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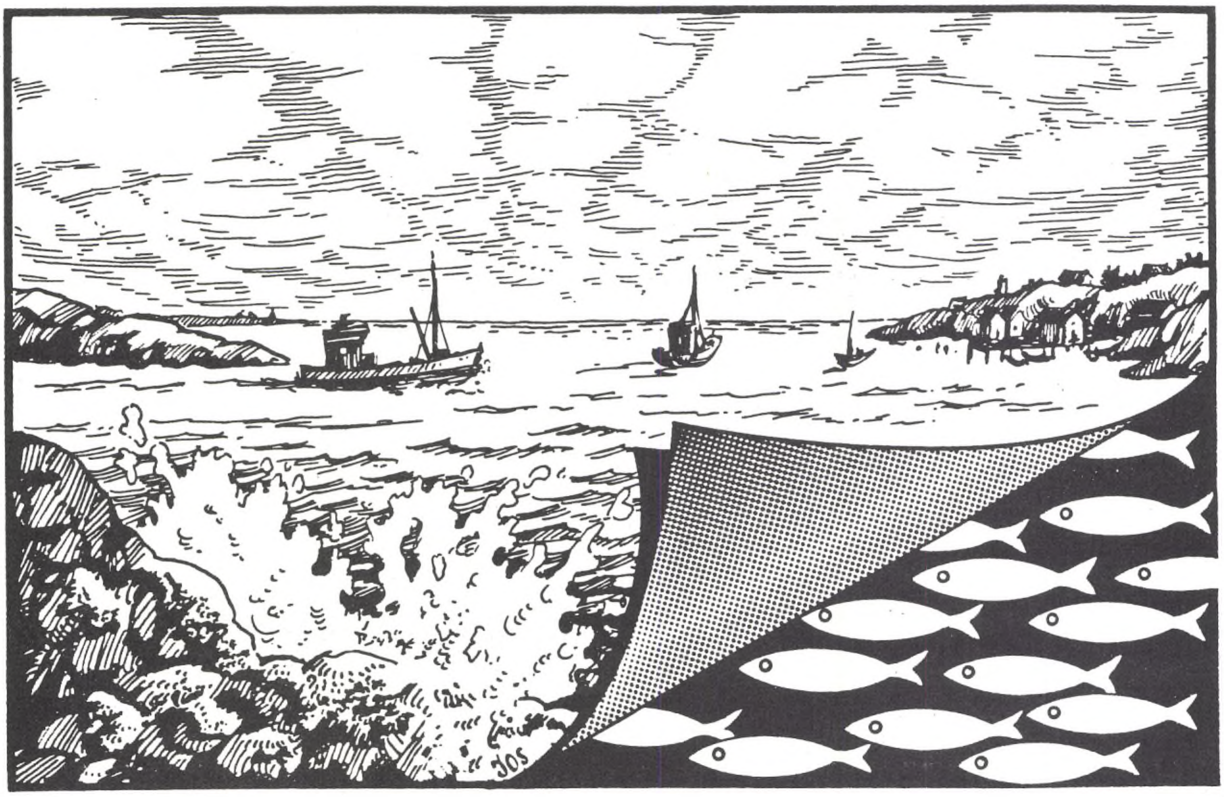

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Gunnar Otterlind

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Gunnar Otterlind
Institute of Marine Research, Lysekil

C o n t e n t s

S u m m a r y:

On the Öresund herring and related population problems

A great number of populations or biological groups of the herring (Clupea harengus L.) have been reported from the Kattegat-southwest Baltic area. Their present occurrence and relations in Öresund and adjacent waters are briefly described and analysed on the basis of literature, interviews with fishermen, and 75 herring samples. The material is essentially from the period 1979-1984 and the samples are presented in Tables 1-5. In view of the mixture of closely related populations and the difficulties in distinguishing them from each other, the results are partly of an indicative nature. Problems of sampling, gear selection and otolith characters are discussed.

It is generally considered that the morphological differences between the herring populations are to a great extent conditioned by environment. Meristic characters such as the mean numbers of vertebrae (VS) and keeled scales (K_2) vary with environmental factors. This applies also to the growth and length of life of the fish. A logical consequence of these well-known facts is that the progeny can show such characters deviating from those of the parental generation. The differences may turn out to be of the same magnitude as between closely related populations.

The varying size and appearance of the herring populations of the area are also dependent on the environment, though frequently in a complex and unclear way. A strong decrease in the occurrence of local autumn-spawning populations in Kattegat and the southern Baltic has been observed since the 1940s, and a decrease of winter-spawners in northern Öresund including the southernmost Kattegat around 1980. The spring-spawners are now strongly predominant in the whole area. A change from autumn-spawning to winter/spring-spawning and vice versa has occasionally been observed. The frequency of such a transition is usually low in the samples, about one or a few per cent.

Tagging experiments and studies on meristic characters show that mature herring often but not always return to the spawning area they have used earlier. To what extent young fish return to their birth area after larval drift with currents and later passive transportation or active migration is not known. Alteration in the frequency and length of the migrations has been noted with the grown-up herring. It seems that passage through Öresund from the Kattegat during late autumn/early winter often takes place in connection with high wind forces from the western sector accompanied by inflow of mainly surface water from the Kattegat.

The open coasts and prevailing currents make the main part of Öresund unfavourable for effective spawning. There is no local, more or less permanent, population belonging to the Sound proper. The herring is as a rule recruited from adjacent waters.

Meristic characters of the herring in Öresund and neighbouring waters are demonstrated by the diagrams in Figs. 3-7. In northern Öresund and southernmost Kattegat, winter-spawners appear with as high VS and K_2 values as those of the spring-spawners of Skagerrak. They can be classified as belonging to the population generally called the "Skagerrak spring-spawners/Kattegat winter-spawners". This type of herring is usually lacking in the remaining part of the investigated area. The

"Kattegat spring-spawners/Rügen-herring" is the dominating population of grown-up herring in the Kattegat-Öresund and, from late autumn to late winter, also in the Arkona Basin in the southwestern Baltic. Their appearance is illustrated by, for example, the nematode infestation of the spring-spawners as shown in Tables 1-6.

The autumn-spawners, too, are represented by various populations in Öresund with adjacent waters of Kattegat and the Arkona Basin. This is evident especially from different growth in northern Öresund, but also from the VS and K_2 values which, however, differ less from those of the herring in the Arkona Basin than do the winter-spawners. These characters are also generally less varying than among spring-spawners. The explanation of the last-mentioned fact is probably the more stable environmental conditions of the autumn-spawners during spawning time. Their spawning takes place in somewhat deeper water, and more frequently close to or in the open sea, than that of the spring-spawners. The spawning of the latter takes place in more varying environments and is exposed to higher frequency of environmental changes in shallow coastal waters during spring and early summer.

The differences of the mean values of VS and K_2 between the winter-, spring- and autumn-spawners in northern Öresund with surroundings are also larger than in the Arkona Basin, where the winter-spawners are lacking (cf. Figs. 3 and 6). In the last-mentioned area these characters often show similar and lower values for spring- and autumn-spawners. Local spring-spawners with longer length of life, with slower growth as mature fish and without nematode infestation usually have still lower VS values. Moreover, so far known these spring-spawners do not migrate as mature fish to Öresund and Kattegat.

The individual growth and the nematode infestation of grown-up spring- and autumn-spawners of different populations is illustrated by Figs. 8-18. When comparing the growth, the varying selectivity of the gill-nets and trawls must be considered.

The autumn-spawners in samples from northern Öresund show great variation in growth during their first two years, as seen for instance from both high and low average values of O_1 and L_1 (cf. Fig. 19). This is doubtless partly due to a mixture of herring of high growth born in the Kattegat-North Sea area and herring of lower growth from the southwestern Baltic (cf. Figs. 11 and 18). The growth variation among winter/spring-spawners here must to a certain extent be due to early and late spawning, but surely mixture of different populations matters also here (cf. below).

With the help of Figs. 19-23 a rough comparison can be made between the average growth of the herring in northern Öresund and surroundings and that of the populations in the Arkona Basin. The samples indicate that the growth of the autumn- as well as of the spring-spawners is as a rule somewhat larger in the north, which has also earlier been generally assumed. The explanation is better feeding conditions in the Kattegat but in part probably also, a contribution of migrated fish from farther away in the north and west. The difference is most obvious with the autumn-spawners. The minor difference between the spring-spawners in the two areas must be due to a greater interchange of grown-up fish by means of the established migrations via Öresund. An expected higher average growth in the northern part of the investigated area is, however, counteracted also to some extent by young herring coming from the Baltic, as suggested by the low VS and K_2 values from samples of young fish from central and northern Öresund (cf. Figs. 3 and 4).

The "Kattegat spring-spawners/Rügen-herring" are thus in all probability a mixed population and a result of migrations through Öresund of grown-up as well as of young herring, in both directions for the mature fish as proved by the tagging results. The young probably migrate mostly to the north or, as larvae and young fish, more or less passively follow the prevailing surface current to Kattegat. This hypothesis is supported by the meristic characters of young herring in the investigated area.

A comparison of the growth between spring- and autumn-spawners in the Arkona Basin at the laying-down of the first winter-ring (wr) on the scales (cf. Fig. 19) shows that the autumn-spawners, owing to their higher age (usually more than half a year), have a clear advantage. The difference is later equalized, as seen especially from wr-group 3 (cf. Figs. 19-23). This can be explained by a better growth in general of the mature spring-spawners as compared with autumn-spawners in the same area.

Owing to their early spawning time, as compared with the autumn-spawners, the mature spring-spawners have a longer and more effective feeding period during the most productive part of the year as regards their food organisms. The nutritional intake of the autumn-spawners is reduced at that time by their spawning. The interchange by migration to and from the Kattegat may also be of more positive importance for the growth of the mature spring-spawners than for the autumn-spawners. In northern Öresund, the equalization of growth between the spawning types is not equally manifest.

In Figs. 24-37 otoliths are demonstrated from 12 examined samples with contour drawings. They show the great variability of some main otolith characters and the frequent occurrence of transitional forms between the otolith types. Experience of these and other samples makes clear, in the opinion of the author, that routine use of otoliths for spawning-type determination and other classification of herring populations can not be recommended. The otoliths can, however, be appropriate for special investigations where many of their and other characters are taken into consideration. Thus, among future research projects, an investigation into the otolith types and growth of young herring in the Öresund area is recommended.

Finally the genetic background of the population differences of herring is discussed and compared with that of cod in the investigated area. Contrary to the herring, cod populations here are distinguished by genetically founded characters like haemoglobin types and enzyme systems. The more pelagic life and stronger schooling behaviour of the herring result obviously in a higher gene flow in spite of the smaller number of their benthic eggs. The partly phenotypically founded, insignificant morphological differences between the spring- and autumn-spawning herring in the Arkona Basin are besides attributed to a more frequent transition here from one spawning type to the other, giving a richer gene flow than in the Kattegat-North Sea. According to this hypothesis the two main spawning types of the latter sea area are genetically more distinguished than in the southwestern Baltic.

Introduction

Öresund (the Sound) and adjacent waters in the southwestern Baltic and the Kattegat constitute a transitional area between the Skagerrak/North Sea and the marked brackish waters of the Baltic. The environmental conditions are changing especially within Öresund, which has a length of about 60 naut. miles. The northern part has a more marine character with variable, fairly high salinity (c. 20-34 ‰) in the deep water below the 10 m-depth and a surface salinity of 10-15 ‰ as a rule, southwards showing lower values. From the southern side of the threshold at Limhamn-Dragör (Drogden max. 8 m deep) a stable brackish water milieu normally prevails. The salinity value here is usually 8-9 ‰ from the surface to the bottom (except for extreme occasions of inflow from the north). Farther to the east and to the south in the Arkona Basin there is a higher, varying salinity usually beginning at a depth of about 30-45 m.

These hydrographic conditions and the geographic position make possible the occurrence of herring populations from the north as well as from the south. They arrive in Öresund both through active migration and through passive transportation by the very often rapid currents (a speed of up to 4 knots can be noted within the Sound). In the surface water, the direction is mostly northward. - A map of Öresund is presented in Fig. 1.

Material

During the end of the 1970s and the beginning of the 1980s, the Institute of Marine Research in Lysekil has undertaken an investigation concerning the occurrence of herring and the development of the herring fisheries in Öresund and adjacent waters, e. g. by numerous and repeated interviews with the fishermen (cf. Otterlind, 1984, 1985). At the same time, samples of the catches have been taken for stock analysis. Special attention was paid to the possibility of using otolith types for the separation of different populations.

Owing to limited research resources and the strong adaptation of the fisheries to the market demand, the material is not as complete as could have been wished. Trawl fishing is banned in Öresund by Danish-Swedish agreement since the turn of the century. The commercial herring fishery is therefore mainly carried out by means of gillnets. During the period in question, the mesh-size used has been almost exclusively that of 27-28 mm bar-length. The catch is therefore solely made up by large herring (5-10 fish per kg), now being the most marketable. Our research vessels have, however, been in a position to catch some samples with a fine-meshed trawl (c. 11 mm bar-length). Outside Öresund, samples from trawling were also obtained from fishermen (the mesh-size of the cod-end is then c. 18 mm bar-length). The main material from the samples is presented in the Tables 1-5.

During the season of March-August the fish samples are few, particulary from the Sound proper. No fishing of herring worth mentioning is then carried on (concentration is on cod and other fish). The intention of our project was, however, not only to investigate, as far as possible, the occurrence of herring in Öresund and surrounding waters, but also - with a view to future research - to demonstrate where there are gaps in our knowledge and to stress the difficulties in herring population research.- In some cases it has been possible to complete the material with samples from earlier years. The number of samples with otoliths examined and included in the tables is 75. In addition to this, there are some, with or without otoliths, used for comparison.

Before presenting an account of population analyses, it is appropriate to give a short survey of the herring populations or biological groups of herring considered to occur in the area from Kattegat to the southwestern Baltic according to the literature. Then there will follow some brief notes on problems of current interest concerning the separation of different populations. Further background material provided is a summary of information - gathered in the field survey - about the herring and herring fishery in Öresund and neighbouring waters.

