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Polymorphus minutus (Acanthocephala) infestation in eiders and its role as a possible cause of death

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One adult male and seven juvenile eiders (*Somateria mollissima*) were studied for acanthocephalan parasites in order to evaluate the role of the parasites in the high mortality of juvenile birds in the archipelago of southwestern Finland in the summers of 1976—1979.

Six of the juvenile birds were found dead. In two of them the infestation by *Polymorphus minutus* (Goeze) was as high as 2200 and 3500 specimens. The acanthocephalans were attached to the intestinal wall. It is suggested that in these cases death was caused by this parasite. In the other cases the number of parasites did not exceed 50 exx.

The sex ratio and the developmental stages of the female worms were studied. According to these criteria, the infestations by *P. minutus* in all the studied eiders were fresh.

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1. Introduction

Acanthocephalans may cause death in both wild birds (Lampio 1946, Sandford 1978) and domestic ducks (Hynes & Nicholas 1963). This report discusses the possible cause of death of eiders (*Somateria mollissima*) in southern Finland and also studies the natural development of *Polymorphus minutus* (Goeze, 1782) infestation in birds.

2. Description of cases and methods

The history of the cases is described below and the results are summarized in Table 1.

Case I (IA—IB). Two dead juvenile eiders found in July, 1976, in the northern Åland archipelago (Idskär, Geta; Grid 27° E 672:10). Both birds contained enormous numbers of acanthocephalans in their intestines (Fig. 1; Table 2).

Case II. Four dead juvenile eiders (IIA—IID) collected on 11.6.1979 from among hundreds of dead birds in the archipelago of Rauma, southwestern Finland (Grid 27° E 679:19). A total of 85 *Polymorphus minutus* worms were found in these birds.

Case III. A juvenile hatched in the summer of 1979 and shot on 3.9.1979 in the area described in case II. It contained 24 parasites.

Case IV. A male shot at the beginning of June 1979 in the same area. It contained only one acanthocephalan — *Filicollis anatis* (Schrank, 1788).

In order to study the development of *P. minutus*, the intestine was divided into quarters (first quarter being that closest to the ventricle), and the worms collected from the quarters of the intestine. In case IB 166 worms were collected and studied from the quarters of the intestine as follows: whole 1st quarter 27 specimens, 2nd and 3rd quarters only specimens from 1 cm of intestine each (55 and 46 specimens, respectively), 4th quarter only specimens from 2 cm of the quarter (38 specimens). All the worms were collected in the other cases.

The sex and developmental phase of the females was determined for all the worms sampled, except in Case IA in which only the number of parasites was estimated. The females were classified into specimens with ovarian balls (young) and mature females with eggs. The length of fresh preparations of the parasites was measured to an accuracy of ±0.1 mm. All work was carried out using a binocular microscope with ×10 magnification.

3. Results

An average of 46.8 % of the parasites in all cases studied were males; the actual values were 50 % or higher, except in Case IID where the percentage of males was remarkably low (less than 28 %; $\chi^2 = 9.95$, $P < 0.05$). In IIA, IIC

Fig. 1. *Polymorphus minutus* (Goeze, 1782) (Acanthocephala) worms in the intestine of *Somateria mollissima* L. Case I (see history of cases). Black stripe = 1 cm.

and IID all the female worms were young; often so young that the ovarian balls had not yet disintegrated. The females in Case IB were also mostly young (about 81 %). In case III the proportion of males was high, although the eggs had already been fertilized, and maturing (though not mature) zygotes were found in 83.3 % of females.

The second and third quarters were the most favoured sites for the parasites in all cases. 34.9 % of the worms in Cases II and III and 45.3 % in Case IB were found in the second quarter, and 47.7 % in Cases II and III and 37.9 % in Case IB were found in the third quarter. Only 17.4 % of the worms in Cases II and III and 15.6 % in Case IB were found in the fourth quarter. No worms were found in the first quarter in Cases II and III and only 1.2 % were found in the first quarter in Case IB (Table 1).

The acanthocephalans which occurred in the first quarter of the intestine in Case IB were smaller than those found elsewhere in the intestine from that case (Table 2). There was no difference in the lengths of males between the 2nd, 3rd and 4th quarters or between the cases. This situation was not reflected in the females. Females with eggs were longer than young females in all cases. It can be seen, even from this small amount of material, that the parasites are smaller when there are large numbers in the intestine (e.g. the worms in Case IB compared to those in Cases II and III (see also Burlingame & Chandler 1941)).

4. Discussion

4.1. Life-cycle

Polymorphus minutus is an example of an animal which is totally parasitic: larval phases occur in intermediate hosts such as *Gammarus pulex* L. (Lampio 1946, Hynes & Nicholas 1963, Soulsby 1968, Lindgard & Crompton 1972), *G. duebeni* Lilljeborg and *G. lacustris* Sars (Nicholas & Hynes 1958), *G. zaddachi* Sexton (Valtonen, E. T.

