MEDDELELSER

FRA

KOMMISSIONEN FOR HAVUNDERSØGELSER

SERIE: **FISKERI** · BIND VII

NR. 1. A. C. STRUBBERG: MARKING EXPERIMENTS WITH COD *(GADUS CALLARIAS L.)* IN DANISH WATERS, 1905—1913..

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BY

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I. Introduction.

A. General remarks.

The following is a report of the results of all the marking experiments with cod (Gadus callarias L.) carried out during the years 1905—1913 by the Danish Committee for Investigation of the Sea in the true Danish waters.

I have to thank Dr. A. C. Johansen, Head of the Danish Fishery Investigations in the said waters, for having entrusted me with the task of dealing with the data here concerned, and I am indebted to him for the valuable advise he has accorded me troughout the course of the work.

The experiments were carried out at various places in the waters inside and outside the Skaw, and to a great extent in territorial waters, partly from the Danish marine research steamer »Thor«, (Exp. of 1905—1907) and partly from various fishing vessels (Exp. of 1911—12 and 1913).

The experiments embrace a total number of abt. 1550 specimens.

As a rule, the fish were marked and liberated immediately after capture, only in some few of the experiments were they kept (in ventilated wells) for 1—3 days before marking. Strictly speaking, no transplantation experiments were made, but in a few (2) of the experiments, the fish were carried two or three miles before being liberated. All fish were measured for length at time of marking; only in one of the experiments were they also weighed.

B. The marks used.

For the 1905 and 1906 experiments, we used the mark which has been generally employed since 1903 by the Committee, consisting of two bone discs and a bronze number-plate, connected by silver wire, and fastened to the gill-cover, near its posterior margin. In the 1907 experiments, the same kind of mark was used, furnished with an additional bronze plate. In 1911 and 1912 a less complicated type, after the English model, was used; this having, in place of the one bone disc and the number-plate, one oval brass disc turning the convex side down towards the fish.

In the 1913 experiments, we used instead two silver plates, one bearing the number, etc, and the two connected by silver wire soldered to one of the plates. This type of mark is less affected by sea water than that formerly used, but on the other hand, appears to cause greater irritation of the tissues. Comparatively many of the fish recaptured from the 1913 experiments had infected sores where the mark had been affixed (see also A. C. Johansen, for the case of turbot marked in this manner, Medd. Komm. Hav., Serie Fiskeri Bd. V No. 3, 1916.)

C. Reports of recaptures.

The great majority of these were received from Danish fishermen, who either communicated the information direct to the Laboratory in Copenhagen, or sent it through the agency of the following gentlemen, who had kindly undertaken to note the particulars of recaptures, as furnished by the fishermen, and to measure (and weigh) the fish. Besides the many individual senders, our thanks are especially due to Fiskeexportør Cloos Lorentzen, of Frederikshavn, Landstingsmand M. C. Jensen of Grenaa, the former Fiskeriforeningsformand Jacob Tønnes Thomsen of Skagen, and Toldkontrollør Guldmann, Bagenkop, for precise information as to marked fish sent in, measurements, etc.

The comparatively few recaptures effected by fishermen of foreign nationality were communicated by Dr. Bolau, of Kiel, Fiskeriinspektør, Dr. F. Trybom, of Stockholm (since deceased) and the Board of Agriculture and Fisheries, London.

In most cases, in addition to particulars as to locality of recapture, the length measurement of the fish retaken was also stated. These measurements are for the greater part sufficiently reliable to warrant conclusions being drawn from the figures so furnished as to growth; the measurements have then been used without correction for shrinkage, as they were generally taken immediately on recapture. In other cases, where the measurements for some reason or another appear less reliable, and have therefore not been used for calculation of growth, this has been noted in the remarks appended to the tables for the separate experiments. In a number of cases, the finder measured the fish in Danish »Tommer«, and — frequently — only to the root of the tail. The figures have then been transposed to the epuivalent in cm. and, in the latter case, a value to equal the length of the tail added, this, measured in mm. being taken as equal to the total length minus the tail, measured in cm.

Weight on recapture is stated in many cases, but as the fish were only weighed at time of marking in some of the experiments, such records are as a rule only of interest as a corrective in estimating the accuracy of the length measurement, or, where this was not noted on recapture, as a guide whereby to calculate the increment of length during the period of the experiment.

D. Length in proportion to weight.

From investigations of cod from abt. 25–100 cm. long taken during the spring months at various places in our waters, in the Kattegat and the Belt Sea, the coefficient of »condition« »K«*) appears in most cases to lie between 0.95 and 0.80, so that the average for K may be taken as approximately 0.90. The investigations have not as yet been carried out to a sufficient extent to give any proper view of the fluctuations of K, for instance, from place to place, and in relation to the seasons. In working out the results of the marking experiments, however, the constant has been taken as 0.90 throughout. This value is used in calculating the length, where unknown, from the weight stated on recapture, according to the formula $W = \frac{l^3}{100} \times 0.90$ as also by way of a check on statements furnished by the finder where both length and weight are reported.

*) See also HEINCKE: Die Beteiligung Deutschlands an der Intern. Meeresforschung IV/V Jahresber. Berlin 1908.

II. The Marking Experiments.

Table 1. Showing locality and extent of the marking experiments with cod in the Danish waters 1905—1913.

Marking Experiment No.	Year and Month	Area	Locality	Central Position N	Central Position E	Depth in metres	No. of cod marked pr. Year	Marked in all
1905, 2	1905, September	North Sea	Off Thyborøn	56° 42′	8° 10′	12	20	20
1905, 1	1905, March	Skagerak	2 miles W of Spirbakken Bn.	57° 42′	10° 23′	17	20	
1911, 1	1911, April	—	Off Kandestederne, 4 miles from shore	57° 41′	10° 15.5′	23	234	254
1906, 5	1906, March	Northern	12 miles E by S ½ S of Skagen Light	57° 43′	11° 00′	35	27	
— 10	— —	Kattegat	7 miles NE by E of Hirtsholmene	57° 34′	10° 46′	26—28	100	
— 7	— —		3 miles S by W of Trindelen Light-Ship	57° 23′	11° 16′	25—35	24	
— 4	— —		6 miles N by W ½ W of Kobbergrunden Light-Ship	57° 14′	11° 18′	19—28	97	
1906, 9	1906, March	Middle Kattegat	At the Mouth of Randers Fjord	56° 37′	10° 34′	6	41	
— a	— May		— — Mariager Fjord				100	
1912, 10	1912, April	Southwestern	6 miles NE by E of Fornæs	56° 30′	11° 06′	18	16	
— 7, 8	— —	Kattegat	5 miles E of Fornæs	56° 27′	11° 06′ ?	17—23	65	
— 9	— —		10 miles — —	56° 27′	11° 13′	17	19	
— 5	— March		5 miles SE of Grenaa Harbour	56° 22′	11° 03′	21	55	
— 12	— November		At Briseis' Bn.	56° 21′	11° 15′	28	15	
1906, 1	1906, March		9 miles S by W ½ W of Fornæs	56° 18′	10° 56′	16	3	
1912, 13	1912, December		600 m S of Schultz' Grund Light-Ship	56° 09′	11° 11′	30	24	
1913, 1, 2	1913, February		— — —	—	—	—	47	
— 3	— —		1 mile NE of — — —	56° 09′	11° 12′	26—34	53	
1912, 6	1912, March		3 miles NE of Mosel Grund	56° 06′	10° 54′	23	145	831
1912, 11	1912, May	Belt Sea	Off Langøre, Samsø	55° 55′	10° 39′		7	
1906, 2	1906, March		Off Ballen —	55° 49′	10° 40′	7	40	
1912, 3	1912, —	Little Belt	Off Strib	55° 33′	9° 45′	28—?8	56	
— 1	— —		1 mile W of Middelfart	55° 31′	9° 42′	26 –28	50	
— 2	— —		— — —	—	—	38	24	
— 4	— —		Off Middelfart	55° 31′	9° 44.5′	28—38	70	
1907, 2	1907, —	Great Belt	½ mile SE of Sprogø Light	55° 19.5′	10° 59′	5 - 7	34	
— 3	— —		— S by W of Tranekær Light	54° 58′	10° 54′	6	76	357
1907, 1	1907, March	Western Baltic	½ mile NW by N of Bagenkop Harbour	54° 46′	10° 39′	7	85	85
							Total . . .	1547

In the following pages, the various groups of experiments are treated under the heading of the separate waters.

Fig. I (pag. 6) shows the sizes of all cod marked.

Out of a total of 1547 cod abt. 1280 were marked in March and April. A considerable number of these were spawning.

A. Experiments in North Sea and the Skagerak.

This group includes the only experiment made in the North Sea, together with two carried out in 1905 and 1911 in the Skagerak, all close in to land.

a. The North Sea Experiment.

On the 21. September 1905, 20 cod of 35—70 cm length were marked and liberated off Thyborøn (Fig. I). The fish were taken in a trawl by the s/s »Thor«, and marked and liberated immediately after

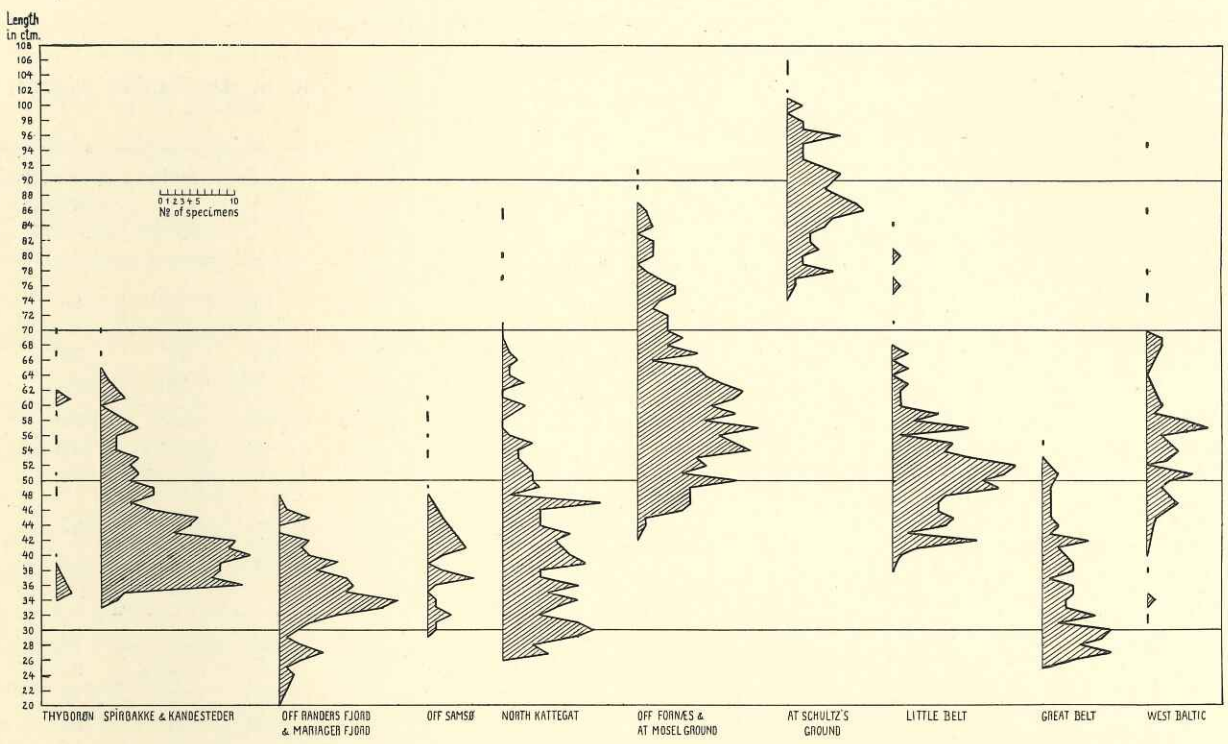

Fig. 1. Marking experiments with cod in Danish waters 1905—1913. Number and Size of cod liberated.

capture. Of the 20 marked fish, 13 were of 35—59 cm., 6 of 60—69 cm and one of 70 cm. Recaptures, made $2^1/_2$ and 7 months later respectively, totalled three, (37, 59 and 51 cm)[1]) or about 15 %.

Two of these three recaptures were made by Danish fishermen; one specimen, the largest, was retaken on the 2nd April, about 2 miles farther south, the other on the 23rd of the same month about 25 miles north of the marking place, both comparatively close to land. The third specimen (37 cm) was retaken on the 5th December 1905 by an English fishing vessel, which, by the way, is a unique occurrence in these experiments of ours. It had thus, in the course of 74 days, covered the considerable distance of abt, 330 miles from Thyborøn down to the south-western corner of the North Sea, near the mouth of the Channel. On enquiry at the Board of Agriculture and Fisheries, London, the correctness of the observation was confirmed. This corresponds to, and thus serves also to confirm, the German report of a similar long migration in the North Sea[2]). This was the case of a cod of 38 cm marked on the southern edge of the Dogger Bank in October 1910 and captured again three months later about 280 miles north of that spot.

Our specimen, a ♀, had in the $2^1/_2$ months or thereabout since marking grown from 37 cm an additional 3.5, or about 1.4 cm average per month.

In the case of the other two recaptures, we have only records of weight. On calculating the length from this, the growth in about 7 months should amount to 9.5 and 15 cm respectively, or an average of 12.8 for initial sizes of 51 and 59 cm respectively. This would then give an average monthly increment of 1.4 and 2.1 cm respectively, a rate of growth which agrees, not only with what has been noted above, but also with results found in some cases with English[3]) and German marking experiments with cod of similar size in the western North Sea and on the Dogger Bank, but far exceeds the rate of growth of the cod in the Bay of Helgoland. (loc. cit.)

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[1]) Figures in brackets ( ) are here and in the following intended to denote initial size in cm, where not otherwise stated.
[2]) H. WEIGOLD, Arb. d. Deut. wiss. Komm. intern. Meeresf. Helgoland No. 18, 1912, p. 137.
[3]) I. O. BORLEY, On the Cod Marking Experiments in the North Sea. Rapp. Proc. verb. X 1909.

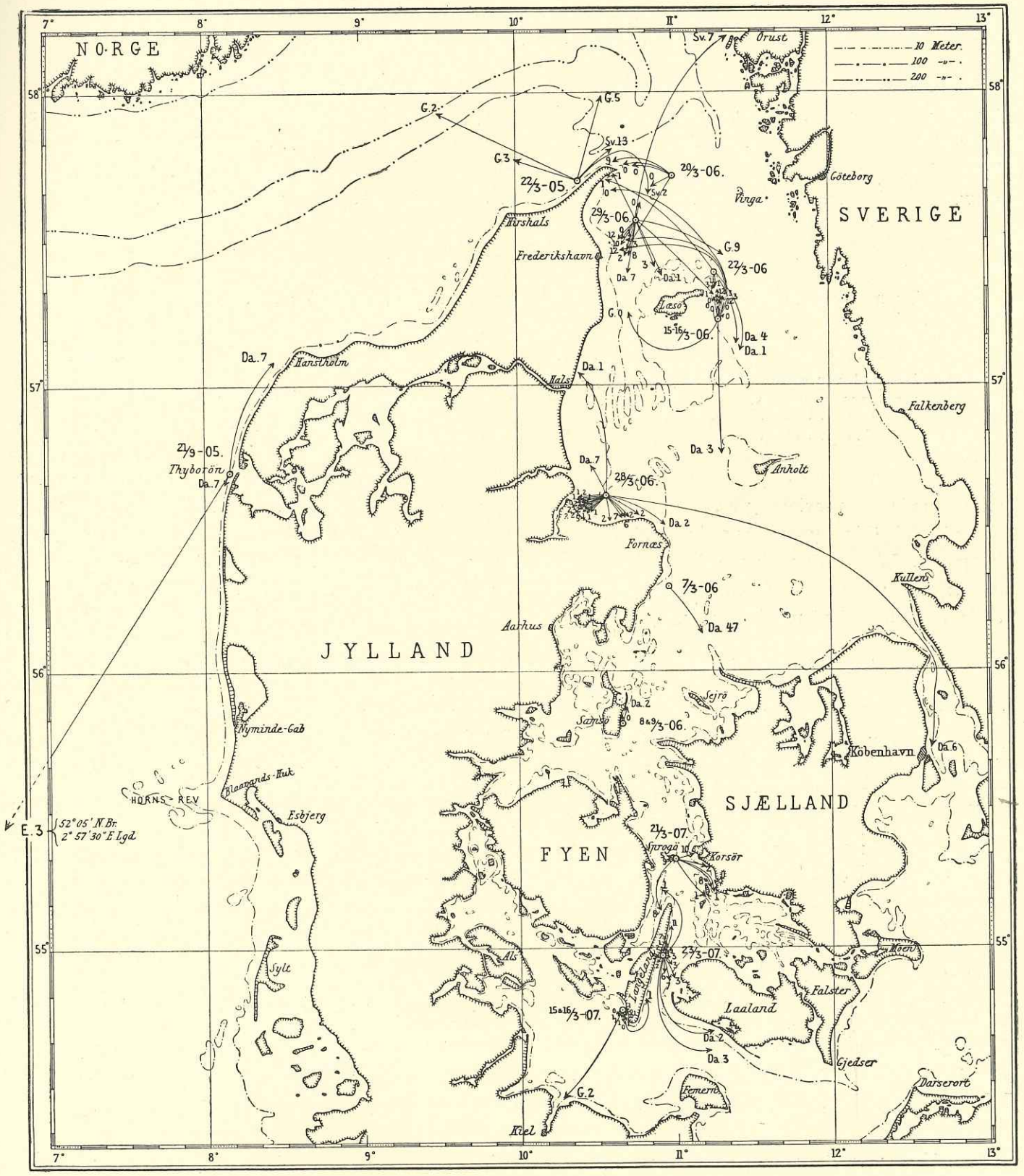

Fig. 2. The Danish marking experiments with Cod in 1905—1907.

Recaptures made by Danish (denoted by Da or a number only), German (G), English (E) and Swedish (S) fishermen.
The numbers denote no. of months within marking and recovery.

b. Experiments in the Skagerak.

1. Locality and date of the experiments.

In March 1905 and April 1911, 20 and 234 cod respectively were marked close in to land off the northern part of the west coast of Jutland (See pag. 5). In the 1905 experiment, the fish were trawled by the s/s »Thor«, marked at once, and liberated. In the 1911 experiment, the cod were taken by a fishing vessel, with the »snurrevaad«, off Kandestederne, about two miles out at sea in 17 metres of water. This experiment was carried out by Mr. H. C. Christensen, mate of the »Thor«.

2. No. of marked fish and recaptures.

The number and size of the marked cod were as follows. (See also Fig. 1).

Table 2.

Initial size in cm	33—34	33—39	40—49	50—59	60—69	70	86	90	Total
Exp. 1, 1905	1	4	10	4	1				20
Exp. 1, 1911	4	70	115	33	9	1	1	1	234

The great majority of the marked fish were 33—49 cm long and, according to the age determinations made the previous year, presumably belonged to the I and II groups, i. e. fish completing their second and third year respectively at the commencement of the experiment, and for the most part immature. The stock with which the 1905 experiment was made seemed, however, also to include other elements, some of the trawling hauls yielding a number of small cod, 27—48 cm long, which despite their small size, had reached maturity (males).

Table 3. Showing no. of fish recaptured from the experiments in the Skagerak.

Exp. in April 1911.

Initial size in cm	No. of cod marked	No. of months between liberation and recovery													Total number recaptured	% recaptured
		0	1	2	3	5	6	7	8	9	10	11	13	15		
60—90	12	—	1	—	—	—	—	—	—	—	—	—	—	—	1	8.3
50—59	33	5	2	—	—	—	1	1	—	—	—	—	—	—	9	27.3
33—49	189	9	2	4	1	7	5	8	8	1	2	1	1	1	50	26.5
Total	234	14	5	4	1	7	6	9	8	1	2	1	1	1	60	25.7

Exp. in March 1905.

Initial size in cm	No. Marked	Recaptured in				Total recaptured	% recaptured
		1905, May	June	August	1906, April		
50—60	5	—	—	—	—	—	—
31—49	15	2	1	1	1	5	33.3
Total	20	2	1	1	1	5	25.0

The percentage of recaptures was very much the same in both experiments, and about twice as high as in the Thyborøn experiment*). In both experiments, the recaptures were for the most part smaller fish, i. e. in the 1911 experiment, initial sizes under 60 cm, in that of 1905 those under 50; the experiment at Kandestederne, however, is the more interesting of the two, owing to its greater extent.

*) At least 61 specimens were recaptured, one, however, without any further particulars whatever recorded.

Here, the number of recaptures shows a marked decrease throughout the spring months of 1911; only 1 is recorded in July-August, but there is a pronounced increase again in autumn and winter (1912), recaptures thereafter ceasing completely with the spring of 1912.

The high proportion of recaptures in autumn and winter 1911—1912 falling to the coastal zone only a few miles from the place of marking would seem to indicate that the strikingly few recaptures made in the previous summer (1911) can hardly be due to spreading of the stock at that early stage; the principal reason is more likely to be that the cod fishery here, as in the Kattegat and elsewhere, is practically at a standstill at this time of year (see p. 35). In the course of the autumn, the percentage of recaptures rises with the more intensive fishery, a feature which recurs in several of the experiments hereafter mentioned.

Fifty-eight of the sixty recaptures in the 1911 experiment were made by Danish fishermen, only two stragglers being taken in the Skagerak by foreign (Swedish) vessels.

Of the 58 mentioned, 49 were taken close in to land off the southern part of the Skagerak shore, between Højen and Thorupstrand, and were landed as follows:

Skagen	Tversted	Hirtshals	Løkken	Lønstrup	Blokhus	Thorupstrand
31	2	4	3	6	1	2

All the 31 specimens landed at Skagen were taken off Kandestederne, quite close to the place of marking, the remainder being taken almost directly outside the coast districts mentioned. It is thus the vessels (motor boats) working from Skagen as their base which have taken the most intensive share in the fishery on the southern part of the Skagerak coast during that year.

The extent of this fishery will be seen from the following comparative table, taken from the official Danish Fishery Report of the years in question, showing the total catch (in kg.) of cod, taken for the most part by long line fishing off (by vessels from) the coast districts between Skagen and Løkken.

Table 4.

Year	Catches landed at					
	Skagen	Højen	Tversted	Lilleheden	Lønstrup	Løkken
1911	47.200	insignificant	4.500	190.000	112.600	46.000
1912	120.000	do.	3.700	174.000	75.500	34.800

Owing to unfavourable weather conditions, the yield in 1911 was, as far as Skagen is concerned, far below normal, and also belov the yield of the districts to the south. The high percentage of recaptures falling, in spite of this, to the Skagen vessels is duo to the fact that the stock remained very largely stationary during the first year of the experiment. (see also p. 11).

As to the distribution of the yield among the different months, no further details are available, but the bulk of it falls in March (1911—1912) and again in October—December; during the summer proper, practically no cod is taken from Skagen etc.

In the 1905 experiment, all 5 recaptures were made by foreign (German and Swedish) vessels fishing Skagen waters. This is an altogether unique occurrence among all the experiments here dealt with.

The 1905 experiment, however, was, in the first place, of far slighter extent than that of 1911, so that accidental circumstances might well alter the general view considerably. And furthermore, the spring of 1905 was unusually stormy on this part of the coast, and consequently highly unfavourable to the coast fishery; these facts are probably sufficient in themselves to explain the otherwise unusual result.

The recaptures, it may be noted, were made 2, 2, 3, 5 and 13 months after marking, in the waters round Skagen (the Skaw).

3. Growth.

The best material for the study of the growth is furnished by the 1911 experiment.

Table 5. Growth of cod liberated in Skagerak in April 1911.

Month recaptured	Period between liberation and recovery	Increase in cm			No. of specimens measured	Initial length in cm		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1911, April	2—8 days	0	0	0	13	44	37	57
— May	1 month	1.4	0	3	5	46.2	37	67
— June	2 —	0.6	0	1.2	3	46	45	47
— July	3 —	4	—	—	1	39	—	—
— September	5 —	5.4	3	10	5	41.6	35	49
— October	6 —	5.7	2	8.4	5	43.2	36	50
— November	7 —	9.0	6.5	12	8 *)	42.8	35	50
— December	8 —	10.8	5	13.5	7 **)	39.4	36	43
1912, January	9 —	(ca. 14)	—	—	1	49	—	—
— February	10 —	14	—	—	1†)	39	—	—
— March	11 —	(> 20)	—	—	1	43	—	—
— May	13 —	9	—	—	1	49	—	—

*) No. 236 omitted.
**) - 331 —
†) - 296 —

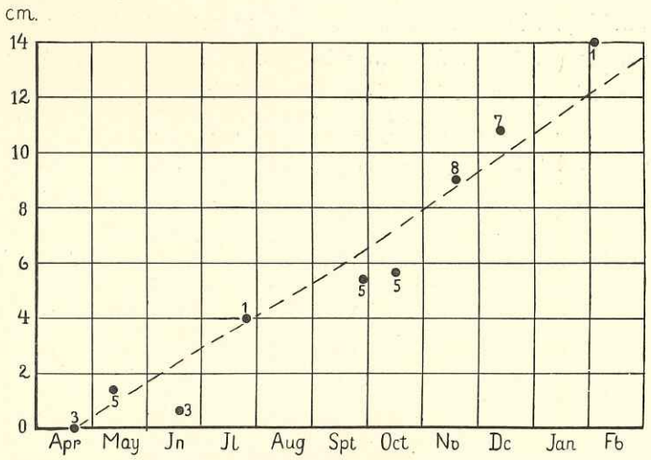

Fig. 3. Rate of growth of 35—50 cm cod, liberated in the Skagerak. April 1911.

The length increment for the first year after marking thus amounts, for sizes 35—50 cm, to about 14—15 cm, or a little over 1 cm average per month, a rate of growth which is in any case not less than that noted by the English and German experiments previously mentioned for young cod from the Dogger and the western parts of the North Sea. (see p. 6)

The most rapidly growing fish show a length increment of nearly 2 cm per month, at any rate for the first 6–8 months. The poorest average only about $^1/_2$ cm per month during the first year.

The length increment as here calculated is in reality somewhat less than the true increment, as in some cases, we have had to reckon with a length measurement taken when the tail fin was somewhat dried, without correction for shrinkage. Furthermore, in the cases — only a few, however — where the ultimate value for length has been calculated from the weight recorded, we have reckoned with a coefficient of condition = 0.9 (see above, p. 4) which would surely not give too high an increment. Altogether, the rate of growth here given should probably be regarded as rather on the low side.

Of the 50 cm fish, one, taken six months after marking, shoved a markedly inferior growth to the smaller ones, viz. only abt. 2 cm in all, while another specimen taken in the following month had grown at least 7 cm during the period of experiment, i. e. far better, and more like the remaining, smaller fish.

The very few fish recaptured from the 1905 experiment show a more or less corresponding rate of growth. A specimen of 49 cm, taken after 4 months, showed an average of abt. 0.8 cm per month, while a smaller (younger?) one of 31 cm showed an increment averaging close upon 1.2 cm per month for 13 months.

