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On the subpopulations of plaice in the Southern North Sea

by

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In 1957 investigations were initiated on the structure of the plaice stocks in the Southern North Sea.

Plaice will spawn everywhere in dephts between 25 and 40 metres if the nature of the bottom and hydrographical conditions are suitable for spawning. Spawning concentrations are found from year to year in the same areas which therefore are called spawning grounds.

The principal theme in the investigations was to find out whether the North Sea plaice stocks should be considered as belonging to one main population in which the individuals may visit different spawning grounds in the course of their life (as suggested by Simpson 1959), or are composed of subgroups, each spawning in a special area.

In earlier publications (de Veen and Boerema 1959; de Veen 1961) the existence of subgroups could be demonstrated in the case of the spawning grounds in the Southern Bight and the German Bight. On the basis of a study of meristic characters - such as the number of vertebrae and finrays - of otolithstructures and of age-composition, growth- and mortality features, it was found that the two subgroups showed no appreciable mixing in the spawning season. Fig. 1 shows for instance, the constancy of form and mean value of the frequency distributions of the width of the 1st year-ring in the otolith of mature plaice for two yearclasses in the two areas in four successive years.

Tagging experiments on mature plaice showed that those tagged in the German Bight returned to the same spawning area in two successive years (fig. 2). Moreover the tagging results revealed that the two subgroups have a tendency to occupy different areas outside the spawning season.

Beside new tagging experiments in the two areas mentioned, additional taggings were carried out in the Flamborough spawning area in 1961 and '62 (together with English tagging experiments on mature plaice in this area), and also in a region situated between the three spawning areas in 1962. In this intermediate region a fair amount of mature plaice was found. It is however not certain whether these fish spawned there, or were on their way to a spawning ground in the vicinity.

The Flamborough taggings too demonstrated a return to the release area in the following spawning season (see fig. 3).

Unfortunately

Unfortunately, hardly any fishing at all takes place in the spawning season in the Southern Bight area, resulting in very few returns from there. For that reason we cannot tell from tagging experiments if some Flamborough or German Bight tagged plaice did not go to the Southern Bight area in the following spawning season. It is however interesting to note that no fish tagged in the Southern Bight area, has been returned from other spawning areas in the next season.

The total areas of distribution of the plaice tagged on the three spawning grounds reveal some general features. After spawning most of the fish migrate to feeding quarters at some distance from the spawning area. The spawning area itself is always situated in the southern part of the total area of distribution of each subgroup. The maximum distance covered by a tagged plaice migrating away from the spawning area is roughly the same for the three subgroups, and amounts to some 200 miles.

Of the plaice tagged in the winter of 1962 in the intermediate region up till now only returns of the first half year after liberation have been received. These results are in good agreement with the general features given for the three spawning areas.

In fig. 4 a schematic picture is given of the total areas of distribution of the different subgroups. The picture given for the taggings in the intermediate region is a provisional one, but these fish do show the tendency to be situated between those of the Flamborough- and German Bight subgroups. The picture of the Flamborough subgroup is largely based on the results of English tagging experiments. We are grateful to Mr. Gulland for allowing us to make use of the English data.

All the information collected thus far indicates that the vast majority of the plaice returns to the same spawning ground, and that outside the spawning season these groups remain fairly separated. How do we have to consider the nature of these groups ?

If the plaice selects the spawning area where it was born, we are dealing with selfmaintaining groups, which for our purpose will be called subpopulations.

On the other hand, it seems possible that the choice of the spawning area is more or less independent of the place where the fish is born. The spawning area, once chosen, will then be revisited in successive years, as has been shown above. In this case the name subgroups will be used.

Subpopulations occur when the fish maturing for the first time may find their spawning place by some sense of "homing", but other factors should not be excluded. In general, the hydrographical situation in the spawning season is rather constant in successive years for a given spawning area. That is why the eggs and larvae produced in this spawning area will

be

be transported to roughly the same nursery ground year after year. There is a fair chance that at the time of its first maturation plaice of this group will reach the spawning area where it was born. In extreme cases this could lead to subpopulations in the same way as when groups are maintained by a "homing"sense. In principle, the choice of a spawning area is, however, governed by other factors than in the case of "homing", and is the chance of mixing greater in the former case than in the latter.

