

## Cysticercosis in Fallow Deer in England

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Chapman N. G. & Chapman D. I., 1987: Cysticercosis in fallow deer in England. *Acta theriol.*, 32, 8: 105—113 [With 3 Tables & 4 Figs.]

The bladderworm cyst *Cysticercus tenuicollis* Rudolphi, 1819 was found in 38 of 309 (12.3 per cent) of fallow deer (*Dama dama* Linnaeus, 1758) examined from three captive and three free-ranging populations in Southern England. The findings report a minimum incidence as only macroscopic examination was performed and livers were not sliced. Most infected deer had only one cysticercus and the maximum number in one deer was three: 91.3 per cent of the cysticerci were attached to the mesenteries or omentum. The difference in incidence between captive and free-living deer was not statistically significant. Deer older than one year had a higher incidence of infection than younger animals: the youngest infected was 8 months old.

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### 1. INTRODUCTION

The presence of the bladderworm cyst *Cysticercus tenuicollis* in deer in Britain is said to indicate that the hosts have grazed ground used by dogs (*Canis familiaris* Linnaeus, 1758) or foxes (*Vulpes vulpes* Linnaeus, 1758), the carnivores most likely to be the definitive host for the adult tapeworm, *Taenia hydatigena* Pallas, 1766. The bladderworm is considered to be of trival importance as it occurs on the serous membranes of the abdominal cavity and can cause harm only if large numbers migrate through the liver (Dunn, 1967). It is the only larval cestode which has been recorded in wild deer in Britain (Dunn, 1969).

*C. tenuicollis* is cosmopolitan in its choice of host which is usually a ruminant or swine. The number and location of the cysticerci appear to vary according to the host species. The incidence and location of these larvae in British fallow deer (*Dama dama* Linnaeus, 1758) are virtually unknown. It was not recorded for fallow in the review of helminths of British deer (Dunn, 1967). The first report appears to be in 1970 (Batty & Chapman, 1970) when one of the 26 fallow examined had a single cysticercus. As part of a study of fallow deer we have investigated their helminths. This paper reports results on the incidence of cysticerci in captive and free-ranging populations from differing habitats.

Table 1  
Numbers, sex and ages of fallow deer examined for cysticerci of *Cysticercis tenuicollis* and number of animals infected

	Males						Females					
	≤1 yr <sup>1</sup>		>1 year		Total		≤1 yr <sup>1</sup>		>1 year		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Knole Park	—	—	2	0	2	0	—	—	9	3	9	3
Holkham Park	1	0	8	13	9	11	3	0	13	3	16	3
Richmond Park	43	7	38	7	81	12	30	0	52	2	82	2
Total (captive)	44	7	48	8	92	11	33	0	74	8	107	8
N. W. Essex	1	100	10	1	11	2	1	0	6	1	7	1
Epping Forest	7	14	26	3	33	4	6	0	18	2	24	2
South Weald	3	33	7	5	10	6	5	0	20	4	25	4
Total (irecliving)	11	3	43	9	54	12	12	0	44	7	56	7
Grand total	55	6	91	17	146	23	45	0	118	15	163	15

<sup>1</sup> The mean age of the male deer was 6.5 months (S.D. 4.1, range 0—12) and that of the female deer was 7.0 months (range 0—12)

## 2. MATERIAL AND METHODS

## 2.1. Animals

A total of 309 deer, from three parks and three other areas, were examined. Carcasses were obtained throughout the year: the monthly sample size ranged from 11 to 65 (Fig. 1). The sample from each locality was divided into four groups according to sex and age (less or more than one year old). The ages were estimated from the eruption and wear of the molariform teeth in comparison with specimens from known-age deer from two (one park, one wild) of the localities (Chapman & Chapman, 1975). Details of the animals are given in Table 1. A few deer had died naturally but the majority were shot or killed

