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THE TOTAL BODY CONDITION FACTOR OF SOUTHERN BALTIC STOCKS OF HERRING *CLUPEA HARENGUS MEMBRAS* (L.) INFECTED AND NON-INFECTED WITH ANISAKID LARVAE

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Abstract

From January 1995 to January 1996 and in April 1996, 9026 specimens of herring *Clupea harengus membras* were caught in ICES-Subdivisions 24, 25, 26 and 27 in the southern Baltic. All fish were examined for nematodes. 5242 *Anisakis simplex* (Rudolphi, 1809) and 3 specimens of *Contracaecum osculatum* (Rudolphi, 1809) (3rd stage larvae) were collected. Only coastal spring herring were infected with *A. simplex*; *C. osculatum* was found in open sea herring. The total body condition factor K of each fish was calculated according to Fulton. The mean body condition factor was found to be higher in infected than in non-infected fish. The highest value of factor K was observed in fish with gonads at stage 6. Factor K reached a minimum in fish infected with 11-20 specimens of *A. simplex* larvae.

INTRODUCTION

Infection with endoparasites may be a source of dysfunction in the host organism. The presence of nematodes and their migration within the viscera could influence the condition of fish.

The aim of the present research was to investigate the relationship between the intensity of Anisakid larvae invasion and the total body condition factor K in infected herring.

MATERIAL AND METHOD

9026 specimens of herring *Clupea harengus membras* were investigated from January 1995 to January 1996 and in April 1996. Samples of herring were taken from coastal and off-shore fishing grounds in ICES-Subdivision 24, 25, 26 and 27, and from the Vistula Lagoon. Fig. 1 shows the fishing grounds in the Baltic Sea.

The sex, gonad stage, total body length and weight of each fish were determined. The total body condition factor was calculated according to Fulton:

$$K = \frac{G}{L^3} \times 100$$

where K – total body condition factor, G – weight [g], L – length [cm]

The occurrence and location of parasitic nematodes in the body cavity were investigated. Spawning populations of fish were classified according to Kompowski's otolith method (1971).

RESULTS

5242 *Anisakis simplex* and 3 specimens of *Contracaecum osculatum* (both species in their 3rd larval stage) were collected. The fish belonged to the three spawning populations – coastal spring herring (5427 specimens), open sea herring (3032) and autumn herring (567). *A. simplex* larvae occurred only in the coastal spring herring, but larval *C. osculatum* were found in the off shore spring population. The autumn herring were free of nematodes.

The number of nematodes found varied from 1 to 87 specimens per fish. *A. simplex* larvae were present mainly in the body cavity, in the mesentery, on the gonads and the pyloric appendices. *C. osculatum* larvae were found in the liver.

The total body condition factor K was found to be higher in herring taken from coastal fishing grounds in ICES-Subdivisions 24, 25 and 26. K was lowest in fish from ICES-Subdivision 27 (Table I). These values were calculated for the total number of fish examined. Similar results were obtained for the coastal spring population (Table II).

The mean total body condition factor varies in the several spawning populations of herring, the highest value being recorded among coastal spring herring, the lowest in autumn herring (Fig. 2).

