A C T A   I C H T H Y O L O G I C A   E T   P I S C A T O R I A
Vol. XXVIII, Fasc. 2 Szczecin 1998

Włodzimierz *GRYGIEL*

Fish pathology

VARIATION IN THE PREVALENCE OF THE EXTERNALLY VISIBLE PATHOLOGICAL SYMPTOMS AFFECTING BALTIC HERRING

ZMIANY W WYSTĘPOWANIU ZEWNĘTRZNYCH OBJAWÓW CHOROBOWYCH U ŚLEDZI MORZA BAŁTYCKIEGO

Sea Fisheries Institute, Gdynia, Poland

Geographical distribution of Baltic herring (*Clupea harengus membras* (L., 1761)) affected with externally visible pathological symptoms is demonstrated, based on the observations of 5 028 individuals. The fish were collected in period 25.11–08.12.1994, from 36 sampling hauls performed on a transect from the south-western to the north-eastern Baltic Sea. The results of analyses indicate statistically significant differences in the fraction of herring with externally visible diseases (mean percentage of 3.7%) dependent on the geographical area. A relationship between the prevalence of emaciation (mean prevalence of 3.3%), infection (mean prevalence of 3.7%) in herring with the parasitic larvae of *Anisakis simplex* (Rudolphi, 1809), and the area of sample collection was shown to exist.

INTRODUCTION

The first observations and ensuing attempts of interpretion of mortality rates due to causes other than fishing, predation and natural ageing processes in the Baltic fish species were undertaken in the 1920s and '30s. Occurrences of dead fishes in the near-shore areas initiated this interest (Draganik et al. 1994). It was concluded that oxygen deficiency or parasitic infection caused high fish mortality.

Lymphocystis, a common fish diseases first described in 1874 (Lang 1994), was recorded in the Baltic species at the end of the 19th century (Aneer and Ljungberg 1976). Increased mortality rates among the Baltic fish species, and a higher number of individuals with externally visible diseases of the skin and muscles, were periodically observed after

World War II. It was proposed that disease occurrences possibly resulted from the deployment of chemical warfare or its improper storage at the bottom of the sea (Draganik et al. 1994). At the end of the '70s, the appearance of dead fishes along some beaches, including the Polish coast, caused widespread apprehension (Draganik et al. 1994). It was believed then, that fishes kills resulted from the deterioration of the natural environment in the Baltic (Różańska 1987; Sherman 1992).

During the 1980s anomalies in the embryonic development were described in Baltic sprat and cod (Grauman and Sukhorukova 1982) and in herring (Hansen et al. 1985). A series of studies of fish diseases have been recently conducted in the Baltic Sea (Aneer and Ljungberg 1976; Rutkowska-Stępień 1990; Draganik et al. 1994; Lang and Dethlefsen 1994; Wiklund 1994; Kosior et al. 1995, 1996, 1997). During the last 15 years, some international organisations, e.g., ICES and BMB encouraged monitoring of pathological changes mostly in demersal fish species. The North Sea and, to a lesser extent, the Baltic were the main research areas (Dethlefsen 1980; Möller and Anders 1983; Hansen et al. 1985, Dethlefsen et al. 1986; Anon. 1989, 1994; Lang 1994; Lang and Dethlefsen 1994; Lang et al. 1995).

In this study, results obtained by the author during the BMB/ICES Sea-going Workshop "Fish Diseases and Parasites in the Baltic Sea" (25.11–08.12. 1994; Lang et al. 1995) are reported. The prevalence of externally visible diseases, emaciation, and parasitic infection with the larvae of *Anisakis simplex* in Baltic herring are analysed in the paper.

MATERIAL AND METHODS

The international survey along the Baltic shores, at 11 sampling stations located on a transect from the Bight of Mecklenburg to the Gulf of Finland, were conducted on board the German RV "Walther Herwig III" (Fig. 1). In total 36 sample hauls were performed, used 180-feet bottom trawl (with 10 mm mesh bar length in the codend). Mean trawling depths among stations no. 3, 4, 5, 7–11 were approximately similar (56 m in avg.), and for eleven hauls (in more shallow water) collected at stations 1, 2 and 6, mean trawling depths equal to 31 m.

Routinely all caught herring were examined for externally visible diseases of the skin and vertebral column anomalies; overall, 5 028 herring were analysed (Tab. 1). In addition, observations of pathological emaciation (4 727 individuals) and parasitic infection (572 individuals) with the *A. simplex* larvae were made for herring. Prevalences were estimated. Total length measurements of random samples of 2 121 herring (grouped in 1 cm length-classes) were performed (Tab. 1). Fish with pathological changes were measured separately.

