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PRELIMINARY REPORT OF A DANISH-SWEDISH STUDY GROUP ON THE HERRING IN KATTEGAT AND ADJACENT WATERS.

Bornö, 10-14 June 1974

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1. Introduction.

1.1. The decline of the North Sea herring stocks and the conservation measures enforced in the North Sea and Skagerrak in the last few years have inevitably drawn attention towards herring stocks in adjacent waters.

Part of the effort released by the restrictions on the herring fishery in the North Sea has been diverted to waters west of the British Isles, to the Kattegat and the Baltic. To assess the effect of an increased herring fishery in these areas have consequently become of rapidly increasing importance and reports on such works are presented at this meeting on the Baltic (CM 1974/H:3) and the west British Waters (CM 1974/H:4).

1.2. In view of the fact that Kattegat has been rather neglected in this context the Danish and Swedish Fisheries Laboratories set up a Study Group to review the data available on the present state of the herring stocks and fisheries in Kattegat and adjacent waters, to attempt a preliminary assessment and to advice on the collection of pertinent data in future.

1.3. The Study Group met at the research station Bornö in Sweden during 1o.-14. June 1974. Participants were:

Dr. Hans Ackefors (Sweden)
Mrs. Inge Boëtius (Denmark)
Mrs. Britt-Maj Karlsson (Sweden)
Mr. Kristian Popp Madsen (Denmark)
Miss Ann-Christine Rudolphi (Sweden)
Mr. Bengt Sjöstrand (Sweden)

1.4. The names of areas mentioned in this paper refer to ICES system 27.3.02.00, the Kattegat (21), the Belt Sea (22), the Sound (23) and the western part of the Baltic proper (24).

2. The Catches.

2.1. Kattegat.

2.1.1. The herring fisheries in Kattegat are almost exclusively carried out by Denmark and Sweden. Total landings from 195o-1973 are shown in table 2.1. When possible the catches are divided on landings for human consumption and for industrial purposes (meal, oil and animal food) respectively.

2.1.2. In the early part of the period - up to 1960 - the combined Danish-Swedish catches kept at a level of about 20,000 tons a year except for 1957-58 when the industrial landings doubled. According to Jensen (1960,1961,1962) an invasion of 0 and I-group North Sea autumn spawners took place in those years and contributed strongly to the large industrial landings in Kattegat. From 1960-64 the catches increased steadily to a level of about 70-80,000 tons except for 1968 and 1973. The increase in 1968 was probably due to the relatively good yearclass of 1967 in the Kattegat spring spawners. The recent increase is undoubtedly due to transfere of effort caused by the poor herring fishery in the North Sea and the close seasons introduced for that area.

2.1.3. There were unfortunately no effort data available neither for the Swedish nor for the Danish Kattegat fisheries. In the latter case some indications can perhaps be obtained from the following table of the number of fishing gear available in the Danish Kattegat districts. The table shows average numbers by five years periods for 1950-1969 and for the last three years.

Period	Gill nets	Floating trawl	Herring trawl	Pair trawl	Industrial trawl	Total trawl
1955/59	7234	194	426	251	744	1645
1960/64	6880	302	528	345	843	2018
1965/69	5622	326	591	374	794	2085
1970/72	4828	289	446	307	695	1737

Apparently the number of trawls has declined in recent years and the decline from e.g. 1968 to 1972 amounts to 21%. This substantiates that the Danish increase in landings in the seventies is mainly due to a diversion of effort from the North Sea and Skagerrak into the Kattegat (and Baltic).

In case of the Swedish fishery a radical change in structure has taken place. From 1968 to 1972 the number of west coast boats with engine power above 100 H.P. decreased by 22% and the total engine power for this category by 35%. This is especially the case of the Bohuslän fleet which hitherto has fished in the North Sea and in the outer Skagerrak, but which has transferred its remaining vessels and effort to the Kattegat (and the Baltic). Over the last five years Kattegat has become the most important herring ground to the Swedish

west coast fishermen.

2.2. Western Baltic-Belt Sea.

2.2.1. The total catches in the Western Baltic and the Belt Seas kept a steady level of about 2o-3o,ooo tons until the middle sixties when they increased to about 4o,ooo tons. Since 1968 a decline has taken place mainly in the landings of adult herring by Denmark and FRG.

2.3. Other Waters.

2.3.1. The Sound is nowadays of very little importance to the herring fisheries. Trawling is prohibited and the small Danish and Swedish landings from gill nets have for many years amounted to about loo tons per year only. In 1971 an increase took place but the landings fell already in 1973 to slightly above the former level. It is noted, however, that dense shoals of herring have been registered on echo sounders in the Sound in recent years, that herring caught on hooks have been a major object to the sportsfishery in the area in winter and that herring caught by that mean have been tagged with great succes (see section 3.2.).

2.3.2. The Limfiord catches of herring for consumption as well as for industrial purposes have fluctuated without any clear trend over the past two decades. The fact that the industrial catches have kept at a rather steady level despite the recent decrease in the influx of young herring from the North Sea stocks could indicate an increase in the fishing effort. There are, unfortunately, no evidence in form of long term effort data to substantiate this.

2.3.3. Ringkøbing and Nissum Fiords. The reason for including these fiords of the Danish North Sea coast in the present paper is, that the spring spawners of these loca apparently spend the major part of the year in the inner Skagerrak and the Kattegat (section 3.2.1.). On their spawning sites these herring are only caught for human consumption and the catches are only of local significance. It appears that the catch figures are highly related and reflects parallel fluctuations in year class strength.

2.3.4. The Skagerrak is undoubtedly the most important of the waters adjacent to the Kattegat. Catch statistics for this area are,

however, collected by the "Assessment Working Group on the Herring South of 62°n.lat.". The Study Group found that the present administrative and statistical dividing line between Skagerrak and the Kattegat (the Skaw to Pater Noster) is highly artificial and, in fact, bisects the most important fishery having the harbour of the Skaw as its center. As time did not permit the Study Group to reach any firm decision on a more significant dividing line, it decided to leave Skagerrak out of consideration for the time being.

3. The Stocks.

3.1. Meristic characters.

3.1.1. Old as well as new investigations show that there are many herring populations with different meristic characters in the Kattegat in comparison with the North Sea and other areas in the North Atlantic. Johansen (1923) stated: "Während sich in Nordmeer und in der Nordsee verhältnismässig wenige Heringsrassen befinden, von denen die wichtigasten einen verhältnismässig grossen Verbreitungsbezirk haben, kommt im Kattegat eine Reihe von verschiedener Heringsrassen mit einem ganz kleinen Verbreitungsbezirk vor. Dieser Reichtum an Heringsrassen in einem so kleinem Gewässer wie dem Kattegat hängt ohne Zweifel zusammen mit den äussert verschiedenartigen und wechselnden klimatischen Verhältnissen, die dort herrschen."

3.1.2. Jensen (1965) presented VS-VP and VS-K_2 diagrams for the herring populations in the Skagerrak, in which he also included herring populations from the Belt Sea, the Kattegat and the North Sea. Jensen (op.cit.) distinguished in the Kattegat between spring spawners (Belt spring, Kattegat spring, N. Kattegat coastal spring, Atlanto Scandian (Bohuslän)), autumn spawners (Belts autumn, Kattegat coastal autumn, Kobberground, the North Sea Bank herring) and winter spawners (Kattegat winter).

3.1.3. It is obvious that many populations of herring may be found in the Kattegat. Some of these populations are spawning in the Kattegat. There are spawning herring in autumn, winter and spring as indicated by Johansen (1923) and Jensen (1949). The former said that it is possible to find spawning herring in all months except June-August. In addition to the spawning

populations there are herrings which spawn in other areas, e.g. the Belt Sea and the North Sea. These herring may be important in the fishery during certain parts of the year, e.g. the North Sea Bank herring during the winter fishery in the northern Kattegat (Johansen (1924)). In 1957/58 the number of young herring from the North Sea herring in the fishery was doubled. The strong 1956 year class of autumn spawning North Sea herring was subsequently very important in the Kattegat. Local spring spawning populations as in the Limfiord and the Ringkøbing Fiord on the western side of Jutland can also contribute to the fishery in the Kattegat (see tagging results, section 3.2.).

3.1.4. With regard to recent samples taken by Danish and Swedish laboratories VS-K_2 and VS-L_1 diagrams were produced (fig. 3.1.1.). The VS-K_2 diagram was constructed as by Jensen (1965) in order to check, if it nowadays is possible to distinguish all the populations stated by him.

3.1.5. The results show that the spring spawning populations in the Ringkøbing Fiord (VS 55.52-55.85; K_2 13.64-13.99), the Limfiord (VS 55.75-56.10; K_2 13.85-14.33) and off the Swedish west coast (VS 56.00-56.10; K_2 13.65-14.00) have the same range of values as the populations "Belt spring" and "Kattegat spring" in Jensen's paper. We have not been able, however, to find samples similar to those described by Jensen as "Belts autumn" (VS $<$ 55.9; K_2 14.0-14.65) and "Kattegat coastal autumn" (VS 55.8-56.2; K_2 14.3-14.8).

3.1.6. A number of samples consisting of autumn spawning herring from the open sea in the Kattegat with VS 56.07-56.60 and K_2 13.73-14.75 were available for the Study Group. The samples were taken at Groves Flak, Kobberground and Little Middelground. The range of the VS data and K_2 data was so wide that it was impossible to separate e.g. the Kobberground herring as described by Jensen with VS about 56.30 and K_2 14.35-14.70. Many Swedish samples taken before 1965 from the Kobberground have a VS about 56.30, but unfortunately very few analyses of K_2 data were available and most of the samples could subsequently not be included in the figure.

3.1.7. The wide range of VS and K_2 in the available Swedish and Danish samples (maturity stages V-VII) overlap the Kattegat coastal autumn, Kattegat coastal spring, Kobberground and the Fladen herring from the North Sea described by Jensen (1965). We have thus been unable to separate the well-known Kobberground population from other autumn spawning populations in the area between Anholt and Læsø in the open Kattegat. As most of the samples are taken before 1965, the decline of Kobberground herring since 1969, as indicated by Swedish larvae surveys 1969-74 (section 4.3), is not relevant in this case. North Sea herring, especially the strong year classes 1956 and 1960, may have been abundant in the northern Kattegat during the sampling time. This may explain the wide range of VS but not the very wide range of K_2.

3.1.8. The Skagerrak spring spawning herring spawn along the Swedish west coast in the Skagerrak and in the northern Kattegat. The herring are of Atlanto Scandian type with VS from 56.82-57.38 and K_2 from 13.75-14.48. The data are similar to those published by Jensen. We have, however, no sample of the Kattegat winter spawner, with VS around 56.80 and K_2 14.35 as Jensen has described.

The VS-L_1 diagram for the Ho Bay herring, Kattegat coastal spawner, Kattegat autumn spawner and the Atlanto Scandian herring indicates that L_1 is similar or overlapping (fig. 3.1.1.).

3.1.9. The limited time made it impossible for the Study Group to make a more thorough analysis of meristic characters for different herring populations. The Study Group wants to emphasize the importance of finding distinguishing characters between the North Sea autumn spawners and those of the Kobberground population, in order to evaluate the relative importance of the two stocks of autumn spawning herring in the Kattegat fishery.

3.2. Tagging Experiments.

3.2.1. An appreciable number of tagging experiments have been carried out in the Ringkøbing Fiord, Limfiord (Jutland), Isefiord (Sjaelland), in the Kattegat, the Sound and in the Belt Seas from 1949 to 1972. A major part was carried out by A.J.C.Jen-

sen, who has given a technical report, Jensen (1955), with a summary of his results. Experiments with mainly spring spawners were carried out in the Rinbkøbing Fiord (in 1971) and in the Limfiord (in 1951) (fig. 3.2.1.). Most of the recaptures came from the tagging areas within 3 months as indicated by the figure. A few recaptures from the Kattegat area and north of the Skaw and Hirtshals indicate a migration into the Kattegat area.

A German tagging experiment carried out in April, 1957, in the estuary of River Elbe (south of 54° N) on local spring spawning herring indicates a connection between the herring in the Kattegat and the one in River Elbe on the German North Sea coast. One herring was recaptured on the Swedish west coast in the northern Kattegat (Krefft (1957)).