A method to determine whether "homing" plays a role is a transplantation experiment of young immature fish.

In the past some experiments have been carried out, the results of which might give information on the subject.

In the period 1921 - 1931 plaice from the Moray Firth were transplanted to the Shetlands. Most of these transplanted plaice followed the local contranatant migration pattern around the islands and spawned there. (Bowman 1933).

In this case the fact that the Shetlands are connected with the Scottish mainland by only a very narrow bridge of a few miles wide at the broadest part and with depths between 40 and 50 fathoms might have made it extremely difficult for the plaice to return to the Moray Firth. Therefore the experiment cannot give much information for our problem.

In the beginning of this century another transplantation experiment was carried out. In May 1907 plaice of a size between 19 and 29 cm were transplanted from 10 miles north of Norderney to the south-east side of the Doggerbank (Reichard 1913).

In the first three months of 1908 - the first spawning season in the new surroundings - the recaptures of these transplanted plaice were distributed over a wide area (fig. 5a). A striking feature is, however, that of the 37 recaptures 10 were reported from the Flamborough spawning area.

Unfortunately, no information is available on the spawning area of the plaice occuring in the Norderney area in May 1907. A number of German experiments were, however, carried out near Heligoland. The recaptures in the spawning season of these experiments are shown in fig. 5b. They too demonstrate a wide distribution of the tagged fish in the next spawning season, but no recaptures were reported from the Flamborough spawning ground.

The results of the transplantation indicate that part of the predominately young plaice selected in the new surroundings a new spawning-ground, and the question arises whether they did follow the spawning migration pattern of the local Doggerbank plaice.

No tagging experiments were carried out in May 1907 which could give information on this local migration pattern, but in September 1908

three German tagging experiments were carried out only few miles to the south-west of the 1907 release area.

The recaptures of these experiments in the spawning season of 1909 suggest that this plaice did not visit the Flamborough spawning area (see fig. 5c).

It may therefore be assumed that at least part of the transplanted plaice, being of sizes from 19 - 29 cm with a mode at about 24 cm, will have matured for the first time in the spawning season following the transplantation. Thus the experiment does not support the view that "homing" plays a substantial role in the migration to the spawning grounds. Comparison of the various experiments leads to the conclusion that the transplanted plaice did not follow the migration pattern of the local plaice in the release area either. Comparison of fig. 5a and 5b suggests that the migrating plaice rather follow a certain compass direction. Further transplantation exper'ments are needed to solve this problem.

Thus the question remains open whether and in how far the plaice spawning in a certain area has also been born there.

This question may have some bearing upon the observation that the relative importance of the main spawning areas appears to have changed in recent years. The number of eggs produced in the German Bight area did increase in the last 25 years (Bückmann 1961). In 1955 it reached a level equal to that of the Southern Bight area. Dutch investigations revealed that in the year 1960 the density of the younger age-groups in the sub-group spawning in the German Bight was about one half of those in the Southern Bight group, whereas the German Bight group was in the period before the first world war of much lesser importance.

It is possible that the circumstances during the egg and larval stages or on the nursery ground have changed in such a degree that this led to an increase in the recruitment in the German Bight subgroup. In fact, there is evidence of such a phenomenon: the watertemperatures in the German Bight did change in the last 30 years. The average minimum-temperature in winter is somewhat lower, the average maximum-temperature in summer rather higher than before 1930 (Goedecke 1952).

Moreover, the growth-rate of the plaice of the German Bight subgroup accelerated, possibly owing to the same change in hydrographical factors. (Bückmann and Kotthaus 1935, Kotthaus 1959, see fig. 6). No such pronounced acceleration in growth-rate was found in the Southern Bight subgroup (Bückmann and Kotthaus 1935, Boerema (in preparation), see fig. 7).

The phenomenon of acceleration of the growth-rate alone may already have brought about an increment in the egg-production. There is evidence that the moment of first maturation in plaice is rather determined by the length than by the age of the fish (Wallace 1914, Simpson 1959, 1 ;

comparison of the data on spawning plaice in the Irish Sea (Simpson 1959, 2) with those of the Southern Bight and the German Bight in recent years.)