Herring populations in the Kattegat-southwestern Baltic area

The character of a transitional area and the Danish waters ramified by islands and fiords, together with the archipelago and bays on the Swedish side, have given rise to a number of more or less separate herring populations in the Skagerrak-Kattegat-Baltic. According to Poulsen (1968) no fewer than 20-25 such populations around Denmark are described.
The separation of these must have required, besides spawning season and spawning area, meristic characters such as the mean numbers of vertebrae (VS) and of keeled scales (K_2, the scales between the ventral fins and the anus) as well as the growth.

Most of the herring populations are closely related to each other, while others have quite different spawning seasons. The meristic characters are now generally considered to be, to a large extent, dependent on the environment. The same applies to growth and length of life. The permanent status of many populations described is therefore uncertain. But it is quite clear that there are minor distinctions and separate populations also within the spring-spawning and autumn-spawning main types of herring.

It is also natural that those populations whose spawning areas are exposed to strong environmental changes show greater variations and have a more uncertain existence than the others. This must be especially applicable to minor populations. In some cases, small differences observed are probably due merely to an earlier or later spawning season or to different access to food. The distinctions noted might sometimes also be influenced by the sampling technique.

Dealt with below are the populations in the Kattegat and the southwestern Baltic which occur or could be expected within Öresund.

The herring in the Kattegat

Four major components are reckoned with in the herring stock of the Kattegat. They are to a great extent the same as in the Skagerrak: the spring-spawners of the Skagerrak, the spring-spawners of the Kattegat, the autumn-spawners of the Kattegat, and the autumn-spawning bank herring of the North Sea. The spring-spawners have in recent years been predominant in the catches. - The information in the summary below has for the most part been obtained from Johansen, 1923, 1927; Andersson, 1936, 1958; Poulsen, 1936; Jensen, 1949, 1951, 1955; Aasen, 1953, 1954; Höglund, 1955, 1967, 1978; Anon., 1974, 1980; Ackefors, 1977; Rosenberg & Palmén, 1982; Otterlind, 1985.

1) The Skagerrak spring-spawners spawn during January-April along the coasts of the Kattegat and Skagerrak, during March-April in the archipelago of the province of Bohuslän, and in some shallow waters at sea. Herring spawning in winter out on the banks in the Kattegat and in the northern mouth of Öresund have also been called the "winter-spawners of the Kattegat". This type of winter-spring spawning herring is being fished mostly in October-April. Tagging results indicate migrations both within Kattegat-Skagerrak and into the waters off south-western Norway. - Number of vertebrae (VS): c. 57 (56.5-57.6), keeled scales (K_2): c. 14.3 (13.9-14.7). All figures mentioned are mean values.

2) The Kattegat spring-spawners spawn during the end of March to May, c. one month later, on average, than the previous group. They are present all the year round in the Kattegat, in the Skagerrak mostly in May-September, and have been reported as the most important part of the Swedish catches on the west coast since the 1970s. Migration habits, spawning areas, and connections to the Skagerrak spring-spawners and to the so-called Rügen-herring in the south-western Baltic are, however, obscure. - VS: c.56 (55.7-56.5), K_2: c. 14 (13.8-14.2).

Besides those two main groups of spring-spawners, two more populations have been named: the Skagerrak spring-spawning fiord herring, occuring in minor populations in the fiords of Bohuslän and southern Norway, and the Kattegat spring-spawning coastal herring, which are said to spawn near the coast and in fiords, but can presumably be brought together with the fiord herring just mentioned. They both have equivalent values of VS and K_2 as compared with the Kattegat spring-spawners. They differ from the latter in their later spawning and lower rate of growth. On the Danish side, there are some spring-spawning populations of similar type with connection to fiords or limited coastal areas. Their spawning season is said to be middle of April to June.

All the populations mentioned are probably more or less mixed with one another, at least when not spawning, and are often included in what is called "the Kattegat spring-spawners". A certain contribution of herring of the so-called Atlanto-Scandian type from the Norwegian coast (S. Bergen) can also occur in the catches from the Skagerrak. This has been proved by Norwegian tagging results.

From Danish and especially from German taggings it appears that the Rügen-type herring from the south-western Baltic occur to a large extent from late spring to early winter in Öresund, the Belts, in the Kattegat, and in the Skagerrak as well. They cannot be distinguished from the Kattegat spring-spawners (cf. below).

3) The Kattegat autumn-spawners consist of some minor populations. The largest one is said to have been the herring of Kobbergrund which, at least formerly, spawned on the banks ESE of Läsö. Since the end of the 1960s, they are considered to be almost extinct. They are, or were, evidently closely related to the bank herring of the North Sea (see below). Other autumn-spawners are known from the waters off and in the northern mouth of the Great Belt and off Anholt. The spawning season for them all is normally in September-October (November). Taggings indicate that autumn-spawners from the Kattegat and the Belts can at times go as far as out into the North Sea. They are for the most part caught during September-December. - VS: c. 56.2 (56.0-56.4), K_2: c.14.3 (14.1-14.5)

Autumn-spawners with a somewhat lower mean number of vertebrae, appearing primarily in the southern Kattegat and being fished there in late summer-autumn, are likely to come from spawning areas in the Belts, the southwestern Baltic, and Öresund (see below).

4) The bank-herring of the North Sea is a kind of herring that has been of great importance for the fisheries in the Skagerrak and the northern Kattegat. They spawn off the coasts of England and Scotland and on banks in the North Sea, chiefly in (August) September-October. After migration to the south and east in the North Sea, they invade periodically in December-January as spent herring - the "winter herring of Bohuslän" - in the Skagerrak and northern Kattegat approximately to a line between Tistlarna and Frederikshavn. This happened from the 1900s up to and including the beginning of the 1920s, in 1943-53, and in 1963-65. They usually stay until March and April, and become the object of intense fishing. The same type of herring is known from the last two great "herring periods" in the province of Bohuslän during the 1700s and 1800s.

Young bank-herring, on the other hand, seem to be quite regular, though varying in occurrence, within the Skagerrak-Kattegat as 0- and I-group herring through drift and migration eastwards from the spawning areas in the North Sea. Before two years of age, they usually return westwards. The occurrence of the young herring in the Skagerrak-Kattegat was established by A.C. Johansen by means of studies of the meristic characters as early as the 1920s. They have also been reported from the southern Kattegat and once even from the Köge Bay in southern Öresund (in July 1943, according to Jensen, 1951).

Even if they mix with other stocks in the Skagerrak-Kattegat, and if influxes further to the south may occur, the bank-herring of the North Sea will probably not be of any importance in Öresund. - VS: c. 56.4 (56.2-56.6), K_2: c. 14.3 (14.2-14.5).

The herring in the southwestern Baltic

In the southern Baltic there is a relatively sharp limit of distribution at Bornholm. Spring-spawning herring from the area to the east and north usually migrate only to a small extent westwards from that island. This has been proved through numerous tagging experiments on the Swedish east coast and in the archipelago of Blekinge on the south coast. Baltic herring that occur in Öresund are therefore mainly from the Arkona Basin (W. Bornholm) and from the waters around the Danish island. Here two different main groups of herring are observed: spring-spawners of the Rügen type and the autumn-spawning herring, both of them consisting of various populations. - The following account is based upon Johansen, 1927; Jensen,1949, 1951, 1955, 1958; Nellen, 1965; Weber, 1975; Anon., 1978; Biester, 1979; Otterlind, 1961, 1962, 1985; Ojaveer, 1981; Popiel, 1984.

1) The herring of Rügen type spawn in shallow, coastal waters along the German and Polish coasts to the west of Bornholm, in the Belt Sea and in the Belts during (February) March-June. They are fast-growing, with a relatively small head and are fairly short-lived like the herring spawning in the Kattegat-Skagerrak. Obviously spawning takes place on a restricted scale only at the south coast of Skåne (Scania) during April-June. The most important spawning area is situated at Rügen (e.g. Greifswalder Bodden). According to the taggings, a great deal of the Rügen-herring from this area migrate after spawning through Öresund and the Belts to the Kattegat and Skagerrak. The younger spawning herring, however, probably stay more frequently in the Arkona Basin and adjacent waters. This applies, to a still greater extent, to the young herring around 1-2 years of age during all seasons. But their migrations have not been studied by tagging. The adult herring is taken by trawling mostly in December-April, in take-nets and in set-nets primarily during the spawning season, in the southwestern Baltic.

Populations related to the Rügen-herring and with a similar pattern of migration are to be found, e.g. along the coast of Mecklenburg, in the

Schlei-Fiord and other river mouths and bays, in the Belt Sea and the Belts. The meristic characters are fairly alike within all populations. - VS: (Rügen) 55.4-57.0, (Schlei) 55.29-55.63, K_2: (Rügen) 13.7-14.3, (Schlei) 13.62-13.99 (cf. Biester, 1979). Like the spring-spawners in Kattegat, they are often characterized as adults by a high degree of infestation with Anisakis nematodes. Other related populations, generally with a lower VS mean number, somewhat lower growth and without nematode infestation, are found spring-spawning in coastal waters mainly in the Bornholm Basin but also west of Bornholm. So far known they do not migrate to Öresund.

Especially during winter-spring, the Rügen-herring can occasionally be caught farther to the east, e.g. in the Hanö Bay and sometimes as far as in the Gdansk Bay during spawning time (Strzyzewska & Popiel, 1974). But in exceptional cases even spring-spawners from the east may appear far off in the Arkona Basin. Herring, ready to spawn, of Swedish east coast type (slow-growing, long-lived, with a bigger head and without Anisakis nematodes) have been found sometimes at Rügen (Greifswalder Bodden) during the spawning there (Biester, 1979). According to Swedish tagging results the adult herring often but not always return to the spawning areas they have used earlier. Change of spawning ground between the Swedish east and south coasts has been proved, however, by our tagging experiments (Otterlind, 1961, 1985). The waters immediately to the west and southwest of Bornholm constitute a mixing-area where herring from the east occur even normally to a limited extent. Only a few recaptures from the Swedish taggings of Baltic herring have been made here, as has already been indicated. One single record is reported from Öresund.

2) Autumn-spawning herring spawn within the southwestern Baltic frequently in the same areas as the spring-spawners but somewhat deeper, preferably at a depth of about 15 m, and sometimes on banks at sea. They consist of different populations at least as far as the spawning area is concerned. This kind of herring has become more rare since the 1940s and shows, in general, larger stock variations than do the spring-spawners. Spawning grounds are known from the north side of Rügen, outside the coastal regions between Stevns on Zealand and Falster, in the Mecklenburger Bay, the southern and northern Belt Sea, in the Belts, and outside Trelleborg and to the west of Bornholm. Scattered occurrence is also noted from the Polish coast, the Slupsk Bank and in the Hanö Bay. The spawning season is September-October (November).

Whether the easternmost of the autumn-spawning populations move westwards on feeding migrations is uncertain (no taggings have been made). The more western ones probably migrate often to the waters around the Danish islands, possibly sometimes farther off via Öresund and the Belts. They are reported to show a lower infestation of Anisakis than do the Rügen type herring, which may indicate a less frequent migration to the Kattegat-Skagerrak. Recaptures of taggings in the Belts have been received from the Kattegat-Skagerrak and even some from the North Sea.

Especially in earlier times, the autumn-spawners were caught by net-fishing during August-October in or near the spawning areas in the Baltic and in Öresund. By trawl-fishing, they are for the most part taken during March-June in the southern Baltic - on feeding migration. The stocks of autumn-spawners have continued to decrease, though a certain increase was noticed during the 1960s in the Bornholm Basin and westwards. At the same time, the spring-spawners have, on the whole, shown a positive growth there and are now strongly predominant. Earlier, the autumn-spawning herring have thus periodically been of great importance for the fishery. Their share has probably been overestimated, however. - VS: c. 55.7 (55.5-55.8), decreasing to the east in the Baltic, K_2: c. 14.2 (14.1-14.3).

Stock separation - a difficult problem

As has already been hinted at, it is doubtful if there is any reason to separate and to name some of the stocks in the Skagerrak/Kattegat. It may partly be a question of small differences in spawning seasons and nutritional conditions - changing to some extent from one year to the next. The relationship between various populations here and in the Baltic requires further investigations, particularly by tagging of young as well as adult herring. The latter should be tagged during spawning in the first place, but also during other seasons. Genetic studies are, of course, of great importance but so far they seem to have been of limited value for the stock separation of herring (cf. Andersson et al., 1981; Ryman et al., 1984).

A general impression of the population investigations over recent decades is that the environmental effects on meristic characters, such as mean numbers of vertebrae (VS) and of keeled scales (K_2), have been underestimated not only during the embryonic and larval period but also later on. Without any doubt, this applies to the otolith characters (cf. P.D. Wallace, according to Wood, 1979).

The manifest seasonal variation of the number of vertebrae in series of samples observed within the spawning area, e. g. as for the Rügen-herring (1957 beginning of March: 57.0 - June: 55.4, monthly mean values March-June: 56.22, 55.77, 55.70, 55.65), has shown that it could be greater than the differences between stocks in separate areas (Biester, 1979). Variations of temperature and other environmental factors in the spawning area over the years must also have affected the meristic mean values obtained. The annual differences can, however, be difficult to prove directly by sufficiently extensive sampling.

Another fact, which seems not to have been considered, is that the impact of environmental factors also implies that the offspring can present other mean values etc. than the parental generation. This must be of special importance in a transitional area with a varying environment and a changing appearance of populations or biological groups of herring from different directions. Probably this is the explanation for the fact that 0-group young herring with VS mean numbers higher than c. 56.5 seem to occur very rarely in the area from central Kattegat to Öresund (according to data published in Annales Biologique mainly by Aa. J.C. Jensen from the end of the 1940s to the beginning of the 1960s). The "Kattegat winter-spawners" may, for example exist here only as older fish that have migrated from the north.

