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Occurrence of herring larvae in the Darss-Zingst Bodden in 1976/77

by

BIESIER, E., F.FREDRICH and U.HOFFMANN

Wilhelm-Pieck-University of Rostock, GDR
Section Biology, WG Fisherybiology

Summary

The young herring stocks in the chain of inlets (boddens) south of the Darss-Zingst peninsula were investigated from May to December, 1976. The salinity of the bodden water varied from 3 to 10 ‰ depending on the distance from the Baltic Sea. Herring larvae and young herring measuring up to 50 mm were found in all parts of the bodden chain. Herring measuring about 40 mm and upwards in length leave the boddens. It was possible to distinguish between two populations (autumn and spring herring) in the samples. The growth rates of the larvae and young fish depend on the temperature and amount to 0.12 mm day in winter and 0.58 mm/day in summer.

Résumé

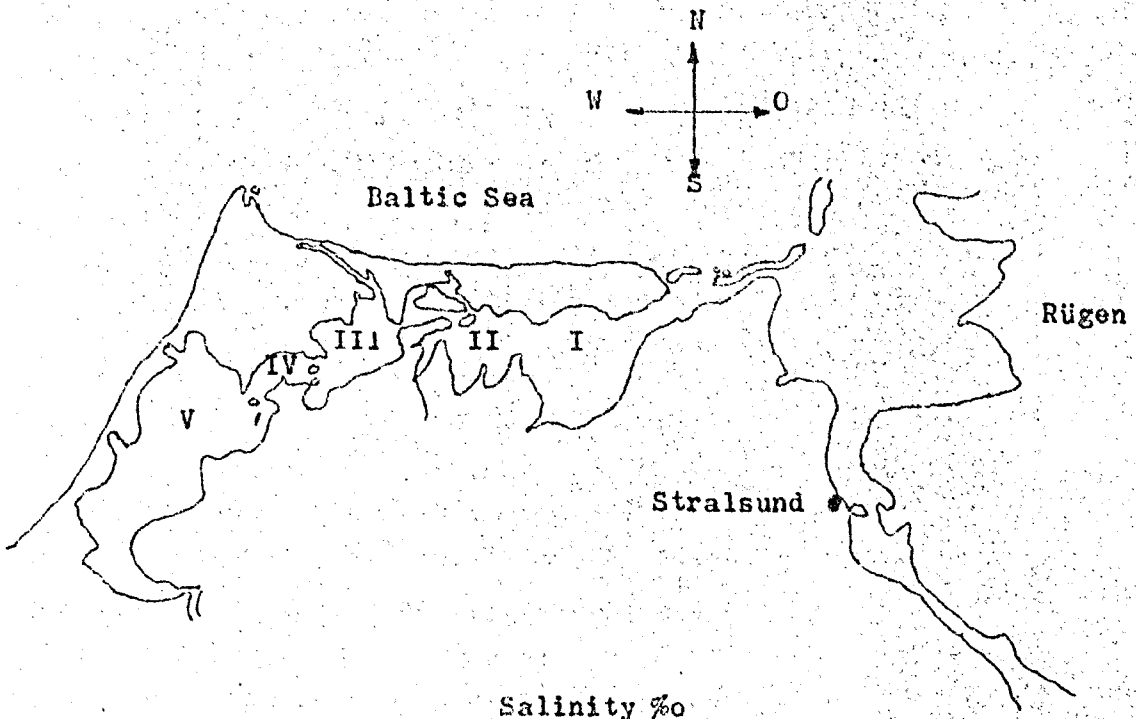
Du mois de mai au mois de décembre 1976 des études portant sur le stock de harengs juveniles dans l'étang Darss-Zingster Boddenkette ont été réalisées. Le contenu de sel de cet étang dépend de la distance à la Mer baltique allant de 3 jusqu' à 10 ‰. Dans toutes les parties de l'étang on a trouvé des larves de hareng et des harengs juveniles. Des harengs qui ont une longueur de plus de 40 mm quittent l'étang. En examinant les échantillons prélevés on a pu distingué les harengs qui fraient en automne de ceux qui fraient au printemps. La croissance des larves et des poissons juveniles dépend de la température et s'élève à 0,12 mm en hiver et à 0.58 mm en été