When plaice grow faster they will thus produce a higher number of eggs per age group than before, since the fecundity increases with length (and age). In cases the fishing mortality remains at the same level, a faster growing subgroup will therefore produce more eggs than a slower growing group. Unfortunately, no sufficient information is available about the fecundity in the prewar period in the German Bight to make an estimate of this effect.

Therefore, until the problem of the mechanism by which a plaice finds its spawning ground for the first time is solved, the probability should be taken into consideration that the German Bight subgroup could have increased through a supply of offspring from the Southern Bight subgroup.

Summary

The results of recent investigations on the structure of the plaice stocks by means of "racial" studies and tagging experiments reveal that the plaice in the Southern North Sea consists of several groups, each with their own spawning area and their own area of distribution outside the spawning season. The latter areas show only a moderate degree of overlapping.

Whereas the results indicate that the fish which once has spawned in a certain area, returns at least in great majority to the same area in following seasons, it is still unknown whether the fish spawning for the first time returns to the area where it has been born.

Transplantation experiments (data from literature) suggest that plaice spawning for the first time are not guided by a kind of "homing sense", but possibly rather follow a certain compass direction. Further experiments are needed to solve this problem.

The observation that of the three main spawning areas in the Southern North Sea the German Bight area increased in importance over the last 30 years is discussed. It seems possible that an acceleration of the growth-rate which did occur in the German Bight subgroup in the same period is at least partly responsible for the increase in egg production.