There is obviously less variation of the meristic mean values within large populations belonging to a more uniform region, e.g. with reference to the main part of the autumn-spawning herring of the North Sea (cf. Zijlstra, 1969). Moreover, it is possible that the t-test which has been used to determine the significance of mean value differences is not really applicable. This should be due to the fact that the number of frequency classes is so small for meristic characters (Harden Jones, 1968).

It is important to emphasize the risk of believing too much in the permanence of migration habits, choice of spawning area, and individual growth of different populations. Examples of the varying habits of migration and the choice of a new spawning area have already been mentioned. We may recall the periodical occurrence of spent North Sea bank herring in the Skagerrak-Kattegat, occasional appearance of the Rügen-herring in the Gdansk Bay during spawning-season, and of Baltic herring from the Swedish east coast at Rügen in connection with spawning, and the proved change of spawning areas on the Swedish coast of the Baltic proper.

With reference to this, one should be reminded also of how the spring-spawning herring from the southwestern Baltic, after the opening of the Kiel canal in 1895, invaded the canal, and lakes connected with it, as a totally new brackish-water spawning area. Some years later they appeared spawning as far off as in the mouth of the canal into the river Elbe, about 95 km from the Baltic coast (Brandhorst, 1956)!

Change of growth conditioned by population density and access to nourishment is a well-known problem. With regard to the autumn-spawning herring, this has been described e.g. from Öresund and the Kattegat/Skagerrak by Andersson (1943, 1954). Unfortunately, no account is given of the mesh-size in the nets used for the fish samples. This reduces the reliability of the comparison as regards the growth during different periods. On the whole, however, the information is probably correct: lower growth with a rich stock as about 1916, and a higher growth with a sparse stock as in the 1930s and later on. Such changes in growth of spring- and autumn-spawners have been described from the southern Baltic, too (e.g. Popiel, 1964, Friess & Kästner, 1982). And Jensen (1949 a) has noted changes in fat content of herring from year to year in the Belt Sea and Skagerrak.

A transitional region such as the Kattegat-Belt-Öresund-SW Baltic is not only a mixing area for various herring populations. The environmental conditions varying locally and with the time period, can also create "new" populations here, phenotypically only slightly different from each other and of varying duration. Normally there is the question of minor changes of meristic mean values, growth and fat content. But shifts of the spawning time may also happen. A change from winter/spring-spawning to summer/autumn-spawning or vice versa is possible (cf. Anochina, 1971) - particulary when considering the very different and varying spawning seasons of the stocks in the area.

Jensen (1949 b) mentions finds of spawning shoals of herring in the southern Little Belt on the 20th of December, 1948. The meristic characters are said to prove that these herring were closley related to the spring-spawners of the Belt Sea but that they also had a certain resemblance to the autumn-spawners in this sea. Jensen stated that there is no sharp border-line between the spawning season of the winter herring and that of the spring herring in the Belt Sea.

Nellen (1965) has clearly proved from the Schlei-Fiord somewhat farther to the south, that herring spawning there to a small extent in October-November also are early spawning spring-spawners (according to meristic characters as well as to scales and otolith types). Iserhagen (1976) made the same observation of Rügen-herring at Mönchgut (SE Rügen) in November 1975. And Biester (1979) has proved that spawning Rügen-herring can be mixed with c. 2 % herring born as autumn-spawners but spawning in spring.

What has been stated above thus calls for caution when estimating the structure and variation of the herring population during different periods. It is, for instance, not possible to conclude for certain which was the main type of herring that constituted the basis of the rich herring period in the southern Baltic during the 1300s and 1400s. But available information, the somewhat warmer climate of that time, and the fact that September was then the most important month for fishing, may indicate that autumn-spawning herring were predominant in the catches (cf. Otterlind, 1984).

The Öresund herring and the fishery

For many years, late summer-early autumn was the most important season for herring fishing in Öresund. In November the fishermen since ancient times passed on to fish cod or to other activities. A change of this pattern took place at the beginning of the 1970s, when west-coast fishermen from the Gothenburg region and the province of Bohuslän started fishing for herring with large-meshed nylon nets during late autumn-winter in northern Öresund and in the adjacent Skälderviken. Two new experiences were then made: concentrations of spawning herring appeared regulary in wintertime off the coastal region of Kullen-Höganäs, and good catches of large spring-spawners (5-10 per kg) of the type of "Rügen-herring/Kattegat spring-spawners" were taken when fishing here and in mid-Öresund (later on also farthest to the south in the Sound).

The spring-spawners mentioned had so far to a great extent escaped attention, due to the fact that the local fishermen of Öresund had used too small meshes in their nets and that they did not carry on any winter fishery for herring (cf. Otterlind, 1984, 1985). The new fishery in the 1970s with large-meshed nets (bar-length 27-28 mm) was now taken up by them also during wintertime in the Sound, as well as in adjacent waters of the Baltic. Possibly changed migration habits of the Rügen-herring may, however, have promoted the positive growth of catches. Moreover, it can be mentioned that these large herring were probably better exploited already during the time of Linné in the middle of the 1700s.

In 1749 Linné mentioned that herring caught at Kullen during August-September, were said to be fatter than other Swedish herring, which may indicate that they were spring-spawners (the size according to available information was probably often about 10-12 per kg). During the present century right up to the beginning of the seventies, the very varying catches within Öresund were entirely dominated by herring in size assortments from 10-20 to 10-15 per kilo. It is obvious that this was largely owing to the small meshes (about 17-22 mm bar-length) of the net used. To what degree these herring were composed of young spring-spawners is not clear. According to the literature, the autumn-spawners are considered to have been predominant in the Sound. In this connection one should also be reminded of the fact that considerable variations in the growth of the Sound herring have occurred (cf. p. 11).

The following account of the occurrence of the herring in Öresund is for the most part based on the above-mentioned field survey among the professional fishermen, but it has also been completed with information from earlier literature. (A more detailed account in Swedish is to be found in Otterlind, 1984; some supplements and amendments have, however, been made here.)

Northern Öresund

The winter-spawning herring in northern Öresund (N. Helsingborg) were thus earlier (cf. p. 6-7) known from ground areas in the Kattegat (the "winter-spawners of the Kattegat"). With the onset of 1972 they became an object of a rather intense fishery between Höganäs and Kullen from the first half of January to the end of February. Occasionally, herring ready to spawn have, however, been caught at Mölle as late as about the middle of March. But the same kind of herring could, during this season, also be caught at Lysegrund and Stora Middelgrund in the adjacent part of the Kattegat. Spawning shoals often appear quite close to land at a depth of 3-20 m, e.g.

just outside Mölle. The best catch was obtained in connection with westerly winds. Naturally spawned roe was found on grapnels and stones when fishing.

Here it was a typical feature of the winter spawning that it was often repeated within the same area, e.g. at Mölle-Höganäs, during a period of up to 5-6 weeks. Previous experience of the fishermen from winter and spring spawning on ground areas off the Swedish west coast indicated that the spawning there seemed to be more of a non-recurrent phenomenon for a short period. As a rule, further fishing was not worthwhile when roe had been laid in a place.

The winter fishery in northern Öresund reached a peak towards the end of the 1970s. In spite of difficulties owing to the ice situation, the winter of 1979 yielded a rich catch. If related to the number of nets used, the gain had, however, begun to decrease earlier according to the fishermen. There are no reliable statistics of this local fishery, but it is a question of a maximum annual catch of about 1 000 tonnes (including also spring- and autumn-spawners).

The decrease in winter spawning became more obvious in the beginning of the eighties, and the winter fishery stopped almost completely in the Sound. Occasional large catches have been taken later, e.g. on St. Middelgrund at a depth of 12-25 m in February 1985. The disappearance of the winter-spawners was supposed by the local fishermen to be the result of too hard a spawning fishery.

The catch of spring-spawners, and autumn-spawners mixed with them, can vary considerably from the end of August to the beginning of the new year. The variation probably depends, at least partly, on the former's irregular migration by wind-induced current towards the Baltic. In the late 1970s and in the beginning of the eighties, for that reason, both the fishermen on the west coast and those from northern Öresund also took up net-fishery for Baltic herring during winter-spring in the Hanö Bay and off the Swedish east coast (to the north up to Oxelösund). Here, rather good catches can often be taken continuously during that season. The fish are less active in the cold water and the more stable brackish water environment particularly in the northern areas. In addition, during spring the herring gather for spawning in the archipelagos.

Fairly frequently, very good catches have been taken of herring, for the most part spring-spawners, in Skälderviken (NE of Öresund) as in 1984 during winter-spring and in the winter of 1985 until the freeze-up. The fishery can be already profitable by the 1st of September and during the autumn in the outer part of the bay. Spawning herring are practically never caught by the net-fishery in Skälderviken. In certain years during April-May, herring ready to spawn can go into take-nets here and lay the roe in them. In spite of intense investigations no natural spawning has been reported, but it probably occurs in the inner part of the bay and/or on ground areas between Vejbystrand and Hallands Väderö though not observed owing to low fishing effort during late spring.

In the waters from Höganäs to Kullen or otherwise in northern Öresund, there are no observations of spawning in spring. Spawning on a small scale has been noticed several times in the end of July and the beginning of August near Arild, at the inner side of Kullen, towards Skälderviken, although not after 1979.

Autumn-spawning herring, ready to spawn, occur every year sporadically during September-October, now and then even in November, in northern Öresund from Kullen (also at Arild) to Viken (N. Helsingborg). Thus they go farther in to the south than do the winter-spawners, and arrive as a rule by south-bound current. They are most frequent farthest to the north, especially with north-westerly winds. To begin with, the herring can then be caught at a depth of about 20-25 m. Later on, if the direction of the wind continues, they come up towards the surface at a depth of 4-5 m (depending on a changed stratification of the water). The quantity of the catch is normally rather insignificant but may, in September, amount to some tonnes. Observations of naturally spawned roe are not reported. Large quantities of roe have, however, been laid in fishing-gear, e.g. when shoals have entered eel take-nets in September.

During the 1950s and the 1960s, a good supply of autumn-spawners was often noticed at the Danish side, between Helsingör and Gilleleje, from the end of August to the middle of October. They were spent in October but could be caught even later in winter as far as any fishing was carried on. The spawning was supposed by the fishermen to take place on the ground areas outside Gilleleje. But it is possible that it was a question mainly of fish on their way to and from the south-western Baltic (cf. p. 15-16). They have been of more rare occurrence lately. The fishermen say, however, that they still, at times, get as many spent autumn-spawners as spring-spawners in late autumn within northern Öresund. - Shoals of small herring are observed mostly during June-July in the take-nets and by the shores here and in Skälderviken.

Central Öresund

From mid-Öresund (Helsingborg-Lomma Bay) no certain spawning ground is known either for winter/spring- or autumn-spawning herring. It is probable, however, that spawning has occasionally occurred in September-October on Disken, a ground area immediately south of Helsingör. Unfortunately, this locality is now partly destroyed by sand extraction. Spent autumn-spawners were earlier, as in the north, common in October, but spring-spawners are now predominant from August-September until the winter.

Herring are to be found also in summer, though even now to an uncertain extent and with an unknown distribution among spawning types. During this season in the 1930s, drift-net fishery was carried on, e.g. from the waters outside Helsingör up to Viken in the north. Later on, the traffic of boats became too heavy here after World War II. - Young herring of the latest year-class (about 5-10 cm in length) are often observed in take-nets set out early and in the harbours during spring-summer until midsummer.

In stable weather the northbound surface current gives the best catches, especially in central Öresund, due to the fact that the herring then go more densely. The explanation is the markedly stratified water with this direction, as compared with the effect of a southbound surface current when a stratification may be completely absent.

Fishing usually starts here about 1st of September. Already as early as that, large spring-spawners of Rügen-type are now predominant in the net catches. Normally they increase in numbers during late autumn, and in certain years they can occur far into the new year. They are usually gone for good by March. It has been proved that "waves" of the large spring-spawners appear in mid-Öresund during the autumn/winter after or during periods of hard winds from the western sector. These winds usually result in a southbound current - towards the Baltic.

Southern Öresund

No regular spawning has been observed lately in southern Öresund (from Malmö to the line Falsterbo-Stevns) - in the Sound proper. However, autumn-spawning still occurs in the southern part of Köge Bay. But this bay is physiographically more a part of the Baltic than of Öresund. Earlier - from the time round the turn of the century (Lönnberg, 1899) to World War II - herring have been observed to spawn in late September and in the beginning of October on the grounds outside Malmö, at the furrows Trindelrännan and Flintrännan, and at Kogrundsrännan down to Skanör, at a depth of 4-6 m.

Autumn spawning became less frequent after World War II, but a fairly large quantity of herring roe was found on fyke-nets for eel during the whole of the 1960s and, very rarely, as late as in the beginning of the eighties (at Sjollen and Kalkgrundet at the depth of 8-12 m in September-October). At the same time, the autumn-spawners have generally - as already mentioned - decreased here and in the southwestern Baltic during the 1940s and 1950s. Spring spawning has never been proved for certain in southern Öresund.

Autumn-spawning herring were earlier caught often, during the 1950s and before then, as spents in Köge Bay during September-October. They were considered to migrate via Öresund to and from the spawning areas in the southwestern Baltic and Köge Bay. The so-called Limhamn-herring from the waters between Flintrännan and Köge Bay were chiefly made up of these autumn-spawners. Nowadays the spring-spawners are predominant in the catches, especially since the wide-meshed herring nets had come into use in southern Öresund from the middle of the seventies.

In view of the time for the herring fishery and the use of comparatively small-meshed nets, the spring-spawners thus had to a large extent escaped the fishery in Öresund. It has been reported that the autumn-spawners were earlier always predominant in the catches. Andersson (1947) says, however, that in 1943 the share of spring-spawners in the catches (probably in the first place from southern Öresund) could in some cases amount to more than 50%.

According to newly acquired knowledge (since the 1970s) the spring-spawners of the Rügen type usually occur in larger numbers about the 1st of September when the water grows colder. Then they increase until the new year when probably most of them have often passed the threshold of Drogden (Limhamn-Dragör) in the direction of the Baltic. Large catches have been taken immediately south of the Falsterbo-Stevns line about the new year. But such catches can now and then be taken also north of the threshold in January and later. To the south in the Köge Bay, for instance, a record catch of 12 tonnes has been reported from a net-fishing boat as late as the end of February.