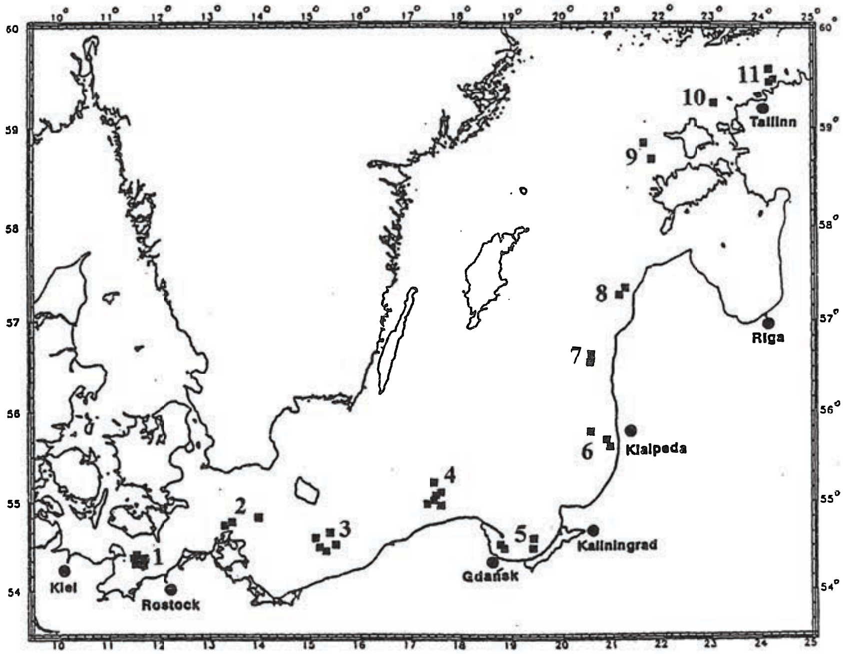

Fig. 1. The geographical location of sampling station (no. 1–11; ▪ – control haul) in period 25.11–08.12.1994

Table 1

The number of Baltic herring examined (25.11–08.12.1994) for externally visible pathological symptoms, according to sampling area

Station number	Haul number	Range of trawling depth [m]	No. of fish			
			examined for			measured and weighed
			diseases	parasite	emaciation	
1	1–5	20–24	362	33	362	11
2	34–36	27–42	123	38	123	123
3	6–10	33–60	111	57	111	111
4	11–16	27–84	163	73	163	163
5	17–20	31–84	506	71	260	254
6	31–33	31–43	141	75	141	141
7	21–22	46–54	415	50	415	231
8	29–30	44–53	327	50	327	327
9	23–24	46–52	792	50	737	297
10	25	68–76	385	25	385	27
11	26–28	46–86	1703	50	1703	436
Total			5028	572	4727	2121

External pathological condition were classified based on the visual inspection. The evaluation of fish diseases was carried out according to the methodologies proposed by the

ICES WGPDMO (Anon 1989). Herring was classified as pathologically emaciated based on external examination only. Emaciated fish were in noticeably poor physical condition, characterised by very poorly developed muscular tissue (Fig. 2). The fish were abnormally symmetrically flattened in the post-cranial region (in the dorsal view) and slightly flattened in the horizontal plane. Parasitic analyses of herring consisted of estimates of prevalence of infection with *A. simplex* inside the ventral cavity.

The statistical methods used in this study included simple regression analysis (linear and multiplicative models) and Chi-squared test, which was employed to test the hypothesis of equal prevalence of pathological changes in fish from different collection sites.

RESULTS

Prevalence of externally visible diseases

Herring was present, with variable abundance, in all 36 bottom hauls, at 11 different sampling stations. The length distributions of healthy and diseased herring from the most abundant length-classes (13–16 cm) were similar (Fig. 3). Length in diseased herring ranged as follows, respectively to disease unit:

lymphocystis	13.0–25.0 cm,
lordosis	16.0–19.0 cm,
dwarfism	15.0 cm,
papilloma	14.0–21.0 cm,
inflammation	18.0 cm,
total diseased	13.0–25.0 cm,
total measured	6.5–30.5 cm.

The highest percentage of diseased herring amounting to 5.5% was found in the length-classes of 14 cm (Fig. 4). Diseases were not found in herring above 25 cm. The results of linear regression—a percentage of herring with externally visible diseases vs. length-classes—did not demonstrate the existence of a statistically significant relation ($p > 0.05$, $r < 0.5$, standard error of parameters a and b $\geq 50\%$ of value of these parameters).

A Chi-squared test showed a significant difference between the prevalence in the skin lesions as well as skeletal anomalies of herring, and the sampling site (at a significance level $\alpha = 0.001$; Tab. 2, Fig. 5 and 6). A relatively high percentage of herring affected with externally visible diseases were recorded in samples caught in the Latvian (8.0%), Lithuanian (5.1%) and Estonian (4.3%) fishery zones. From 0.8% to 2.7% of herring caught in a vicinity of the Rügen Island and in the western part of the Polish EEZ showed external symptoms of disease. No herring with externally visible diseases were observed in samples collected from the Bight of Mecklenburg and from the central and eastern part of the Polish EEZ, as well as from the western part of the Russian EEZ (southern Baltic; Tab. 2, Fig. 5

