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Preliminary results of tagging experiments on cod in the Western
Baltic in 1973 .

by
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I. Introduction :

Tagging of cod in the Kiel Bay was carried out by BAGGE (1961 , 1969) and THUROW (1963) , suggesting that cod forms a unit stock in the Kiel Bay with only little exchange with the adjacent stocks. In 1973 the author started a series of 19 experiments to study the tagging mortality and the tag losses of cod by keeping the fish in net cages for various times (KOCK 1974). The net cages were located in the inner Kiel Fjord (Fig. 1). The experiments showed that tagging mortality was negligible in autumn and winter. Therefore at the end of the last 4 experiments in November / December 1973 a total of 392 cod were released from the cages to study their migrating behaviour. A calculation of fishing mortality was based on the return rates.

II. Material and methods :

Cod were caught by trawl and set net in the area of 'Stollergrund' and 'Stohl - Tonne Kiel A' . The trawling time was limited to one hour. After being caught the fish were immediately put into a tank with a circulating sea - water system and then transported to the cages where they were tagged. All fish were in good condition .

Two types of tags were used :

- a. the 'German Spaghetti tag' (LAMP 1967) and
- b. the modified CARLIN tag (CARLIN 1955). The visibility of CARLIN tags was improved by adding a red - white plastic flag of 40 x 8 mm size.

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All fish were measured to the centimeter below. The mean length of cod is shown in Table 1 .

Tab. 1 : Mean length of tagged cod

<u>Tag type</u>	<u>No. tagged</u>	<u>mean length (cm)</u>	<u>standard deviation</u>
CARLIN	158	42.2	4.38
Spaghetti	234	42.9	7.65

Cod were released on 23.11. , 5.12. , 12.12. and 15.12. in the inner Kiel Fjord after a period of 15 - 22 days in the cages.

III. Results :

Recaptures

Within one year after liberation a total of 86 (54,4%) CARLIN tags and 114 (48,7%) Spaghetti tags were returned. 136 (68,0%) were recaptured by German fishermen while 64 (32,0%) came back from Denmark. All Danish recaptures were in the period from December to July when the cod were staying in the northern part of the Western Baltic for spawning. 164 (82,0%) were caught by bottom trawl and set net while only 5 (2,5%) came from line and fyke net catches. For 31 (15,5%) tags no information about the catching method could be obtained. 54,4% of the returns included information on the stage of maturity showing that 82,1% of the cod were sexually mature.

Migrations

After liberation the cod moved to the outer parts of the Kiel Fjord. Three cod which were returned from the inner Fjord were caught on the day of release. While a number of fish were captured in the outer Fjord (area Schilksee - Bülk) , the others migrated to the spawning grounds in the northern parts of the Western Baltic. The fish preferred two directions : some headed for the Little Belt and the Vejsnäs - Rinne by way of the 'Stollergrund' while others moved to the southern Great Belt by way of 'Millionenviertel' and 'Winds Grav' , which was observed by THUROW (1963) too.

In January a considerable number of tags was reported from the northern Kiel Bay and the southern Little Belt (20 recaptures). Four tags came

back from the middle part of the Little Belt (Holstebank , Thorøhus, S of Brandsø). These fish had a length of 48 - 53 cm , so one can presume that they were sexually mature. This suggests that the inner part of the Little Belt is used for spawning too (Fig. 1) .

In March (main spawning time , THURØW 1970) the recaptures from the northern part of the Western Baltic reached their climax (Table 2).

Tab. 2 : Recaptures of tagged cod during the spawning time in the northern and southern parts of the Western Baltic.

	Recaptures northern parts of the Western Baltic		Recaptures southern parts of the Western Baltic	
	n	%	n	%
January	20	40.8	29	59.2
February	11	50.0	11	50.0
March	23	85.2	4	14.8
April	7	53.8	6	46.2
May	3	50.0	3	50.0
June	3	20.0	12	80.0

From April onwards the returns from Danish fishermen slightly decreased. Cod obviously migrated to the feeding grounds in the southern Kiel Bay (Fig. 2). Since August no tagged cod was recaptured from the northern area of the Western Baltic. (Fig. 3).

In September the return rate suddenly increased due to one bottom trawl haul at the 'Stollergrund' consisting of 7 tagged cod. These fish had been released on December 15th 1973 and probably stayed together.

The pattern of migration as indicated by recaptures is biased to some extent by the uneven distribution of fishing effort. It is however thought that the general conclusions are valid because the recapture rate of some 50 % p. a. leaves little room for a completely different pattern.

Fishing mortality

The returns are grouped in time intervals of length T (= 3 months). The number n_r caught during the r^{th} interval between times $rT_1, (r+1)T$ is therefore :

$$n_r = N_o e^{-(F+M)rT} \frac{F}{F+M} (1 - e^{-(F+M)T})$$

(The first interval after tagging is $r = 0$).

