MIGRATION, MINGLING AND HOMING OF NORTH-EAST ARCTIC COD FROM TWO SEPARATED SPAWNING GROUNDS

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ABSTRACT

Migration of mature North-east Arctic cod tagged in 1975 and 1979-81 on two different spawning areas were studied. The numbers tagged were 11,500 in Lofoten and 3,350 off Møre, of which 1,088 and 476 recaptures are reported respectively.

During the feeding periods in the Barents Sea and the Bear Island - Spitsbergen area mature cod from the two spawning areas intermingle, although the Møre cod have a more westernly and southernly distribution than cod from Lofoten.

Returns from the experiments clearly indicate homing to the spawning area where tagging occured. Whether this is homing in the strict sense of the word, i.e. return to birth area, can not be answered from these tagging results. The results show that cod spawning off Møre and in Lofoten do not randomly interbreed during repeated spawnings, and a possible division into separate spawning populations is discussed.

INTRODUCTION

The North-east Arctic Cod is treated as one management unit, with the main spawning areas along the Norwegian coast and nursery and feeding areas in the Barents Sea and the Bear Island - Spitsbergen area. A subdivision into an eastern and a western component according to the location of the nursery areas has been discussed by various authors.

Meek (1916) inferred fish migration from information available on their spawning localities and the distribution of their eggs and larvae. He suggested that the spawning on the two main spawning grounds, Lofoten and Møre, probably resulted in recruits to the eastern and western fisheries off the northern Norwegian coast respectively.

Trout (1957) showed that otolith pattern could be used to seperate the two components. From tagging experiments he also found that cod tagged in the Bear Island - Svalbard area were recaptured to a greater extent in the western and southern spawning localities. This was in contrast to those tagged in Lofoten and in the Barents Sea which were mainly caught in Lofoten.

Tagging experiments carried out in Lofoten in March-April indicated only sporadic migration to the Møre spawning ground (Dannevig 1953, Hylen og Sætersdal 1959); however, cod tagged on the banks northwest of Lofoten in January and February were caught to a greater extent off the Møre coast (Hylen og Sætersdal 1959).

The relationship between the Møre and Lofoten cod has till now not been extensively studied. In the present paper migration, mingling and homing will be discussed on the basis of recent tagging experiments carried out on the spawning grounds in Lofoten and off Møre.

MATERIAL AND METHODS

Tagging experiments were carried out on both the Lofoten and the Møre spawning grounds during the spawning season in 1975, 1979, 1980 and 1981. The cod used in these experiments were caught by purse seine in Lofoten and mainly by Danish seine and purse seine at the Møre coast (a few cod caught by gill net and hand line were released off Møre in 1975 and 1980). The tagging areas are shown in Fig. 1. The numbers of cod tagged and released from the Møre and Lofoten spawning grounds in the various years are given in Table 1. All taggings were done in March and April with the hydrostatic Lea-tag fastened before the first dorsal fin. Reported recaptures are recorded according to the statistical areas used in the Norwegian fisheries (Fig. 1).

Table 1. Numbers of tagged and released cod caught by the various gears off the Møre coast and in Lofoten from 1975 to 1981.

Tagging area	Year of release	Tagging gear	Number tagged
Lofoten	1975	Purse seine	2800
Møre	1975	Danish seine	207
	1975	Gill net	16
Lofoten	1979	Purse seine	3400
Møre	1979	Danish seine	347
Lofoten	1980	Purse seing	1500
Møre	1980	Danish seine	739
	1980	Hand line	41
Lofoten	1981	Purse seine	3800
Møre	1981	Purse seine	2000
Lofoten total			11500
Møre total			3350

The designation "spawning season" will in this paper include the months January-April, while the rest of the year is called the "feeding period". The spawning areas Møre and Lofoten are covered by the statistical areas 07 and 28 and 00 respectively (Fig. 1).