3.2.2. Another tagging experiment at the northeastern part of Jutland in the Kattegat (fig. 3.2.2.) in April 195o shows a migration back to the Limfiord from the Kattegat. It also indicates migrations to the north into the Skagerrak area and to the south into the Kattegat.

3.2.3. Tagging experiments with spring spawning herring in April-May (in 1951, 1969, 197o) in the Isefiord (Sjaelland) show that this population spends the autumn and winter in the Kattegat or the Sound (fig. 3.2.3.). A migration in spring and summer to the Belt Sea and the western part of Baltic proper (Area 24, ICES system 27.3.02.00) is also indicated by the recaptures.

3.2.4. Four tagging experiments in March-April (1951-52) in the Belt Sea between Fyen and Jutland (fig. 3.2.4.) indicate that this herring have a very restricted migration and seem to remain in the spawning area during the adult life-cycle.

3.2.5. Tagging experiments with autumn spawning herring in October, 1949-50, in the Belt Sea between Fyn and Sjaelland (Fig. 3.2.5.) show that this herring migrated northwards into the Kattegat-Skagerrak area and to the south east into the western Baltic, where a part of the population spend winter and spring.

3.2.6. In October and November (1949-1972) tagging experiments were carried out with autumn spawning herring in the Sound (fig.

3.2.6.). The main part of the recaptures were taken in the western part of the Baltic proper in winter and spring and a minor part in the same time in the Kattegat and in the Skagerrak.

3.2.7. Tagging experiments in the central Kattegat in the autumn (September, 1968) with both spring and autumn spawners indicate a migration of herring from the Kattegat to the south and to the northwest (fig. 3.2.7.). A few receptures occurred both in the western part of the Baltic proper and in the northeastern North Sea in April-May. Another experiment with a majority of spring spawners in October, 1970, shows mainly recaptures along the Skagerrak coast (fig. 3.2.8.). Single recaptures from the southern Kattegat, the Sound and the Kiel Bight indicate some migration to the south.

3.2.8. The tagging experiments indicate that the herring in the Kattegat (Area 21), the Great Belt (the NE part of Area 22) and the western part of the Baltic proper (Area 24, ICES system 27.3.02.00) can be treated as one management unit. The herring in the Little Belt and the southern part of western Baltic (the southern and southwestern part of Area 22) should perhaps be treated as a separate management unit.

3.3. Growth.

3.3.1. Growth parameters were estimated by fitting the von Bertalanffy growth function to age-length data of the "pure-stock" samples.

Average length by age for the samples are shown in tables 3.3.1 to 3.3.5. For each area (except Ho Bay) samples were pooled and mean length by age calculated and used for fitting the growth curves. From Ho Bay samples the year classes 1946 and 1947 through 1951-55 were used. Tables 3.3.6. and 3.3.7. show the input data and the parameter estimates.

3.3.2. Comparison with older data, from the Limfiord 1939-1961 (Jensen(1964)) and from the Kattegat autumn spawners 1916-52 (Andersson (1954)) reveals that a substantial increase in growth rate has taken place during the last decades. Andersson (op. cit.) suggests density dependent growth as he found good coincidence between growth rate and year class strength. If densi-

ty dependence would be the main reason for growth changes, the gain in yield by reduced fishing mortality and/or mesh regulations will be less than indicated by the yield curves.

4. Towards an assessment.

4.1. Mortality Estimates.

4.1.1. As mentioned in the introductory remarks, Kattegat and its adjacent areas have been neglected in many respects from an assessment point of view. The Study Group had no data at its disposal concerning catch and effort distribution and apart from a restricted number of samples from the Swedish fishery on adult Kattegat herring since 1968 it had no biological data by which a break down of the total catches could be made. There were, however, data present in case of a few restricted areas like the Ringkøbing Fiord, the Limfiord and the Isefiord, which are spawning sites for some of the components of the Kattegat Stock complex.

4.1.2. Ringkøbing-Nissum Fiords. The fishery in these fiords on the Danish North Sea coast is solely carried out by poundnets, which are placed in positions and numbers according to traditions of long standing. It is, therefore, reasonable to assume that the fishing mortality generated in the fiords has been rather constant over the last two decades. Any change in mortality (assuming no change in natural mortality) should in that case be attributable to changes in the fishing intensity in these areas outside the fiords where the herring spend the time between spawning seasons.

4.1.3. As indicated in section 3, the fiord herring of the Danish west coast seem to migrate to the inner Skagerrak and northern Kattegat after the spawning season in April-June. In passing northeastwards along the coast in June-July the spent spring spawners of these stocks will go undeterred by any major fishery until they reach the area north of Hirtshals and waters east thereof. They are then apt to suffer another heavy fishing mortality in the area around the peninsula Skaw, which forms a very artificial administrative border between the Skagerrak and the Kattegat fisheries.

4.1.4. The main fisheries for herring in the Skagerrak take place in

winter (spent North Sea autumn spawners) and in August-September (mature Kobberground autumn spawners and recovering spring spawners). As both fisheries have declined since the middle sixties the Study Group found it reasonable to ascribe changes in form of increasing fishing mortalities to the development in the Kattegat area mainly.

4.1.5. Catch statistics from Ringkøbing Fiord are available since 19o9. Samples of the herring caught, however, are only available since 1965. From 1951 to 1965 samples were secured from the spawning in Ho Bay south of Ringkøbing Fiord. On the assumption of parallel year class fluctuations in the two areas, age distributions from Ho Bay have been applied to the total catch in Ringkøbing Fiord prior to 1965 in order to calculate the annual numbers caught per year class. The major source of bias in the results so obtained derives from the obvious lack of young fish in the Ho Bay-samples. The effect of this would be an overestimate of the numbers of older fish in years, when a comparatively strong year class entered the Ringkøbing Fiord as 2-group recruits. This would tend to an underestimate of mortality as calculated from the numbers of adult caught the year before. The opposite, of course, would occur if a small year class entered the catchable range of length in a certain year.

4.1.6. On the assumption, that the fishing intensity in Ringkøbing Fiord has kept at a steady level, total mortality rates can be calculated directly from the numbers caught per year class (table 4.1.6.). The results shown below are average values for the respective periods:

Period	$\bar{Z}$
1951-54	0.43
1954-58	0.88
1958-63	0.73
1963-65	0.60
1965-69	1.06
1969-73	1.83

It appears from these figures that the fishing mortality outside the fiord may have increased by more than 1.0 since the

fifties and that the adult herring known to spend part of the year in the eastern Skagerrak and northern Kattegat suffer a mortality here comparable with or even exceeding that of the North Sea adults in recent years.

4.1.7. The Limfiord fisheries. The main fishing gears in the Limfiord are pound nets, gill nets and the socalled floating trawl (a pair trawl with a light foot rope and a high opening). As to the former types of gear the same conclusions may be drawn as in section 4.1.3. In case of the floating trawl the situation is more intrecate. This gear is only legal from 1 October to 31 May and though the number of trawls "in circulation" has kept rather constant for the last 6-7 years, the actual effort as measured in hours of trawling shows big differences.

4.1.8. On the assumption, however, of a relatively stable effort over the last 5-6 years, the number caught per yearclass (table 4.1.8.) can be used directly for estimating the total annual mortality coefficient. The results are shown below:

Period	$\geq$ 3 gr/$\geq$4gr.	$\geq$ 4gr/$\geq$ 5gr.	$\bar{Z}$
1969/1970	1.81	1.75	1.78
1970/1971	3.27	-	-
1971/1972	1.50	1.61	1.55
1972/1973	2.25	-	-
$\bar{Z}$	2.21	1.68	2.o3

The Study Group had no data from former periods for comparison. Jensen (1964) estimated the annual mortality rate at 75-80 % from percentage age distributions averaged over 1939-1961. This could imply, that the fishing mortality in the Limfiord has been exceedingly high for many years. Even though adult herring are only caught during 2-3 months, an effect of changes in fishing intensity outside the fiord could be masked by the versatility of the floating trawl effort in the fiord.

4.1.9. In the inner part of the Isefiord which directly connects with the southern part of Kattegat the main gears are again pound nets and gill nets. Estimated numbers of herring caught per

year class are only available for 1969 and 1970 (Table 4.1.9.). As above a direct estimate of the annual mortality coefficient can be calculated on the assumption that with the gears in question there will be no important change in effort from one year to another. The result so obtained is $\overline{Z} = 1.65$.

4.1.1o. The recapture rate of the several tagging experiments may also give some information on the fishing intensity even though external tags are not very suitable for mortality calculations. The recapture rates from comparable experiments are shown below.

The Sound	1971	2o.5 %
"	1972	3o.3 %
Isefiord	1969	32.6 %
"	197o	34.o %
Limfiord	1951	39.2 %
Ringkøbing Fiord	1971	7o.7 %

Except for the Sound, where the tagged fish were released in an area without noteworthy fishing intensity, most recaptures from the other tagging sites were made shortly after tagging in the enclosed waters densely stocked with fishing gear. It seems therefore reasonable to assume, that the long term recaptures from the Sound-taggings, giving a recapture rate of about the same order of size as the"enclosed" taggings, indicate a mortality rate of the "freeliving" herring which is not very different from that measured at the spawning sites by the methods indicated in the previous sections.

4.1.11. On the evidence presented above the Study Group concluded, that the present fishing mortality in the Kattegat area could well be F=1.o or more for adult herring. As the industrial landings of small immature herring are equal to or exceeding those for human consumption, the Study Group also found it reasonable to assume, that the fishing mortality of the young herring is at least as high as that of the adults, even though an important part of the young herring may belong to exogene herring stocks as e.g. the North Sea autumn spawners.

4.2. Yield curves.

4.2.1. Yield per recruit calculations were made for autumn spawners in the Kattegat and for spring spawning stocks at the Danish west coast. Growth parameter estimations were averaged for Ho Bay, Limfiord and Rindkøbing-Nissum Fiords.

No data were available for estimating the natural mortality. The values adopted here (M = .1, .2) are those which have been used for North Sea herring assessments.

4.2.2. Danish samples indicate values for length at first capture of 8-10 cm in the fishery for industrial purposes, whereas an approximate value of 15 cm applies to the fishery for human consumption. The resulting yield curves are shown in figs. 4.2.1.-4.2.4. With the present fishing mortality (F = 1.0) and mean length at first capture the exploitation rate of the stocks is apparently far from optimal. Both a reduced fishing intensity and a larger size at first capture would increase the yield per recruit.

4.2.5. The effects as shown by the yield curves, of reducing the fishing mortality from 1.0 to 0.5 and/or increasing the l_c from 9 to 15 cm and from 15 to 20 cm are summarized below. (As percentual increase in yield):

		Change in l_c			
		none	9cm	9cm to 15cm	15cm to 20cm
Change in F	none	0%	0%	60%	40%
	1.0 to 0.5	55%	25%	100%	50%

4.2.4. These increases are based on the assumption that growth rates are not density dependent.

4.3. Larval surveys.

4.3.1. A summary of the spawning areas for winter-spring spawners and autumn spawners were published by Jensen (1949). In the same paper he published data about herring larvae surveys from the 1920' and 1930'. He found great quantities of larvae during April (Winter herring) and even greater quantities in

October as a result of the autumn spawning herring. In May he found a small number of larvae as a result of the spring spawning herring. Although the density of sampling stations in the Kattegat was rather uneven it is obvious that the number of winter herring larvae (1o-22 mm) in April was of the same magnitude in the northern and southern Kattegat. Concerning the larvae (≤ 1o mm) of authumn spawning herring the greatest densities occurred in the northeastern area mainly between Laesø-Anholt and the Swedish coast, in the Great Belt, between Sjaelland and Jutland and in the western part of the Baltic proper. (The area in the western Kattegat north of 56^{o}1o'N was not sampled except for a few stations south of the Skaw).

4.3.2. The results from surveys in the Kobberground area in the northeastern Kattegat, where the greatest number of larvae have been found in recent investigations, are of greatest interest in this context. Although Jensen used other gears (a ringtrawl with a radius of 1 m (an opening of 3.14 m^2)) than used in recent investigations, his results may be of interest. All results nowadays are published as number larvae/m^2 and whereas Jensen has published his results as number larvae/3o min. trawling.