The number caught in successive intervals can therefore be used to give estimates of F . (Table 3).

$$\log n_r = -(F+M) rT + \log \left(\frac{FN_o}{F+M} (1 - e^{-(F+M)T}) \right)$$

If $\log n_r$ is plotted against r the result is a straight line with the slope $-(F+M) T$. F can now be estimated from the intercept of the y - axis

$$\log \left(\frac{FN_o}{F+M} (1 - e^{-(F+M)T}) \right) \quad (\text{GULLAND 1969}).$$

Tab. 3 : Recaptures compiled in three months intervals .

	I	II	III	IV	F
CARLIN	45	29	7	5	1.79
Spaghetti	62	26	16	10	1.25

The great difference in F between cod tagged with CARLIN and Spaghetti tag may be due to the greater vulnerability of CARLIN tagged cod against set nets. Analyses of the recapture data during the first three months interval show that 46.3 % of the Spaghetti tags were reported from set nets and 53.7 % came back from bottom trawl hauls. 80.0 % of CARLIN tagged cod came back from set nets while only 20.0 % were recaptured by bottom trawl. The difference is significant ($\chi^2 = 9.56$, $FD = 1$, $p \leq 0.01$).

Both estimates result in an extremely high fishing mortality. No further estimation is possible as the tagged fish were all liberated at one place and no allowance could be made for the fishing effort.

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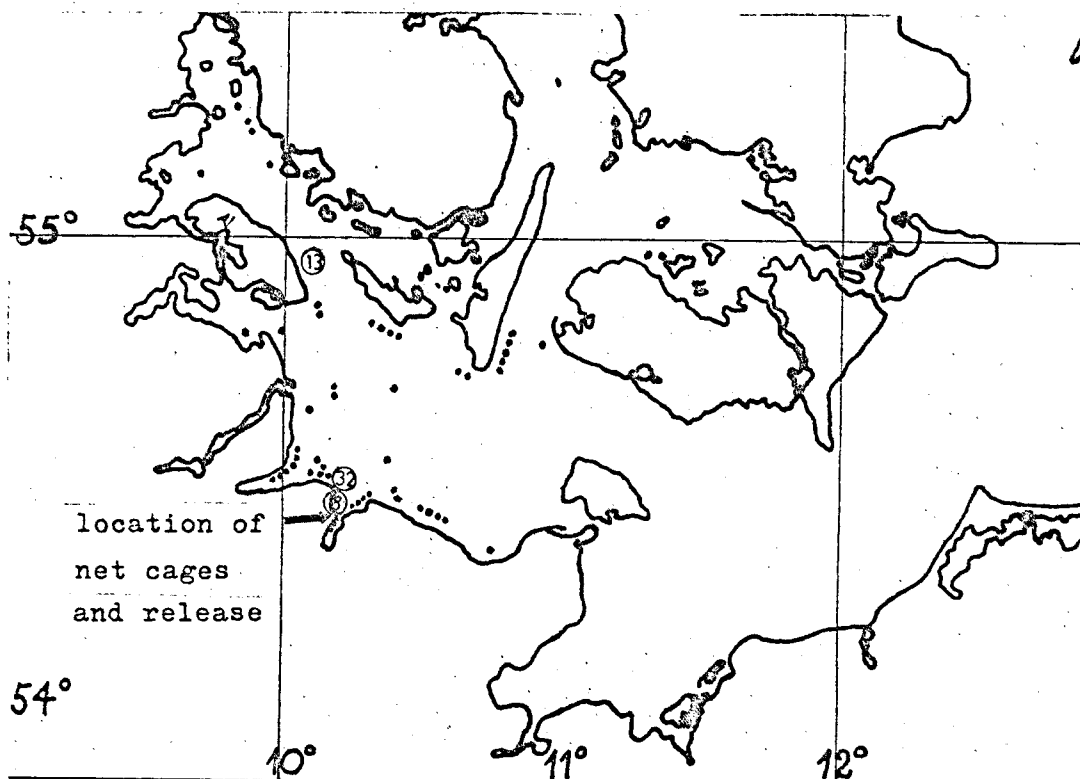


Fig. 1 : Kiel Bay , Location of net cages , Recaptures end of November - February . No. in circles : No. of tagged cod caught at that locality

