Infectivities of Four Isolates of *Taenia taeniaeformis* to Various Rodents

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**ABSTRACT.** *Taenia taeniaeformis* were isolated from Norway rats captured at Sapporo (SRN isolate) and Kuala Lumpur, Malaysia (KRN) and from Bedford's gray red-backed voles at Toubetsu (TCR) and Abuta (ACR). SRN, KRN and TCR isolates showed similar degree of infectivity to various rodents in which cysticeri with hooks were obtained in laboratory rats, while tuberous lesions in mice and no cysts or lesions in Mongolian gerbils and voles. Contrary to this, inoculation with ACR isolate eggs resulted in strobilocerci formation in the liver of voles, but no cysts were observed in rats, mice or gerbils. This host specificity of ACR isolate to voles suggests that it might be a new species of *Taenia*.

**Key words:** infectivity, strain variation, *Taenia taeniaeformis*.

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Establishment of *Taenia taeniaeformis* in intermediate hosts is dependent upon host susceptibility and infectivity of parasite strains. Variated susceptibility of rodents to *T. taeniaeformis* infection has been widely suggested to be influenced by age, sex, species and strain of the host [2, 4-6, 11-13, 19]. In addition, infectivity of *T. taeniaeformis* to various host species varied among the parasite strains [3]. In surveys of hepatic helminths of rodents captured in Hokkaido, Japan, natural infections of *T. taeniaeformis* has been reported in several rodent species including those belonging to the genera *Clethrionomys*, *Apodemus* and *Rattus* [7, 20], indicating the existence of a possible sylvatic life cycle of *T. taeniaeformis*. However, variation in characteristics of *T. taeniaeformis* found in different rodent hosts has not been investigated. We report herein the infectivity of four isolates of *T. taeniaeformis* to various rodent species.

Strobilocercus of four isolates of *T. taeniaeformis*, designated by their host species and locality collected (Table 1) were fed individually to four helminth-free cats. The animals were sacrificed under chloroform anaesthesia and necropsied 60 days later. Mature parasites were recovered from small intestine and morphologically mature eggs of each isolate were obtained from the last six proglottids [8]. The eggs were stored at 4°C in sterile saline supplemented with penicillin (1,000 IU/ml), streptomycin (10 mg/ml) and fungizone (0.125 mg/ml) [11, 19] and used within a year.

Four-week-old male Wistar rats and ICR mice purchased from Shizuoka Laboratory Animals Agricultural Cooperative Association, 9- to 11-week-old Mongolian gerbils (*Meriones unguiculatus*) reared in our laboratory and gray red-backed voles (*Clethrionomys rufocanus bedfordiae*) captured at Toubetsu, Hokkaido, were orally inoculated with the eggs of four *T. taeniaeformis* isolates (Table 1). Inoculation with SRN, KRN and TCR eggs resulted in cyst formation in liver of rats and necrotic lesion in mice, but in gerbils and voles, no trace of establishment of infection was observed except for one vole in the group inoculated with TCR eggs. Hook formation was observed in worms recovered from rats inoculated with either SRN, KRN or TCR. However, all lesions in mice inoculated with either SRN, KRN or TCR showed white tuberous necrosis with diameter less than 4 mm and did not contain any worms. In contrast, inoculation with ACR eggs resulted in cyst formation in the liver of voles, but not in rats, mice or gerbils. Cysts recovered on day 62 post-infection from voles inoculated with ACR contained strobilocerci.

All the voles used in this study were captured from the field and not treated with any anthelmintics. Therefore, the voles might be naturally infected with parasites prior to experimental infection. It could be argued that the cysts recovered from voles inoculated with ACR eggs were due to natural infection prior to being captured at Toubetsu. However, our survey data showed that, of the 286 voles captured at Toubetsu, only one was infected with a single cyst of *T. taeniaeformis*. On the contrary, the result of our experimental infection with ACR eggs showed 100% infection rate. Moreover, the parasite found in the cysts recovered on days 10, 11 and 32 post-inoculation did not develop to strobilocerci, indicating that the infection in the voles was a relatively recent event. Therefore, it is more likely that the cysts recovered from voles inoculated with ACR eggs were the result of experimental rather than that of the natural infection. On the other hand, the origin of one strobilocercus found in a vole inoculated with TCR eggs is not clear. Whether the strobilocercus was from natural or experimental infection could not be determined, because the period of experimental infection (60 days) is long enough for the parasite to develop to strobilocerci. However, the TCR eggs at next generation (recovered from a cat orally inoculated with the strobilocercus) was not infective to voles (7 voles inoculated with 1000 TCR eggs of the next generation, none was infected).

