1950

International Commission

for the

Northwest Atlantic Fisheries

1970

RESTRICTED

Serial No. 2425
(B.g. 7)

ICNAF Res.Doc. 70/77

ANNUAL MEETING - JUNE 1970

A comparative study of herring taken at Magdalen Islands and along southwestern Newfoundland during the 1969 autumn fishery

by

V.M. Hodder and L.S. Parsons
Fisheries Research Board of Canada
Biological Station, St. John's, Nfld.

Introduction

Since its beginning in the autumn and winter of 1964-65, herring landings from the purse seine fishery primarily along the western half of the south coast of Newfoundland increased rapidly from less than 10,000 metric tons in 1965 to about 170,000 metric tons in 1969. The herring concentrations, on which the fishery is based, appear in the coastal waters in late November and disappear in April. Hodder (1966, 1969) suggested that the herring, like the cod, probably exhibit a seasonal migration between the Gulf of St. Lawrence and the south coast of Newfoundland. Just prior to the beginning of the Newfoundland fishery a short but intense fishery occurs at Magdalen Islands in late October and November, and a similar fishery takes place there in late April and May after the termination of the fishery along the south coast of Newfoundland, followed by a summer fishery (July to September) in the southwestern part of the Gulf of St. Lawrence. These observations together with information on the temporal and spatial distribution of herring catches along the south coast of Newfoundland suggest the hypothesis that the herring fisheries at various times and places in the southern Gulf of St. Lawrence and southern Newfoundland areas occur on the same stock or group of stocks along a 400-mile migratory route. One may even further hypothesize that, as the stock complex which inhabits the southwestern Gulf of St. Lawrence in summer moves eastward in the autumn, most of the herring schools which move around the northern part of the Magdalen Islands ultimately overwinter in the fjords of southwestern Newfoundland while most of those which pass around the southern part of the islands move eastward past Cape Breton and southeastward along the southern side of the Laurentian Channel to overwinter in deep water (Fig. 1).

The rapid development of Canadian purse seine fisheries in the Gulf of St. Lawrence and southwestern Newfoundland and midwater trawl fisheries by some European countries off northeastern Nova Scotia has led to considerable concern regarding the size and extent of the herring resource and its capacity to withstand the rapidly increasing fishing pressure of recent years. This is all the more important if the various fisheries at different times and places occur on the same stock complex. In an attempt to resolve this problem three main lines of approach were considered for implementation beginning in the 1969-70 season: (1) herring tagging to be carried out in 1970 at 3 or more locations along the hypothetical migratory route; (2) herring samples to be collected at various locations for biochemical analyses; and (3) herring samples from various areas to be compared using such biological characteristics as age, length, sex, maturity, meristics, and parasite incidence. The purpose of this report is to present the results of a preliminary study involving one phase of the third line of approach, namely a comparison of the biological characteristics of herring samples taken at Magdalen Islands just prior to the start of the Newfoundland fishery in the autumn of 1969 and samples taken in the coastal waters of southwestern Newfoundland shortly thereafter.

Materials and methods

During November 1-17, 1969, ten samples of herring, each containing 50 specimens, were taken from the landings of purse seiners which obtained their catches in the vicinity of the Bird Rocks, just north of Magdalen Islands. Similarly, an additional ten samples were randomly chosen for detailed examination from samples for age and growth studies collected routinely during the first 3 weeks after the commencement of the purse seine fishery along southwestern Newfoundland. All 20 samples used in this comparative study were collected at Isle aux Morts, Newfoundland, and shipped in a frozen condition to the St. John's Biological Station where the examinations were carried out 4-6 weeks later.

The specimens were measured from the tip of the lower jaw to the end of the longest lobe of the caudal fin with the lobe extending posteriorly in line with the body (greatest total length). Length measurement data, recorded to the nearest millimeter, were grouped into 1-cm intervals to the 0.5 cm below (e.g. all lengths ranging from 320 to 329 mm were grouped into the 32-cm interval).