4. Migrations.

Fig. 4 shows the distribution of recaptures for the 1911 experiment round the site of marking. Some of the fish had, it will be seen, within a month of liberation already moved as far as 10—15 miles to the north, and more especially south, along the coast, whereas recaptures made as late as 6, 7 and 8 months after marking were made quite close to the spot. Eleven ont of fifteen, for instance, were retaken less than 4 miles away, and 1—2 miles closer in to land. Even 10 and 15 months after marking, two specimens (39 and 48 cm) were taken here. The remainder are scattered about the coastal waters to the north and south, here again for the most part quite close in to land; 6 specimens, for instance, were recaptu-

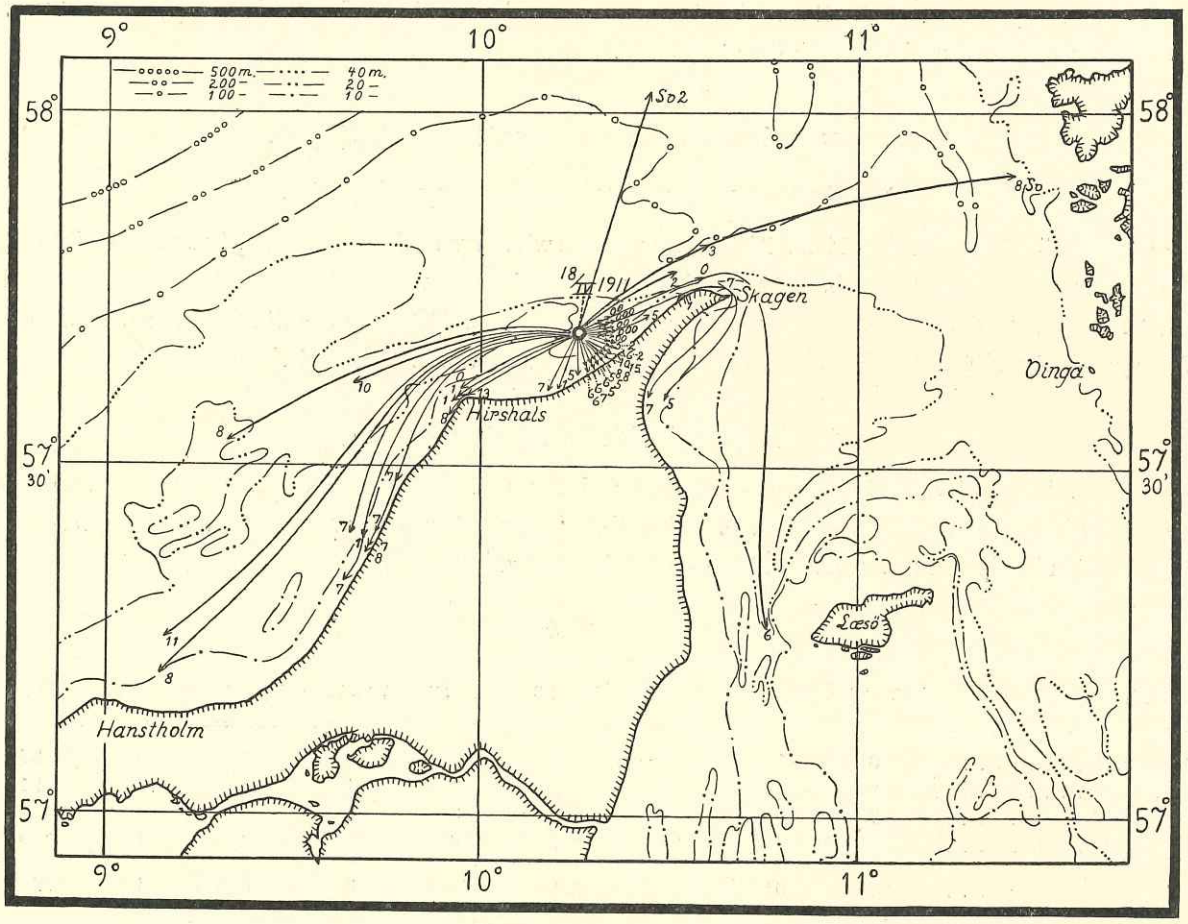

Fig. 4. Marking experiments with cod in the Skagerak in April 1911.

red after 7 and 8 months about 30 miles south, close in to shore, all within a range of about 4 miles, between Rubjerg and Løkken. Some few specimens (36—45 cm) had during the same period rounded the Skaw, and were found in the Kattegat, in Aalbækbugten and Vesterrenden off Læsø. One (49) had in the course of 8 months crossed the Skagerak, and was taken off the coast of Sweden. Of the 5 recaptures made 10—15 months after marking, 2 (39 and 48 cm) were made between the place of marking and the shore immediately adjacent, and 3 (43, 45, 49 cm) farther out at sea, in the Skagerak, up to 20 miles from land. None were taken more than 50 miles away.

In the course of the summer 1912, the gradual spreading of the stock away from the coastal zone continued, so that the resumption of the cod fishery in the autumn of the same year and later failed to show a single recapture.

In the 1905 experiment (at Spirbakken), Fig. 1, some difference is observable. All the recaptures here lie within 2—13 months of liberation, and about 10—35 miles from the site, close off the Skaw, over

greater depths in the Skagerak, (up to abt. 170 metres) and in the Kattegat 8 miles SE of the Skaw. Though the marked fish were of about the same size, and probably age, as in the Kandested experiment (1911) we find, as mentioned, all recaptures in this case (1905) noted comparatively far from the original place of marking (p. 9).

B. Experiments in the Kattegat.

During the years 1906, 1912 and 1913, a considerable number of marking experiments were made with cod at various places in the Kattegat. (See p. 5).

a. Experiments in the northern Kattegat.

1. Date and locality of the experiments.

On the 15—29th March 1906, 248 cod were trawled by and marked on board the »Thor«, distributed as shown in the table, p. 5, between four stations in the waters between the Skagen and Kobbergrunden, 27 about midway between Skagen and Vinga, (Exp. 5) 100 off Aalbækbugten (Exp. 10) and 24 and 97 respectively NE and SE of the eastern end of Læsø (Exp. 7 and 4).

2. No. and sizes of fish marked.

In Exp. 4, 5 and 7, as in the Skagerak experiments, the fish marked were for the most part (134 out of 148) under 50 cm. In Exp. 10, i. e. off Aalbækbugten, the fish were somewhat larger.

Several, chiefly males, were mature (see table below).

Table 6.

Initial size in cm	26–29	30—39	40—49	50–59	60–69	70—79	80—89	100—106	Total
Exp. Nr. 5	6	10	9	2	—	—	—	—	27
— 7	3	9	8	1	1	1	1	—	24
— 4	7	51	31	4	3	1	—	—	97
— 10	8	21	29	22	16	1	2	1	100
Total . . .	24	91	77	29	20	3	3	1	248
Of which mature at time of marking	2♀, 1♂	19♂	20♂	0	4♀, 1♂	0	2♂	0	

Here, then, we had a considerable number of small, mature cod, especially in the Læsø experiment.

From age determinations made at the same time, the II and III groups would seem to be chiefly represented in the sizes 20—49 cm; of three males of 62 cm, one (immature) belonged to the III group, and two, mature, to groups IV and V, while a mature female of the same length was assigned to Group IV.

3. No. of recaptures.

The percentage of recaptures is about the same as with the experiments in the North Sea and Skagerak, All were made within the first year after liberation, mostly during the first four months, i. e. March—June.

Table 7. Showing no. of fish recaptured from the experiments in the northern Kattegat. March 1906.

No. of experiments	No. of cod marked	No. of months between liberation and recovery										Total number recaptured	% recaptured
		0	1	2	3	4	7	8	9	10	12		
1906— 5	27	3	—	—	1	—	—	—	1	—	—	5	18.5
1906— 7	24	—	4	—	1	1	—	—	—	—	—	6	25.0
1906— 4	97	7	1	—	3	—	—	—	—	—	3	14	14.4
1906—10	100	2	3	1	1	—	2	1	1	1	1	13	13.0
Total . . .	248	12	8	1	6	1	2	1	2	1	4	38	15.4

As in the Skagerak Experiments, the number of recaptures decreases during the summer months, only one being reported for the period July—September. In autumn and winter, a few again occur here and there, especially in the experiments SE of Læsø and off Aalbæk.

Here also, it is chiefly the smaller sizes which are retaken. Taking all four experiments together, we find that the fish under 49 cm initial size show a percentage of 18.2 recaptured, those from 50—106 cm only 5.4 %.

Three of the 38 recaptures were made by foreign fishermen. One was taken by a Swede in the Skagerak, two by German trawlers E and W of Læsø respectively (See Fig. 2). Practically all the remainder were taken by fishermen from Skagen and Frederikshavn.

4. Growth.

Fig. 5 and the table below show the average length increment during the first year after marking in all satisfactorily measured fish recaptured.

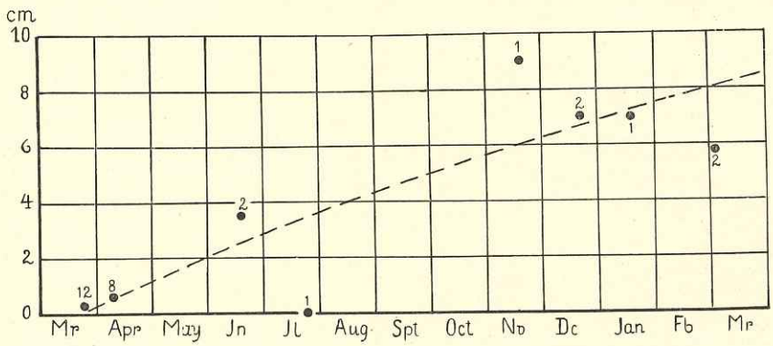

Fig. 5. Rate of growth of 27—49 cm cod, liberated in the northern Kattegat. March 1906.

Table 8. Growth of cod liberated in the northern Kattegat in March 1906.

Month recaptured	Period between liberation and recovery	Increase in cm			No. of specimens measured	Initial length in cm		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1906, March	0—13 days	0.3	0	0.5	12	36.4	27	53
— April	1 month	0.6	0	1.5	8	46.9	37	67
— June	3 —	3.5	1.5	5.5	2	39.5	30 *)	49
— July	4 —	0	—	—	1 ♂	47	—	—
— November . .	8 —	9	—	—	1	32	—	—
— December . .	9 —	7	5	9	2	40	33	47 **)
1907, January . . .	10 —	7	—	—	1 ♂	36	—	—
— March	12 —	5.8	5	6.5 ♂	2	38	37	39

*) Increase 1.5 cm.
**) — 5 cm.

From this it would seem as if only the smallest, immature fish, i. e. initial sizes less than 33 cm, have a growth amounting to abt. 1—1.1 cm average per month, the somewhat larger sizes, (37—49 cm) of which several were mature at time of marking only grew about half as much. Reliable observations are unfortunately few, but even in the best grown fish, the growth here seems to be inferior to that of the marked Skagerak cod of similar size.

5. Migrations.

Fig. 2 shows the distribution of recaptures.

Experiment E of Skagen. (Exp. 5)

The three fish (27, 41, 53 cm) taken 8 days after marking, had all moved westward into shallower water (19—28 m) off Skagen. Here also, the one specimen (33 cm) recaptured (9 months) later was taken. Apart from these, there is recorded the finding of a loose mark from this experiment, probably found in July of the same year at Hirsholmene, so that the specimen in question must here again have moved in closer to land, but towards the SW. None of these seems to have been mature at time of marking.

Experiment NE of Hirsholmene. (Exp. 10)

Six of the 13 recaptures were made abt. 5—10 miles nearer land, towards S and SW, off Hirsholmene, 0, 2, 7, 8, 10 and 12 months after liberation; the two last were at time of marking 36 cm, ♂, and 43 cm long. Two were found abt. 10—13 miles away towards SSE, near Læsø Rende, 1 (43 cm) at the east end of Læsø (distance abt. 20 miles) all 1—3 months after liberation, and 1 (47 cm) 9 months after marking at Læsø Trindel, abt. 20 miles away to the east. The remaining three had moved north, 1 (41 cm) hardly five miles away, taken in the first two days after marking 1 (55 cm) up near Skagen in the first month of the experiment, while 1 (39 cm) had crossed the Skagerak and was taken off the coast of Bohuslän after 7 months.

The Experiment at Trindelen. (Exp. 7)

Save for 1 specimen (44 cm) taken 14 days later at Skagen, the remaining five recaptures were made south of the site of marking, 1/2—4 months later, being 3, of which two mature, ♂ (43 and 47 cm) and 1 (29 cm) at east end of Læsø; and two (47, ♂, and 67 cm) farther south at Kobbergrunden, a distance of nearly 20 miles from Trindelen.

The Experiment at Kobbergrunden. (Exp. 4)

Nine of the total 14 recaptures were made 0—12 months after marking, off the east end of Læsø, 2—3 miles north of the site of liberation. Only two specimens (30 and 39 cm) had moved a greater distance towards north-west during the three first weeks, being taken close in to land in Aalbækbugten. At the same place, also, a specimen (29 cm) was taken 12 months later.

Only 1 specimen (49 cm) had moved southward, being taken 3 months after marking at Anholt; this, by the way, was the largest fish recaptured. The distance covered is not particularly great even here, only about 30 miles.

Altogether, these experiments show, like the Skagerak experiment, predominantly stationary conditions in the first year of the experiment. Most of the recaptured were, as mentioned fish under 50 cm, initial size, and several of these were mature. The very few larger fish, as also several of the smaller, mature and immature together, had moved comparativety far during the first months of the year of the experiment, but only a single recapture lies outside the area of the water concerned. The cessation of recaptures with the expiration of the first year of the experiment seems, also, as in the case of the Kandested experiment, to suggest that the stock gradually scatters more widely over the adjacent waters.

It is hardly possible to discern any definitely marked direction in the movements of the fish. In the Aalbækbugten experiment, and that farther to the north, east of Skagen, the recaptures show a

movement of the stock to the south, south-west and west, partly down through Vesterrenden, partly in towards the shallower water east of Skagen. Furthermore, in the experiments NE and SE of Læsø, there seems a tendency among the marked fish in the spring months of the year of experiment to assemble (while spawning?) off the east end of the the island above the eastern verge of the Læsø plateau, at depths of from 5–30 m. Most of recaptures, at any rate. were made here, whether from this cause or owing to the fact of the fishery here being particularly intensive.

b. Experiments in the south-western Kattegat.

These experiments may be divided, according to locality, as well as according to size of the fish marked, as follows:

1. A group of experiments in the waters round Fornæs, 5—12 miles from land, 16—23 m, where, in March 1906 and March-April 1912, abt. 170 cod (mostly 50—75 cm) were marked. With these may be included a smaller experiment with cod of somewhat larger size, (chiefly 70—85 cm) in November 1912 in Briseisrenden, 28 m.

2. A group of experiments at Schultz's Grund, 26—34 m, in November 1912 and February 1913, with abt. 130 large cod, mostly 75—100 cm, and

3. An experiment at Moselgrund, 23 m, in March 1912, with 145 fish, chiefly 45—75 cm.

1. Experiments in the waters round Fornæs.

1. Locality and date of the experiments.

The table on p. 5 shows the situation and extent of the experiments. The small experiment in 1906 was made with 3 fish, trawled by the »Thor«. The remaining experiments were with cod taken in »snurrevaad« from a fishing cutter. The work in 1912 was under the direction of Mr. Christensen, mate of the »Thor«.

Table 9.

Initial size cm	33–45	48—49	50—59	60–69	70—79	80–89	Total
Exp. No. 1, 1906	3	—	—	—	—	—	3
— 5, 1912	—	2	19	27	5	2	55
— 7, 8, —	—	1	29	23	9	3	65
— 9, —	—	—	7	9	1	2	19
— 10, —	—	—	3	8	5	—	16
— 12, —	—	—	—	1	7	7	15
Total . . .	3	3	58	68	27	14	173
Of which mature at time of marking	3 ♂	1 ♀	9 ♂, 1 ♀	10 ♂, 2 ♀	8 ♂, 1 ♀	2 ♂, 1 ♀	

2. No. and sizes of fish marked.

As will be seen, the fish here marked were mostly 50—75 cm, i. e. essentially larger sizes than in the experiments hitherto dealt with. Mature specimens were found in all groups.

3. No. of recaptures.

Table 10.

Initial size in cm	No. marked	% recaptured
70—89	41	9.8
60—69	68	16.2
33—59	64	18.8
Total . . .	173	15.6

In all these experiments, taken together, the percentage of recaptures is abt. 16 %, or about the same as in the northern Kattegat experiments. In the separate experiments, apart from the very small one of 1906, the figure varies from abt. 11 to abt. 21, and is, as with the previously mentioned experiments, considerably lower for the larger and largest sizes marked, even including the Briseis experiment, where only large fish were marked.

Eighteen out of the 27 recaptures were landed at Grenaa. Disregarding the small experiment of November 1913, the proportion is 18 and 24. Only 1 were landed at Frederikshavn.

Table 11. Showing number of cod recaptured from the experiments in the southwestern Kattegat. March 1906, March, April and Novembre 1912.

No. of Experiments	No. of cod marked	No. of months between liberation and recovery																Total number recaptured	% recaptured
		1	4	5	6	7	8	9	10	11	12	13	14	16	17	24	25	47	
March, 1906, 1 . .	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	33.3
— 1912, 5 . .	55	—	—	—	1	2	1	1	1	1	—	1	—	—	—	—	—	—	6	10.9
April, 1912, 7, 8 .	65	—	1	—	—	1	—	—	1	—	2	2	—	—	1	—	—	—	10	15.4
— — 9 . . .	19	—	—	2	—	—	—	—	—	—	1	—	—	—	—	—	1	—	4	21.1
— — 10 . . .	16	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	—	—	3	18.8
November, 1912, 12	15	1	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	3	20.0

A particularly striking feature in the recaptures here is the fact that the earliest were not made until the autumn months. In the spring experiments previously mentioned, many of the marked fish were retaken already in the spring and early summer, and again, as here, later in the year. The only explanation is, that the busy season for cod fishing in the water ceased comparatively early that spring (1912), at any rate as regards the fishery from Grenaa. That this is actually the case, is evident from the Fishery Statistics for the Grenaa cod fishery, Grenaa being the principal centre for this industry in these waters.

The following quantities of cod (in kg) were landed at Grenaa in 1912.

	Jan.-Febr.	March	April	May-July	August	Sept.-Dec.
Cutter-fishery:	56.000	52.000	3.100	0	68	14.400
Boat-fishery:	57.000	35.250	3.500	0	0	115.500

A larger proportion — 9 out of 27 — were taken more than 12 months after liberation; one indeed, no less than 4 years after! Most of these, moreover, were found only a few miles away. This shows, inter alia, that the durability of the marks used, and arrangement of the experiment generally, were satisfactory. As to how far any inadequacy in this respect in our earlier experiments — especially that of 1906 in the northern Kattegat — may have been wholly or partly responsible for the cessation of recaptures with the first year from date of marking, it is impossible to determine exactly. It is possible, for instance, that the fish for the 1912 experiments which were chiefly taken in the »snurre-

vaad«, an implement gentler in operation than the ottertrawl as used in 1906, have had their vitality less impaired in process of capture.

Three of the 27 recaptures were made by foreign (Swedish) fishermen, who found two of the marked fish in the water where liberated, and one at the entrance to the Sound.

4. Growth.

Table 12 shows the average length increment for the experimental period in reliably measured recaptures from the March-April experiments.

Table 12. Growth of cod liberated in the southwestern Kattegat in the waters near Fornæs in 1906 and 1912.

Date of liberation	Month recaptured	Period between liberation and recovery	Increase in cm			No. of specimens measured	Initial size in cm			Remarks
			Average	Minimum	Maximum		Average	Minimum	Maximum	
1912, March	1912, September	6 Months	1	—	—	1	68	—	—	
	— October	7 —	3.5	3	4*)	2	61	60 ♂**)	62	*) Growth calculated.
	1913, January	10 —	7	—	—	1	65	—	—	**) recovered as mature.
	— February	11 —	(> 15†)	—	—	1	56	—	—	†) Growth calculated.
	— April	13 —	0	—	—	1	65 ♂	—	—	Mature at liberation.
1906, March	1910, February	47 Months	ca. 29	—	—	1	34	—	—	Growth calculated. Mature at liberation.
1912, April	1912, August	4 Months	0	—	—	1	55	—	—	
	— September	5 —	5 5	1	10	2	63.5	61	66*)	*) Increment 1 cm.
	— November	7 —	4	—	—	1	61	—	—	
	— December	8 —	ca. 2	—	—	1	57 ♂	—	—	Growth calculated. Mature at liberation.
	1913, January	9 —	2.5	—	—	1	49	—	—	
	— February	10 —	12	—	—	1	58 ♂	—	—	Mature at liberation.
	— March	11 —	5.5	—	—	1	58	—	—	Very meagre.
	— April	12 —	11.5	2 ♂	21*)	2	60.5	54	67	*) fide fisherman.
	— May	13 —	ca. 13	—	—	1	56	—	—	Growth calculated.
	— August	16 —	3	—	—	1	61	—	—	
	— September	17 —	8	—	—	1	57 ♂	—	—	Mature at liberation.
	1914, April	24 —	7	—	—	1	70 ♂	—	—	do. do. Very meagre.
	— May	25 —	9	—	—	1	60	—	—	Very meagre, sore.
1912, November	1913, April	5 Months	3.5	—	—	1	86.5	—	—	
	1914, January	14 —	ca. > 5	—	—	1	75	—	—	Growth calculated.

As mentioned, we have here, in contrast to previous experiments, chiefly fish over 50 cm initial size. Most of the data refer to fish between 56—69 cm. As might be expected, the length increments found exhibit a very high degree of fluctuation. The material is more heterogeneous, from the mere fact of its covering more age-groups than that previously dealt with, which consisted mainly of the II and III year-groups. Furthermore, these experiments from their situation, and the composition of the stock, must be expected to include a greater number of growth-types; slow-growing coastal forms and fast-growing fish from the more open waters (See C. G. Joh. Petersen in »Danish Biol. Stat«, Report No. XI, 1902, p. 16). The reliable measurements available are too few to give a trustworthy picture of the average growth of the size groups in question, but it may be noted that several (immature?) specimens of 54—58 cm, and a single one of larger size, 61 cm, had an increment of abt. 13 cm during the first year after marking, or close upon 1.1 cm average per month; some few, indeed, considerably more. Such a rate of growth is far in excess of that shown by the few more slowly growing specimens (49 and 56 cm) in these experiments. It also exceeds the growth of the smaller fish in the northern Kattegat experiments,

but corresponds well enough to that of the few of abt. 50 cm, from Kandestederne as well as of the smaller fish there marked.

The increment for cod of 60—75 cm initial size may with approximate accuracy be stated as hardly more than 7 cm average for the first year of experiment, i. e. nearly $^1/_2$ cm average per month. Corresponding to this are the few records available from the November experiment (Briseisrenden) in this respect, where a cod of 86.5 cm for instance, had grown 3.5 cm in 5 months. In some cases, however, the growth for the year is barely half as much, one specimen, for instance, a mature male of 67 cm, showing a growth for the year of less than 2 cm. Corresponding to this we have a mature male of 70 cm, which in the space of two years had only grown 7 cm. These fish, and the male of 57 cm before mentioned, which had only grown abt. 2 cm in 8 months, are distinct examples of very slight growth in the larger mature males. The males, also mature, already mentioned as marked in the northern Kattegat, were smaller, less than 49 cm, and their rate of growth more than twice this, being abt. 6—7 cm. in the first year from time of marking.

One specimen (34 cm) which was recaptured nearly four years (47 months) after marking, showed a length increment of 29 cm, and scaled 6—7 times its initial weight.

We have, however, no material for determining increase in weight generally. Calculating from the scanty data available for the 56 and 57 cm fish, it would appear to amount to a doubling of the initial weight during the first year in well-grown fish.

5. Migrations.

Exp. No. 1, 1906. The only recapture (34 cm) was made 47 months after marking, at Schultz's Grund, i. e. only abt. 15 miles distant, towards SE. (Fig. 2).

Exp. No. 5, 1912. Four out of the six recaptures were likewise made only a few miles away. One specimen, for instance (62 cm) was retaken in October the same year abt. 20 miles to the SE, and three (72, 56 and 65 cm, ♂) in January, February and April of the following year, 8—15 miles E and NE. Two, on the other hand, were captured already in September and October 1912 farther off, one (68 cm) at the Sound and (60 cm, ♂) off Langeland.

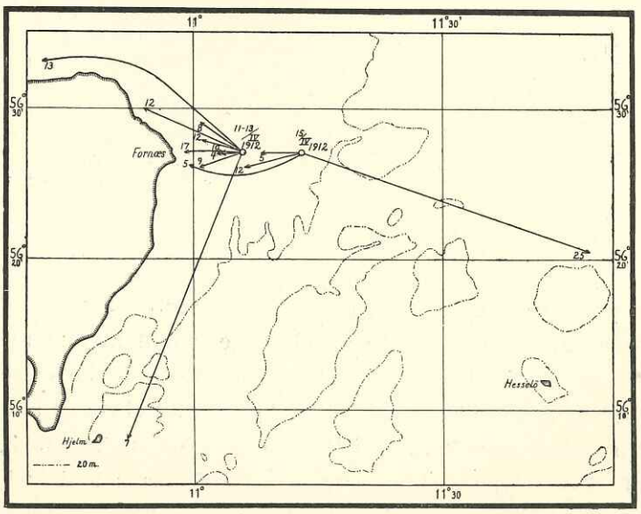

Fig. 6. Marking experiments with cod in the Kattegat of Fornæs in April 1912.

Exp. No. 7, 8. 1912 (Fig. 6). All recaptures here were made within 20 miles of the site, most of them less than 10 miles away, and closer in to land, during the autumn, winter, and following spring (1913). As late as September of this year a single specimen (57 cm, ♂) was taken only a few miles away. Most of the recaptured fish here were small, 50—59 cm initial size.

Exp. No. 9. 1912, (Fig. 6), Three of the four recaptures were made in September and the following April, and only a few miles away, closer to land. The sizes, 54, 61 and 66 cm, are as in the previous experiment. Two of them are among the best grown in these experiments. The fourth specimen recaptured (60 cm) was taken after a lapse of 2 years, only abt 16 miles away, to the eastward, near Lysegrunden, north of Hesselø.

Exp. No. 10, 1912. All (3) recaptures here (58, 61 and 70 cm, ♂) were made quite close to site of marking, less than 5 miles away, and closer in to land, 1, $1^1/_2$ and 2 years after liberation.

Exp. No. 12, 1912. In this experiment, on the other hand, all (3) recaptured fish had covered comparatively considerable distances being taken without exception off the north-west coast of Sealand between Gilbjerg and Spodsbjerg, from 1—5 months after liberation. These specimens were the largest initial sizes of all the Fornæs fish marked being 80, 82 and 86 cm.

Altogether then, we find in these experiments the fish of 50 – 60 cm and to some extent also those of 61—72 cm comparatively stationary, not only during the first year, but slso, in contrast to the smaller fish marked in the northern Kattegat, throughout the second year after liberation, while a single specimen was found as late as four years after marking only a few miles away. Several of these fish had spawned. Most were recaptured nearer to land, in the autumn and winter after marking, but at about the same depth as where marked; as late as 1 – 2 years after marking some were retaken here. A few had moved towards E and SE, but in all these cases the distances covered were only slight.

The very few larger specimens whose movements we are able to follow had, on the other hand, for the most part moved farther away. The same applies also in some degree to the fish of 61—72 cm. In the course of autumn and winter (1913) these had moved in towards the Sound (62, 82 cm) down towards (and into) the Isefjord (80, 86 cm) and the Great Belt (60 cm ♂).

2. Experiments at Schultz's Grund.

In December 1912 and February 1913, some experiments with large cod, larger than in any other of the Danish experiments, (cf. Fig. 1, p. 6) were made in the vicinity of the Schultz's Grund Lightvessel. The fish was trawled from »Thor«.

Table 13.

Initial size in cm	74—79	80—89	90—99	100—106	Total
No. marked	15	64	39	6	124
No. recaptured	1	7	2	1	11
% recaptured	10		6.6		8.8

In these experiments, the fish were weighed at time of marking.

The recaptures amount to 8.8 %, a lower percentage than in any other ot the experiments here dealt with, but answering pretty closely to the number of larger and largest sized fish recaptured in several of the Fornæs experiments. (p. 16)

Despite the small number, we find here also the frequency of recaptures decreasing markedly from the smaller to the larger sizes.

