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Bibliography

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MIGRATIONS OF CRABS (CANCER PAGURUS L.) IN NORWEGIAN WATERS

by

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INTRODUCTION

The crab fishery in Norway takes place mainly in the period August-November. The total catch varies normally between 2 -4000 tons yearly. About 90 per cent of the catch is used by canneries, and there is a close relation between the canneries demand for crabs and the catch. Only a small part of the catch is used for human consumption as fresh and frozen products, although the freezing industry and transportation of alive and newly boiled crabs to Sweeden have had a little improvement the last years.

Up to 1958 only little work had been done in Norway in studying the biology of the edible crab, but this year crab investigations were started and have up to this date made one yearly part of the research program on shellfish at the Institute. The main aim of the program was to study the biology of the crab including size composition, growth, migration and natural and fishing mortality. To obtain information on some of these questions, tagging of crabs was considered to be of great value, and the main part of the work at the beginning was to try different methods of tagging crustacea. Some results of these experiments are published (Gundersen, 1973 and 1976). This paper deals with migrations of the

edible crab in Norwegian waters.

MATERIAL AND METHODS

Crabs for tagging were partly fished by the Institute, but the main part from 1962 and up to 1972 was bought from commercial fishermen at Geitanger in the Hjeltefjord west of Bergen.

At the beginning the suture crab tag was used (Butler 1957, Mistakidis 1960, and Edwards 1964). Later on a toggle tag was used in all experiments up to 1969 (Gundersen 1963). This year also an improved suture tag was tried (Edwards 1964).

As the main objective of this paper is to determine crab movements, recaptures given in the figures are a summary of tagging experiments from 1962 up to 1972.

RELEASE AREAS

Table 1 gives the summary of tagged crab releases 1962 -72 and the recapture details to the end of 1976. The crabs were released in different areas west of Bergen.

The place Kjeldosen is located on the outer side of the skerries called Øygarden (Figure 1). To the west the bottom of the skerrie border on the North Sea is going slowly down to 300 m, and to the east, to the Hjeltefjord, it is going more steeply down to 2 -300 m depth.

The coastline here is characterized with numerous insels and sounds with possibilities for crabs to migrate in shallow waters along the coast in NW and SE directions on the outer side and through sounds to the inner side of the skerries.

The place Tofteholmene is only about 1 nautical mile to the east located at the inner part of the skerries border on the Hjeltefjord (Figure 3).

The place Geitanger is located at the bottom of the Hjeltefjord surrounded by deep water to the fjord to NW and more shallow water to insels and sounds to the east, south and west (Figure 5).

The release area Rotøy is located 1 nautical mile north of Geitanger surrounded by a depth about 200 m to the east, south and west and about 100 m to the north (Figure 7).

Of these places, the fishing intensity is highest at Geitanger and Rotøy with a fishing period from June to November, while Tofteholmene and Kjeldosen mainly are fished from August to November.

RESULTS

Figure 1 and Figure 2 give the details of recaptures of females and males released at Kjeldosen 1962. Females have migrated to the south and to the north. The longest distance is 15 nautical miles in air-line to the north. As the coastline here is very interrupted by sounds and insels, and the profile of the bottom is very rugged, the real distance migrated must be much longer.

The males, on the other side, seem to be more local when all recaptures are taken within 1 nautical mile from the releasing place.

Figure 3 and 4 give the migration pictures of crabs released at Tofteholmene. Tagged crabs are released every year from 1962 -72 except the year 1971. The migration pattern here seems to be mostly the same as in Kjeldosen. Females migrate to the north and the south with the majority moving to the south. Approximately one third are recaptured close to the tagging place, while the greatest part of the rest are taken within a distance of about 5 nautical miles. Only very few have moved for a longer distance up to 20 nautical miles in air-line which is the longest migration in this experiment.

The males are moving in a smaller scale than the females, about three fourth part are taken within 1 nautical mile from the

releasing area, and the rest are caught not longer away than 6 nautical miles. The greatest number are taken south of the release area.

At Geitanger tagged crabs are released every year from 1962 to 1972 in different numbers.

Figure 5 and Figure 6 give the details of recaptures from this area.

The difference in migration behaviour between females and males seems to be similar to other areas, but the distances moved by females are not long, mostly all recaptures are taken within 5 nautical miles while approximately all the males are recaptured less than 1 nautical mile from the tagging place.

At Rotøy tagged crabs are released in the same period as at Geitanger, but the number released is not so high. Figure 7 and Figure 8 give the recapture positions of females and males. Also here the females move longer distances, but in this case almost the same quantity, 90%, of recaptures of females and males are taken close to the tagging place.

According to the direction of movements, the majority of recaptures are taken south of the releasing area.

Approximately 15% of the tagged crabs were recaptured in the tagging year (Table 2), and most of the crabs were taken the year after tagging, about 69% of the females and 76% of the males. The recapture percent decreased rapidly the following year, and no recaptures were made more than five years after tagging.

DISCUSSION

It is obvious from these experiments that crabs are able to migrate considerable distances, and that female crabs move longer distances than male crabs. This is in accordance with other observations (Meek 1905 and 1906, Mistakidis 1960, Edwards 1964, Mason 1964, Hallbäck 1969 and Bennett 1976).