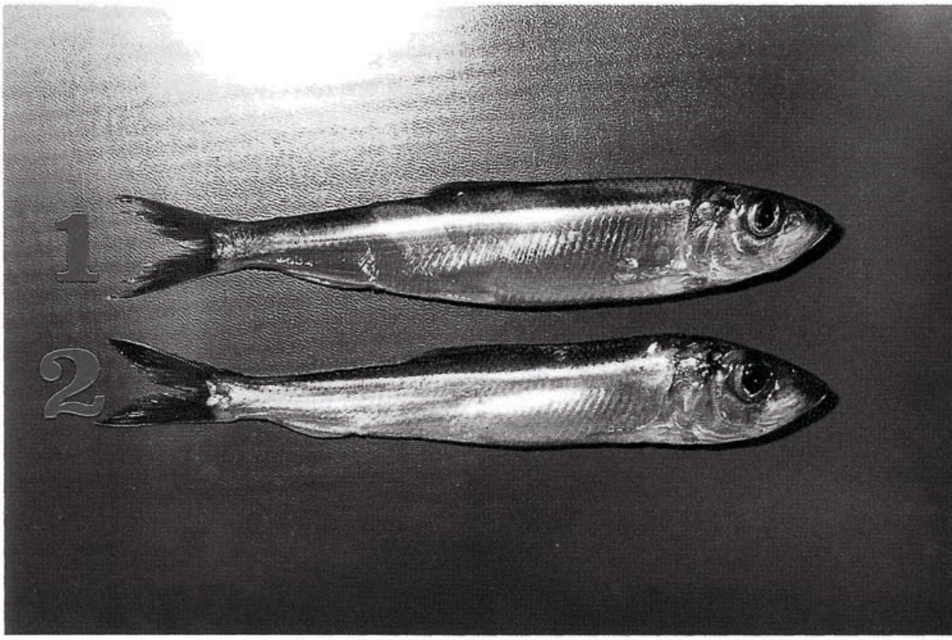

Fig. 2. The example of Baltic herring with a symptom of pathological emaciation; caught on 06 Dec. 1994, on geographical position φ=55°46.9′N, λ=20°31.3′E, trawling depth 43 m;
no. 1—normal specimen: length – 17.5 cm, weight – 29.6 g, male, stage of gonads – III, stomach fullnes – 0, age group – 2, coastal spring spawning population; no. 2––emaciated specimen: length – 17.5 cm, weight – 22.8 g, male, stage of gonads – VIII, stomach fullnes – 0, age group – 5, open sea spring spawning population (phot. and data from biological analysis of mentioned two herring, by courtesy of MSc Mirosław Wyszyński – SFI, Gdynia).

and 6). The overall mean percentage of diseased herring in all sampling sites was 3.7%. The most common disease was lymphocystis (found on the ventral side of the body surface, the nodules are about 1.0–1.5 mm in diameter; mean infection rate of 3.5%). Vertebral anomalies, i.e., lordosis (mainly in the caudal part of the body) and compression of the vertebrae—dwarfism—(mainly near the dorsal and ventral fins) were recorded in prevalences of 0.1% and 0.02%, respectively. Herring were also affected with epidermal papilloma (hyperaemia; mean prevalence equal to 0.08%) and jaw inflammation (probably by bacteria; mean prevalence equal to 0.02%; Fig. 6).

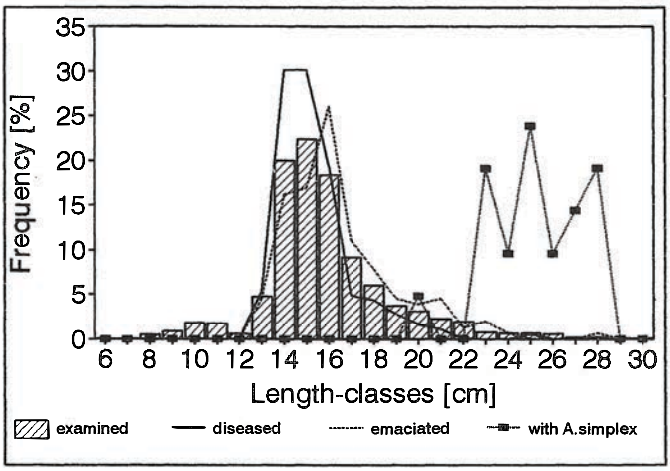

Fig. 3. Length distribution of healthy herring and herring affected with diseases, pathological emaciation, and infected with *A. simplex* (data from all investigated Baltic areas)

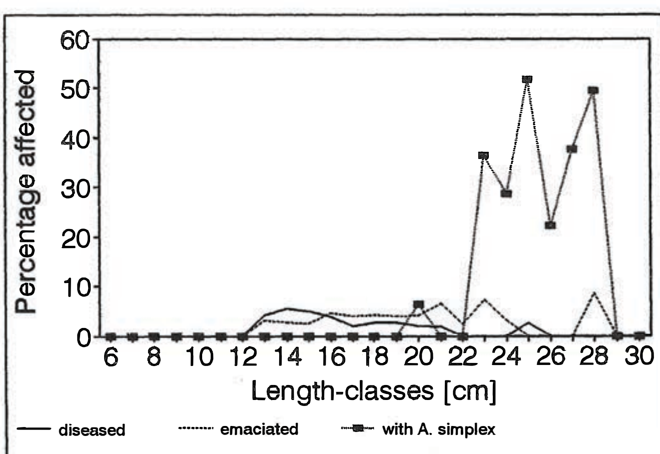

Fig. 4. The relationship between prevalences of diseases, pathological emaciation, infection with *A. simplex* and length-classes for herring collected from the all investigated Baltic areas