Here, as with the Fornæs and other experiments, no recaptures are recorded during the summer months, and none at all more than 7 months after marking.

Swedish fishermen accounted for two recaptures, the rest were made by Danish fishermen.

With regard to growth, the material affords very little information indeed. The few at all reliable records of length and weight suggest perhabs with a single exception a very slow rate of growth, which also agrees with the results of our other experiments.

The migrations (Fig. 7) correspond to what was noted in the case of the larger fish from the Fornæs experiments, i. e, covering in most cases some considerable distance. Two had moved eastward, one (87) down into the Sound, one (76) into the mounth of the Isefjord. Two (100 and 99 cm) had

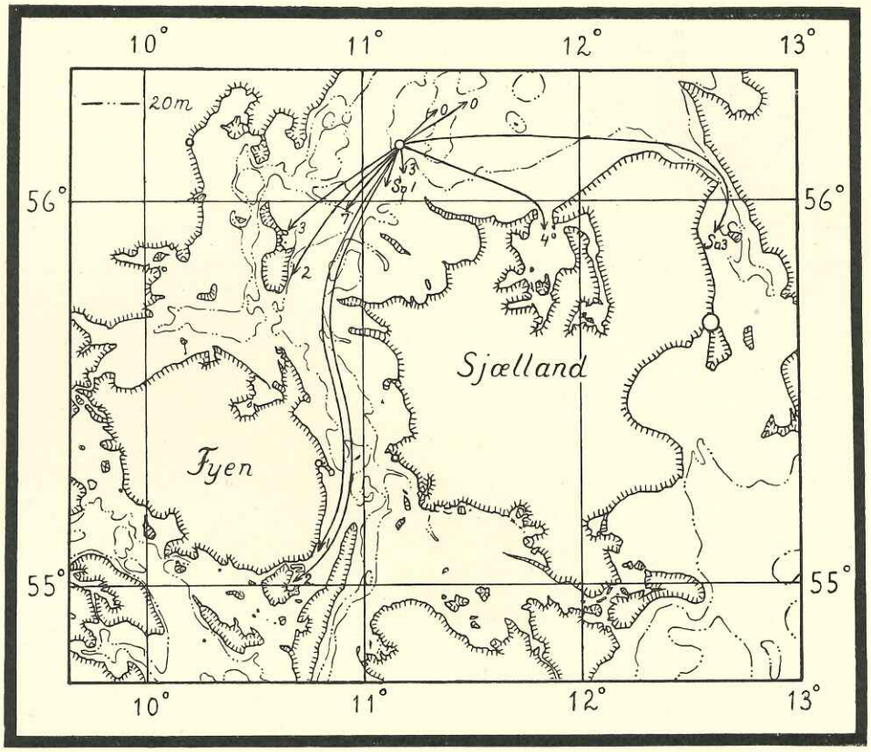

Fig. 7. Marking experiments with cod at Schultz's Grund in December 1912 and February 1913.

moved southward far down in the Great Belt, between Taasinge and Langeland, in March and April respectively of 1913, i. e. 1 and 2 months after marking. These two were the largest of the recaptured fish.

3. The Moselgrund Experiment.

1. Locality and date.

On the 30. March 1912, 145 cod were marked 3 miles NE of the bell-buoy at Moselgruud. The cod were taken on the spot, with the »snurrevaad«, from a fishing cutter, and marked and liberated immediately after capture. This experiment also was made by Mr. Christensen, mate of the »Thor«.

2. No. and sizes of fish marked.

The sizes correspond roughly to those in the Fornæs experiments.

Initial size cm:	42—44	45—49	50—59	60—69	70—79	80—91	Total
No. marked:	3	29	60	32	14	7	145

Only a very few, 9 in all, (51—89 cm) are here noted as mature (♂ and ♀) at time of marking (cf. the Fornæs experiments, where in April of the same year, 38 out of 173 were noted as mature. p. 15.)

3. No. of recaptures.

Table 14. Showing no. of fish recaptured from the experiment in the southwestern Kattegat near Moselgrund. 30 March 1912.

Initial size in cm	No. of cod marked	No. of Months between liberation and recovery																Total number recaptured	% recaptured
		0 *)	1	2	3	4	5	6	7	8	9	10	11	12	20	21	22	29	
70—91.	21	—	—	—	—	—	1	1	—	—	1	—	—	1	—	1	—	—	5	23.8
60—69.	32	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	3	9.4
50—59.	60	3	—	—	1	1	2	—	1	2	—	1	1	—	1	—	—	—	13	21.7
42—49.	32	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	1	1	4	12.5
Total . . .	145	3	1	1	1	1	5	1	2	2	1	1	1	1	1	1	1	1	25	17.2

*) = April.

The percentage of recaptures, abt. 17, answers fairly closely to that found in the Fornæs experiments. Within the separate size groups, it varies irregularly; possibly the more inshore situation of the experiment in this case may have something to do with it.

Otherwise, the recaptures are distributed in the same characteristic fashion as with the other Kattegat experiments, the numbers decreasing from spring to summer, and increasing again in the course of the following autumn; here, however, there were a few, though only very few, recaptures made during the summer months.

The largest specimens were not recaptured until the second half-year of the experiment, and later still. As in the Fornæs experiment, we have here again recaptures noted from the second and third year after marking.

Only one foreign fisher (Swedish) sent in a marked fish from this experiment, which of course is not unnatural, from the situation of the experiment, comparatively far up in the Danish waters. Of he Danish recaptures, 11 were landed at Grenaa, 5 at Aarhus, 2 at Samsø, 1 at Kallundborg, and 2 at various places in the Sound.

4. Growth.

Table 15. Growth of cod liberated in the southwestern Kattegat near Moselgrund. March 1912.

Month recaptured	Period between liberation and recovery	Increase in cm			No. of specimens measured	Initial size in cm			Remarks
		Average	Minimum	Maximum		Average	Minimum	Maximum	
1912, April	4-20 days	(3.0)	2.5	4.0	3	55.3	53	59	
— May	1 month	1.5	—	—	1 ♂	63	—	—	
— June	2 —	3	—	—	1	47	—	—	
— July	3 —	3	—	—	1	53	—	—	
— August	4 —	0	—	—	1	56	—	—	
— September	5 —	3.3	3	3.5	2	67	62	72	Growth calculated.
— October	6 —	ca. 6	—	—	1	84	—	—	Growth calculated from weight, mature at liberation *).
— November	7 —	0	—	—	1	65	—	—	
— December	8 —	ca. 9	—	—	1	59	—	—	Growth calc. from weight.
1913, February	10 —	3.5	—	—	1 ♂	50	—	—	Mature of recovery.
— March	11 —	5	—	—	1	59	—	—	
— April	12 —	4	—	—	1	71	—	—	Growth calculated.
— December	20 —	5	—	—	1	57	—	—	Growth calc. from weight.
1914, January	21 —	13	—	—	1	77	—	—	

*) omitted from Fig. 8.

The few available observations do not permit of any calculation of the rate of growth in the separate size groups. Taken together, as in table above and Fig. 7, it will be seen that the

increment during the first year in most cases hardly exceeds 6—7 cm. The initial sizes concerned are chiefly 50—65 cm. In the case of two (84 and 59 cm) out of the few that appear to have grown more rapidly, viz. abt. 1 cm average per month for 6 and 8 months respectively, the ultimate length was calculated from the weight, this value alone being noted on recapture. Both specimens were captured nearly 20 miles to the SW. Of slower growth than the above is a ♂, (50 cm) spawning on recapture, showing for 10 months only 3.5 cm, and a specimen of 57 cm, showing only abt. 5 cm in 20 months; these were taken abt. 20 miles away, to the NE and SW repectively.

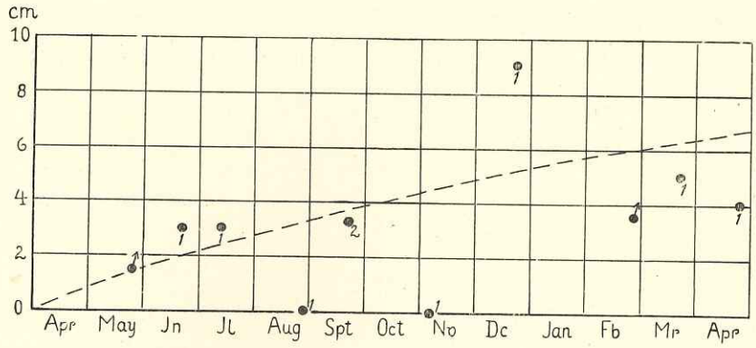

Fig. 8. Rate of growth of 47—72 cm cod, liberated at Moselgrund. 30 March 1912.

In the Fornæs experiment, the rate of growth for corresponding initial sizes, i. e. between 50—65 cm during the first year of experiment is in most cases nearly twice as much (1.1 cm per month), in some few others, of slower growth, it answers more nearly to that seen in the Moselgrund experiment.

The table below shows, for the sake of convenience, all available observations as to growth in in the two experiments compared. The *italics* refer to the Moselgrund experiment.

Table 16. Growth in cm of liberated cod. Experiment in the southwestern Kattegat off Fornæs and at Mosel Ground. Spring 1912.

Initial size in cm	No. of months between liberation and recovery																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	16	17	20	21	24	25	47
70- 84	—	—	—	—	*3.5*	*6*	—	—	—	—	—	4 *4*	—	—	—	—	*13*	7 ♂	—	—
65—69	—	—	—	—	1	1	*0*	—	—	7 ♂	—	2 ♂	0	—	—	—	—	—	—	—
60—64	*1.5* ♂	—	—	—	10 *3*	—	4 3 4	—	—	—	—	—	—	3	—	—	—	—	9	—
50—59	—	—	*3*	0 *0*	—	—	—	2 *9*	—	12 ♂ *3.5* ♂	5.5 > 15 *5*	21	13	—	8 ♂	*5*	—	—	—	—
47—49	—	*3*	—	—	—	—	—	—	2.5	—	—	—	—	—	—	—	—	—	—	—
34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29

5. Migrations.

Our experiments here, as at Fornæs, show relatively stationary conditions during the first half-year of the experiment; thus 9 (47—59 cm) of 11 were taken within a radius of 5 miles in the waters N of Hjelm during the first six months after marking. One specimen, (63 cm) was taken two months after marking abt. 20 miles away, to the SW, at the mouth of the Great Belt, another (72 cm) four months later in Kalundborg Fjord.

During the second half-year, and in the following twelvemonth, the stock in the Mosel experiment seems to scatter more than was the case with the Fornæs fish, towards NE and SW, but in the first place, the migrations shown are in most cases not of very great extent (less than 40 miles) and

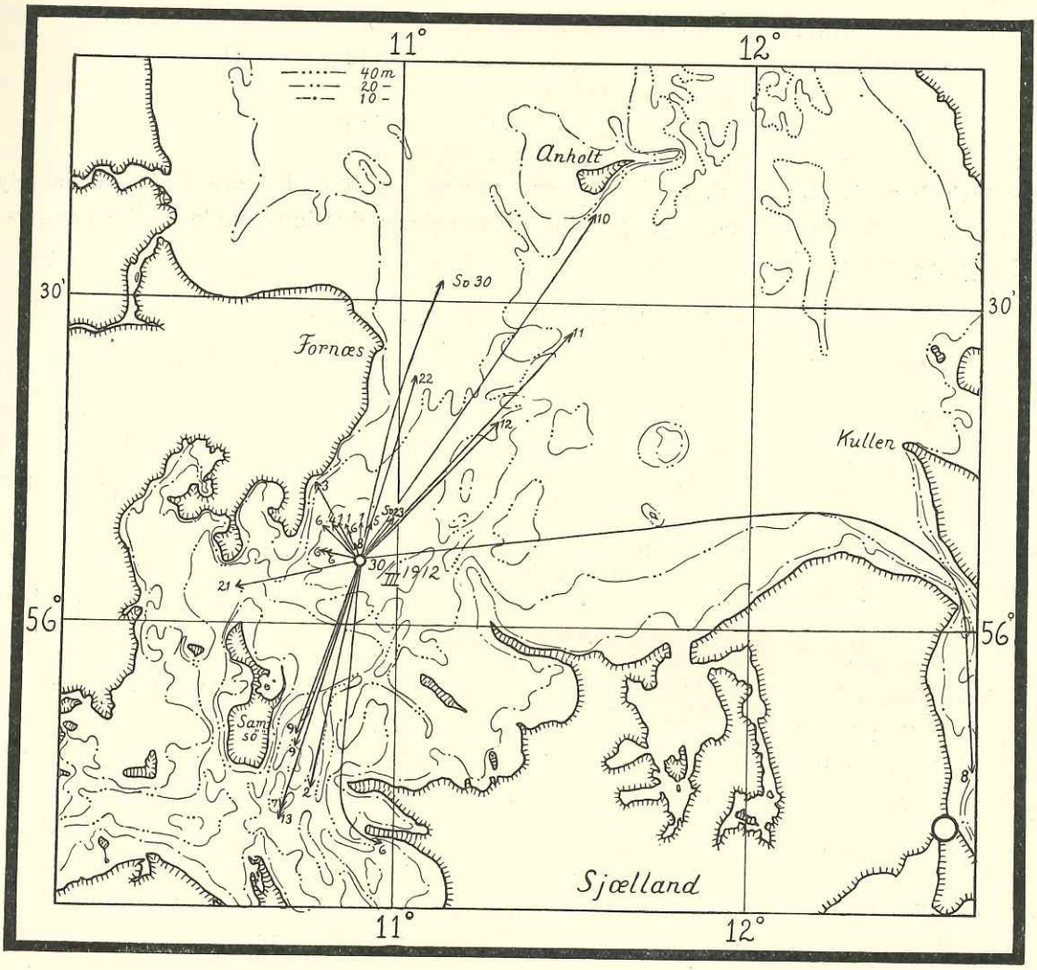

Fig. 9. Marking experiment with cod at Moselgrund in March 1912.

furthermore, the recaptures of that part of the stock which had moved NE towards the site of the Fornæs experiments show, that in this water up to E of Fornæs, a number of the marked fish are still at the conclusion of the second year after marking, less than 30 miles away.

Both sizes under and over 60 cm are represented among those covering greater distances.

c. Experiments in the Western Kattegat.

Exp. outside Randers Fjord.

1. Locality and date.

On the 29. March 1906, 41 cod were marked and liberated from the s. s. »Thor« at the bell-buoy outside Randers Fjord, abt. two miles off shore, in 6 metres of water. The fish were taken in traps along the coast immediately adjacent. (See p. 5)

2. No. and sizes of fish marked.

These fish, together with those mentioned on p. 25 as marked a month later at the mouth of the Mariager Fjord and off Samsø, represent the smallest sizes hitherto used for the experiments in Danish waters, all being under 48 cm. In the Randers Fjord experiment, the actual sizes were as follows:

Initial size in cm. . . .	29—39	40—48	Total.
	31	10	41
Of which spawning at time of marking. . . .	4 ♂, 7 ♀	4 ♀	

The stock here is composed, as in the experiments in the northern Kattegat, largely of cod which spawn at a small size, and chiefly, to judge by age determinations made at the time, comprising the II and III year-groups.

3. No. of recaptures.

Table 17. Showing no. of cod recaptured from the experiment off Randers Fjord. March 1906.

Initial size in cm	No. of cod marked	No. of months between liberation and recovery						Total numbre recaptured	% recaptured
		1	2	5	6	7	13		
40—48	10	2	3	—	—	—	—	5	58.3
35—39	14	2	4	1	1	1	—	9	
20—34	17	4	4	—	1	1	1	11	64.7
Total . . .	41	8	11	1	2	2	1	25	61.0

The percentage of recaptures here is higher than in any other of our experiments, being 61 % in all, or 58.5 % within the first year from date of marking. The principal cause of this is presumably that the site of the experiment lies so comparatively close in to shore, along a range of coast where cod fishery is intensively carried on; furthermore, the fish here marked were of a size which, as it has been found, remains very stationary during at least the greater part of the first year after marking. This also agrees with the fact that all recaptures were made by Danish fishermen, for the most part within the three-miles limit; fishermen from Udbyhøj alone accounted for twelve recaptures.

As almost everywhere throughout the experiments previously mentioned, the recaptures were made in spring and autumn; from June to August none are recorded at all. This agrees with the fishery statistics for cod fishery in the districts of Udbyhøj (K 13) and Stavnshoved (K 14) embracing the range of coast nearest the site of the experiment, and within which most of the recaptures were made.

Table 18.

	Quantities of cod (in 1000 kg) taken in 1906 and landed							
	Jan.—March	April	May	June—July	August	September	October	Novb.—Dec.
K 13	4.8	2.6	0	0	0	2.1	4.6	9.7
K 14	30	40	5	4.5	4.5	45	35	22

4. Growth.

Table 19. Growth of cod liberated off Randers Fjord. March 1906.

Month recaptured	Period between liberation and recovery	Increase in cm			No. of specimens measured	Initial size in cm		
		Average	Minimum	Maximum		Average	Minimum	Maximum
1906, April	1 month	0.3	0	1.0	8	35.8	31	46
— May	2 —	1.4	0	c. 4	7	37.0	32	45
— August	5 —	c. 2.0	—	—	1	36.0	—	—
— September	6 —	1.5	0	c. 3	2	36.0	33	39
— October	7 —	c. 11	c. 9	c. 13	2	33.0	29	37

The material affords but little information as to growth throughout any length of time. Several of the fish were badly measured, or measured when dead and somewhat shrunken after recapture; in other cases, the length has been merely calculated from the weight. Most appear to have grown very slowly, generally abt. $^1/_2$ cm average per month for the first half-year after marking. Two specimens, taken 7 months after, had, however, grown considerably better, showing respectively abt. $1^1/_2$—$1^4/_5$ cm average per month. (ultimate size calculated.)

5. Migrations.

Most of the recaptures were made closer to shore, and only a very few miles away. (Fig. 2). One only (33 cm) was taken farther away to the north, off Hals, at a distance of abt. 30 miles, and one (33 cm) was taken 6 months after in the Sound, a record which appears to be correct. These last, as also the recapture (37 cm) off Mariagerfjord 7 months after marking, and likewise the few made later than September, might suggest that the younger fish here marked scatter and move farther out from the coast during the first year after marking.

Experiment in Mariager Fjord.

On the 31 May 1906, 100 cod, 20—42 cm, captured off the coast at the mouth of the fjord, were marked and liberated farther up in the fjord, close off Mariager itself.

This experiment has only yielded comparatively few recaptures, totalling abt. 16 %. Adding to this the fact that several of the recaptures were not very reliably measured, the whole experiment becoms of less walue. Of the 16 recaptures, 9 were made in June, 6 in August, of the same year, and 1 in January 1907, i. e. here also none in the true summer season. All these recaptures were made in Mariagerfjord, none outside. Three reliably measured specimens show for the period June—August the poor growth of abt. 1 cm each only. Far better growth — better indeed than the great majority from our other experiments — is shown, however by a specimen of 36 cm recaptured on the 19th of January 1907, viz. abt. 19 cm for the six months, i. e. abt. 3 cm average per month for the period of experiment, presuming the measurements to be correct.

C. Experiments in the Belt Sea.

These fall into three groups:

a. East coast of Samsø.
b. Little Belt (in the narrows).
c. Great Belt, (off Sprogø and off Langeland).

a. The Samsø Experiments.

On the 8th March 1906, 40 cod, of 29—48 cm, were captured, marked and liberated off Ballen. On the 10th May 1912, 7 cod of 49—62 cm taken on the Flensborg Ground, abt. 6 miles E of Samsø, were liberated close in to shore, off Langøre.

The recaptures numbered two and one respectively, which for the two experiments together represents a percentage of abt. 6.5, an extremely low figure compared with our experiments in waters

closely adjacent. Two (33 and 36 cm) of these were taken $^1/_2$ and $2^1/_2$ months later respectively, east of Samsø, less than a mile from site of marking, while one was taken five months after marking in Kertemindebugt.

The fish captured in May 1906, abt. $2^1/_2$ months after marking, had grown 2 cm. These experiments are, however, owing to their slight extent, hardly suitable for further consideration here.

b. Experiments in the Little Belt.

1. Date and locality.

On the 15. March 1912 (Exp. I, 1912) 50 cod were captured and marked abt. 1 mile W of Middelfart, in 26—28 metres of water. During the days from 19—23 of the same month (Exp. 2, 3 and 4, 1912) 150 cod were captured and marked, some between Middelfart and Fænø, others off Strib. The fish were caught by line from fishing vessels, in 28—38 metres of water (See table on p. 5). These experiments were carried out by Mr. Christensen, mate of the »Thor«.

2. No. and sizes of fish marked.

Table 20.

Initial size in cm	38	40—44	45—49	50—54	55—59	60—69	71—84	Total
Exp. 1, 1912	1	29	17	0	3	—	—	50
— 2, 3, 4, 1912 .	—	—	29	65	31	18	7	150
Ialt . . .	1	29	46	65	34	18	7	200

The sizes in Exp. 2, 3 4, 1912, answer pretty closely to those of the fish marked at Moselgrund (see p. 20) but are considerably smaller that those in Exp. 1—1912 in shallower water.

34 ♂ and 50 ♀, 38—80 cm, were mature, spawning being thus well in progress at commencement of the experiment.

3. No. of recaptures.

Table 21. Showing no. of cod recaptured from the experiments in Little Belt. March 1912.

Initial size in cm	No. of cod marked	No. of months between liberation and recovery																Total number recaptured	% recaptured
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	19	24		
60—84	25	—	2	—	—	—	—	—	—	—	—	—	—	1	—	—	—	3	12.0
50—59	99	3	16	5	5	3	1	5	1	2	2	3	1	—	2*)	1	1	51	51.5
38—49	76	3	9	5	2	4	1	5	—	—	1	2	—	—	1	—	—	33	43.4
Total . . .	200	6	27	10	7	7	2	10	1	2	3	5	1	1	3	1	1	87	43.5

*) No. 890.

The percentage of recaptures, abt. 44, is higher here than in our other experiments in Danish waters, except off Randers Fjord. Here also, the smaller sizes are more frequently retaken. Most were recaptured within a year of marking, some few in the second year of the experiment, and none later than that (cf. Fornæs and Mosel Exp., p. 16—21). In contrast to results of the previous experiments, the recaptures are here distributed throughout all months of the year, i. e. including the summer proper.

Of 87 recaptures, the great majority, 85, were landed at fishing stations in the Little Belt, 7 out of 85 at Middelfart, 12 at Skærbæk, Fredericia and adjacent stations, only one at Assens and 1 at Faaborg.

These figures correlate very closely to the conditions of fishery in the Belt. Cod fishery in the narrows of the Little Belt is carried on for the most part by means of traps, and, to a sligther extent, lines, and as will be seen from the figures given below, (reports furnished to the official fishery statistics for 1912) chiefly from »Middelfart« and »Skærbæk«; also — albeit with varying extent of yield — throughout all months of the year.

Quantities of cod taken in Little Belt 1912, and landed at stations adjacent.

Quantities landed (in 1000 kilos) per month.

Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Decr.
17	18.5	22	27	11	4.5	4	7.4	13	12	16	19.5

All recaptures in these experiments were made by Danish fishermen, as was to be expected from the locality where marked

4. Growth.

Table 22. Showing growth of cod liberated in Little Belt. March 1912.

Month recaptured	Period between liberation and recovery	Increase in cm			No. of specimens measured	Initial size in cm			Remarks
		Average	Minimum	Maximum		Average	Minimum	Maximum	
1912, March . . .	1-12 days	1.2	0	3.0	7	48.3	38	52	
— April . . .	1 month	2.5	0	8.0	25	51.3	42	62	
— May	2 —	3.4	0	8.0	8	47.6	45	52	
— June . . .	3 —	5.1	3	10.5	7	49.8	42	54	
— July	4 —	3.6	0	8	7	50.0	40	57	
— August . .	5 —	6.0	4	8	2	47.0	44	50	
— September	6 —	8.1	4	12	9	48.9	41	53	
— October . .	7 —	14	—	—	1	54	—	—	
— November	8 —	14.5	14	15	2	57.5	57	58	
— December.	9 —	8.7	3	14	3	52.3	47	57	
1913, January. .	10 —	9.8	5	14	5	51.2	45	59	
— February .	11 —	16.5	—	—	1	51	—	—	
— March. . .	12 —	13	—	—	1	67	—	—	
— April . . .	13 —	8.5	8	9	2	49.5	42	57	
— October . .	19 —	ca.19	—	—	1	57	—	—	Growth calculated.
1914, March . . .	24 —	ca.34	—	—	1	53	—	—	do.

The initial sizes 44—59 cm and especially 50—54 cm are most numerously represented among the recaptures where growth was determined. According to the tables and Fig. 10, the growth during first year averages abt. 1.1 cm per month, possibly somewhat more during the summer and slightly less later in the year.

These experiments also show a marked degree of variation in the growth, albeit with comparatively slighter deviation from the mean value than in most of our other experiments in the Kattegat and Belt Sea.

Table 23. Average growth in cm. Experiment in Litlle Belt. March 1912.

Initial size in cm	No. of months between liberation and recovery														
	1	2	3	4	5	6	7	8	9	10	11	12	13	19	24
62—67	3.5	—	—	—	—	—	—	—	—	—	—	13	—	—	—
55—59	1.7(6)	—	—	—	—	—	—	14.5(2)	3	11	—	—	8	ca.19	—
50—54	3.2(10)	3.3(4)	5.8(5)	3.2(2)	8	8.1(5)	14	—	9	10(2)	16.5	—	—	—	ca.34
44—49	1.5(5)	3.8(4)	4.0	5.5(3)	4	9.3(3)	—	—	14	8.5(2)	—	—	—	—	—
40—42	3.2(3)	—	3.0	1.0	1	4.5	—	—	—	—	—	—	9	—	—

Figures in brackets indicate numbers of specimens measured.

Altogether, the average growth in Little Belt experiment is essentially superior that in the Moselgrund experiment. The rate of growth corresponds, on the other hand, better to that shown in the Fornæs Experiments (p. 17) in the specimens — mostly somewhat larger — there marked. This applies only to the average rate of growth; in the Moselgrund experiment, some few specimens showed for the first year of the experiment a growth fully equal to that of the Little Belt fish.

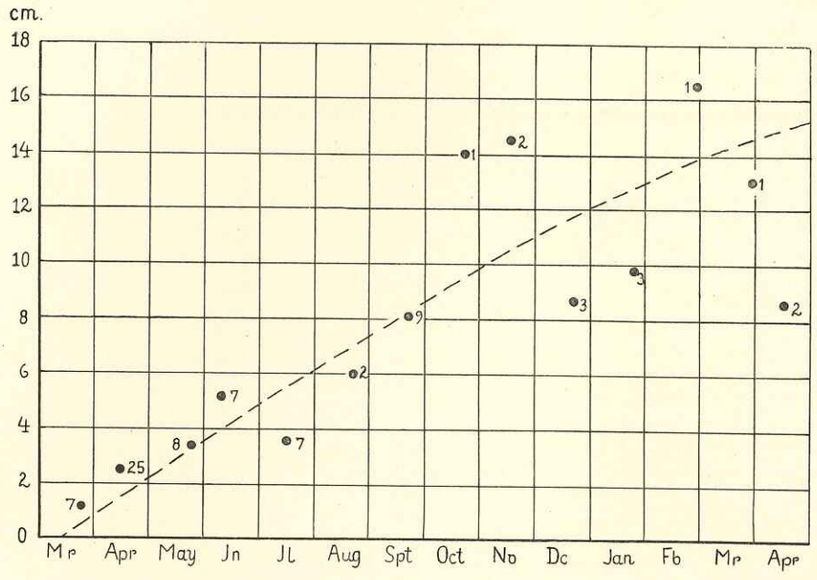

Fig. 10. Rate of growth of 38—67 cm cod, liberated in Little Belt. March 1912.

