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An Attempt to Estimate the Rate of Transatlantic Exchange of Large Bluefin Tuna from German Tuna Catches by means of the Feeding Condition Factor "K"

by

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Mather (1962), in his paper on the transatlantic migration of two large bluefin tuna, states: "Mr. Hamre reported (personal communication) that the tuna still bearing its tag was one of a very long but extremely lean variety found in some years among the the late-season Norwegian catches and locally called 'long-tailed bluefin'. He had previously supposed that these were eastern Atlantic fish which had failed to feed successfully because of old age or some other reason. This recapture, however, led him to believe that they were actually western Atlantic tuna which had been crossing the ocean during the summer, when bluefin tuna normally are on the continental shelves feeding heavily and gaining weight rapidly".

If the poor feeding condition of the fish should be a general characteristic for tuna, which have just crossed the Atlantic, it should be possible to use the K-factors ($K = \frac{\text{weight}}{(\text{length})^3} \cdot 100$) of a large number of tuna representing a total or a part of a certain eastern Atlantic tuna population, to determine roughly the share, which such lean tuna are holding on the stock, and thus to estimate the rate of transatlantic exchange of bluefin tuna.

Since 1951, i.e. the beginning of the German bluefin tuna research, the individual length and weight of nearly all tuna caught by German fishermen are registered by the Institut für Küsten- und Binnenfischerei (Table 1).

Table 1. Data collection of the German bluefin tuna research.

Year	Number of tuna caught	Number of tuna measured and weighed	Number of tuna measured in % of the tuna caught
1951	1,120	480	43
1952	1,420	589	41
1953	1,560	513	33
1954	3,100	2,405	78
1955	4,810	4,173	87
1956	2,306	1,389	60
1957	5,599	5,244	94
1958	1,625	1,581	98
1959	3,818	3,179	83
1960	1,623	1,436	88
1961	1,092	892	82
1962	733	721	98
	28,806	22,602	78

Since 1951 the length and weight of 22,602 bluefin tuna, i.e., from 78 % of the total German catch were taken. The length of fish was measured by the fork length to the nearest cm and the weight of gutted fish but with gills and head was determined to the nearest kg. For all fish the feeding condition factor "K" had been determined. The "K"-factors, given in the follwoing, refer to gutted fish. If they shall be re-calculated to ungutted fish a raising factor of 1.026 has to be applied, since the relationship between the weight of ungutted fish and the weight of gutted fish is as follows: w = w'. 1.o26, wherein w is the weight of ungutted fish and w' the weight of gutted fish with head and gills (Hamre & Tiews, 1962). The correlation factor was calculated according to data given by Krummholz (1959).

How much the feeding condition of the bluefin tuna changes during the course of the fishing season of the German fishermen in the North Sea has been described several times (Bahr, 1952; Lühmann, 1959; Tiews, 1957, 1961, 1962 and 1963). Latest Tiews (1963) gives the follwoing Table 2, which shows the differences found on the average for "K" within and between the fishing seasons.

Table 2. K-factors calculated for North Sea tuna of German catches in various seasons.

	1954	1955	1956	1957	1958	1959	196o	1961
August	1.69	1.81	1.78	1.74	1.82	1.81	1.78	1.75
September	1.65	1.74	1.91	1.77	1.84	1.83	1.88	1.75
October	1.72	1.89	1.96	1.84	1.88	1.93	1.9o	1.83

In most of the years the "K"-factor grows steadily during the course of the fishing season from month to month. However, there are years, when the size of the "K"-factor had declined from August to September, such as in 1954 and 1955, or when it remained unchanged during August and September as in 1961. It is evident that in those years new lighter fish must have arrived in September (Tiews, 1957). Another important finding is that there are considerable differences in the feeding condition of tuna between the years. So in some years the bluefin tuna has been found to be lighter on an average at the end of its feeding time in the North Sea than it was in other years at the beginning of its feeding time. This was especially the case in October 1954. But also in 1961 and 1957 the fish left the North Sea relatively badly fed.