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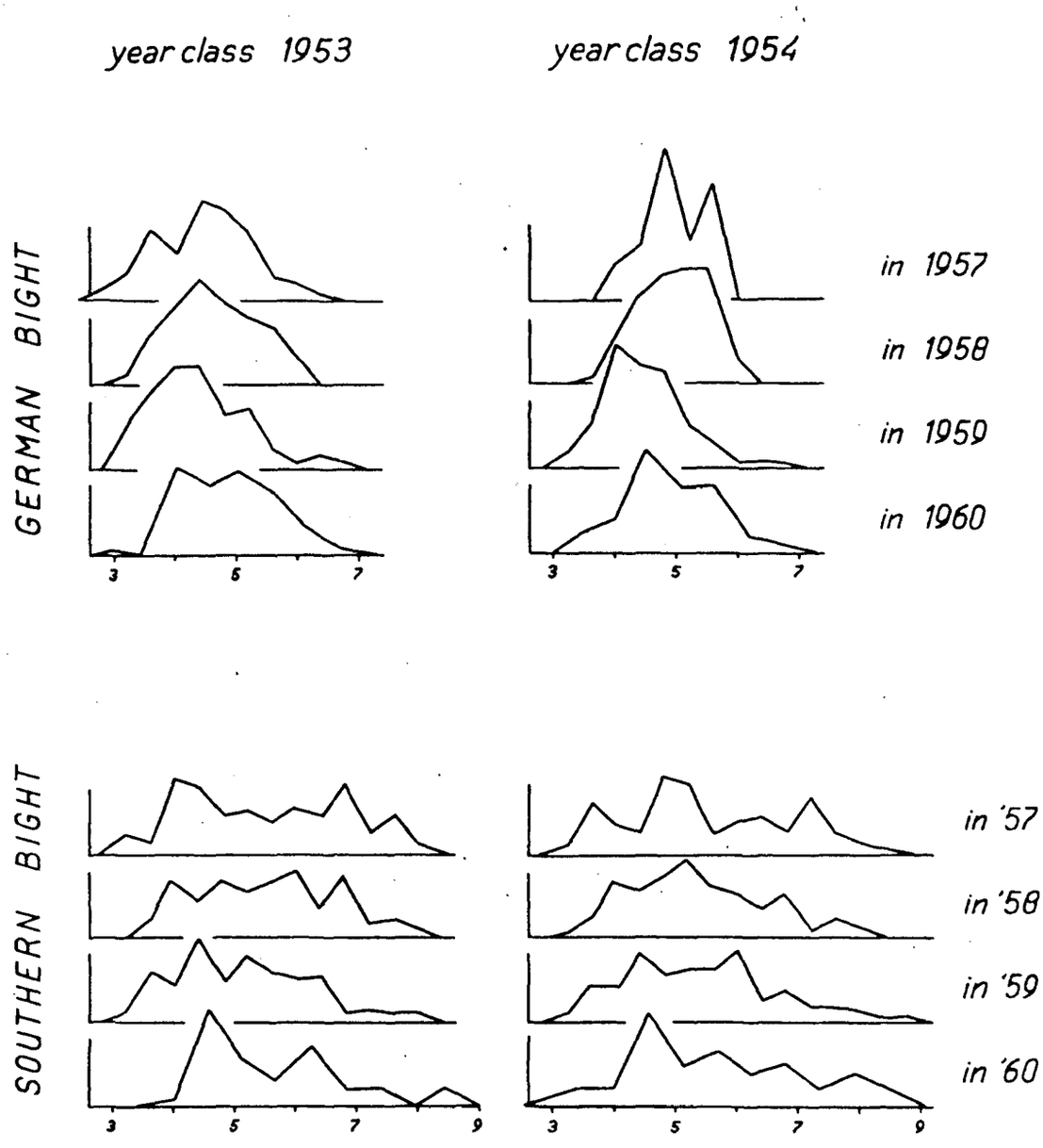
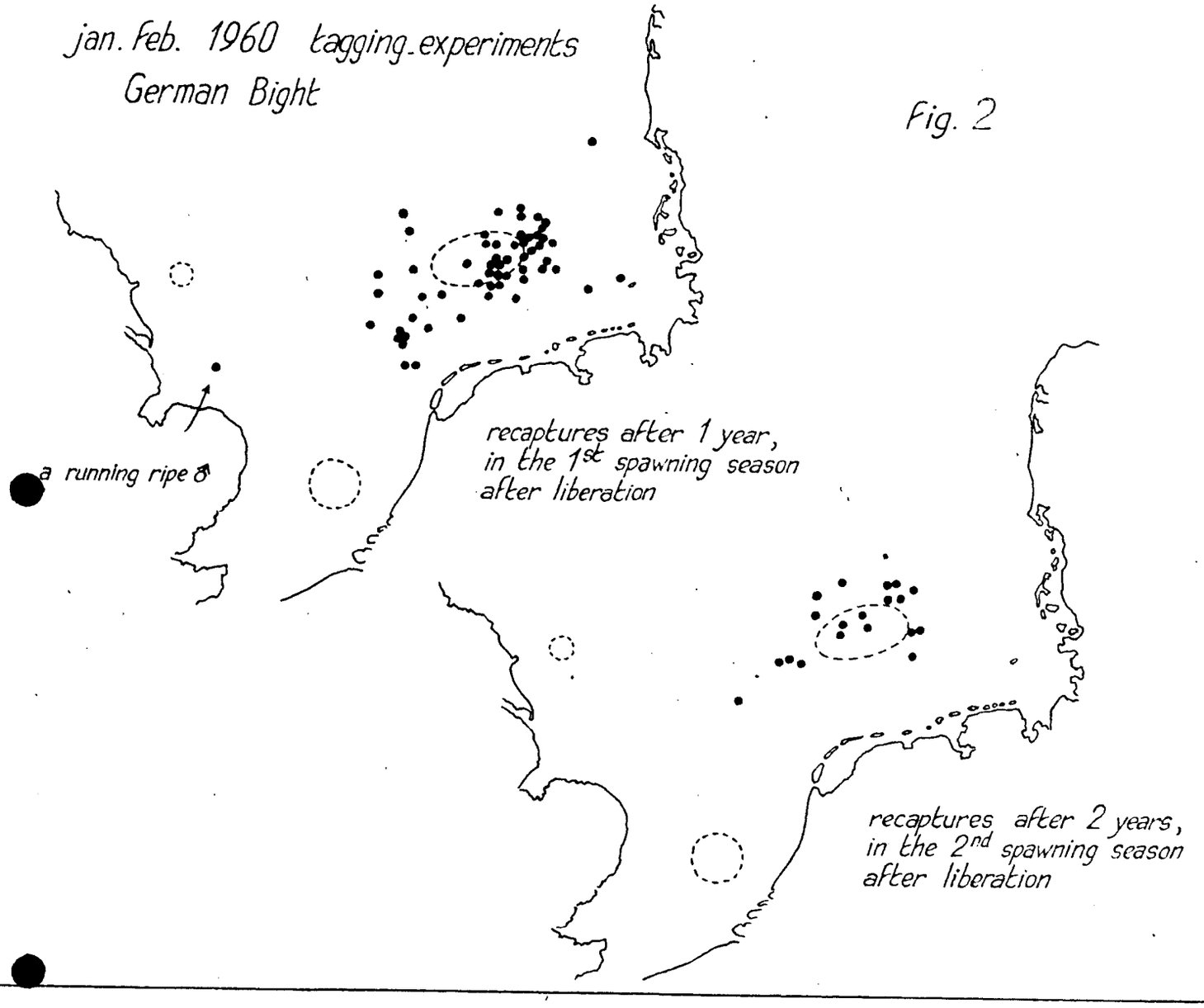
Fig. 1 Frequency distributions of the width of the first yearring in the otolith of plaice, spawning in different areas, in successive years