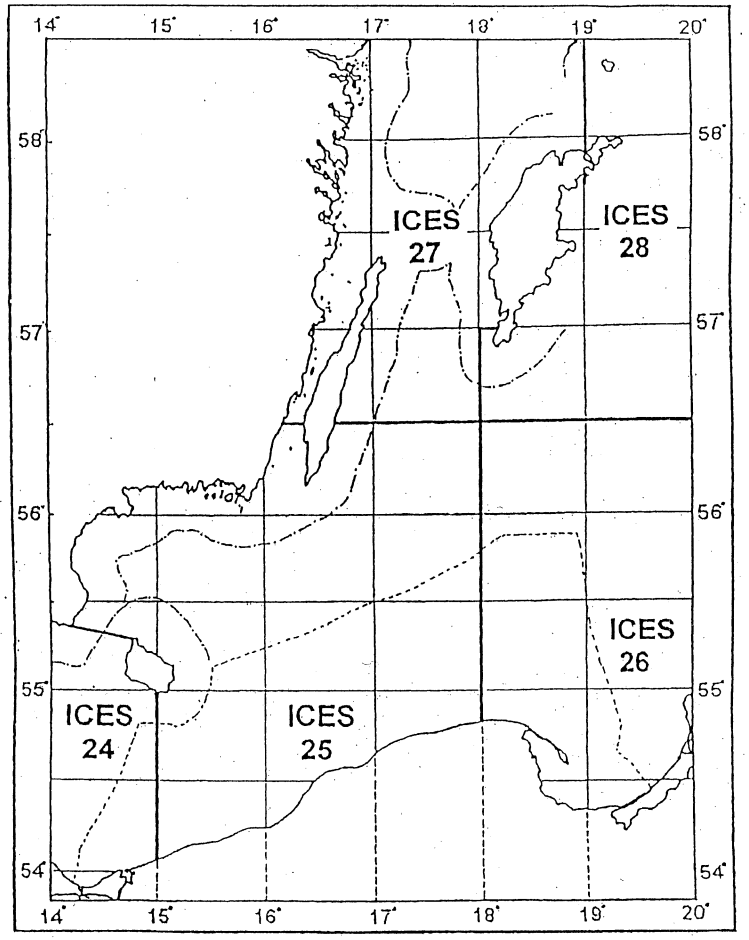

Fig. 1. Fishing grounds of the Baltic Sea

The analysis suggests that K was higher in herring from the coastal, rather than off shore fishing grounds in the subdivisions investigated. In the majority of the samples, this factor was higher in infected than in non-infected fish. Its highest value was recorded in fish caught in the above-mentioned coastal fishing grounds (Fig. 3).

K increases in value according to the number of parasites and is highest in cases of infection with 11-20 nematodes. In fish infected with > 20 parasites, however, K decreases. A similar relationship was observed in the coastal spring population (Fig. 4).

Table 1

The mean total body condition factor K in herring from several ICES-subdivisions

ICES	FISHING GROUND	NUMBER OF FISH	MEAN VALUE OF K IN FISH		
			EXAMINED	INFECTED	NON-INFECTED
24	COASTAL	188	0,722	0,761	0,676
25	COASTAL	113	0,763	0,776	0,747
	OFFSHORE	3824	0,612	0,721	0,608
26	COASTAL	336	0,753	0,761	0,746
	OFFSHORE	3631	0,613	0,698	0,611
	VISTULA LAGOON	345	0,686	0,756	0,655
27	OFFSHORE	586	0,579	0,554	0,579

Table 2

The mean total body condition factor K in coastal spring herring from several ICES-subdivisions

ICES	FISHING GROUND	NUMBER OF FISH	MEAN VALUE OF K IN FISH		
			EXAMINED	INFECTED	NON-INFECTED
24	COASTAL	188	0,722	0,761	0,676
25	COASTAL	113	0,763	0,776	0,747
	OFFSHORE	2000	0,624	0,722	0,615
26	COASTAL	319	0,751	0,761	0,742
	OFFSHORE	2436	0,614	0,7	0,611
	VISTULA LAGOON	336	0,687	0,756	0,654
27	OFFSHORE	35	0,591	0,554	0,592

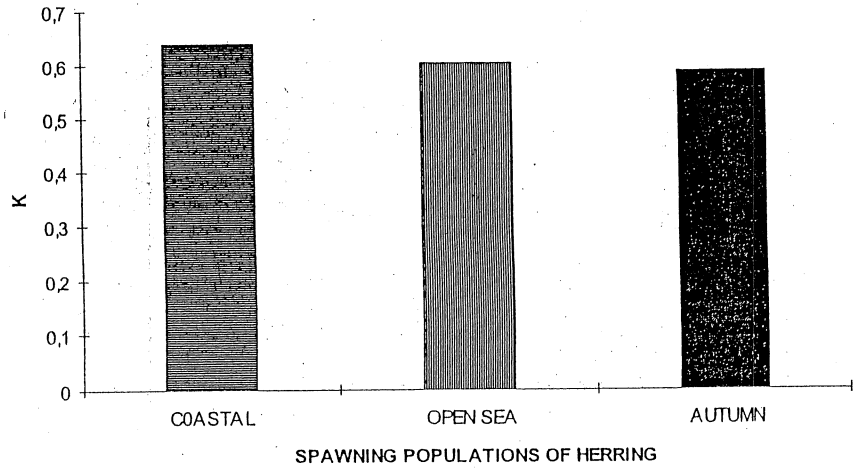

Fig. 2. The total body conditionfactor K in several spawning populations of Baltic herring