It is suggested by several authors that migrations of female crabs probably are related to breeding behaviour.

Meek (1905 and 1906) was of the opinion that the main part of migrating females on the Scottish east coast moved to the north.

Mason (1964), on the other side, observed no mass migration of either sex in either direction on the Scottish east coast, and Mistakidis (1960) did not observe any marked movement to the north rather than to the south on the east coast of England.

Brown (1975) has observed that a northerly migration of female crabs occurs along the whole east coast of England, and that these migrations probably are associated with the dispersal of the planktonic crab larvae which are carried south along the coast by the residual water movement.

Bennett (1976) observed movements of tagged crabs in a westerly or south-westerly direction in the English Channel, and he indicates that the migrations of female crabs probably are related to breeding behaviour and also associated with the dispersal of the planktonic larvae stages. He also indicates that a particular area in the English Channel may be a rich feeding ground for females because the autumn fishery in this area is based almost exclusively on large mature females with ripe ovaries. According to these studies in Norwegian waters, particular areas suitable for breeding crabs are not known.

The Norwegian tagging experiments are made in areas with very complex current systems. The tide make great changes in the current along the coast and through the sounds. At flow tide the water is running along the coast on the outer side of the skerries, and in the Hjeltefjord in a northerly direction and through the sounds from west to east. In ebb tide the current turns round in opposite direction, but the residual water movement in this area has a northerly direction.

Taking all positions of recaptures together, it is likely to

assume that the majority of migrations have a southerly direction, and as a result of this, movement would be against the current, but it is evident that the rate of recaptures and places are affected by many factors.

As the fishermen in these areas only use small boats and mostly do their fishing close to their living places, recaptures of tagged crabs released far away probably give the most correct details of movements.

Having this in mind and cutting out for instance all recaptures taken less than 2,5 nautical miles north and south of the releasing place, it is only the females released at Tofteholmene which show distinct major movements to the south. Of 117 recaptures about 20% is taken north and 80% south of the releasing place.

Another factor which may affect the recaptures is the fishing intensity. Gundersen (1976) showed that fishing mortality is higher at Geitanger and Rotøy than at Tofteholmene, and that this was a result of a longer fishing period caused by the possibilities of selling crabs at the market in Bergen. In addition, the areas in the skerries south of Tofteholmene are fished more intensive than areas south of Tofteholmene.

As a whole, the fishing intensity is decreasing with the increasing distance from the market in Bergen, and this may have influenced the higher rate of recaptures south of Tofteholmene.

The chance for movement is partly dependent of the nature at the releasing place. Crabs released at Kjeldosen and Tofteholmene are able to migrate both in south- and northerly direction, while the surroundings to Geitanger and Rotøy are more complicated.

As a whole, the results of these tagging experiments show that crabs may move considerable distances and females at a higher extent than males, and if any relation exists between migration, breeding and dispersal of the planktonic larvae stages, the picture

of movements from the experiments made at Toftholmene probably indicate this.

SUMMARY

1. To study crab movements, 8505 tagged crabs were released at four places in the skerries west of Bergen.
2. The crabs were marked partly with the suture and the toggle tag.
3. Most of the crabs were recaptured the first year after release, 69% of the females and 76% of the males.
4. Females moved more frequent and longer distances than males.
5. The major part of movements were in a southerly direction against the residual water movements.
6. Longest distance moved was 20 nautical miles in air-line.

ACKNOWLEDGEMENTS

I wish to express my thanks to the crab fishermen for their interest in sending tags with informations of dates and places of recaptures and particularly to Nina Lorentz for all her work with the material, plotting all the recaptures on maps, typewriting and duplicating.

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Table 1 Summary of tagged crab releases 1962 -72 and recapture details to the end of 1976

Area	Years	Males			Females		
		Numbers released	Numbers recaptured	%	Numbers released	Numbers recaptured	%
Kjeldosen	1962	47	7	15	164	42	26
Tofteholmene	1962 -72	842	278	33	1044	358	34
Geitanger	1962 -72	1543	693	45	2271	1104	49
Rotøy	1962 -72	1177	542	46	1417	696	49

Table 2 Details of recaptures in number and per cent at the different tagging places in subsequent years after release

Years after release	Kjeldosen		Tofteholmene		Geltanger		Rotøy		
	No.	%	No.	%	No.	%	No.	%	
0	7	17.1	81	23.1	137	12.4	78	11.3	
1	27	65.8	209	59.7	867	78.7	530	77.0	
2	7	17.1	43	12.3	81	7.4	61	8.9	
3			15	4.3	15	1.4	17	2.5	
4			2	0.6	2	0.2	1	0.2	
5							1	0.2	
Females									
0	2	28.6	28	10.1	61	8.8	57	10.5	
1	5	71.4	201	72.8	587	84.8	418	77.0	
2			27	9.8	39	5.6	55	10.2	
3			18	6.5	5	0.7	11	2.0	
4							1	0.2	
5			2	0.7					
Males									