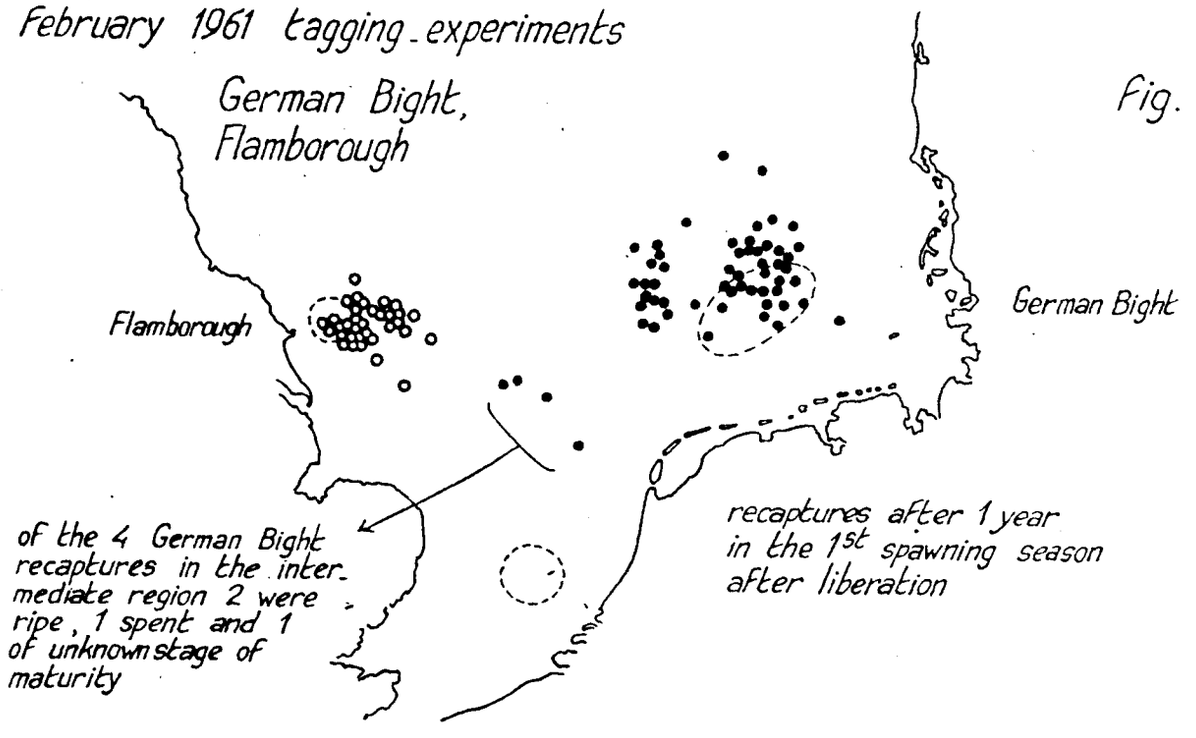
jan. feb. 1960 tagging-experiments
German Bight