Jensen's results indicate that when maximum abundance of herring larvae occurred in 192o's, he got 12oo-19oo larvae per 3o min. in the Kobberground area.

4.3.3. The international trawling surveys for herring larvae in the Kattegat, 1967-1973, have been carried out by scientists from Norwegian, Danish and Swedish laboratories. (Coop.Res. Rep: ICES no 19 (1967-68), no 22 (1968-7o), no 28 (197o/71) and later published in papers inside the Pelagic Fish (Northern) Committee C.M. 1972/H:28 and C.M. 1973/H:13). Most of the surveys have taken place in the middle or in the end of October. Unfortunately the area has not been covered completely all the years and the effort have been different during each of the years 1967-1973. The maximum number of larvae per m^2 caught at a station in 1967-1973 is shown below:

Year	Max. nr/m^2
1967	3oo
1968	6
1969	48
197o	2o
1971	3
1972	1
1973	<1

4.3.4. Larval abundance estimates (numbers x 10^{-9}) in the second half of October 1967-197o (Coop.Res.Rep.no 28) and the max. abundance per m^2 during Swedish surveys at 1o stations in the area between Laesø-Anholt and the Swedish coast (Kobberground) 1969-1973:

Year	International surveys <1o mm x 10^{-9}	International surveys ≥1o mm x 10^{-9}	Swedish surveys <15 mm max. abundance/m^2
1967	59.5	0	
1968	9.2	2.3	
1969	28.1	1.1	48
1970	30.5	9.7	10
1971	-	-	3
1972	-	-	1
1973	-	-	<1

4.3.5. All results indicate that the spawning population in the Kobberground area has been reduced very much since the end of 1960's.

5. Summary and Conclusions.

5.1. The work of the Study Group was heavily curtailed by lack of relevant data. An assessment of the herring stocks in Kattegat and the Belt Seas could not be undertaken at the meeting as only a short time series of biological data on the Swedish fishery for adult herring was available. The composition of the Danish industrial fishery which is mainly based on the youngest year classes is virtually unknown and statistics on the distribution of catch and effort are almost entirely lack-

ing except for the very latest years and for some odd years in an earlier period.

5.2. The Kattegat herring are known to comprise a great number of populations some of which are of local origin while others spend periods of varying lengths in the area as part of their migrational patterns. The Study Group found that from an assessment point of view it was important to be able to distinquish the component of young North Sea herring from the other populations which frequent the Kattegat area and which could be treated as one management unit. (See section 3.1.).

5.3. On the basis of mortality estimates for well defined spawning communities bordering the Kattegat the Study Group found that at present the fishing mortality in Kattegat proper could well be about 1.0 or even higher for the adult herring. Assuming the same fishing mortality for young and adult herring and assuming the validity of yield curves based on actual growth parameters there could be a gain in yield per recruit of about 3o % by an overall reduction in fishing intensity of 50 %. A much higher gain, however, would accrue from increasing the present length at first capture of about 9 cm to 15 cm. This would give a gain of about 60 % with unaltered fishing intensity and combined with a 50 % reduction of the latter a gain of not less than 100 % could be obtained.

5.4. From tagging results and other data it appears that the herring stocks in the Little Belt and areas north of the Bay of Kiel (part of the Belt Sea; area 22) have less connection with Kattegat than is the case of other adjacent areas. This indicates that these herring should be treated as a management unit apart and that the Western Baltic-Belt Seas is an inhomogenius area for assessment purposes.

5.5. The Study Group draws attention to the border line between Skagerrak and Kattegat as defined at present. Drawn from the Skaw to the light house Pater Noster on the Swedish west coast the border line bisects the important fishing ground around the Skaw. This creates great difficulties in collecting fisheries statistics and as the border does not appear to have any biological significance nor any obvious administrative assets a revision appears highly pertinent. The Study Group did not, however, find time to produce a well founded proposal at its

first meeting.

5.6. The Study Group thought that its preliminary findings were sufficient argument for an increased scientific effort in the Kattegat area. To the fisheries laboratories of Denmark and Sweden being the nations mainly concerned with the herring fisheries in the Kattegat, the Study Group consequently recommends the following research activities:

a) The Danish sampling of catch and effort statistics, at present restricted to the Skaw, be extended to other landing places in order to ensure coverage of the entire area. The Swedish sampling scheme under preparation should be strongly supported and, if possible, its implementation should be advanced in time.

b) Biological samples be secured at a minimum rate of 1 sample of consumption herring per week and 1 sample a day from industrial landings. Special sampling at well defined spawning sites should be continued and extended.

c) 2 - 3 larvae surveys for spring spawned larvae be conducted in early summer in addition to the larvae surveys already carried out in autumn.

d) Danish participation in the Young Herring Surveys in Kattegat in February supplementary to the Swedish research vessel effort already exerted.

e) Special joint investigations be undertaken in addition to the routine work suggested above. Prime items are supplementary tagging experiments and methods of disciminating the main stock components of the Kattegat herring.

f) Another meeting of the Study Group be held in early fall 1975 in order to evaluate further data known to be stored at the respective laboratories and to appraise the eventual sampling program established by then.

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Table 2.1 Herring catches in Kattegat 1950-1973. C=herring for human consumption. I=industrial landings. Figures in tons.

Year	Sweden		Denmark		Total		Grand
	C	I	C	I	C	I	total
1950	2 024		1 534	8 600	3 558	8 600	12 158
1951	2 110		1 130	7 040	3 240	7 040	10 280
1952	2 322		1 351	8 600	3 673	8 600	12 273
1953	1 497		1 707	8 100	3 204	8 100	11 304
1954	1 129		1 609	16 298	2 738	16 298	19 036
1955	2 899		1 543	17 243	4 442	17 243	21 685
1956	3 655		2 145	12 439	5 800	12 439	18 239
1957	4 168		3 491	28 996	7 659	28 996	36 655
1958	3 435		3 011	39 192	6 446	39 192	45 638
1959	4 887		3 798	9 762	8 685	9 762	18 447
1960	8 800	2 800	5 842	13 618	14 642	16 418	31 060
1961	8 200	3 700	6 017	23 154	14 217	26 854	41 071
1962	12 500	5 500	4 130	29 542	16 630	35 042	51 672
1963	12 700	6 400	4 617	40 542	17 317	46 942	64 259
1964	12 900	17 500	4 421	44 545	17 321	62 045	79 366
1965	15 400	17 600	5 773	42 572	21 173	60 172	81 345
1966	20 100	10 900	6 320	38 142	26 420	49 042	75 462
1967	15 300	12 600	6 094	37 960	21 394	50 560	71 954
1968	27 400	14 400	9 030	58 422	36 430	72 822	109 252
1969	21 400	5 300	7 912	31 137	29 312	36 437	65 749
1970	31 400	3 500	10 562	28 872	41 962	32 372	74 334
1971[1/]	36 586	2 177	10 588	39 589	47 174	41 766	88 940
1972[1/]	26 214	2 878	12 740	40 015	38 954	42 893	81 847
1973[1/]	27 969	1 783	8 713	69 412	36 682	71 195	107 877

1/ Industrial herring landed in Sweden not included.

Table 2.2. Herring catches in Western Baltic-Belt Seas 195o/1973. C= human consumption. I= industrial landings. Figures in tons.

Year	Denmark		FRG	GDR	Total		Grand total
	C	I	C	C	C	I	
1950	3 770				3 770		3 770
1951	4 557		20 696		25 253		25 253
1952	5 456		18 107		23 563		23 563
1953	4 525		21 416		25 941		25 941
1954	3 669	1 883	18 830		22 499	1 883	24 382
1955	3 004	5 574	20 888		23 892	5 574	29 466
1956	3 955	1 644	25 928		29 883	1 644	31 527
1957	3 717	5 739	18 026		21 743	5 739	27 482
1958	2 982	5 978	20 439		23 421	5 978	29 399
1959	2 515	6 538	14 475		16 990	6 538	23 528
1960	3 357	2 620	15 794		19 151	2 620	21 771
1961	2 551	9 597	14 138		16 689	9 597	26 286
1962	5 021	7 736	20 731		25 752	7 736	33 488
1963	4 765	5 534	12 756	2 868	20 389	5 534	25 923
1964	6 740	17 909	14 235	3 866	24 841	17 909	42 750
1965	4 537	11 723	13 447	2 553	20 557	11 723	32 260
1966	3 286	15 337	13 364	3 635	20 285	15 337	35 622
1967	4 478	12 927	18 170	5 820	28 468	12 927	41 395
1968	5 125	9 586	14 170	4 049	23 344	9 586	32 930
1969	5 638	7 559	12 716	3 711	22 065	7 559	29 624
1970	3 968	6 909	12 546	4 662	21 176	6 909	28 085
1971	3 462	10 282	11 275	5 431	20 168	10 282	30 450
1972	3 088	8 296	7 847	5 454	16 389	8 296	24 685
1973	2 127	12 270	6 081	-	8 208	12 270	(20 478)

Table 2.3. Herring landings by Areas, 1950-1973. Figures in tons.
C= human consumption. I= industrial landings.

Year	Sound			Limfiord			Ringkø-bing Fiord	Nissum Fiord
	Denmark	Sweden	Total	Denmark			Denmark	Denmark
	C	C		C	I	Total	C	C
1950	61	28	89	1 545	1 680	3 225	759	52
1951	73	54	127	1 170	2 257	3 427	363	41
1952	73	29	102	1 119	3 847	4 966	478	139
1953	44	25	69	1 464	3 344	4 808	395	74
1954	25	5	30	2 717	3 972	6 689	369	40
1955	7	14	21	1 777	4 812	6 589	437	50
1956	5	35	40	1 565	3 405	4 970	324	46
1957	25	75	100	2 818	3 351	6 169	353	30
1958	26	16	42	1 729	2 927	4 656	121	17
1959	51	48	99	4 334	4 502	8 836	196	87
1960	9	40	49	2 182	3 083	5 265	45	25
1961	26	85	111	3 377	4 024	7 401	69	29
1962	33	111	144	2 801	3 960	6 761	193	55
1963	33	105	138	1 319	3 832	5 151	132	64
1964	55	105	160	1 449	5 085	6 534	234	47
1965	42	108	150	1 824	3 401	5 225	806	191
1966	26	115	141	2 700	4 617	7 317	415	87
1967	45	112	157	2 006	4 615	6 621	463	37
1968	20	96	116	1 632	4 592	6 224	255	71
1969	106	108	214	2 295	2 850	5 145	336	62
1970	226	?	(226)	2 131	3 979	6 110	493	39
1971	633	?	(633)	2 981	4 621	7 602	645	106
1972	414	?	(414)	3 175	2 977	6 152	1 131	171
1973	187	?	(187)	928	-	-	659	43

Table 3.3.1.

Average Length and Variance in Autumn. Adult Herring. Limfjord.

(nos. in brackets).

Date of catch w.r.	1969 111o	1969 12o1	1969 1217	197o 1111	197o 12o2	1971 11o1	1971 11o1	1971 11o9	1972 11o6
0	-	8.4 (113) 0.8931	-	11.2 (84) 1.6788	11.5(1o5) 1.3143	9.6 (8o) 1.331o	1o.6(77) 1.3738	-	-
I	-	-	22.3 (1)	-	-	-	-	22.9 (4) 2.o625	23.2 (9) 1.4653
II	25.7(127) 1.23o5	-	24.9(116) 1.1681	-	-	-	-	24.5(92) 1.5448	25.5 (44) 1.8177
III	26.9 (15) 2.2o24	-	27.4(22) 0.7365	-	-	-	-	27.3 (2) 12.5oooo	27.6 (69) 2.18o1
IV	-	-	29.4 (3) 0.3334	-	-	-	-	-	31.3 (1)
V	-	-	31.3 (1)	-	-	-	-	-	-
VI	-	-	-	-	-	-	-	-	-

Table 3.3.2.

Average Length and Variance in Spring. Adult Herring.Limfiord.