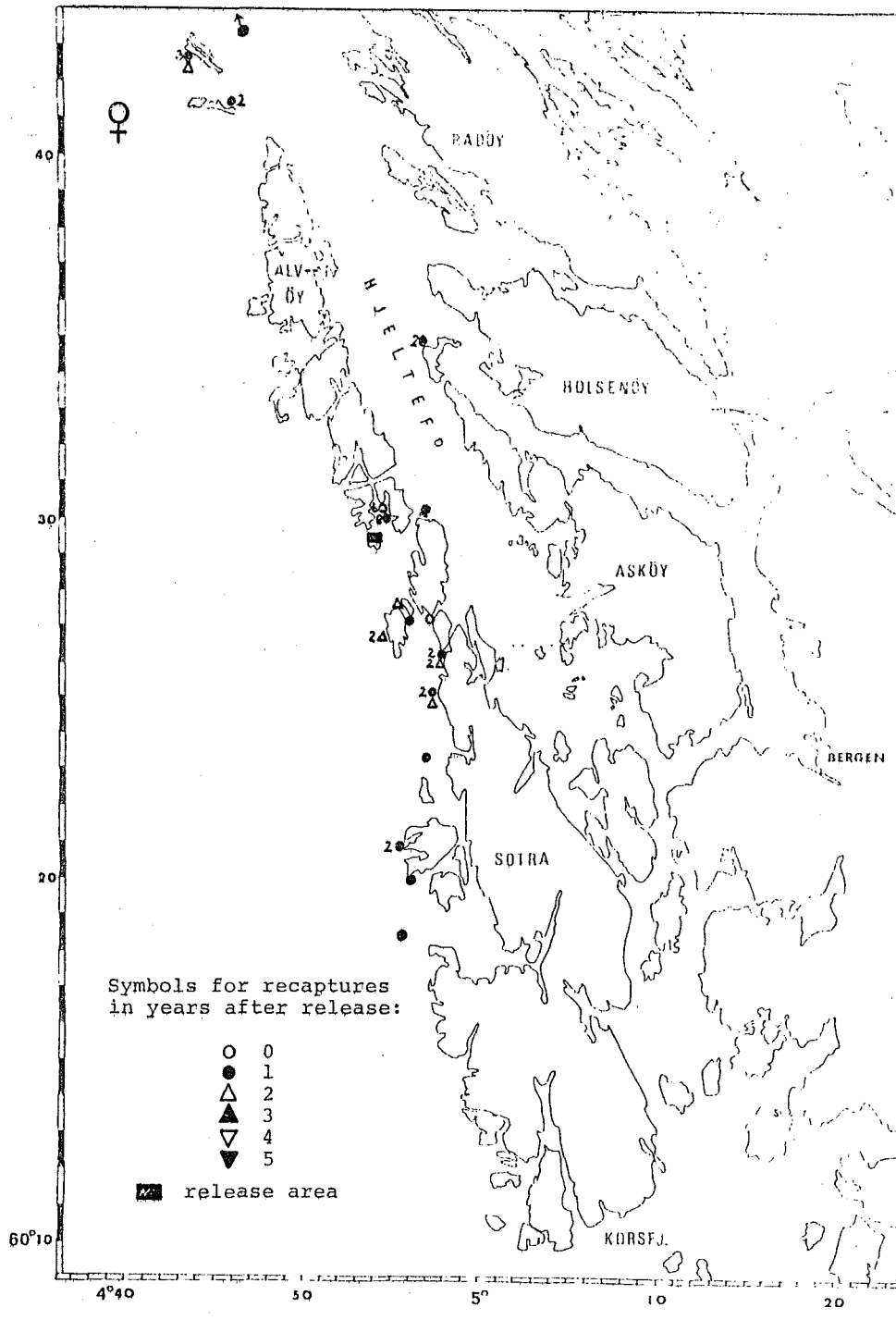


Figure 1 Recapture positions and time in years after tagging of female crabs released at Kjeldosen in 1962