No relation between degree of maturity at time of marking and rate of growth during the months imediately following can be shown with certainty; the males grow in the whole quite as well as the females within the size-groups (44—60 cm) here concerned.

Growth of the fish recaptured later will be seen from the following:

In the course of	12	13	13	19	and	24 months from time of marking,
specimens of	67	♀ 42	♀ 57	57	and	♀ 53 cm
had grown approximately	13	9	(8)	19	and	34 cm

Figures in brackets indicate growth calculated from weight on recapture. The growth here also answers more or less to the average for first year's growth. The four last specimens were all recaptured in the Belt, the first in Great Belt. The age of the specimen which in 12 months had grown from 67 to 80 cm was on recapture 5 years.

5. Migrations.

The great majority were recaptured in the couse of the first year after marking in the narrows of the Little Belt, quite close to site of liberation. This applies both to the smaller fish marked 15th March, W. of Middelfart, and the larger ones marked there and off Strib in the succeeding days. Even 13, 19 and 24 months after marking, three specimens (57 and 53 cm) were taken

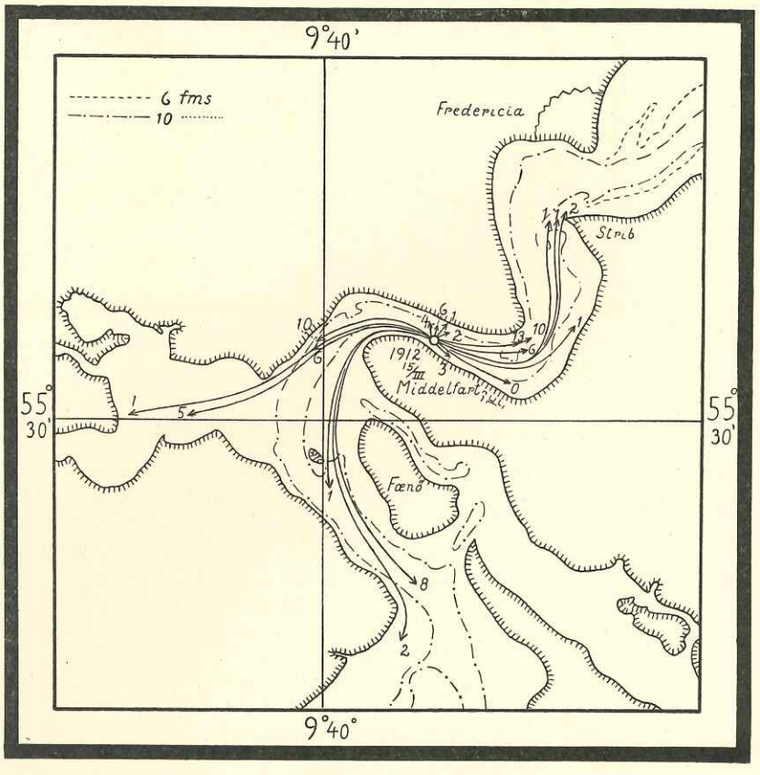

Fig. 11. Marking experiment woth cod in Little Belt. 15 March 1912.

only a few miles distant. Altogether, only 3 specimens were recaptured at any greater distance from the site, 2 (63 and 59 cm) after 1 and 10 months respectively farther south in the Little Belt, and 1 (67 cm) 12 months after liberation, in the Great Belt, off Kerteminde (p. 33). Save for the first month of the experiment, all the remaining recaptures were smaller than these and, as mentioned, retaken closer to

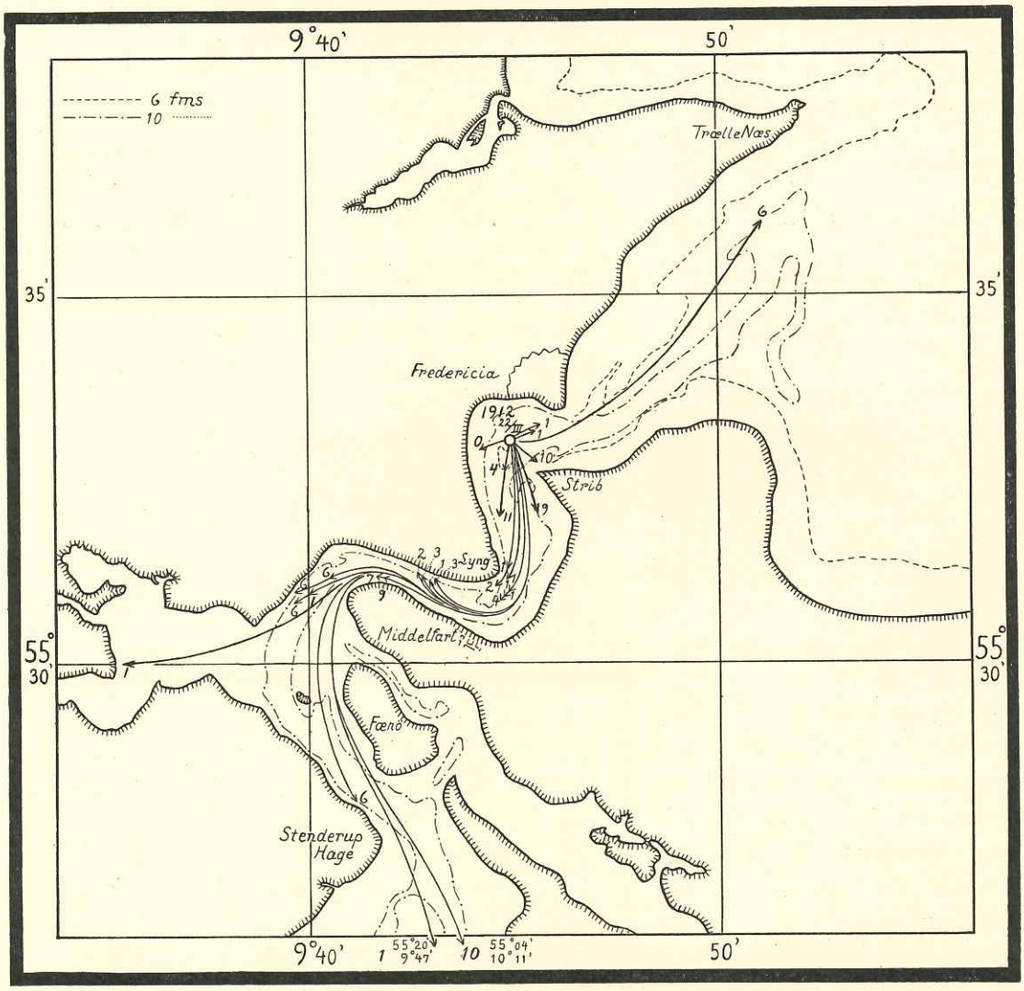

Fig. 12. Marking experiment with cod in Little Belt. 22 March 1912.

the site of liberation. Such movements as these appear to have made at all are for the most part merely irregular wanderings (Fig. 11). Only among those marked 22 March off Strib (Fig. 11) are there many which show a marked southerly trend down through the narrows as far as Fæno.

Aslate as 19 and 25 months after marking two specimens, (53 and 57 cm), were taken here, these being the last recaptures made in any of these experiments.

C. Experiments in the Great Belt.

1. Locality and date.

On the 21 and 23 March 1907, 34 and 76 cod respectively were marked from the s. s. »Thor« off Sprogø (Exp. 2, 1907) and SW of Tranekær (Exp. 3, 1907). The fish were taken in trawl, marked and liberated at the same localities.

2. Sizes of fish marked.

Initial size cm.	25—29	30—39	40—49	50—59	Total
Exp. No. 2, 1907	5	17	7	5	34
- - 3, -	26	33	16	1	76

The fish here marked, for the most part under 50 cm, are thus smaller than those marked in Little Belt, but answer to the smaller sizes marked outside Randers Fjord and off the E coast of Samsø. Many were spawning, especially of the Langeland fish. Here, then, as in the experiment outside Randers Fjord, and elsewhere, the stock is chiefly composed of small spawning cod.

Initial size cm.	25—29	30—39	40—49	50—59	Total
Exp. 2, 1907		4 ♂ 1 ♀	3 ♀	1 ♀	4 ♂ 5 ♀
- 3, -	7 ♂ 4 ♀	7 ♂ 11 ♀	5 ♀		14 ♂ 20 ♀

In these experiments and that following (Bagenkop) the fish were weighed at time of marking, most being under 750 gr. and of these again most under 500 gr.

3. No. of recaptures.

Table 25. Showing no. of cod recaptured from the experiment in the Great Belt. March 1907.

No. of Experiment	No. of cod marked	No. of months between liberation and recovery											Total number recaptured	% recaptured
		0	1	2	3	5	6	7	8	9	10	11		
1907—2	34	—	2	1	—	1	—	—	3	1	1	—	9	26.5
1907—3	76	1	2	3	4	—	1	2	—	2	—	1	16	21.0
Total . . .	110	1	4	3	4	1	1	2	3	3	1	1	25	22.7

The percentage of recaptures, abt. 26.5 (Exp. 2, 1907) and 21 (Exp. 3, 1907) is essentially lower than in the Little Belt (44%) and answers roughly to the figures for the Fornæs and Moselgrund experiments.

All the recaptures were made within the first 11 months after marking, of which, as in most of our other experiments, only a very few fall to July-September, with a rise in the autumn thereafter.

All were made by Danish fishermen; in the Sprogø experiment, 4 of the 8 recaptured fish are landed at Korsør, 2 in Skelskør; in the Tranekær experiment, 7 out of 12 were landed at Botofte, 2 at Spodsbjerg, and 3 at stations in Lolland.

4. Growth.

Weights and measurements on recapture are here for the most part unreliable. The few observations as to growth which may be taken as trustworthy enough for consideration are shown below:

Table 26. Showing growth of cod liberated in Great Belt. March 1907.

Recaptured	Period between liberation and recovery	Initial size in cm	Sex (mature at liberation)	Increase in cm	Remarks
1907, May	2 months	42	—	ca. 1	Ultimate size given as length to base of caudal fin a correction being added.
— —	—	42	—	- 2	
— —	—	47	—	- 2.5	
— June	3 —	27	♀	0	
— —	—	28	—	—	
— —	—	38	♀	0	do.
— August . . .	5 —	40	♀	ca. 3	
— September . .	6 —	27	—	- 0	
— October	7 —	27	—	- 5	♀ imm. at recapture
— —	—	39	—	- 7	do.
— November . .	8 —	35	—	- 3	do.
— — . .	—	27	—	- (9)	tail dry
— December . .	9 —	36	♂	- 4	
— — . .	—	29	—	- 0	
— — . .	—	30	♂	- 6	
1908, January . . .	10 —	32	—	- 3	III Group, correction added to ultimate size, ♀ mature
— February . . .	11 —	42	—	> 15	at recovery

Some few specimens (in both experiments) show a good rate of growth, similar to that in the Little Belt, i. e. abt 1 cm. per month, but others, especially among those spawning at time of marking or on recapture, have grown far less. Altogether then, we find here a mixture of quick- and slow-growing fish, but no average rate of growth for the first year after marking can be given.

5. Migrations.

Fig. 2 shows that the recaptures in the Sprogø experiment were made either quite near to Sprogø after 5—10 months, or farther south in the Belt — a few miles away scattered over the range from Halskov to Agersøsund; the recaptures here include the largest specimen retaken (55 cm) abt. a month after liberation. Only one was taken on the western side of the Belt, off Langeland.

In the Tranekær experiment, the recaptures were likewise chiefly made only a few miles away, north or south of the site of liberation. A single specimen (32 cm, ♀) was taken after one month at the north end of Langeland, and two (33 ♂ and 38 ♀) after 2 and 3 months respectively off the south coast of Lolland.

Altogether, these experiments as well as those in the northern Kattegat and outside Randers Fjord, show stationary conditions in the stock for the first year of experiment. Such migrations of any length as we are able to follow tend mostly southwards. The cessation of recaptures at the close of the first year may here, as there, appear to indicate that a more pronounced dispersal of the stock gradually takes place.

D. Experiment in the Western Baltic.

1. Date and locality.

On the 15 and 16 March 1907, 85 cod were marked off Bagenkop, on the south-east coast of Langeland. The fish were taken in nets close in to shore, and were marked and liberated a few hours after capture, from the s. s. »Thor«.

2. Sizes of fish marked.

Initial size in cm	30—39	40—49	50—59	60—69	70—95	Total
	5	14	46	14	6	85

The great majority (71 out of 85) were fully spawning, viz. 14 ♂ and 57 ♀.

Initial weight in gr.	200—950	1000—1490	1500—1900	2000—2900	3000—3900	4000—5000	9000—9500
	8	30	22	16	5	2	2

The fish here marked are thus essentially larger than in the Great Belt experiments just mentioned, answering more to the sizes marked in the Little Belt 1912. (See also Fig. 1, p. 6).

3. No. of recaptures.

Table 27.

Initial size in cm	No. of cod marked	Recaptured in 1907			% recaptured
		March	April	May	
60—95	20	—	—	—	—
50—59	45	2	2	—	8.7
30—49	20	3	5	1	47.4
Total . . .	85	5	7	1	15.3

The percentage of recaptures here (abt. 15%) is thus even lower than in the Great Belt experiments (abt. 21% and 26.5%) and not a single fish was here retaken more than 3 months after liberation. The reason of this can hardly be stated with certainty, but apart from possible errors in the arrangement (? reduced vitality of the fish owing to method of capture?) a contributory cause may be presumed to lie in the fact that the fishery here is not carried on with the same intensity during the summer months, and indeed, at no season of the year so intensively as in the Little Belt and many other places in our waters.

A single recapture was made at the mouth of the Kielerfjord abt. $1^1/_2$ months after liberation, by a German fisherman; the remainder were made by Danish fishermen, chiefly with gillnets and stakenets in the inmediate vicinity of the spot, ten of the 13 recaptures being landed at Bagenkop.

The catches of cod landed at Bagenkop and in the neighbouring district during 1907 were as follows (in kg).

Jan.	Febr.	March	April	May—Sept.	Oct.	Nov.	Dec.
3500	2500	0	1500	0	1500	6000	7000

From the circumstances of the case, the material affords practically no information regarding the growth; some few have grown 1.5 cm (in one month) but several far less during the same period.

Concluding Remarks.

1. Growth.

The experiments afford information only as to increase in length.

a. The best and most regular growth is found in the Skagerak (off Kandestederne) and in the Little Belt. The cod here (35—50 and 47—57 cm) showed an average growth of 12 cm during the first year after marking.

In the Little Belt, close on half the total number of fish were ready to spawn at time of marking, though this fact has not made any demonstrable reduction in the rate of growth as compared with the average.

b. A somewhat slower average rate of growth, with, moreover, a higher degree of individual variation, is found in the case of cod from the south-western Kattegat, Fornæs and Mosel (chiefly 45—65 cm fish). The average here is hardly more than 7—9 cm during the first year, though in several specimens, the rate of growth was not inferior to that of the Little Belt fish.

A similarly irregular, but on the whole, slow growth is found in the case of the small cod of 30—45 cm from the western Kattegat outside Randers Fjord and in the Great Belt.

In these experiments, as already mentioned, a great part of the stock is composed of fish which are ready to spawn even at this small size. Many of these had grown very slowly, only about 4—5 cm in the first year of experiment, or a corresponding amount during such part of the year as we were able to follow them (Fig. 5). Other specimens — both smaller (30—35 cm) and larger (41—44 cm) — which do not appear to have reached maturity at time of marking showed an average increase of 1 to 1.2 cm per month, as in the case of the larger fish above mentioned. Age-determinations of some of the more rapidly growing smaller fish also showed that they were generally younger than the slow-growing spawning fish of equal initial size.

c. The material of growth-determined fish over 60 cm is but small. In the Fornæs experiment, the growth for first year after marking varies between abt. 3 and abt.

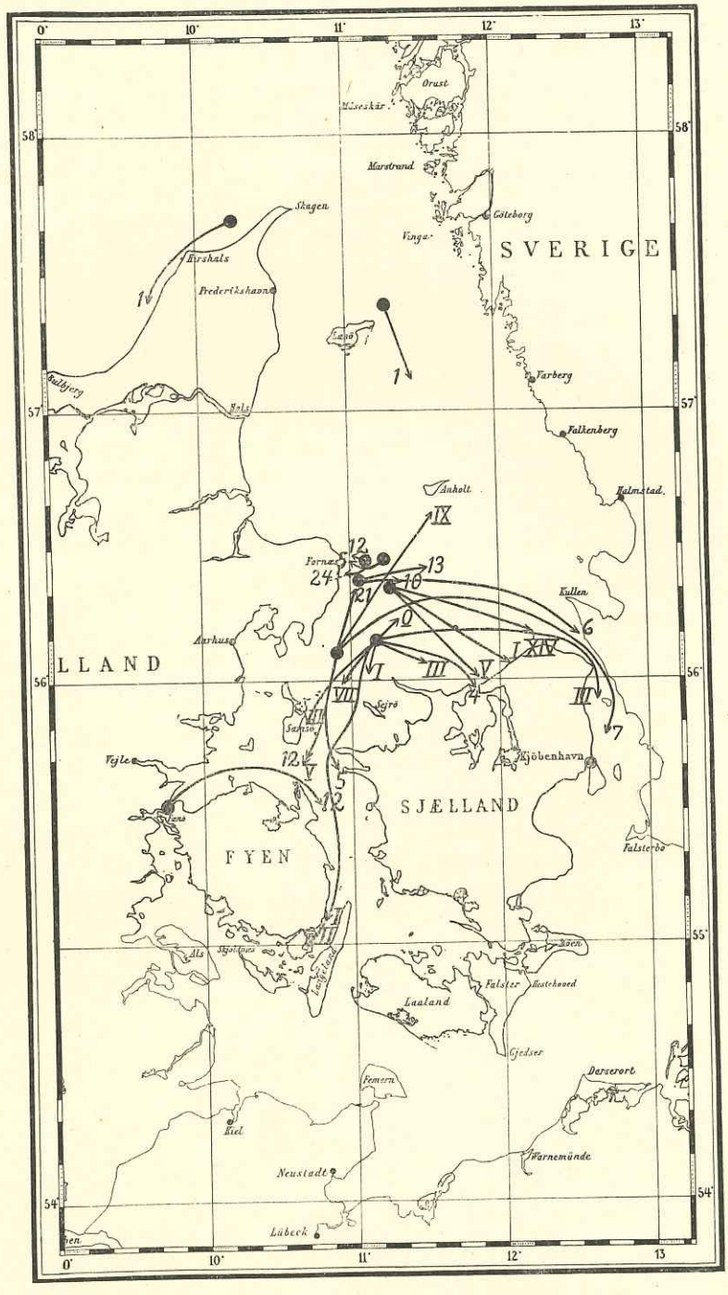

Fig. 13. Migrations of 65—76 cm cod (as denoted by arabic figures) and of 80—100 cm cod (as denoted by roman figures).

7 cm. A single specimen from Schultz's Grund (80 cm) seems during the same period to have grown as fast as the smaller ones, viz. abt. 1 cm average pr. month; the few others for which reliable measurements are available showed, however, markedly inferior growth.

2. Migrations.

a. The great majority of recaptures exhibit more or less stationary conditions during the first year of the experiments. Only a few of the largest specimens — some from Schultz's Grund, and some from other experiments — had in the course of a few months covered greater distances, for the most part from the Kattegat southward and down into the Sound, the Isefjord, or the Belts. The rest were generally retaken either at or quite close to the spot where they were liberated. The smaller fish, (< 50 cm), marked in the Skagerak, in the Kattegat between Læsø and Skagen, and outside Randers Fjord, had in some cases moved in to shallower water in the course of the autumn after marking; the distances covered, however, amounted as a rule to no more than a few miles.

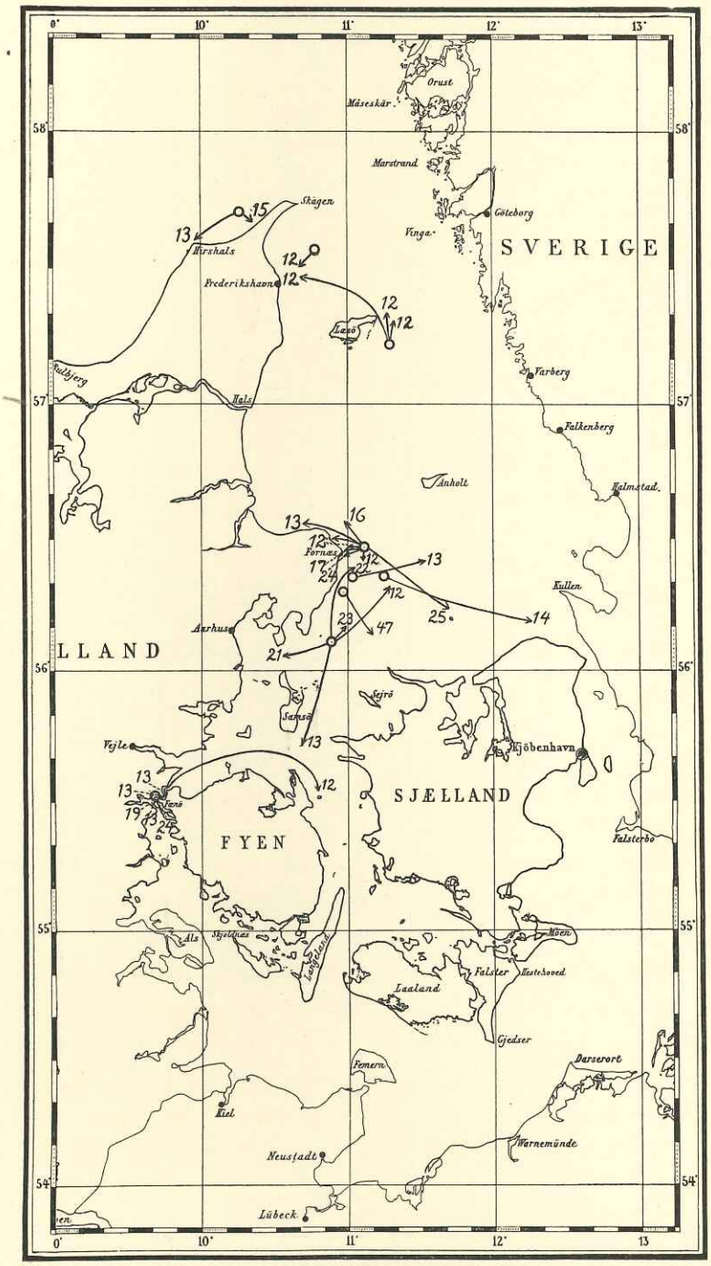

Fig. 14. Migrations of all marked cod recaptured 12 months and later on after liberation.

In the second year after marking, the larger fish (45—70 cm) are largely stationary. Right up to the commencement of the third year after marking, a number of specimens were recaptured off Fornæs and in the Little Belt, less than 5 miles from site of liberation.

The smaller fish (25—45 cm) were hardly ever retaken later than 12 months after liberation. This is especially the case with the small, full cod marked outside Randers Fjord and in the Great Belt, and in somewhat deeper water in the nothern Kattegat. The comparatively early cessation of recaptures here may be due, inter alia, to the very high percentage during the first year (Randers Fjord); at any rate, this is doubtless a contributory cause. These experiments are, however, too small and few in number to permit of any far reaching conclusions, as for instance in the matter of how far the cessation of recaptures might also be due to distribution of the stock in the course of the winter or following spring, especially as regards the small, full fish in the coastal waters. But for the present, we are unable to follow up the question further.

This last also applies to the largest specimens (over 70 cm) which were found, even in the first year, to be moving away from the area of experiment.

b. In a very few cases, the marked fish were found to have covered considerable distances (Fig. 2 & 13). The longest migration met with in these experiments is that of a fish, 37 cm long, marked off Thyborøn in 1905 and retaken at the mouth of the English Channel, a distance of at least 330 miles, covered in 74 days (See Fig. 2). Migrations of slighter extent were noted in the case of a few, chiefly very large fish, which in the course of 1—3 months had moved from the south-western Kattegat far down into the Sound or the Great Belt. A few specimens from the experiments on the northern part of the Skagerak coast and in the northermost waters of the Kattegat had rounded the Skaw and moved down into the Kattegat, or vice verca; some had crossed the Skagerak and were found near the Swedish coast; none of these, however, had covered more than abt. 50 miles.

Taken as a whole, then, migrations of any considerable extent from one water to another have only been found in quite a few cases within the period covered by our experiments.

3. Percentage of marked fish recaptured.

a. No. of recaptures within first year of liberation. The total recaptures numbered (at least) 338, or 21.8 %, the great majority being retaken within a year from date of liberation.

0—12,	13—18,	19—24,	25—30	and 47 months after liberation
316	13	6	2	» 1 specimens were retaken.

The numbers of recapture during the first year do not as a rule exhibit a regular decline within that period. The following table shows the distribution of percentages in the case of the March-April experiments, i. e. embracing by far the greater part of the material.

Recaptured in	March & April	May & June	July & Aug.	Sept. & Oct.	Nov. & Dec.	Jan. & Febr.	March & April
I. Exp. in Skagerak, North & W. Kattegat and Great Belt . . .	27.6	17.1	4.0	17.1	21.0	6.6	6.6
II. Exp. in Little Belt.	40.3	20.7	11.0	13.4	6.1	7.3	1.2

Group I comprises altogether 152 + 13, Group II a total of 82 + 5 recaptured respectively during first year and remainder of period.

In Group I, the number of recaptures decreases considerably during the summer months, rising again thereafter in course of the autumn; in the Little Belt experiments, however, (Gr. II) the case was somewhat different.

These facts correspond well with the seasonal character of the cod fishery in most of our waters[1]), and thus indirectly serves to confirm the correctness of the general view of the intensity of capture presented by the marking experiments.

The cause of this »summer pause« in the fishery is hardly to be found in any emigration of the cod. At any rate, the marking experiments show that most of the recaptures, apart from the largest fish, for the first year or more after liberation fall comparatively few miles away so that there during this period can be no question of more than a temporary shifting of the stock within a narrowly restricted area.

The interruption of the fishery is rather due to difficulties in keeping the fish alive or fresh at this time of year. In some localities, however, as for instance in the Little Belt, where deep flowing

*) See, inter alia, A. C. JOHANSEN: Medd. Komm. Havunders. Serie: Fiskeristatistik, vol. II 1913, p. 45, and C. F. DRECHSEL: Oversigt over vore Saltvandsfiskerier 1890, p. 30.

water quite close in to shore presents more favourable conditions than generally elsewhere, a not inconsiderable fishery is carried on even during the hottest summer months (also table p. 27).

b. Percentage of recaptures according to size of fish marked. In the various experiments taken separately, a decrease was found in the percentage of recaptures with increasing size of the fish marked.

Taking all the experiments together, the intensity of capture for fish under 60 cm is about the same, abt. 25 %, and more than twice that of the larger fish, among which again it is lowest in the case of the largest specimens; these last, however, are, it is true, very few in number.

Of the initial sizes

70—109	cm	210	specimens	were	marked,	and	20,	or 10.0 %	recaptured
60— 69	»	169	»	»	»	»	19,	» 11.2 %	»
50— 59	»	344	»	»	»	»	93,	» 27.0 %	»
40— 49	»	390	»	»	»	»	104,	» 26.7 %	»
25— 39	»	434	»	»	»	»	102,	» 23.5 %	»

On comparing the separate experiments one with another, we find a somewhat varying proportion between the size of fish marked and degree of intensity of capture (Fig. 15). The figure, and the table given below, indicate, it is true, that the experiment with largest sizes (Schultz's Grund) shows the lowest percentage of recaptures; otherwise, however, it will be seen that the stock, consisting of approximately the same size-groups, is fished with varying intensity in the various parts of our waters. (cf. the Little Belt and S. W. Kattegat experiments.)

Table showing % of recaptures in the different groups of experiments.