Table 2

Chi-squared test for Baltic herring caught at different trawling stations, and affected with pathological changes; abbreviations used: observed (n.d.) and estimated (n.d$_t$.) number of fish with pathological changes, f.n.d.—fraction of fish with pathological changes, value (χ^2) and critical value ($\chi^2_{crit.}$) of chi-statistic, d.f.—degrees of freedom, α—significance level

Station number	Herring affected with externally visible diseases			Herring affected with externally visible emaciation			Herring infected with *Anisakis simplex*		
	n.d.	f.n.d.	n.d$_t$.	n.d.	f.n.d.	n.d$_t$.	n.d.	f.n.d.	n.d$_t$.
1	0	0	13.4	0	0	11.8	2	0.061	1.2
2	1	0.008	4.6	1	0.008	4.0	15	0.395	1.4
3	3	0.027	4.1	1	0.009	3.6	3	0.053	2.1
4	0	0	6.0	1	0.006	5.3	0	0	2.7
5	0	0	18.7	5	0.019	8.5	1	0.014	2.6
6	8	0.057	5.2	5	0.035	4.6	0	0	2.8
7	19	0.046	15.4	9	0.022	13.5	0	0	1.8
8	26	0.080	12.1	20	0.061	10.7	0	0	1.8
9	29	0.037	29.3	53	0.072	24.0	0	0	1.8
10	16	0.042	14.2	11	0.029	12.5	0	0	0.9
11	84	0.049	63.0	48	0.028	55.5	0	0	1.8
Total	186	0.037	186.0	154	0.033	154.0	21	0.037	20.9
χ^2		69.33			69.06			153.92	

Note: d.f. = 11; $\alpha < 0.001$; $\chi^2_{crit.} = 31.26$

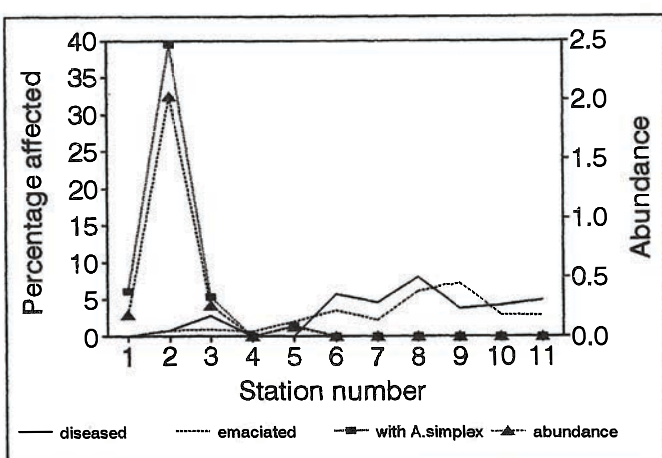

Fig. 5. Changes in prevalence of Baltic herring affected with diseases, pathological emaciation, infected with *A. simplex*, and mean abundance of infection at trawling stations

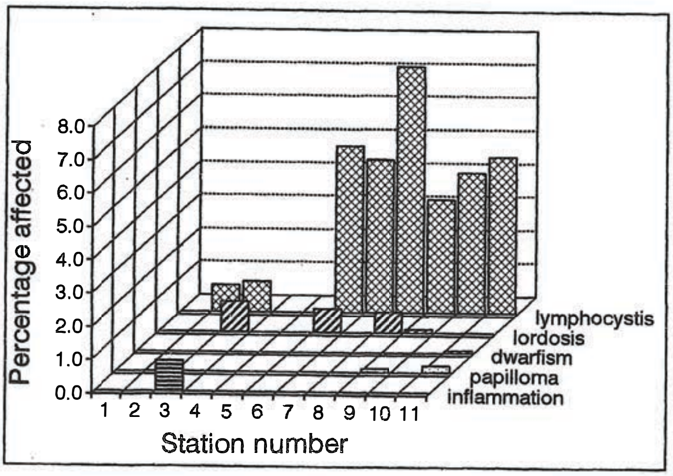

Fig. 6. Changes in prevalence of externally visible diseases in Baltic herring caught at different trawling stations

Prevalence of externally visible pathological emaciation

Symptoms of the pathological emaciation in herring were observed in 154 individuals collected in 18 hauls. The fraction of emaciated herring in hauls varied; fish length ranged from 13 cm to 28 cm and the 16 cm length-class was dominant (26.0% in length distribution of emaciated fish; Fig. 3). The length distribution of healthy and starving fish in the length-classes 16–20 cm was alike (mean prevalence in this size group was 4%). The maximum value of prevalence of this pathological change among larger herring was 8.6%. The results of linear regression—a prevalence of herring with externally visible emaciation vs. length-classes—did not demonstrate the existence of a statistically significant relation.

