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THE DISTRIBUTION OF *Centrorhynchus aluconis* (ACANTHOCEPHALA) AND *Porrocaecum spirale* (NEMATODA) IN TAWNY OWLS (*Strix aluco*) FROM GREAT BRITAIN

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Abstract.—The small intestines of a sample of 109 tawny owls (*Strix aluco*) were examined for the presence of endoparasitic helminths. Most of the owls had been collected as road kills from locations in England, Scotland, and Wales between November 1983 and September 1991. *Centrorhynchus aluconis* (Acanthocephala) was found in 67.9% of the owls indicating that this helminth is widely distributed in tawny owls in Great Britain. *Porrocaecum spirale* (Nematoda) was found in 18.3% of the owls. Concurrent infections occurred in 11.9% of the owls. *C. aluconis* was found to be located in the posterior half and *P. spirale* in the anterior half of the small intestines of owls. In concurrent infections, these distributions were generally retained, but both species of helminth were found to be located significantly more anteriorly in the sections of the small intestine. No evidence was found of any association between owl body weight and the number of worms present.

Key Words: *Acanthocephala*; *Great Britain*; *Nematoda*; *parasitism*; Strix aluco; *tawny owl.*

Distribución de *Centrorhynchus aluconis* (Acanthocephala) y *Porrocaecum spirale* (Nematoda) en *Strix aluco* de Gran Bretaña

Resumen.—Intestinos delgados de una muestra de 109 individuos de *Strix aluco* fueron examinados con el fin de detectar la presencia de helmintos endoparásitos. La mayoría de los individuos colectados murieron en carreteras de diferentes localidades de Inglaterra, Escocia y Gales, entre noviembrede 1983 y septiembre de 1991. *Centrorhynchus aluconis* (Acanthocephala) fué encontrado en el 67.9% de los individuos lo que indicaría una amplia distribución de este helminto en *S. aluco* en Gran Bretaña. *Porrocaecum spirale* (Nematoda) fué encontrado en el 18.3% de los individuos. Coexistencia de infecciones ocurrieron en el 11.9% de los individuos muestreados. *Centrorhynchus aluconis* se localizó en la porción media posterior y *P. spirale* en la porción media anterior del intestino delgado. Cuando ocurrió infección simultánea, la distribución generalmente se mantuvo. Sin embargo, ambas especies de helmintos se localizaron significativamente en sectores más anteriores del intestino delgado. No hubo evidencia de alguna asociación entre el peso de los individuos y el número de gusanos presentes.

[Traducción de Ivan Lazo]

All members of the phylum Acanthocephala are endoparasitic at all stages of their life histories. Sexual maturity is attained in the small intestine of vertebrate definitive hosts and development occurs in the body cavity of arthropod intermediate hosts. Transmission between hosts depends on the oral route; invariably paratenic hosts are involved in the life histories of acanthocephalans whose definitive hosts are often predators at the top of food chains (see Crompton and Nickol 1985).

Centrorhynchus is one of the largest genera of the phylum with many species requiring raptors as definitive hosts (Yamaguti 1963). In the United Kingdom, sexually mature *C. aluconis* have been found by Ewald and Crompton (1993) in tawny owls (*Strix aluco*). Out of a sample of 23 tawny owls, most of which had died in road accidents and were given by members of the public to Monks Wood Experimental Station, Cambridgeshire, Ewald and Crompton found that 17 harbored *C. aluconis*. The carcasses of these infected owls, which came from sites as widely separated as Ewhurst in Surrey, England, and Tarbet in Strathclyde, Scotland, had been collected between November 1987 and August 1990. Earlier, Ewald et al. (1991) had found encysted *C. aluconis* in the body cavities of common and pygmy shrews (*Sorex araneus* and *S. minutus*) from Cambridgeshire, indicating that these insectivores were likely to serve as paratenic hosts for *C. aluconis* despite the fact that shrews are not considered to be preferred prey items

Table 1. The prevalence (%) and intensity (mean worm burden per infected owl ± standard deviation) of *Centrorhynchus aluconis* (Acanthocephala) and *Porrocaecum spirale* (Nematoda) in single and concurrent infections in tawny owls (*Strix aluco*) from Great Britain.