Introduction

The Greifswalder Bodden has been known as an important spawning ground for Baltic herring since 1958. The first investigations on herring larvae by WALDMANN (1961) and ANWAND (1962) were made at that t
Initial investigation of the young fish stocks in the chain of narrow inlets (boddens) south of the Darss-Zingst peninsula show that herring also spawn in these waters. Although adult herring have been commercially fished during the first months of the year for some time in these waters, it was not known in the past that these boddens also serve as spawning grounds.

The Darss-Zingst bodden chain on the East Mecklenburg coast is a group of shallow inlets occupying, according to LINDNER (1972), an area of 197 km^2 and having a mean depth of 2 m. The severely eutrophic chain of boddens consists of four large interconnected water bodies (see fig. 1).

Fig. 1: The Darss-Zingster-Boddenkette



			Salinity ‰
I	-	Grabow	9 - 10
II	-	Barther Bodden	8 - 10
III	-	Bodstedter Bodden	6 - 8
IV	-	Koppelstrom	
V	-	Saaler Bodden	3 - 5

In the east, the bodden chain opens into the Baltic. The water flows into or out of the boddens according to the weather situation. The salinity is 10 ‰ in the eastern part and drops to 4 ‰ in the western part. Due to fluctuations in the flow conditions, it varies by 4 ‰ in the east and 2 ‰ in the west.

Material and methods

Samples were obtained by means of a trawl for young fish which was designed especially for the shallow bodden waters. The trawl has a spread of 10 m^2 and the mesh size of the cod end is 500 um. The trawling speed was 2 nm/h and the trawling time was 30 minutes. Samples were taken over the period from May, 1976, to December, 1976. The samples were conserved in 4 % formalin immediately after they had been caught. The length measurements were rounded off to the next mm below the actual size and the weights were measured to the nearest mg.

In addition, samples of adult herring were taken from the catches obtained by the commercial trap net fisheries and uses to determine the most important fishery biological parameters.

Results

Young herring and post-larval stadiums were found in large numbers in all parts of the bodden chain from May to July. Only isolated animals were found in August and no more young herring were caught in September.

The number of herring per haul decreased in all parts of the waters in the course of the year, the reduction in the western, less saline parts of the bodden chain being less pronounced than near the connection to the Baltic Sea. The density of the herring population increases with the salinity of the bodden water. For example, on June 9th, 1976, 102 herring per haul were obtained in the saaler Bodden, the most western of the waters, and 381 per haul were caught in the Koppelstrom. On June 10th, 1976, 1.501 animals per haul were caught in the Bodstedter Bodden, whereas 20.993 herring were taken in the Barther Bodden on May 18th, 1976.

Table 1: Number of herring per haul and mean length

Date	Saaler Bodden		Koppelstrom		Bodstedter Bodden		Barther Bodden	
	Number	Mean L_t	Number	Mean L_t	Number	Mean L_t	Number	Mean L_t
11.5.	2	19,4	141	15,99				
13.5.					1278	17,34		
18.5.							20993	19,94
9.6.	102	31,65	381	30,56				
10.6.					1501	31,24		
29.6.	7	38,03						
30.6.					54	34,01		
28.7.					4	45,18		
12.8.					1			
13.8.	2	65,4						
24.8.					1			

(L_t-stations in mm)

However, table 1 includes only the herring which were contained in the haul and had hatched during the spring of 1976.

As figure 2 shows, herring with a mean length of 44.68 mm were already found in the catch on May 13 th, 1976, and similar results were obtained for all catches made in May. No herring of similar size were found in any of the later catches.