Prevalence of herring with the symptoms of patholological emaciation and the geographical location of the fish were statistically dependent, as demonstrated by the results of the Chi-squared test (Tab. 2, Fig. 5). The highest percentage (6.1–7.2%) of herring with the symptoms of emaciation was observed in the eastern part of the central Baltic, that is, in the area between the Island of Hiiumaa (Estonia) and Ventspils (Latvia). Mean percentage of emaciated herring in all sampling sites was 3.3%. Herring with the mentioned pathological symptoms constituted only the minimal fraction (0–0.9%) in samples collected in the western area of the Baltic.

Infection with *Anisakis simplex*

Infection with the *A. simplex* larvae was observed in 21 herring, collected in 6 control trawls. The length of these fish ranged from 20 cm to 28 cm, with a slightly higher abundance of fish from the 25 cm length-class (23.8% in length distribution of infected herring; Fig. 3). Larvae were located mainly in the digestive tract (inc. pyloric caeca), and gonads of herring.

Length distributions of healthy and infected herring varied (Fig. 3), because the larvae were observed only in relatively large fish, e.g., prevalence of infection in herring from 25 cm length-class equal to 51.8% (Fig. 4). Prevalence of infection in herring (> 22 cm) ranged from 22.2% to 51.8%. Average prevalence for all collected herring from the entire investigated Baltic area was 3.7% (Tab. 2, Fig. 5). Based on the collected data, the hypothesis about a positive relationship between a prevalence of *A. simplex* infection and fish length was found, to be statistically significant ($Y = -14.767+1.336X$; $r = 0.57$, $p = 0.003$).

Prevalence of infected herring and the geographical location of the fish were dependent as indicated by the results of the Chi-squared test (Tab. 2, Fig. 5). The highest prevalence (39.5%) was observed in the western part of the southern Baltic, that is, in the vicinity of the Rügen Island. No infected herring were found in the samples collected in the eastern part of the southern and central Baltic (only one specimen caught in the Gulf of Gdańsk was infected). Mean abundance of infection was 0,2 (range in sampling stations amounting 0–2; Fig. 5).

DISCUSSION

The results of this study of the prevalences of externally visible diseases, parasitic infection, and pathological emaciation in Baltic herring has implications for the following stock assessment issues:

- stock differentiation,
- the relationship between mortality and diseases,
- the estimation of natural mortality coefficient (M), obtaining more precise predictions of fish stock size by VPA or MSVPA methods,
- obtaining indirect, biological indicators of degree of pollution in the sea environment,
- technological utilisation of exploited fish for food processing and consumption.

During the last 15 years, the attempts to link pollution (mainly chemical) of the sea environment to the increase of pathological changes in fish often ran into the problem of how to interpret the data (Sindermann 1965; Dethlefsen 1980; Ipatov 1988; Sherman 1992; Anon. 1994; Draganik et al. 1994; Winklund 1994; Kosior et al. 1997). In general, in the available literature there is lack of information about the results from the mathematical analyses—a prevalence of the pathological changes affected Baltic herring vs. hydrological parameters. In the period of 1981–1990, an observed decreasing trend in mean weight, length and condition coefficient for the coastal spring spawning herring population in the southern Baltic was believed to be caused by an increased abundance of the spawning stock and by changes in some hydrological parameters, i.e. decreased mean sea water salinity (Wyszyński 1991). The observations presented in this study of emaciation in herring are an extreme example of morphological changes in this fish.

The results of the research on prevalence of externally visible diseases in herring, presented here, differ from the scarce data published elsewhere. Anner and Ljungberg (1976) recorded occurrence of individuals with lymphocystis among herring caught in the period of 1971–1972 along the Swedish coast (near Askö); the prevalence of disease ranged from 0% to 2.7%. Length distributions of healthy and diseased fish were similar to the ones presented in this study. Draganik et al. (1994) recorded in 1993 the mean prevalence at level 0.1% of this disease in herring caught in the Polish EEZ. The range and mean value of prevalence of lymphocystis affected herring, recorded for the period 25.11–08.12.1994 were as follows: 0–7.4%, and 3.5%, respectively.

Rutkowska-Stępień (1990) reported mainly ulceration of the skin in herring collected in the period of 1987–1988. The yearly mean prevalence of ulceration in herring was 0.12% and 0.06%; respectively. According to the data presented by Draganik et al. (1994), prevalence of ulceration in Baltic herring ranged in the period of 1982–1993 from 0% to 0.7%. Herring collected by author of this paper did not display ulceration of the skin, however also: lordosis, dwarfism, papilloma and jaw inflammation were indentified, in low prevalence (avg. < 0.1%).