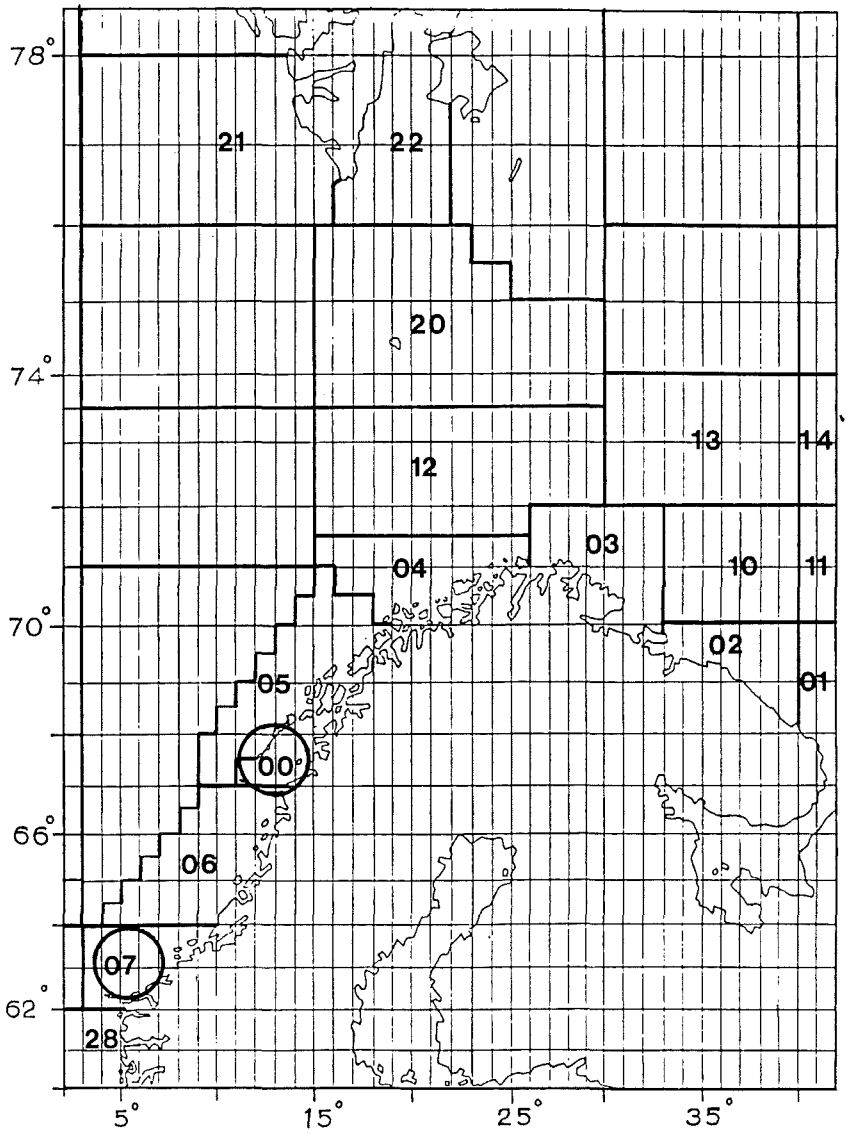

Fig. 1. Norwegian statistical areas in the North-east Atlantic. Tagging areas are encircled.

Rollefsen (1933) distinguished between coastal cod (CC) and North-east Arctic cod (NAC) according to zonation of the otoliths. The CC comprises local cod resources along the coast and has limited migration. The CC as well as NAC spawn in the same areas (Hylen 1964, Godø 1981). In this paper only experiments where the percentage of NAC exceeds 70% of the total number of

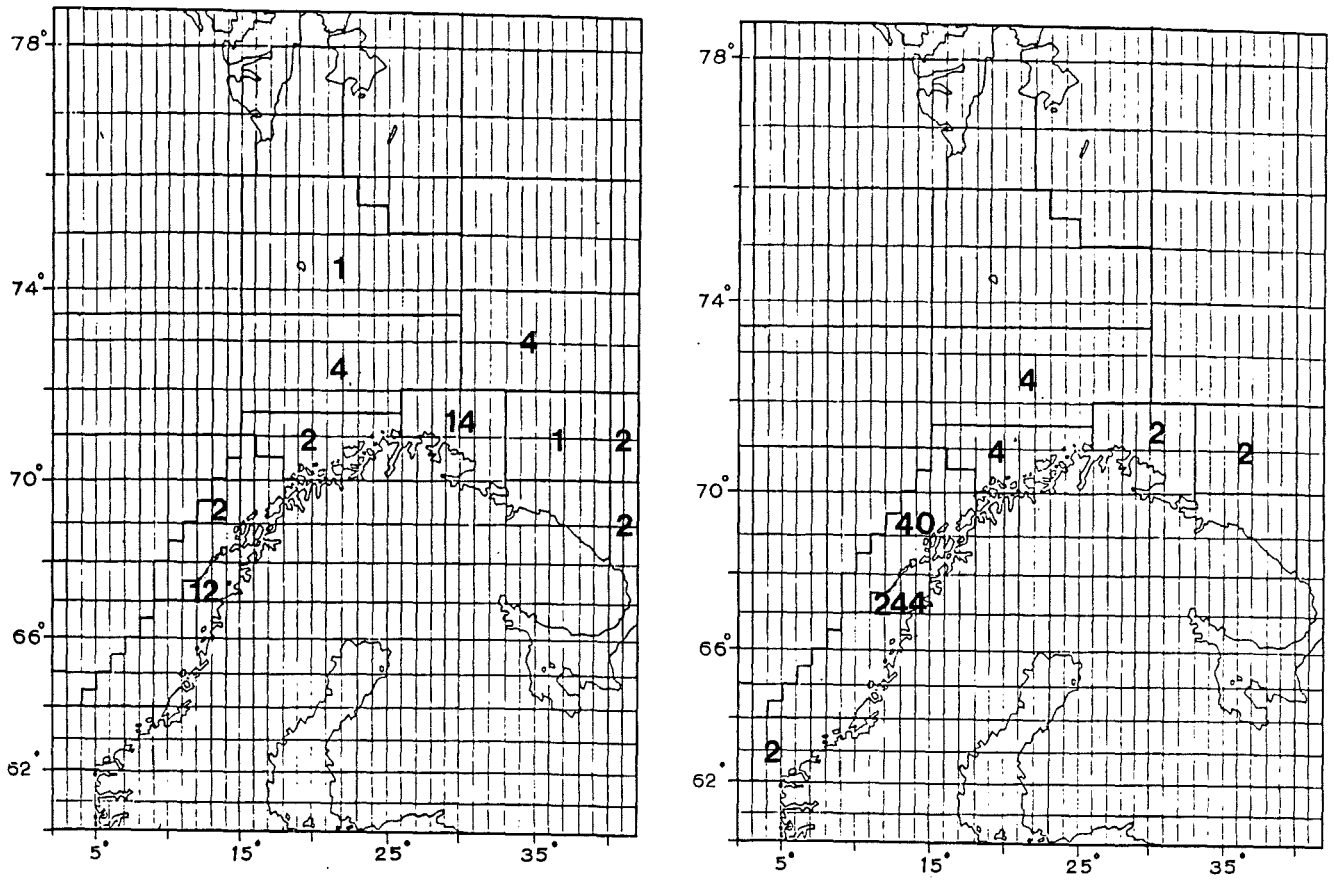

Fig. 2. Recaptures from the Lofoten experiment in 1975.
A) Feeding period B) Spawning season.