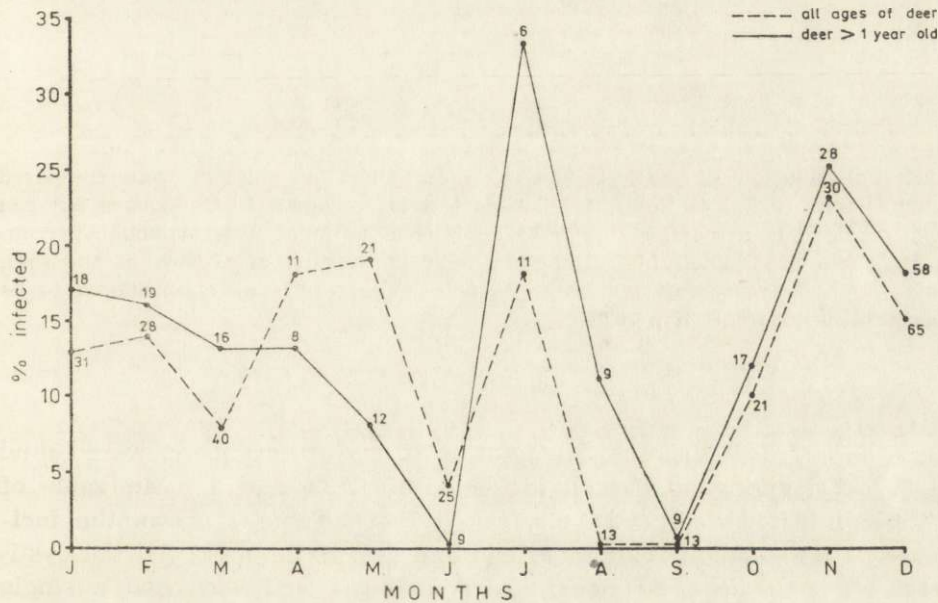


Fig. 1. Monthly sample size and incidence of cystercerci.

in accidents. The abdominal organs and lungs were examined macroscopically, usually without dissection, for the presence of mature cysticerci. The abdominal fluid was not examined for larvae and the livers were not sliced.

## 2.2. Study Areas

Data pertaining to the parks at the time of the survey are given in Table 2. Foxes and dogs were present in each of the parks but only at Richmond Park could they possibly gain access to the disposed viscera of culled deer.

The free-ranging deer came from three areas of Essex: Epping Forest and its environs, South Weald near Brentwood and, with two exceptions from mid-Essex, from North-west Essex. These areas all included deciduous woodland with arable land and pasture (Chapman, 1977). Foxes and dogs occurred in all the areas.

Table 2  
Data pertaining to the parks from which fallow deer were examined.

Park	Holkham	Knole	Richmond
Location	Wells-next-the-Sea, Norfolk	Sevenoaks, Kent	Richmond, Surrey
Area to which deer had access	130 ha pasture & deciduous woodland	340 ha pasture	950 ha pasture & deciduous woodland
No. fallow deer	c. 850	c. 500	300—400
Other grazing stock	all year: — spring/summer: c. 750 sheep autumn: c. 100 cattle	c. 220 sika deer	250—350 red deer Apr.—Sept.: 300— —400 sheep

### 2.3. Statistical Analysis

The distribution of cysticerci between categories of animals were compared using G-tests (Sokal & Rohlf, 1969). This test is analagous to Chi-square but can be partitioned in a manner similar to analysis of variance tests. Although percentage figures are quoted in conjunction with the results of G-tests in the text, tests were always carried out on frequencies. The results were considered to be significantly different if  $p < 0.05$ .

### 3. RESULTS

In the 309 deer examined, a total of 46 mature cysticerci were found in 38 deer, giving an overall incidence of 12.3% and a mean value of 1.2 per infected deer (S.D. 0.5, range 1—3). Table 1 shows the incidence of infection in relation to age and sex of the deer. All the cysticerci were *Cysticercus tenuicollis*. Thirty-two deer each had a single cysticercus, four deer each had two and two deer each had three cysts. The majority (91.3%) of the cysticerci were attached to the omentum or the mesenteries, with the remainder either on the liver (4.3%) or attached to the muscles of the abdomen (4.3%). The cysticerci were usually about 20 mm in diameter but the largest measured 40 mm.

Thirty-two of the 209 deer older than one year (15.3%) and six of the 100 immature deer were infected, the difference being statistically significant ( $G=6.07$ ,  $p < 0.02$ ). The youngest animal found to be infected was an eight-month old fawn from Richmond Park. These age-related differences in the incidence of infection were significant in females (<1 year, 0%, >1 year, 11%;  $G=6.71$ ,  $p < 0.01$ ) but not in males (Fig. 2).

In general, male deer were more frequently infected than females

( $G=3.07$ ,  $0.1 > p > 0.05$  and this difference was significant among fawns ( $G=4.14$ ,  $p < 0.05$ ), (Fig. 2). This appeared to be a localised effect since the only significant differences between the sexes were from Richmond Park ( $G=4.72$ ,  $p < 0.05$ ) and South Weald ( $G=4.55$ ,  $p < 0.05$ ).