HELMINTH INFECTIONS	ALL OWLS[a] (N = 109)	MALE OWLS (N = 47)	FEMALE OWLS (N = 52)
	PREVALENCE (%)		
C. aluconis	67.9 (74/109)	66.0 (31/47)	67.3 (35/52)
C. aluconis (single)	56.0 (61/109)	51.1 (24/47)	55.8 (29/52)
P. spirale	18.3 (20/109)	25.5 (12/47)	15.4 (8/52)
P. spirale (single)	6.4 (7/109)	10.6 (5/47)	3.8 (2/52)
C. aluconis and *P. spirale* (concurrent)	11.9 (13/109)	14.9 (7/47)	11.5 (6/52)
	INTENSITY ($\bar{x}$ ± SD)		
C. aluconis	16.9 ± 19.4 (N = 74)	14.3 ± 14.1 (N = 31)	16.5 ± 20.2 (N = 35)
C. aluconis (single)	16.2 ± 17.0 (N = 61)	14.3 ± 13.4 (N = 24)	14.3 ± 14.1 (N = 29)
C. aluconis (concurrent)	20.1 ± 28.8 (N = 13)	14.1 ± 17.5 (N = 7)	27.0 ± 38.9 (N = 6)
P. spirale	15.0 ± 17.0 (N = 20)	17.3 ± 20.6 (N = 12)	11.4 ± 9.8 (N = 8)
P. spirale (single)	7.7 ± 6.7 (N = 7)	9.0 ± 7.8 (N = 5)	4.5 ± 0.7 (N = 2)
P. spirale (concurrent)	18.9 ± 19.7 (N = 13)	23.3 ± 25.2 (N = 7)	13.7 ± 10.4 (N = 6)

[a] Information was not available about the sex of 10 of the owls.

of tawny owls (Southern 1954, Kirk 1992). Five of the owls examined by Ewald and Crompton (1993) were infected with the ascarid nematode (*Porrocaecum spirale*) which is also known to infect shrews (Crofton 1966). The intermediate host of *C. aluconis* remains elusive (Schmidt 1985). It is likely to be a terrestrial arthropod and perhaps a species of isopod should be sought since Marchand and Grita-Timoulali (1992) have recently found that *Porcellionides pruinosus* is a suitable intermediate host for *C. milvus*, a parasite of the black kite (*Milvus migrans*) in Senegal.

Here, we present further information about host-parasite relationships between tawny owls, *C. aluconis*, and *P. spirale*. The results were obtained from the examination of the alimentary tracts of a further sample of 109 tawny owls which were originally part of a study conducted by Steve Petty on behalf of the Wildlife and Conservation Research Branch of the Forestry Authority, Ardentinny, Argyll, Scotland. Most of the owls had died in road accidents and were collected between November 1983 and September 1991.

MATERIALS AND METHODS

The alimentary tracts of the owls had been stored at −20°C prior to examination; no information was available on how long specimens were dead before freezing took place. After being allowed to thaw at room temperature, the tract was slit open longitudinally from the esophagus to the ileo-caeco-colic junction and the numbers of helminths and sex of each were recorded together with its position in the gut. Measurement of the location of the worms in the small intestine is difficult; the locations observed at *post-mortem* examination may differ from those occurring in a living host (see Freehling and Moore 1987) All measurements were made by the same observer in all cases. Position was estimated by expressing either the attachment point or anterior end of the helminth in terms of its percentage distance along the length of the small intestine from the pylorus (anterior, 0%) to the ileo-caeco-