(nos.in brackets)

Date of catch w.r.	1969 o415	1969 o43o	197o o413	197o o521	197o o526	1971 o52o	1972 o4o8	1973 o226	1973 o312	1973 o4o9	1973 o5o8
0	-										
I	-	-	-	9.4(1o3)	-	-	-	7.92(5) o.127o	8.75(4) 3.6367	-	-
II	-	22.8(25) o.7775	22.4(1)	-	22.7(2)	23.o(87) o.7997	-	22.7(1)	23.4(18) 2.481o	22.1(41) o.4685	22.4(62) o.7o39
III	26.8(41) o.7676	25.5(66) 1.1529	26.1(91) o.9696	-	26.1(119) o.8387	25.1(11) 1.o136	24.8(35) 1.5315	24.2(98) o.998o	25.o(48) 1.5196	24.6(39) 1.6278	25.o(24) 1.1526
IV	28.8(32) o.9574	29.5(1)	27.5(7) 2.4881	-	27.9(15) 1.8857	25.7(1)	26.7(1)	26.9(63) 1.o625	26.9(87) 1.o936	27.1(19) 1.4748	26.8(12) 1.3436
V	3o.3(9) 1.1875	29.6(3) o.3334	31.6(1)	-	28.3(2) o.5ooo	27.o(1)	-	27.4(1)	28.9(5) o.538o	-	26.7(1)
VI	3o.8(7) 1.9524	-	-	-	-	-	-	-	-	3o.6(1)	3o.5(1)
VII	31.5(1)	-	-	-	31.o(2) o.125o	-	-	-	-	-	-
VIII+	-	-	-	-	-	-	-	-	-	-	-

Table 3.3.3.

Average length and Variance in Spring. Adult Herring. Isefiord.

(nos. in brackets).

Date	4/5-66	27/5-69	20/5-70	8/6-70
w.r.				
0				
I			16.1 (1)	
II	22.8 (1) -	22.4 (27) 0.4729	22.3 (62) 0.8811	22.5 (46) 1.4749
III	25.7 (42) 0.7590	24.6 (45) 2.0286	24.5 (26) 1.3635	23.7 (51) 2.3996
IV	27.2 (48) 1.6914	27.o (14) 1.5673	26.2 (6) 0.6416	25.4 (4) 0.7292
V	27.5 (7) 1.4o48	28.2 (5) 4.1751	28.8 (3) -	
VI	27.5 (1) -	28.7 (5) 2.4251		3o.8 (1) -
VII	26.o (1) -	28.8 (3) 5.25oo	27.3 (1) -	
VIII			27.5 (1) -	28.5 (2) -

Table 3.3.4.

Average Length and Variance by Age. Ringkøbing and Nissum Fiords. (nos. in brackets).

Date	1o/5-65	21/4-66	21/4-66	1o/5-66	15/5-67	15/4-69	2o/5-7o	26/5-7o	13/5-71	27/5-71	2o/3-73
w.r. 0											
I	12.8(1o) 3.6667			18.9 (3) 0.3334	18.5 (2) -				16.7 (6) 8.7417		
II	21.o (8) 0.882o	21.8 (2) -	19.8 (1) -	2o.8 (3) 7.oooo	21.4(68) 0.7832	23.7(22) 1.927o	22.2(64) 0.8516	22.1(77) 0.5o6o	21.7(73) 2.45o6	22.5(147) 0.8677	21.9 (15) 1.3o95
III	25.5(126) 1.1542	25.6(42) 1.2382	24.9(22) 1.1889	24.4(83) 1.1115	24.3(1o8) 1.8o34	25.3(58) 1.77o7	24.6(32) 1.o555	25.o(26) 1.6616	24.4(34) 0.42oo	25.2(21) 0.8322	23.9 (171) 0.9723
IV	28.3 (7) 1.5833	28.1(94) 0.71o9	27.8(112) 0.842o	27.5(81) 0.95o6	25.9(35) 3.4o21	27.7(19) 1.7194	28.1 (5) 1.825o		26.4 (4) 2.8958	28.o (1) -	28.5 (14) 2.3737
V	29.6 (1) -	29.o(6) 1.475o	28.1 (3) 0.o834	28.7(7) 1.6191	28.8(15) 0.3738	3o.2 (6) 0.9417	29.5 (1) -				29.3 (9) 1.9375
VI	28.8 (1) -	27.8(2) -	3o.3 (2) -	3o.2 (1) -	28.o(1) -	3o.6 (7) 0.6429					3o.5 (1) -
VII		29.3(2) -	29.6 (5) 0.7ooo	29.8 (1) -		3o.5 (2) -					
VIII+		3o.5(1) -		29.1 (1) -							

Table 3.3.5.

Average Length and Variance by Age and Year. Ho Bay.

(nos. in brackets)

Age	3	4	5	6	7	8	9	9+
1951	25.17 (6) 0.9417	24.25 (145) 1.1771	25.97 (119) 0.7o19	26.15 (15) 1.2571	27.3 (4) -	26.8 (2) -	- (1) -	28.3 (2) -
1952	- (1) -	26.3 (2) -	26.44 (7o) 0.7983	27.31 (99) 0.7494	28.oo (8) 1.oooo	- - -	- (1) -	27.9 (3) -
1953	24.37 (17) 0.4228	26.o (2) -	26.4 (4) -	27.18 (79) 0.4342	28.22 (76) 0.3822	28.4 (3) -	- (1) -	28.8 (4) -
1954	24.67 (85) 0.6697	26.29 (14) 1.1717	26.5 (2) -	- (1) -	28.22 (16) 0.849o	28.91 (19) 0.64o4	29.1 (3) -	29.1 (3) -
1955	24.35 (41) 0.6o27	26.36 (66) 0.6677	26.75 (1o) 2.2778	26.5 (2) -	28.o (2) -	28.25 (18) 1.oo74	29.o5 (23) 0.63o4	- - -
1958	24.25 (13) 0.1667	26.33 (121) 1.2125	27.o (2) -	28.95 (5) 1.575o	29.15 (5) 0.425o	3o.5 (1) -	3o.1 (3) -	3o.25 (4) -
1962	24.o7 (5o) 2.1914	26.71 (24) 1.31o8	27.o (4) -	28.48 (11) 0.7182	29.6 (3) -	27.8 (2) -	- - -	- (1) -
1963	25.o9 (28) 1.1677	26.16 (125) 1.1991	27.62 (31) 0.9495	- (1) -	28.89 (7) 0.9762	3o.17 (13) 1.4359	29.67 (23) 1.3557	- (1) -
1965	26.o4 (81) 1.58o4	27.88 (12) 1.3693	- (1) -	- - -	- 1 -	- - -	- (1) -	- (1) -
1972[x)]	25.o6 (99) 0.7734	27.63 (38) 2.4248	29.15 (5) 0.8oo1	-	-	-	-	-

x) caught medio December 1971

Table 3.3.6. Length and Growth Parameters for different Localities.

w.r.	Ringkøbing, Nissum Fiords $\bar{l}$	s	n	Limfiord spring samples $\bar{l}$	s	n	Limfiord autumn samples $\bar{l}$	s	n	Isefiord $\bar{l}$	s	n	Ho Bay
0													Length values of year classes 1946,1947 taken from tab. 3.3.5.
1	15.33	3.248	21										
2	22.11	1.185	480				25.14	1.258	379	22.39	0.995	136	
3	24.67	1.307	723	25.42	1.314	572	27.46	1.412	108	24.59	1.500	164	
4	27.65	1.261	372	27.25	1.295	238	29.88	1.061	4	26.98	1.307	72	
5	29.07	1.094	48	29.36	1.442	23				27.99	1.439	15	
6	29.86	1.244	15	30.74	1.215	9				28.83	1.604	7	
7	29.74	0.700	10	31.17	0.382	3				27.94	2.055	5	
8													

					1947	1946
L_∞	30.70	32.43	30.85		28.77	25.69
K	0.524	0.416	0.347		0.576	0.472
t_0	0.090	-0.560	-1.237		0.766	0.611

Table 3.3.7. Length and Growth Parameters. Kattegat Autumn Spawners.

Date	67-09-19		68-09-23		68-09-19		69-10-16		66-09-19		67-10-17		70-09-21		65-10-06		Grand mean	
w.r.	$\bar{l}$	n	$\bar{l}$	n	$\bar{l}$	n	$\bar{l}$	n	$\bar{l}$	n	$\bar{l}$	n	$\bar{l}$	n	$\bar{l}$	n		
0																		
1	20.91	246									20.97	92					20.99	349
2	25.09	100	26.67	27	25.69	58	26.40	95	26.82	33	25.69	74	29.08	15	27.00	6	26.01	408
3	27.33	3	29.24	25	28.20	49	28.14	25	28.42	12	28.14	7	30.42	50	28.71	21	28.96	192
4	29.62	8	29.70	10	29.50	2	30.89	14	29.74	27	29.33	3	30.79	22	29.41	128	29.67	218
5	30.23	13	30.44	9	32.00	3			30.41	115	31.25	8	32.29	11	30.75	4	30.01	164
6	31.62	8	31.70	10	31.00	2			30.17	6	32.00	3			31.12	16	31.26	45
7			31.95	41	32.12	17	32.50	8	31.33	3	31.75	4			31.67	3	32.02	77
8															32.00	17	31.98	22
9									32.40	5							32.92	12

								Average
$L\infty$	32.53	32.44	33.01	34.16	32.53	32.44	non sense values	32.852
K	0.443	0.463	0.426	0.338	0.329	0.524	→	0.4205
t_o	- 0.525	- 0.965	- 0.733	- 1.486	- 2.50	- 0.106		- 1.053

$L\infty$ 31.80
K 0.611
t_o 0.028

Table 4.1.6. Ringkøbing Fiord - Nissum Fiord. Herring for Consumption. Nos. caught per Year Class in Millions.

Year	w.r.	I	II	III	IV	V	VI	VII	VIII+	Total
1951		-	-	0.06	1.60	1.31	0.17	0.05	0.05	3.24
1952		-	-	0.02	0.04	1.31	1.85	0.15	0.07	3.44
1953		-	-	0.25	0.03	0.06	1.16	1.12	0.12	2.74
1954		-	-	1.74	0.29	0.04	0.02	0.35	0.49	2.93
1955		-	-	0.83	1.34	0.21	0.04	0.04	0.83	3.29
1958		-	-	0.09	0.72	-	0.03	0.03	0.05	0.92
1962		-	-	0.85	0.41	0.07	0.19	0.05	0.05	1.62
1963		-	-	0.12	0.52	0.13	0.00+	0.03	0.16	0.96
1965		-	-	5.19	0.77	0.06	-	0.06	0.12	6.20
1965		0.52	0.41	6.56	0.37	0.06	0.06	-	-	7.98
1966		0.02	0.04	0.86	1.67	0.09	0.03	0.05	0.01	2.77
1967		0.04	1.46	2.32	0.75	0.32	0.02	-	-	4.91
1969		-	0.48	1.27	0.42	0.13	0.15	0.04	-	2.49
1970		-	3.79	1.56	0.13	0.03	-	-	-	5.51
1971		0.16	5.79	1.45	0.14	-	-	-	-	7.54
1973		-	0.48	5.47	0.45	0.29	0.03	-	-	6.72

Table 4.1.8. Limfiord Herring for Human Consumption. Nos. caught per Year Class in Millions.

Year	Season	I	II	III	IV	V	VI	VII	Total
1969	S	-	1.17	5.08	1.62	0.58	0.34	0.05	8.84
	A	0.03	6.06	0.92	0.08	0.02	-	-	7.11
1970	S	-	0.14	10.32	1.04	0.14	-	0.08	11.72
	A	-	-	-	-	-	-	-	-
1971	S	-	19.57	2.47	0.22	0.22	-	-	22.48
	A	0.72	16.47	0.35	-	-	-	-	17.54
1972	S	-	-	22.71	0.65	-	-	-	23.36
	A	0.10	0.48	0.76	0.01	-	-	-	1.35
1973	S	0.11	2.19	2.87	2.33	0.09	0.04	-	7.63
	A	-	-	-	-	-	-	-	-

Table 4.1.9. Isefiord Herring for Human Consumption. Nos. caught per Year Class in Millions.

1969	S	-	0.304	0.507	0.157	0.056	0.056	0.033	1.113
1970	S	0.009	0.913	0.651	0.085	0.026	0.009	0.035	1.728

Legends.