It is impossible to determine the precise growth rate of the herring which hatch during the spring since, as proved by the results obtained for 1977, the herring arrive in several waves in order to spawn (see fig.3, maturity). Due to the fact that the samples could not, in some cases, be taken closely enough together and the continual movement of the water body (inflow and outflow) which promotes the very rapid mixing of fry of different ages it is impossible to follow the growth of animals which are of precisely the same age.

The considerable differences in salinity within the bodden chain has some effect on the growth of the herring (SCHNACK, 1971). In order to obtain a provisional general idea of the growth of the herring fry and young figh, the mean L_t values of almost all samples were used to calculate the growth curve. The curve was calculated by the formula

$$L_t = a \times e^{bxt}$$

where a is the length at birth
b is a constant and
t is the age in days.

Figure 4 shows a growth curve for 1976 which was calculated according to

$$L_t = 6.92 \times e^{0,01t}$$

This curves conform well with all values which were obtained empirically. According to the curve, the growth rate is 0.1 ... 0.2 mm/day in March and April, 0.2 ... 0.4 mm/day during May and June and 0.6 mm/day in July. The mean daily growth is thus 0.3 mm.

The increase in weight also followed an exponential curve in the same way as the growth in length. This is shown by the length/weight distribution of the sample taken in the Bodstedter Bodden on June 30th, 1976 (fig.5). This curve matches the formula

$$G_t = 2.12 \times e^{0.12t}.$$

As confirmed by empirical findings, the weight increases slowly in the length groups below 30 mm but thereafter rises substantially. This is even externally apparent in the young herring, which, when a length of 30 - 40 mm is reached, become much more corpulent and have much higher backs. Unfortunately, the food of the young herring in these waters has not yet been investigated, so that the effects of the available food sources and feeding activity on the growth in length and weight must be disregarded.

Discussion

The chain of boddens south of Darss-Zingst can be regarded as a further spawning ground for the Baltic herring on the coast of the GDR. Investigations during 1977 have produced facts which prove that spawning takes place in the two eastern boddens. Herring spawn adhering to sea grass and floating vitelline larvae were caught during March, April and May this year in the Grabow and the Barther Bodden. At the same time, the commercial fisheries landed adult animals which had not yet spawned also from these waters. No such proof is available for the more westerly boddens since no samples could be taken there in the spring of either 1976 or 1977. However, larvae with a mean length of 15 - 20 mm were caught in May, 1976. This leads to the conclusion that these boddens with a salinity of 3 - 7 ‰ are also used as spawning grounds. It is inconceivible that post post-larval forms could proceed from the eastern to the western part of the boddens by their own movement or as a result of movement of the water body.

The samples taken at the beginning of May, 1976, in the different parts of the boddens contained young herring with a length of 44 mm. Their metamorphosis had already been concluded, so that they were

easily distinguishable from the herring larvae. These young herring can have hatched either in the winter or during the autumn of the preceding year. If the water temperatures during January, February and March which were almost permanently below 1° C and only briefly rose to less than 2° C are taken into consideration together with the fact that herring spawn take 49 days to develop at a water temperature of 3 - 4° C (RUSSEL, 1976), the winter months must be eliminated as the spawning time for these herring. Calculations which take the low temperatures and the reduced amount of available food into consideration indicate that the spawning time was propably October and November. This hypothesis is also corroborated by values obtained in 1975. For example, young herring measuring 32.5 mm in length were caught on January 32st, 1975. Young herring caught on April 29th, 1975, had a mean length of 45.1 mm. Absolute certainly regarding the hatching time will be obtained by the investigation of otholites.

The proportion of autumn herring among the whole sample taken on May 13th, 1976, was only 9.79 %. However, it is as yet impossible to say whether this is due to the different sizes of the spawning stocks alone or whether natural mortality and the migration of the young herring lead to this age structure in the samples.

The young herring remain within the boddens until they have reached a certain stage of development. Both spring and autumn herring leave the chain of boddens when they have reached a length of 40 - 50 mm.