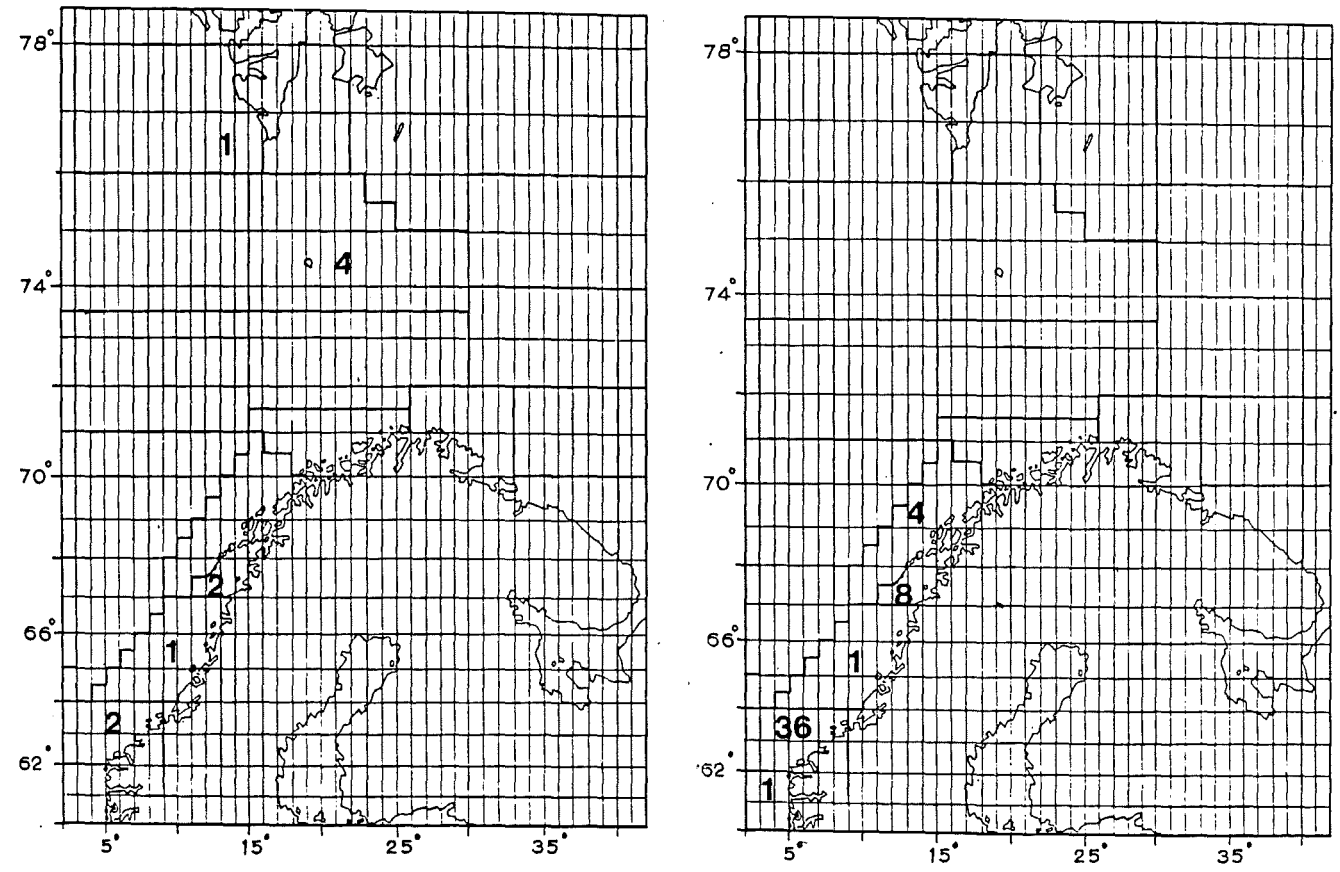

Fig. 3. Recaptures from the Møre experiments in 1975.
A) Feeding period B) Spawning season.

cod released are included. This percentage is based on samples of otoliths from catches of cod which are thought to be representative of the released cod.

The information from recaptures taken during the first month after release are considered to be biased due to changed behaviour and incomplete mingling. Recaptures during the spawning season of tagging are consequently not included in the presentation. Reported recaptures up untill June 1982 will be analyzed. Reports with imprecise date or area of recapture are excluded.

Tagging experiments have been carried out in Lofoten in every spawning season since 1948. In the present paper those experiments in Lofoten which were carried out in the same years as the experiments off Møre (1975, 1979-1981) will be considered.

RESULTS AND DISCUSSION

The recaptures are divided into two categories:

- recaptures taken during the spawning seasons
- recaptures taken during the feeding period.

Reported recaptures during the two periods are shown in Figs. 2-9.

The feeding period

A substantial part of the recaptures in the feeding seasons came from the tagging area, particularly for those cod tagged off Møre (Figs. 2-9). Otoliths from 34 cod that were marked off Møre and subsequently caught during the feeding periods were available. These were divided into three categories according to the otolith zonation: Coastal cod, North-east Arctic cod and a transition type,