In order to be able to recognize different components by which the German tuna catches may have been composed, frequency distributions of "K"-factors were calculated for the years 1952 - 1962 x) for two major periods, extending from the 16th - 3oth September and from the 1st October until the end of the fishing season, which usually terminates in the middle of October. Two periods were chosen in order to have control values, and they were chosen at the end of the fishing season for two reasons:- firstly, because the chance to detect the arrival of lean tuna among those being already fattened at the end of their feeding period is greater than it would be at the beginning of the feeding period, when the fish is generally lean, and secondly, because these periods correspond with the time, when the two transatlantic migrators were recaught on the Norwegian coast (28th September and 6th October) (Figure 1).

Figure 2 shows that, within the size range of tuna caught by the German fishermen, the size of the "K"-factor is not related to length. It is certainly permitted, therefore, to treat the data regardless to length.

With respect to the shape of the curves Figure 1 reveals considerable differences between the years, however, a general correspondence between the September and October curves is obvious in most of the years. The generally higher values of the October curves are related to the better feeding condition of the fish at the end of its feeding time in the North Sea.

During most of the years the curves permit to conclude the existence of two groups of fish from which the smaller one is related to lower "K"-values, or in other words consist of lean fish, and the bigger one respectively to higher "K"-values. This appears very much pronounced during the years 1952, 1953, 1954 and 1961, but is less distinct in 1955, 1956, 1958 and 196o. In 1959 the picture is even more unclear and in 1957 and 1962 the picture is far from permitting to conclude the existence of more than one group of tuna in the catches.

Attention may be drawn to the 1953 and 1954 pictures, when very lean fish were caught in September (both years) and in October (1953). In all the other years the group of lighter fish consisted of fish being relatively heavier, as indicated by the higher values of the "K"-factor.

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x) The data collected for 1951 were excluded since during 1951 the length was taken as total length and not as fork length.

For estimating the size of the share held by the group of lean tuna on the total catch, the two groups of tuna had to be approximately separated using the graphical representation of data for this purpose (Figure 1). The arrows placed in Figure 1 indicate at what "K"-values the curves were divided into the two groups. In most of the years a "K"-value between 1.5 and 1.6 was chosen. Only in 1952 and in 1961 a "K"-value of 1.65 was found to suit more the shape of the curves and in 1954 a "K"-value of 1.4 was found. In 1955 the October curve only indicates the existence of a 2-moded curve, while for the years 1957, 1959 and 1962 a separation in two groups was felt to be impossible in both periods.

Table 3 gives rough estimates of the shares held by the group of lean tuna on the total catch made during these periods for each of the two periods and also on the unweighted average of the two periods.

Table 3. Estimate of the size of the share held by the group of lean tuna on the total catch in %.

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	
Periods												
16.IX-30.IX	16	42	12	-	6	-	8	-	14	33	-	%
October	26	35	4	4	7	-	6	-	8	(-)xx)	-	%
Average	21	39	8	4	6	-	7	-	11	33	-	%

The group of lean tuna was largest during the years 1952, 1953 and 1961 when about 20 - 40 % of the catches were such lean fish. Much smaller was the group in the other years when between 0 and 11% of the catches were composed of lean fish. On an average, during the 11 years' period under research some 12 % of the German catches consisted of lean fish.

It might well be that these fish or at least the greater part of it are identical with tuna, which just have crossed the Atlantic.

It is not worth mentioning that during 1952 and 1953 a remarkably strong and relatively young new tuna year-class had invaded the German fishing grounds and had replaced a year-class of fish, which was about 5 years older and which had dominated until 1951 in the German catches. The sudden change in the size composition of German tuna catches during these years has no parallel in the period thereafter, extending until 1962 (Figure 3). It might be that this strong recruit year-class, which dominated during several years in the German catches, had come from the other side of the Atlantic and became more or less stationary on this side of the Atlantic, as the high rates for transatlantic migrators for 1952 and 1953 suggest. However, there is also much probability that normally a more or less regular exchange of stock between both sides of the Atlantic at a smaller rating takes place, because otherwise one cannot easily explain the high average rate of 12 % per year for transatlantic migrators.

Finally, it shall be pointed out that the figures for 1961 also indicate an especially strong influx of bluefin tuna from the western Atlantic side. This finding corresponds to the recapture of the two transatlantic migrators in the same years and may be related to the sudden increase of tuna catches on the Norwegian coast beginning in 1961, as Table 4 shows.