The young fish disappear first from the more western boddens and it is not until later that they, now somewhat larger, leave the more easterly boddens. As a result of their lower growth rate arising from the temperature conditions, the autumn herring remain in the boddens longer than the spring herring. It cannot be assumed that the young herring undertake major migrations before reaching a length of 40 mm. RUSSEL (1976) states that young herring do not form schools, a necessary condition for major migrations, until they have reached a body length of 30 mm. Their motility prior to reaching this length and especially the water movements caused by currents and wind effects lead to the continual movement and mixing of the fry groups.

The growth of the young herring in the Darss-Zingst bodden chain is not linear. It is clearly dependent upon the water temperature. It is not intended to discuss the effects of the low and continually changing salinity and the availability of food on growth at this point. The growth rate increases exponentially with the water temperature. Table 2 shows

the mean water temperatures over three periods of ten days each per month together with the mean growth per day for each whole month.

Table 2

10-day period	Month					
	March	April	May	June	July	August
I	1.23	6.24	10.32	15.47	21.72	16.47
II	0.18	8.75	14.73	15.90	21.71	20.53
III	2.09	8.56	15.20	19.99	19.09	18.90
Mean growth	0.12	0.17	0.27	0.38	0.58	0.88

(Mean growth in mm, mean water temperatures in ^{o}C)

Towards the end of June, the water temperature increases rapidly from 15^{o} C to 20 - 23^{o} C. The vertex of the growth curve is also situated within this period. The young herring grow from 30 mm to 40 mm.

As already stated, young herring of this length are able to undertake wide-ranging migrations and to seek food over large areas. In August, the herring is already able to devour a wide range of food and to hunt its prey, this promoting a high growth rate.

The number of samples taken in 1976 and containing autumn herring is too small to permit of statements regarding the growth rate. Values from 1975 show that the autumn herring has a mean growth rate of 0.14 mm/day from January to April. This indicates that both autumns and spring spawners are equally dependent on the water temperature, although it is noteworthy that the growth rate of young fish measuring 30 - 40 mm in length is the same as that of the larvae at identical temperatures. (WEBER, 1971) also drew attention to the dominant effect of the water temperature on growth and is of the opinion that the temperature is an important pacemaker for growth irrespective of the race and relative size of the larvae. Comparison with figures for growth rates stated in the literature shows that our figures agree well with those published by other authors (see table 3). The high growth rates of 0.3 - 0.4 mm/day attained by the atlantoscandian herring are particularly conspicuous in this table and are not attained in the Darss-Zingst bodden chain. At the lower end of the temperature range, the growth of the herring in the Darss-Zingst-bodden chain is completely comparable to that of herring from other waters. However, due to its slight depth the temperature of the bodden water rises rapidly so that the herring is exposed to high water temperatures in summer and consequently achieves very high growth rates during this period. The growth rates achieved in June, July and August

Table 3 : Growth rates of young herring from different waters at various temperatures

				Watertemperature (in °C) 2	2	5	6	7	8	9	10	11	13	17	21	without statement
BRANDHORST	1956,	Kiel Canal	SS				0,16	0,18			0,24	0,27				
WEBER,	1971,	Kiel Bight	AS			0,13					0,24	0,26				
BÜCKMANN,	1951,	Downs, Dogger	AS					0,2-0,27								
HEMPEL,	1970,	Downs	AS						0,2							
SCHUBERT,	1967,	atlantoscandia						0,3-0,4								
RUSSEL,	1976															0,3
SCHNACK,	1971,	North Sea	AS													0,23
NELLEN,	1963,	Schlei	SS												max.	0,6
our values	1976,	Darss-Zingst bodden Chain	SS	0,12					0,17				0,27	0,38	0,58	
	1975	"	AS			0,14										

(AS = autumn spawners; SS = spring spawners)

Some values taken from WEBER, 1971 and SCHNACK, 1971

are in some cases much greater than those stated in the literature. The table also shows that the low salinity in the Darss-Zingst bodden chain has no negative effect on the growth of the herring larvae or young fish.