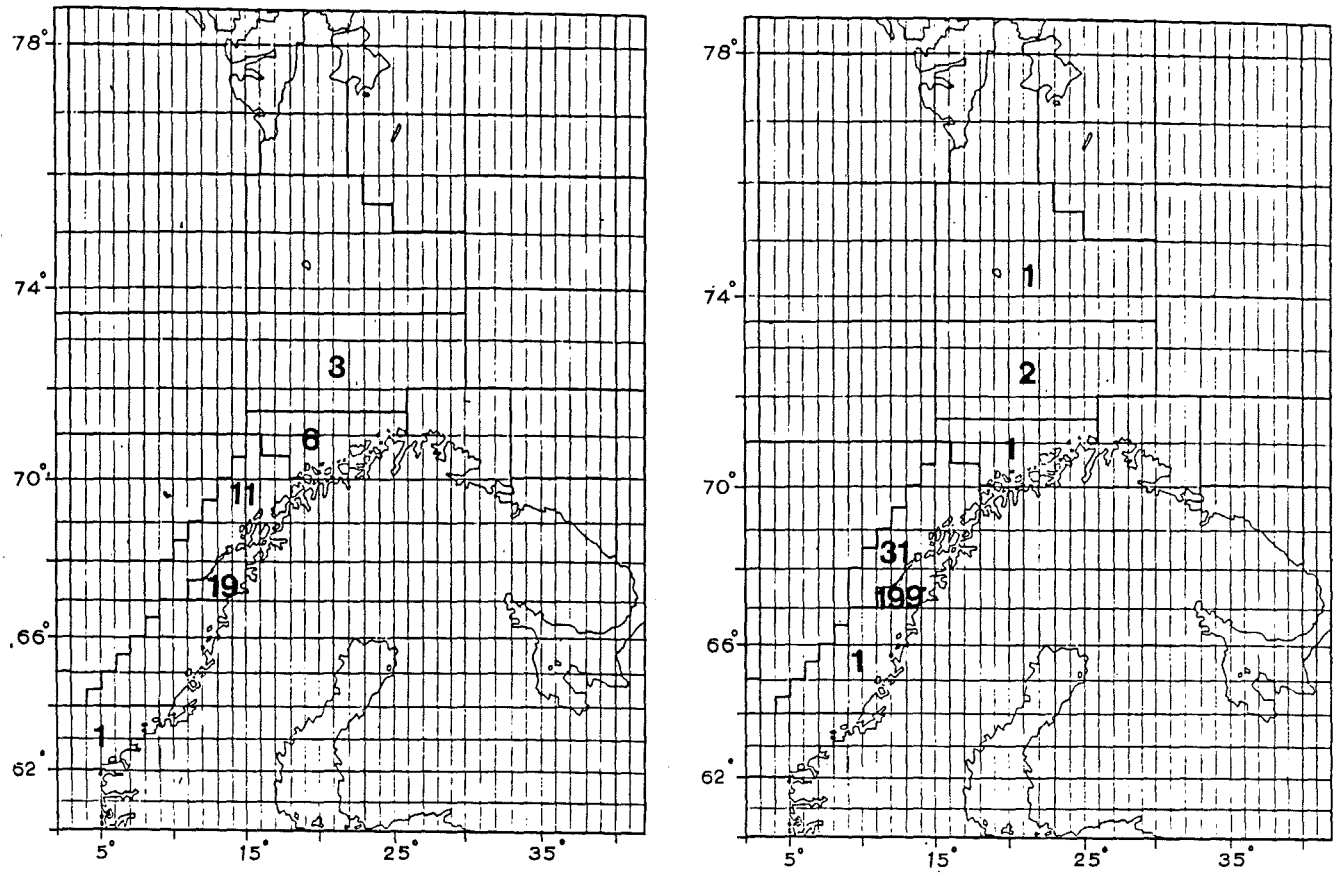

Fig. 4. Recaptures from the Lofoten experiment in 1979.
A) Feeding period B) Spawning season.