Table 1. Quantitative data of the cases of *Polymorphus minutus* in eiders in Finland.

Case	Weight of bird (g)	No. of *P. minutus*	♂♂ (% of total)	Young ♀♀ (% of ♀♀)	Length of parasites (mm) ♂♂	Young ♀♀	♀♀ with eggs	Distribution in intestine quarters (%) 1st	2nd	3rd	4th	Other notes
IA	400	3500	not investigated					full of parasites				
IB	400	2200	51.1	80.9	5.1 (33)	5.9 (21)	7.3 (10)	1.2	45.3	37.9	15.6	
IIA	77	20	50	100	7.2 (3)	9.4 (5)	—		5	85	10	Many trematodes in 1st quarter.
IIB	78	—										Hundreds of trematodes in 1st and 2nd.
IIC	80	18	55.5	100	6.3 (7)	6.6 (6)	—		6.2	87.6	6.2	Abundant trematodes in 1st.
IID	103	47	27.7	100	6.3 (5)	6.9 (14)	—		76.6	17.0	6.4	— » —
III	550	24	50	16.7	10.6 (6)		11.6 (8)			54.2	45.8	Trematodes in 2nd, Cestodes in 3rd, 4th.
IV	2300	—										One *Filicollis anatis* (22.2 mm) in 1st.

Table 2. *Polymorphus minutus* acanthocephalans in different quarters of the intestine of a dead juvenile eider from Åland, Finland 18. VII. 1976. (Case IB).

	Quarter 1	2	3	4
Number of parasites				
total	27	996	833	344
investigated	27	55	46	38
♂♂ (% of total)		52.7	45.7	55.3
Young ♀♀ (% of ♀♀)		80.8	76.0	88.2
Mean length of parasites (mm, N)				
♂♂		5.1 (10)	5.0 (11)	5.3 (12)
young ♀♀		6.2 (7)	5.8 (7)	5.8 (7)
♀♀ with eggs		5.8 (5)	7.9 (4)	7.3 (1)
sex undet.	3.6 (20)			

unpubl.), *G. oceanicus* Segerstråle (Fagerholm, unpubl.) and *Carcinus moenas* (L.) (Rayski & Garden 1961). In general, hosts seem to be mainly shrimps of the genus *Gammarus*, where *P. minutus* develops to the cystacanth stage. *G. duebeni* specimens (det. Pentti Kangas) were found in the stomach of an eider shot in September, 1979, and which was obviously the carrier of the parasite in this case.

Several waterfowl have been reported as being the final hosts of this parasite: the domestic duck in England (Hynes & Nicholas 1963), the mallard (*Anas platyrhynchos*), tufted duck (*Authya fuligula*) and other aquatic birds in England (Crompton & Harrison 1965), aquatic birds in Yugoslavia (Brglez 1977) and in Sweden (Lundström 1942) (see also Bezubik 1956 and Styczynska 1958). Epidemic cases have been observed in eiders in Finland (Lampio 1946, Grenquist 1952) and in Sweden (Borg 1949).

P. minutus has also been found by chance in fish, where it cannot, however, mature. Fagerholm & Valtonen (1980) reported this acanthocephalan from the Åland area, in the stomach and intestine of *Coregonus lavaretus*, which is known to feed on *Gammarus* species (Valtonen, T. 1976).

4.2. Age of infestation

It has been observed that the relative number of male and young female acanthocephalans indicates the age of infestation in poikilothermic fish (Bauer & Nikolskaya 1957, Valtonen, E. T. 1980), homothermic birds (Hynes & Nicholas 1963, Crompton & Whitfield 1968), white rats (Burlingame & Chandler 1941, Crompton et al. 1972) and seals (Helle & Valtonen, E. T. 1980). At the onset of infestation the proportions of the sexes tend to be equal, whereas when the animal has been infested for a longer period the number of males decreases and the young females carrying ovarian balls develop into those carrying eggs.

According to Nicholas & Hynes (1958), the ovary of *P. minutus* in common ducks disintegrates into ovarian balls by the 4th day. The first eggs were found in the females after three weeks, while very few male worms were found by the 36th day of infestation (Crompton & Whitfield 1968), and according to Nicholas & Hynes (1958), no male worms were found after 32 days. In the ringed seal, the presence of females in the young ovarian ball stage may be a more precise indication of the freshness of infestation than the decreasing proportion of the males (Helle & E. T. Valtonen 1980).