Fig. 2



February 1961 tagging-experiments
German Bight, Flamborough

Fig. 3



SCHEMATIC PICTURE OF THE TOTAL AREA OF DISTRIBUTION OF PLAICE TAGGED MATURE IN FEBRUARY IN DIFFERENT SPAWNING AREAS

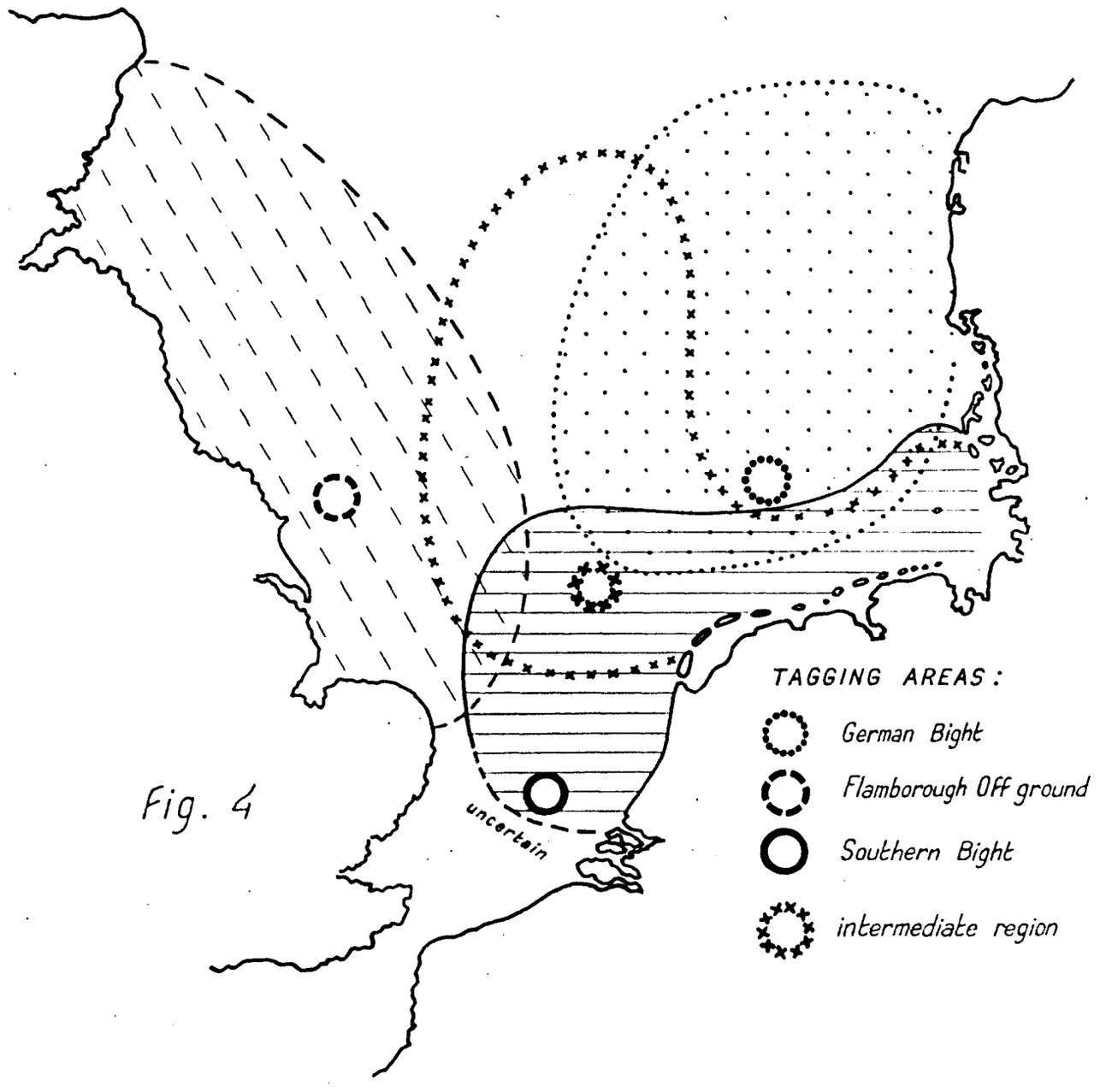


Fig. 4

Transplantation of young plaice . A.C. Reichard (1913)