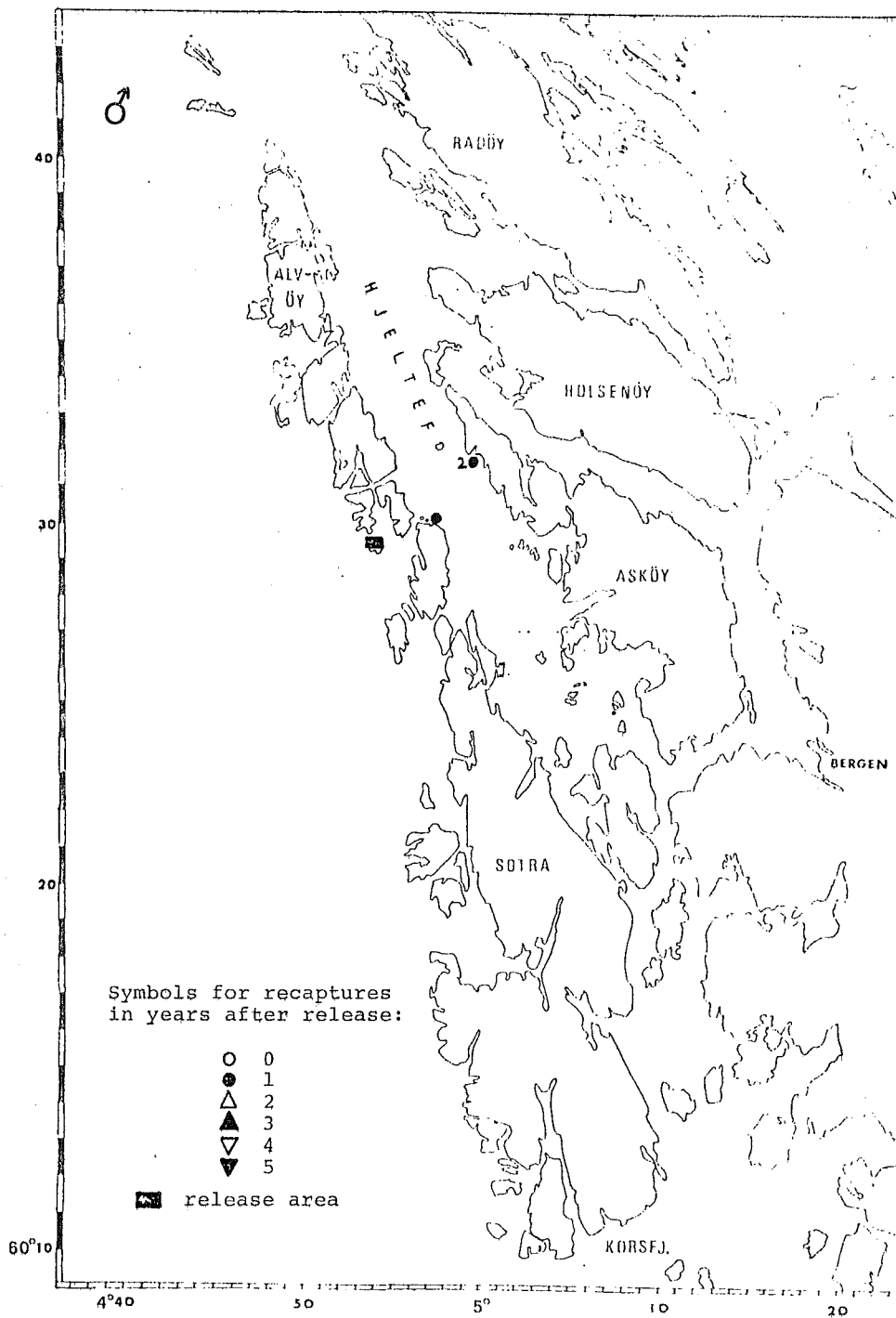


Figure 2 Recapture positions and time in years after tagging of male crabs released at Kjeldosen 1962