The prevalence and intensity of infection with *A. simplex* larvae in herring within the Polish EEZ, has previously been reported in the literature by Lubieniecki (1972), Rokicki (1972), Grabda (1974, 1981), Strzyżewska (1979), and Rokicki et al. (1997). Lubieniecki (1972) recorded the presence in herring collected in the Gulf of Gdańsk in the winter and spring of 1969–1972, with prevalence of 12% and mean intensity of 3.6. In one sample of herring (from length-classes 22–32 cm), collected in March 1974 in the corresponding area, Strzyżewska (1979) found *A. simplex* in 64.5% of the fish. Fish otoliths investigations suggested that the infected herring belonged to the coastal spring spawner Rügen population, and migrated from the Pomeranian Bay (Strzyżewska 1979, 1987; Rokicki et al. 1997). Herring from the local Baltic stocks were on the beginning of 1970s free of *A. simplex* (Grabda 1974).

The results obtained by the author (from a Chi-squared test) showed a significant differences between the prevalence of externally visible diseases, emaciation, *A. simplex* infection affecting Baltic herring, and the geographical location of the fish (Tab. 2). The relatively high percentage of externally visible diseases (range: 3.7–8.0%) as well as emaciation (range: 6.1–7.2%), and lack of infection from the *A. simplex* larvae were indicated in herring caught in sampling sites located in the fishing zones of Latvia, Lithuania and Estonia (Tab. 2, Figs. 5, 6). The relatively low percentage of diseases (range: 0–2.7%) as well as emaciation (range: 0–2.1%), and the highest infection (39.5%—in the vicinity of the Rügen Island) of herring were recorded in the investigated part of the western and southern Baltic Sea. Herring displaying starvation were observed by the author in Estonian, Latvian and Polish fisheries zones also during yearly hydroacoustic surveys aboard RV "Argos", RV "Issledovatel Baltiki", and RV "Baltica" each October in period 1988–1992, and in 1996. Pathological changes of the fish were not investigated at that time. In the literature there is lack of information about the results from the mathematical analyses—a prevalence of the pathological changes affected Baltic herring vs. geographical location of the fish samples.

The results obtained by author of this paper indirectly shows that herring smaller than 13.0 cm were apparently healthy. Diseases were also not found in herring above 25.0 cm. There were no larger fish with disease symptoms, because those either recovered from sickness or died (e.g., by predation). The last conclusion is supported by a different shape of frequency distribution curves for the healthy and diseased herring, with discrepancies starting for individuals 17.0 cm in length of fish (Fig. 3). The analysed material did not suggest a positive relationship between the prevalence of emaciated herring and the length, exceptionally in the length-classes 16–20 cm, in which the length distribution of healthy and emaciated fish was similar (Fig. 3). The susceptibility to this pathological symptom among above mentioned length-classes were in equal degree (Fig. 4). In the available literature there is lack of information about a prevalence of the emaciation affected Baltic herring.

Based on the investigations of the herring caught in the Pomeranian Bay in spawning period in 1972, Grabda (1974) estimated the prevalence of infection to be 93.0% and mean intensity at 11.3 in specimens from the length-classes 26–30 cm. In 1975 and 1976, prevalence values for the length-classes 22–32 cm were 60.0% and 38.0%, respectively (Strzyżewska 1979). Strzyżewska (1987) as well as Grabda (1974), remarked that in the period of 1976–1980 herring infected with *A. simplex* were only present in the winter and spring catches, when pre-spawning and spawning concentrations of fish were exploited; in autumn, herring were free of this nematode. Fish smaller than 20 cm were not infected. Grabda (1974) and Rokicki et al. (1997) suggested that the prevalence and intensity of infection increases with the length and the body condition coefficient (K) of herring. This issues have been supported by the results presented by the author of this study. *A. simplex* in samples of herring collected in the western part of the southern Baltic, was mainly observed in the length-classes 23–28 cm. Mean prevalence of infection ranged from 5.3% to 39.5%; average prevalence in all sampling sites was 3.7% (Fig. 5, Tab. 2). These values fall within the range of estimates reported by others.

The interaction effects of three other sources of variability influencing the relationship in question, namely, a prevalence of diseases, emaciation and infection affected herring vs. length of fish, probably disturbed its stability. The afore-mentioned sources of variability are:

- location of sample collection,
- potentially different susceptibility to diseases in males and females,
- relatively low effectiveness of fishing gear for clupeids.

RECAPITULATION

A Chi-squared test showed a significant difference (at $\alpha = 0.001$) between the prevalence of externally visible diseases, emaciation, *A. simplex* infection affected Baltic herring, and the geographical location of the fish. In herring, five diseases were identified, mainly lymphocystis (mean prevalence of 3.5%) and lordosis (mean prevalence of 0.1%). The relatively high percentage of externally visible diseases (range: 3.7–8.0%) as well as emaciation (range: 6.1–7.2%), and lack of infection from the A. *simplex* larvae were indicated in herring caught in sampling sites located in the fishing zones of Latvia, Lithuania and Estonia. The relatively low percentage of diseases (range: 0–2.7%) as well as emaciation (range: 0–2.1%), and the highest infection (39.5%—in the vicinity of the Rügen Island) of herring were recorded in the investigated part of the western and southern Baltic Sea. The results from the simple regression analysis did not demonstrate the existence of statistically significant relationships between the prevalence of herring displaying three pathological symptoms and fish length, except the relation between the prevalence of infection (*A. simplex*) and length ($r = 0.57$, $p = 0.003$).