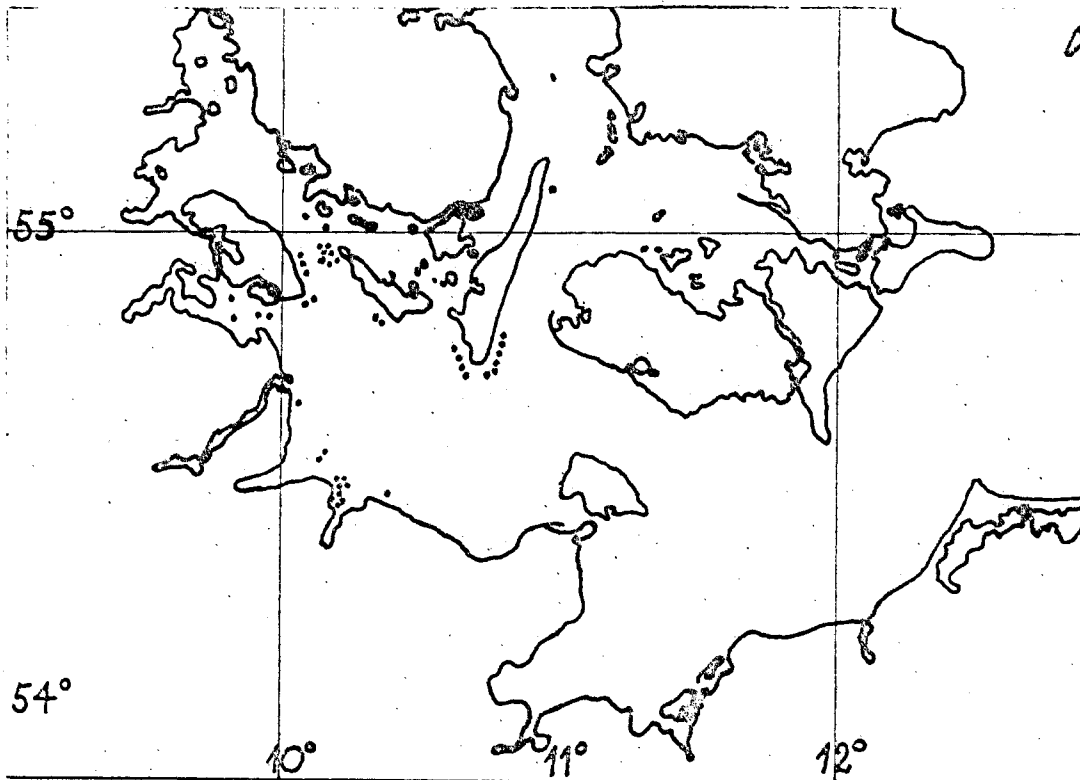


Fig. 2 : Kiel Bay , Recaptures March - May

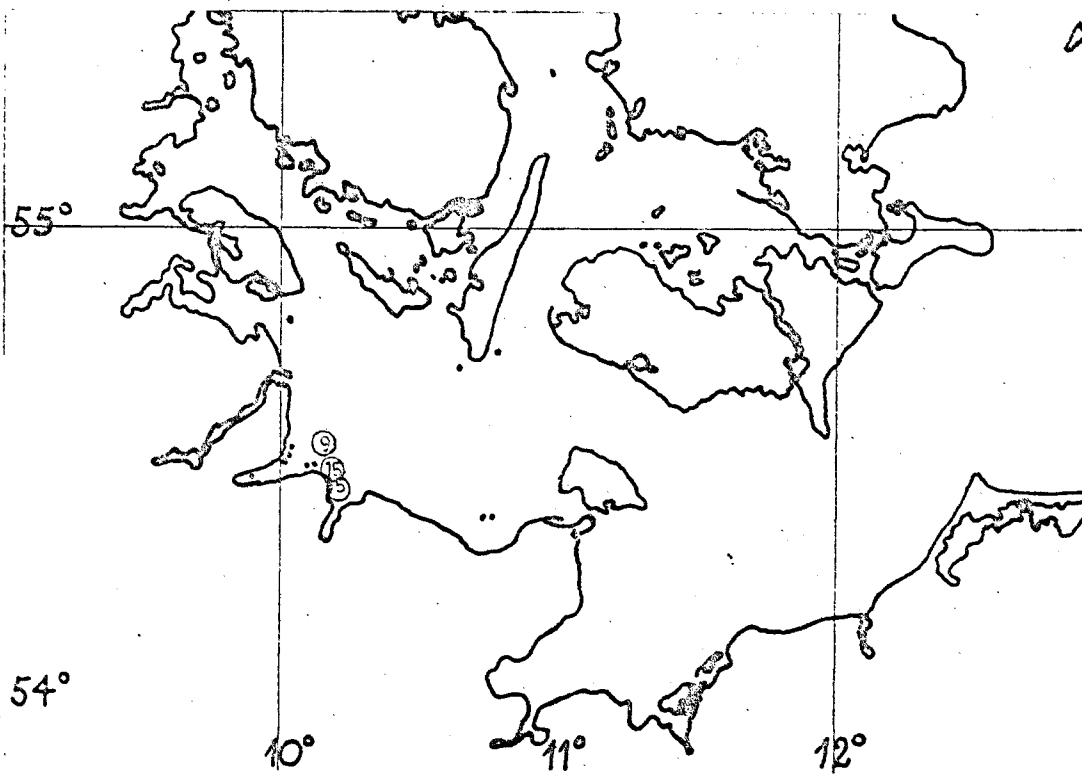


Fig. 3 : Kiel Bay , Recaptures June - November