Table 4. Norwegian tuna catches in number of fish north of 63°N and south of 62°N (Hamre & Tiews, 1962 and 1963).

	North of 63°N	South of 62°N	Total
1958	3,099	17,513	20,612
1959	1,843	13,724	15,567
1960	1,571	20,050	21,621
1961	9,515	27,858	37,373
1962	10,477	27,616	38,093

xx) A share has not been estimated because of too small materials.

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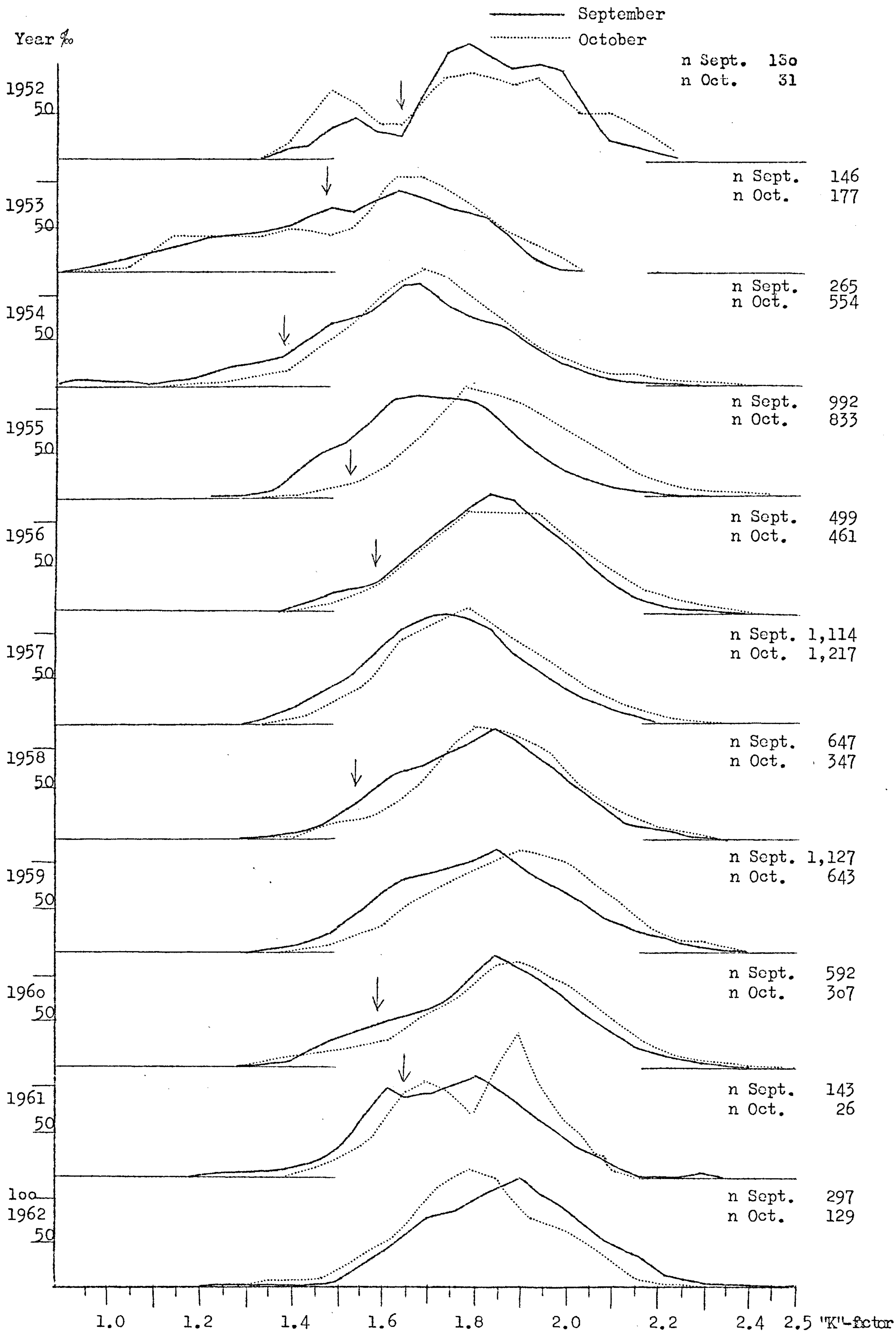

Figure 1. Frequency distribution of "K"-factor calculated for North Sea tuna.