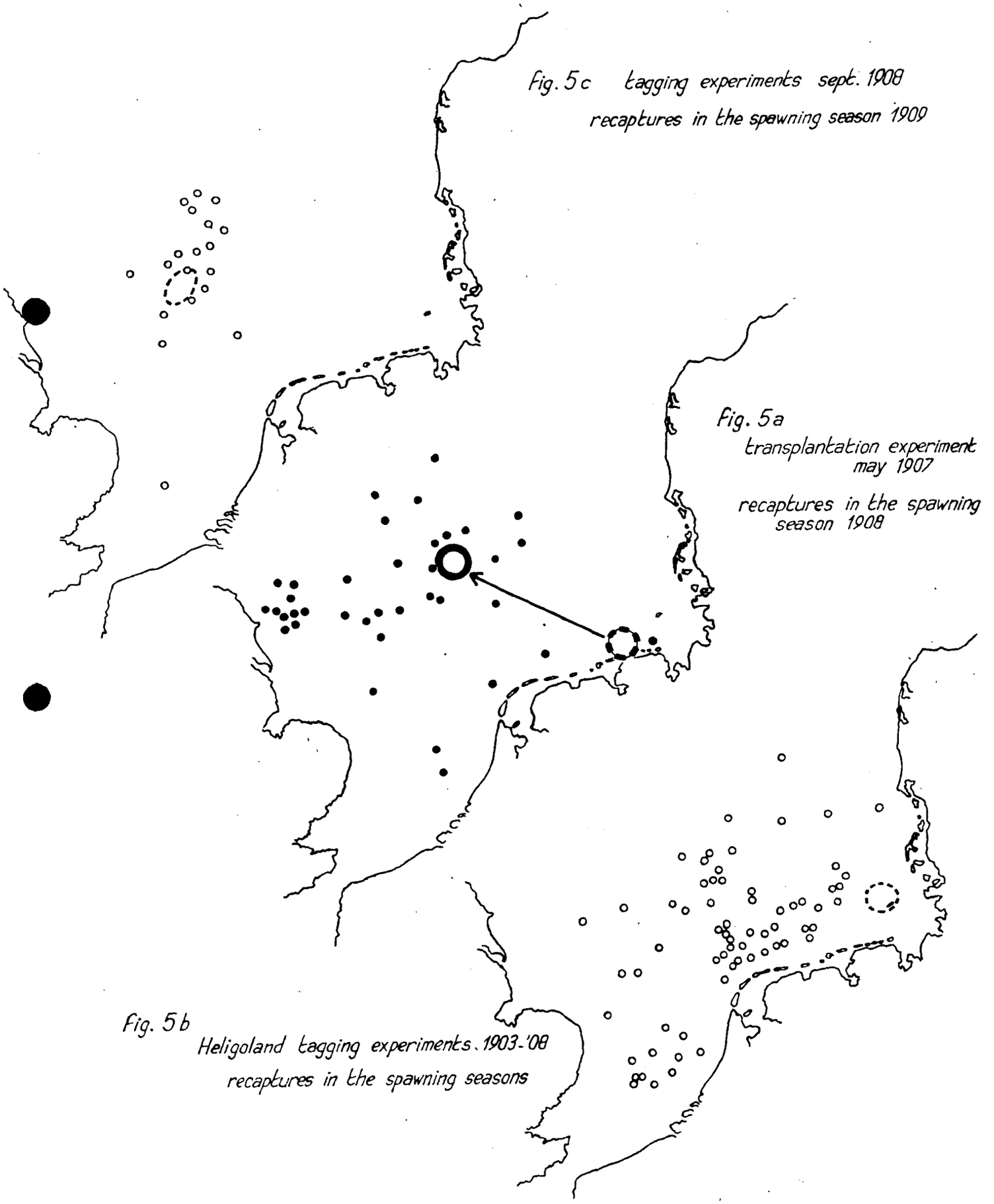


Fig. 5c tagging experiments sept. 1908
recaptures in the spawning season 1909

Fig. 5a
transplantation experiment
may 1907
recaptures in the spawning
season 1908