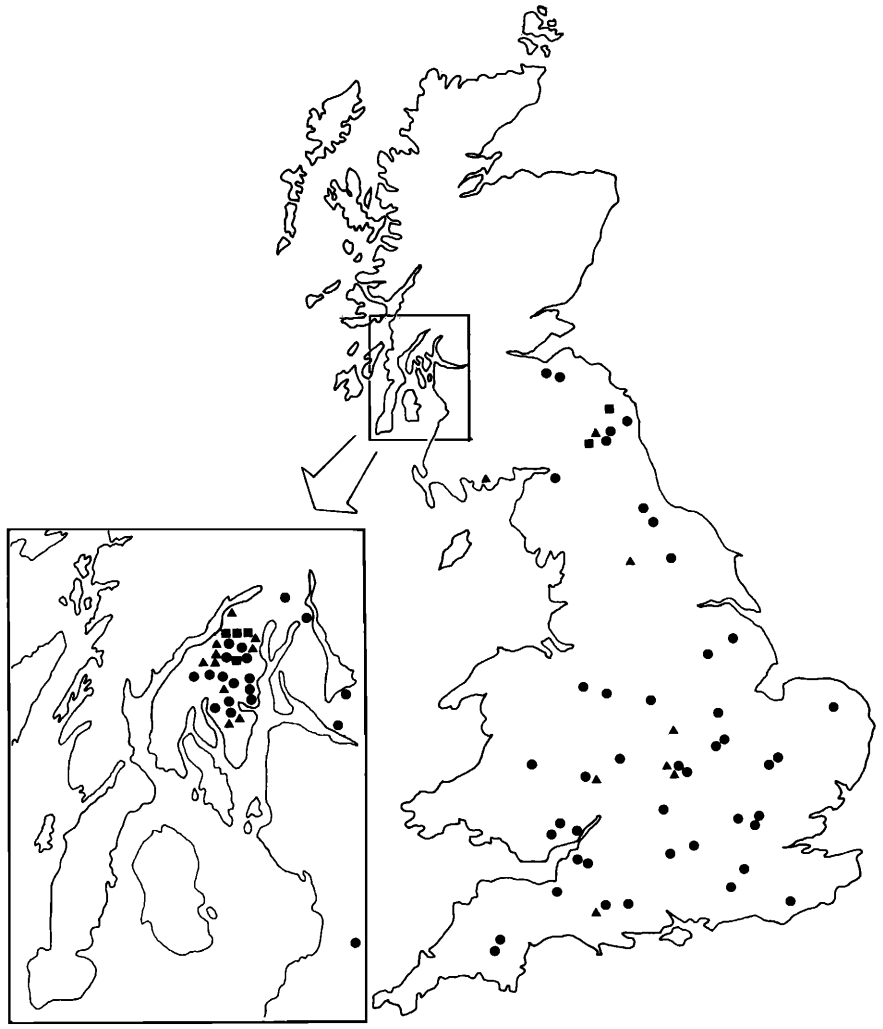

Figure 1. The general distribution (not to precise locations) of *Centrorhynchus aluconis* and *Porrocaecum spirale* in the sample of tawny owls collected in Great Britain. Locations for some of the owls examined (Table 1) could not be included because of incomplete information. Also included are locations from 17 infected tawny owls examined by Ewald and Crompton (1993). *C. aluconis*; ●. *P. spirale*; ■. *C. aluconis* and *P. spirale* in concurrent infections; ▲.

colic junction (posterior, 100%). Contents of the gizzard were examined and identified after storage in 10% aqueous formaldehyde solution. Statistical investigation of the data was carried out with Minitab Version 8. When $P < 0.05$, the result was judged to be statistically significant.

OBSERVATIONS AND DISCUSSION

Prevalence and Distribution. Helminths identified as *Centrorhynchus aluconis* (Müller, 1780) and *Porrocaecum spirale* (Rudolphi, 1795) were recovered as single infections from the small intestines of 61 and seven tawny owls, respectively, and as concurrent infections from 13 tawny owls. Identification was based partly on comparison with specimens studied by Ewald and Crompton (1993) and lodged in The Natural History Museum, London. The acquisition numbers are 9304, 9313, and 9366 for *C aluconis* and 9380 for *P. spirale*. Overall 67.9% of the owls were found to be infected with *C. aluconis* and 18.3% with *P. spirale* (Table 1). Statistical investigation indicated that the occurrence of both the

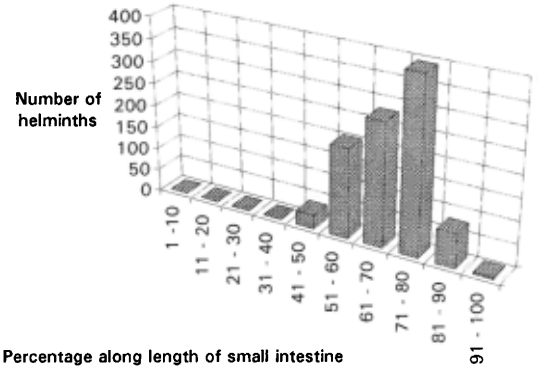

Figure 2. Location of *Centrorhynchus aluconis* in single infections in the small intestine of tawny owls. Note that significant *post-mortem* effects may have occurred before the owls were examined (see also Figs. 3 and 4). The mean location was found to be 68.9% of the distance along the length of the small intestine and the 95% confidence interval was 68.2–69.6%.

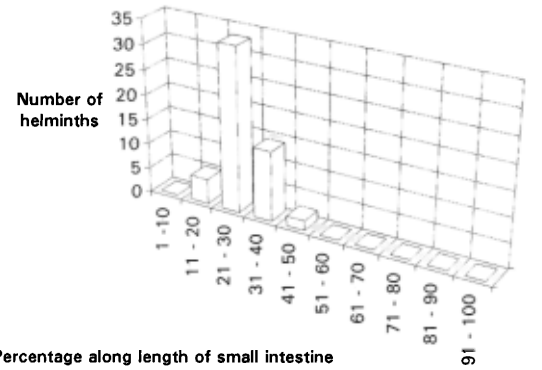

Figure 3. Location of *Porrocaecum spirale* in single infections in the small intestine of tawny owls. The mean location was found to be 27.6% of the distance along the length of the small intestine and the 95% confidence interval was 25.7–29.6%.

acanthocephalan and the nematode in the same owl was the result of random events; the two species of helminth did not appear to be either positively or negatively associated with each other ($\chi^2 = 0.13$, df = 1, $P > 0.05$). No significant difference was detected between owl sex and the prevalences of *C. aluconis* ($\chi^2 = 0.06$, df = 1, $P > 0.05$) and *P. spirale* ($\chi^2 = 1.63$, df = 1, $P > 0.05$).

