BRIEF NOTE

THREE NEW HOSTS FOR THE CYSTICERCOID OF *HYMENOLEPIS DIMINUTA*[1]

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The rat tapeworm *Hymenolepis diminuta* (Rudolphi, 1819) is known to have a broad spectrum of intermediate hosts. A list of arthropods reported to serve in this role follows (Oldham 1931, unless otherwise noted):

Myriapoda: *Fontaria virginiensis*, *Julus sp.*

Lepidoptera: *Aglossa dimidiata*, *Aphornia gularis*, *Pyralis farinalis*, *Tinea granella*, *T. pellionella.*

Coleoptera: *Akis spinosa*, *Aphodius distinctus* (Faust and Russel 1964), *Dermestes peruvianus*, *D. vulpinus* (Bacigalupo 1951), *Dyscinetus gagates* (Bacigalupo 1951), *Geotrupes stercosus* (Faust and Russel 1964), *G. sylvaticus*, *Gnathocerus cornutus* (MacDonald and Wilson 1964), *Scaurus striatus*, *Stegobium paniceum* (Faust and Russel 1964), *Tenebrio molitor*, *T. obscurus* (Bacigalupo 1951), *Tribolium castaneum*, *T. confusum* (Voge and Heyneman 1957), *Ulosonia parvicornis.*

Siphonaptera: *Ctenocephalides canis*, *C. felis* (Marshall 1967), *Leptopsylla segnis*, *Monopsyllus anisus* (Yamada *et al* 1936), *Nosopsyllus fasciatus*, *Orchopeas howardii*, *Pulex irritans*, *Xenopsylla cheopsis.*

Embioptera: *Embia argentina* (Bacigalupo 1938).

Dermaptera: *Anisolabis annulipes.*

Orthoptera: *Blatella germanica*, *Blatta orientalis*, *Periplaneta americana*, *Schistocerca gregaria* (Lethbridge 1971).

Mehra's (1955) abstract note, with no supportive data, also lists the beetles *Latheticus oryzae* and *Opatroides vicinus* as experimental intermediate hosts. Many of these species are recognized as being coprophagous or scavengers during some part of their life cycle. This broad host variability prompted our investigation of several additional insect species as possible intermediate hosts of *H. diminuta.*

Adult cestodes were maintained in Sprague-Dawley/Holtzman strain white rats and gravid proglottids were recovered from fecal pellets. Proglottids were washed in aged tap water, ruptured to facilitate feeding, and presented to insects on various substrates. All insects were starved for 24 hours prior to proglottid feeding, and sufficient proglottids were supplied for *ad libitum* feeding for a 24 hour period. After 26 days all insects were dissected and any cysticercoids present removed and counted. A tabulation was made of the number and species fed proglottids, substrate used, normal food supply, number of surviving insects, number and percent of infected insects and number of cysticercoids recovered from infected insects (table 1). It should be noted that *Forficula auricularia* (earwig) required 2 feedings 24 hours apart before infection took place, while *Amblycorypha sp.* (round-headed katydid) and *Melanopus femur-rubrum* (red-legged grasshopper) were successfully infected after a single feeding.

Some of the cysticercoids recovered from each infected insect species were introduced via duodenal tube into uninfected Sprague-Dawley/Holtzman rats. Twenty days later fecal samples were examined for gravid proglottids. At least 10 more days were allowed for tapeworm

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TABLE 1

Results of Proglottid Feeding to Insects.

No.	Species	Proglottid Substrate	Normal Food	No. Survivors*	No. Inf.	% Inf.	No. Cysticercoids in Inf. Insects
39	*Forficula auricularia*	moist filter paper	dandelion (*Taraxacum officinale*) leaves and moist, uncooked oatmeal	34	0	0	—
30	*F. auricularia***	moist filter paper	dandelion leaves and oatmeal	23	3	13	1, 3, 11
21	*Melanopus femur-rubrum*	clover (*Trifolium repens*)	clover and grass clippings	6	5	83	1, 4, 11, 30, 59
24	*Popillia japonica*	clover leaf	grape (*Vitis sp.*) leaves	21	0	0	—
3	*Dissosteira carolina*	clover leaf	clover and grass clippings	2	0	0	—
1	*Amblycorpha sp.*	clover leaf	clover and grass clippings	1	1	100	36
1	*Tenodera aridifolia sinensis*	proglottids smeared on grasshoppers	live grasshoppers	1	0	0	—

*26 Days after Proglottid Feeding.
**Fed Once, Then Again 24 Hours Later.

maturation before all animals were sacrificed and adult tapeworms recovered, fixed in AFA and preserved in 75A. Adult cestodes all appeared normal in width, length, and color (table 2). It should be noted that all rats fed cysticercoids developed adult tapeworms.

The suitability of different insect species for development of *Hymenolepis* cysticercoids was highly variable (table 1). This variability may have been due to differences in insect mouthpart structure, the ability of the insect gut to resist penetration of the hexacanth, defense mechanisms of the cysticercoid against the action of insect hemocytes (Ubelaker *et al* 1970), and/or other unknown factors. The high rate of successful infection of rats with cysticercoids (table 2) demonstrated that they were probably functionally similar to those that occur in naturally infected intermediate hosts. No morphological abnormalities were observed when such cysticercoids were examined under low power (35X) magnification.

The cause of death of many of the insects used in this study was unknown. Mortality may have been due to natural causes, the inroads of cysticercoid de-

TABLE 2

Results of Cysticercoid Introduction into Rats.

Source of Cysticercoid	No. Rats Infected	Cysticercoids Introd.	Mature Worms Recovered	% Develop. to Maturity
Forficula auricularia	3*	15	8	53
Melanopus femur-rubrum	1	36	27	75
Amblycorypha sp.	1	30	9	30

*Rats were fed 11, 3, and 1 cysticercoids respectively; adults recovered numbered 6, 1, and 1.

velopment, or other unknown factors. While the insects used in this study were not coprozoic and in nature would only rarely encounter rat feces containing *H. diminuta* eggs, our success in infecting 3 of the 6 species investigated further demonstrated the low degree of host specificity of *H. diminuta* cysticercoids.

It has been shown here that 3 additional species of insects, *Forficula auricularia* (Linn.), *Melanopus femur-rubrum* (DeGeer) and *Amblycorypha sp.* (Stahl) can serve as intermediate hosts of *Hymenolepis diminuta* and can give rise to cysticercoids infective to rats. Data on the percent of infectivity for *Amblycorypha sp.* (table 1) must be considered inconclusive because only one insect was abailable for study. Since limited numbers of *Dissosteira carolina* and *Tenodera aridifolia sinensis* were used in this study, the possibility that they also might serve as intermediate hosts for this tapeworm should not be overlooked. Additional investigations utilizing other insect species would probably further expand the already large number of suitable intermediate hosts of this tapeworm.

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