Age determinations were made from whole otoliths premounted in small circular depressions of otolith trays made of black plexiglass. A description of the tray and technique of otolith mounting is given by Hourston (MS, 1968). The age was recorded as the number of actual summer (opaque) growth zones on the otolith. The authors initially read the otoliths independently with 60 to 80% agreement on a sample basis. Subsequently the initial disagreements were mutually resolved. The degree of uncertainty for specimens of age X and greater was such that these were grouped into an X+ category. Such grouping of old herring is not unusual, for Tibbo et al. (MS, 1969) used a similar grouping for Gulf of St. Lawrence herring, and Boyar (1968) grouped all herring greater than age VIII into an VIII+ category.

The specimens have been assigned ages based on the number of summer zones, but they have not been assigned to year classes because of the current difficulty in relating the time of spawning of adults, as determined from gonad development, to the time when these same individuals were hatched. Messieh (1969) and Hourston and Parsons (MS, 1969) have questioned the validity of using otolith nucleus type as indicative of the time of hatching for Northwest Atlantic herring.

The sex and the stage of maturity were determined by gross examination of gonads using the various stages of gonadal development as adopted by ICES in 1962 and by ICNAF in 1964 (ICES, 1963; ICNAF, 1964). For the purpose of assigning individuals to spawning groups, maturity stages III and IV were classed as spring spawners and stage VIII as autumn spawners.

Three meristic characters are considered in this report - the numbers of vertebrae, dorsal fin rays and pectoral fin rays. The vertebral and dorsal fin ray counts were determined from radiographs; the left pectoral fin rays were counted with the use of a binocular microscope. The hypural is not included in the vertebral counts.

The specimens were examined to determine the incidence and intensity of infestation with larval nematodes of the genus *Anisakis*. Previous examination of the musculature of herring in the Newfoundland area by slicing and candling the fillets has revealed that less than 1% of the specimens have nematodes in the musculature (Unpublished data, St. John's Biological Station). Consequently for this study the examination for nematodes was restricted to the body cavity and viscera.

Sample details of capture, maturity condition and size are given in Table 1. With the exception of samples 17 and 19, the size and maturity condition exhibit a high degree of similarity between samples and between areas. For analytical purposes the 10 samples from each area were combined.

Results

Spawning groups

Out of 500 specimens collected for this study from each of the two areas, only 20 from the Magdalen Islands and 4 from southwestern Newfoundland were classed as immature (stage II). The remainder were assigned to two categories on the basis of gonadal development. Those with well-developed gonads (stages III and IV) were designated as spring spawners, and those showing little if any gonad development following a recent spawning (stage VIII) were classed as autumn spawners. Although stage VIII passes into stage III during the gonad developmental cycle, no borderline cases were observed and the distinction between spring and autumn spawners was clearcut. The few immature specimens have not been included in the data analyses that follow.

Autumn spawners constituted 77% and 72% of the adults in the combined samples from Magdalen Islands and from southwestern Newfoundland respectively (see Table 1). A chi-square test for homogeneity showed no significant difference between areas ($P = 0.10$) insofar as the ratio of spring to autumn spawners is concerned.

Length and age

The relative length and age compositions by spawning groups are shown in Fig. 2. Although differences between spring (S) and autumn (A) spawners within areas are obvious, the frequency pattern is similar for the same spawning groups between areas.

The modal length group for spring spawners in both areas is 32 cm and for autumn spawners is 34 cm. The mean length for autumn spawners from both areas is 33.3 cm. Spring spawners at Magdalen Islands were slightly smaller (31.8 cm) than those from Newfoundland (32.3 cm). The difference (significant at $P = 0.05$ but not at $P = 0.01$) is due largely to the presence in the Magdalen Islands samples of more fish less than 30 cm in length (Fig. 2).

The age composition data (Fig. 2) show a mode at age VIII for the spring spawners and age IX (assuming that age X+ fish are distributed over several age groups of age X and greater) for autumn spawners. The similarity of the age frequency data from both areas is striking, especially for autumn spawners in which the VIII group from each area is less abundant than the VII and IX age-groups.

