Competition between Two Closely Related \textit{Tetrabothrius} Cestodes of the Fulmar (\textit{Fulmarus glacialis} L.)

J. Riley* and R. Wynne Owen

Department of Zoology, The University, Leeds

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Summary. The two congeneric \textit{Tetrabothrius} cestodes of the fulmar are so closely related that they can only be reliably distinguished by differences in the number of testes. The two species show a considerable distributional overlap along the intestine. Statistically it can be shown that high numbers of the common, anteriorly situated species (\textit{T. minor}) affect the distribution of the rarer, more posteriorly situated species (\textit{T. procerus}), causing the latter to occupy a more posterior site in the intestine. Several possibilities are discussed concerning the mechanism by which \textit{T. procerus} is affected, and how this mildly competitive situation is maintained. It is probable that niche segregation between the two species is more or less complete, but that this is reinforced in concurrent infections by interactive site segregation.

Introduction

In a survey of the parasite fauna of the fulmar (\textit{Fulmarus glacialis} L.) only three species of parasites were found to inhabit the intestine (Riley, 1970). One, the heterophyid trematode \textit{Cryptocotyle lingua} was present in low numbers (average of 38/bird) in all the birds examined. The remaining two were the closely related cestodes \textit{Tetrabothrius minor} (Loennberg, 1893) and \textit{Tetrabothrius procerus} (Späthlich, 1909).

A preliminary analysis of the distributions of the two cestodes indicated that they favoured different regions of the small intestine, but nevertheless there was a considerable distributional overlap. A more detailed analysis was initiated therefore, to establish whether the presence of one species modified, in any way, the distribution of the other.

Mayr (1957) noted that there are numerous records from the literature of the existence of two or more congeneric species in the same host, and as one of several examples, he cites the two tetrabothrid cestodes of the fulmar. Mayr adds "that the literature rarely states how many of these species can coexist in the same host individual, or to what degree parasites segregate into different parts of the intestinal tract or other parts of the body"; in other words, to what extent do they compete.

A fundamental tenet of ecology is the Gause hypothesis which simply stated is, "that two species with a similar ecology cannot coexist in the same place." Inherent in this concept is that the two species would compete and that one would be eliminated. The arguments against a rigid interpretation of this competitive exclusion principle are given by Williamson (1972). Suffice it here to

* Present address: Department of Biological Sciences, The University, Dundee DD1 4HN, Scotland.
say that mild competition in nature is probably widespread, but severe competition, to the point of the extinction of one of the competitors, is rare. However, competition is a considerable diversifying evolutionary pressure and the data presented in this paper suggest that interactive site segregation, a mildly competitive situation, occurs when the intensity of infection is high.

**Materials and Methods**

Thirty fulmars were taken during the months of January, February and July in 1968. All birds were shot between the hours of one and three p.m. thereby minimising possible effects due to diurnal migrations of parasites within the host.

Corpses were taken to the laboratory within 6 hrs where they were deep frozen to $-24^\circ C$ for subsequent dissection. The length of intestine from the gizzard to the rectal caeca was removed and the duodenal loop was separated from the remainder of the intestine, which was divided into tenths. The gut was opened longitudinally and the cestodes were segregated into each section of gut to avoid severing them when the sections were separated. Segments of gut were then transferred to water where the cestodes were gently brushed out. The washings were poured through a 300 μm mesh sieve and transferred to a petri dish for counting.

Worms were fixed briefly in 10% formol-saline, washed, and stained *en masse* in Demké's celestin blue solution for 10–20 min. Stained cestodes were washed, dehydrated in graded alcohols, and cleared in oil of wintergreen for final identification. Staining was necessary because the two cestodes can only be reliably distinguished by differences in the number of testes: *T. minor* 6–12 *contra* *T. procerus* 15–20 (Baer, 1954) (Fig. 1).

**Results**

Table 1 shows the incidence and range of numbers of the two cestode species collected from 30 birds. From a preliminary examination of the cestode burden of the first 10 birds it was apparent that the two species favoured different regions.