Sizes of cod liberated.					
25—50 cm		50—70 cm		70—106 cm	
Skagerak	25 %	Southw. Kattegat	16 %	Schultz's Grund	9 %
North-Kattegat	15 %	Little Belt	44 %		
Outside Randers Fjord	61 %	W. Baltic	15 %		
Great Belt	24 %				

c. Intensity of fishing and nations participating. The most intensive fishery in the areas embraced by our experiments is that in the Little Belt and close in to shore from the mouth of Randers Fjord (Udbyhøj) and eastward as far as Stavnshoved; i. e. coast fishery in the strictest sense of the word. Here, nearly half the total number of fish marked were recaptured within the year. The experiment off Kandestederne, on the other hand, shows that the inshore fishery in the Skagerak, at any rate as regards the stretch Hirshals—Skagen was carried on far less intensively during the year of the experiment.

Almost the same recapture percentage as for Kandestederne is found in the Great Belt experiments, the figure being somewhat lower again in the experiments in the open waters of the north and south-western Kattegat. With minor fluctuations as between one experiment and another, we find an average of recaptures here amounting to abt. 20 % i. e. only abt. $^1/_6$—$^1/_5$ of the stock was taken here during the first year of the experiments. Scattered and relatively few in number as these experiments are, the comparatively slight variation of the recapture percentage within one and the same experimental group (cf. Fig. 15) suggests that we have as a whole a reliable picture of the intensity of the largely seagoing fishery here.

Even within the Kattegat, where most of our experiments were made, the fishery in our experimental areas naturally covers only a small portion of the total Kattegat fishery; a total picture of the intensity of capture in the whole of this water, is therefore not to be obtained from the material here

available. The same applies to the proportion between the fisheries of the different nationalities in the Kattegat as well as in our other waters.

The extent of the Danish cod fishery in the years 1905—1914 will be seen from the following table, showing the annual average yield (in tons) for the said period (reproduced from the »Bulletin Statistique«).

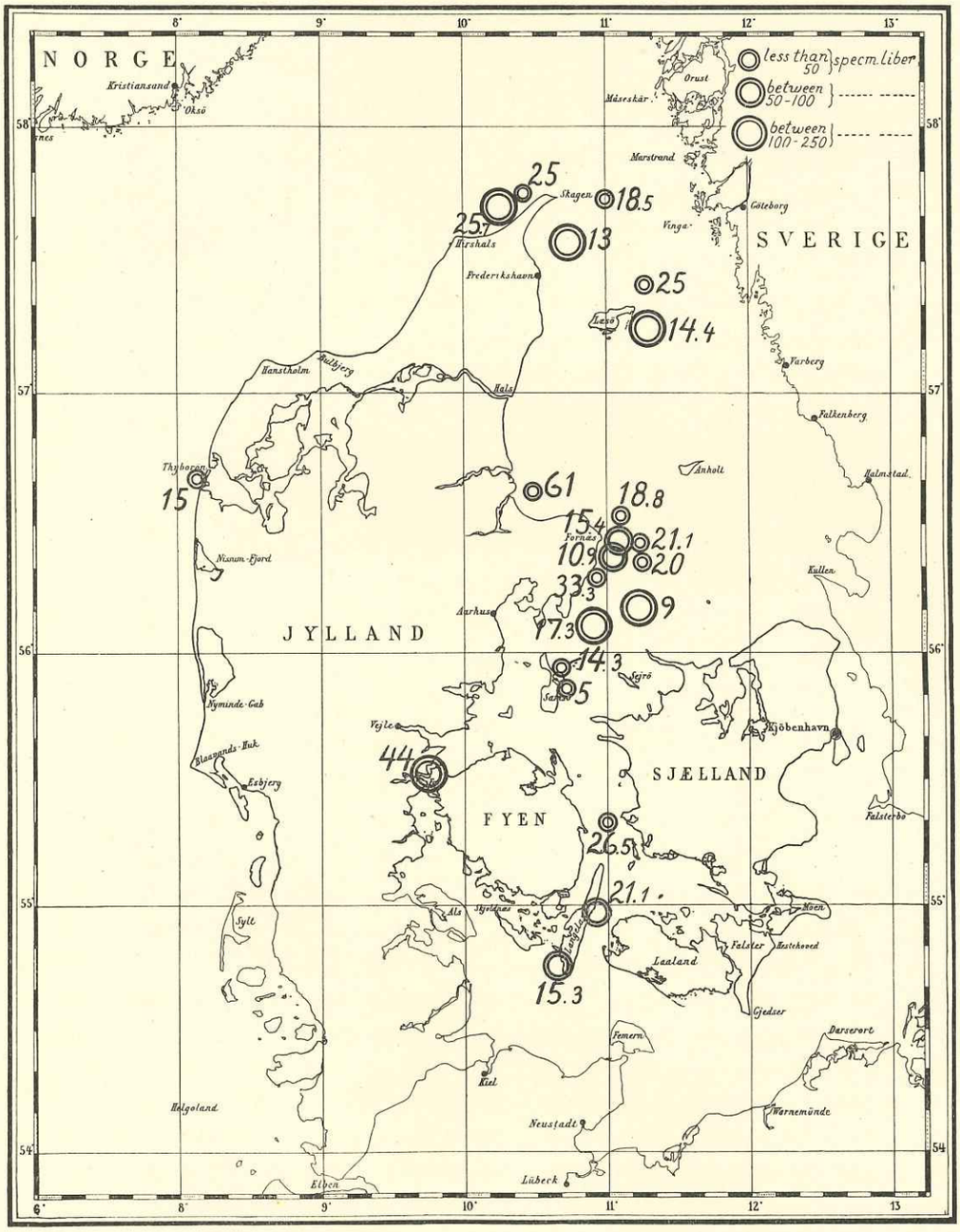

Fig 15. Percentage of recaptures in the Danish experiments with marked cod.

North Sea	Skagerak	Kattegat	Belt Sea[1])	E. Baltic	Limfjord	Total
908	856	2718	2749	525	473	8229

The Kattegat and the Belt Sea are the two principal areas for the Danish cod fishery, which, moreover, is one of the leading fisheries in these waters. In the Belt Sea, it is mostly a coast fishery,

[1]) Including the Sound and the western Baltic for the period 1905—1908; from 1909, the Sound is included in the Kattegat.

with stationary nets (traps, pound-nets) and from small vessels; in the Kattegat, on the other hand, an essential part of the yield — in 1912 and 1913 nearly one third — is derived from seagoing vessels from Frederikshavn, Skagen, Grenaa and Copenhagen in the open waters.

The extent of foreign — i. e. Swedish and German — fisheries in our waters, the North Sea excepted, will be seen from the following figures, likewise drawn from the »Bulletin Statistique«. It should here be noted, however, that the data in the case of Sweden are imperfect.

Swedish Fishery.

	1905	1906	1907	1908	1909	1910	1911	1912	1913
Skagerak.....	(270)	(238)	(488)	(1020)	(200)	(224)	(259)	(177)	(1045)
Kattegat [1])	658	900	1486	1680	2018	2150	1956	1766	1386
E. Baltic.....	630	756	584	682	660	734	717	589	651

German Fishery.

	1905	1906	1907	1908	1909	1910	1911	1912	1913
Skagerak	2055	1955	1855	1842	1584	1184	982	1435	1898
Kattegat	623	424	471	473	400	676	1166	911	1286
Western Baltic	—	—	—	—	623	841	796	612	498
Eastern Baltic.....	—	—	1502	1295	1067	814	442	607	756

For the Kattegat, the catch is then divided into the following percentages as between Danish, Swedish and German fishermen:

Danish	Swedish	German
abt. 55	abt. 35	abt. 10

The results of the marking experiments in the Skagerak and Kattegat present a different picture, viz:

% Recaptured by	Danish Fishermen	Swedish Fishermen	German Fishermen
Skagerak.....	abt. 86	abt. 8	abt. 6
Kattegat-Total	» 92	» 6	» 2
» Fornæs Exp.	» 89	» 11	» »

This is presumably due to the fact that most of our experiments lie in the western waters of the Kattegat, where foreign fishery is carried on only to a lesser degree. In the Fornæs experiments, embracing a water also worked, at least. by Swedish vessels, the proportion of recaptures falling to these is naturally somewhat higher.

In the Skagerak, where the only experiment of any considerable extent was made close in to shore, the distribution of recaptures likewise affords no true indication of the part played by foreign fishermen in the work; the same applies to the few small experiments made in the North Sea.

In the Belt Sea all, and in the western Baltic practically all the recaptures are Danish, which is probably, at any rate as regards the Belts, in accordance with the actual proportion between the relative fisheries of the nationalities concerned.

[1]) i. e. Kattegat and the Sound.

4. Fluctuations in the yield of the Danish cod fishery and the relation between the stock of cod in the North Sea and that in the Kattegat and the Baltic waters.

The yield of the Danish cod fishery will be seen from the following table, showing the annual yield (in 1000 kg) for the period 1905—1914 (reproduced from the »Bulletin Statistique«).

	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	Aver.
North Sea	529	422	1033	698	718	811	1069	1330	1049	1426	908
Skagerak	422	642	714	633	1017	899	954	769	1337	1175	856
Kattegat	1405	1827	2430	2128	1609	3089	3593	3416	3945	3739	2718
Belt Sea[1]	2640	2170	1957	1966	2366	3296	3595	4080	2919	2497	2749
E. Baltic	211	105	322	503	1119	811	432	529	535	687	525
Limfjord	875	507	466	415	445	510	585	627	197	99	473
Total	6082	5673	6922	6343	7274	9416	10228	10751	9982	9623	8229

Taken as a whole, the total catch has greatly increased during the years 1906—1914, and a further augmentation, up to three times the 1906 figure, was shown in 1919. The cause of this increase, must presumably for a great part be ascribed to continual development of technical methods. It is outside the scope of the present work, however, to enter into the question as to how far we have also to reckon with particular conditions independent of and unaffected by the fishery, such as fluctuations in the stock itself. This must be dealt with by special investigation in the future.

In most of our waters, a corresponding increase of the yield is to be noted: in the case of the North Sea, the increase is comparatively greater. Specially favourable market conditions, together with increasing use of the »snurrevaad« for the capture of round fish led during some years of the war to a greatly augmented yield from this water, while in other years, war conditions appreciably reduced the output of the industry here. Even in the most favourable years, however, the North Sea cod fishery has never been worked to the same extent as the principal fisheries i. e. prior to 1914 flatfish, and later haddock.

As regards our most important cod fisheries, in the Kattegat an the Belt Sea, conditions here were, save in 1917—18, less directly affected by the war. The decline in these years must be ascribed to the altogether abnormal state of things then generally prevailing.

The increase in the years 1909—12, with the setback of 1913, whatever the cause may be is not an isolated phenomenon in the case of the Kattegat and Belt Sea, but is also found to apply to the North Sea area. In Fig. 16 the curve N repre-

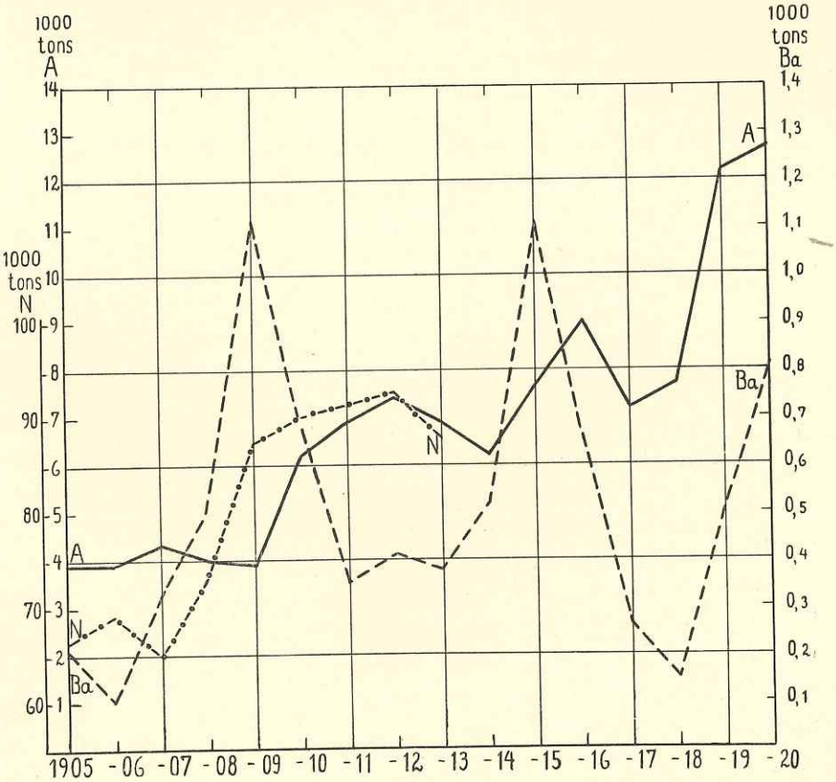

Fig. 16. Total yield of Danish cod fishery in the Kattegat and Belt Sea (curve A) and in the true Baltic at Bornholm (curve Ba) 1905—1920. Curve N, see text pag. 39—40.

[1]) Including the Sound and the western Baltic for the period 1905—1908; from 1909, the Sound is included in the Kattegat.

sents the total yield of the cod fishery in the North Sea proper, (i. e. excluding the Norwegian) as shown by the figures in the »Bulletin Statistique«: the course of this courve corresponds very closely to that of the curve for waters inside the Skaw. For the Norwegian fishery in Finmarken also (the capelan fishery) the years 1911—1913 were exceptionally favourable, which decidedly argues in favour of generally prevalent conditions all round.

In the case of the Norwegian fisheries, the cause of this rich yield is traced back to the unusual extent of the spawning in 1904 (Hjort; Rapp. Proc. Verb. XX) and in the North Sea proper also, the enormous quantities of fish of the »small« group in the trawler hauls of the preceding years (1908—1909) seem to suggest that the cause of increased yield during the period immediately following lies chiefly in an unusually large contingent of young fry from some particularly rich spawning year or years.

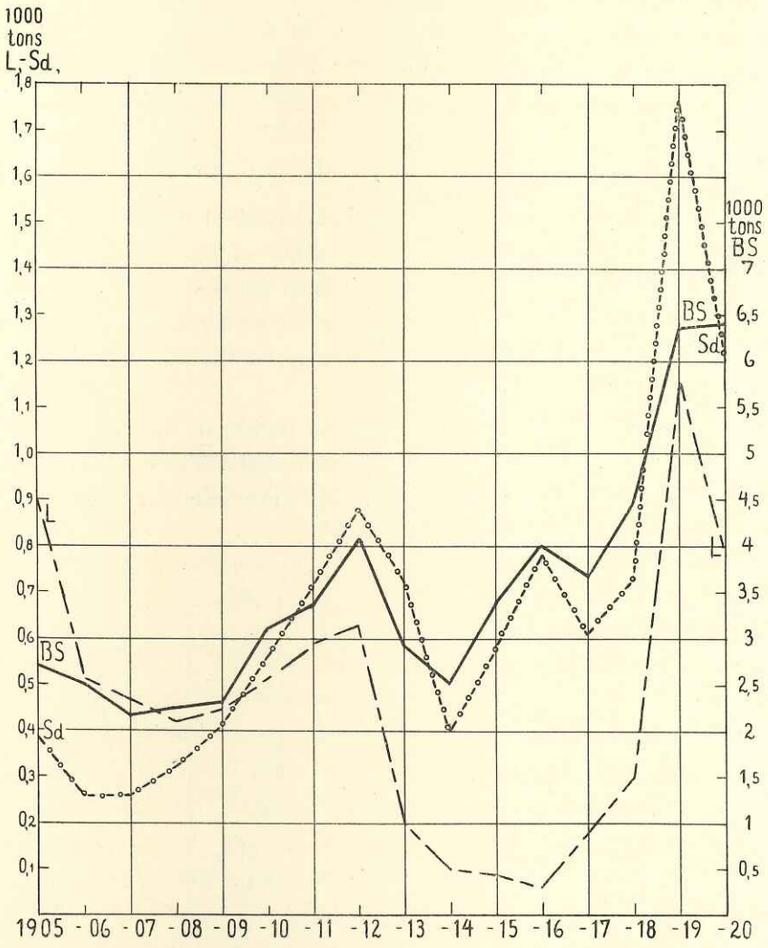

Fig. 17. Total yield of Danish cod fishery in the Belt Sea (curve BS) in the Sound (curve Sd) and in the Limfjord (curve L) 1905—1920. (Bull. stat.).

From this point of view, it is interesting to compare the yield of the cod fisheries in several of our different waters.

From Fig. 17, curves BS and Sd, it will be seen that the yield of the fisheries in the Belt Sea and the Sound for 1905—1920 exhibits essentially the same fluctuations throughout this period.

The cod-fishery in the Limfjord, curve L, Fig. 17, shows, like that of the Belt Sea and the Sound, no essential alteration as to methods during the years 1905—1920, and exhibits fluctuations in the yield which for 1905—1914 and 1917—1920 likewise correspond very closely to those for the areas mentioned (Fig. 17).

In the case of the Kattegat fishery, we find a somewhat different state of things, due more particularly to the development of a seagoing fishery, and we cannot directly compare the results with those for the Belt Sea and the Sound. Moreover, the statistics bearing on this seagoing Kattegat fishery are themselves far from complete as regards the first years of the period in question (prior to 1909), rendering any comparison for these years uncertain. We do find, however, also in the case of the Kattegat, an increase of yield in 1909—1912, but in contrast to the Sound and Belt Sea, this is here continued throughout the two following years. During the war, on the other hand, and after, the course of the curves will again be found to correspond in a quite appreciable degree.

Altogether different are the fluctuations in the yield of the Eastern Baltic fishery. Curve Ba, Fig. 16, shows the yield of the cod fishery from Bornholm, which is carried on chiefly by line. This is by far the most important of our cod fisheries in these waters. That the yield can also be taken as

fairly representative of the production in these waters will be seen from a comparison with the corresponding statistics for the cod fishery off the coast of Pomerania, where the fluctuations exhibit much the same trend (maxima during the years 1908—10 and 1914—16, minima during the years 1911—13 and 1917—19) (cf. Mitt. d. deutschen Seef. Vereins, Berlin).

The question then arises as to how far these parallel fluctuations in the yield of the fisheries in the Limfjord, Kattegat, Belt Sea and Sound are to be taken as due to the uniform influence of external conditions upon the stock of cod in these waters, or whether they are an indication of identity of the stocks, and thus of the same with that of the North Sea. In the latter case, the marked increase of yield in 1918—19 might perhaps be regarded as a result of the marked decrease in the intensity of fishing enjoyed by the stock in the North Sea due to the Great War. That such identity exists in the case of the Limfjord is hardly to be doubted; the immigration of the young fry from the west can here be directly observed.

The apparent discrepancy seen in the values for 1913—14 for the Kattegat might also be explained as due to the fact that the fishery here, despite its absolute extent, does not affect the stock in proportionately the same degree as in the Belt Sea, the Sound or the Limfjord (cf. the high percentage of recaptures in the Little Belt, in 1911 particularly, 40—45 %, with the lower figures for experiments in the open Kattegat, 20—25 %, (see Fig. 15). This question is directly related to the problem as to how far the stock of cod in Danish waters is indigenous, or has immigrated from the adjacent areas of sea; a point which has not yet been altogether determined.

According to C. G. Johs. Petersen (Dan. Biol. Stat. Rep. 11, De danske Farvandes Plankton, 1900—1901), the stock of cod in the Kattegat and Belt Sea really forms part of that of the North Sea; it is derived from, and maintained by that stock, and cannot be said to exist independently of the same. According to his investigations, the cod spawn in the Kattegat and Belt Sea, but while he has found enormous numbers of pelagic ova, only comparatively few pelagic fry and bottom stages have been found there. Presuming the specific gravity of the ova to be constant, he considers that the facts may be explained as due to the prevailing hydrographical conditions, whereby the great bulk of the pelagic ova met with in our inner waters during the winter months, are carried out from there towards the Skagerak with the upper water-layers of lower salinity.

Andreas Otterström (Dan. Biol. Stat. Rep. 13, 1906) likewise finds many pelagic ova of cod and other winter-spawning fish in our inner waters, while the number of older stages found is far smaller (1903—04). He explains the facts in the same way, and opines that ova and pelagic fry are carried in considerable quantities away from our inner waters, to the northward in the upper water layers, whilst the young ones immigrate again when they have reached the bottom stage.

Against this, we have the investigations of A. C. Johansen 1907 and 1908 (Medd. Kom. Hav. Serie Fiskeri Bd. III No. 2 1908). He finds, in both years, great quantities of ova and pelagic fry of cod (and other winter-spawning fish) in the Kattegat and Belt Sea, far more than in the Skagerak. He was able to show that the specific gravity of the ova is not constant, but varies considerably in the first place, within one and the same species in different waters, and also, in general, increases in course of development. The ova will thus, as the growth of the embryo proceeds, no longer be able to remain in water layers of the same specific gravity. Many sink down into the deeper, salter levels, where the main trend of movement is inwards. The movement of the upper layers, again, does not appear to be rapid enough to transport, for instance ova spawned in the Belt Sea out of our waters before the young fry are hatched out, when they would for the most part move down into deeper water layers.

In agreement with this, he also finds that the young bottom stages are very common in the Belt Sea, more than of the west coast of Jutland, in the Kattegat, or in the true Baltic.

He therefore sums up his view as follows:

1) That the movements of the water in the Kattegat and Belt Sea are not unfavourable to the presence of ova and pelagic fry; and

2) That the Kattegat, Belt Sea and Baltic have their own indigenous stock of cod, to which is added a further contingent of individuals immigrating during the winter months from the Skagerak.

It is possible that the apperent contrast between his results and those of Otterström as regards the frequency of the young ones in the Kattegat and Belts are merely the result of a simple variation in the quantity of the O-group of cod from one year to another, such as has been found, for instance in the case of plaice in the southern Kattegat and Belt Sea.

The question, however, as to what extent our stock of cod is renewed by this winter-immigration, or is maintained by the young produced in our waters, is still undecided.

The results of our marking experiments do not solve the problem. They confirm the stationary character of the stock in certain areas at any rate during the first years of life, and show, as a natural result of this, a not inconsiderable difference in growth between one area and another, albeit with many instances of the intermingling of slow- and fast-growing fish. The least stationary were the large cod of 75—105 cm marked in the southern Kattegat, which were found to have moved outside the experimental area within a few months after liberation.

The laws governing the migrations of these fish, and those of the others moving to considerable distances, the direction and extent of the movements in relation to season, — in a word, the biological significance of the migrations observed, — cannot be explained by the results of our few experiments. We find, however, the well-known trend from the northward down into the Sound and the Belts, in the case of these larger fish; otherwise, there are very few instances of movement beyond the area of our inner waters (See Fig. 2).

The statistical data given above suggest a certain relation, of whatever sort it may be, between the stock of our various waters, and would seem to indicate, at least, that their fluctuations ar governed by the same laws. Only in the true Baltic are fluctuations of another rythm observed (Fig. 16) showing that the stock of cod here must be isolated as far as regards any connection with our other waters. This also agrees with the fact, as shown by other investigations (Otterström l. c. and Strodtmann) that a considerable local production of young takes place here, while the hydrographical conditions likewise suggest that the stock in this water has chiefly to rely upon its own production for renewal.

Summary.

1. During the years 1905—1913 (for the most part in March and April) a total of abt. 1550 cod were marked in Danish waters, more particularly within the Skaw. Abt. 800 were marked in the Kattegat, abt. 350 in the Belt Sea, abt. 85 in the Western Baltic, abt. 250 in the Skagerak, but only 20 in the North Sea off Thyborön.

2. Most of the marked fish were abt. 25—70 cm, and of these again the majority under 50 cm. Only in a single experiment in the open waters of the southern Kattegat were fish of larger size (75—105 cm.) employed, these numbering abt. 125 specimens. (The Schultz's Grund experiment). Many of the fish, both large and small, were ready to spawn at time of marking (March—April experiments).

3. The recaptures numbered in all 338, or abt. 22%, of which abt. 315 retaken within a year of liberation, 19 within 2 years, 2 26 & 29 months and one 47 months from date of marking. The recaptures from the March—April experiments which, as mentioned, are the most numerous, are not evenly distributed throughout the various months of the year, the numbers showing a marked decrease during the summer (July—August), increasing again thereafter in course of the autumn. This is due to the fact that the Danish cod fishery in most of our waters is carried on with far less intensity during the hot summer months.

The percentage of recaptures is considerably higher among the smaller fish; abt. 25 % for abt. 1.170 specimens, of less than 60 cm. as against only abt. 10 % for the remaining, larger fish, abt. 380 in number, ranging from abt. 60—109 cm. This agrees with the few recaptures of the large cod already referred to in the Schultz's Grund experiment. The percentage of recaptures varies, however, very considerable in the different groups of experiments, fluctuating more according to the various inner waters concerned than according to the size of the smaller fish here marked. The figure is highest for the experiments made close inshore outside Randers Fjord and in the Little Belt, where we have abt. 61 % and abt. 44 % respectively; lowest, inter alia, in the open Kattegat, abt. 15—16 %. Close inshore in the Skagerak, the recapture percentage is about equal to the average of all experiments together, i. e. abt. 25 %.

For purposes of comparison, the following recapture values are noted for corresponding English, German and Norwegian experiments in the North Sea:

Near Dogger-Bank	abt. 17 %	of cod	marked
Bay of Heligoland	- 60 %	—	—
Lofoten	- 27 %	—	—
North of Norway	- 14 %	—	—
In Norwegian Fjords	- 17-21 %	—	—

4. In the experiments inside the Skaw, close inshore, all the recaptures were made exclusively by Danish fishermen. In the Skagerak experiments and in the open Kattegat, a (small) part of the recaptures were made by German and Swedish fishermen, the proportions being as follows:

Danish, abt. 86—92 % German, abt. 2—6 % Swedish, abt. 6—11 %

According to the Fishery Statistics, the yield of cod in the Kattegat for 1905—1914 falls in percentages as follows to the fisheries of the three countries:

Danish, abt. 55	Swedish, abt. 35	German, abt. 10
(abt. 2,7 million kilos)	(abt. 1,7 million kilos)	(abt. 0,5 million kilos)

That the Danish fishery should have accounted for so relatively large a number of recaptures is due presumably to the fact that most of our Kattegat experiments were made in the western part of that water, where the foreign fisheries play a subordinate part.

5. The experiments furnish a considerable amount of good material as to length increment during the first year after liberation, but afford no information as to increase in weight. The material is very heterogeneous as regards number and initial sizes of fish marked, and the numbers differed considerable in the various experiments.

a) The best and most regular growth is seen in the cod from Kandestederne (Skagerak) and Little Belt with a length increment from abt. 12 cm average in the year after marking.

Many specimens from the Little Belt experiment were ready to spawn at time of marking (length abt. 45—65 cm); the average growth of these, however, does not generally fall below the mean.

b) Somewhat slower growth, hardly more than 7—9 cm average, but also with more individual variation, is shown by the fish from the south-western Kattegat, length of abt. 45—60 cm.

c) A similarly irregular and generally slow rate of growth is likewise found in the case of the smaller fish, 30—45 cm marked, in the northern Kattegat, outside Randers Fjord and in the Great Belt. Several of these, mature at time of marking, had grown only 4—5 cm in the following year, while others, presumably immature, though embracing both smaller sizes (30—35 cm) and larger (41—44 cm) showed a growth of abt. 1—1.2 cm. per month.

d) The growth of cod over 60 cm also exhibits, in the few cases under observation, considerable variation, ranging from 3—7 cm in the first year after marking.

e) The few data afforded by the experiments as to growth throughout a longer period are given below:

No. of Months	Initial size in cm	Growth in cm	Liberated
16	61	3	S. W. Kattegat.
17	57	8 ♂	—
19	57	abt. 19	Little Belt.
20	57	5	S. W. Kattegat.
21	77	13	—
24	53	abt. 34	Little Belt.
24	70	7 ♂	S. W. Kattegat.
25	60	9	—
47	34	abt. 30	N. Kattegat.