In the southwestern Baltic, between Falsterbo and Trelleborg, the first large shoals of immigrating spring-spawners can arrive by the beginning of October. Later on they increase and stay chiefly within the Arkona Basin (W. Bornholm) during the autumn-winter before entering the spawning areas, primarily at the German and Polish coasts. In December 1984 a temporarily rich occurrence was noted from SW. Sandhammaren to the inner part of the Hanö Bay. Odd specimens were found in a sample as far to the east as SE. Utklippan, identified through their growth and infestation by Anisakis nematodes.

Small herring (about 5-10 cm, sometimes smaller) have been noted in take-nets at Klagshamn mostly in the end of March and in April, to some extent also in the beginning of September. The very sparse trawl samples of our research vessels in mid- and northern Öresund have usually been dominated by young herring about one year old during autumn and early spring (cf. Table 5 B).

Öresund as a spawning area for herring

As can be seen from the foregoing account, the spawning of herring has been observed in recent years regularly only in northernmost and southernmost Öresund (Köge Bay). This indicates that the area is not very suitable for the recruitment of the herring. The reason is the unstable environment, the strong and directionally changing currents. As has been mentioned, they can reach a speed up to 4 knots (2 m/sec). Owing to this, the newly hatched larvae from the roe laid on the bottom vegetation are easily dispersed to widely separated and varying environments. No doubt, this reduces their chances of survival. Spring spawning does not occur at all. The discharge of water from the Baltic in spring is very intense and the temperature of the surface water is low.

According to Danish investigations in 1927-39 (Jensen, 1949 b), larvae of winter-spawning herring appear relatively frequently in April in northern and mid-Öresund by inflow from the north of the deep water. To what extent they remain there is uncertain. With regard to their vertical migration at night to the surface layer, where the current is usually outward-bound (to the north), they may in the main be transported back to Kattegat. In May only an insignificant number of larvae of spring-spawners were reported, and only in northern Öresund.

In October, plenty of larvae of autumn-spawners, less than 10 mm in length, were obtained by Jensen in the waters east of Laaland-Själland, to the north up to the southern part of Köge Bay. The Sound proper displayed decreasing larval frequency northwards. But, for instance, the occurrence of 87 such small larvae in 1929 with a 30-minute-haul just south of Helsingör may indicate spawning there in that year. Otherwise, it is here likley to be, for the most part, a question of transportation by the surface current from the southwestern Baltic. A great deal of the young autumn-spawning herring should later be recovered in the Kattegat, according to the meristic characters observed (Jensen, 1967).

Weber (1971) has presented a hypothesis of how larvae of autumn-spawning herring in the southern Belt Sea can gather at the Kiel Bay through a combination of differnt currents. However, this hypothesis seems not to have sufficiently considered the possibility of larvae transportation by way of varying currents from several other spawning areas, in the Great Belt, the northern Belt Sea, and from the western part of the Arkona Basin (cf. Jensen, 1949 b). The sampling of larvae also gives in general a most varying result during the autumn months. This is, as shown by Kändler (1952), hardly related to the size of the new year-class to which the larvae will give rise.

The observations of the fishermen are, of course, mainly limited to the periods and water areas frequented when fishing. It may be reasonable if spawning - in spite of no recent reports from the main part of the Sound proper - occasionally occurs in different localities with temporarily favourable external conditions. Apparently, it must often result in what can be called an abortive spawning - without success (cf. Otterlind, 1985). A similar situation is to some extent found in the Belts and Belt Sea areas. In the inner parts of fiords and bays, however, the herring larvae meet with a relatively stable environment, suitable for their survival.

The above account probably presents a fairly reliable picture of Öresund as a scarcely convenient spawning area for the herring - without any true local population. As a feeding area for young as well as adult herring of various populations, the Sound can, on the contrary, offer a positive environment.

Sampling methods

Problems with sampling

In Öresund, as in most of our sea areas, there are thus several populations or biological groups of herring represented. Mixture occurs between them to a varying degree, especially during feeding migrations, and perhaps at times during larval and juvenile stages. They can definitely be mixed in connection with catching. In trawl-fishing, the gear is often dragged for some naut. miles. Quite often, therefore, the catch consists of both spring- and autumn-spawners, of young and old herring. A fine-meshed trawl can yield a fairly random selection of both large and small fish.

In gill-net fishing, the mesh width sorts the herring so that the variation of size within the catch decreases sharply. Yet both spring- and autumn-spawners can be caught while the nets are lying out, usually overnight or for some hours. Even here, one can thus get fish of different types and origins, but the chance of mixture is often less than with trawl-fishing. The selection of a certain size occurs primarily according to the herrings´ "thickness", which is, however, related to the total length. Full herring can, though, be caught more easily than spent herring of the same length, or vice versa, in accordance with the mesh-size of the net.

For stock investigations, samples of spawning herring are best captured with fine-meshed take-nets and seines or similar equipment. The population of sexually mature fish can then be considered as unmixed ("pure") as possible, and the sample regarded as uninfluenced by the mesh-size. Usually, however, trawl- or net-herring must be accepted also outside the area and time of spawning. Race-analysis of such samples from herring gives lower certainty than with "pure" spawning samples - even if fish in spawning stage or in adjacent roe/milt stages are chosen. The gonad stages are then in part difficult to judge as regards duration, depending among other things on the existing water temperature. The occurrence of related populations with identical or similar spawning time may further reduce the stock separating value of the mean figures of, for example, the vertebral number and keeled scales from samples taken in this way.

In addition to the mean number of vertebrae etc., one must rely on different growth and otolith types. It has long been well-known that autumn-spawners attain a greater total length (L_1) than spring-spawners by the time of laying-down the first winter-ring on the scales. Within the investigation area this ring is laid-down in spring (especially young fish) and early summer. The autumn-spawners are then usually 6-9 months older than the corresponding spring-spawners as they lay-down the first winter-ring after their second winter. A long and varying spawning period can involve problems of judgement. Separating samples of young fish of pronounced autumn- and spring-spawners from each other is, however, often possible with the help of their length distribution (cf. Rosenberg & Palmén, 1982, Hagström, 1984). As stated above, samples of young fish from Öresund are rare in the material presented here.

Different types of variation

At least two types of variation must be expected in the most commonly occurring samples of herring from Öresund and adjacent waters. One is due to the normal variaton, always present even in a "pure" spawning population, for example of mean vertebral number and of growth in different year-classes. Another results from mixture between more or less distinct populations. Since it is seldom possible to obtain "pure" samples (from spawning areas during spawning time), the mixture-variation is difficult to avoid. The variation between different year-classes can be taken into account by comparing the mean values for the same year-class in separate samples.

A further variation or source of error exists in the very handling of samples. Fresh, but insufficiently cooled, and frozen samples can, to a varying extent, create difficulties in judgement, particulary of the gonad stages and intestinal fat. Moreover, some variation can be caused by different sample-takers. For assessment of the value of herring samples in stock analysis, it is therefore of great importance that the methods of catching, sample handling, and sample selection are reported. This has, unfortunately, not always been done in previous investigations.

Otoliths and stock identification

In the present investigation the division of samples into spring- and autumn-spawners has been made primarily with the help of otolith characters, such as the otolith's form and the size of the first winter zone (O_1). The latter is measured between the outer edges (greatest length) of the first hyaline zone. Usually the measurement is parallel to the otolith's long axis from the rostrum to the postrostrum (cf. Fig. 2), but sometimes an insignificant angle to the long axis is followed. We also try to distinguish different populations within the main spawning types by means of the otolith's growth and form.

The otoliths, after washing in 96% alcohol, have been embedded in "eukitt" (manufacturer O. Kindler, 78 Freiburg, West Germany) on small black plastic plates (10 otolith pairs on each plate). Dilution of eukitt is done when necessary with acetone (less hazardous than xylene). The otoliths are measured and studied in incident light from the otolith's concave, outer surface. The hyaline winter zones then appear dark.

As regards the Baltic herring, Kändler (1942, without any further description) and Popiel (1955) introduced otolith types as a criterion for spring- or autumn-spawning herring. The method was subsequently developed primarily by Ojaveer (1962), Rauk (1965), Rannak (1967), Kompowski (1969, 1971), and Ojaveer et al. (1981). The otolith type thus came to be used also for characterization of geographically more or less distinct stocks belonging to the same spawning type, principally spring-spawners in the Baltic.

Wood (1979) has clearly demonstrated the size difference for the otoliths' first hyaline winter zone in spring- and autumn-spawners of the North Sea area. There is a parallel phenomenon in the laying-down of the first winter-ring on the scales (cf. above).

In the study and judgement of our otolith samples, the author has received very valuable help from Ann-Christin Rudolphi, who has devoted great interest and ability to this work. She is also responsible for all the otolith drawings.

According to the literature four criteria can be used as general guides to the separation of spawning types with the help of the otoliths, but none of them alone is decisive (frequently one or two are lacking):

		Spring-spawners	Autumn-spawners
1)	general form	long and narrow	more compact and rounded
2)	excisura minor	usually clear	weakly marked or absent
3)	line from nucleus to excisura minor relative to long axis of otolith	usually parallel or at a negligible angle	usually at a clear angle
4)	size of first hyaline winter zone	small	great

According to our experience, it can be said that the form and other features of the otoliths within the herring groups considered here are rather variable. The variation can, no doubt, only partially be explained by different distributional origin. Individual characters must also be weighted together and combined with the gonad stage. The latter comparison can sometimes clearly reveal that herring which were born as autumn-spawners on the basis of their otoliths, have become spring-spawners or vice versa (cf. p.11). As a rule, however, the gonad spawning stage agrees with the spawning type indicated by the otoliths.

The judgement of the transition from one spawning type to the other is made difficult partly by the otolith variation mentioned, and partly by the identification of the various gonad stages and their durability, particularly during late autumn-winter. The herring samples investigated have as a rule been frozen and cold-stored before being examined, a fact which sometimes may contribute to uncertainty in the separation of the various gonad stages.

In addition to the four spawning type characters mentioned above, the development of the otolith nucleus may be of importance for the separation. A large nucleus occurs in autumn- and winter-spawners, but its hyalinity varies greatly, with age among other things. Spring-spawners that breed early also have a larger nucleus than do those which breed late. The width across the first hyaline winter ring, moreover, is greater in autumn-spawners, and the ring is better delimited, than in spring-spawners. In addition, the otoliths of autumn-spawners usually have a more even upper (dorsal) lengthwise edge than do those of spring-spawners. Early spring-spawners of, for example, the Rügen-herring often have a secondary hyaline ring within the first summer zone. The latter is generally wider than in late spawners.

Age determination with scales

Age determination of the herring, and calculation of the length (L_1) at laying-down of the first winter-ring, have been made during the present studies with the help of scale samples (without correction for the larval growth). Five scales were taken from each fish, and the best was chosen for measurement. If the scale´s winter-ring for the sample year was laid-down (by the beginning of the new growth) only in some of the herring, this was adjusted so that all fish from one year-class were brought together. It must be stressed, however, that some uncertainty may be connected with the age determination of old herring, particularly from an age of about eight years and older. In some cases with dubious result from scale reading, the otoliths have been used as a possible check on the age determination.

Scales always exist from sample-taken herring, even if in the case of trawl-caught fish there are frequently only so-called crest-scales left, which are less suitable for measurement. Sometimes otoliths can not be used for measuring the first winter zone's length (O_1) because of diffuse zone limits, and damage or loss during sampling. If this measurement is lacking, it can, in spawning-type determination be replaced to some extent by the calculated L_1. However, at times even the scale sample is unmeasurable and the fish must be excluded from the material.

The herring samples investigated

The herring samples collected are presented in a condensed form by the Tables 1-5. In the individual table they are arranged seasonally from June to May (no sample from July). Some legends and comments on the tables are necessary.

In Tables 1-4 are mentioned under the column "Sample data": sample number, the number of fish in the investigated sample, gear (N = gill-net, usually 27-28 mm bar-length; NB = take-net, bar c. 18 mm; T = trawl, c. 18 mm bar-length in the cod-end; TS = trawl, c. 11 mm etc.), locality and position (lat. N, long. E, in degrees and tens of minutes), date, the total number of fish measured (Md, including the sample), the limiting values of length distribution and maxima of interest within the distribution. (According to recent information the locality for sample no. 1285 of Table 1 is the waters off Mölle, not Skälderviken.)

In the next column are given the number (n) and percentage per spawning type in the sample (S = spring-spawner, A = autumn-spawner, the rest percentage = undefined type), furthermore the most frequent gonad stages (1-7; 23 etc. = intermediate between 2 and 3, in the text below designated 2-3; Im = juvenile fish sample separately in Tab. 5 A-C), and the age-groups represented, in number of winter-rings (wr) on the scales. -- = some age-group(s) not mentioned.

Under "Total mean" are given mean values with number and standard deviation of L_1 (total length at the laying-down of the first winter-ring), O_1 (length of the first winter zone of the otolith - cf. Fig. 2 - in number of eyepiece units noted in an ocular micrometer, where 10 units = 0.38 mm), VS (total number of vertebrae, the urostyle included), and of K_2 (number of keeled scales between the ventral fins and the anal opening). Individuals showing fusions of vertebrae were always excluded when VS mean was calculated. The column "Age(wr)-group mean" gives the the mean, number and standard deviation of the total length, l, and of L_1, O_1, VS and K_2 for the most frequent age(wr)-group or groups.

The column of "Remarks" contains information i.a. on the percentage of fish per spawning type in the samples, which were infested by nematodes (NEM), as a rule probably Anisakis sp., and on possible sub-types of otoliths. In Table 4 the infestation percentage is given in the same way and per assortment (A 0-5) for the commercial trawl samples. Herring with a total length of about 22 cm and smaller are seldom infested by nematodes in the investigated area. The assortments are designated by the number of fish/kg (max. or range): A 0:8 fish (from June 1983:7), (sometimes A 00:5), A 1:10, A 2:10-17, A 3:17-24, A 4:24-32, A 5:32 and more fish/kg.