Because of the grouping of ages greater than IX into an age X+ category statistical procedures based on the assumption of normality are not valid. A non-parametric test, considered suitable for comparing two frequency distributions, without the assumption of normality, is the Kolmogorov-Smirnov 2-sample test as described by Siegel (1956). This test is claimed to be more powerful in all cases than the chi-square test and to have a power-efficiency greater than 90% when compared with the *t*-test. While the difference between spring and autumn spawners was found to be highly significant ($P < 0.01$) for both areas, the difference between areas for the same spawning group was not significant ($P > 0.05$).

Meristics

Frequency distributions of the three meristic characters examined are shown in Fig. 3. Differences between means for spring and autumn spawners within each area and between areas for each spawning group were tested for statistical significance using the *t*-test at $P = 0.05$.

There was no significant difference between mean vertebral counts of spring and autumn spawners within each area and between areas. Although several European workers (Einarsson, 1951; Wood, 1936; Johansen, 1924; and others) have found significant differences between the mean vertebral counts of spring and autumn spawners in the Northeast Atlantic, Tibbo (1957), Day (1957) and Jean (1956) concluded that spring and autumn spawners in the southern Gulf of St. Lawrence did not differ in mean vertebral count. Similarly our results show that mean vertebral counts do not differ between spring and autumn spawners sampled at the Magdalen Islands and along southwestern Newfoundland.

Within each area the mean dorsal and pectoral fin ray counts were significantly higher for autumn spawners than for spring spawners; in fact the mean pectoral fin ray counts (18.49 and 18.59 for autumn spawners compared with 17.18 and 17.28 for spring spawners) were significantly different at $P = 0.01$. However, comparisons of Newfoundland south coast and Magdalen Islands herring by spawning group showed no significant differences between areas.

Parasites

Herring from both the northwest and northeast Atlantic Ocean and from the northeast Pacific Ocean are infected with larval nematodes of the genus *Anisakis*; the incidence of infestation by this parasite has been used as a means of separating herring populations. Bishop and Margolis (1955) reported that British Columbia herring were frequently infected with *Anisakis* larvae and that the level of infection varied with area. Sindermann (1957) used larval nematodes as well as other parasites to distinguish populations of herring in the western North Atlantic. Khalil (1969) investigated the occurrence of *Anisakis* larvae in herring from British coastal waters and found that infection increased with increase in fish length (age) and varied with locality.

Herring from Magdalen Islands and southwestern Newfoundland were examined to determine the incidence and intensity of infestation with *Anisakis* larvae. Practically all of the nematodes occurred free in the body cavity, encapsulated on the mesenteries, or were coiled in spirals against the intestine or the posterior extension of the stomach. Figure 4 shows the level of infection by age and the frequency distribution by spawning group for both areas. The Kolmogorov-Smirnov two-sample nonparametric test (Siegel, 1956) was used to determine whether the frequency distributions of infected fish and of nematodes by length and age differed between areas; no significant area differences were found ($P > 0.05$). Subsequent tests were performed without regard for length or age.

In both areas none of the spring and autumn spawners less than 31 cm in total length were infected. Overall incidence in spring spawners was 30.8% for Magdalen Islands and 42.3% for southwestern Newfoundland. Autumn spawners from both areas had the same level of infection (32.8%). A chi-square test at $P = 0.05$ indicated that there were no significant area differences in the level of infection by spawning groups.

The intensity of infestation was generally low in both areas. In spring spawners the average number of nematodes per herring examined was 0.41 for Magdalen Islands and 0.59 for southwestern Newfoundland; for autumn spawners the corresponding values were 0.57 and 0.48. With spawning groups tested separately by chi-square, the frequency distributions of larval nematodes were not significantly different between areas ($P > 0.05$).

The intensity of infection was much lower in our samples than in herring from British coastal waters (33.1 larvae per fish with 30-50 larvae per herring being frequent) as reported by Khalil (1969). Herring from the west of Scotland and the northwest of Ireland (3.2 and 1.6 nematodes per fish respectively) were considered to have a low level of infection. Thus it appears that the very low intensity of *Anisakis* larvae in herring from southwestern Newfoundland and the Magdalen Islands poses a negligible problem in the utilization of herring for human consumption.