Fig. 3.1.1.
VS-K_2 and VS-L_1 diagram based on Swedish and Danish herring analyses from the Kattegat area and adjacent waters with herring migrating to the Kattegat.

Fig. 3.2.1.
Tagging experiments with spring spawning herring in April, 1951, and in May, 1971, in the Ringkøbing Fiord and the Limfiord. (Symbols, see fig. 3.2.9.).

Fig. 3.2.2.
Tagging experiments with spring spawning herring in April, 1950, south of Skagen in the northern Kattegat. (Symbols, see fig. 3.2.9.).

Fig. 3.2.3.
Tagging experiments with spring spawning herring in April-May, 1951, 1969 and 1970, in the Isefiord. (Symbols, see fig. 3.2.9.).

Fig. 3.2.4.
Tagging experiments with spring spawning herring in April, 1951, and in March-April, 1952 in the Little Belt. (Symbols, see fig. 3.2.9.).

Fig. 3.2.5.
Tagging experiments with autumn spawning herring in October, 1949-50, in the Great Belt. (Symbols, see fig. 3.2.9.).

Fig. 3.2.6.
Tagging experiments with autumn spawning herring in October, 1949, November 1950-51, November 1952, October 1971-72. (Symbols, see fig. 3.2.9.).

Fig. 3.2.7.
Tagging experiments with a mixture of spring and autumn spawning herring in September 1968. (Symbols, see fig. 3.2.9.).

Fig. 3.2.8.
Tagging experiments with spring spawning herring in October, 1970. (Symbols, see fig. 3.2.9.).

Fig. 3.2.9.
Symbols for figs. 3.2.1-8. explaining the tagging experiments. Figures in front of or above a symbol indicate the number of recaptures.

Fig. 3.1.1.

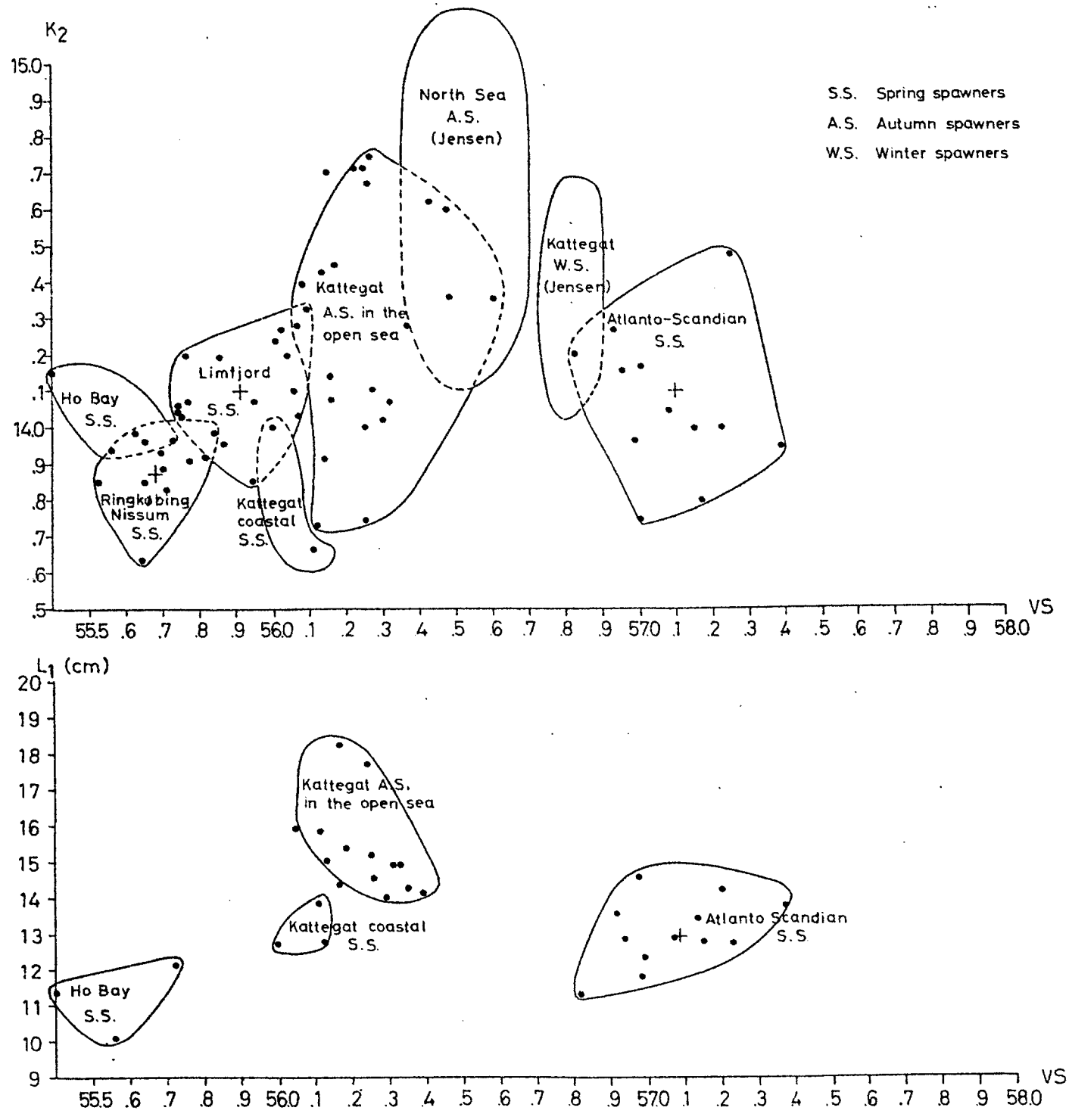

K2
15.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
14.0
.9
.8
.7
.6
.5
S.S. Spring spawners
A.S. Autumn spawners
W.S. Winter spawners
North Sea
A.S.
(Jensen)
Kattegat
W.S.
(Jensen)
Kattegat
A.S. in the
open sea
Atlanto-Scandian
S.S.
Limfjord
S.S.
Ho Bay
S.S.
Ringkøbing
Nissum
S.S.
Kattegat
coastal
S.S.
55.5 .6 .7 .8 .9 56.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 57.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 58.0
VS
L1 (cm)
20
19
18
17
16
15
14
13
12
11
10
9
Kattegat A.S.
in the open sea
Kattegat coastal
S.S.
Atlanto Scandian
S.S
Ho Bay
S.S.
55.5 .6 .7 .8 .9 56.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 57.0 .1 .2 .3 .4 .5 .6 .7 .8 .9 58.0
VS

Fig. 3.2.1.

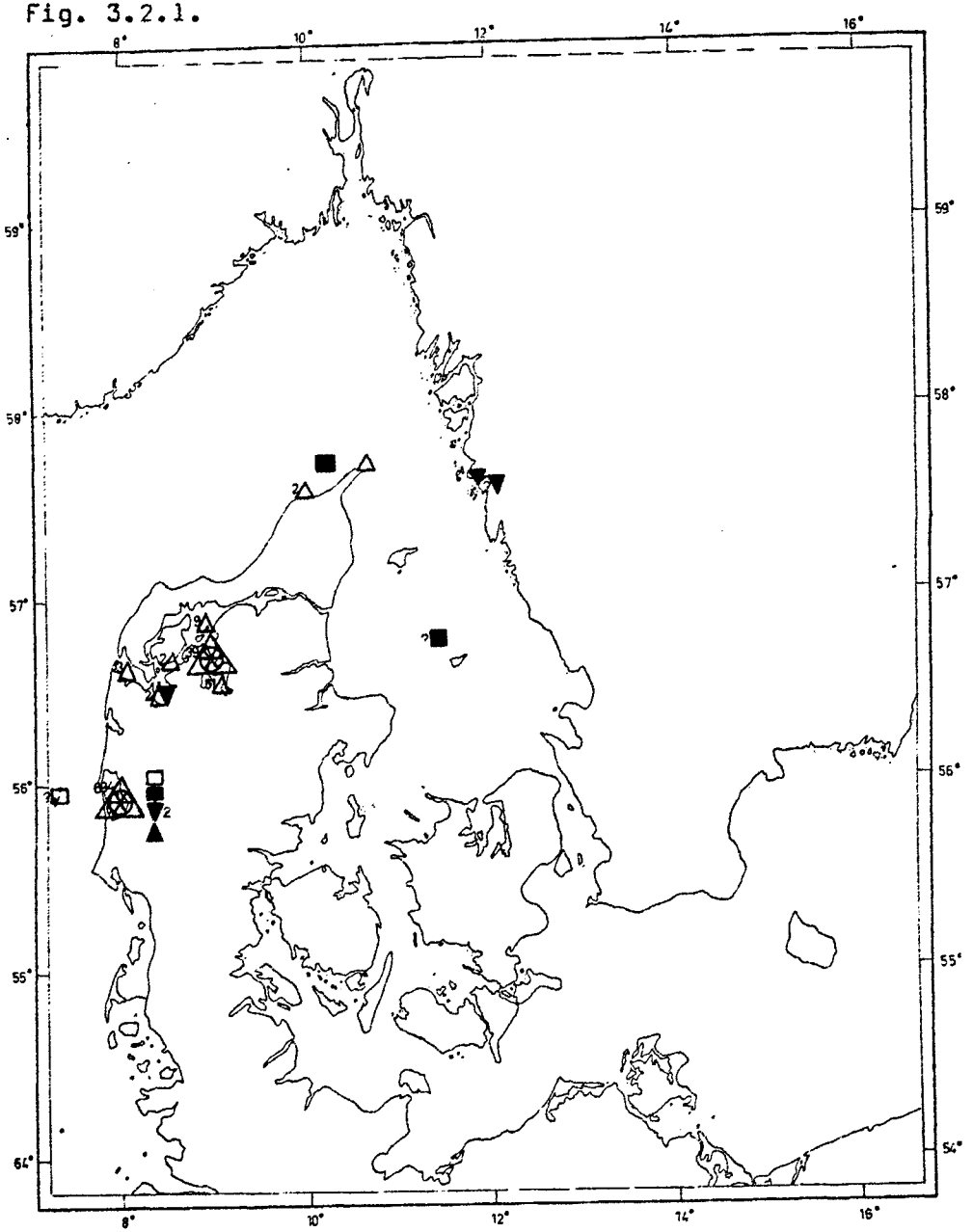


Fig.3.2.2.