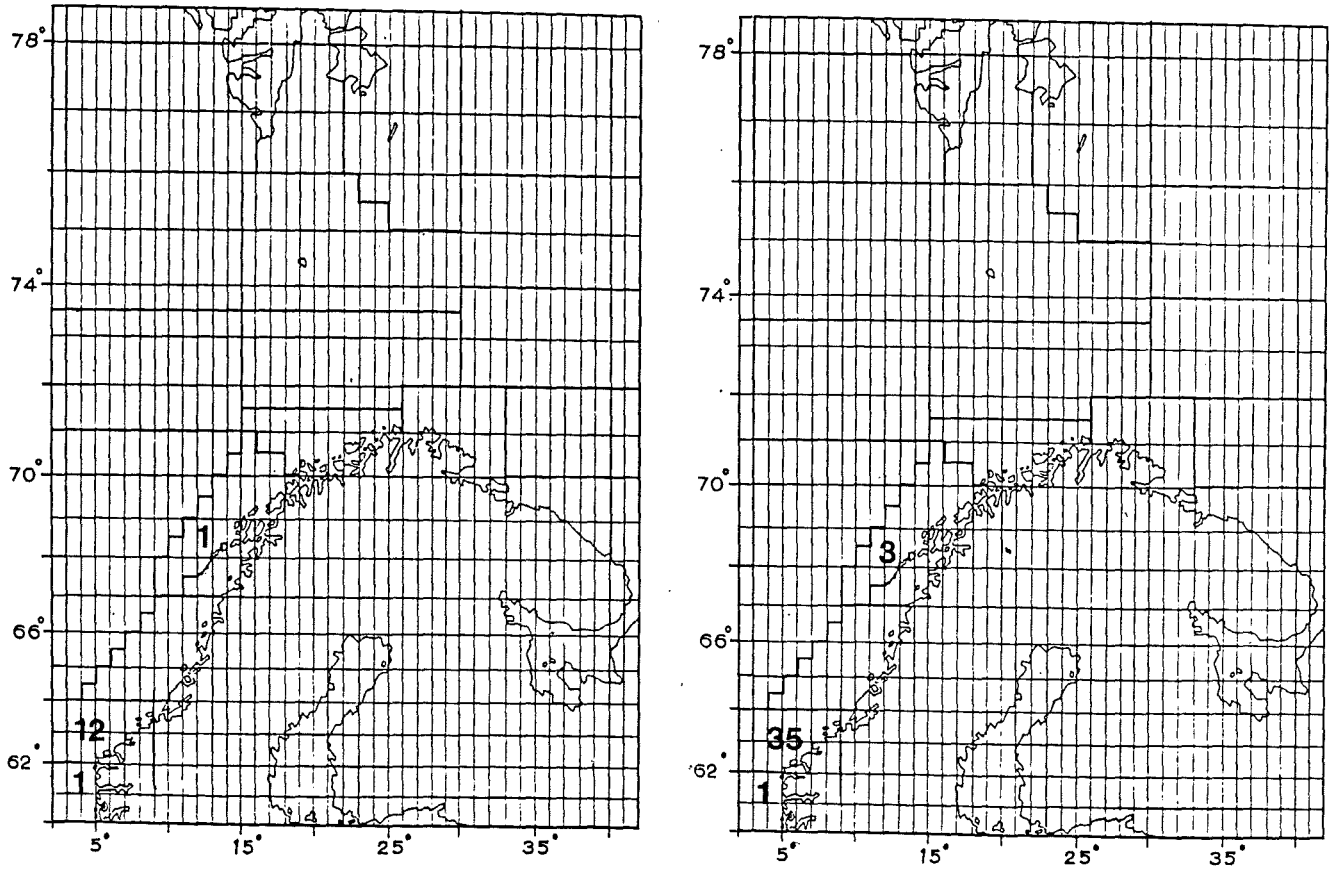

Fig. 5. Recaptures from the Møre experiments in 1979.
A) Feeding period B) Spawning season.

Area	CC type	NAC type	Transition type
From Lofoten and northward	0	15	3
South of Lofoten	11	5	0

The results indicate that the NAC do not necessarily migrate to the northern feeding areas immediately after the spawning season. Studies of otoliths from commercial catches has verified the presence of NAC on the Møre coast in June. A higher share of CC in the tagged populations from Møre, or simply that the Møre cod feeds on more southerly locations, may explain the higher recapture frequency on the southern grounds from the Møre experiments.

A comparison of the geographic distribution of recaptures from the two sets of experiments is impeded by the fact that the Møre cod has to pass through the coastal area from Møre to Lofoten before possibly mingling with the Lofoten population. If it is assumed that the Møre and Lofoten cod completely intermingle on the feeding grounds north of Lofoten, the recapture frequency of the two sets of experiments in the various statistical areas should be roughly the same. Figs. 2-9 indicate that Møre cod are more frequently caught in the western parts. To further analyze this, the results are summarized in Table 2. The eastern region covers the Barents Sea east of 30°E including all area 03 (Fig 1). The western region comprises the areas west of 30°E and includes areas south to Lofoten. The 1979 experiments gave rather few recaptures in the northern areas compared with the others. In addition all recaptures were returned from the western region. All other experiments gave a higher recapture frequency in the western region from the Møre releases than from the Lofoten ones. The possibility that this difference in geographic distribution is observed by chance, is less than one percent (Fisher-Irvin test (Hodges and Lehman 1970)). Taking together with the higher recapture frequency from the southern coastal areas of cod tagged in the Møre experiments (Figs 2-9), these results