Conclusions

For all characters tested statistically, except vertebral counts, the differences between spring and autumn spawners within areas were highly significant (Table 2). With the spawning groups considered separately the between-area comparisons revealed no significant differences except for length of spring spawners, which was significantly different at P = 0.05 but not at P = 0.01. This difference is due largely to the presence of slightly more small herring in the Magdalen Islands samples than in the samples from southwestern Newfoundland (Fig. 2). On the basis of these analyses we conclude that the samples taken at Magdalen Islands and along southwestern Newfoundland were derived from the same stock complex and that the winter fishery along southwestern Newfoundland is largely dependent on herring concentrations which migrate eastward out of the southern part of the Gulf of St. Lawrence in the autumn.

References

Bishop, Y.M.M., and L. Margolis. 1955. A statistical examination of *Anisakis* larvae (Nematoda) in herring (*Clupea pallasi*) of the British Columbia coast. J. Fish. Res. Bd. Canada, 12(4): 571-592.

Boyar, H.C. 1968. Age, length, and gonadal stages of herring from Georges Bank and the Gulf of Maine. Int. Comm. Northw. Atlant. Fish., Res. Bull. 5: 49-69.

Day, L.R. 1957. Populations of herring in the southern Gulf of St. Lawrence. Fish. Res. Bd. Canada, Bull. 111, p. 121-137.

Einarsson, H. 1951. Racial analysis of Icelandic herring by means of otoliths. Rapp. Cons. Explor. Mer, 128: 55-74.

Hodder, V.M. 1966. Recent herring investigations in Newfoundland waters. (Proceedings Canadian Atlantic Herring Fishery Conference, Fredericton, N.B., May 5-7, 1966.) Canadian Fish. Rept. No. 8, p. 39-54.

1969. Herring landings and distribution of catches in Newfoundland, 1967-68. Fisheries of Canada, 22(4): 3-6.

Hourston, A.S. MS, 1968. Age determination of herring at the Biological Station, St. John's, Newfoundland. Fish. Res. Bd. Canada, Tech. Rept. No. 49, 24 p.

Hourston, A.S., and L.S. Parsons. MS, 1969. Opaque and hyaline otolith nuclei as indicators of spring and autumn spawning herring in Newfoundland waters. Fish Res. Bd. Canada, Tech. Rept. No. 138, 26 p.

ICES. 1963. Report of Herring Committee. App. I. Recommendations adopted by the Herring Committee concerning routine methods and the reporting of herring biological data in the ICES area. Cons. Int. Explor. Mer, Proc-Verb. Réunion 1962, p. 71-73.

ICNAF. 1964. Report of Standing Committee on Research and Statistics. App. I. Report of ad hoc group on herring and other pelagic fish. Int. Comm. Northw. Atlant. Fish., Redbook 1964, Part I, p. 23-30.

Jean, Yves. 1956. A study of spring and fall spawning herring (*Clupea harengus* L.) at Grande-Rivière, Bay of Chaleur, Quebec. Quebec Dept. Fish., Contr. No. 49, 76 p.

Johnansen, A.C. 1924. On the summer and autumn spawning herrings of the North Sea. Medd. Komm. Havundersøg Kbh., ser. Fisk., 7(5): 1-119.

Khalil, L.F. 1969. Larval nematodes in the herring (*Clupea harengus*) from British coastal waters and adjacent territories. J. Mar. Biol. Assoc. U.K., 49: 641-659.

Messieh, S.N. 1969. Similarity of otolith nuclei in spring- and autumn-spawning Atlantic herring in the southern Gulf of St. Lawrence. J. Fish. Res. Bd. Canada, 26(7): 1889-1898.

Siegel, Sidney. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Co. Inc., New York, 312 p.

Sindermann, C.J. 1957. Diseases of fishes of the western North Atlantic. V. Parasites as indicators of herring movements. Maine Dept. Sea Shore Fish., Res. Bull. 27, 30 p.

Tibbo, S.N., 1957. Herring of the Chaleur Bay area. Fish. Res. Bd. Canada, Bull. 111, p. 85-102.