6. Most of the smaller fish, i e. those under 65 cm initial size, are more or less stationary during the first year of experiment. In the experiments from the south-western Kattegat and the Little Belt, several of these fish were recaptured in the same water as late as two full years after liberation, and only a few miles away.

The experiment in the western Baltic form an exception. The fish here were ready to spawn at time of marking, and none were retaken more than 2 months later.

Apart from these, only a very few specimens < 65 cm but all the large fish > 65 cm marked in the southern Kattegat, had already in the early part of the first year moved away; these covered some considerable distance, chiefly southward from the Kattegat down into the Sound and the Belts.

Then, with a few specimens from the experiments in the northern Kattegat and Skagerak which had passed from the Kattegat to the Skagerak and vice versa, or had crossed the Skagerak to the Swedish coast, are the few instances observed of migration from one water to another. And in most cases, the distances even here amount to but some few miles.

The greatest distance noted was in the case of a specimen of 37 cm, marked off Thyborön on the 21st September 1905, and recaptured in December of the same year at the eastern entrance to the English Channel. Altogether, the migrations observed do not appear to follow any general rule.

7. The difference in growth observable between the different experiments in the same year, especially in the Belt Sea and Kattegat areas, likewise shows the stationary character of the stock during the first year, or two years, after marking.

Dansk Resumé.

Mærkningsforsøg med Torsk *(Gadus callarias L.)*.

I det følgende skal der i korte Træk gøres Rede for samtlige Forsøg med mærkede Torsk i Farvandene omkring Danmark. Forsøgene er foretaget i Aarene 1905—1913 af »Kommissionen for Havundersøgelser«.

Formaalet har som ved de tidligere Mærkningsforsøg med andre Fisk, særlig Rødspætter, været at skaffe Oplysninger om: 1) Fiskens Vækst, 2) Fiskens Vandringer og 3) den Intensitet, hvormed Fiskeriet drives.

Ialt mærkedes c. 1550 Torsk.

Fiskene til Forsøgene blev dels trawlet fra Havundersøgelsesskibet »Thor« dels fisket fra forskellige danske Fiskerifartøjer med Snurrevaad eller Snøre. Et mindre Antal blev taget med Ruser eller Garn under Kysten.

Straks efter Fangsten blev de levedygtige Torsk mærkede, maalte og sat i Frihed paany, enten paa samme Sted, hvor de var fanget eller dog kun faa Kvartmil derfra.

Der benyttedes i Aarenes Løb forskellige Typer af Ben- eller Broncemærker, som anbragtes paa Fiskenes Gællelaag.

Nedenstaaende Tabel viser, hvorledes Forsøgene er fordelt i vore Farvande, Antal og Størrelse af Mærkefisken samt Procentantallet af genfangne.

Farvand	Aar og Maaned	Fisken fanget med	Størrelse (cm)	Antal mærk.	Genf. %
Nordsøen udf. Thyborøn	1905 Sept.	Trawl	35—70	20	15
Skagerak - Spirbakken	1905 Marts	Trawl	31—70	20	25
- Kandestederne	1911 April	Snurrevaad		234	25,7
Kattegat Ø. af Skagen	1906 Marts	Trawl	26—86	248	15,4
Ø. af Hirsholmene					
S. t. V. af Trindelen					
N. t. V. af Kobbergrunden					
Farvandet Ø. af Fornæs	1906 Maj	Trawl	33—89	173	15,6
	1912 Marts	Snurrevaad			
	1912 April				
	1912 Novbr.				
Ved Schultz's Grund	1912 Decbr.	Trawl	74—106	124	8,8
	1913 Febr.				
N. Ø. af Mosel Grund	1912 Marts	Snurrevaad	42—91	145	17,2
Udfor Randers Fjord	1906 Marts	Ruser	29—48	41	61
I Mariager Fjord	1906 Maj	Ruser	20—48	100	(16)
Belthavet ved Østkysten af	1906 Marts	Trawl	29—61	47	6,5
Samsø	1912 Maj				
Lille Bælt	1912 Marts	Snøre	38—84	200	43,5
ved Sprogø	1907 Marts	Trawl	25—55	34	26,5
Langel. udfor Tranekær	1907 Marts	Trawl	25—55	76	21
Vestlige Østersø udfor Bagenkop	1907 Marts	Garn	31—95	85	15
				Ialt 1,547	

Fig. 1, Side 7, giver en grafisk Fremstilling af Torskens Antal og Størrelse i hvert Forsøg. Kun i eet Forsøg — ved Schultz's Grund — er der mærket store Torsk. Hovedmængden af Mærkefisken er dels smaa (25—45 cm) dels noget større (45— 70 cm) Fisk. Mange af Fiskene, baade større og mindre, var gydefærdige ved Mærkningen, der i de fleste Tilfælde foretoges i Foraarets Løb (Marts—April).

1. Væksten af de mærkede Torsk.

Da Forsøgsdyrene kun er længdemaalt, kan der alene ventes Oplysning om Længdetilvæksten ikke tillige om Vægtforøgelsen i Forsøgstiden. Desværre er det, Forsøgene kan oplyse om Væksten, af højst ulige Værdi, flere af Forsøgene har haft et ringe Omfang, i andre Tilfælde savnes paalidelige Maal af de genfangne. Hertil kommer, at de allerfleste Genfangster er gjort i Løbet af det første Aar efter Mærkningen, saaledes at det kun i faa Tilfælde har været muligt at følge Væksten i en længere Periode (se Tab. Side 44). Da ydermere Forsøgene forskellige Steder er gjort ved noget forskellige Størrelser af Torsken, bliver den fundne Væksthastighed i eet Farvand ikke umiddelbart sammenlignelig med Forholdene i andre.

a. Den bedste og jævneste Vækst viser Torsken ved Kandestederne og i Lille Bælt (se Fig. 3 & 10). De her mærkede, henholdsvis f. st. Delen 35—50 og 45—67 cm lange, Torsk er voksede i Gennemsnit 11 cm i første Aar efter Mærkningen, hvad der vil svare til en omtrentlig Vægtforøgelse fra henholdsvis ca. 1 kg til ca. $1^3/_4$ kg og fra ca. $1^1/_2$ kg til ca. $2^1/_2$ kg.

I Lille Bælt var henved Halvdelen af Individerne gydefærdige ved Mærkningen, uden at dette Forhold har nedsat Væksthastigheden paaviseligt.

b. Noget langsommere, men tillige med større individuel Variation er de noget større Torsk (45—60 cm) vokset, der mærkedes i det sydvestlige Kattegat udfor Fornæs og ved Mosel-Grund. Gennemsnitsvæksten her overskrider næppe 7—9 cm i Forsøgenes første Aar. Der er dog i begge disse Forsøg flere Individer, hvis Væksthastighed ikke staar tilbage for Lille Bælt-Torskens.

c. En lignende ujævn men gennemgaaende langsom Vækst forefindes hos de smaa, 30—45 cm lange, Torsk, der mærkedes i det vestlige Kattegat udfor Randers Fjord og i Store Bælt.

I disse Forsøg udgøres, som før nævnt, en væsentlig Del af Bestanden af Torsk, der er gydefærdige ved denne ringe Størrelse. Mange af disse, men iøvrigt ingenlunde alle, er vokset meget langsomt, kun henved 4—5 cm, i Forsøgets første Aar (Fig. 5). Hos andre, baade mindre (30—35 cm) og større (41—44 cm), der ikke synes at have været modne ved Mærkningen, svarer Væksthastigheden til den i Lille Bælt o. a. St. fundne og andrager c. 1—1.2 cm pr. Maaned. Enkelte Aldersbestemmelser af disse hurtigere voksende blandt de mindre Fisk viser, at de er yngre end de langsommere voksende og gydende, af samme Begyndelses-Størrelse.

d. Væksten af de større Torsk, d. v. s. over 60 cm lange, har kun kunnet følges i faa Tilfælde. I Fornæs-Forsøget svinger Væksten i første Aar efter Mærkningen mellem c. 3 og 7 cm. En enkelt Fisk (80 cm) mærket ved Schultz's Grund synes i samme Tidsrum at være vokset saa godt som nogen af de mindre, nemlig c. 1 cm. i Gennemsnit pr. Maaned, de faa andre paalideligt maalte derimod væsentlig ringere, uden at nærmere dog kan angives.

2. Vandringerne af de mærkede Torsk.

Kortene, Fig. 2, 4, 6, 7, 9, 11 & 12 illustrerer Beliggenheden af de Pladser, hvor Torskene er mærket og genfanget. I Korthed har Forsøgene vist:

a. De allerfleste er forholdsvis stationære i Forsøgenes første Aar. Kun de allerstørste — de ved Schultz's Grund mærkede, og enkelte af de største Individer i andre Forsøg — er vandret længere Distancer, f. st. Delen syd paa, fra Kattegat ned i Sundet, Issefjorden og Bælterne. De øvrige er taget enten umiddelbart ved Stedet, hvor de sattes i Frihed efter Mærkningen, eller dog kun ganske faa Kvartmil borte. De mindre, under 50 cm lange, Torsk, der er mærket paa noget større Dyb i Skagerak (25 m) og i det nordlige Kattegat, samt paa grundere Vand udfor Randers Fjord, er for en stor Del taget nærmere

Land, inde paa lavere Vand, hvor de formentlig har tilbragt en Del af Sommeren, men Distancerne, som disse har gennemvandret, er som nævnt oftest kun mindre betydelige.

b. I andet Aar efter Mærkningen er de større, 45—70 cm lange, Individer for en Del fremdeles stationære. I Farvandet udfor Fornæs og i Lille Bælt er der saaledes endnu indtil Begyndelsen af 3. Aar efter Mærkningen genfanget flere i Nærheden af, d. v. s. mindre end 5 Kvartmil borte fra, Stedet, hvor de sattes i Frihed (se Fig. 6).

De mindre (yngre?), 25—45 cm lange, Individer er derimod saa godt som ikke genfanget senere end 12 Maaneder efter Mærkningen, og vi ved derfor intet om deres Vandringer i den følgende Periode. Dette gælder særlig Forsøgene med smaa, gydefærdige Torsk udfor Randers Fjord, i Store Bælt, samt lignende Forsøg paa noget dybere Vand i det nordlige Kattegat, øst af Skagen og øst af Læsø.

At Genfangsterne ved disse Forsøg ophører forholdsvis tidligt, kan muligvis skyldes en eller anden Mangel ved Forsøgenes Gennemførelse, f. Eks. den anvendte Mærketypes ringe Holdbarhed. En medvirkende Aarsag, for Udbyhøj-Forsøget vel Hovedaarsagen, er sikkert at søge i det store Antal Genfangster i første Forsøgsaar. Disse Forsøg er dog for faa og smaa til at oplyse, hvorvidt der virkelig foregaar en Spredning navnlig af de nævnte smaa gydefærdige Individer fra Kystvandet og bort fra det paagældende Farvandsomraade. Vi kan derfor ikke følge deres Vandringer videre.

Dette sidste gælder ogsaa for de største Individer (over 70 cm), der allerede i første Aar fandtes i Færd med at vandre bort fra Forsøgsstedet.

I tredie og fjerde Aar efter Mærkningen er der kun taget to af de mærkede Fisk, begge kun faa Mil borte fra Udsættelsesstedet, og dermed ophører Genfangsterne.

c. Ganske enkelte af Individerne har tilbagelagt længere Strækninger, hvorpaa Fig. 2 vil vise Eksempler. En særlig lang Vandring er paavist hos en 37 cm lang Torsk, der i 1905 mærkedes udfor Thyborøn og $2^1/_2$ Maaned senere fangedes igen nede ved Mundingen af den engelske Kanal, en Distance af mindst 330 Kvartmil tilbagelagt i mindre end 74 Dage (se Fig. 2).

Mindre vidtstrakte Vandringer, om end dog ret anselige, viser enkelte, f. st. Delen meget store Individer, der fra det sydvestlige Kattegat i Løbet af en eller faa Maaneder er søgt langt ind i Øresund eller gennem Store Bælt ned under Langeland.

Enkelte Individer fra Forsøgene i det sydlige Skagerak samt i det nordligste Kattegat har rundt Skagen passeret fra Skagerak til Kattegat og vice versa, enkelte har krydset Skagerak til ind under den svenske Kyst, men ingen af disse Vandringer overstiger dog forholdsvis faa Sømil.

Som Helhed set er Vandringer fra Farvand- til Farvandsomraade saaledes kun paavist i ret faa Tilfælde ialtfald indenfor den Periode og de Størrelsesgrupper, vore Forsøg kan oplyse noget om.

3. Antal af de genfangne, mærkede Torsk.

a. Ialt er der genfanget 338, hvorom Meddelelse haves, eller ca 22 %, og deraf toges de allerfleste, c. 315, i Løbet af første Aar efter Mærkningen; i andet Aar toges 19, i tredie Aar kun 2 og atter i Slutningen af fjerde Aar 1 Individ. Genfangsterne fordeler sig ikke jævnt indenfor første Aars enkelte Maaneder. Tages der alene Hensyn til Forsøgene, der er begyndt i Marts—April, og det er langt de fleste, viser det sig (se Tab. paa Side 40), at Genfangsterne ved Forsøgene i Skagerak, Kattegat og Store Bælt (Gruppe I) tager stærkt af i Antal i Sommermaanederne Juli og August og derpaa tiltager igen i Løbet af Efteraaret. Ved Forsøgene i Lille Bælt (Gruppe II) er Forholdet et noget andet. (Side 40).

Dette hænger nøje sammen med, at Torskefiskeriet i vore Farvande for største Delen hviler i den varmeste Sommertid (de faa Genfangster). Aarsagen til denne »Sommerpause« i Fiskeriet ligger for en Del i Vanskeligheden ved at bevare Fangsten levende (frisk) i Varmen; for en Del vel ogsaa deri, at Torsken i denne Periode har trukket sig noget bort fra det grundere Vand.

Vore Mærkningsforsøg viser imidlertid, at der i Almindelighed, bortset fra de største Størrelser, ikke er Tale om nogen hverken varig eller synderlig vidtstrakt Bortvandring. De fleste Genfangster i

Efteraaret og Vinteren efter Mærkningen falder indenfor faa Kvartmils Afstand paa Stedet, hvor Dyrene sattes i Frihed om Foraaret.

I Lille Bælt, hvor Forholdene for et Sommerfiskeri er gunstigere, bl. a. fordi der her er dybt, strømmende Vand ganske nær Kysten, drives et ikke ubetydeligt Torskefiskeri selv i de varmeste Sommermaaneder, og svarende hertil aftager Antallet af Genfangster heller ikke saa stærkt i denne Periode som i de øvrige danske Farvande. Forsøgene i Lille Bælt viser iøvrigt ogsaa, at Vandringerne her baade for de sommerfangne og de senere tagne f. st. Delen er meget lidt udstrakte.

b. Genfangst-% i Forhold til Størrelsen af Mærkefisken.

I de enkelte Forsøg er der som oftest genfanget forholdsvis færrest af de større Fisk. Tages alle Forsøgene under eet, er Genfangst-% for Fisken under 60 cm c. 25 %, omtrent ens for Størrelserne: 25—39, 40—49 og 50—59 cm, og mere end dobbelt saa stor som for de større Fisk, hvor den igen er lavest for de største, ganske vist kun faa Individer.

Af Begyndelsesstørrelserne:

70—109	cm	mærkedes	210	Individer	og	genfangedes	10,0 %
60— 69	-	—	169	—	-	—	11,2 %
50— 59	-	—	344	—	-	—	27,0 %
40— 49	-	—	390	—	-	—	26,7 %
25— 39	-	—	434	—	-	—	23,5 %

Antallet af Genfangster ved de enkelte Forsøgsgrupper fremgaar af Tabellen paa Side 45 samt af Fig. 15. Svarende til, at der i det Hele er genfanget forholdsvis færrest af de større Fisk, viser Schultz'-Grund Forsøget, Forsøget med de største Torsk, den laveste Genfangst-%. Ved de øvrige Forsøg er derimod Genfangst-% meget vekslende, hvad der betyder, at der i forskellige Dele af vore Farvande fiskes ulige stærkt paa den forhaandenværende Bestand. Særlig paafaldende er denne Forskel, hvor der som f. Eks. i Lille Bælt Forsøgene og i Forsøgene omkring Fornæs er mærket Torsk af omtrent samme Størrelse og nogenlunde samme Antal, men genfanget henholdsvis henved $^1/_2$ og kun $^1/_6$ af disse Antal.

Nedenstaaende Oversigt viser ganske klart, hvorledes Genfangst-% varierer med Farvandet, uafhængig af Størrelsen af de mærkede Fisk:

25—50 cm	50—70 cm	70—100 cm
Skagerak ..... 25 %	Sydvestlige Kattegat 16 %	Schultz' Grund..... 9 %
Nordlige Kattegat.. 15 %	Lille Bælt ..... 45 %	
Udf. Randers Fjord 61 %	Vestlige Østersø ... 15 %	
Store Bælt ..... 24 %		

Indenfor en og samme Gruppe Forsøg, f. Eks. i det nordlige Kattegat, ved Fornæs og i Lille Bælt, varierer Genfangst-% saa lidt (se bl. a. Fig. 14 paa Side 40), at det ikke kan være rene Tilfældigheder, der betinger den forskellige Fangst-% i de forskellige Farvandsomraader. Vi maa derfor antage, at denne som Helhed giver et paalideligt Billede af Intensiteten af Fiskeriet indenfor hvert Farvand.

c. Fiskeriets Intensitet i forskellige Omraader.

Det stærkeste Fiskeri i de Omraader, hvor vore Forsøg er foretaget, foregaar herefter indenfor Skagen, i Lille Bælt og under Land fra Mundingen af Randers Fjord og østefter til Stavnshoved, altsaa ved Kystfiskeri i egentlig Forstand, hvor henved Halvdelen og mere af de mærkede Fisk er taget igen inden et Aars Forløb. Derimod viser Forsøget under Kysten ved Skagerak, at der her mellem Spirbakken og Blokhus, ialtfald i Forsøgsaaret, har været fisket langt mindre stærkt paa Bestanden. Omtrent samme Genfangst-% som ved Kandestederne viser Forsøgene i Store Bælt; noget lavere ligger Tallene ved Forsøgene i det aabne nordlige og sydvestlige Kattegat. Med mindre Svingninger fra Forsøg til Forsøg ligger Genfangst-% omkring 20, det vil sige, at kun henved $^1/_5$—$^1/_6$ af Bestanden opfiskes her i Forsøgenes første Aar.

Til Sammenligning skal anføres, at der ved lignende Forsøg forskellige Steder i Nordsøen genfangedes i den aabne Nordsø i Nærheden af Dogger Bank ca. 17 %, i Helgolandsbugten derimod c. 60 %, ved Lofoten og Nord-Norge henholdsvis c. 27 og 14 %. (Engelske, tyske og norske Mærkningsforsøg.)

Selv i Kattegat, hvor de fleste af vore Forsøg er anstillet, omfatter Fiskeriet i Forsøgsomraaderne kun en ringe Del af hele Kattegatfiskeriet. Et Helhedsbillede af Fangstintensiteten i hele Kattegat kan Forsøgene derfor ikke give. Det samme gælder med Hensyn til Forholdene mellem de forskellige Nationers Fiskeri i Kattegat som i vore andre Farvande.

De allerfleste Genfangster er gjort af danske Fiskere, kun 18 af 338 skyldes fremmede, tyske, svenske og engelske, saaledes procentvis fordelt i de forskellige Grupper Forsøg:

	Danske	Tyske	Svenske	Engelske
I Nordsøen....	c. 67	—	—	33 (1)
- Skagerak	c. 86	c. 6	c. 8	—
- Kattegat.....	c. 92	c. 2	c. 6	—
- Lille Bælt ...	100	—	—	—
- Store Bælt...	100	—	—	—
- Vestl. Østersø	c. 95	c. 5	—	—

Dette Forhold mellem de forskellige Nationers Fiskeri har selvsagt kun Gyldighed indenfor de enkelte Forsøgs Omraader. Efter Fiskeristatistikkens Angivelser bliver Forholdet et ganske andet, naar Fiskeriet i hele det paagældende Farvand, Skagerak, Kattegat, Belthavet o. s. v. opgøres.

I Aarene 1905—1914 er der saaledes af danske Fiskere aarlig landet mellem 5.6 og 10.8 Mill. kg Torsk eller i Gennemsnit pr. Aar c. 8.2 Mill. kg i danske Havne. Deraf er fisket i Mill. kg:

I Nordsøen	Skagerak	Kattegat	Belthavet	Ø. Østersø	Limfjorden
0,9	0,9	2,7	2,8	0,5	0,5

Kattegat og Belthavet er de to vigtigste Omraader for vort Torskefiskeri. I Belthavet drives det for st. Delen som Kystfiskeri med staaende Redskaber og fra Smaafartøjer. I Kattegat skyldes derimod en væsentlig Del af Udbyttet — i 1912 og 1913 ca. $^1/_3$ — det søgaaende Fiskeri fra Frederikshavn, Skagen, Grenaa og København i det aabne Farvand.

Det fremmede Fiskeri — det vil sige det af svenske og tyske Fiskere praktiserede — i vore Farvande Nordsøen undtagen har i Aarene 1905—1914 givet et Mængdeudbytte, der er anført paa Tabellerne Side 38.

Den procentvise Fordeling af Fangsten mellem de danske, tyske og svenske Fiskere vil herefter for Kattegats Vedkommende blive omtrent:

Danske Fiskere.	Svenske Fiskere.	Tyske Fiskere.
ca. 55.	ca. 30.	ca. 15.

Ved Mærkningsforsøgene fordeltes Genfangsterne i Kattegatsforsøgene sig procentvis saaledes

	Danske F.	Svenske F.	Tyske F.
Kattegat:	Total..... ca. 92.	ca. 6.	ca. 2.
»	Fornæs Exp. » 89.	» 11.	—

Herved maa erindres, at de fleste af vore Forsøg ligger i det vestlige Kattegat, hvor det fremmede Fiskeri kun drives i mindre Udstrækning. Ved Fornæs Forsøgene, der er foretaget i et Farvand, hvor svenske Fiskere arbejder mere almindeligt, bliver disses Andel i Genfangsterne ogsaa lidt højere.

I Skagerak, hvor det eneste Forsøg af noget Omfang blev foretaget under Kysten, giver Fordelin-

gen af Genfangsterne mellem de forskellige Nationers Fiskere ikke noget paalideligt Billede af den Rolle, det fremmede Fiskeri spiller i dette Farvand, og det samme gælder de faa og smaa Forsøg i Nordsøen.

I Belthavet er alle og i den vestlige Østersø saa godt som alle Genfangsterne gjort af danske Fiskere.

4, Om Fluktuationer i Udbyttet af Torskefiskeriet og om Forholdet mellem Bestanden af Torsk i Nordsøen og Bestanden i de indre danske Farvande.

Kurve A paa Fig. 16 giver en grafisk Fremstilling af det samlede Mængdeudbytte for Kattegat, Sundet og Belthavet, Hovedomraadet for Torskefiskeriet. Kurven kan sammenholdes med Mængdeangivelserne for Aarsfangsterne paa Side 39.

Set under eet er Totalfangsten her steget stærkt i Perioden 1906—1914, nemlig fra c. 4,0 Mill. kg. til c. 6,2 Mill. kg., og en yderligere Forøgelse indtil det tredobbelte af 1906-Fangsten er iøvrigt naaet i Løbet af 1919, c. 12,1 Mill. kg.

Indenfor andre af vore Farvandsomraader kan tilsvarende Udbyttestigning paavises. For Nordsøens Vedkommende er Stigningen endda forholdsvis stærkere. Særlig gunstige Afsætningsforhold i Forbindelse med tiltagende Anvendelse af Snurrevaadet til Fangst af Rundfisk særlig i enkelte af Krigsaarene satte netop dette Farvands Produktion stærkt i Vejret, medens Krigsforholdene i andre Aar paa forskellig Maade hæmmede Fiskeriet her føleligt. Selv i de gunstigste Aar har Torskefiskeriet her imidlertid ikke været udnyttet i samme Omfang som Hovedfiskerierne: før 1914 Fladfisk, i de senere Aar Kuller. For vort vigtigste Torskefiskeri, i Kattegat og Belthavet, har Vilkaarene — bortset fra 1917—18 — været mindre direkte paavirket af Krigen.

Udbyttesvingningerne. Stigningen i Fangstmængden har ingenlunde været jævn, men, som Figuren ogsaa viser det, stadige Fluktuationer undergivet. Tilbageslaget i 1917 og 1918 skyldes formentlig f. st. Delen forskellige Vanskeligheder for Fiskeriet, Mangel paa Redskaber, Motorolie m. m., og maa saaledes tilskrives de ganske abnorme Forhold. Det ligger iøvrigt udenfor Opgaven her at komme ind paa Aarsagerne til Stigningerne, som vel for en stor Del ogsaa for disse Omraader maa søges i en stadig mere udviklet Fangstteknik, flere og større Fartøjer, forøget Maskinkraft, mere fiskedygtige Redskaber o. s. v. I hvor høj Grad man ved Siden heraf tillige har at regne med særlige, af Fiskeriet uafhængige og upaavirkede Fluktuationer i Bestanden maa blive Genstand for særlige Undersøgelser.

Saadanne Fluktuationer, Udbyttesvingninger, er velkendte Fænomener ogsaa andre Steder og i andre Fiskerier. For Torskefiskeriets Vedkommende gør de sig tydeligt gældende ogsaa for Nordsøomraadet. Kurve N paa Fig. 16 repræsenterer det samlede Udbytte af Torskefiskeriet i den egentlige Nordsø, Fiskeriet fra Norge undtaget, men iøvrigt omfattende engelsk, tysk, hollandsk o. s. v. Fiskeri. Kurvens Forløb svarer ret nær til Kurven for Farvandene indenfor Skagen (Kurve A paa Fig. 16).

For Norges Vedkommende, hvor ligeledes Aarene 1911—13 var overordentlig gunstige især for Fiskeriet i Finmarken (Loddefisket), har disse Udbyttesvingninger været nærmere studeret, og Fænomenets omfattende Karakter er paavist. For de norske Fiskeriers Vedkommende føres det store Udbytte i Aarene omkring 1910 tilbage til det overordentlig rige Yngelaar 1904 som Aarsag. For den egentlige Nordsøes Vedkommende er der vel ikke paavist noget nærmere om Forholdet i Relation til Resultatet af Undersøgelserne fra Norge, men alt tyder paa, at Aarsagen til Udbyttestigningerne i Aarene omkring 1910 ogsaa her først og fremmest er at søge i et eller nogle Aars særlig rige Yngelproduktion.

Herudfra har det Interesse at sammenligne Udbyttet af Torskefiskeriet i de forskellige af vore Farvande, for om muligt at paavise parallelle Udbyttesvingninger og dermed yderlig sandsynliggøre Fænomenets Udstrækning. Paa Fig. 17, Kurve B & S er Udbyttet af Torskefiskeriet i Belthavet og Sundet i Aarene 1905—1920 fremstillet grafisk. Det fremgaar af Fig., at Fiskeriudbyttet i de to Farvandsomraader har været væsentlig de samme Svingninger undergivet i hele denne Periode. De to Kurver harmonerer endda overraskende godt.

Fiskeriet i Limfjorden, Kurve L. Fig. 17, der ligesom Fiskeriet i Belthavet og Sundet ikke væsentlig har ændret Karakter indenfor Perioden 1905—1920, viser Udbyttesvingninger, der for 1905—1914 og for 1917—1920 ligeledes ret nøje følger de tilsvarende paa disse Omraader. At et stort Torskefiskeri her staar i Relation til et enkelt eller nogle faa foregaaende Aars store Yngelmængde (indvandret eller indfødt) viser de senere Aars Indberetninger flere Exempler paa.

