorimorpha. There are presently 17 nominal species of *Catenotaenia* (Tables 1 and 2). Species diversity is highest in muroid rodents (Myomorpha), particularly in Muridae and Cricetidae. *Catenotaenia* spp. are widely distributed in Eurasia and North America but evidently absent in Africa, South America and Australia. Several hypotheses have been proposed for the evolutionary relationships within the family Catenotaeniidae (see Quentin 1971, 1994; Tenora *et al.* 1980). However, there are no phylogenetic studies of *Catenotaenia* spp. or other catenotaeniid cestodes based on explicit methods.

The taxonomy of *Catenotaenia* spp. is challenging because they lack rostellum, hooks and are otherwise anatomically uniform. Species delimitation and identification of *Catenotaenia* has been based largely on the number of uterine branches. This has led to broadly defined species concepts and assumed host spectra. For example, the type species *C. pusilla* (Goeze, 1782) has been identified from at least 20 species of rodents representing eight genera (mostly Muridae and Cricetidae), and *C. cricetorum* Kirshenblat, 1949 from at least 27 species representing 12 genera (Muridae, Cricetidae and Dipodidae) (Host-Parasite Database of the Natural History Museum, London; Gibson *et al.* 2005). These species have been assigned equally wide host spectra in the compendium of cestodes of rodents in the former USSR (Ryzhikov *et al.* 1978). Also, many species have been described from a small number of samples according to rather slight differences in the number of uterine branches, although the intraspecific variability of this feature is usually poorly known

Thus, there has been a need for additional features that help to resolve diversity within *Catenotaenia*. Asakawa *et al.* (1992) and Tenora *et al.* (1992) suggested that proglottid shape may be a species-specific feature of *Catenotaenia*. This approach enables a more precise delimitation of the type species *C. pusilla* (with "semioval" gravid proglottids), supporting the view that it is a host-specific parasite of *Mus musculus* Linnaeus (see Tenora & Murai 1975) rather than a host-generalist parasite of murid and cricetid rodents. Some other species appear to be characterized by distinctly craspedote proglottids or proglottids approaching the acraspedote condition. Tenora & Murai (1975) suggested that there is pronounced variation in the egg morphology of *Catenotaenia* spp. Unfortunately, this feature has not yet been comprehensively surveyed.