Information about the sites where the owl carcasses were found strongly suggests that *C. aluconis* is widely distributed in Great Britain and that tawny owls serve as important definitive hosts for this helminth. An impression of the general distribution is given in Fig. 1. This distribution map overlaps with maps displaying the distributions of tawny owls and shrews (Sharrock 1976, Corbet and Southern 1977). *Porrocaecum spirale* is probably equally widely distributed in Great Britain (Fig. 1), but the lower prevalence value (Table 1) means that this is no more than a tentative conclusion.

Intensity. On average, owls infected with *C. aluconis* harbored 16.9 ± 19.4 worms and those with *P. spirale* harbored 15.0 ± 17.0 worms (Table 1). Since the intensity data were found not to be normally distributed, a logarithmic transformation was carried out to allow for the use of parametric statistics. For both species of helminth, no significant differences in intensity were observed between male and female owls (*C. aluconis*, $t = -0.93$, df = 64, $P = 0.36$; *P. spirale*, $t = 0.01$, df = 18, $P = 0.99$) or between single and concurrent infections (*C. aluconis*, $t = -0.15$, df = 72, $P = 0.88$; *P. spirale*, $t = 0.84$, df = 18, $P = 0.41$).

Frequency Distribution of Numbers of Worms Per Owl. The variance : mean ratio ($S^2/\bar{x}$) for the numbers of *C. aluconis* per owl, regardless of the presence of *P. spirale*, was found to be 22.2 indicating that the acanthocephalan's distribution within the owls was highly overdispersed (see Anderson and Gordon 1982). The pattern was observed with data obtained from either male or female owls or from adult (>3 yr) or immature birds. A similar pattern was observed for the frequency distribution of numbers of *P. spirale* per owl ($S^2/\bar{x} = 19.4$) even though the number of owls infected with this species was much less than the number infected with *C. aluconis* (Table 1).

Location of *C. aluconis* and *P. spirale* in the Small Intestine. The mean length of the small intestine of the owls examined in this study was about 760 mm, but it should be noted that the alimentary tract had been frozen and thawed before the measurements were made and so may not reflect the condition in living birds. The locations of *C. aluconis* and *P. spirale* in single infections are illustrated in Figs. 2 and 3 and in concurrent infections in Fig. 4. Before statistical investigation, the data were subjected to arcsine transformation for dealing with percentages. The results of one-way ANOVA ($F = 1241$, df = 3, 1539, $P < 0.001$) and the application of tests for least significant differences showed that the locations of *C. aluconis* in single and concurrent

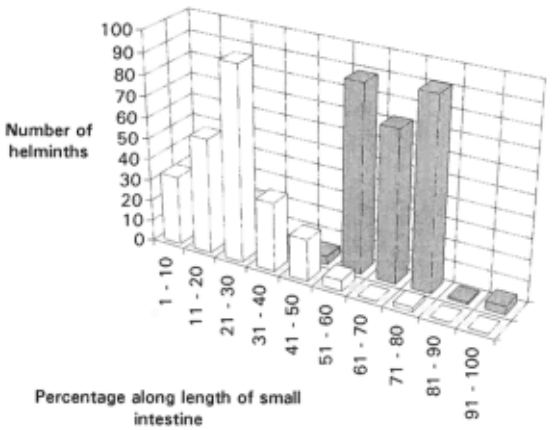

Figure 4. Locations of *Centrorhynchus aluconis* ■ and *Porrocaecum spirale* □ in concurrent infections in the small intestine of tawny owls. The mean location of *C. aluconis* was found to be 66.6% of the distance along the length of the small intestine and the 95% confidence interval was 65.5–67.7%. The location of *P. spirale* was 20.7% and the 95% confidence interval was 19.2–22.3%.

infections were significantly different (Fig. 2, 4; $P < 0.05$) as were those of *P. spirale* (Fig. 3, 4; $P < 0.05$). Also the locations of *C. aluconis* in single and concurrent infections differed significantly from those of *P. spirale* and *vice versa* (Fig. 2, 3, 4; $P < 0.05$).

Host Body Mass and Intensity of Infection. For convenience, owls were sorted into two groups consisting of those with body masses of <400 g or >400 g with the aim of investigating any effects of intensity of infection on body mass. No evidence was obtained to suggest that there was any association between the number of worms of either species present and the body masses of the owls (*C. aluconis*, $t = 0.50$, df = 62, $P = 0.62$; *P. spirale*, $t = 1.75$, df = 17, $P = 0.098$).

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