Fig. 5b
Heligoland tagging experiments. 1903-'08
recaptures in the spawning seasons

Fig. 6 average length of some age groups of plaice in pre- and postwar periods in May

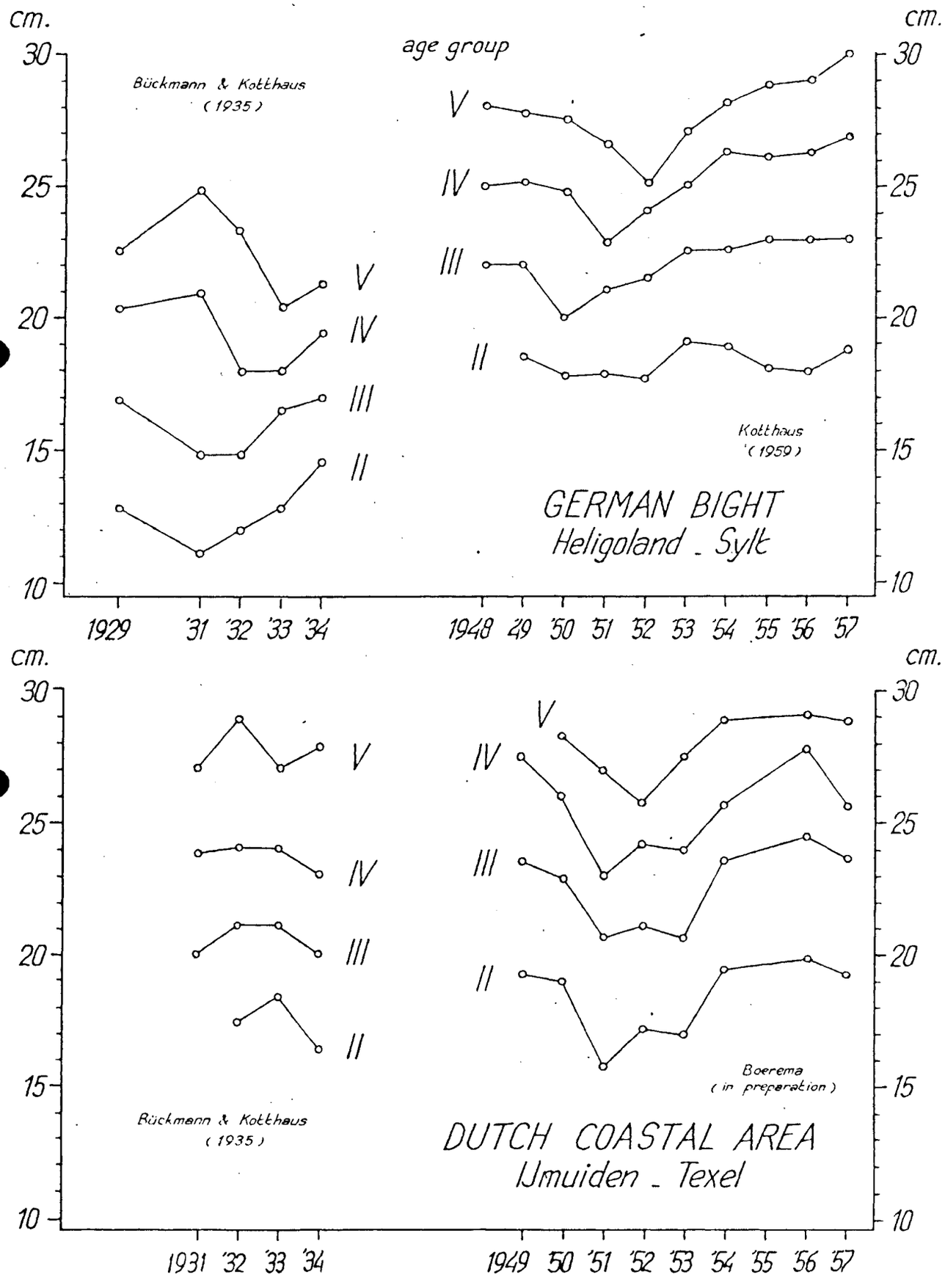


Fig. 7