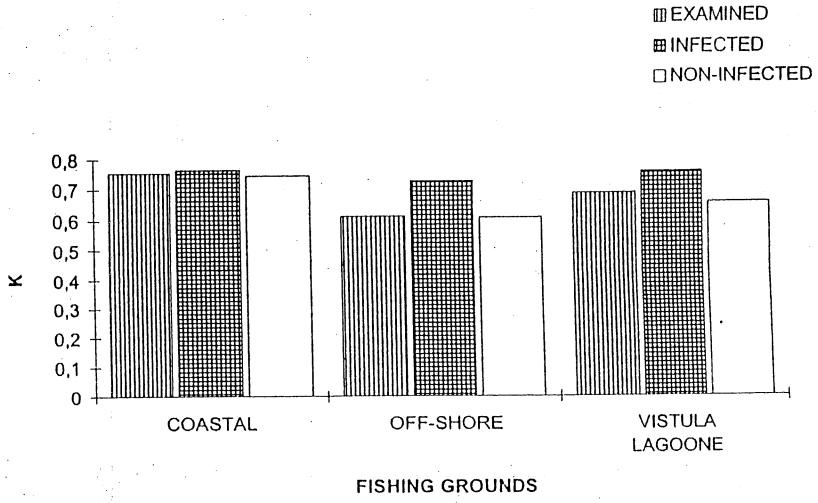

Fig. 3. The total body condition factor K in herring from several fishing grounds

The total body condition factor depends on the gonad stage of the herring. A very high value of K was noted in herring with prespawning and spawning gonad stages (4, 5 and 6 in Maier's classification). K was highest in the worst

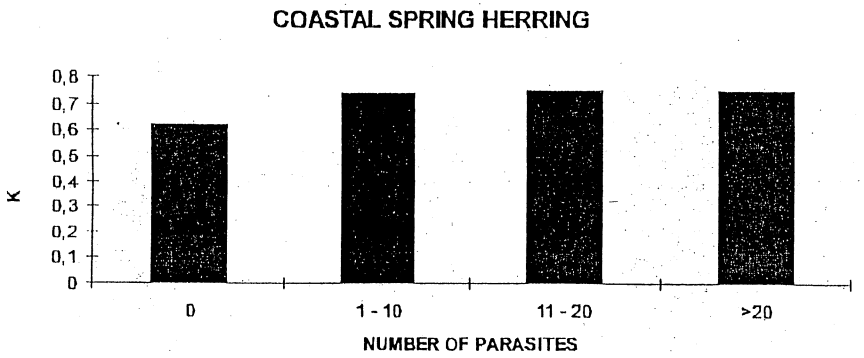

Fig. 4. The intensity of infection

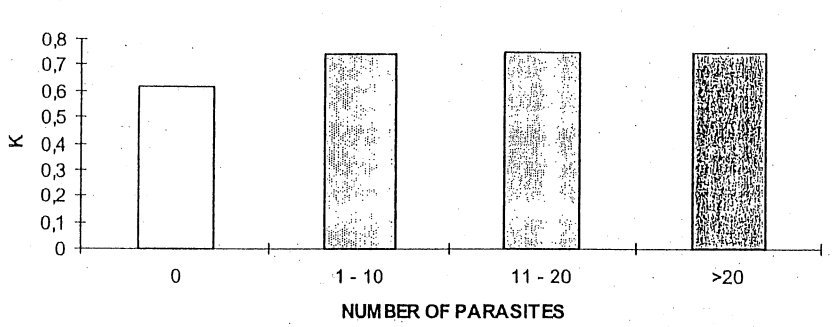

Fig. 5. The total body condition factor K in herring at different gonad stages

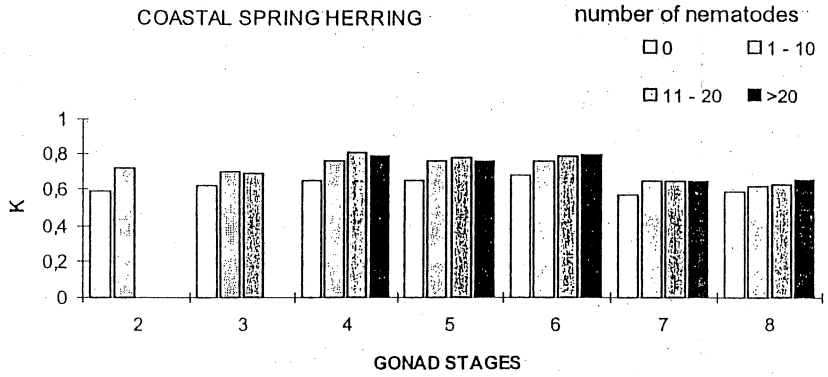

Fig. 6. The total body condition factor K in costal spring herring at different gonad stages

infected fish at gonad stage 6, but there was little or no invasion in fish at gonad stage 2 (Fig. 5 and 6).