Tibbo, S.N., S.N. Messieh, and C.D. Burnett. MS, 1969. Catch statistics, length and age composition Gulf of St. Lawrence herring. Fish. Res. Bd. Canada, Tech. Rept. No. 139, 81 p.

Wood, H. 1936. Race investigations of the herring populations of Scottish waters. Fish Bd. Scotland, Sci. Invest. 1936, No. 3, 52 p.

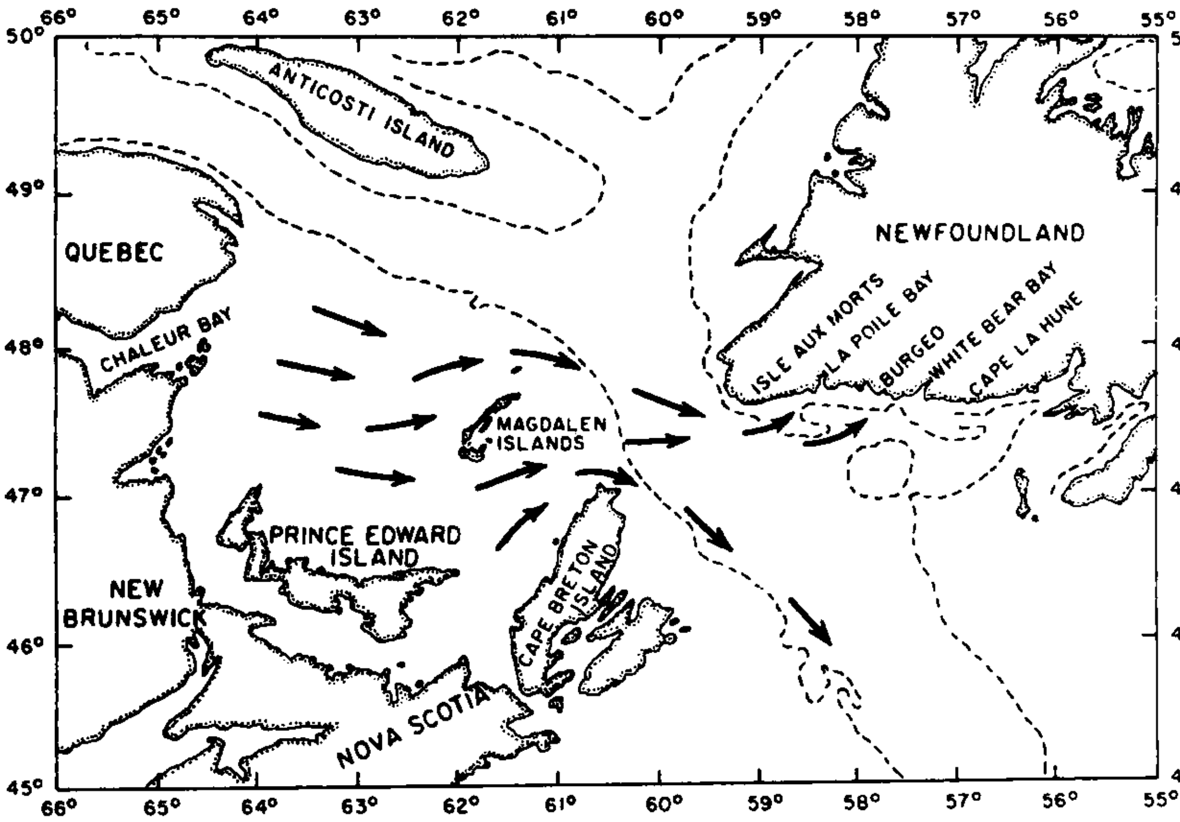

Figure 1. Map of the southern Gulf of St. Lawrence and Newfoundland showing the hypothetical autumn migration of herring.