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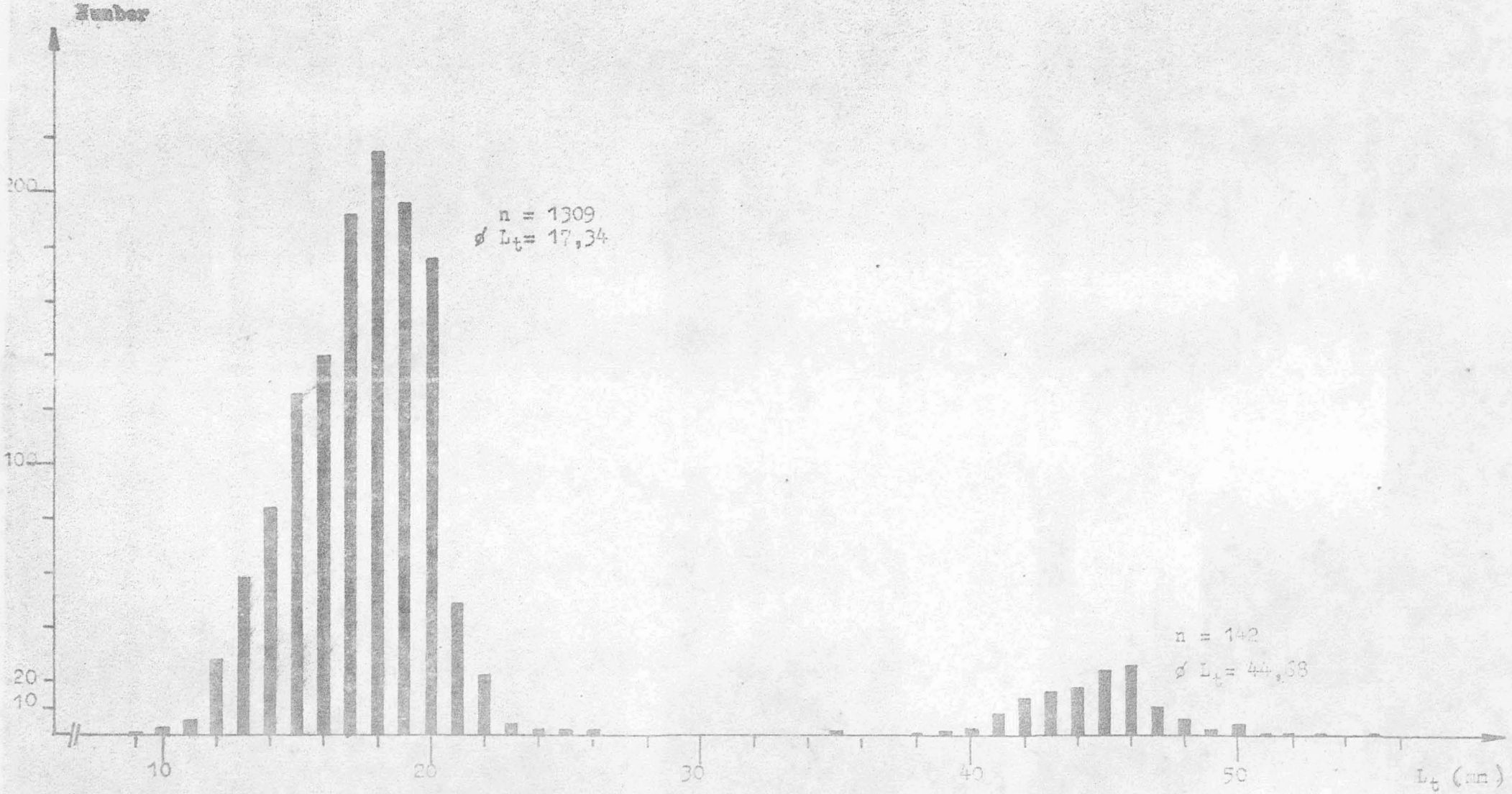