The majority of infested herring always belong to assortments 0 and 1. Sometimes, however, a fairly great variation is noted in the assortment: e. g. A 2 can in reality correspond to A 1, with fish generally larger than c. 22 cm. Following that, an unexpectedly high infestation percentage may be found in A 2, as in samples nos. 2896-2898 (Table 4).

In Tables 5 A-C, on juvenile herring, the legends are mainly identical with those of Tables 1-4, but we note the mean etc. of total length (l), of VS and K_2 for the 0-group (no winter-ring, wr) and the I-group (one wr), and of O_1 and L_1 for the latter. In the length distribution some older fish may be included.

Owing to lack of investigation facilities or of space in the tables, not all characters or all mean values per age-group have been reported. Among the excluded ones are: sex, number of prehaemal vertebrae (V_{ph}), intestinal fat (0-4), the head length (nose tip to rear edge of operculum) in percentage of total length, weight and condition coefficient. Excluded from the tables are also usually small sample fractions which could not be determined as to otolith type, or as a consequence of other insufficiencies (e. g. broken or incomplete otoliths or too few fish to give a mean value of importance).

The basic material from the investigation is preserved as sample records at the Institute of Marine Research (Havsfiskelaboratoriet) in Lysekil. A sample can easily be located, when necessary, by means of its number in the tables. - The samples tabulated here have as a rule been frozen and later analysed in the laboratory,

Samples with more than one serial number have been taken from commercial, assorted catches (one number for each assortment). They comprise sub-samples randomly selected from up to six assortments. The total mean figures are weighted in relation to the number of age-determinated fish in the sub-samples.

In this context it is necessary to stress once more the importance of the mesh-size of the gear. It has a great influence on the length distribution of the sample and thus also on its age distribution and the noted mean length per age(wr)-group. An illustrative example is given by the samples nos. 3264 and 3265 from May (in Table 4) which were taken with nets of different mesh-sizes.

Results of sample analyses

As a lot of populations mix in the area investigated, the number of samples in Tables 1-5 must be considered fairly small. The material at hand is described and analysed as far as possible. It is in the nature of such a study that the proof of distinguishing characters and of relationships is to a large extent of an indicative kind.

The size of the first hyaline winter zone of the otoliths and the general shape of the otoliths have been preferably used to separate fish born as spring- and autumn-spawners. The otoliths are commented on also for potentially different populations belonging to either of these spawning types.

For additional information concerning the referred migration habits of the herring, elucidated by taggings (cf. pp. 7-9) and by the occurrence of nematodes of Anisakis type in the mature Rügen-herring (cf. p. 9) a review is first given of the nematode infestation found in the investigated samples. After that will follow a description of the herring from various parts of the investigation area and some further comments on the growth-rate and on the otolith types and their usefulness.

Nematodes as "biological tags"

In our herring investigations, routine records were kept of the occurrence of nematodes in the fish's body cavity (usually in the intestinal fat). These were uniformly of Anisakis type (no closer study has been made of species determination or frequency in the individual fish). Observations of such nematodes in the southern Baltic have been mentioned by several authors as indicating that the herring had spent time in Kattegat-Skagerrak. The reported intermediate host organisms (euphausids such as Meganyctiphanes norvegica and shrimps of the genus Pandalus) occur there, but not in the Baltic.

While this reasoning can be accepted, more detailed parasitological investigations are essential, as is study of the infestation degree in herring of various ages during different seasons in Kattegat. In Atlantic herring Anisakis were shown to survive at least 61 weeks, but probably more than three years (Smith, 1984, according to Möller & Anders, 1986). Final hosts of Anisakis are cetaceans and sometimes seals. The following is a short survey of the nematode occurrence in the investigated material, complemented by our otherwise available samples from southern Baltic (cf. Table 6).

The material presented in Tables 1-4 shows that nematodes were encountered in all samples of adult herring from Öresund (28, including those from the southernmost Kattegat) and in all but one of the 22 from the Arkona Basin (although there usually with lower frequency in the individual samples).

As a rule, the nematodes emerge very sparsely in herring up to c. 22 cm long. The number of infected fish then grows with the herring's size, not seldom reaching 100% in fish of c. 28 cm and longer in southernmost Kattegat and Öresund, as well as to some extent in the Arkona Basin. In young herring from the first-mentioned area, nematodes have been noted only sporadically in fish of 15-21 cm (in three fish from central Öresund and one from central Kattegat), but the investigated material here is small (cp. Table 5 A-B). No finds in young herring have been made in our numerous samples from the Baltic.

The frequency of herring with nematodes decreases as one goes east in the southern Baltic. Table 6 collates the number of nematode-positive samples per month from a total of 187 with adult herring from three areas: the Arkona Basin (including the 22 otolith-investigated samples in Table 4), western Hanö Bay (from the Bornholm Strait to the western Karlskrona archipelago) and eastern Hanö Bay (from the eastern Karlskrona archipelago to the waters south of Öland). The material is from the years 1971-84.

The infestation degree in percent has been calculated here on the total number of investigated fish from assortments 0 and 1, as well as from the gill-net catches which normally correspond to these assortments. In entirely unsorted catches, the percentage has been summarily calculated on fish larger than 22 cm. Since some fish longer than 22 cm are included in assortment 2, and since the general size distribution over 22 cm length obviously always - and especially in the unsorted samples - influences the stated percentages, these are comparable to a somewhat variable extent. The percentage figures mainly concern spring-spawners, often identified here through current gonad stages. Since the spawning type has not always been definitely determinable, a small number of autumn-spawners is sometimes included. A few representative samples of autumn-spawning herring from September-October, partly also present in Table 4, are commented on below. Further, the values of infestation percentage per sample as given in Table 6 are approximate.

In the Arkona Basin, 59 out of 67 samples of adult herring were nematode-positive (88.1%), the highest percentage per sample for infected fish being in October-November (although with a large variation of 3-92%), and with low values during April-September (0-23%). In western Hanö Bay, 29 out of 46 samples showed nematode infestation (63.0%), the highest values being registered in November-December (9-47%), while with generally lower percentages than in the Arkona Basin. Eastern Hanö Bay, as far as southern Öland, yielded 24 positive samples out of 74 with adult fish (32.4%). Here the infestation percentage in our samples did not reach 10% during the autumn, but a few relatively high values were noted during January-March (max. 24%).

Particularly low was the nematode frequency in spring-spawning herring taken with purse seine and seine in the Karlskrona archipelago. Of 15 samples during April-May in 1971-84, only four were nematode-positive. In two cases, a single fish was involved (less than 1%); in the two others, 2 and 4 fish (respectively 1.5% and 2.9% of the investigated fish). Five samples of spring-spawning herring, caught in take-nets or gill-nets during the same period in the innermost western Hanö Bay, were all positive with a higher percentage in four cases (1.5, 3, 7, 7, and 13%).

The Arkona Basin revealed, among seven samples of autumn-spawning herring in September-October, nematodes in all. The percentage, in six cases with representative numbers of fish, varied from 5 to 24% (higher values for autumn-spawners in Table 4 are due in the main to chance and to "skewed" age distribution in small samples). Of two samples of this spawning type in the innermost western Hanö Bay during the same period, one was positive (1 fish or 0.5%). Of seven other samples (regardless of spawning type) from this period in western Hanö Bay, two were positive. In the outer Karlskrona archipelago, one of two samples of autumn-spawners during August-September was positive (3 fish or 2%). All nine other in eastern Hanö Bay during the same period were negative.

In Swedish waters north of Hanö Bay, only two herring with nematodes of Anisakis type have been noted from a very large number of samples. They were caught off the north point of Öland in March and October.

The occurrence of nematodes in spring-spawning herring of the southern Baltic can be said - in terms of time, distribution and frequency - to agree well with the appearance of mature, fast-growing "Kattegat spring-spawners/Rügen-herring" and with the tagging results (compare pp. 8-9). It decreases rapidly toward the east. The same relationship evidently holds for the infestation degree in the rarer, migrating autumn-spawning herring populations of the area.

Northern Öresund

The herring material from the waters around Kullen (from Helsingborg to Skälderviken) represents both northern Öresund and southernmost Kattegat. All samples of adult herring (14 in Table 1) were net-caught during September-April. The mesh-size of the gear used has been reported to be uniformly c. 27-28 mm bar-length, and the catches unsorted. Hence these samples, like others net-caught in the material as a whole, are strongly selective for large adult herring. Some variation may, however, occasionally be caused by somewhat different mesh-sizes, and perhaps by unreported sorting. Two samples of young herring were taken by trawl with mesh-size c. 11 mm bar-length (nos. 3155 and 3228, from December and March respectively, in Table 5 B). From southern Kattegat come three more young-herring samples trawl-caught in February-March (nos. 1645, 1648, 1556 in Table 5 A).

Spawning types. The separation of herring born through spring- and autumn-spawning has thus been made, here and in the following, with otolith characters (see pp. 18-19). Erroneous judgement of original ("primary") spawning type may have occurred in part, however, due to the strong variation of otoliths which is commented upon later. Comparison with current gonad stages (cf. p. 20) indicates or demonstrates, in some samples, a transition from primary autumn-spawning type to winter/spring-spawning type. This applies mainly to no. 1278, and otherwise mostly to individual fish as in nos. 2500 and 3162. Change of spawning period, with transition from primary spring- to autumn-spawning, also occurs with some individual herring in samples nos. 2429, 3162 and 13444, perhaps also in 2770 and 3112. This is often not apparent from Tables 1-4, where it has been possible to register only the most abundant gonad stages.

Overweight of spring-spawners was noted in all samples but one, no. 13444 from March. In some cases, though, the number of herring whose original spawning type could not be determined by the method employed was significant. The otoliths were then either of uncertain type, unmeasurable or defective, as in nos. 1278, 1285 and 13438. Generally, too, some degree of subjectivity always affects the spawning-type determination by means of otoliths. This source of error is also important in attempts to distinguish groups within the same spawning type.

Both spawning types occur, as expected, to varying extent throughout the year in the area around Kullen. That the spring-spawners as a whole dominated the catches in the investigation is, however, clear and in full agreement with experience from the commercial fishing in Kattegat. Samples with herring at spawning (gonad stage 6) or nearly so (stage 5 or 5-6) are also most abundant during winter and spring, totalling five in January-April (nos. 1087, 1278, 1285, 13438, and 13451). The ordinary spawning period in autumn yielded only one such sample with original autumn-spawners (no. 2429 from late October).

Groups within spawning types. Attempts have been made to distinguish groups of spring-spawners in samples nos. 1087, 1278 and 1285, according to otolith characters (cf. Fig. 25). But the variation was great and the subdivision difficult (especially for nos. 1278 and 1285). In Table 1 two groups, "SS-type" and "SW-type", are reported separately for these three samples. The former type, despite rather large variation, has normal spring-spawning otolith characters. The latter type also shows great variation, but resembles the autumn-spawners by the excisura minor lying at a clear angle to the vertical; otoliths with intermediate characters are, however, fairly usual. Otherwise the SW-type has spring-spawning characters with normal dimension of the first growth zone (O_1<70 length units, cf. p. 20) etc. In small numbers, this type has also been noted in other samples, such as no. 13438 and the three samples of young fish from southern Kattegat.

No certain difference can be established between the two groups of spring-spawners within the three samples mentioned in Table 1 as regards the reported characters. The otolith variation may be dependent on mixing of fish from distinct areas with different recruitment and/or growth possibilities, as well as on changes in environment from year to year. Perhaps the SW-type in pronounced form represents fish which were born in water of higher salinity or temperature (e. g. farther to the north or west, or in early winter spawning). Among spring-spawners of both types, one can notice some relatively high mean values for O_1 in nos. 1278, 2429, 13444, and 13451. These are probably due to favourable growth conditions or early spawning (variation exists between different age-groups), and probably also to partially misdetermined, primary spawning type.

The autumn-spawners in samples nos. 3162 and 3196, which show an unusually high proportion of large measurements for O_1 in otoliths (up to 96 length units), were divided each into two groups, with $O_1 < 75$ and ≥ 75 length units respectively. As Table 1 and Fig. 9 indicate, the groups exhibit no other difference than growth. The latter is also well-manifested through the first length growth (L_1). The autumn-spawners with rapid primary growth in these samples are probably of more northerly or westerly origin (e. g. bank herring of the North Sea) and/or products of an earlier spawning period in the parent generation than are the other fish.

Figure 3 demonstrates the meristic characters, with means for the vertebral number (VS) and for the number of keeled scales (K_2) in all samples from the area (cf. Tables 1 and 5 B), and in Figure 7 three samples from southern Kattegat are presented (cf. Table 5 A). The diagrams indicate that the winter/spring-spawners in the four samples nos. 1087, 1278, 1285, and 13438 (all from the period January-March) clearly diverge from the majority of samples, with high values, for both VS (56.45-57.47) and K_2 (13.89-14.71), which agree well with corresponding values in the literature (cp. p. 7) for "Skagerrak spring-spawners/Kattegat winter-spawners". No young-fish sample (including those from Kattegat) exhibits this combination of high values, which also agrees with what is published in the Annales Biologiques (see p.10 above).

The spring-spawners occupy an intermediate position in samples 2429 (October) and 2500 (February): VS is 56.32 and 56.20, while K_2 is 14.02 and 14.04. But these values fall also within the limits for "Kattegat spring-spawners/Rügen-herring", although K_2 is relatively low. Most of the samples of spring-spawners from northern Öresund, including the five young-fish samples mentioned and representing the period September-April, have the following range of variation in mean values: for VS 55.67-56.14, and for K_2 13.27-14.38. The VS values agree with those of the "Kattegat spring-spawners/Rügen-herring", yet the K_2 values are often somewhat lower.

The spring-spawners in samples nos. 13438 and 13444, which were taken at the same place on two successive days in March, illustrate how the sample types can vary. They show different VS, K_2, and gonad stage distribution. Evidently no. 13438 (partly individuals with SW-type otoliths) essentially represents "Skagerrak spring-spawners/Kattegat winter-spawners", whereas no. 13444 represents "Kattegat spring-spawners/Rügen-herring" and autumn-spawners (cp. Table 1 and Figs. 10 and 11).