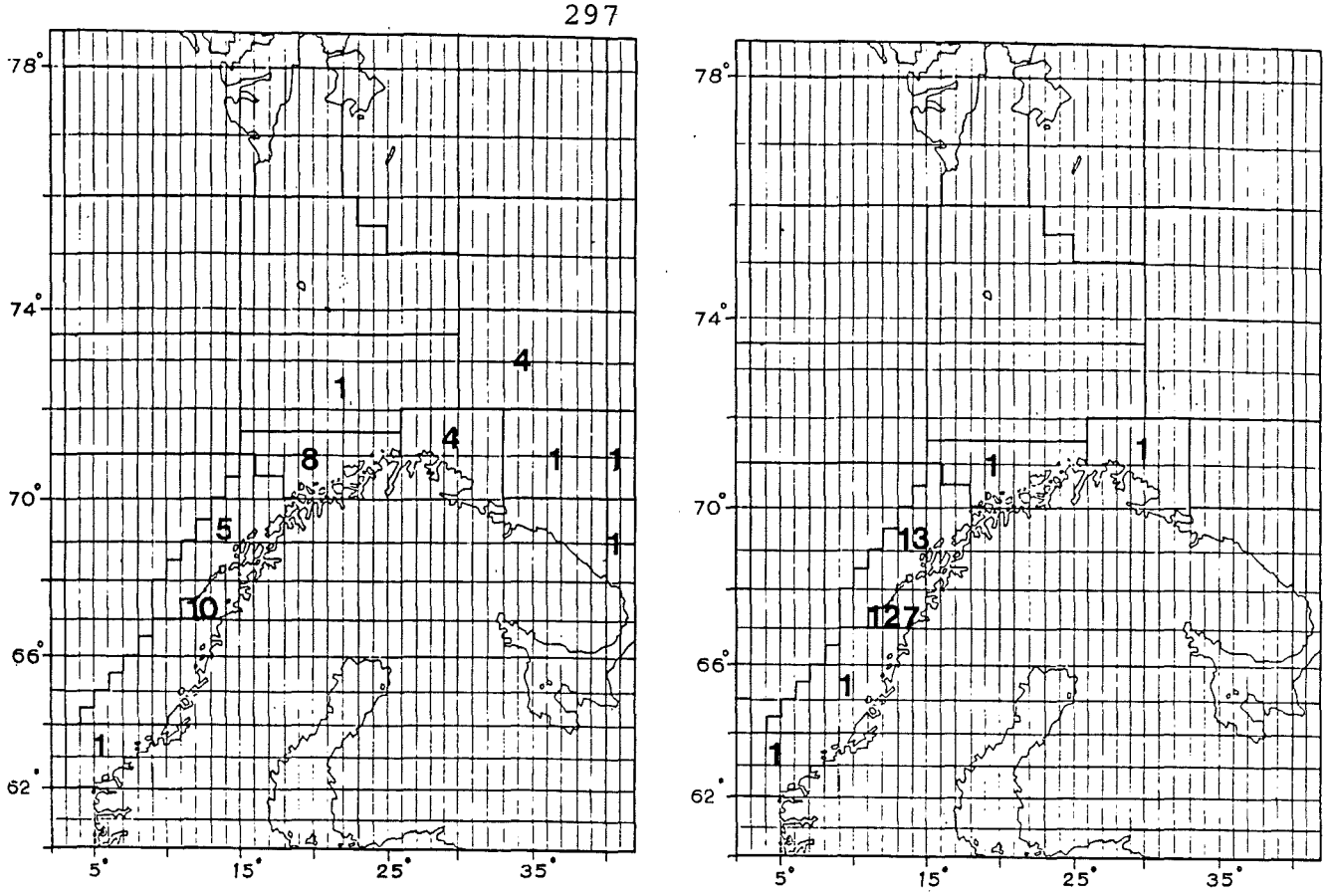

Fig. 6. Recaptures from the Lofoten experiment in 1980.
A) Feeding period B) Spawning season.

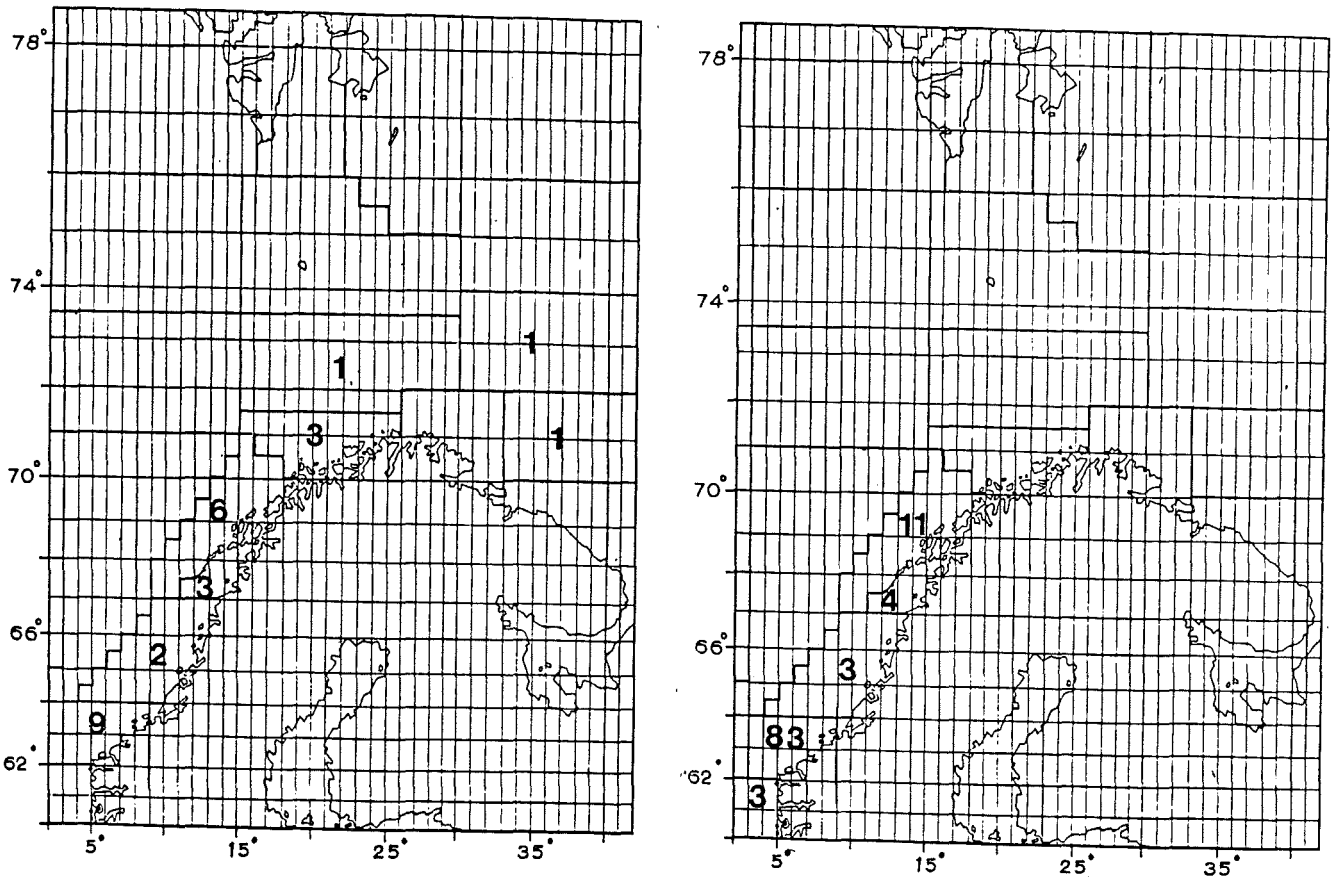

Fig. 7. Recaptures from the Møre experiments in 1980.
A) Feeding period B) Spawning season.

indicate that the main feeding grounds of the Møre spawning population tend to be more westernly and more southernly than those of the Lofoten cod.

Table 2. Geographic distribution of recaptures during the feeding period in the Barents Sea.