Fig.2 Length distribution C.harengus 13.5.1976 Bodstedter Bodden

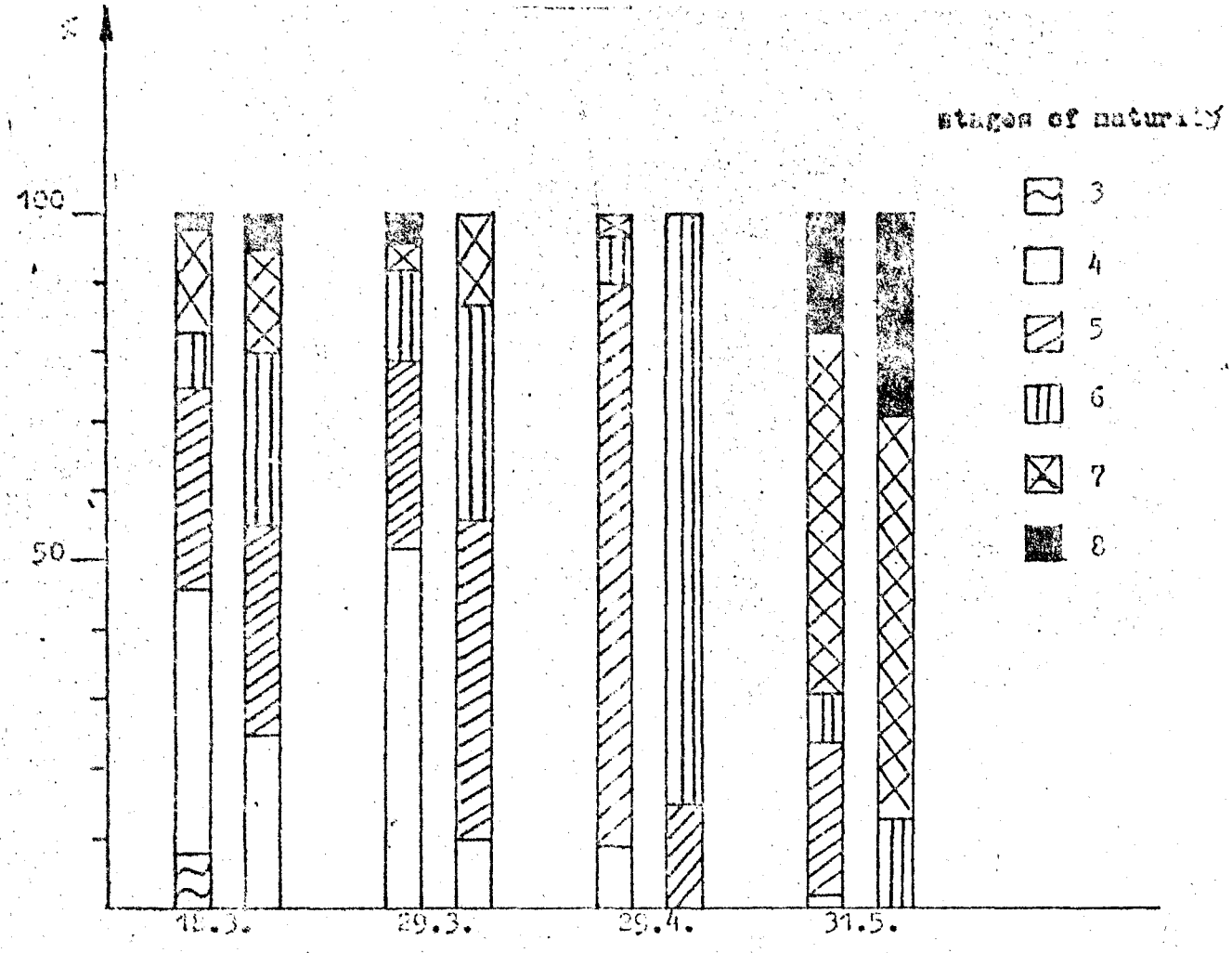

Fig.3 stages of maturity