The autumn-spawners are represented by mean values from 15 of the 19 samples (including five young-fish samples, otherwise only some individual fish). In contrast to the spring-spawners, they have generally rather uniform VS: 55.98-56.56, but somewhat more variable K_2: 13.47-14.71, the highest values for both characters being from winter samples. These lie mainly within the known values for Kattegat autumn herring and North Sea bank herring. In view of these and the season, autumn-spawners with high values may represent the last-named type. Also the majority of other autumn-spawners in the current samples from northern Öresund and southernmost Kattegat probably cannot consist to any larger extent of fish born in southwest Baltic, which have lower vertebral numbers (cf. p. 9).

Nematodes of Anisakis type were found in all reported samples of adult herring from northern Öresund (including southernmost Kattegat), but the occurrence varied: during the autumn on to December, c. 30-70%; and after New Year, generally high (often up to 100%) at least until the beginning of April. No difference in infestation degree can be observed between spring- and autumn-spawners. In young fish from the area, no nematodes were noted, but they occurred in a young spring-spawner from central Kattegat in November (sample no. 3410 in Table 5 A: 18 cm, 1 wr; autumn-spawners dominated in this sample).

In Figs. 8-11 is shown, besides nematode occurrence, the growth of spring- and autumn-spawners in four samples. Since they derive from net fishing, the length and age distribution is influenced to a varying extent by the mesh-size of the gear (as a rule 27-28 mm bar-length): young fish as a whole are given too high growth and old ones sometimes too low. Moreover, sample no. 2797 in Fig. 8 is probably influenced by a somewhat smaller mesh-size than most of the others from the area (or by some sorting). However, the age groups with 2-4 wr, in comparison to samples from winter/ spring with the same wr, have smaller length also because their last growth period is not yet completed in September. The autumn-spawners' normally higher age compared to that of spring-spawners with the same wr-number must also be kept in mind. The spring-spawners in sample no. 2797 can, in view of meristic characters (see Table 1 and Fig. 3), be assumed to represent "Kattegat spring-spawners/Rügen-herring", and the autumn-spawners primarily "Kattegat autumn-spawners" with an admixture of fish from the southernmost Baltic (and perhaps the Belts). The autumn-spawners' low growth in the wr-groups 1 and 2 of the sample supports this origin, as possibly does the relatively low degree of infestation.

The diagrams in Figs. 10 and 11 give information on the above-named sample 13438 and 13444, taken at a day's interval in March at the same place. The former sample is dominated by spring-spawners with high VS and K_2 values which indicate "Skagerrak spring-spawners/Kattegat winter-spawners". The most frequent gonad stages are 5, 6, and 6-7. No. 13444 shows a fairly even division into spring- and autumn-spawners, but the spring-spawners here have low mean values of VS and K_2 (compare Table 4), with 3 and 4 as the commonest gonad stages and a high infestation degree (like no. 13438). This, and the season, lead one to assume that they are Kattegat-spawning representatives of the "Kattegat spring-spawners/Rügen-herring" type. The indicated lower growth of the spring-spawners in Fig. 11 in comparison to preceding sample is probably a coincidence. Other samples with similar meristic mean values show higher growth, such as nos. 2770 and 13451 (diagram not included here). Differing mixture of the stocks is naturally of significance for the sample's average values.

The autumn-spawners in sample no. 13444 (Fig. 11) are fully grown throughout, with relatively high meristic mean values. They are not autumn-spawners of Baltic type but must originate from the North Sea-Kattegat area. The same applies to the autumn-spawners in most of the samples from late autumn until spring, such as no. 3196 (Fig. 9, from 9.2.1983) with the same kind of composition as no. 13444. Here, autumn-spawners with high O_1 value ($\geqslant$75 length units) are specially marked with an extra horizontal dash (uncertain spawning type in this case with vertical dash). Most numerous are those in wr-group 1, meaning that the growth was high during 1980-81 (wr not yet laid-down in 1983).

In sample no. 2429 (south Kullen 24.10.1979) six autumn-spawners (total length 22.7-26.6 cm) with one wr only, were in gonad stages 5, 5-6 and 6-7, thus spawning before the laying-down of wr 2.

The diagrams in Figs. 8-11 give, besides an orientation as to growth, also information on the age distribution. Herring with more than 5-6 wr normally occur very rarely. This is true of all samples of adult herring from the area (cp. Table 1). The low frequency may, however, be somewhat amplified through the mesh-size's selective effect in gill-net fishing.

Central Öresund

The material comprises three net-caught samples, and one trawl-caught, of adult herring during August-March (Table 2), as well as seven trawl-caught young-herring samples from the same period (Table 5 B; see above on the gear) - a total of 11 samples. The catch area extends from Helsingborg to Lomma Bay.

The spring-spawners dominate strongly in three adult samples from August-October. The fourth (no. 1090), from mid-March, shows predominance of herring determined as autumn-spawners, but these may include some primary winter-spawners (relatively low O_1). Also in the sample were some winter/spring-spawners in gonad stages 5-7. No autumn-spawners in the spawning stage were noted in the four samples from central Öresund.

In the young-fish samples, the dominance is high for the spring-spawners in six, while one sample from November shows some overweight of autumn-spawners. One herring with otoliths of autumn-spawner type in sample no. 3140 from October was, according to gonad stage (2-3) and high fat content, in transition to spring-spawning (four others were possibly of similar type); the sample was generally difficult to assess.

The diagram in Fig. 4 may be connected with the winter/spring-spawners in northern Öresund (Fig. 3) through the spring-spawners in sample no. 1090 from March, which have relatively high VS and K_2: 56.19 and 14.17 respectively. This sample is from the northernmost part of that area and shows, among the four samples, the highest nematode infestation in both spring- and autumn-spawners (93.8% and 97.6% respectively). It also included eight fish with "SW-type" otoliths (not tabulated). The variation range of spring-spawners in the ten other samples is 55.15-55.86 for VS and 12.97-13.83 for K_2 (cf. Tables 2 & 5 B and Fig. 4). It resembles that of most samples in northern Öresund (although the mean values are somewhat lower as a whole), meaning that the fish may belong to "Kattegat spring-spawners/Rügen-herring". A couple of young-fish samples, however, show unusually low values.

For the autumn-spawners, too, the same main picture was obtained of the meristic characters as in northern Öresund, with fairly uniform vertebral number values of 55.48-56.58. Autumn-spawners having a low VS, e. g. 55.48 and 55.70, may be assumed to derive at least in part from the southwest Baltic. The K_2 values for the autumn-spawners were 13.08-14.30, somewhat lower than in northern Öresund, perhaps due to partially southern origin.

All four samples of adult herring contained nematodes. Low frequency in no. 13533 (August) may indicate Baltic origin to some extent of both its spring- and autumn-spawners (infestation per cent for fish >22 cm: 6.7% and 21.1% respectively). In the other samples of adult fish, the frequency was 50.0-97.6%. As in northern Öresund, the infestation percentage was similar for spring- and autumn-spawners. Three finds of nematodes were made in young autumn-spawners with lengths 15.2, 16.1 (both 0 wr) and 21.3 cm (1 wr), all from March (see Table 5 B).

Southern Öresund

The material from southern Öresund (Table 3) comprises only adult fish. Of these ten samples, all but one were taken with gill-nets (mesh-size as above) during September-May in the area between Malmö and Falsterbo. One from May (no. 3245) was caught with take-net (bar-length 18 mm). Usually only a few autumn-spawners occurred in the samples, although they made up 27.1% and 9.7% respectively of nos. 2764 and 3105, both from September. The spring-spawners thus strongly dominated. Fish about to spawn(gonad stages 5 and 5-6) occurred in only two samples (nos. 2440 and 3245, from October and May respectively) of spring-spawners, and in three of autumn-spawners (nos. 2764, 2605, and 2440, from September-October).

Relatively high mean figures for O_1 and L_1 of the spring-spawners in some samples (e. g. nos. 3245, 2314, both from May, and 2440 from Oct.) may imply a partial transition from autumn-spawning to spring-and winter-spawning; but if so, other autumn characters of the otoliths are very atypical. The high values refer mainly to the wr 1-group of the first two samples mentioned and to wr 2-group of no. 2440 and probably generally to fish of northern origin. Alternative explanations are possibly favourable growth conditions during the first growth period and/or recruitment through early winter/spring-spawning. Gonad stage 5 in 33 fish from no. 2440 of October, may now indicate a transition to autumn/winter spawning (or else misdetermination of primary spawning type).

In sample no. 3132 from October, a herring was noted with spring otoliths in gonad stage 6, implying transition to autumn-spawning. No. 2314 from 23.5.1979 showed spring-spawners with generally late-developed gonads (cf. Table 3), probably due to the hard winter of 1979 and low water temperatures (potential summer/autumn-spawners during that year?).

In no. 2440 from 30 October, males predominated among the spring-spawners. The male/female quota was 24/8 for the 2-wr group, and 42/20 for the 3-wr group, presumably a sorting effect of the net's mesh-size.

Figure 5 shows VS and K_2 values for the spring-spawners: (55.04) 55.77-56.03 and 13.00-14.13 respectively. The low VS value for no. 3336 (November) is probably due to erroneous counting methods; such low average values have occurred earlier only in the Blekinge archipelago. A westerly origin is also supported by the high nematode frequency (72.1%) in this sample. The values otherwise lie within the range for spring-spawners from the Kattegat-Rügen area, although the K_2 mean values are generally lower than those reported in the literature.

For the autumn-spawners in samples nos. 2764 and 3105 from September, the values are 55.74 and 56.00 for VS, and 13.71 and 13.82 for K_2. They may represent a mixture of fish from Kattegat and the Baltic.

All samples from southern Öresund contained nematodes. In those from September-October, the nematode frequency was 21.6-75.0% (the lowest probably reflecting the small number of older herring). The highest was noted in November for both spring- and autumn-spawners (72.1-100.0%), while relatively low values occurred in the two samples from

May (34.6% and 32.6% for spring-spawners, 37.5% for autumn-spawners). The last-mentioned circumstance may indicate a significant proportion in May of herring which were linked earlier with the Baltic. Fish of high age, however, were relatively rare in the material. - The infestation percentage was generally similar for both spawning types.

The Arkona Basin

Comprising the area from the Danish islands to Bornholm, the Arkona Basin is naturally of great importance for herring occurrence in Öresund. Here the sampling has taken place mainly in trawl catches. These are not size-selected in the same way as with net fishing. The adult herring's length distribution is mostly independent of the trawl mesh-size (see below). The majority of the samples are from the waters off the coast between Falsterbo and Ystad, where coastal fishing for herring with nets and take-nets is presently rather sporadic, and the same appears to be partly true of herring spawning. Both of these circumstances have made it difficult to obtain material of spawning fish, especially in early spring.

A total of 22 samples of adult herring is reported in Table 4, besides 12 of young herring in Table 5 C. Eight of the latter are also included in the normally sorted herring samples which recur in Table 4. Nine samples were net-caught with mesh-size (bar-length) c. 27-28 mm, unless stated otherwise in the table, and 13 were trawl-caught with mesh-size c. 18 mm (= T in the tables) or c. 11 mm (= TS). Young-herring samples are all taken by trawl (mesh-size as above).

Spawning types. In the material of old fish, spring-spawners dominate in 18 samples (from June, August-November, February-March and May), and the autumn-spawners in four (from September-October). The latter samples were all taken by gill-net. Trawl-catches during September-October show, on the other hand, a low percentage of autumn-spawners (max. 15.5% according to Table 4). Yet autumn-spawners are also included in other samples, except two caught by take-net in May: the proportion varies between 3.1 and 26.5% for the total samples, with highest values in May-June (higher figures sometimes when only mature trawl-caught fish are considered). The spring-spawners dominate in all young-fish samples. These are from June, August-September, November, March and May, all also including autumn-spawners. - Winter-spawners are lacking in the Arkona Basin.

Samples of old herring at spawning (gonad stage 6) or nearly so (stage 5 or 5-6) are scarce in the material. For spring-spawners, these stages occur mainly in four samples, nos. 2701-2706, 2734-2739, 3265, and 3264 (otherwise individually). The first is from March (trawl-caught), the others from May (1 trawl-caught, 2 net-caught). None of the samples show general spawning, but no. 3264 from 24.5.1983 does so to the extent of c. 15% (net-caught at depth 16 m). In no. 2734-2739, there were 46 fish in stage 7 and 7-2 (spent), and 7 fish in stage 6 and 6-7, on 7 May 1981 (trawl-caught at c. 30 m bottom depth). Only 3 of these 53 spring-spawners were nematode infested. Stage 5-6 occurs also in some fish in three samples during September-October (no. 3129 with five fish in stage 5, 5-6 and 6, nos. 2804 and 2802), where a transition from spring- to autumn-spawning has occurred. However, misdetermination of primary spawning type may be involved to some extent (relatively high O_1 and L_1 average values in two of the samples). Transition of spring-spawners to summer/autumn-spawning is probable for 7 fish with gonad stage 3 and 3-4 at the beginning of June (no. 2757-2762), and possibly for 22 examples in no. 2734-2739 (stage 2 and 2-3 at the beginning of May), as well as quite obviously for single individual fish in other samples.

For the autumn-spawners, four samples can be noted with fish at spawning or nearly so (nos. 3129, 3164, 2804, and 2802), besides one trawl-caught on 23 September at 35-40 m depth, partially past spawning (no. 3131: 14 specimens in stage 7 and 7-2). All are from September-October. Samples with single individual fish in these stages are not counted here and in earlier examples. More general spawning characterized only no. 2802 from 22 October, while nos. 3129 and 2804 were in partial spawning. All three are net-caught in shallow coastal waters (16-20 m depth). Transition from autumn- to spring-spawning type is indicated by no. 2529-2534 (2 fish in March in stage 4), and probably no. 2817-2820 (2 fish in October in stage 3), as well as some other single individuals.