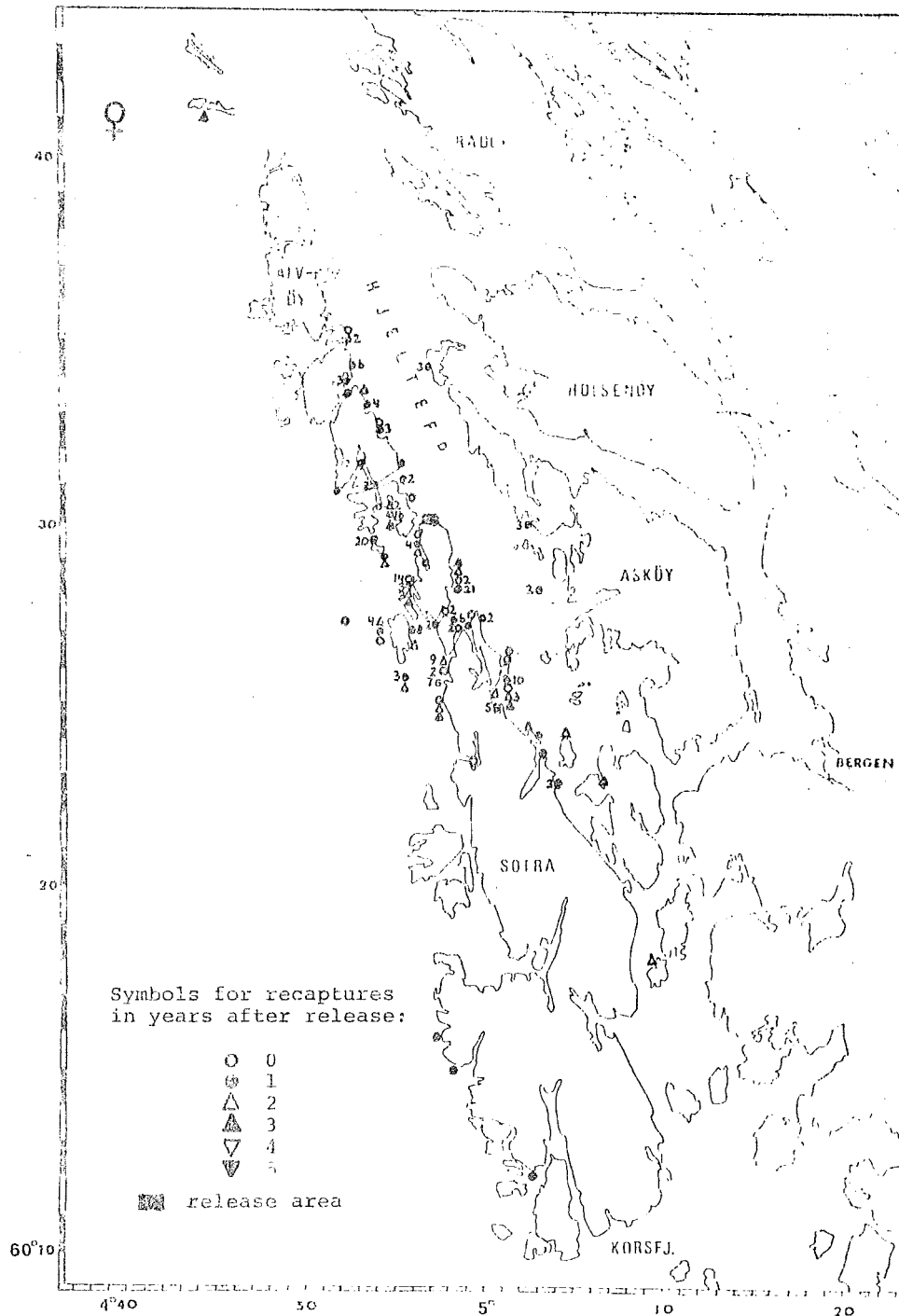


Figure 3 Recapture positions and time in years after tagging of female crabs released at Tofteholmene in the period 1962 -72

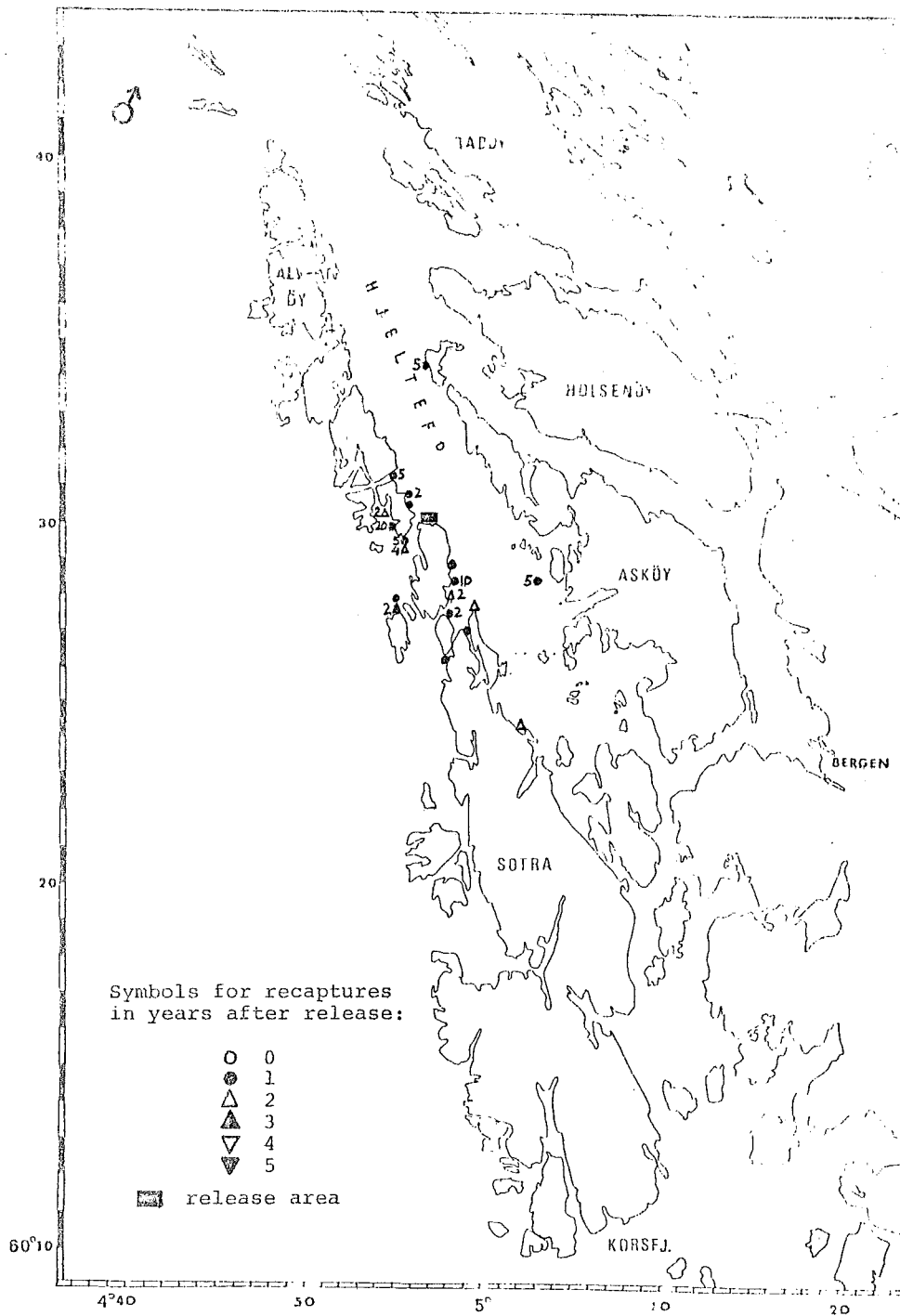


Figure 4 Recapture positions and time in years after tagging of male crabs released at Tofteholmene in the period 1962 -72