Tagging year	Tagging area	East of 30°E		West of 30°E	
		%	N	%	N
1975	Lofoten	72	23	28	9
	Møre	0	0	100	5
1979	Lofoten	0	0	100	20
	Møre	0	0	100	1
1980	Lofoten	44	11	56	14
	Møre	17	2	83	10
1981	Lofoten	40	18	60	27
	Møre	13	3	87	20
Total	Lofoten	43	52	57	70
	Møre	12	5	88	36

The spawning season

Reported recoveries from the spawning seasons following the years of tagging are shown in Figs. 2-9 and are summarized in Table 3. From 71% to 92% of all recaptures reported during the spawning seasons following the years of tagging were taken in the spawning area of release. The basic data show that 9% of the recaptured Møre cod were caught in Lofoten, while only 1% of the spawning season recaptures from the Lofoten releases were caught off Møre. Most of the tags from the Møre experiments reported from Lofoten were found before March 15. In the 1981 Møre experiment, which had the highest number of returns from Lofoten, 17 out of the 21 recaptured cod were caught

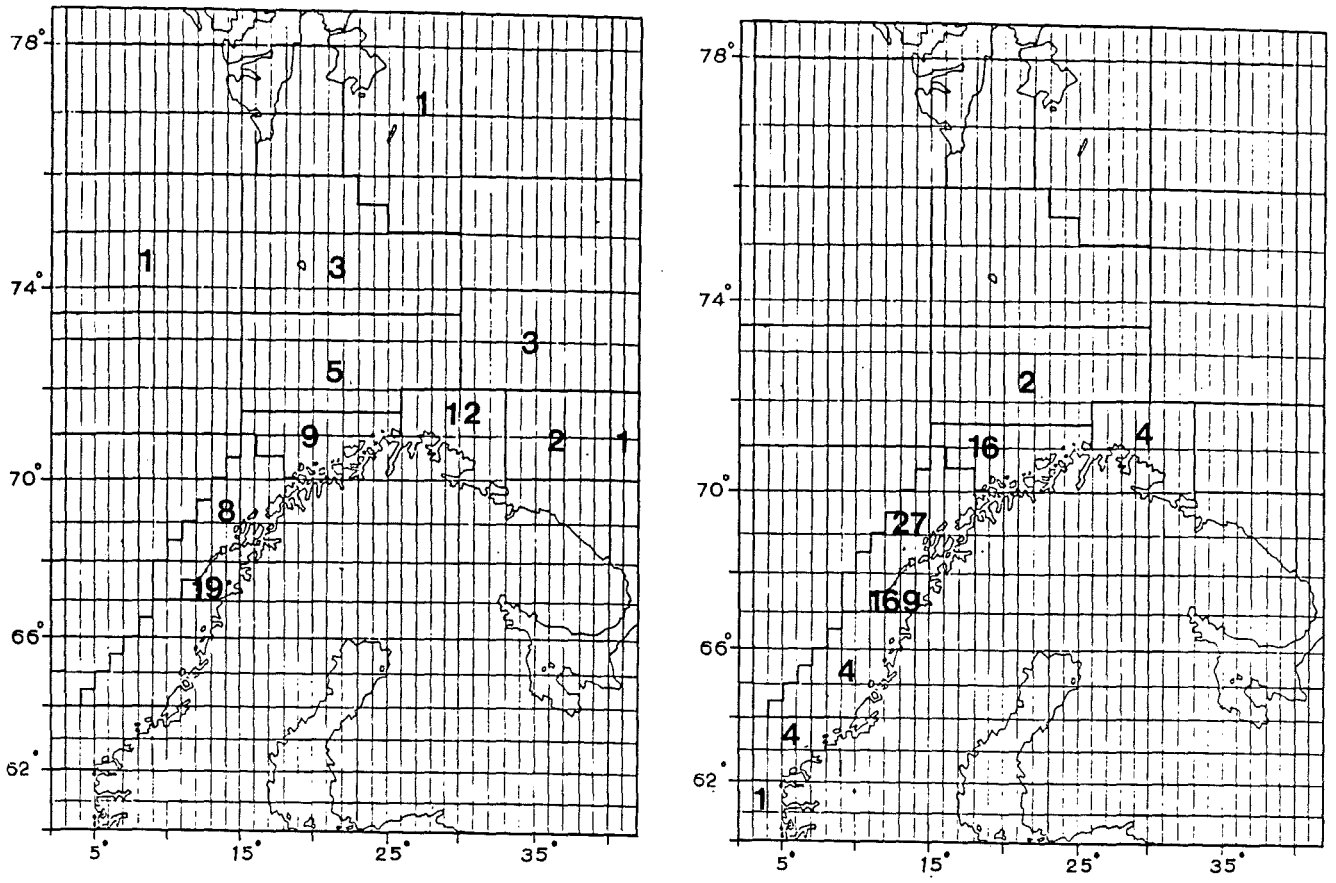

Fig. 8. Recaptures from the Lofoten experiment in 1981.
A) Feeding period B) Spawning season.