Meristic characters. In Fig. 6 is demonstrated the relation between mean numbers for vertebrae (VS) and keeled scales (K_2). General features in the Arkona Basin are that the difference between spring- and autumn-spawners is usually small, that the vertebral mean number is seldom as high as 56.0, that spring-spawners may show lower vertebral numbers than 55.5, and that this applies especially to young spring-spawning herring (only exceptionally to young autumn-spawners). The mean vertebral number normally lies between 55.5 and 55.9 for old fish of both spawning types, while for K_2 the mean number is normally between 13.1 and 14.1 (total ranges for spring-spawners: VS 55.12-55.83, K_2 12.74-14.07; for autumn-spawners: VS 55.20-56.22, K_2 13.10-14.20; cf. Tables 4 & 5 C).

A comparison with samples from Öresund thus shows that the spring-spawners in the Arkona Basin have, on average a somewhat lower vertebral number (see Figs. 6 and 3-5). For the adult herring, however, this still falls inside the range of variation for Baltic "Rügen-herring" according to the literature - although partly, with lower values, outside the reported variation in spring-spawners of northern Öresund-Kattegat. As in our Öresund samples the K_2 means generally lie a bit lower than stated in the literature, but they deviate little from our results on the Öresund spring-spawners (except for the group with high values from the northernmost part of the Sound). Frequently, however, young fish show still lower VS and K_2 values in the Arkona Basin.

The VS and K_2 mean for the autumn-spawners in the Arkona Basin agree well with those reported earlier from the southwest Baltic. But K_2 is somewhat lower. Both VS and K_2 are thus also usually lower than with the Kattegat autumn-spawners, and somewhat lower still in comparison with the North Sea bank herring.

Nematodes. The nematode infestation, which varies considerably and is low from spring to early autumn, is a characteristic feature of the herring material from the Arkona Basin (cp. Table 6). The higher infestation during autumn-winter is clearly caused primarily by the temporary mixing which then occurs with adult fish immigrating from Kattegat (at least partly after previous emigration to that area) and more local herring and to some extent other herring from waters around Bornholm and farther east. The last-mentioned fish, according to tagging recoveries (cf. p. 9), do not migrate as adults to any significant extent westwards from the Arkona Basin.

High nematode infestation was observed mainly in October-November, but still occurred here during February-March, chiefly in the area´s western part. Still at the beginning of March 1981, however (cp. no. 2701-2706 in Table 4), 54.5% was recorded in herring of assortment 0 (max. 8 fish/kg, usually 5-6 fish/kg), but only 3.1% in assortmnet 1 (max. 10 fish/kg), in a trawl-catch from the Bornholm Strait. Low values are noted from March to September parallel with the dominance of younger herring and fish of higher age (>6 wr). No general difference could be seen in infestation percentage between spring- and autumn-spawners.

In the twelve young-herring samples from the Arkona Basin, nematodes were entirely absent, as expected. The maximum mean total length for herring of the 1-wr group was 21.5 cm for autumn-spawners (in May, new wr not yet laid-down), and 18.9 cm for spring-spawners (March, wr 2 not yet formed).

Growth and age. A study of Tables 1-4 shows a clear increase in the frequency of herring with high age in the material from the Arkona Basin, fish with 7-14 wr. This applies to both autumn- and spring-spawners. The recruitment of the older fish must be essentially local and from the areas around or east of Bornholm.

No pure spawning sample of the typical, fast-growing "Kattegat spring-spawners/Rügen herring" has been obtained at the Swedish south coast. But this fish is extensively caught, mainly by trawl, during late autumn to winter in Swedish waters, mostly in the western part of the Arkona Basin (cf. samples nos.3337, 2896-2898, and 2701). Fishermen have reported that spawning occurs during April in the coastal area Falsterbo-Trelleborg; it may then concern the typical "Kattegat/Rügen-herring". The spawning-herring samples obtained in May from our investigations certainly contain a varying number of fish with nematode infestation and "Kattegat/Rügen" growth, but they are dominated by noninfested herring, often with high age and somewhat lower growth (cf. below and Figs. 14-17).

The diagrams in Figs. 12-18 exhibit growth and nematode occurrence in spring- and autumn-spawners, in seven samples selected from Table 4 from the Arkona Basin. Four are taken by net and three are trawl-caught. The latter can be regarded as randomly selected samples of the adult herring, while the former are selected through the mesh-size, which was reported to be the same here as in northern Öresund (c. 27-28 mm bar-length).

In the September sample from 1980 (no. 2599, Fig. 12), a gill-net catch just south of Falsterbo, the herring is evenly divided between spring- and autumn-spawners, with low nematode infestation in both types (16.4 and 5.3% respectively). The growth is strikingly small in the autumn-spawners with 2 wr, as in sample no. 2797 from Mölle (Fig. 8), while that of the spring-spawners rather agrees with the generally observed pattern in Öresund. For both of the cited samples, the number of uncertain spawning-type determinations was relatively large. The low growth in the autumn-spawners and the low infestation degree, indicate that the proportion of fish born in the southwest Baltic probably is great in sample no. 2599.

In the October material of 4.10.1982, no. 3130 (Fig. 13) also taken by net in the same place, the spring-spawners strongly dominate and their infestation degree is 75.0% (compared to 72.2% for the autumn-spawners). The growth of these spring-spawners mostly lies within the limits of previous Öresund observations, as seems also to be true for the autumn-spawners in this sample. The meristic mean values noted are slightly higher than in the September sample. Herring immigrants via Öresund probably dominate both spawning types. A similar picture is given by e. g. sample no. 2817-2820 of 15.10.1981 from south Trelleborg, for corresponding age-groups (cp. Table 4).

Of sample no. 2896-2898 (from assortments 0, 1 and 2) in Fig. 14 taken by trawl on 5.2.1982, south Trelleborg, 95.5% consists of spring-spawners with high nematode infestation (82.5, 46.4 and 37.7% for respective assortment). Here too, the growth of spring-spawners largely resembles that usually noted in northern Öresund. But the wr-groups 2 and 3, in particular, are more richly represented due to the method of catching (bar-length c. 18 mm), with lower average length in spite of a somewhat later catching time. The age-distribution is otherwise similar with only one fish showing more than 6 wr. The adult herring in the sample clearly consist mainly of "Kattegat spring-spawners/Rügen-herring" which had immigrated through Öresund during late autumn-winter.

In the trawl sample no. 2529-2534 of 31.3. 1980 from south Trelleborg (Fig. 15), age distribution and growth of spring-spawners are mostly as in the preceding one, and the autumn-spawners are equally rare. But the nematode infestation has declined drastically, being 5.9 and 1.8% respectively in assortments 0 and 1. Judging from Table 4 it also seems possible that shoals of adult herring may be found all the year round in the Arkona Basin which show the meristic characters and growth of the "Kattegat spring-spawners/Rügen-herring", though often without, or with a very low observable nematode infestation.

A completely new picture emerges from the trawl-caught sample no. 2734-2739 of 7.5.1981 from southeast Ystad (Fig. 16). The proportion of fish older than those with 5-6 wr has sharply risen, combined with a high percentage of autumn-spawners among mature fish (in assortments 0 and 1 together 40.6%) as well as a low infestation in the spring-spawners (in ass. 0 and 1 respectively 3.3 and 3.4%), and none in the autumn-spawners. In mature spring-spawners the most frequent gonad stages noted for the assortments 0 and 1 were 7 and 7-2 (among 40 fish with these stages two only were nematode infested).

A similar age-composition for the spring-spawners though with higher percentage of old fish is seen in the net-caught sample no. 3265 of 20.5. 1983 from west Trelleborg (Fig. 17). The herring are mainly in gonad stages 4, 5 and 5-6, and autumn-spawners are wholly absent. An infestation percentage of 11.6% indicates that a small proportion of the adult "Kattegat spring-spawners/Rügen-herring" still exists in the area. Fish with more than 6 wr are fairly abundant and show no nematode infestation (6 wr = seventh year of life for spring-spawners; in the present sample the wr 7 is just about to be laid-down). These old herring have a total length which may frequently correspond to that of spring-spawners with 4-5 wr in the material of the "Kattegat/Rügen/type". As Table 4 shows, the fish in the sample also generally have low values for L_1 and O_1, demonstrating that the initial growth was low, too.

The same characteristics distinguish sample no. 3264 (cp. Table 4), taken four days later at 5-6 naut. miles to the east, at Gislöv (E Trelleborg). Use of a smaller mesh-size (bar-length c. 22 mm) gave the catch a different length distribution. This also imposed, as mentioned earlier, a lower average length per age-group. But it is, of course, possible that the length change was partially influenced also randomly by different age distribution in the fish shoals. No. 3264 consisted of herring at spawning or nearly so. No nematodes were observed, this being probably explained in part by the lower proportion of large fish compared with sample 3265.

In a trawl-caught sample, no. 2757-2762 of 2.6. 1981 from southeast-south Trelleborg (see Table 4), the age distribution and growth of spring-spawners resembled those in nos. 2734-2739 and 3265. The infestation percentage in no. 2757-2762 for spring-spawners was 1.8 and 1.7% for assortment 0 and 1 respectively (autumn-spawners showed no infestation).

Spring-spawners of this type, with somewhat slower growth than the Rügen-herrings, frequently with higher age (>6 wr) and no or low nematode infestation, may probably have been a substantial portion of the catches from March to September in the Arkona Basin. This is true at least off the Swedish south coast during the investigation period. It is possible, of course, that young fish of this type are mixed with young Rügen-herring in the samples from westernmost Arkona Basin and Öresund.

The diagram in Fig. 18 demonstrates a net-caught sample no. 3129 from 20.9.1982 at Gislöv, east Trelleborg, with autumn-spawners nearly at spawning. The number of spring-spawners included is small, totalling seven. The nematode infestation for the autumn-spawners, is low at 14.2%. The growth here resembles, as in sample no. 2804 of similar type (see Table 4), that of the autumn-spawners in no. 2797 from Mölle (Fig. 8), in nos. 2599 and 3130 from Blenheim, south Falsterbo (Figs.12-13), and in no. 2734-2739 of 7.5. 1981 from southeast Ystad (Fig. 16). In the last-mentioned sample, the nematode infestation of autumn-spawners is zero, while it contains a significant proportion of older fish of both spawning types. A similar relationship occurs in sample no. 2757-2762 of 2.6. 1981 from southeast-south Trelleborg. Both were taken by trawl.

The comparatively low vertebral number (VS) and the frequently low or nonexistent infestation of the autumn-spawners and their growth type in the Arkona Basin suggest that a fair share of them consists of herring born and raised in the southwest Baltic. However, the occurrence of an exchange of autumn-spawners in both directions through Öresund is indicated rather clearly by i.a. the above-cited samples nos. 2797 (northern Öresund) and 3130 (Arkona Basin) and in central and southern Öresund by samples as nos. 2763 and 2764 (cf. VS means and nematode infestation according to Tables 1-5).

Growth in different herring populations

The diagrams in Figs. 8-18 show how strongly the individual length within age-groups can vary in the investigated material: often by up to 5-7 cm in the commonest wr-groups, 2-4. The length range might be expected to be greatest in trawl-caught material (cf. Figs. 14-16), but it is frequently equally great in most age-groups from net-caught samples (as in Figs. 8, 9 and 18) despite the selective effect of the meshes. It is even large in samples taken from populations near the spawning stage, such as those in Figs. 17 and 18. This is explained by the fact that single fish, too small or too large to be caught by the meshes, are entangled in the gill-nets.

The basic cause of the varying growth must be the nutrient conditions (including influence of competition for food) or other environmental factors, such as temperature. In principle low temperature results in low metabolism and growth. Spawning early or late in the year can prolong or shorten the first growth period and increase the variation in young herring, but in this way it can also have a more permanent effect on the fish's length.

There is some difficulty in using the present material to make comparisons of average growth in the herring of various areas, for example in northern Öresund (including southernmost Kattegat) and in the Arkona Basin of the southwest Baltic. The selective effect, of the gears used, as already pointed out, is considerable in net fishing. One cannot directly draw reliable conclusions about the real average growth e. g. by comparing observed mean growth for herring caught by large meshed gill-nets in the first mentioned area with corresponding data for fish taken by finer-meshed trawls in the Baltic. In addition to this is the variation due to a shifting combination of different populations - which cannot always be distinguished - and of seasons as well as years for the sampling.

In fishing with wide-meshed nets young fish largely slip through the meshes without being caught, if not entangled in the net. Bigger fish are caught almost as effectively in nets with a mesh-size of 27-28 mm bar-length as in the fine-meshed trawls used. Above a certain fish size the gill-net selectivity works oppositely: the herring are too big to fasten in the meshes (though they can be entangled in the net to some extent). The small dispersion of growth among autumn-spawners in the diagram of Fig. 9 may, for example, be due partly to the failure of bigger fish to fasten in the meshes.

Unusually high values for growth are shown by sample no. 1087 (cf. Table 1) of "Skagerrak spring-spawners/Kattegat winter-spawners" from Mölle at the northern mouth of Öresund, taken by net in January 1972. The explanation may be twofold: 1) the catch possibly occurred with rather large-meshed nets (up to 30-32 mm bar-length) which were used somewhat by west-coast fishermen in Öresund during the early 1970s, and/or 2) the winter spawning herring in southern Kattegat with adjacent Öresund waters must grow on average a little faster than spring-spawners here and in southwest Baltic (cf. Table 1 and below regarding L_1).This higher growth may depend on the first long growth period of the young (if primary winter-spawners) and on a more effective feeding period of the mature fish (cf. p. 36).

It should also be mentioned that samples from net fishing presumably give somewhat higher mean values for the total length of fish in the same age-groups from the southwest Baltic, since the herring are known to be slimmer on average there than in the waters around northern Öresund.