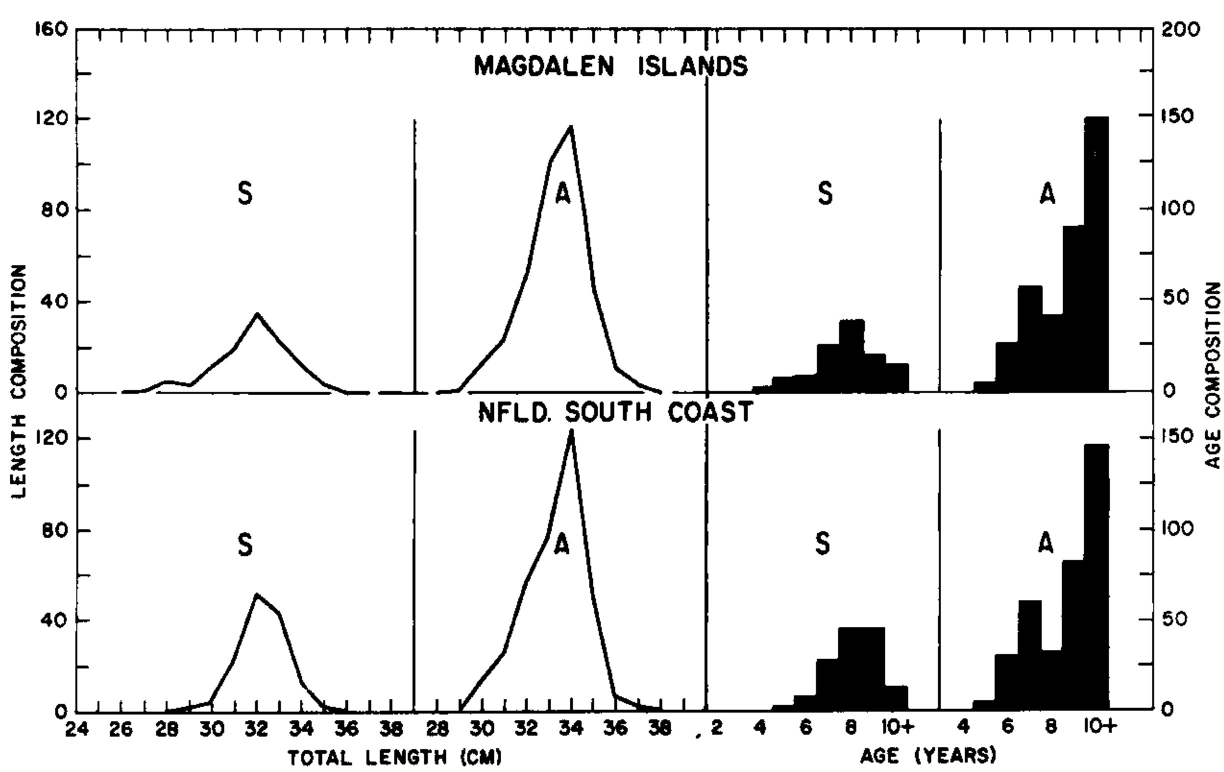

Figure 2. Length and age composition of herring samples by spawning group and area.

