International Council for
the Exploration of the Sea

C.M. 1974/F 17
Demersal Fish
Northern Committee

Seasonal changes of the weight-length relationship of plaice in the Eastern North Sea

by

Gert Rauck

Institut für Küsten- und Binnenfischerei
der Bundesforschungsanstalt für Fischerei
Hamburg

Parallel to length and age investigations on plaice of the Eastern North Sea landed by German deep sea cutters at Hamburg fish market single weights of male and female plaice have been taken during the period of 1969-1974 aiming to contribute to the changes of body weight of male and female plaice throughout the year.

This investigation is based on the weight-length relationship of plaice according to Fulton's equation:

$$K = \frac{\text{weight} \times 100}{\text{length}^3} .$$

Several authors as Dunker (1923-30), Heincke (1908, 1913, 1916), Krefft (1950), Lundbeck (1951), Reibisch (1907), Fulton (1901, 1902, 1903, 1904), et al. have been describing the seasonal changes of the nutrition coeffecient of plaice and other food fishes in the North Sea, Baltic Sea and the North Atlantic by various means. The weight-length relationship of gutted or ungutted fishes seperated by sex, age and cm-groups is the most common method of describing the food condition of fishes. In case of the plaice also the relationship between weight-length and thickness of the flatfish has been used (Reibisch 1911).

2/-

Chemical investigations such as determining the fat, protein and moisture content of several fish species (not for plaice) have been undertaken as useful supplement for a better understanding of the seasonal fluctuation of weight/length relationship in fishes (Meyer 1968).

Method:

From 1969 to 1974 5.095 weight/length data of gutted male and female plaice was collected at Hamburg fish market. The plaice were caught in the Eastern North Sea at the fishing ground Northern and Southern Schlickbank. The samples were taken at different months of the years 1969-1974. Dates and numbers of investigated plaice are given in table 1. Each sample reflects the length variation of male and female plaice within the respective months although cm-groups with less than 5 fish were excluded from the later calculation. All fish weights were taken by using a portable balance with a dial reading device and an accuraracy of 1 g.

In order to guarantee representative sampling weighing of fish took always place during the vessel was being unloaded. By this method plaice from the first until the last day of fishing as well as fish of the lowest and the top part of the ice hold were recorded. (Fish lose weight as a consequence of pressure and ice in a fish hold).

Results:

Althagh the length frequency of plaice in the Eastern North Sea varies slightly from month to month (during summer less plaice of the upper cm range are to be found) one average K-value for each sample was calculated for male and female plaice seperately. (Fig. 1)

Except for the period July to October the values for both sexes differ throughout the year. The mode of the two curves however are quite similar.

The K-values for both male and female drop from the end of summer to mid of April-May to their lowest values as a result of the passed spawning period. From May onwards length goes parallel with a surplus of weight increase leading to a maximum value of K = 1.05-1.07 in August-September. Since Fig. 1 shows only average values over the whole cm-range of each sample Fig. 2 gives detailed information

3/-

on combined 3 cm-groups over a one years' period.

Female plaice:

Nearly all 8 curves of female plaice within the range of 26-40 cm show a falling tendency of K from August-September to April-May (Fig.2). From May onwards the K-values of the cm-groups 26-40 cm increase to a maximum in August-September. Plaice of the 41-49 cm-group however show a similar pattern up to July and increase further up to the end of the year as a result of the development of their gonads.

Smaller female plaice are throughout the year in a better food condition as indicated by the absolute K-values compared with large plaice which vary much more due to their different gonad stages from ripening ripe and spent (Fig. 2 and 3).

Male plaice:

In general the seasonal pattern of K for the male plaice is similar to this of the males Fig. 2.

As compared to female only fish in the range of 26-34 cm show falling tendency from August-September onwards, older males of the range of 35-40 cm however increase their K. In case of male plaice the variations of K throughout the year are much less than compared with female plaice. In addition it is remarkable that with increasing size of male plaice the lowest K-values shift from early February to April-May (Fig. 2).

Discussion:

Body weight reduction

Male and female plaice loose weight from autumn to spring. According to Borley (1912) an average of 17%, according to Heincke (1913) up to 30% weight reduction in certain cases especially for juvenile plaice can be observed. For the plaice of the Eastern North Sea similar figures have been achieved (Table 2). Under the assumption that plaice do not grow from autumn to spring (this fact is stated by Heincke und other authors) the loss of weight for male and female plaice in terms of absolute figures (g) and per cent of the total gutted body weight is given in table 2.

The reduction of body weight varies between 10.4-15% for female plaice between 26-40 cm length, for larger plaice with a higher percentage of gonad weights between 19.1 and 26%. The figures for small males (13-14.7%) are similar to those of small females. Larger females however lose about 7% more of their body weight than males (16.2-16.4%) of the same size.