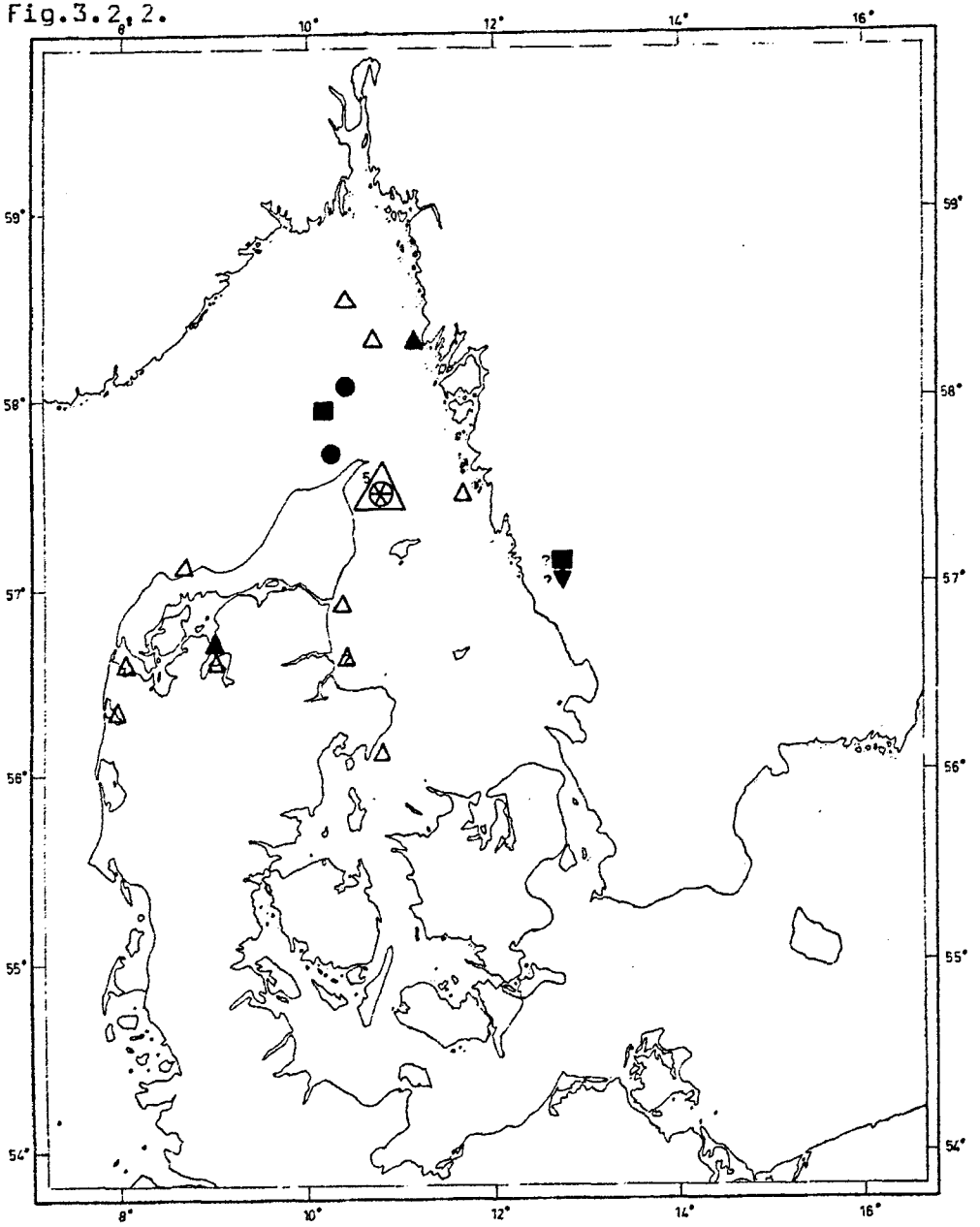


Fig.3.2.3.

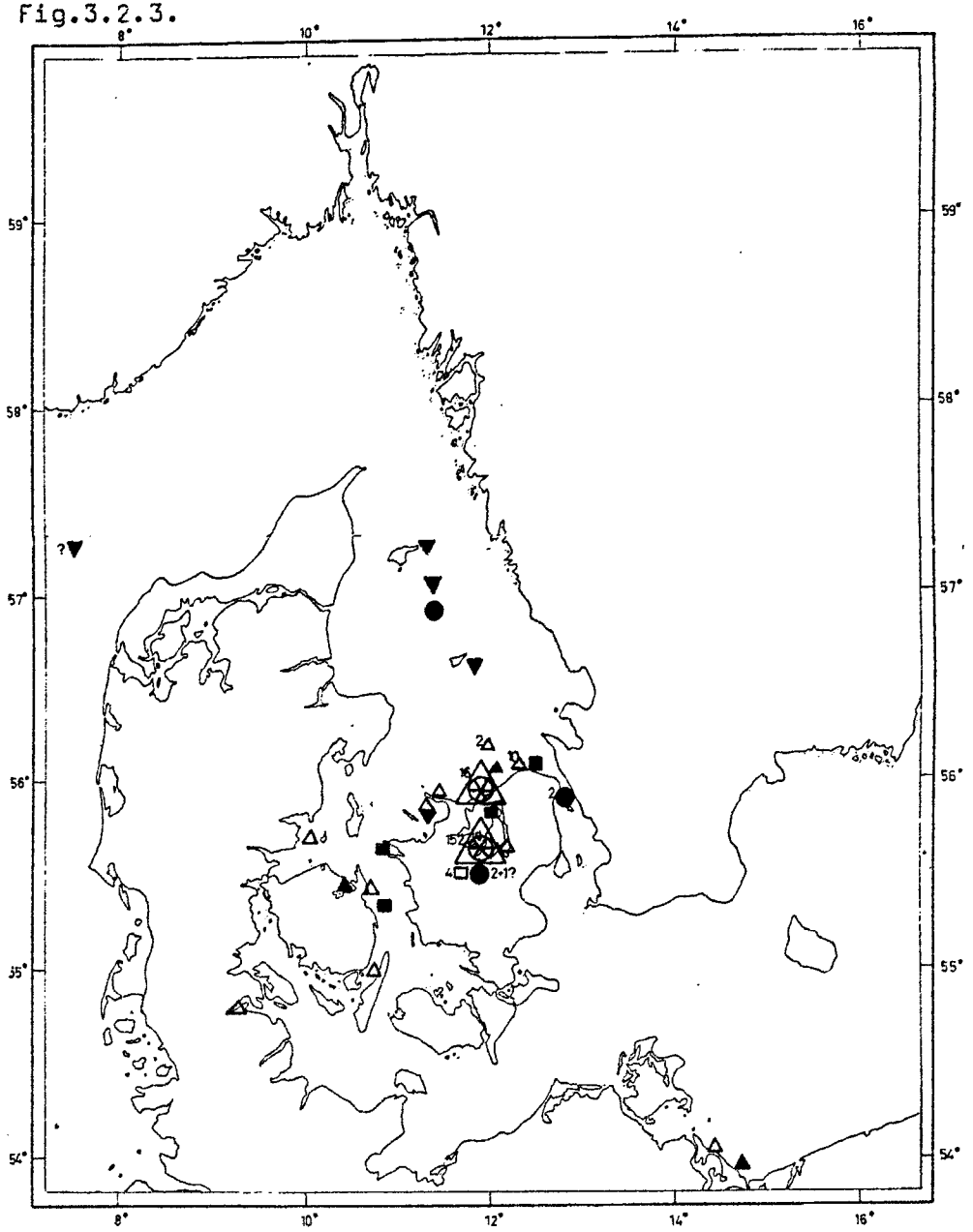


Fig.3.2.4.

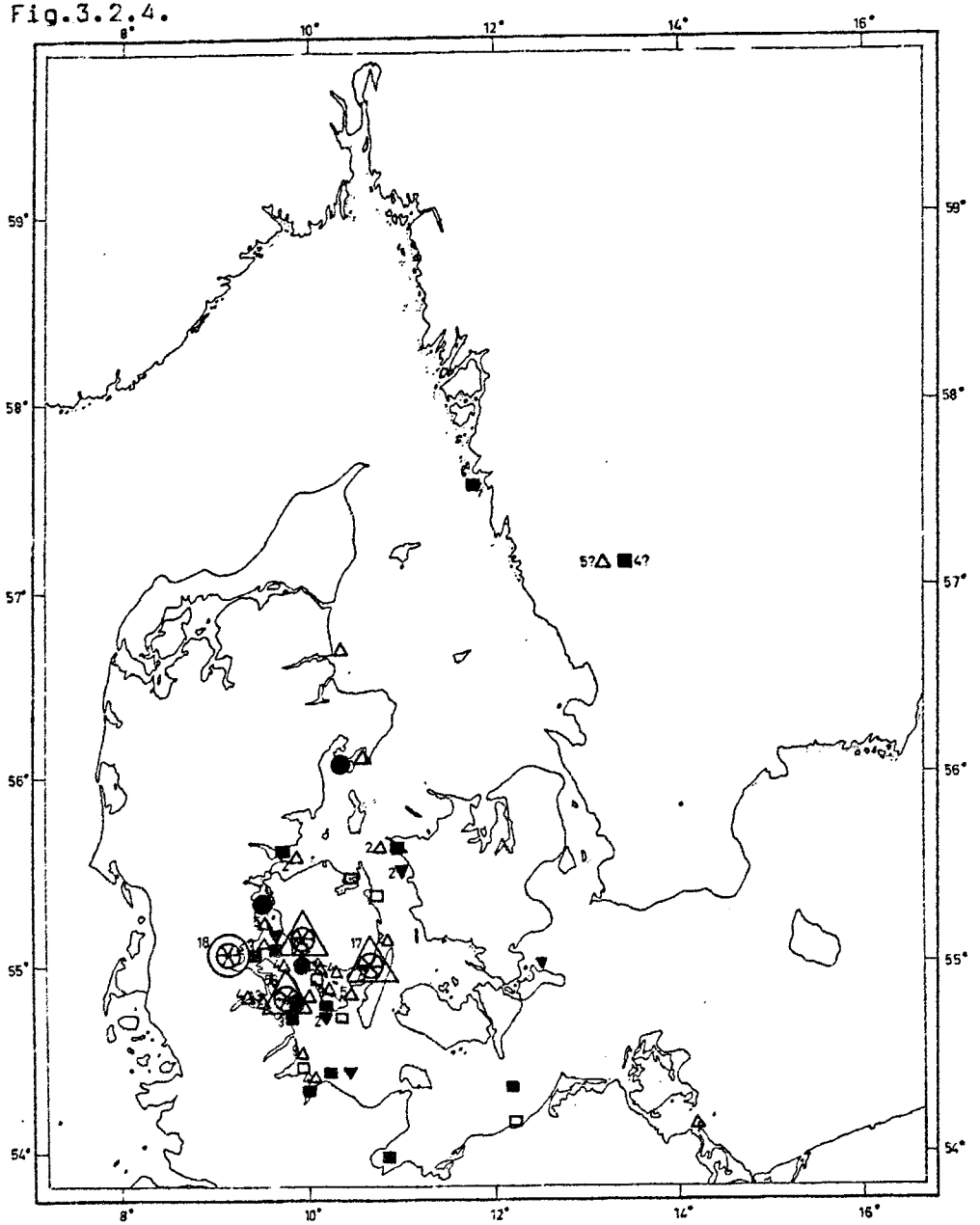


Fig.3.2.5.

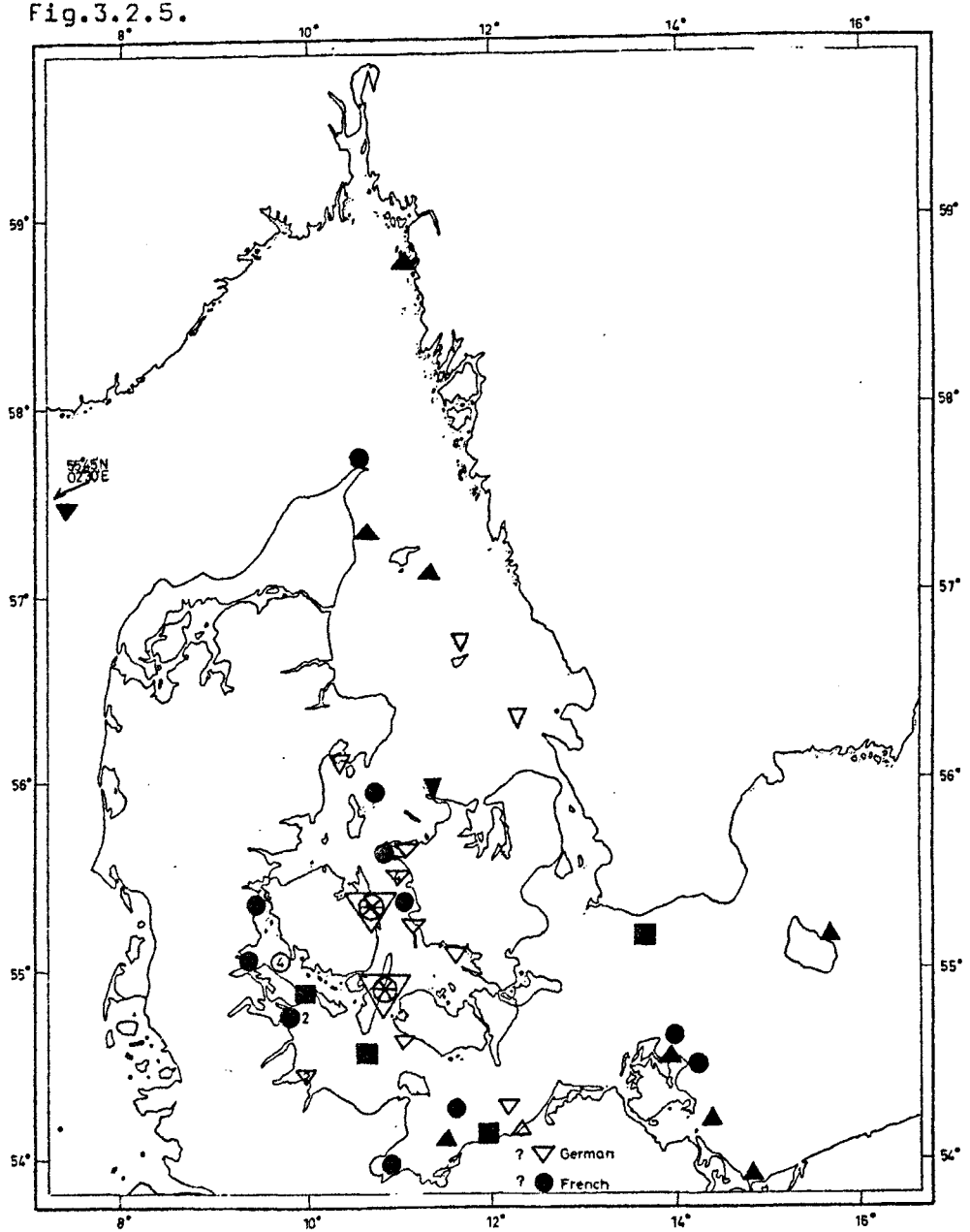


Fig.3.2.6.