ACKNOWLEDGEMENTS

I wish to thank: Dr. Thomas Lang from the Institut für Fischereiökologie (Cuxhaven, Germany), Dr. Stig Mellergaard from the Danish Institute for Fisheries Research (Fish Disease Laboratory, Frederiksberg, Denmark), and Dr. Murdoch McAllister from the Imperial College of Science, Technology and Medicine (RRAG, London, UK) for their kind effort in a preliminary evaluation of the manuscript and suggestions regarding changes in the text.

REFERENCES

Anon., 1989: Methodology of Fish Disease Surveys. Report of an ICES Sea-Going Workshop held on U/F "Argos": 16–23 April 1988, ICES Coop. Res. Rep. No. 166, Denmark.

Anon., 1994: Report of the Study Group on Occurrence of M-74 in Fish Stocks. ICES C.M.1994/ENV: 9, ref.: E, F+M.

Aneer G., O. Ljungberg, 1976: Lymphocystis disease in Baltic herring (*Clupea harengus* var. *membras* L.). J. Fish. Biol., **8**,: 345–350.

Dethlefsen V., 1980: Observations of fish diseases in the German Bight and their possible relation to pollution. Rapp. Proc.-Verb. Reun. Cons. Int. Explor. Mer. No. 179; 110-117.

Dethlefsen V., E. Egidius, A.H. McVicar, 1986: Methodology of fish disease surveys. Report of a Seagoing Workshop held on R/V "Anton Dohrn" 3–12 January 1984. ICES Coop. Res. Rep. No. 140, Denmark.

Draganik B., W. Grygiel, J. Kuczyński, K. Radtke, M. Wyszyński, 1994: Results of the screening of fish diseases in the southern Baltic. ICES C.M. 1994/J:20, Ref.: F,G,H Balt. Fish Com.

Grabda J., 1974: The dynamics of the Nematode larvae *Anisakis simplex* (Rud.) invasion in the South-Western Baltic herring (*Clupea harengus* L.). Acta Ichth. Piscat., **4**, 1: 3–21.

Grabda J., 1981: Zarys parazytologii ryb morskich [Outline of parasitology of marine fish]. PWN, Warszawa. (In Polish).

Grauman G., L. Sukhorukova, 1982: On the emergence of sprat and cod abnormal embryos in the open Baltic. ICES C.M. 1982/J:7.

Hansen P.D., L. von Westernhagen, H. Rosenthal, 1985: Chlorinated hydrocarbons and hatching success in Baltic herring spring spawners. Mar. Environ. Res., No. 15: 59–76.

Ipatov V., 1988: Some aspects of disease etiology in commercial fishes in the Baltic Sea. ICES Symposium 1988 BAL/38.

Kosior M., W. Grygiel, J. Kuczyński, K. Radtke, M. Wyszyński, 1995: Zdrowotność śledzi, szprotów, dorszy, ryb płaskich, węgorzyc i moteli południowego Bałtyku w 1994 roku [Health condition of herring, sprat, cod, flatfish, eelpout and rocling from the southern Baltic in 1994]. In: Reports of the Sea Fish. Inst., 1993–1994. Edited by the Sea Fish. Inst., Gdynia; 253–257. (In Polish).

Kosior M., W. Grygiel, J. Kuczyński, K. Radtke, M. Wyszyński, 1996: Morbid symptoms observed in Baltic fish during two research cruises in 1995 and 1996. ICES C.M. 1996/J:28, B.F.C.

Kosior M., W. Grygiel, J. Kuczyński, K. Radtke, M. Wyszyński, 1997: Assessment of the health state of fish of the southern Baltic; observations of externally visible symptoms of diseases. Bulletin of the Sea Fish. Inst., No. 3 (142): 3–25.

Lang T., 1994: Lymphocystis disease in flatfish. In: Diseases and parasites of flounder (*Platichthys flesus*) in the Baltic Sea. BMB Publ. Abo, No. 15: 9–15.

Lang T., V. Dethlefsen, 1994: Externally visible diseases and liver neoplasms in flounder (*Platichthys flesus*) of the south-western Baltic Sea. BMB Publ. Abo, No. 15: 39–47.

Lang T., S. Mellergaard, T. Bezgachina, S. Bogovski, W. Grygiel, V. Kadakas, M. Koie, G. Nagel, K. Neumann, A. Paukste, I. Tabolina, T. Wiklund, 1995: BMB/ICES Sea-going Workshop "Fish diseases and parasites in the Baltic Sea". A preliminary report. ICES C.M. 1995/F:11, Maric. Comm.

Lubieniecki B., 1972: Anisakidoza śledzi i makreli poławianych w rejonach południowego Bałtyku, Morza Północnego i północno-zachodniego Atlantyku [Anisakiosis affected herring and mackerel caught in the southern Baltic, in the North Sea and north-west Atlantic]. PhD thesis, Agricultural University in Szczecin (mimeo, in Polish).