For Kattegatfiskeriets Vedkommende ligger Forholdene noget anderledes, og er næppe uden videre sammenlignelige med Forholdene i Belthavet og Sundet. Der er derfor heller ikke forsøgt nogen grafisk Fremstilling af dette Fiskeri. For de tidligere Aar i Perioden er Statistiken navnlig af det søgaaende Fiskeris Udbytte noget mangelfuld. Da dette Fiskeri her spiller en saa væsentlig Rolle, kan man formode i nævnte Mangel at have en Hovedgrund til det mindre Udbytte her i flere af Aarene fra 1905—1910. Ogsaa her ser vi en Udbyttestigning 1909—1912, men denne fortsættes i 1913—1914. For de følgende Aar — Krigsaarene og senere — stemmer derimod Kurvernes Forløb igen godt overens.

Det bliver nu Spørgsmaalet, om disse parallele Fluktuationer lader sig føre tilbage til ydre Forholds ensartede Paavirkning af disse Farvandes Torskebestand som Aarsag, eller om de er et Udtryk for Samhørighed af disse Bestande og dermed med Nordsøens. I sidste Fald lod det sig tænke i den stærke Stigning af Udbyttet i 1918 og 1919 at spore en Virkning af Krigsaarenes »Fredning« af Bestanden i Nordsøen. At en saadan Samhørighed eksisterer ialtfald for Limfjordens Vedkommende er neppe tvivlsomt, ialtfald for den væsentligste Del for Bestandens Vedkommende; Indvandringen Vest fra kan følges direkte.

Den tilsyneladende afvigende Udbyttestigning for 1913 og 1914 i Kattegat lod sig i saa Fald forklare ved, at Fiskeriet her ikke paavirker Bestanden i forholdsvis samme Grad som i Belthavet, i Sundet eller i Limfjorden. (Sammenlign den høje Genfangstprocent i Lille Belt netop i 1911, 40—45 %, og den lavere i alle de større Forsøg i Kattegat, 20—25 %, se Fig. 15).

Spørgsmaalet er imidlertid til Dato ikke besvaret afgørende. Vi ved derfor endnu intet om i hvor høj Grad de danske Farvandes Torskebestand er indfødt eller indvandrer fra de tilgrænsende Havomraader.

C. G. Johs. Petersen, Lederen af Dansk Biologisk Station, har opfattet vore Farvandes Torskebestand som en uselvstændig Del af Nordsøens; d. v. s. den stammer derfra og staar stadig i Vekselvirkning dermed. Selvstændige Lokalformer skulde ikke eksistere i vore Farvande. Efter hans Undersøgelser skulde Torsken yngle i alle disse, men medens han fandt store Mængder af pelagiske Æg, lykkedes det kun at finde faa pelagiske Unger og Yngel i Bundstadiet. Han antog, at dette maatte forklares derved, at Hovedmassen af de drivende Æg, der fandtes i vore indre Farvande i Vinter- og Foraarsmaanederne, med de øvre, ferskere Vandlag førtes ud af vore Farvande til Nordsøen.

Andreas Otterstrøm, der ligeledes har undersøgt Sagen fra Biologisk Station, paaviste paany Mængder af drivende Torskeæg i vore Belter o. a. St. i de indre Farvande. Ogsaa han fandt betydelig mindre Mængder af Yngelens pelagiske Stadier; han opfattede og forklarede Fænomenet paa samme Maade saaledes, at Æggene og den drivende spæde Yngel transporteres bort fra vore indre Farvande med de øvre Vandlag mod Nord, medens Yngelen indvandrer paany, naar Bundstadiet er naaet.

A. C. Johansen, der sidst har arbejdet med Sagen, er imidlertid kommet til et andet Resultat. Han fandt i de to Aar (1907 og 1908), Undersøgelserne stod paa, ligeledes store Mængder af drivende Æg og Yngel af Torsk (o. a. Fisk) i Kattegat og Belthavet, langt flere end i Skagerak. Det lykkedes ham at paavise, at Æggenes Vægtfylde ikke som tidligere antaget er konstant men forandres i Løbet af Udviklingen. Æggene vil derfor, efterhaanden som de udvikles, ikke kunne holde sig svævende i Vandlag af samme Vægtfylde. Mange vil derved synke ned fra de øvre ferskere Vandlag i de dybe, mere salte, hvor Hovedbevægelsen er indadgaaende i vore Farvande. Hastigheden af de øvre Lag synes iøvrigt heller ikke at være stor nok til at transportere Æg, der f. Eks er gydt i Belthavet ud af vore Farvande, før de er udklækkede, paa hvilket Tidspunkt Yngelen for Størstedelen ogsaa vil søge ned i dybere Lag.

I Overensstemmelse hermed lykkedes det ham at paavise, at de ganske unge Bundstadier af Torsken i Virkeligheden var meget almindelige i Belthavet, mere almindelige end ved Jyllands Vestkyst, i Kattegat eller i den egentlige Østersø. Han udtaler som sit Resultat, 1) at Strømforholdene i Kattegat og Belthavet ikke er saaledes, at de vil forhindre, at de pelagiske Æg kan klækkes i vore Farvande, og 2) at Kattegat, Belthavet og den egentlige Østersø har deres indfødte Torskestamme, idet der dog tillige sker en Indvandring fra Skagerak i Vintermaanederne.

Den tilsyneladende Modsætning mellem hans Resultater og de tidligere Undersøgeres med Hensyn til Mængden af Yngel i vore indre Farvande, skyldes muligvis alene Variation i Mængden af Yngel fra Aar til andet, saaledes som det er velkendt f. Eks. for Rødspætten i det sydlige Kattegat og Belthavet.

Det er saaledes godtgjort, at Torsken yngler i stor Udstrækning, og at Yngelen kan udvikle sig her, men det er fremdeles et aabent Spørgsmaal, i hvor høj Grad Bestanden tillige vedligeholdes og fornyes ved Indvandring fra Nordsøen og Skagerak.

Vore Mærkningsforsøg afgør ikke Sagen. De bekræfter, at Bestanden er stationær ialtfald mange Steder i vore indre Farvande og i de første Leveaar. Som en naturlig Følge af dette sidste viser Forsøgene ikke ubetydelig Forskel i Væksthastighed fra det ene Farvand til det andet, om der end forekommer mange Exempler paa Bestandens Sammensætning af hurtigt og langsomt voksende Fisk. De mindst stationære var de største 75—100 cm lange Torsk, der blev mærket i det sydlige Kattegat, og som allerede i Løbet af faa Maaneder havde forladt Forsøgsfeltet og var vandret syd paa.

Lovene paa disses Vandringer saa vel som for de blandt de mindre Individer, der har gennemvandret større Strækninger, Vandringernes Retning og Udstrækning, Forhold til Aarstiden m. m., oplyser vore forholdsvis faa Forsøg intet om. Som nævnt bekræfter de dog det velkendte Træk Nord fra ned i Sundet og Bælterne i Løbet af Efteraaret og Vinteren af de større Torsk. Kun i meget faa Tilfælde er der paavist en Vandring Nord paa bort fra vore indre Farvande. (Se Fig. 2).

De fiskeristatistiske Tal godtgør, at der er en vis Relation mellem Bestandene i vore indre Farvande, af hvad Art denne nu end kan være; i det mindste synes deres Fluktuationer at lyde de samme Love. Kun i den østlige Østersø er der iagttaget afvigende Svingninger i Udbyttet, der viser, at Torskebestanden der maa betragtes som isoleret i Forhold til vore øvrige Farvandes. Dette stemmer ogsaa med, at det baade fra dansk og tysk Side er paavist, at her foregaar en betydelig Yngelproduktion, medens de hyrografiske Forhold ligeledes afgjort taler for, at Bestanden her væsentlig er henvist til at fornye sig selv.

Particulars regarding the Danish marking experiments with Cod in the Danish waters 1905—13.

Fb. = Fishingboat — S/T Steamtrawler

A a. Experiments in the North Sea.

Particulars of liberation, Date, Locality, No. of Fish etc.	Date	No on Label	Locality reported	Depth in cm	Central Position (Approximately) N.	E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
North Sea 1905 September 21 Off Thyborøn 56°42′N, 8°10′E 12 m 20 Cod liberated Da 4 No. 421—440 Marking experiment No. 2 1905	1905 Dec. 5	425	Southern North Sea	36—38	52°5′	2°57′30″	English S/T	III	♀	37	40.5	Sound
	1906 April 2	430	Off Harboøre 2 miles from shore		56°40′	8°08′	Danish Fb.	VII		59	(71)	le. calcul. from ult. we.- 3626 g
	» » 23	438	3 miles NW of Klitmøller		57°05′	8°27′	—	VII		51	(60.5)	— 2000 g

A b. Experiments in the Skagerak.

Skagerak 1905 March 22 Off Spirbakken 57°42′N, 10°23′E 17 m 20 Cod liberated Da 4 No. 401—420 Marking Experiment No. 1 1905	1905 Maj 15	416	Skagerak	174	57°56′	9°30′	German S/T	II	—	45	47	
	» » 16	403	8 miles SE of Skagen	19	57°39′	10°51′	Swedish Fb.	II	—	42	42.5	
	» June 9	410	Skagerak	—	57°46′	10°00′	German S/T	III	—	41	42	stale, tail hurted
	» Aug. 1	411	15 miles N of Skagens Light	113—132	57°59′	10°33′	»	V	—	49	52	
	1906 April 3	405	Close N of Skagen	—	57°48′	10°37′	Swedish Fb.	XIII	—	31	46	950 g
1911 April 18 Off Kandestederne 4 miles from shore 57°41′N, 10°15,5′E. 23 m. 234 Cod liberated Marking experiment No. 1 1911	1911 » 20	418	NW of Skagens Light	47	57°46′	10°35′	Danish Fb.	0	—	37	?	
	» » 23	330	Off Kandestederne, 2 miles from shore	23	57°41′	10°21′	—	0	—	38	37	
	» » »	317	— —	—	»		—	0	—	50	50	
	» » »	312	— —	—	»		—	0	—	51	50	
	» » 26	209	— —	—	57°42′	10°20′	—	0	—	37	37	
	» » »	225	— —	—	»		—	0	—	53	52	
	» » »	251	— —	—	57°41′	10°21′	—	0	—	37	37	
	» » »	278	— —	—	57°42′	10°20′	—	0	—	53	53	
	» » »	289	— —	—	57°41′	10°21′	—	0	—	37	37.5	
	» » »	297	— —	—	57°42′	10°21′	—	0	—	40	39.5	
	» » »	306	— —	—	»		—	0	—	41	40.5	
	» » »	356	— —	—	57°41′	10°21′	—	0	—	57	57	
	» » »	399	— —	—	»		—	0	—	37	37	
	» » »	407	Hirtshals Light bearing S by W	38	57°37′	9°56′	—	0	—	41	41	
	» May 1	432	Højen Light bearing SE by S	28	57°45′	10°33′	—	I	—	37	37	
	» » 8	319	Off Hirtshals, 1 miles from shore	—	57°36′	9°56′	—	I	—	51	(52)	le. calcul. from ult. we. 1250 g
	» » »	350	— —	—	»		—	I	—	50	(52)	—
	» » 18	374	Tversted Bn. bearing S by W	12	57°37′	10°11′	—	I	—	41	42	
	» » 29	386	1 mile NW of Løkken	—	57°24′	9°41′	—	I	—	67	[67]	[1]) Corr. added 2840 g
	» June 12	248	Kandestedernes Bn. bearing S	11	57°40′	10°21′	—	II	—	46	46	
	» » »	292	— S by W	23	»		—	II	—	47	47.5	
	» » 26	246	Højen Light bearing S	117	57°47′	10°32′	—	II	—	45	46.2	
	» » 28	238	20 miles N½W of Skagen	—	58°3′	10°20′	Swedish Fb.	II	—	38	39	gutted label wound sore
	» July 24	318	Skagens Light bearing S	117	57°49′	10°36′	Danish Fb.	III	—	39	43	
	» Sept. 1	388	NE of Aalbæk	8	57°36′	10°29′	—	V	—	38	43.1	

[1]) No. in [ ] indicate the ultimate size given in Da. inches, calculated to cm.
»Corr. added« indicates the ultimate size given as length to base of caudal fin, a correction being added.

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No on Label	Locality reported	Depth in m	Central Position (Approximately) N. E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
	1911 Sept. 9	305	N of Spirbakken Bn.	21	57°43′ 10°26′	Danish Fb.	V	—	46	51	
	» » 23	332	Off Skiveren	13	57°38′ 10°16′	—	V	—	40	44	
	» » 25	285	Kandestedernes Bn. bearing S	8	57°39′ 10°21′	—	V	—	49	52	
	» » 25	364	—	21	57°40′ 10°20′	—	V	—	35	45	
	» » 30	234	—	25	»	—	V	—	36	?	
	» » 30	284	—	8	»	—	V	—	40	?	
	» Oct. 5	279	—	21	57°40′ 10°21′	—	VI	—	44	47	
	» » 5	359	—	24	57°40′ 10°20′	—	VI	—	39	?	
	» » 14	385	—	—	»	—	VI	—	50	52	
	» » 15	342	—	—	»	—	VI	—	41	49	
	» » 15	414	—	—	»	—	VI	—	45	52	
	» » 20	405	1 mile S of Læsø NW reef.	—	57°16′ 10°46′	—	VI	—	36	44.4	
	» Nov. 3	340	N off Skagen	23	57°45′ 10°38′	—	VII	—	39	46	
	» » 10	316	Off Aalbæk	8	57°36′ 10°27′	—	VII	—	43	51.1	
	» » 11	364	Kandestedernes Bn. bearing S	21	57°40′ 10°20′	—	VII	—	35	45	
	» » 21	397	3 miles NW of Løkken	—	57°24′ 9°39′	—	VII	—	47	56	1750 g
	» » 24	212	4 — SW —	8	57°20′ 9°38′	—	VII	—	44	56	stale, dry II gr
	» » 27	243	1 mile NW —	—	57°23′ 9°42′	—	VII	—	40	50	1075 g
	» » 28	324	Off Lønstrup 1 mile from shore	9	57°29′ 9°47′	—	VII	—	50	56.5	tail dry
	» » 28	416	NW of Løkken 1 mile from shore	—	57°24′ 9°43′	—	VII	—	44	55	1500 g
	» » 28	236	Tannisbugt 300 fms. from shore	—	57°36′ 10°10′	—	VII	—	48	[63]	Corr. added 2250 g omitted
	» Dec. 1	298	Off Blokhus, near shore	—	57°16′ 9°35′	—	VIII	♀	43	56	tail dry imm.
	» » 3	347	Off Thorupstrand 3 miles from shore	—	57°12′ 9°08′	—	VIII	—	40	45	1000 g
	» » 10	428	Skagerak	—	?	—	VIII	—	37	47.5	stale
	» » 12	323	16 miles NW of Løkken	23	57°32′ 9°19′	—	VIII	—	43	56	
	» » 13	420	Kandestedernes Bn. bearing S	24	57°40′ 10°20′	—	VIII	—	38	45.5	
	» » 15	422	—	28	57°40′ 10°20′	—	VIII	—	36	49.5	
	» » 15	352	Skagerak	—	?	—	VIII	—	39	[52]	Corr. added 1250 g
	» » 25	331	Off Løkken	—	57°23′ 9°42′	—	VIII	—	40	[49]?	Corr. added, omitted
	1912 Jan. 5	426	2 miles NW of Hamneskär	—	57°55′ 11°25′	Swedish Fb.	IX	—	49	[63]	
	» Feb. 4	250	Kandestedernes Bn. bearing S	24	57°40′ 10°21′	Danish Fb.	X	—	39	53	
	» ult. »	296	10 miles WNW of Hirtshals	—	57°37′ 9°39′	—	X	—	45	52	1850 g
	» March 14	256	Off Thorupstrand 7 miles from shore	—	57°15′ 9°09′	—	XI	—	43	(63)	le. calc. from ult. we. 2500 g
	» May 25	291	Off Hirtshals ½ mile from shore	—	57°36′ 9°57′	—	XIII	—	49	58	2000 g
	» July 17	258	Kandestedernes Bn. bearing S	24	57°40′ 10°21′	—	XV	—	48	?	

B a. Experiments in the Northern Kattegat.

1906 March 20 12 miles E by S ½ of Skagens Light 57°43′N, 11°00′E 35 m 27 Cod liberated Da 5 No. 2301—2327 Marking experiment No. 5 1906	1906 March 28	2303	N of Hertha's Flak	26	57°41′ 10°52′	Danish Fb.	0	—	41	41.5	fresh
	» » »	2315	E of Skagen	28	57°45′ 10°45′	—	0	—	53	53	fresh
	» » »	2323	NE of Skagens Light	19	57°45′ 10°41′	—	0	—	27	27.5	fresh
	» June		SE of Hirsholmene	—	57°28′ 10°42′	—	III	—	36	?	label only
	» Dec. 28		Off Skagen, North Side	28	57°46′ 10°37′	—	IX	—	33	42	
1906 March 29 7 miles NE by E of Hirsholmene 57°34′N, 10°46′E 26—28 m 100 Cod liberated Da 5 No. 2401—2500 Marking experiment No. 10 1906	» March 31	2463	10 miles NE of Hirsholmene	30	57°37′ 10°48′	—	0	—	41	40	fresh
	» » 31	2469	E of Hirsholmene	28	57°30′ 10°41′	—	0	—	30	30	fresh
	» April 2	2413	Off Skagen South Side	11	57°43′ 10°37′	—	I	—	55	56	fresh
	» » 9	2483	At Knolden E of Læsø	15	57°19′ 11°15′	—	I	—	43	44	living
	» » 21	2458	At Nordre Rønn Læsø	11	57°23′ 10°56′	—	I	—	37	37	dead
	» May 23	2500	SE of Hirsholmene	—	57°28′ 10°42′	—	II	—	27	(c. 26)	corr. added stale
	» June 7	2468	N of Nordre Rønn Læsø	17	57°25′ 10°53′	—	III	—	30	31.5	fresh
	» Oct. 12	2407	SE of Frederikshavn	23	57°23′ 10°42′	—	VII	♂	45	?	
	» » 15	2488	North Side of Gulholman Bohuslän	—	58°11′ 11°21′	Swedish Fb.	VII	♂	39	56 5	fide fisherman, omitted
	» Nov. 17	2491	SE of Hirsholmene	32	57°27′ 10°43′	Danish Fb.	VIII	—	32	41	
	» Dec. 11	2455	E by N of Trindelen Lightvessel	—	57°27′ 11°20′	German S/T	IX	—	47	52	
	1907 Jan. 19	2432	E of Hirsholmene	23	57°29′ 10°41′	Danish Fb.	X	♂	36	43	living
	» March 3	2464	Off Hirsholmene	—	57°30′ 10°41′	—	XII	—	43	—	

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No. on Label	Locality reported	Depth in m	Central Position (Approximately) N. E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
1906 March 22	1906 April 6	2334	E of Læsø	38	57°20′ 11°16′	Danish Fb.	I	♂	47	47	living
3 miles S by W of	» » 6	2336	Off Skagens old church	7	57°42′ 10°35′	—	I	—	44	45	fresh
Trindelen Ligtvessel	» » 6	2352	E of Læsø	38	57°20′ 11°16′	—	I	♂	43	42	living
57°23′N, 11°16′E	» » 10	2347	S of Kobbergrund	33	57°07′ 11°26′	—	I	—	67	68.5	living
25—35 m	» June 15	2338	E of Læsø	19	57°20′ 11°15′	—	III	—	29	29	salted
24 Cod liberated	» July 23	2354	SE of Kobbergrund	38	57°08′ 11°24′	—	IV	♂	47	47	
Da 5 No. 2333—2356											
Marking experiment No. 7 1906											
1906 March 15 & 16	1906 March 15	2121	5—6 miles W of Læsø	—	57°14′ 10°43′	German S/T	0	—	32	31	
6 miles N by W ½ W	» » 17	2157	At the place of Liberation	20	57°14′ 11°18′	Danish S/T	0	—	34	34	fresh
of Kobbergrund	» » 26	2183	E of Læsø	13	57°18′ 11°15′	Danish Fb.	0	♂♂	40	(38)	corr. added fresh
Lightvessel	» » 27	2131	E of Læsø at Flyndergrounds Brush Bouy	34	57°16′ 11°17′	—	0	♂♂	40	40.5	fresh
57°14′N, 11°18′E	» » 27	2199	E of Læsø	34	»	—	0	—	35	34.1	fresh
19—28 m	» » 27	2200	E of Læsø	34	»	—	0	—	34	34	fresh
97 Cod liberated	» » 28	2171	Aalbæk Bay S of Skagen	17	57°40′ 10°37′	—	0	—	30	30 5	fresh
Da 5 No. 2104—2200	» April 6	2154	E of Hirsholmene	23	57°30′ 10°42′	—	I	—	39	39.5	living
Marking experiment No. 4 1906	» June 16	2184	E of Læsø	19	»	—	III	—	41	42	dry
	» » 24	2186	E of Læsø	23	»	—	III	—	30	30.5	salted
	» » 28	2155	WNW of Anholt	17	56 46′ 11°19′	—	III	—	49	[54.5]	corr. add. 1450 g
	1907 March 2	2178	E of Tællemands Brush Buoy at Læsø	34	57°20′ 11°16′	—	XII	♂	39	45.5	living
	» » 5	2117	4 miles E of Læsø	56	57°18′ 11°19′	—	XII	—	37	42	living
	» » 28	2143	SE of Hirsholmene	23	57°28′ 10°40′	—	XII	—	29	?	

B b 1. Experiments in the Southwestern Kattegat off Fornæs.

1912 April 17	1913 March 26	99	8 miles E of Fornæs Light	17	56°28′ 11°12′	Danish Fb.	XI	—	58	63.5	very meagie
6 Miles NE by N	» Aug. 19	98	6 miles N of Fornæs	12	56°23′ 10°59′	—	XVI	—	61	64	2000 g
of Fornæs	1914 April 7	87	1 mile E of Grenaa Hb.	—	56°24′ 10°58′	—	XXIV	♂	70	77	very meagie 3750 g
56°30′ N 11°06′ E											
18 m											
16 Cod liberated											
Da 12 No. 85—100											
Macking experiments No. 10 1912											
1912 April 11—13	1912 Aug. 22	25	4 miles E of Fornæs	14	56°27′ 11°05′	Danish Fb.	IV	—	54	53	living
5 miles E of Fornæs	» Nov. 26	15	½ mile E of Hjælmen	11	56°08′ 10°52′	—	VII	—	61	65	
56°27′ 11°06′ E	» Dec. 8	34	2 miles N of Fornæs	19	56°29′ 11°01′	—	VIII	♂	57	[59]	corr. added.
17—23 m	1913 Jan. 18	44	2 miles SE of Fornæs	15	56°26′ 11°01′	—	IX	—	49	51.5	living
65 Cod liberated	» Feb. 25	22	3 miles E of Fornæs	17	56°27′ 11°03′	—	X	♂	58	70	living
Da 12 No 1—65	» April 15	18	2 miles ENE of Fornæs	17	56°28′ 11°01′	—	XII	♂	67	(69)	corr. added.
Marking experiments No. 7—8 1912	» » 21	27	Gjerrild Bag	—	56°30′ 10°54′	—	XII	—	55	?	only label
	» May 21	62	Found on pontoon Grenaa	—	?	—	XIII	—	55	?	only label
	» » 30	50	1 mile N of Treaa Mølle	—	56°33′ 10°42′	—	XIII	—	56	(69)	corr. added 3500 g
	» Sept. 20	6	1 mile E of Fornæs	11	56°27′ 10°59′	—	XVII	♂	57	65	living
1912 April 15	1912 Sept. 12	66	1 mile ESE of Fornæs	17	56°27′ 11°00′	Danish Fb.	V	—	66	(67)	corr. added.
10 miles E of Fornæs	» » 28	79	6 miles E of Fornæs	19	56°27′ 11°08′	—	V	—	61	71	
56°27′ N 11°13′ E	1913 April 6	68	5 miles ESE of Fornæs	20	56°26′ 11°06′	—	XII	—	54	75	3000 g
17 m	1914 May 6	83	2 miles N of Lyseground	26	»	—	XXV	—	60	69	very meagre, label wound sore
19 Cod liberated											
Da 12 No. 66—84											
Marking experiments No. 9 1912											
1912 March 27	1912 Sept. 1	1034	At Svinbådan lightvessel	—	56°10′ 12°32′	Swedish Fb.	VI	—	68	69	meagre 1700 g
5 miles SE of	» Oct. 20	1036	Off Dagelykke, Langeland	9	55°04′ 10°51′	Danish Fb.	VII	—	60	63	♂ mature
Grenaa Hb	» » 24	1043	NE of Hjælmen	10	56°09′ 10°50′	—	VII	—	62	(66)	corr. added.
56°22′N 11°03′E	1913 Jan. 19	1017	2 miles NW of Briseis-Brush- Buoy	30	56°21′ 11°20′	—	X	♂	65	72	living 3000 g
21 m	» Feb. 15	1049	8 miles ESE of Grenaa	24	56°22′ 11°15′	Swedish Fb.	XI	—	56	(75)	le. calcul. from ult. we. 4000 g
55 Cod liberated	» April 11	1018	16 miles S by ½ W of Anhalt	—	56°25′ 11°31′	Danish Fb.	XIII	—	65	64.6	
Da 11 No. 1001-1055											
Marking experiment No. 5 1912											

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No on Label	Locality reported	Depth in m	Central Position (Approximately) N.	E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
1912 Novembre 14	1912 Dec. 4	763	Off Tisvildeleje, 1/2 mile from shore	—	56°04′	12°04′	Danish Fb.	I	[1]	82	(90)	fide fisherman 5000 g
At Briseis Brush-buoy	1913 April 16	773	1 1/2 mile N of Spodsbjerg Light	—	56°01′	11°51′	—	V	[2]	86	90	very meagre 4500 g
56°21′N 11°15′E	1914 Jan. 16	765	1 mile N of Gilbjerghoved	—	56°11′	12°16′	—	XIV	[3]	75	(80)	le. calcul. from ult. wei. 5000 g
28 m												
15 Cod liberated												
Da. 12 Nr. 761-775												
Marking experiment No. 12 1912												
1906 March 7	1910 Feb. 22	441	Schultz's Grund	29	56°08′	11°10′	Danish Fb.	XLVII	—	34	(63)	le. calcul. from ult. wei. 2250 g
9 miles S by W 1/2 W of Fornæs												
56°18′N 10°56′E												
16 m												
3 Cod liberated												
Da. 4 No. 441—443												
Marking experiment No. 1 1906												

B b 2. Experiment in the Southwestern Kattegat at Schultz's Grund.

1912 Decembre 4-7	1913 March 4	794	8 miles E of Sjællands Reef	21	56°04′	11°30′	Danish Fb.	III	[4]	84	(88)	corr. added. ult. we. 6000 g
600 m S of Schultz's Grund Light-vessel	» April 8	776	At Lynæs Sand, entrance to Isefjord	—	55°56′	11°50′	—	IV	[5]	76	?	
56°09′N 11°11′E												
30 m												
24 Cod liberated												
Da. 12 No. 776-800												
Marking experiment No. 13 1912												
1913 February 4-16	1913 Feb. 14	5	7 miles NE of Schultz'Grund Light vessel	23	56°14′	11°20′	Danish Fb.	0	—	85	85	initial we. 4000 g living
At Schultz s Grund Light-vessel	» » 27	73	—	34	56°15′	11°28′	—	0	—	90	90	» 5600 g »
56°09′N 11°11′-12′E	» March10	68	Off Sjællands Odde, entrance to Great Belt	—	56°02′	11°06′	Swedish S/T	I	—	85	?	» 5700 g
26—34 m	» » 17	14	1 mile S of Elsehoved	9	55°05′	10°47′	Danish Fb.	I	—	100	?	
100 Cod liberated	» April 12	23	Off Ballen, Samsø	—	55°49′	10°40′	—	II	—	85	?	ini. we. 4700 g ult. 4500 g, meagre
Da. 13 No. 1—100	» » 23	85	Lunkebugten, at Taasinge	—	55°01′	10°40′	—	II	—	99	?	ini. we. 7600 g label wound sore
Marking experiment No. 1, 2, 3 1913	» May 10	82	W of Hveen, Øresund	—	55°55′	12°38′	Swedish Fb.	III	—	87	87	ini. we. 5550 g
	» » ?	81	At Samsø	—	?		Danish Fb.	III	—	81	?	» 5200 g label only
	» Sept. 26	7	2 miles NW of Munkegrunds Brush-buoy	13	55°59′	10°56′	—	VII	—	86	?	» 4700 g

B b 3. Experiment in the Southwestern Kattegat at Mosel Ground.