Free-ranging deer tended to have a greater incidence of infection with cysticerci than did the captive deer ( $G=3.78$ ,  $0.1 > p > 0.05$ ), (Fig. 3). The frequency of infection tended to vary among the three wild pop-

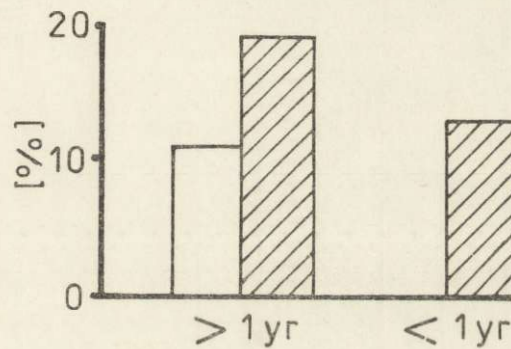


Fig. 2. Percentage incidence of infestation of *C. tenuicollis* relation to age and sex of host. Females — open bars, males — hatched bars.

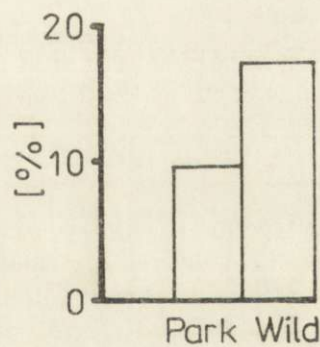


Fig. 3. Percentage incidence of infection of *C. tenuicollis* in park and free-living fallow deer.

ulations ( $G_2=4.55$ ,  $0.1 > p > 0.05$ ) from 11.8% in Epping Forest to 30% at South Weald. There also tended to be differences between park populations ( $G_2=4.80$ ,  $0.1 > p > 0.05$ ).

The incidence of infection varied significantly between seasons in females ( $G_2=6.97$ ,  $p < 0.05$ ) and tended to vary in males ( $G_2=5.10$ ,  $0.1 > p > 0.05$ ). However the timing of peak infection differed between

the sexes (Fig. 4). Females were most infected in winter (October — March, 16.5%) and least infected in April — June (0%). In contrast, males were most infected in April — June (26.9%) and least infected in June — September (4.3%). Only in April — June were the differences in frequency of infection significantly different between the sexes ( $G=8.10$ ,  $p<0.01$ ).

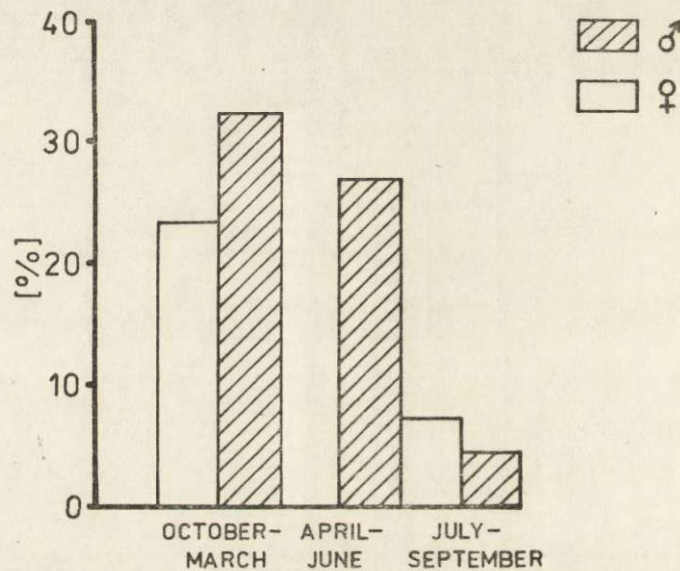


Fig. 4. Seasonal incidence of *C. tenuicollis* found in fallow deer.

#### 4. DISCUSSION

The incidence of infection found in the present study is compared with other published results in Table 3. Information on the degree of infection in other species of deer in Britain seems to be lacking. No cysticerci have been found in 120 muntjac (*Muntiacus reevesi* Ogilby, 1839) from eight counties nor in the gastro-intestinal tracts of 50 roe deer (*Capreolus capreolus* Linnaeus, 1758) from Suffolk (personal observations). In Hungary Murai and Sugár (1976, 1979) reported incidences of 24% and 41% in red deer (*Cervus elaphus* Linnaeus, 1758) and 61% and 49% in roe deer.

In general, the incidence of infection by *C. tenuicollis* in fallow deer appears lower than that recorded for some species of deer in North America where, in some areas, over 80% were infected (Leiby & Dyer, 1971).