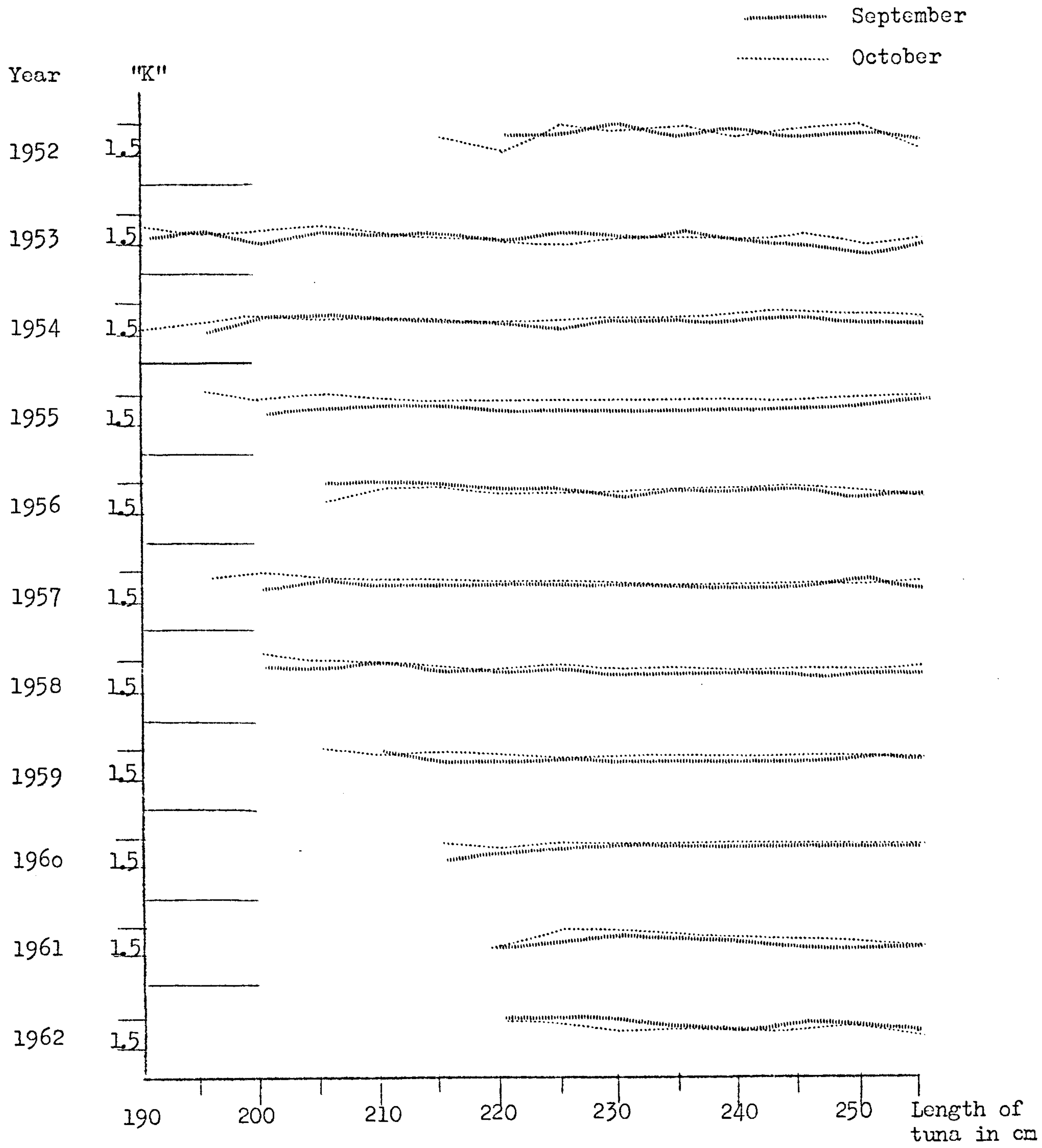

Figure 2. Relationship between "K"-factor and length of tuna