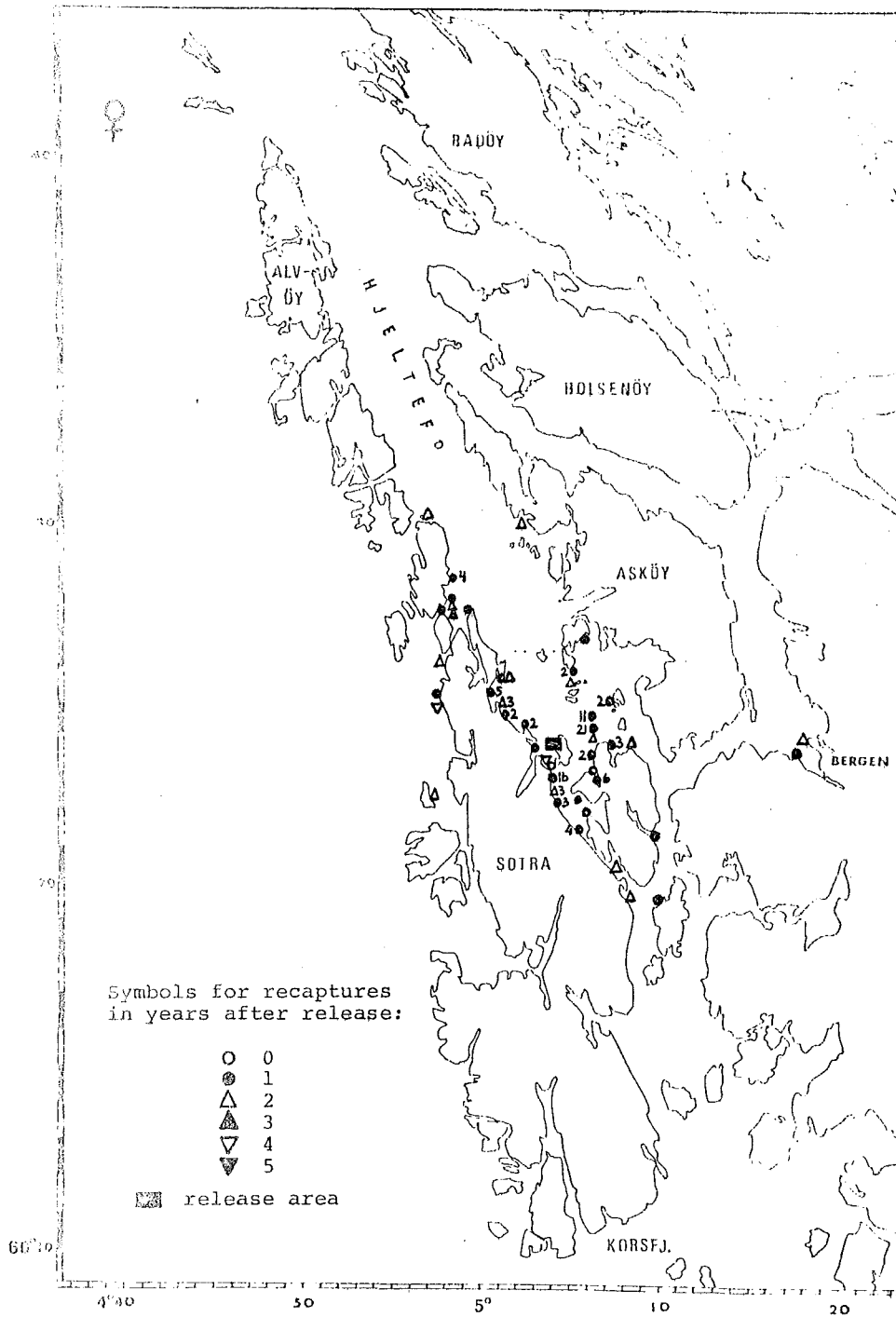


Figure 5 Recapture positions and time in years after tagging of female crabs released at Geitanger in the period 1962 -72