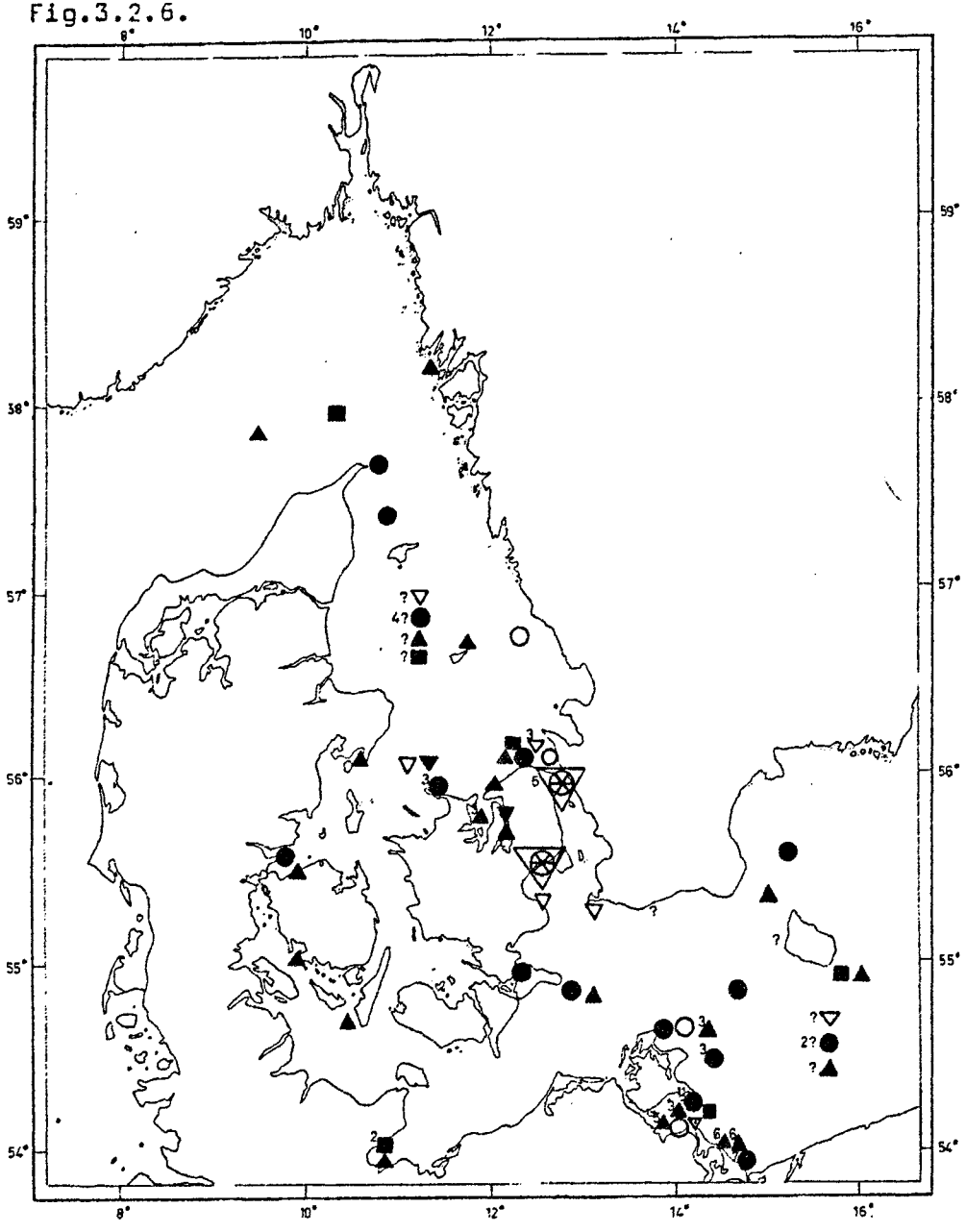


Fig.3.2.7.

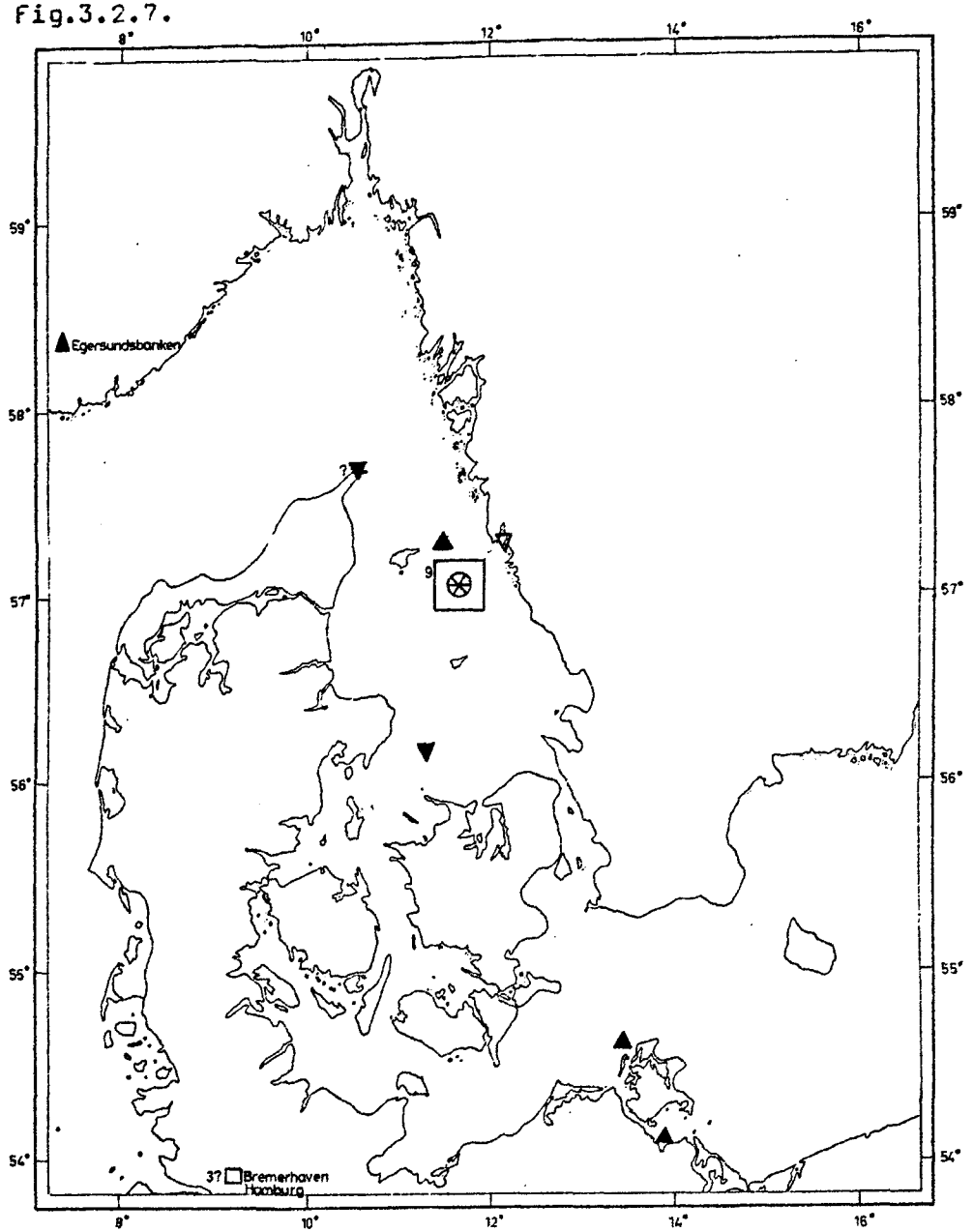


Fig.3.2.8.

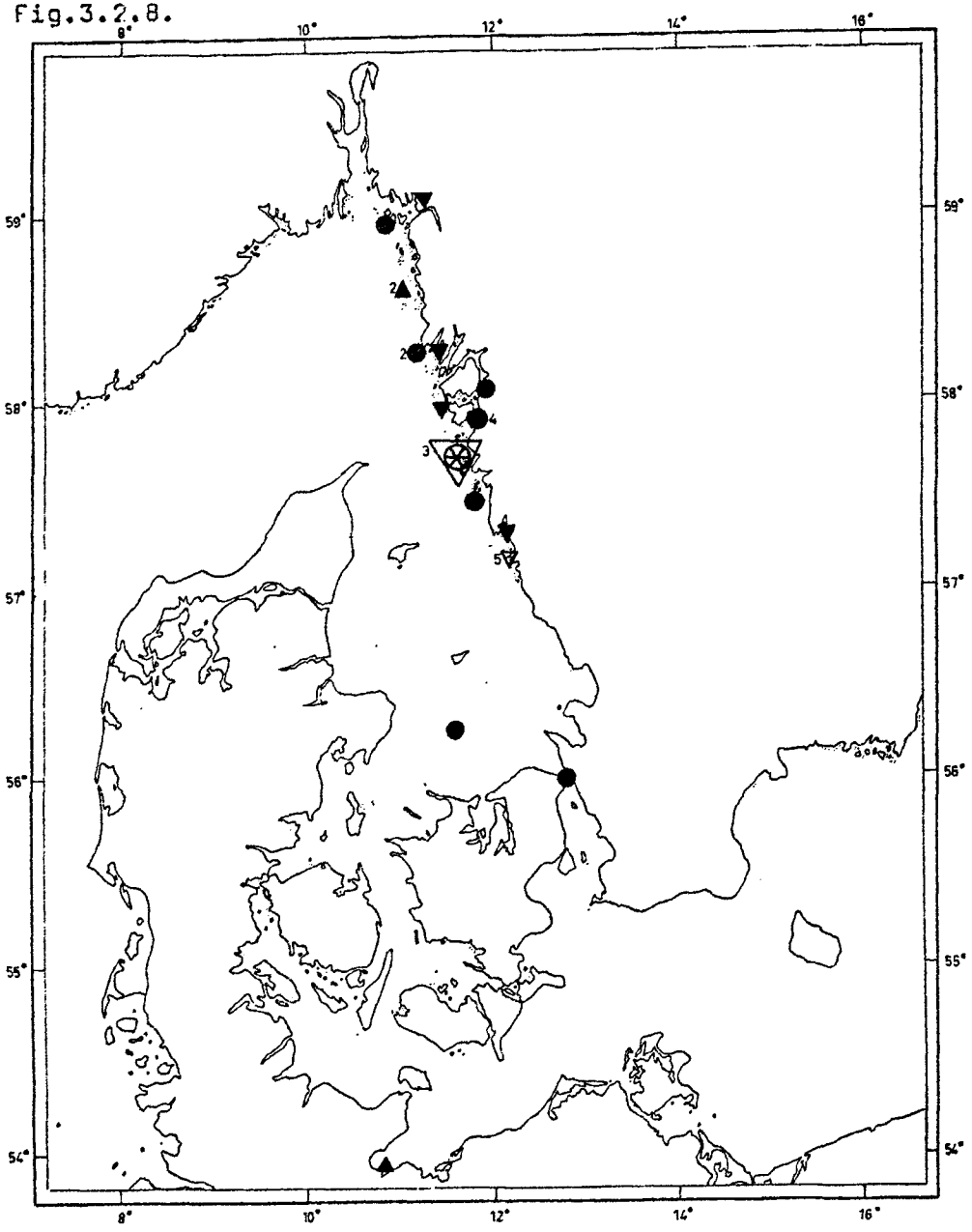
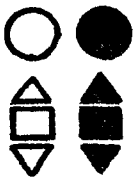