Möller H., K. Anders, 1983: Krankheiten und Parasiten der Meeresfische. Verl. H. Möller, Kiel.

Rokicki J., 1972: Larwy *Anisakis* sp. u śledzi *Clupea harengus* L., w Bałtyku [*Anisakis* sp. larvae in Baltic herring *Clupea harengus* L.]. Wiad. Parazytol., **18**: 89–96. (In Polish).

Rokicki J., M. Podolska, M. Wyszyński, 1997: Zapasożycenie śledzi i szprotów bałtyckich nicieniami Anisakis sp. w latach 1995-1996 [Infection of Baltic herring and sprat with Anisakis sp. in 1995-1996]. In: Prognoza możliwości połowów śledzi i szprotów bałtyckich z uwzględnieniem sezonowości, relacji międzygatunkowych i jakości ryb jako surowca na tle danych wieloletnich. Studia i Materiały, ser. B, nr 69, Editor: the Sea Fish. Inst. Gdynia; 160–180. (In Polish).

Różańska Z., 1987: Zasoby, zanieczyszczenia i ochrona wód morskich ze szczególnym uwzględnieniem Bałtyku [Resources, contaminants and conservation of sea waters with special regard to the Baltic]. PWN, Warszawa. (In Polish).

Rutkowska-Stępień I., 1990: Stan zdrowotny użytkowych gatunków ryb bałtyckich w latach 1987–1988. [Health condition of commercial Baltic fish species in 1987–1988]. Bulletin of the Sea Fish. Inst., Gdynia, No. 1–2 (117–118); 26–29. (In Polish).

Sherman K., 1992: Stress, mitigation, and sustainability of biomass yields in large marine ecosystems. Bulletin of the Sea Fish. Inst., Gdynia, No. 3 (127); 43–59.

Sindermann C.J., 1965: Effects of environment on several diseases of herring from the western North Atlantic. Spec. Publ. Int. Comm. N. W. Atl. Fish. No. 6; 603–610.

Strzyżewska K., 1979: Zapasożycenie śledzi larwami *Anisakis simplex* (Rud.) [Infection of herring with *Anisakis simplex* (Rud.) larvae]. In: Zmiany składu i zasobów stad śledzi południowego Bałtyku w latach 1968–1977 [Changes in composition and stocks size of herring in the southern Baltic in 1968–1977]. Studia i Materiały, ser. B. nr. 43, Editor: the Sea Fish. Inst., Gdynia; 40–45. (In Polish).

Strzyżewska K., 1987: Wyniki badań nad stadami śledzi bałtyckich w podrejonach 24, 25, 26 prowadzonych w latach 1976–1979/1980 [The results of investigation of Baltic herring stocks in Subdivisions 24, 25, 26 conducted in 1976–1978/1980]. In: Zasoby ryb Bałtyku w latach 1975–1980 [Baltic fish resources in 1975–1980]. Studia i Materiały, ser. B. nr 55, Editor: the Sea Fish. Inst., Gdynia; 52–80. (In Polish).

Wiklund T., 1994: Skin ulcer disease of flounder (*Platichthys flesus*): disease patterns and characterization of an etiological agent. Academic Dissertation, University Abo, Finland.

Wyszyński M., 1991: Changes in the growth rate of southern Baltic herring in relation to hydrographic conditions and stock density in 1981–1990. ICES C.M. 1991/J:6, B.F.C.

Włodzimierz *GRYGIEL*

ZMIANY W WYSTĘPOWANIU ZEWNĘTRZNYCH OBJAWÓW CHOROBOWYCH U ŚLEDZI MORZA BAŁTYCKIEGO

STRESZCZENIE

W pracy przedstawiono zmiany ekstensywności występowania objawów patologicznych u śledzi bałtyckich (*Clupea harengus membras* (L., 1761)) wywołanych chorobami, wychudzeniem i zapasożyceniem larwami *Anisakis simplex* (Rudolphi, 1809). Analizom poddano materiał zebrany przez autora na niemieckim statku badawczym RV „Walther Herwig III", podczas zorganizowanego w okresie od 25.11 do 08.12.1994 r. międzynarodowego BMB/ICES Sea-going Workshop „Fish diseases and parasites in the Baltic Sea". Wyniki testów wskazują na statystycznie istotne zróżnicowanie w rozmieszczeniu geograficznym (na profilu od Zatoki Meklemburskiej do Zatoki Fińskiej – 11 stacji połowów kontrolnych ryb) śledzi dotkniętych rozpatrywanymi zmianami patologicznymi. Analiza regresji nie ujawniła statystycznie istotnej zależności między ekstensywnością występowania trzech rozpatrywanych zmian patologicznych u śledzi a długością ryb; jedyny wyjątek stanowi statystycznie istotna zależność między frakcją śledzi zapasożyconych a długością ryb.

Received: 6 May 1998

Author's address:

Włodzimierz Grygiel PhD
Sea Fisheries Institute
Kołłątaja 1, 81-332 Gdynia, Poland