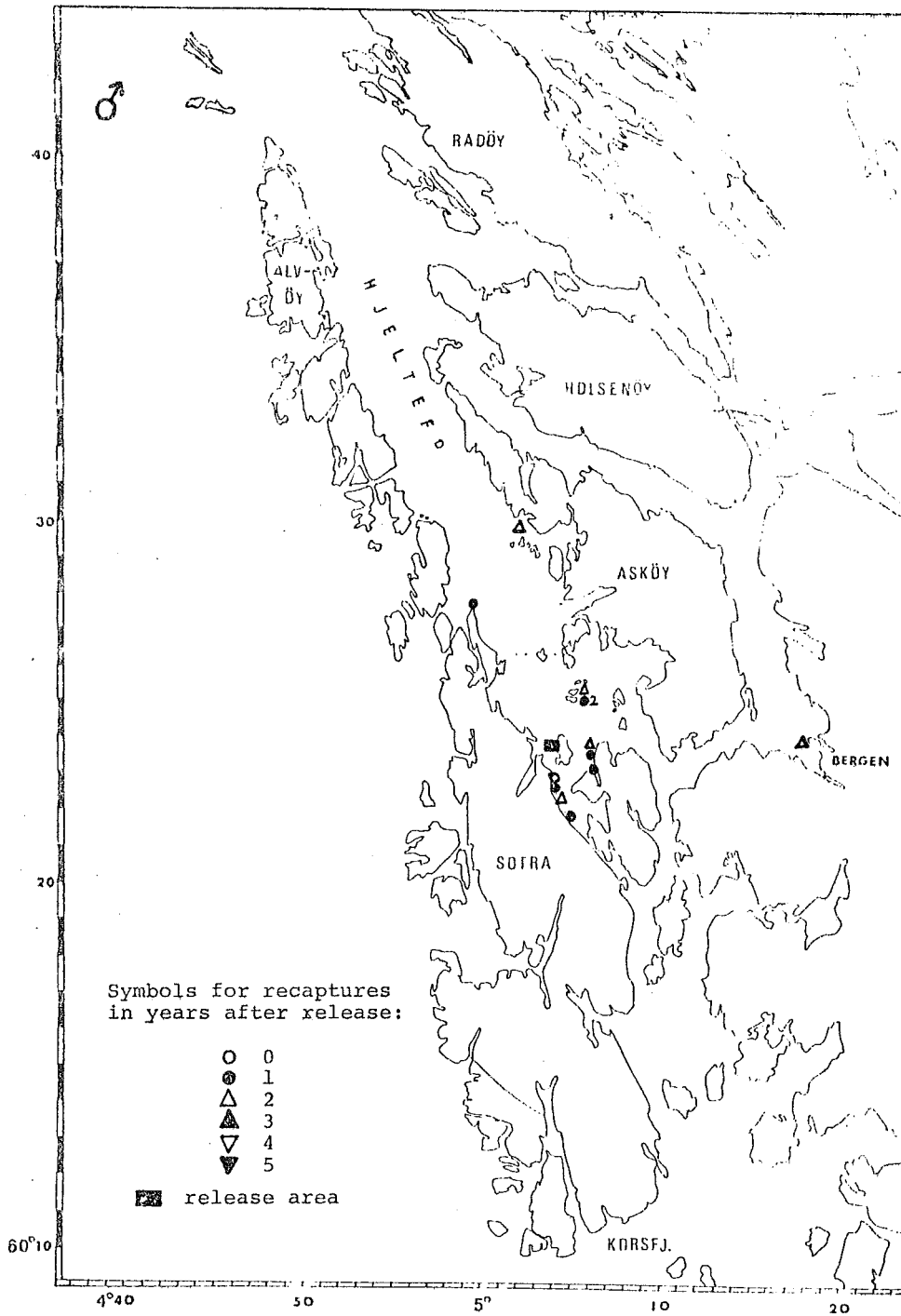


Figure 6 Recapture positions and time in years after tagging of male crabs released at Geitanger in the period 1962 -72 .