Length and weight increase

In case of both sexes the increase of K in spring or earlier is due to weight increment as a result of intensive feeding. Even though growth of plaice in length takes place at the same time K does not drop due to a surplus of weight increase. In July to August growth and weight increment come to a stillstand except for the large male and female increasing their K by gonad development up to December/January.

The female and especially the male plaice of small size up to about 30 cm start feeding earlier and reach from May onwards K-values of 1.04-1.06 with increasing tendency to August-September. Those plaice are of best food condition from May anwards up to August and are famous for their good taste (Mai-Scholle).

Summary

Based on 5.095 single weights of gutted male and female plaice of the Eastern North Sea the seasonal changes of the weight-length relationship has been investigated. The whole material was collected at the Hamburg fish market, the weight-length relationship is expressed by Fulton's equation: $K = \frac{\text{weight} \times 100}{\text{length}^3}$. Both sexes show low K values in April-May. Growth in length and a surplus of weight increase lead to a rising K-factor up to August-September. In case of small male and female growth and weight increase stops and K drops until the next spring to a minimum value. Large male and female however increase their K further as a consequence of their gonad development.

Under the assumption that length increment comes to a stillstand in autumn small female plaice lose 10.4-15.3%, larger female 19.1 to 26% of their body weight up to April-May, small males 13.2-14.7,

larger males 16.2-16.4%. Small female especially small male are in a better food condition throughout the year compared with large female and male.

References:

BORLEY, A. : A comparison of the condition of the plaice of different regions as to weight.
4. Rep. North Sea Fish Comm. 1909. 1012

DUNKER, G. : Die Korrelation zwischen Länge und Gewicht bei Fischen.
Wiss.Meeresunters.NF.Abt.Helgoland Bd XV Nr.4/1922

FULTON, T.W. : The rate of growth of fishes
22. Rep.Fi.Bd.Scotl. f 1903, 1904

HEINCKE, F. : Untersuchungen über die Scholle, Generalbericht, 1. Teil
Rapp. et Proc.Verb. XVII a 1913

KREFFT, G. : Untersuchungen über die Gewichtsverhältnisse bei ausgenommenen Plattfischen
Mitt.Inst.f.Seefischerei H 1 1950

LUNDBECK, J. : Biologisch-statistische Untersuchungen über die deutsche Hochseefischerei. III Das Körpergewicht und das Längengewichts- Verhältnis bei den Nutzfischen.
Ber. der dtsch. Meeresf. B XII H 3

MEYER, V. : Fische und Fischerzeugnisse, C. Einflüsse auf die Zusammensetzung der Fisch und Fischerzeugnisse.
Biochemie und Mikrobiologie, Handbuch der Lebensmittelchemie 3.Bd. 2. Teil, New York 1968

REIBISCH, J. : Ein Dicken-Koeffizient als Mass für Alter- und Ernährungszustand der Fische
Die Beteiligung Deutsch. u. Intern. Meeresf.
Bd IV/V (1907) 1908

Table 1

Dates of sampling and number of fish weighed(3cm-groups with less than 5 speciments not included.)

date	30. 1.69	6. 2.69	10. 2.71	20. 2.70	6. 3.70	10. 4.74	2. 5.74	5. 6.69	9. 7.70	20. 8.73	4. 9.69	20. 9.73	16.10.70	27.11.69	
cm						♀									
26-28	6	--	--	13	--	--	--	--	14	24	17	19	13	22	
29-31	22	20	19	30	20	23	30	6	30	30	27	30	28	30	
32-34	25	10	30	30	27	25	30	21	30	30	29	29	30	30	
35-37	29	--	30	24	25	30	30	28	30	30	53	30	30	30	
38-40	42	--	30	30	19	30	30	27	30	30	41	29	30	24	
41-43	74	77	30	30	26	30	31	30	30	30	24	29	30	18	
44-46	57	97	30	28	25	30	--	25	21	15	35	22	27	16	
47-49	22	66	21	14	7	27	--	13	13	--	24	29	18	7	
50-52	23	15	30	7	--	8	--	--	--	--	9	14	9	--	
	300	285	220	206	149	203	151	150	198	189	259	231	215	177	total 2.933
cm						♂									
26-28	21	33	--	7	8	14	23	--	30	24	19	27	24	24	
29-31	45	35	30	30	30	30	31	13	30	30	89	30	30	30	
32-34	78	22	30	30	30	30	30	33	28	30	91	30	30	30	
35-37	72	--	30	25	30	30	30	29	20	30	63	30	28	30	
38-40	52	8	26	25	27	30	21	24	9	20	27	27	7	12	
41-43	23	24	12	10	14	13	--	7	--	--	8	--	--	--	
	291	122	128	127	139	147	135	106	117	134	297	174	119	126	total 2.162