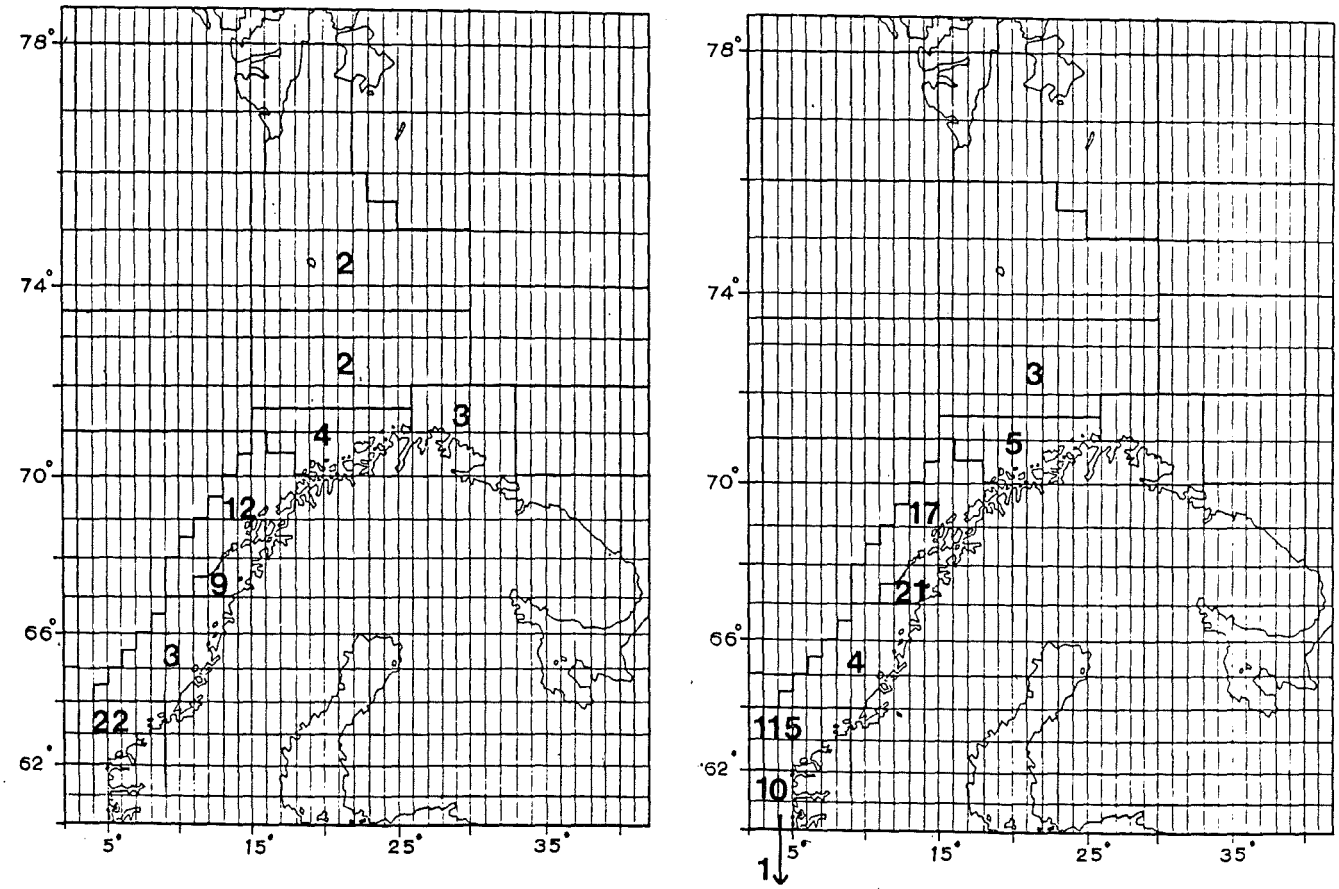

Fig. 9. Recaptures from the Møre experiments in 1981.
A) Feeding period B) Spawning season.

before this date. The highest spawning activity in Lofoten during the period 1976-81 has been recorded usually to be the first week of April (Solemdal 1981). The same peak spawning time has been shown for the Møre area in resent investigations (Godø and Sunnanå 1983). These results indicate that some of the Møre cod caught in Lofoten were probably on their spawning migration to Møre. The totals of 17% and 14% of the recaptures taken in other areas (Table 3), were mainly returned from north of Lofoten.

Table 3. Distribution of recaptures during the spawning seasons following the tagging years.

Tagging year	Tagging area	Number marked	Place of recapture: Lofoten %	Lofoten N	Møre %	Møre N	Others areas %	Others areas N
1975	Lofoten	2800	82	244	1	2	17	52
	Møre	225	16	8	74	37	10	5
1979	Lofoten	3400	85	199	0	0	15	36
	Møre	350	0	0	92	36	8	3
1980	Lofoten	1500	88	127	1	1	11	16
	Møre	780	4	4	83	86	13	14
1981	Lofoten	3800	75	169	2	5	23	53
	Møre	2000	12	21	71	125	17	30
Total	Lofoten	11500	82	739	1	8	17	157
	Møre	3355	9	33	77	284	14	52

Results of former tagging experiments carried out in Lofoten have shown a high return frequency to Lofoten, while reports from Møre have been scarce (Dannevig 1953, Hylen og Sætersdal 1959, Hylen, Midttun og Sætersdal 1961). The present results from the Lofoten experiments support their earlier findings. In addition the Møre taggings indicate homing to the tagging area

during repeated spawning to nearly the same extent as that found for the Lofoten experiments.

CONCLUSIONS

Tag recoveries from the northern feeding areas indicate that the Møre cod is more southernly and westernly distributed than cod from Lofoten during the feeding period. Cod from both spawning populations pass through roughly the same localities on their southward bound spawning migration till they reach Lofoten. The area outside Lofoten seems to be the most likely area of separation.

The presented results clearly show that NAC from Møre and Lofoten are not randomly interbreeding. It is thus indicated that the Møre and Lofoten cod belong to two more or less separated spawning populations of the NAC. Genetic studies have till now, however, not shown any differences between the two spawning groups (Reisegg and Jørstad 1983). Whether the return process is homing in the strict sense of the word, i.e. homing to the area of birth, cannot be answered with the data currently available.

The parallel tagging experiments off Møre and Lofoten have been carried out through a limited period only and thus the persistence of the observed situation is unknown.

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