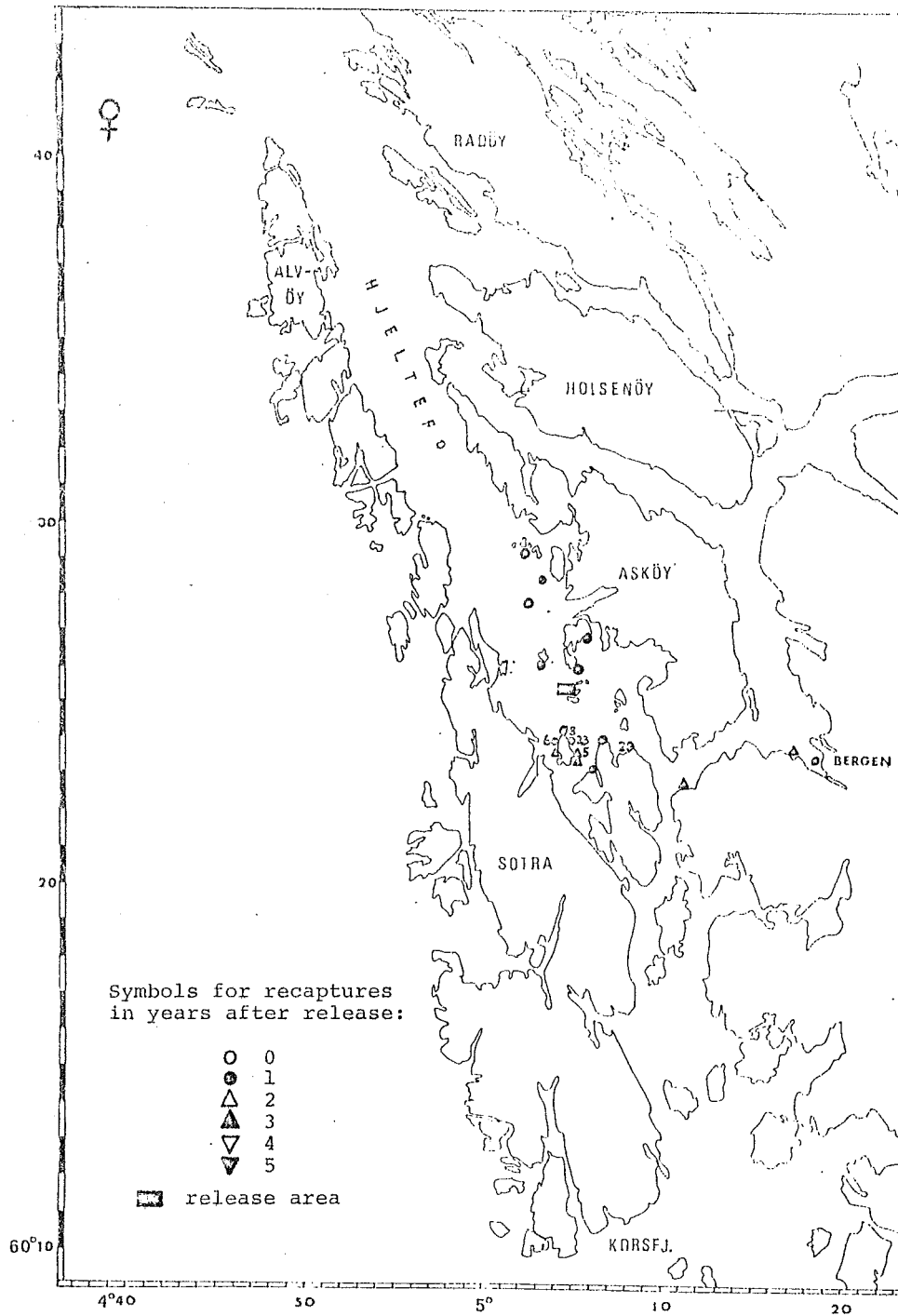


Figure 7 Recapture positions and time in years after tagging of female crabs released at Rotøy in the period 1962 -72

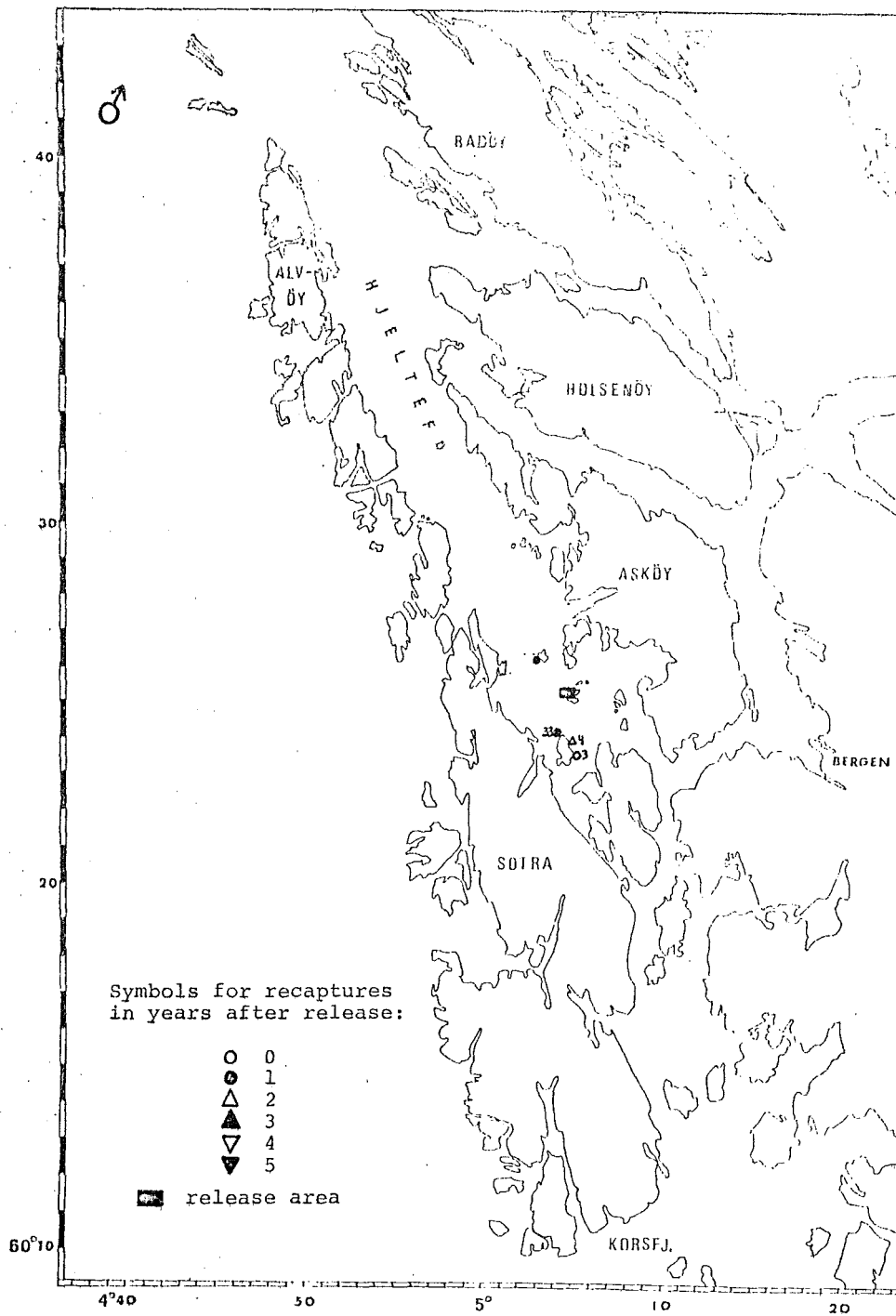


Figure 8 Recapture positions and time in years after tagging of male crabs released at Rotøy in the period 1962 -72