Fig. 3.2.9

Position for the tagging experiment

Recaptures within 3 months unfilled symbols
– " – after 3 – " – filled – " –



January – March
April – June
July – September
October – December

Fig. 4.2.1

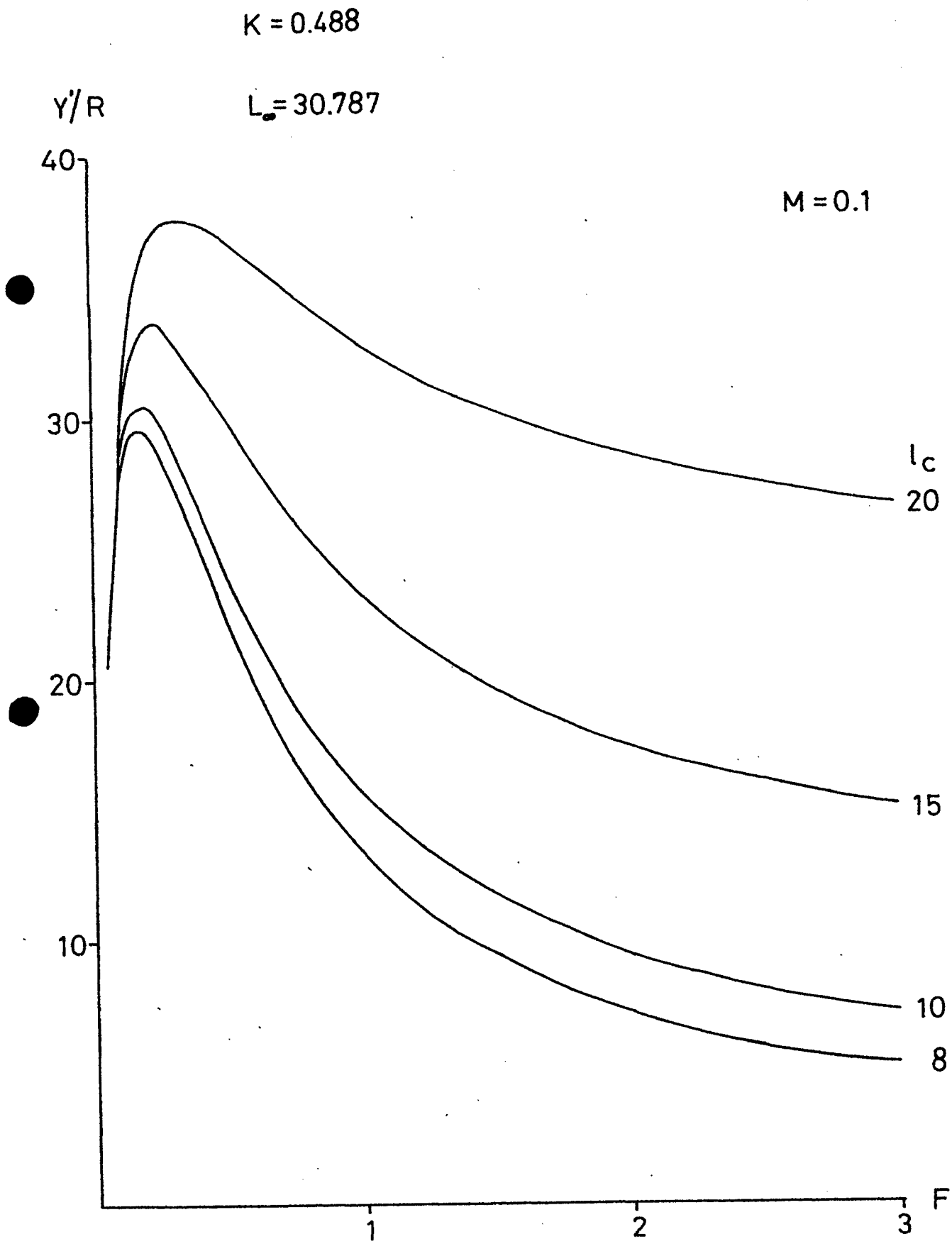


Fig.4.2.2

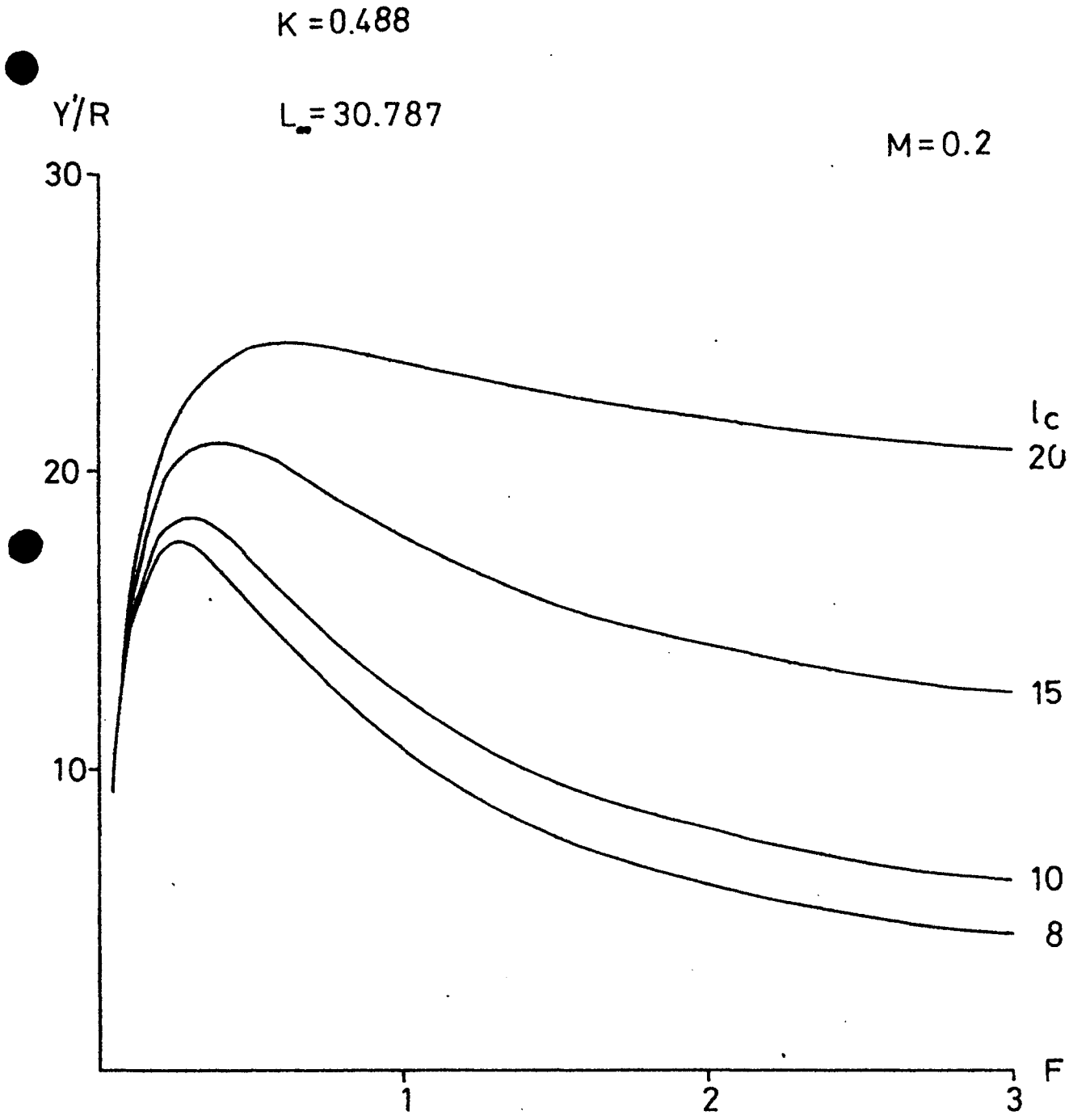


Fig.4.2.3

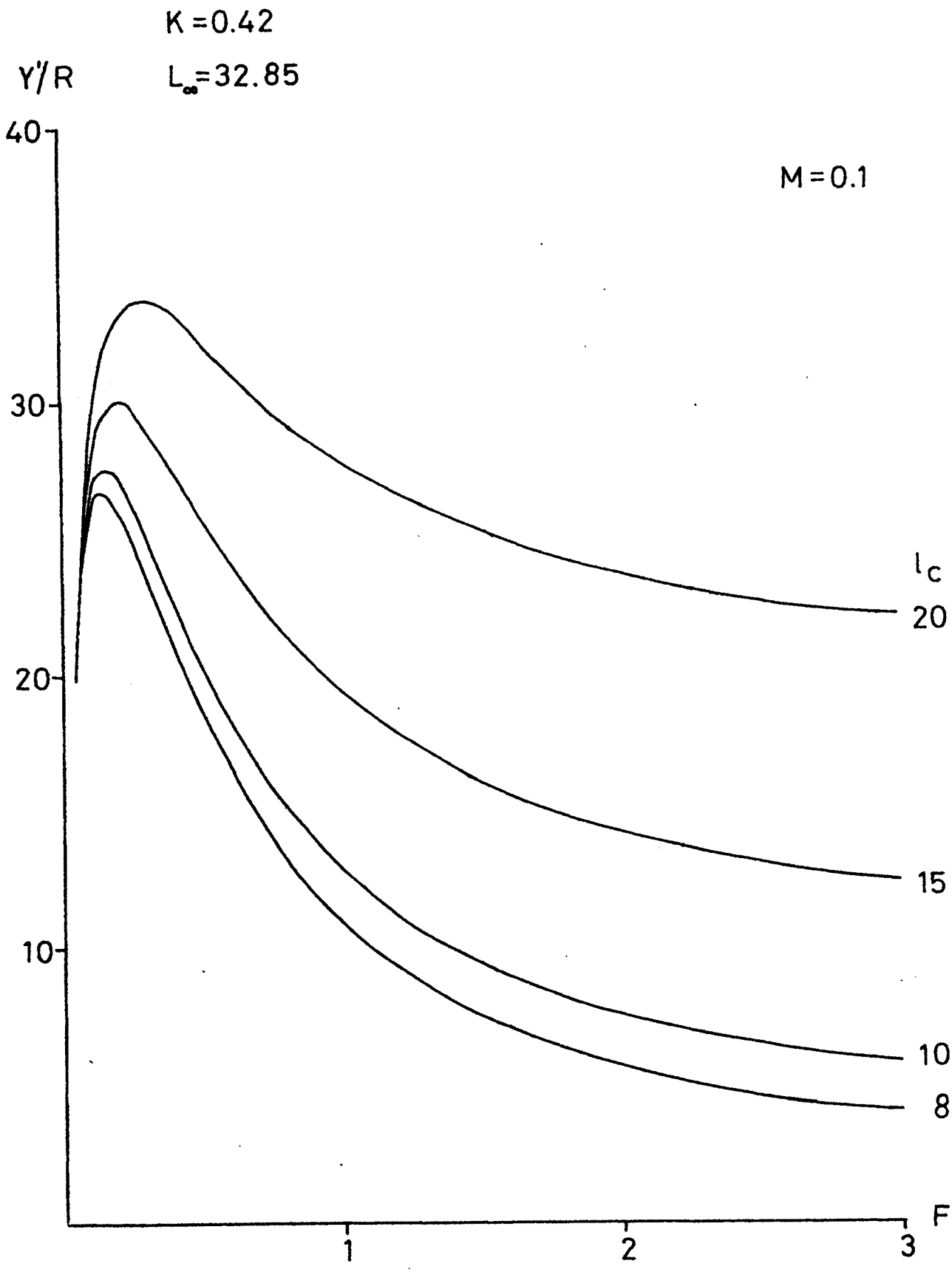


Fig.4.2.4