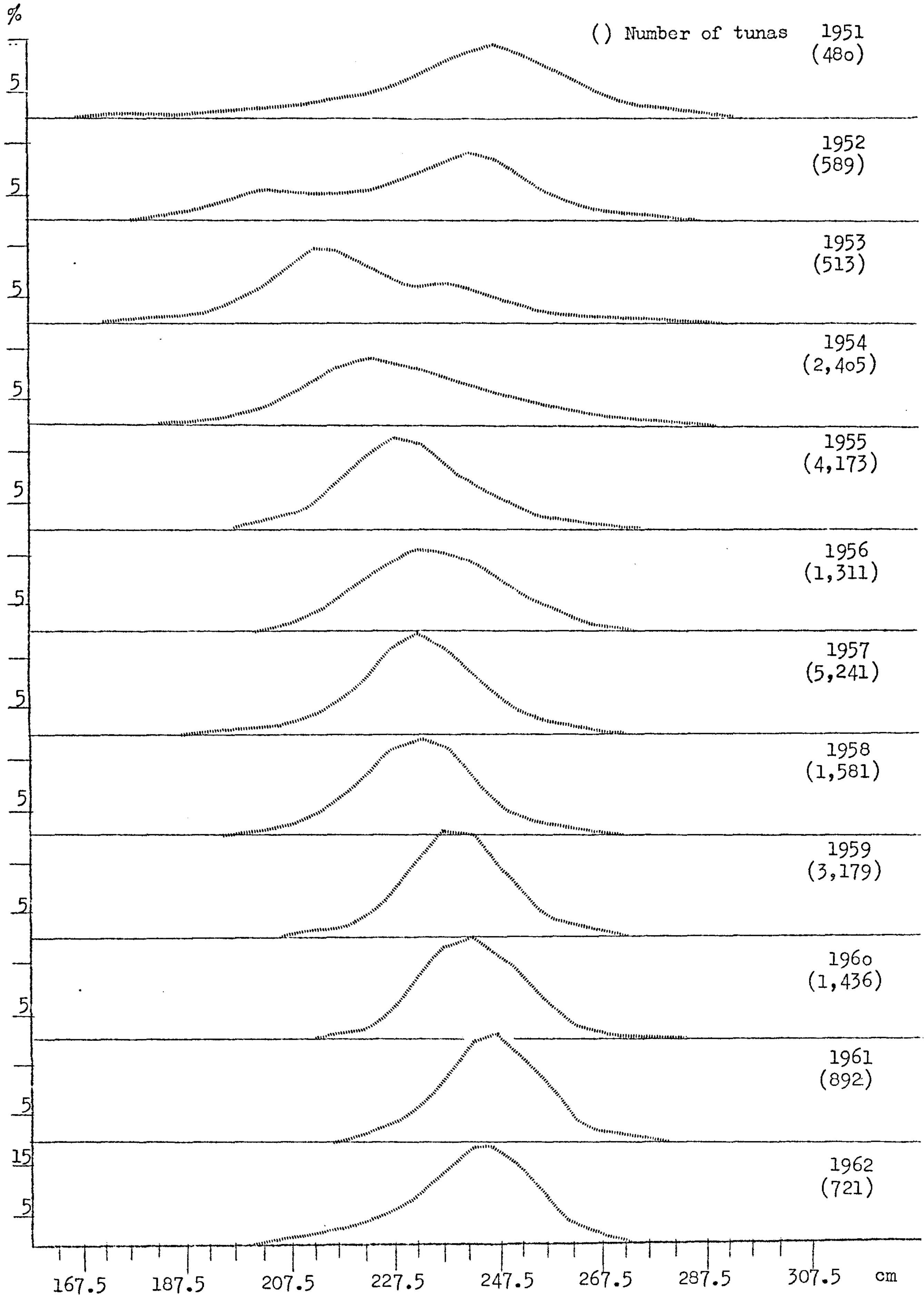

Figure 3. Length composition of German tuna catch from 1951 - 1962