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Table 1. Four isolates of *Taenia taeniaeformis* designated by different host and locality

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Host</th>
<th>Location</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRN</td>
<td><em>Rattus norvegicus</em></td>
<td>Sapporo, Hokkaido, Japan</td>
<td>1984</td>
</tr>
<tr>
<td>KRN</td>
<td><em>Rattus norvegicus</em></td>
<td>Kuala Lumpur, Malaysia</td>
<td>1985</td>
</tr>
<tr>
<td>TCR</td>
<td><em>Clethrionomys rufocanus bedfordiae</em></td>
<td>Toubetsu, Hokkaido, Japan</td>
<td>1985</td>
</tr>
<tr>
<td>ACR</td>
<td><em>Clethrionomys rufocanus bedfordiae</em></td>
<td>Abuta, Hokkaido, Japan</td>
<td>1986</td>
</tr>
</tbody>
</table>

a) Two life cycles maintained in rats and cats after isolation.
T. taeniaeformis was found in a variety of hosts belonging to the family Muridae which comprise such genera as Mus, Apodemus, Micromys, Rattus, and Clethrionomys [1]. T. taeniaeformis isolated in Europe was reported to be infective to mouse, but not to rat, and those isolated in Malaysia infective to rat, but not to mouse [3]. In Echinococcus granulosus, host specificity has been demonstrated in equine and ovine strains which also exhibit morphological differences [10]. Most strains of Taenia and Echinococcus species have been separated on the basis of the differences in intermediate host preference and morphological characteristics. Such strains could be further defined on a finer scale by comparing genetic variation using recent advanced techniques such as isozyme electrophoresis, DNA restriction site analysis and DNA hybridization [18]. Strain variation in Echinococcus arose as a result of cloning by mutant individual cells in the course of asexual reproduction in intermediate host, and self-fertilization in definitive host has been suggested [16]. Alternatively, Rausch [14, 15] argued that ecological or geographical segregation is a major factor in giving rise to the various E. granulosus strains. With the advent of new techniques in the study of genetic differentiation, Thompson and Lymberry [17] suggested two criteria for identifying strains of Echinococcus, namely the population should be genetically differentiated, and secondly, they should differ in one or more characteristics which is of significance to the epidemiology and control of hydatid disease. To date, T. taeniaeformis isolated in Japan is known only to be infective to rats. However, in this study, ACR was found to be able to infect only voles and not rats. Further study in epidemiology, morphology and genetics is required to determine whether or not ACR is a new strain of T. taeniaeformis or even possibly a new species of Taenia. Nevertheless, it could also be a result of the high capability of cyclophyllidean cestodes to adapt to different environments.

Finding a T. taeniaeformis strain infective to voles, C. rufocanus bedfordiae, which serve as a major intermediate host of Echinococcus multilocularis in Japan, may be of significance in the biological control of multilocular echinococcosis. One of the proposed study to control the disease is through application of antagonistic competition using cross immune reaction between E. multilocularis and a closely related cestode, such as those belonging to the Family Taeniidae [9]. In designing the biological control of multilocular echinococcosis, candidate cestodes which are possible competitors of E. multilocularis should complete their life cycle in the same ecosystem as E. multilocularis and ideally be non-pathogenic for both animals and humans. One of the major constraints in promoting biological control is the lack of an appropriate cestode competitor against E. multilocularis. T. taeniaeformis is a cestode belonging to the Family Taeniidae which is relatively non-pathogenic. Therefore, this T. taeniaeformis strain which is infective to C. rufocanus bedfordiae may help in the biological control studies of multilocular echinococcosis.

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