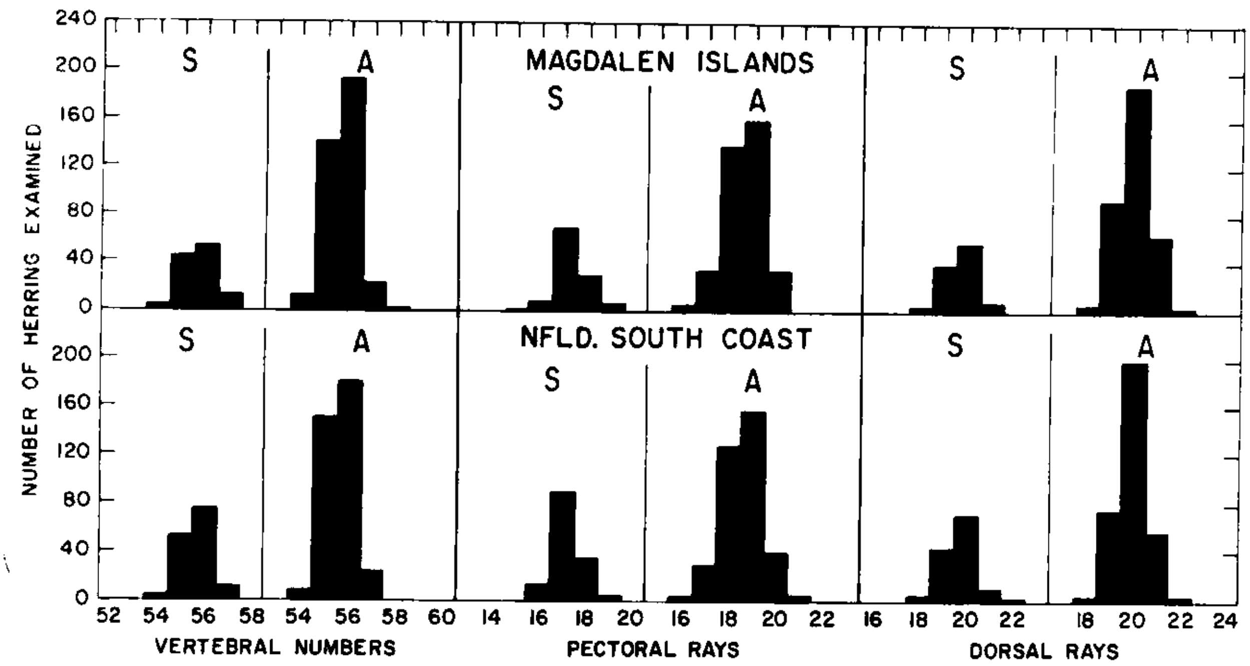

Figure 3. Frequency distributions of vertebrae, pectoral rays and dorsal rays by spawning group and area.