DISCUSSION

The research shows, that the total body condition factor K in herring varies in different stocks and fishing grounds, and increases according to the intensity of infection with parasitic nematodes. The value of K was higher in fish taken from coastal fishing grounds than from elsewhere. The maximum concentration of herring infected with Anisakid larvae is recorded in the coastal fishing grounds in the western Baltic Sea (Podolska 1996). Herring became infected with *A. simplex* larvae in the North Sea and the Danish Straits, where the intermediate hosts of *A. simplex* (Euphausiacea) occur. In spring, infected herring belonging to the coastal spring population come to the southern Baltic and spawn in the coastal waters.

In samples taken from spawning grounds, the coastal spring population was predominant. By contrast, it was rare to find open sea herring there, because they spawn in a different area of the Baltic (Elwertowski 1982).

According to Lang et al. (1990), the highest degree of infection was noted in western regions of the Baltic (ICES-Subdivisions 22 and 24). Grabda (1974) showed that the prevalence of infection in these ICES-Subdivisions to be similar. Podolska (1996) recorded the highest prevalence of infection in samples of herring from the spawning grounds of ICES-Subdivision 24 in the Polish zone of the Baltic Sea.

The gonads of infected fish were at stages 2–8, but the intensity of invasion in herring with at gonad stages 2 and 3 was lower. The highest intensity of infection was noted in fish at gonad stages 4–6. According to Strzyżewska (1979) and Podolska (1996) the gonads of infected herring from the southern Baltic were at stages 4–7.

The total body condition factor depends on the gonad stage of fish (Popiel &. Strzyżewska 1971), and is highest in fish with gonads at stages 5 and 6.

In the spawning period, the growth of fish gonads proceeds at the expense of their body weight, and the fish are thus in poorer condition.

In spring, fish with gonads at stage 6 prevail in the spawning area. After having spawned, coastal spring herring return to the Danish Straits and the North Sea and feed there (Kühlmorgen-Hille 1979), since those areas are more abundant in food than the Baltic Sea. The composition of the herring food is determined mainly by its concentration (Ostrowski 1994). Euphausiids are the dominant prey in the northwestern North Sea. Feeding intensively in these regions abundant in species structure, herring grow faster than those feeding in the southern Baltic. Stocks of herring which migrate to the North Sea, became infected with *A. simplex* by feeding on euphausiids, which act as intermediate hosts for these nematodes.

Infected herring belong to the coastal spring population. Among this population in the southern Baltic, there are a number of local stocks. The majority of these

herring do not migrate very far from the spawning grounds. The differentiation in K at several fishing grounds, could be caused by the different components in the herring's food in the study areas and by the different growth rates of the fish.

Herring not become infected with *A. simplex* larvae in the Baltic Sea. Infection with these nematodes indicates that euphausiids were the dominant component of the herring's food. This implies that the herring must have visited regions where euphausiids occur. This is reason for the correlation between the intensity of infection and high value of K.

On the other hand, nematodes often found in very large numbers in fish could cause disfunctions of their internal organs. Larvae penetrating the viscera can cause inflammation, infiltration of blood cells and oedema of the damaged tissue. These pathological changes can lead to an increase in the weight of the fish, as well as in the factor K. In general, parasitic invasion adversely affect the host's condition. Kabata (1958) revealed that infestation of haddock *Melanogrammus aeglefinus* (L.), with copepods *Lernaeocera obtusa* (L.), decreased the body condition factor of the infected fish. Wrzesiński (1982) found that the body weight of mackerel *Scomber japonicus peruanus* (Jordan & Hubbs) infested with parasitic isopods *Meinertia gaudichaudi* (Edwards, 1840) was lower that of fish free of parasites. This study shows a different relationship between the host's condition and the level of infection, which were caused by correlation between the food composition of the hosts and its infection.

In spite of the facts indicating that factor K is highest in infected herring, we are cannot state that nematode invasion a exerted a positive influence on fish condition.

CONCLUSIONS

The total body condition factor was higher in infected than in non-infected southern Baltic herring.
- Factor K was highest in infection with 11–20 nematodes.
- Factor K was highest among the worst infected fish at gonad stage 6.

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