7/-

Table 2: Reduction of weight from maximum values in August-December to minimum values in spring in g and per cent for male and female plaice of the Eastern North Sea. (1969-1974)

cm	month	min (g)	month	max (g)	Δ g	lost weight (%)	
26-28	April	189	October	211	22	10.4	
29-31	April	257	November	294	37	12.6	
32-34	April	338	November	399	61	15.3	
35-37	April	439	Aug-Sept	499	60	12.0	
38-40	April	546	Aug-Sept	629	83	13.2	♀
41-43	April	659	Aug-Sept	815	156	19.1	
44-46	April	756	July	1021	265	26.0	
47-49	April	929	Aug-Sept	1183	254	21.5	
26-28	February	185	Aug-Sept	217	32	14.7	
29-31	Feb-March	254	Aug-Sept	292	38	13.0	
32-34	Feb-March	334	Aug-Sept	385	51	13.2	♂
35-37	April-May	415	Nov-Dec	495	80	16.2	
38-40	April-May	516	October	617	101	16.4	

8 /-

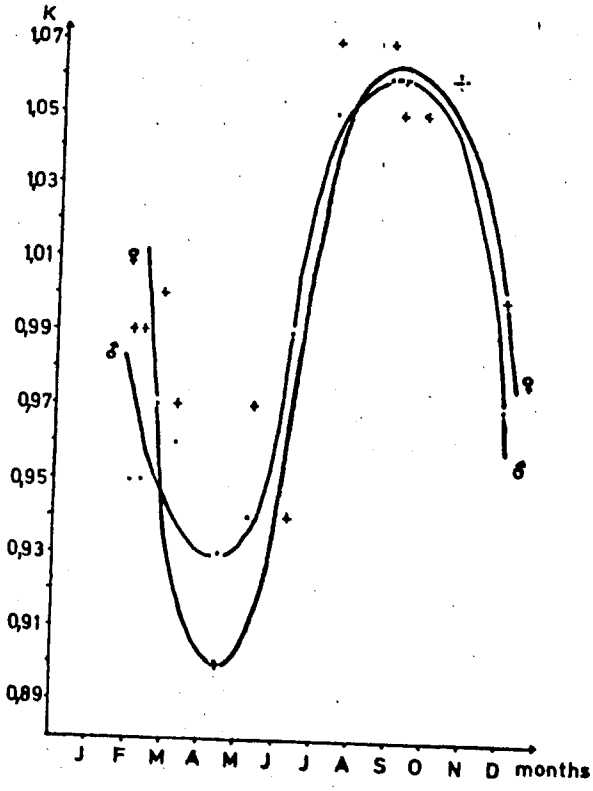

Fig. 1: Seasonal changes of the weight-length relationship of male and female plaice of the Eastern North Sea

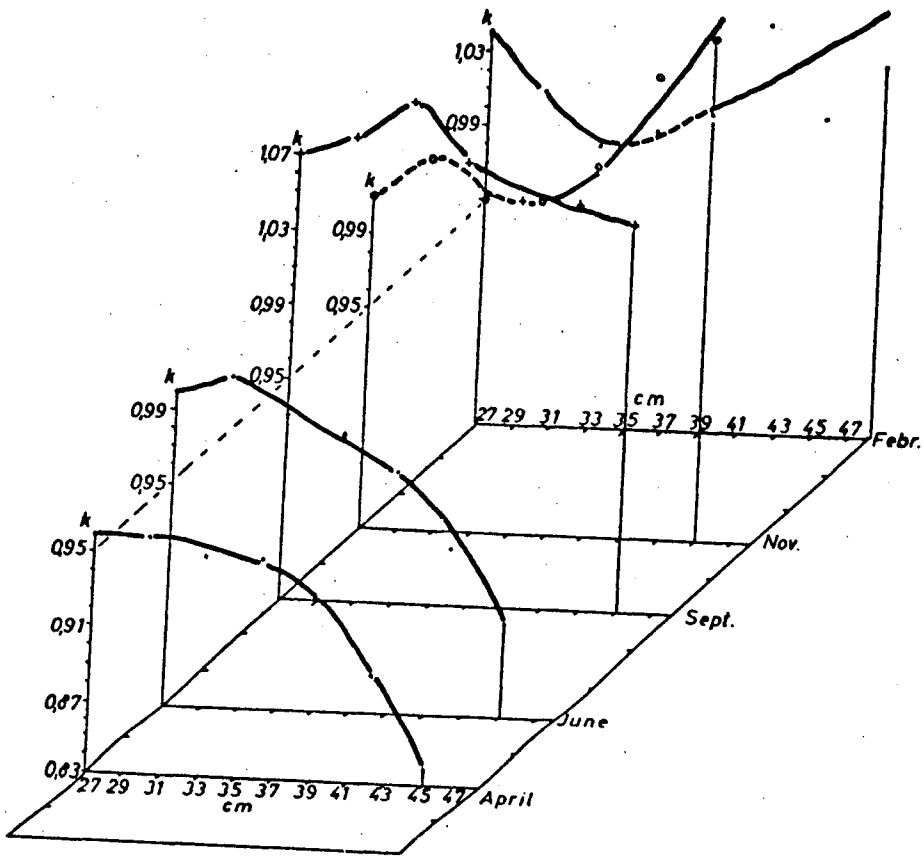

Fig. 3: Weight-length relationship (K) of female plaice according to size and season