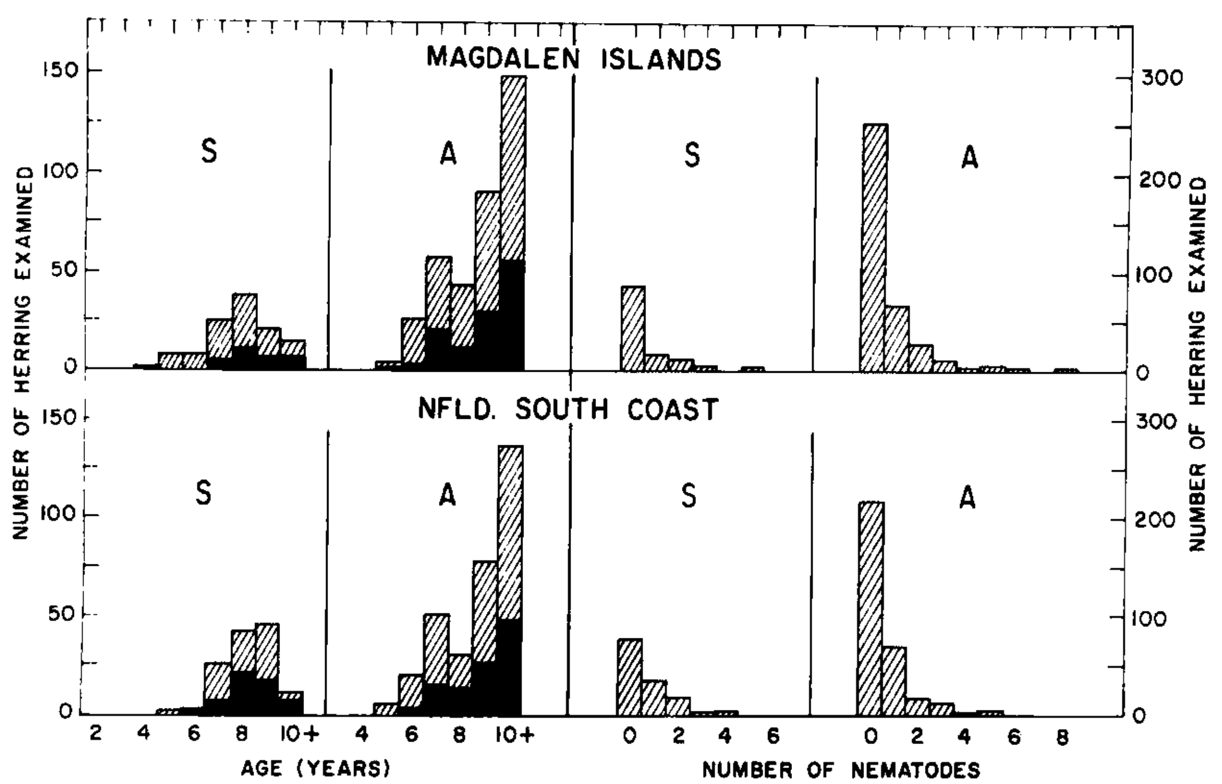

Figure 4. Frequency distributions of infected herring by age-groups (left) and of the number of nematodes (right) by spawning group and area. (In the left half of the diagram the solid bars represent the numbers of infected fish and the cross-hatched portions the numbers of herring with no nematodes.

Table 1. Date and locality of capture, maturity condition and average length of herring samples taken at Magdalen Islands (samples 1-10) and along southwestern Newfoundland (11-20) in the autumn of 1969.

Sample No.	Date of capture	Locality	Maturity condition: Imm.	Maturity condition: Spring spawn.	Maturity condition: Autumn spawn.	Maturity condition: Total	Average length (cm)	Length range (cm)
1	Nov. 1	Bird Rocks	-	11	39	50	33.2	29-36
2	" 2	" "	4	10	36	50	32.9	27-36
3	" 2	" "	6	11	33	50	32.0	27-37
4	" 8	" "	5	14	31	50	32.2	27-36
5	" 9	" "	-	14	36	50	33.2	30-36
6	" 17	" "	1	6	43	50	33.0	28-35
7	" 17	" "	3	14	33	50	32.6	29-37
8	" 17	" "	-	10	40	50	33.0	30-36
9	" 17	" "	1	10	39	50	32.7	29-37
10	" 17	" "	-	12	38	50	33.2	31-36
			20	112	368	500	32.8	27-37
11	Nov. 22	Burgeo	-	10	40	50	33.3	31-36
12	" 25	"	1	11	38	50	33.0	27-35
13	" 25	White Bear Bay	-	13	37	50	32.7	29-36
14	" 29	Cape La Hune	-	9	41	50	33.4	31-37
15	" 30	Bay de Vieux	1	14	35	50	32.7	28-35
16	Dec. 1	White Bear Bay	-	14	36	50	33.5	31-36
17	" 1	Burgeo	-	25	25	50	32.5	29-34
18	" 4	LaPoile Bay	1	10	39	50	32.4	29-37
19	" 5	White Bear Bay	1	22	27	50	32.8	28-36
20	" 12	Burgeo	-	11	39	50	33.2	30-36
			4	139	357	500	32.9	27-37

Table 2. Summary of statistical analyses for herring samples taken at Magdalen Islands and southwestern Newfoundland during the 1969 autumn fishery.

Biological character	Area	Spring spawners between areas		Autumn spawners between areas		Between spawning groups within areas
		Mean	P	Mean	P	P
Length (cm)	MI	31.81	<0.05	33.31	>0.05	<0.01
	SN	32.27	>0.01	33.28		<0.01
Age (years)	MI	7.82+	>0.05	8.73+	>0.05	<0.01
	SN	8.17+		8.67+		<0.01
Vertebrae	MI	55.65	>0.05	55.62	>0.05	>0.05
	SN	55.64		55.61		>0.05
Pectoral rays	MI	17.28	>0.05	18.49	>0.05	<0.01
	SN	17.18		18.59		<0.01
Dorsal rays	MI	19.63	>0.05	19.89	>0.05	<0.01
	SN	19.70		19.95		<0.01
Anisakis incidence	MI	30.8%	>0.05	32.8%	>0.05	-
	SN	42.3%		32.8%		-
Anisakis intensity	MI	0.41	>0.05	0.57	>0.05	-
	SN	0.59		0.48		-

MI = Magdalen Islands; SN = southwestern Newfoundland; P = probability of random occurrence.