According to these observations, the *P. minutus* infestation in all of the present cases seems to have been fresh (e.g. the ovaries of many females had not yet begun to disintegrate into ovarian balls). In single cases (from the year 1979) the ♂/♀ ratio was either 1:1 or even dominated by males (Case IIC). Case IID was an exception in which the ♂/♀ ratio of 1:2.6 indicates an older infestation. However, this is denied by the immaturity of the females. The decrease in numbers of males almost seems to have happened too early in Case IID, because in the female worms the eggs had not even started developing when the males had begun to decrease. This phenomenon seems therefore to be the result of a change disruption in the male/female ratio in the intermediate hosts. Crompton & Harrison (1965) found worms of varying age in the natural infestations of wildfowl shot in Kent.

The infestation in Case III, in which the bird was shot and thus not killed by the parasites, was a little older because the eggs were maturing (though not yet mature; see Tedla & Fernando 1970) although the proportion of males was high. In this case, therefore, the infestation seems to have been younger than three weeks according to the data of Nicholas & Hynes (1958) and Crompton & Whitfield (1968).

4.3. Localization of the parasites in the intestine

Nicholas & Hynes (1958) showed that *P. minutus* favours the posterior half of the bird's intestine, especially the region just behind the yolk stalk. The majority of the *P. minutus* worms were attached in a zone from 65 to 85 % of the length of the intestine in the mallard (Crompton & Harrison 1965). The parasite has been found to occupy the same region of the intestine in domestic ducks, whereas it occupies a more anterior region in the tufted duck (Crompton & Harrison 1965). The same phenomenon was seen in this study; the second and third quarters of the intestine appeared to be the most favoured sites of attachment. Most of the worms were located in these areas in all cases. The slight reduction in the occurrence of males and young females in the third quarter of Case IB can be understood against this background. The first invaders occupy the preferential sites, forcing subsequent worms to spread to nearby regions.

The avoidance of the first quarter as a location for *P. minutus* was quite clear in all cases. This may be connected with the fact that the worms pass quickly through this area and have just evaginated by the time they reach the second quarter. This can be seen from the first quarter of Case IB, in which most of the posterior ends of the worms were (at least partly) invaginated as is the case in intermediate hosts, although some parasites had attached themselves lightly to the mucosa of the intestine by their proboscis. This also explains the shortness of the parasites in comparison to those in other parts of the intestine.

Hynes & Nicholas (1963) state that an infestation intensity of even 100 worms is not detrimental to the condition of the host, and apparently much larger numbers are needed to cause serious damage. Sandford (1978) found 150—2000 specimens of *Polymorphus boschadis* (syn. *P. minutus*) in dead cygnets (*Cygnus olor*). This infestation was believed to have killed the hosts. It is therefore possible that the birds in Cases IA and IB were killed by the parasites. The numbers found in the young eiders during 1979 were much lower than these. That the cause of death was the same in these cases cannot, however, be excluded, because the juvenile birds were only about 7—10 days old and their resistance to the detrimental effects of the infestation was probably not well developed. The present report does not, however, exclude the possibility that these juvenile birds were killed by some other factor such as a secondary bacterial infection. The heavy trematod infestation found in some of the cases should also be studied. This may have been the cause of death in the eider in Case IIB which contained no acanthocephalans but showed heavy trematode infestation. It is also possible that starvation during the course of the infestation may have decreased the number of *P. minutus* originally present (Nicholas & Hynes 1958).

The mechanisms by which the worms perhaps cause death to their host follows a pattern. The parasites penetrate deeply into the mucosa with their proboscis and produce anaemia, cachexia, mechanical damage to the intestine and subsequent loss of weight, which may finally lead to the death of the host (Lampio 1946, Soulsby 1968, Wehr 1972).

The localization of cystacanths to the favoured site is rapid; 25 min after infestation they are located at the yolkstalk region and the first evaginations can be observed (Lindgard & Crompton 1972). These authors explain the accumulation of cystacanths in this region as a result of peristalsis, which is known to be reduced posteriorly in the alimentary tract.

The juvenile birds in the present study died before the maturation of the parasite. As our figures show (Table 1) none of the female worms in Cases II and III had mature infective acanthors. In Case IB they made up only 19.1 % of all parasites studied. This suggests that the parasites themselves regulate the size of their own population and it is probable that the parasite population decreases rapidly.

4.4. Filicollis anatis infestation (Case IV)

Firstly, the intermediate host of *F. anatis* is *Asellus aquaticus* (L.) (Soulsby 1968), a shrimp which is found in fresh water, in Finland. Secondly, the eider was still in the mating condition which indicates that it had recently come from the wintering areas. Because the parasite specimen was a female with acanthors (length 22.2 mm) it is assumed to have originated from the wintering areas or possibly during the previous autumn. This species has been found earlier in eiders in Finland (Lampio 1946), as well as in other aquatic birds in the Hailuoto area, in northern Finland (Valtonen, E. T. & Merilä, E. unpubl.).

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