found among adult herring Crabow 1977

Fig.3: Length/weight distribution

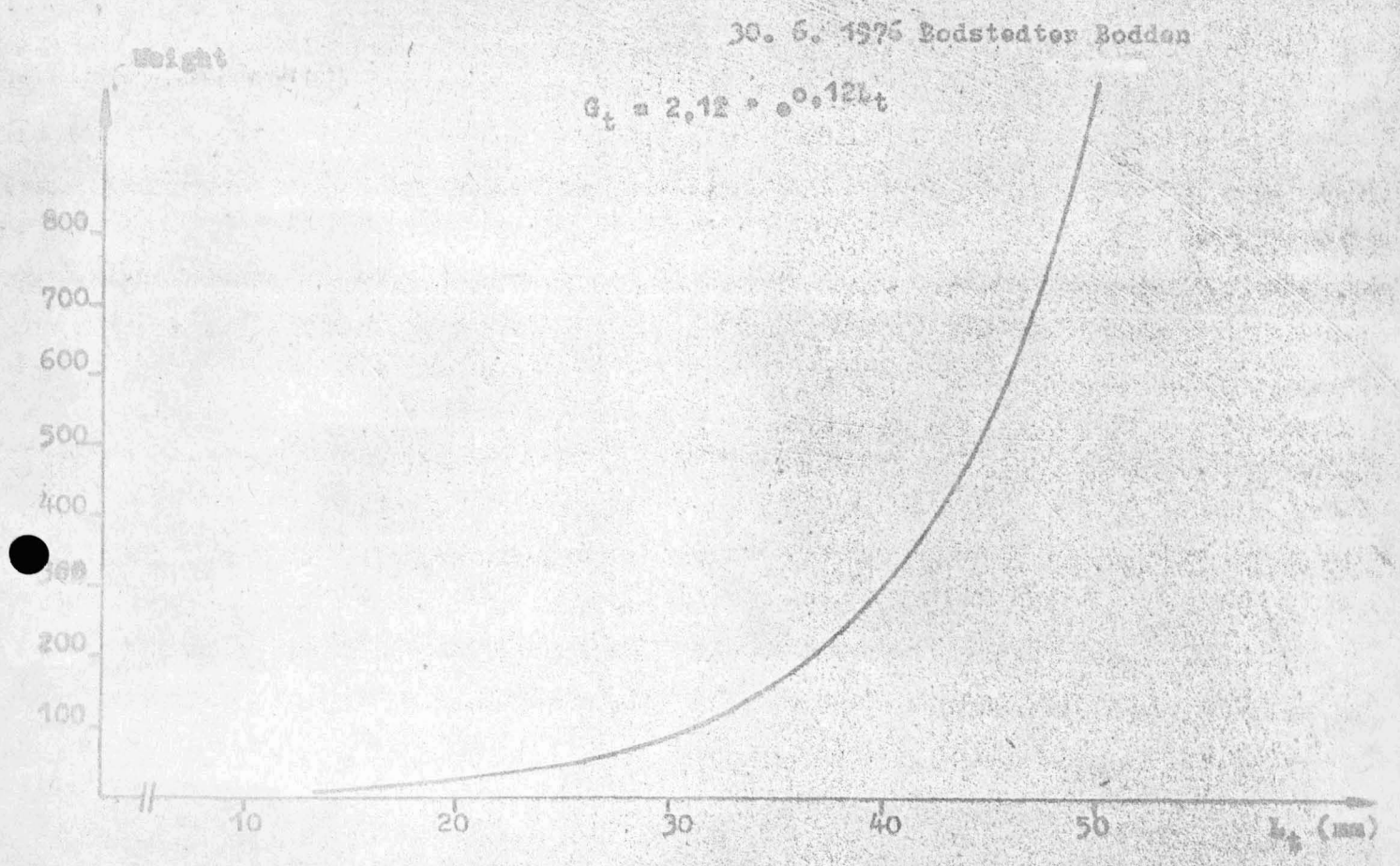

Fig.4: Growth curve