The majority of the cysticerci were located on the omentum or mes-

enteries, which were also the most usual sites recorded in roe deer in one locality in Dorset (McDiarmid, 1968). The Hungarian studies on the three species of deer, wild boar (*Sus scrofa* Linnaeus, 1758) and mouflon (*Ovis musimon* Pallas, 1811) reported that most cysticerci were on the omentum, with some on the liver, in the lungs or the pelvic region (Murai & Sugár, 1979). Similarly, in mule deer (*Odocoileus hemionus* Rafinesque, 1817) the larvae were most frequent on the omentum (Cowan, 1946) but in Alaskan reindeer (*Rangifer tarandus* Linnaeus, 1758) they occurred primarily in the liver (Neilund, 1972).

The maximum number of cysticerci per fallow deer was 3 whereas in one mule deer 23 were found, although the mean was only 3.6 (Cowan, 1946). Reindeer seldom had more than 5—10 (Neilund, 1972). In Murai and Sugár's survey (1979) a range of 1—25 cysticerci was recorded in five intermediate hosts but the figures for fallow deer were not reported separately.

Table 3  
Incidence of infection by *Cysticercus tenuicollis* in fallow deer.

Country		No. deer examined	% incidence	Reference
England	1)	309	12.3	Present study
	2)	26	3.8	Batty & Chapman, 1970
Eire		16	12.5	Sleeman, 1983
Hungary	1)	49	12.3	Murai & Sugár, 1976
	2)	35	20	Murai & Sugár, 1979
Poland		13	7.7	Drózdź, 1966
Czechoslovakia	1)	323	0.9	Kotrlý, 1964
	2)	476	3.9	Kotrlá & Kotrlý, 1975
New Zealand	1)	67	9.0	Sweatman & Williams, 1962
	2)	30	0.0	Sweatman & Williams, 1962
	3)	6	67	Sweatman & Williams, 1962

Older deer have had longer in which to ingest tapeworm eggs so the greater incidence of cysticerci in the older age category was expected. However, of the 53 deer over six years old, only 7% of the males and 9% of the females were infected.

The significantly greater incidence of infection among males at Richmond Park might be attributed to the adult males greater tendency to scavenge at litter bins (Chapman & Chapman, 1975). These were sited at car parks where very many dogs began their exercise, probably depositing more faeces and a greater number of tapeworm eggs in the vicinity. However, this behaviour does not apply to fawns which showed the more significant difference between the sexes, and at South Weald four of the five infected males were under 19 months old and probably ranged over the same ground as the female deer.

Variation in the incidence of infection among the various populations may reflect variation in the incidence of *T. hydatigena* in the carnivore hosts and this was unknown. A survey by Beresford-Jones (1961) on helminths in foxes included nine localities in Essex but *Taenia* was not identified to specific level. Cook and Clarkson (1971) did not find *T. hydatigena* in any of the 59 dogs examined from 33 farms in East Anglia, including north-west Essex.

It was not possible to determine the months in which the deer had become infected but seasonal variation in the incidence of infection is surprising since once a cysticercus has matured it will remain in its host for many years. Little is known of longevity of *C. tenuicollis* but a female fallow that died 11.5 years after being brought into captivity had an apparently viable cysticercus (personal observation). As no dogs or foxes had access to the paddock she presumably had become infected when in the wild.

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#### WĄGRZYCA DANIELI W ANGLII

##### Streszczenie

Wągrzy *Cysticercus tenuicollis* Rudolphi, 1819 wykryto u 39 (12.3%) spośród 309 danieli (Tabela 1). Badane zwierzęta pochodziły z trzech zagrodowych i trzech wolno-żyjących populacji tego gatunku z południowej Anglii (Tabela 2). Niniejsza praca podaje tylko minimalne liczby zainfekowanych osobników, ponieważ przeprowadzono jedynie makroskopowe badania jamy brzusznej. U większości zainfekowanych danieli stwierdzono obecność 1 cysty (maksymalnie 3 cysty u jednego osobnika). W 91.3% przypadków pasożyt występował w krezce i na sieci. Różnice między danielami z hodowli zagrodowej i z wolności nie były istotne statystycznie (Ryc. 3). Zwierzęta powyżej 1 roku były zainfekowane częściej niż osobniki młode. Najmłodszym osobnikiem, u którego stwierdzono *Cysticercus tenuicollis*, było zwierzę 8-miesięczne.