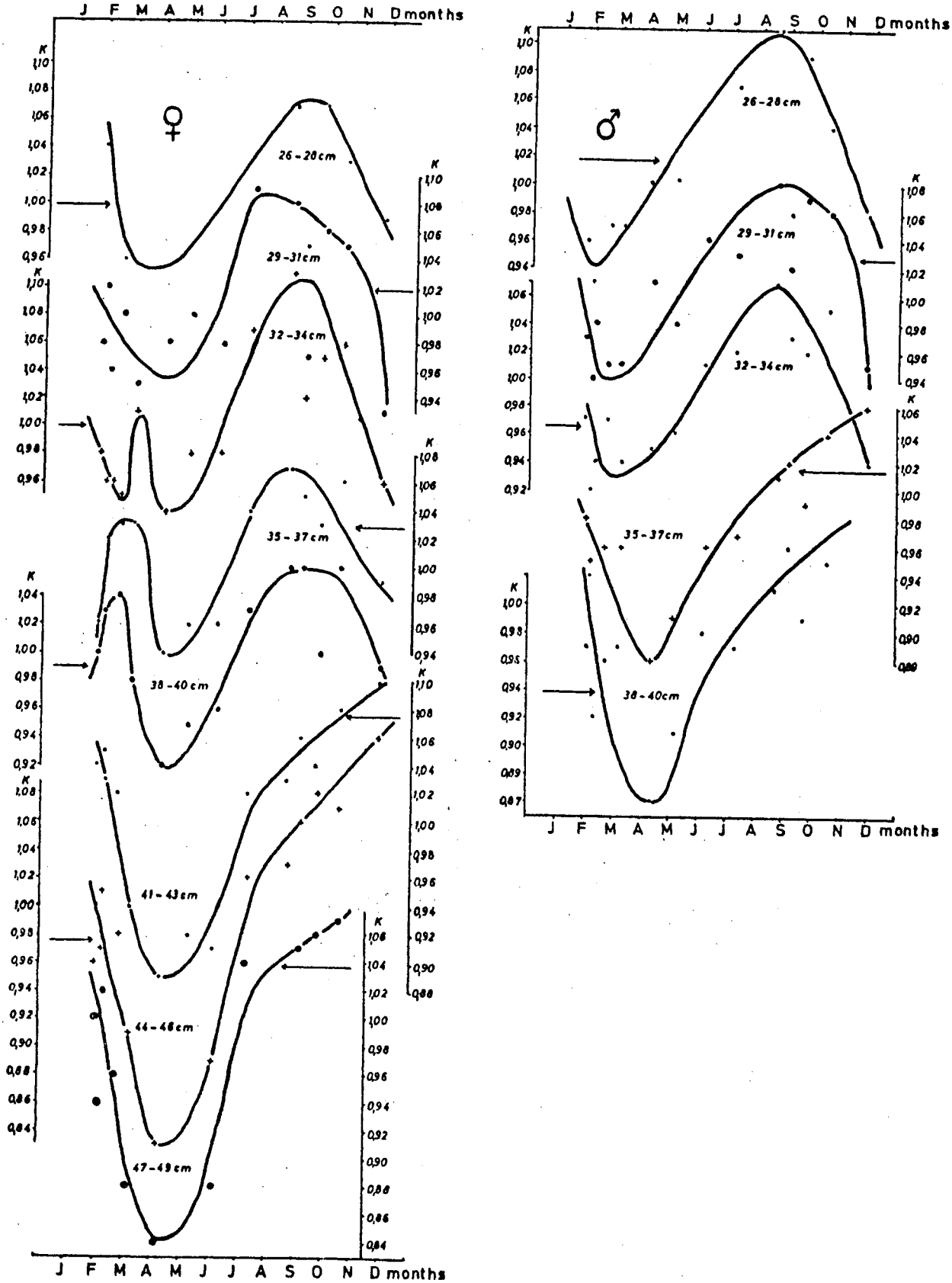

Fig. 2: Weight-length relationship (K) of female and male plaice of the Eastern North Sea (grouped to 3 cm).