1912 March 30	1912 April 3	1132	1 mile NNE of Hjælmen	17	56°09′	10°50′	Danish Fb.	0	—	54	56.5	fresh
At Mosel Ground Bell-buoy	» » 3	1187	—	17	56°09′	10°51′	—	0	—	59	63	fresh
56°06′N 10°54′E	» » 20	1110	3 miles NNE of Hjælmen	17	56°09′	10°54′	—	0	—	53	[55.5]	ult. we. 1500 g
23 m	» May 24	1171	Between S. point of Samsø a. Refsnæs L.	19	55°45′	10°46′	—	I	♂	63	64.5	
145 Cod[6] liberated	» June 21	1120	Boeslum bay 1/4 mile from shore	15	56°13′	10°46′	—	II	—	47	50	fresh
Da. 11 No. 1056-1200	» July 11	1161	NNE of Hjælmen	15	56°09′	10°49′	—	III	—	53	56	
Marking experiment No. 6 1912	» Aug. 26	1177	E of Hjælmen	19	56°09′	10°55′	—	IV	—	56	56	living
	» Sept. 7	1129	1 mile NNW of Hjælmen	30	56°09′	10°47′	—	V	—	55	?	
	» » 12	1131	1 1/2 mile NE of Hjælmen	18	56°09′	10°51′	—	V	—	57	?	
	» » 17	1098	2 miles SW of Hjælmen	15	56°07′	10°47′	—	V	—	47	[52]	corr. ad. very meagre 750 g sore
	» » 17	1105	—	15	»		—	V	—	62	[65]	— 2250 g
	» » 26	1097	Off Havnemark, Kallundborg Fjord	—	55°40′	10°58′	—	V	—	72	(75.5)	ult. le. calc. from we. fresh 3875 g
	» Oct. 15	1157	Off Bulsaksen	—	55°43′	10°41′	—	VI	—	84	(90)	— 7000 g
	» Nov. 7	1139	1 mile W of Taarbæk Light-buoy	—	55°47′	12°39·	—	VII	—	65	[63]	corr. added.
	» » 28	1184	3 miles SE of Hjælmen	15	56°07′	10°53′	—	VII	—	50	?	1125 g
	» Dec. 5	1092	3 miles E of Ballen Hb., Samsø	17	55°50′	10°43′	—	VIII	—	50	?	
	» » 21	1166	—	17	55°49′	10°43′	—	VIII	—	59	(68)	ult. le. calc. from wei. 2800 g

[1]) Initial wei. 5300 g. [2]) Initial wei. 6700 g. [3]) Initial wei. 5200 g. [4]) Initial wei. 6900 g. [5]) Initial wei. 4100 g. [6]) Captured 3 miles NE of Mosel Ground Bell-buoy.

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No on Label	Locality reported	Depth in m	Central Position (Approximately) N. E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
	1913 Jan. 22	1180	At Anholt	—	56°38′ 11°33′	Danish Fb.	IX	—	80	?	3000 g
	» Feb. 26	1158	14 miles S by W of Anholt	32	56°27′ 11°29′	—	X	—	50	53.5	♂ mature
	» March 20	1141	14 miles SE of Fornæs Light	20	56°19′ 11°17′	—	XI	—	59	(64)	corr. added, hurt from label
	» April 25	1087	N of Bolsaksen	16	55°42′ 10°41′	—	XII	—	71	75	3250 g meagre, sore
	» Dec. 12	1102	Between Sletterhage Light & Samsø	34	56°03′ 10°33′	—	XX	—	57	62	2400 g
	1914 Jan. 6	1136	3 miles SE of Grenaa	17	56°23′ 11°03′	—	XXI	—	77	90	8000 g
	» Febr. 14	1165	6 miles ENE of Hjælmen	23	56°10′ 10°59′	Swedish	XXII	—	48	?	? 2000 g very meagre
	» Sept. 5	1079	8 miles NE of Fornæs	—	56°32′ 11°08′	—	XXIX	—	46	?	

B c. Experiment in the western Kattegat.

1906 March 28 Entrance to Randers Fjord 56°37′N 10°34′E 6 m 41 Cod liberated Da. 5 No. 2360-2400 Marking experiment No. 9 1906	1906 April 2	2395	Off Randers Fjord, ESE of Udbyhøj Light	—	56°34′ 10°26′	Danish Fb.	I	—	31	[31.5]	corr. added.
	» » 6	2400	—	—	56°34′ 10°26′	—	I	♀	42	[35 5]	corr. added.
	» » 10	2398	—	—	56°34′ 10°26′	—	I	♀	35	[34.5]	corr. added.
	» » 24	2380	The shore of Hou at Hals	3.8	57°03′ 10°23′	—	I	—	33	[34.5]	corr. added.
	» » 25	2391	3 miles S of Randers Fjord	—	56°34′ 10°26′	—	I	♂	35	35.5	fresh II gr.
	» » 27	2365	Off Udbyhøj	—	56°35′ 10°23′	—	I	—	46	47	fresh III gr. ♀
	» » 27	2392	—	—	56°35′ 10°23′	—	I	♂	31	31	fresh II gr.
	» » 27	2393	—	—	56°35′ 10°23′	—	I	♂	33	33	fresh II gr.
	» May 3	2375	—	—	56°35′ 10°23′	—	II	♀	39	[40]	corr. added 790 g
	» » 10	2376	4 miles N of Fornæs	—	56°31′ 10°56′	—	II	—	39	38.5	tail dry
	» » 11	2360	Off Staunshoved, Djursland	7	56°33′ 10°46′	—	II	—	39	39	500 g
	» » 11	2367	At Udbyhøj	—	56°35′ 10°23′	—	II	—	45	(46)	le. calcul. fr. ult. weight 875 g
	» » 11	2386	Off Udbyhøj	—	56°35′ 10°23′	—	II	—	34	(35)	— 375 g
	» » 11	2387	—	—	56°35′ 10°23′	—	II	♀	45	44	tail a little dry
	» » 11	2394	—	—	56°35′ 10°23′	—	II	—	34	34.5	—
	» » c. 15	2388	?	—	?	—	II	—	32	ca. 35	fide fisherman
	» » 17	2379	Off Udbyhøj	—	56°35′ 10°23′	—	II	♀	43	44	fresh III gr spent
	» » 20	2370	Off Fjellerup, N of Djursland	—	56°32′ 10°35′	—	II	—	39	39	a little dry
	» » 26	2366	Bønnerup Strand, Grenaa	8	56°33′ 10°42′	—	II	—	34	(38)	le. calc. fr. ult. wei. meagre 500 g
	» Aug. 29	2397	3 miles S of Randers Fjord	—	56°34′ 10°26′	—	V	—	36	(38)	le. calc. fr. ult. wei. 500 g
	» Sept. 4	2382	Birkholm, Øresund	—	55°44′ 12°39′	—	VI	—	33	36	fresh II gr.
	» » 24	2376	Bønnerup Strand	—	56°33′ 10°41′	—	VI	♀	39	(39)	good le. calc. fr. ult. wei. 500 g
	» Oct. 11	2374	—	—	56°33′ 10°41′	—	VII	♀	29	(38)	le. calc. fr. ult. wei. 500 g
	» » 11	2390	Off Mariager Fjord	—	56°43′ 10°28′	—	VII	—	37	(50)	— 1125 g
	1907 April 5	2368	?	—	?	—	XIII	—	34	?	
1906 May 31 Entrance to Mariager Fjord 100 Cod liberated Da. 5 No. 3001-3100 Marking experiment No. A 1906	1906 June 1	3076	Mariager Vig	—	»	—	0	—	36	?	
	» » 1	3084	—	—	»	—	0	—	33	?	
	» » 1	3086	—	—	»	—	0	—	40	40	
	» » 4	3002	Nybroflak	—	»	—	0	—	35	36	
	» » 13	3074	Off Cimbria	—	»	—	0	—	36	?	
	» » 15	3087	Høllet	—	»	—	0	—	35	?	
	» » 16	3100	Off Fladbjerg	—	»	—	0	—	34	34	
	» » 16	3037	Off Stinesminde	—	»	—	0	—	35	?	
	» » 16	3061	?	—	»	—	0	—	38	38	
	» Aug. 7	3091	Høllet	—	»	—	II	—	33	?	
	» » 10	3095	Off Stinesminde	—	»	—	II	—	32	?	
	» » 15	3098	Off Skovgaardshage, Hobro	—	»	—	II	—	27	28	
	» » 18	3021	Off Stinesminde	—	»	—	II		45	?	
	» » 18	3040	—	46	»	—	II	—	37	?	
	» » 18	3064	—	—	»	—	II	—	40	41	
	1907 Jan. 19	3030	Off Mariager	—	»	—	VII	—	36	55 ?	unreliable

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No on Label	Locality reported	Depth in m	Central Position (Approximately) N. E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
C a. Experiment in the Belt Sea E of Samsø.											
1906 March 8—9 Off Ballen E-coast of Samsø 55°49′N 10°40′E 7 m 40 Cod liberated Da. 4 No. 444-484 Marking experiment No. 2 1906	1906 March 21	463	Off Ballen	—	55°49′ 10°40′	Danish Fb.	0	—	36	—	600 g
	» May 22	468	Off Staalhøjshage	—	55°52′ 10°41′	—	II	—	33	35	stale
1912 May 10 At Langøre E-coast of Samsø 55°55′N 10°39′E 7 Cod liberated Da. 11 No. 1304-1310 Marking experiment No. 11 1912	1912 Oct. 8	1306	Kerteminde Bay	—	55°27′ 10°43′	Danish Fb.	V	—	56	?	1250 g
C b. Experiment in the Belt Sea in Little Belt.											
1912 March 15 1 mile W of Middelfart 55°31′N 9°42′E 26—28 m 50 Cod liberated Da. 11 801—850 Marking experiment No. 1 1912	1912 March 20	829	Off Middelfart	38	55°31′ 9°44′	Danish Fb.	0	♂	38	38	
	» April 16	821	Off Strib	26	55°32′ 9°45′	—	I	♀	44	45	♂ mature
	» » 16	835	S of Fænø Kalv	28	55°29′ 9°40′	—	I	—	45	43	800 g
	» » 17	834	Off Strib	6	55°32′ 9°45′	—	I	♂	44	47	875 g
	» » 26	801	Off Stavrby Skov	17	55°31′ 9°46′	—	I	♂	42	45	♂ mature
	» » 26	809	Off Snoghøj	15	55°31′ 9°43′	—	I	—	42	45	750 g
	» » 29	823	Entrance to Koldingfjord	4	55°30′ 9°36′	—	I	♀	42	45.5	750 g
	» May 11	820	W of Snoghøj	23	55°31′ 9°43′	—	II	♂	45	46	♂ mature
	» » 20	810	Off Stenderup Strand	—	55°27′ 9°42′	—	II	—	47	(48)	le. calc. fr. ult. wei. 1000 g
	» » 29	824	Off Strib	8	55°33′ 9°46′	—	II	♀	45	45	♀ mature
	» June 6	838	At Kongebro	19	55°31′ 9°43′	—	III	—	42	45	750 g
	» July 28	837	Between Fænø light and Stenderup-hages Brush buoy	26	55°31′ 9°43′	—	IV	♀	40	41	♀ mature
	» Aug. 25	803	Entrance to Koldingfjord	8	55°30′ 9°37′	—	V	—	44	48	750 g
	» Sept. 10	843	Off Hagenør	30	55°31′ 9°40′	—	VI	♀	49	60	1750 g
	» » 11	812	Off Lyng	28	55°31′ 9°45′	—	VI	—	41	45.5	750 g
	» » 19	847	Off Snoghøj	26	55°31′ 9°43′	—	VI	—	44	49	♀ mature
	» Nov. 16	811	At Fænø lighthouse	—	55°28′ 9°42′	—	VIII	—	58	73	3000 g
	1913 Jan. 29	826	Off Lyng	13	55°31′ 9°45′	—	X	♀	47	(52)	le. calc. fr. ult. wei. 1250 g
	» » 29	836	Off Hagenør	11	55°31′ 9°40′	—	X	—	45	57	1750 g
	» April 9	814	Off Lyng	19	55°31′ 9°45′	—	XIII	♀	42	51	1200 g mature
1912 March 16-22 1 mile W of Middelfart 55°31′N 9°42′E 38 m 24 Cod liberated Da. 11 851-874 Off Strib 55°33′N 9°45′E 28—38 m 56 Cod liberated Da. 11 875—930	1912 March 16	874	Off Treldenæs	21	55°36′ 9°52′	—	0	♂	52	52.5	♂ mature
	» » 25	912	Off Sanddal	15	55°33′ 9°45′	—	0	♀	51	[52]	1250 g
	» » 25	936	W of Snoghøj	26	55°31′ 9°43′	—	0	♀	52	54	♀ mature
	» » 26	996	Off Kongebroskov	23	55°31′ 9°44′	—	0	♀	48	49	♀ mature
	» » 27	873	—	26	»	—	0	♀	49	52	♀ mature
	» April 1	854	At Flessingen, N of Fænø	4	55°30′ 9°40′	—	I	—	49	50.5	1125 g
	» » 5	893	Off Lyng	19	55°31′ 9°45′	—	I	—	52	55	1500 g
	» » 8	892	Off Hagen, N of Ægholm at Baagø	—	55°21′ 9°47′	—	I	♂	63	(63.0)	le. calc. fr. ult. wei. 2250 g
	» » 9	948	Off Hagenør	28	55°31′ 9°40′	—	I	—	50	53	1250 g
	» » 9	973	Fanø Sound	—	55°29′ 9°42′	—	I	—	52	54	
	» » 11	896	Between Strib and Fredericia	30	55°33′ 9°46′	—	I	♀	55	56	♀ mature
	» » 12	853	Off Trellenæs	4	55°36′ 9°51′	—	I	♀	53	(52.5)	le. calc. fr. ult. wei. 1300 g
	» » 15	918	Off Lyngsodde	19	55°31′ 9°45′	—	I	♀	47	48	♀ mature
	» » 16	906	Off Strib	26	55°33′ 9°46′	—	I	♀	55	58	♀ mature

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No. on Label	Locality reported	Depth in m	Central Position (Approximately) N.	E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
Off Middelfart 55°31'N 9°44.5'E 28—38 m 70 Cod liberated Da. 11 931—1000 Marking experiment No. 3, 2 & 4 1912	1912 April 16	927	Off Lyngsodde	23	55°31'	9°45'	Danish Fb.	I	♀	59	61	♀ mature
	» » 16	950	Off Strib	26	55°33'	9°45'	—	I	♂	50	58	♂ mature
	» » 17	875	Off Lyng	28	55°31'	9°45'	—	I	—	53	55	1250 g
	» » 17	890	Off Hagenør	28	55°31'	9°40'	—	I	♂	59	62	2000 g
	» » 17	958	Between Lyng and Strib	26	55°32'	9°45'	—	I	♀	59	59	
	» » 17	991	Off Lyng	28	55°31'	9°45'	—	I	—	58	59	1375 g
	» » 19	985	Off Strib	8	55°33'	9°46'	—	I	—	62	65.5	2250 g
	» » 20	917	Off Lyng	23	55°31'	9°45'	—	I	♀	48	49	♀ mature
	» » 24	901	Off Snoghøj	13	55°31'	9°43'	—	I	—	54	57	1500 g
	» » 24	946	Off Lyng	25	55°31'	9°43'	—	I	♀	50	52	
	» » 24	975	W of Snoghøj	13	55°31'	9°43'	—	I	♂	51	52	♂ mature
	» » 28	907	At Aalebo near Kolding	—	55°30'	9°36'	—	I	—	54	[57.5]	1550 g
	» » 29	866	E of Strib	15	55°33'	9°46'	—	I	♂	51	55	♂ mature
	» May 9	951	E of Fænø	8	55°29'	9°43'	—	II	—	51	55	
	» » 19	981	At Kongebro	19	55°31'	9°43'	—	II	—	51	56.5	
	» » 20	999	Off Hagenør	28	55°31'	9°40'	—	II	—	50	51	1125 g
	» » 22	963	Off Lyng	9	55°31'	9°45'	—	II	♂	52	54.5	1000 g meagre
	» » 28	949	Off Snoghøj	15	55°31'	9°43'	—	II	—	47	52	1300 g
	» » 29	858	Off Lyng	19	55°31'	9°45'	—	II	—	49	57	1500 g
	» » 29	876	Off Snoghøj	26	55°31'	9°43'	—	II	♀	57	52 ?	♀ mature
	» June 5	942	Between Lyng and Strib	19	55°32'	9°45'	—	III	♀	54	57	♀ mature
	» » 6	920	Off Snoghøj	11	55°31'	9°43'	—	III	♀	53	58.5	1650 g
	» » 10	925	—	19	55°31'	9°43'	—	III	—	50	55	1375 g
	» » 10	945	—	19	55°31'	9°43'	—	III	♀	52	62.5	2000 g
	» » 13	983	Off Lyngsodde	19	55°31'	9°45'	—	III	♀	48	52	
	» » 19	977	Off Stavrby Skov	26	55°31'	9°46'	—	III	—	50	55	♂ mature
	» July 5	984	Off Lyng	28	55°31'	9°45'	—	IV	—	49	55.5	875 g meagre
	» » 6	928	Off Strib	23	55°33'	9°45'	—	IV	—	57	57	♂ mature
	» » 7	884	Off Lyng	28	55°31'	9°45'	—	IV	—	54	56.5	750 g meagre, sore
	» » 16	987	—	19	55°31'	9°45'	—	IV	—	49	57	♀ mature
	» » 19	974	—	28	55°31'	9°45'	—	IV	♂	54	58	1350 g meagre, sore
	» » 29	940	At Kongebro	19	55°31'	9°43'	—	IV	—	49	52	1075 g
	» Aug. 20	997	Off Lyng	28	55°31'	9°45'	—	V	—	50	58	1625 g
	» Sep. 5	887	Off Hagenør	30	55°31'	9°40'	—	VI	♀	51	60	1500 g
	» » 8	879	—	30	55°31'	9°40'	—	VI	♀	50	55.5	1375 g
	» » 12	934	Off Galsklint	32	55°31'	9°41'	—	VI	♂	51	55	♂ mature
	» » 16	881	Off Børup	25	55°31'	9°41'	—	VI	—	53	63	♀ mature
	» » 24	919	Off Stenderup Strand	—	55°28'	9°41'	—	VI	♂	52	(64)	le. calc. fr. ult. wei. 2400 g
	» » 28	926	Off Treldenæs	—	55°36'	9°51'	—	VI	—	48	(68)	— 2875 g
	» » 30	938	Off Lyng	28	55°31'	9°45'	—	VI	—	49	61	1750 g
	» Oct. 25	902	Off Galsklint	26	55°31'	9°42'	—	VII	♀	54	68	2575 g
	» Nov. 18	989	Off Lyngsodde	23	55°31'	9°45'	—	VIII	♂	57	71	
	» Decb. 4	889	Off Strib	19	55°31'	9°45'	—	IX	♂	47	61	1750 g
	» » 28	965	Off Fænø Kalv	47	55°29'	9°40'	—	IX	♀	53	62	1625 g
	» » 30	904	Off Galsklint	30	55°31'	9°42'	—	IX	♂	57	60	
	1913 Jan. 6	930	Off Strib	15	55°33'	9°45'	—	X	—	53	59	
	» » 20	922	Off Lillegrund, Faaborg	—	55°04'	10°11'	—	X	—	59	(71)	le. calc. fr. ult. wei. 3250 g
	» » 27	994	Off Lyng	13	55°31'	9°45'	—	X	♀	52	66	immature 2375 g
	» Feb. 28	910	Off Strib	30	55°32'	9°45'	—	XI	♀	51	67.5	immature 2500 g
	» March 27	851	3 miles N of Romsø	—	55°34'	10°46'	—	XII	—	67	80	IV gr.
	» April 12	856	Between Løverodde a. Stenderup Hage	28	55°29'	9°40'	—	XIII	♀	57	(65)	le. calc. fr. ult. wei. 2500 g
	» Oct. 3	976	Between Fænø Kalv and Rønshoved	—	55°29'	9°40'	—	XIX	—	57	[75.7]	le. calc. fr. ult. wei. 4000 g, 76 cm
	1914 March 1	947	Off Stenderup Hage	—	55°28'	9°42'	—	XXIV	—	53	(87)	— 6000 g
	?	878	Off Baaringvig ?	—	?		—	?	—	59	60	♀ stale

Particulars of Liberation, Date, Locality, No. of Fish etc.	Date	No. on Label	Locality reported	Depth in cm	Central Position (Approximately) N. E.	Fishing vessel	No. of Months between Liberation and Recovery	Sex	Initial Size cm	Ultimate Size cm	Remarks
C c. Experiment in the Great Belt (Belt Sea).											
1907 March 21 ½ mile SE of Sprogø Light 55°19′30″N 10°59′E 5—7 m 34 Cod liberated Da. 5 No. 2886-2919 Marking experiment No 2 1907	1907 April 10	2919	Omø Sound at Skelskør	—	55°11′ 11°11′	Danish Fb.	I	♂	35	[32]	corr. added. 380 g
	» » 22	2910	Agersøsund	—	55°13′ 11°13′	—	I	♀	55	52	init. wei. 1420 g ult. wei. 1250 g
	» May 15	2892	S of Klarskov at Bonderup, Korsør	7	55°18′ 11°11′	—	II	—	47	[49.5]	— 960 g — 1000 g
	» Aug. 16	2915	At Sprogø	—	55°19′ 10°58′	—	V	♀	40	43	— 700 g — 750 g
	» Novb. 11	2904	Agersøsund	6	55°13′ 11°12′	—	VIII	—	35	[37.5]	corr. add. init wei. 370 g, ult. wei. 375 g
	» » 20	2909	Great Belt	—	?	—	VIII	—	27	36	tail dry
	» » 26	2893	Off Lohals	—	55°09′ 10°54′	—	VIII	—	30	40	init. wei. 290 g, ult. wei. 250 g
	» Decb. 6	2917	At Sprogø	—	55°19′ 10°58′	—	IX	♂	36	?	
	1908 Jan. 27	2890	Close S of Halskov Odde	—	55°20′ 11°06′	—	X	—	32	(35.5)	corr. added. ♀ mature, III g
1907 March 23 ½ mile S by W of Tranekjær Light 6 m 76 Cod liberated Da. 5 No. 2920-2995 Marking experiment No. 3 1907	1907 March 27	2969	Off Botofte Light, Langeland	9	54°59′ 10°54′	—	0	—	44	[44]	corr. added.
	» April 20	2980	Kobbergrund, N of Langeland	4	55°12′ 10°54′	—	I	♀	32	32.4	II gr
	» » 25	2972	Off Botofte, Tranekjær	—	54°59′ 10°53′	—	I	—	28	27	
	» May 1	2935	—	—	54°59′ 10°53′	—	II	—	42	(44)	init. wei. 650 g, ult. wei. 750 g
	» » 16	2931	Kramnitze, Laaland	—	54°42′ 11°14′	—	II	♂	33	?	
	» » 16	2968	Between Spodsbjerg and Botofte Light	7	54°57′ 10°52′	—	II	—	42	[43]	corr. add. init. wei. 800 g, ult. wei. 675 g
	» June 8	2983	Taars Hage, Nakskov	5	54°53′ 10°58′	—	III	—	28	28	tail dry
	» » 9	2956	Fehmern Belt	—	54°37′ 11°13′	—	III	♀	38	[34.5]	corr. add. init. wei. 610 g, ult. wei 250 g
	» » 25	2953	Off Botofte	19	54°58′ 10°56′	—	III	♀	27	25.5	init. wei. 200 g, ult. wei. 250 g
	» » c. 27	2970	Langelands Belt	16	»	—	III	—	33	?	
	» Sept. 20	2992	—	—	»	—	VI	—	27	25	init. wei. 190 g, ult. wei. 2 0
	» Oct. 10	2985	West side of Laaland	—	»	—	VII	—	27	32	♀ immature
	» » 16	2924	Off Leibølle, Langelands Belt	7	55°01′ 10°55′	—	VII	—	39	[46]	corr. add. init. wei. 500 g, ult. wei 950 g
	» Dec. 10	2944	Off Botofte, Tranekjær	—	54°59′ 10°53′	—	IX	—	29	(28.5)	corr. add. init. wei. 240 g, ult. wei. 350 g
	» » 17	2942	—	6	54°59′ 10°54′	—	IX	♂	30	[36]	corr. add. init. wei. 250 g, ult. wei. 550 g
	1908 Febr. 12	2964	Snøde Ør, Langelands Belt	—	55°05′ 10°57′	—	XI	—	42	[57.5—63]	corr. add. init. wei. 880 g, ult. wei. 2250 g
D. Experiment in the Western Baltic.											
1907 March 15 & 16 ½ mile NW by N of Bagenkop Harbour 54°46′N 10°39′E 7 m 85 Cod liberated Da. 5 No. 2801-2885 Marking experiment No. 1 1907	1907 March 17	2864	W of Gulstav	19	54°43′ 10°39′	Danish Fb.	0	♀	50	[51.5]	corr. add. init. we. 1350 g, ult. we. 1250 g
	» » 20	2821	W of Langeland	—	?	—	0	♀	48	49	III gr
	» » 20	2853	¼ mile off Bagenkop harbour	6	54°45′ 10°40′	—	0	♂	58	(60.5)	corr. add. init. we. 1950 g, ult. we. 2000 g
	» » 24	2882	¼ mile W of —	15	54°45′ 10°39′	—	0	♂	31	(31)	corr. added.
	» » 28	2879	¼ mile NW of —	19	54°45′ 10°38′	—	0	♀	49	(49.5)	corr. add. init. we. 1050 g, ult. we. 1000 g, III gr
	» April 9	2885	¼ mile NW of the harbour Light, Bagenkop	17	54°45′ 10°38′	—	I	♂	32	(35)	corr. add. init. we. 290 g. ult. we. 325 g, III gr
	» » 12	2838	¼ mile of Old Fyrbakke	19	54°44′ 10°39′	—	I	♀	48	?	III gr
	» » 13	2802	⅓ mile N by W of Bagenkop harbour	8	54°45′ 10°40′	—	I		57	58.5	init. we. 1600 g, ult. we. 1800 g, IV gr
	» » 16	2829	¼ mile W of Snikkegrund	17	54°43′ 10°40′	—	I	♂	49	48.5	init. we. 1000 g, ult. we. 850 g, V gr
	» » 24	2866	½ mile NW of Bagenkop harbour	15	54°45′ 10°39′	—	I	♀	50	50	init. we. 1300 g, ult. we. 1030 g, V gr
	» » 24	2883	⅛ mile NW of the harbour, Bagenkop	15	54°45′ 10°39′	—	I	♀	34	35	init. we, 270 g, ult. we. 325 g, III gr
	» » 27	2830	Off Hjortholm, Langeland	9	54°49′ 10°48′	—	I	♀	48	? 47	
	» May 8	2810	Kieler Fjord	—	54°27′ 10°16′	German S/B	II	♀	47	? 46.5	

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