A rough comparison of the average total lengths in the commonest age-groups (wr 1-4) of herring from the investigated areas can be made with the help of Figs. 19-23. Here the material reported in Tables 1-5 for wr-groups 1 and 4 (and 3 with autumn-spawners) is complemented by some mean lengths, which the tables omitted due to lack of space. These figures are often based on a small number of fish, but at least ten as a rule; if smaller, the number is noted in the diagram. Such mean figures refer primarily to the northern Öresund area and to wr-group 1. Samples taken by trawl are marked with a dash under the month-symbol as they are the most reliable ones.

The diagrams indicate - for one and the same month or season - that mean values of the total length are largely higher - as expected - for herring from northern Öresund and adjacent waters than for herring in the Arkona Basin. This is most obvious for wr-group 1 and 2 and for autumn-spawners.

For the age-groups mentioned the mesh selection of the gill-nets used in the northern water area has a strengthening effect, difficult to estimate. The primary reason for higher growth in northern Öresund and southern Kattegat must be a combination of better growth conditions there, such as nutrient supply and temperature. With increasing age and size of the herring, there is an equalization of the sample differences between the two areas (partially as a consequence of lower gear selection).

In the samples of autumn-spawners, equalization of the growth difference with increasing age is less substantial than with the spring-spawners, when fish from the two relevant areas are compared. Autumn-spawners in the same wr-group as spring-spawners are older, and thus larger on average (cf. p. 17). In view of the length/age diagrams it is obvious that autumn-spawners in northern Öresund and adjacent waters generally grow faster than those in the Arkona Basin (cp. diagrams in Figs. 9 and 11 with that in Fig. 18). The higher mean length values of the autumn-spawners in the north may be explained to some extent, however, by mixing with North Sea autumn-spawners, and a less frequent migration exchange with the southwestern Baltic. The migrations of "Kattegat spring-spawners/Rügen-herring", well documented by taggings and other observations, contribute to an equalization for the spring-spawners.

By comparing the average values for L_1 (length at laying-down of the first winter-ring on the scales) in Tables 1-5 for samples from the different areas, the direct influence of gear selection can be partly avoided. Yet it is not without effect. To the extent that growth may be genetically determined, or if the variation of the fish´s current length is otherwise strongly dependent on the first growth period, the selection does affect the calculated mean values for L_1.

The diagram in Fig. 19 reveals large variation also in the total mean L_1 values, for example from 13.07 to 17.31 cm among autumn-spawners in northern Öresund, and from 10.02 to 13.89 cm among spring-spawners in the Arkona Basin. If using L_1 means of individual age-groups the variation can be still larger (up to a maximum mean length of 18.99 cm in the first mentioned example). This variation must, here as well, be caused partly by the inclusion of herring from different populations in the samples. Another, lesser source of variation in total length figures and in recorded L_1 is some possible misjudgement of the primary spawning types.

For the spring-spawners, the L_1 values in the limited material may also be seen to lend support to a rather higher growth of young herring in northern Öresund and southern Kattegat (cf. Fig. 19). That the difference between the areas shown by the diagram is not more distinct for adult herring can be explained by the migrations of mature fish. The partly low mean VS and K_2 values of young spring-spawners in samples from central and northern Öresund in Figs. 3 and 4 indicate an immigration of young fish from the Arkona Basin having a similar effect (cf. Fig. 20).

The two samples of spring-spawning herring from the Arkona Basin which have the lowest L_1 values, respectively 10.53 and 10.02 cm, are nos. 3265 and 3264 caught by net in May, nearly at spawning on the south Scania coast. Fig. 17 demonstrates the growth and age distribution in sample 3265. Herring with high age, 7-13 wr here, also display low L_1 mean values, between 8.45 and 11.04 cm (the number of fish in these age-groups is, however, small: 1-6 per wr-group). The L_1 mean values in these samples agree with those which often occur with spring-spawning herring east of Bornholm and in the Karlskrona archipelago. The trawl-caught sample no. 2734-2739 from southeast Ystad in May, given in Fig. 16 certainly exhibits on the whole a relatively low mean value for L_1 in spring-spawners (11.65 cm), but the old fish with 7-12 wr have L_1 mean values between 9.90 and 13.05 cm (number per wr-group: 1-6), which may indicate less uniform origin than for the two samples just mentioned.

For the autumn-spawners' L_1 the diagram in Fig. 19 shows that the difference between fish from northern Öresund with adjacent Kattegat and those from the Arkona Basin is frequently greater than with spring-spawners. This, as in the case of total lengths, is doubtless partly a result of mixing in the north with northern and western populations of autumn-spawners. The autumn-spawning herring in the Arkona Basin, which must be mainly linked to the southwest Baltic, Öresund and the Belts as well as southernmost Kattegat, contribute through migration via Öresund to the great variation in the north (see pp. 9 and 26).

For the spring-spawners in the Arkona Basin, according to Fig. 20, it can be seen that the mean length during winter-spring before laying-down - in (May) June - of the second winter-ring, is often 18.5-19.0 cm (earlier in August-September c. 16-17cm), while the autumn-spawners' average length lies mostly around 20.5-21.5 cm in spring. From southern Öresund there are only two samples in this age-group (nos. 3245 and 2314 captured by take-net and gill-net, respectively), both from May, with the mean lengths 22.08 and 24.49 cm (and corresponding relatively high L_1 and O_1 values, cf. Table 4). These have been commented on already (p. 28) and they surely represent immigrant shoals from the north, and probably a transition from autumn- to spring-spawning.

From central Öresund there are two mean values for spring-spawners of the relevant age-group (1 wr), with a length of c. 19-20 cm in March, and some earlier and lower values (c. 17 cm) in the autumn. The material from here of autumn-spawners is small with dispersed figures. There may be an indication of a larger length, however. In northern Öresund and the adjacent waters of Kattegat the spring-spawners with one wr have mean values mainly around 19-20 cm in winter-spring, whereas the autumn-spawners' obviously lie frequently in the interval 23-26 cm (the material is sparse, cf. Fig. 20).

For wr-groups 2-4 is referred to Figs. 21-23. Here must be stressed the often small difference in mean length between mature spring- and autumn-spawners of the Arkona Basin, particularly from wr-group 3 - in spite of the higher age of the autumn-spawners. The explanation must be a lower growth of the mature autumn-spawners compared with that of the spring-spawners. The latter populations have a longer and more effective feeding period throughout the most productive part of the year as regards their food organisms. The food intake of the autumn-spawners is reduced during their period of spawning (cf. Jespersen, 1936, Popiel, 1984). A greater migratory exchange with the Kattegat may also be in favour of the spring-spawners' mean growth.

The growth advantage of the wr-1-group of the autumn-spawners is thus largely overtaken by the mature spring-spawners in southwestern Baltic. A similar development is indicated for the two spawning types of northern Öresund and southernmost Kattegat. There it seems not to be of the same magnitude, however, possibly a result of more uniform nutrient conditions and milder temperature throughout the year.

The reliability of the otoliths

The present account shows that the variability of the otolith characters is a complicating factor when separating the two main herring types, spring- and autumn-spawners. The difficulties grow in importance when using the otoliths to discern different populations within the spawning types, and particularly where various herring populations are mixing, as in the investigated area, Öresund and adjacent waters.

In the literature on Baltic herring, one frequently finds idealized otolith pictures not seldom combined with an underestimation of the great variation of the otoliths and of the difficulties in defining their value as stock characteristics. According to our experience transitional forms of the individual characters are always at hands between different otolith types. The variable otolith morphology is obviously to a large extent a result of environmental changes in time and space concerning temperature, salinity and availability of food, especially during the early development of the fish. To some extent such variations in otolith morphology must also be a later consequence of migrations and change of environment.

Sometimes it has been possible to use a characteristic pattern of the otolith as a "biological tag". Thus the 1956 year-class of herring in the central part of the North Sea showed a special ring structure, probably caused by the food conditions in the area (Raitt, 1961).

It must be considered, however, that a certain degree of subjectivity in judgements and measurements of otoliths is unavoidable. When separating the main spawning types it has thus been necessary in the present investigation to include also fish with slightly uncertain otolith characters, as such otoliths may occur fairly frequently (cf. Fig. 8 and 12). The possibility of a successfull analysis is likely to be somewhat greater in water areas with more uniform hydrographical conditions and where less mixing of various herring populations occurs than in and around Öresund. But I do not think that the otoliths are appropriate for routine classification of the herring as to sub-population in the Baltic Sea (cf. Anon., 1986), and particularly not below the spawning type level. Otolith type determination, for instance in connection with the yearly stock assessments by ICES (Intern. Council for the Expl. of the Sea) is too time consuming, demanding long experience, great accuracy, and a pronounced visual memory. In addition to that, age-determination with otoliths is more difficult than with scales. These circumstances and the usually small personnel resources of the fisheries laboratories mean that the otolith types will probably seldom be determined to a satisfactory extent.

Yet the otoliths can be of important value for special investigations. By using a great number of otolith characters, other morphological characters and measurements from a selected herring year-class, combined with complicated statistical and computer treatment, Ojaveer et al. (1981) were able to identify six different otolith types among spring-spawners in the Baltic Sea, from the Gulf of Finland to the Arkona Basin, and relate them to different herring populations. It would be valuable if a project according to these lines could be repeated, to establish to what extent the characters used and the populations identified are permanent and stable in this sea area.

In our investigation of the Sound herring, resources for a detailed analysis of the type just mentioned were missing. Attempts made to describe the otoliths gave fairly diffuse results and therefore the report has principally been limited to the two main spawning types and some few sub-types within them. It was also obvious that the great variability of the otoliths make a definitive identification by them of individual fish as a member of a specific population impossible.

By way of the contour drawings in Figs. 24-37 made by using a drawing apparatus, attached to a microscope, some of the main features of the otoliths, their variability and, not least, the difficulties to separate different types are elucidated. The otoliths were selected from the most abundant winter-ring (wr)- groups. Figs. 24-29 demonstrate samples from northern Öresund and for comparison one sample (24) from northernmost Kattegat (Marstrand). They show the winter-spawners' (25) similarity with the "Skagerrak spring-spawners" (24) as well as with autumn-spawners (27). The otoliths of Fig. 27 according to meristic and other characters of the herring represent autumn-spawners from the Kattegat-North Sea area. Those of Fig. 28 have been interpreted as "Skagerrak spring-spawners" with reference to i. a. high VS value. The otoliths in Fig. 29 have mainly, in consequence of great O_1 measurements and meristic characters been classified as primary autumn-spawners, but the current gonad stages reveal spawning in winter, which means transition to a new spawning type. Thus, according to O_1 values, meristic characters, gonad stages, and to the origin of the herring, the samples represented in Figs. 24-37 have been allotted to the herring populations mentioned.

From central and southern Öresund (Figs. 30 and 31) the material is rather small, but great variability in the morphological characters and growth indicate a mixing between various populations. In the May sample (30) a more well-defined first wr was noted compared with samples from the same month in the neighbouring Trelleborg area of the Arkona Basin (Fig. 35). The autumn otoliths of Fig. 31 partly look more like those of autumn-spawners in northern Öresund and southernmost Kattegat than those of herring in the Arkona Basin (cf. Fig. 37).

Otoliths of spring-spawners from samples caught in the Arkona Basin are presented in Figs. 32-36. Figs. 32 and 33, which also can be compared with Fig. 26, refer to "Kattegat spring-spawners/Rügen-herring". Their otoliths frequently show hyaline extra ring structures inside the first winter-ring. Fig. 35 represents mainly the more local Baltic population, described on pp. 32-33, with lower growth at high ages, as a rule without nematode infestation and with later spawning time. The otoliths are distinguished by an ill-defined first wr and rarely with the hyaline structures mentioned above. Sample no. 2933 (Fig. 34) from March displays varying otolith types and so does sample no. 2599 (Fig. 36) from September. The variation appears to be greater in the first mentioned case particularly as to growth. High variation in otolith types is frequently a common feature of samples taken off the Swedish south coast here as in the southern and central Öresund, indicating a mixture of different populations. The otoliths often show large, sometimes almost right angle in exicura major.

Otoliths of autumn-spawners in the Arkona Basin (Fig. 37) also show great variability as to both shape and size. They may resemble the elongate otoliths of spring-spawners rather than the ordinary rounded autumn type. Particularly older fish show more rounded otoliths than usual is the case in samples from northern Öresund and adjacent Kattegat waters. Thus the variability of the autumn-spawners´ otoliths, as well as observations on meristic characters and nematode infestation supports an exchange through Öresund and a mixing of herring recruited in different areas.

Concluding remarks

As the present investigation shows, the differences between the characters of the herring populations in the studied area are often small and somewhat uncertain. The currently available material thus does not allow a definite determination of how, for example, the most important stock, here called "Kattegat spring-spawners/Rügen-herring", is usually recruited. Recruitment to the mature fish stock may probably occur by a varying mixture of young and old herring components from different spawning areas and populations in the Kattegat-southwestern Baltic area.

A systematic year-round study of otoliths, growth and meristic characters in the young herring, up to the age when the second winter-ring is laid-down on the scales, would probably yield more clear and reliable information than do otolith types and so forth in adult herring.

Such a project could throw light on the recruitment and young-fish migration of both spring- and autumn-spawners in Öresund and the surrounding sea areas. This should be given high priority, as should the study of spawning sites in southern Kattegat and the southwest Baltic, parallel with tagging especially of young herring in both regions. Another urgent project is investigation of the occurrence of Anisakis nematodes in herring of different ages in Kattegat. In the future it is also necessary to use more detailed computer programmes than that at hand during the present investigation. Characters like intestinal fat, condition coefficient, head length in relation to body length, number of gill rakers, and additional otolith information may be of great interest and need to be considered.

The herring populations´ genetic relationships and systematic status have not been discussed above. The variations of occurrence in both Skagerrak-Kattegat and the Baltic proper, as well as changes of spawning area - detected through tagging - from the Swedish east coast to the south coast at Hanö Bay and the Arkona Basin, support a genetic exchange between populations even in rather widely separated regions. It is likely that the migrations here, including those of "Kattegat spring-spawners/Rügen-herring", are a direct reaction to actual hydrographic phenomena and food supplies, more than a migration pattern cultivated through selection and controlled by other factors. There is probably no question of real "homing". But, of course, there are also small isolated populations of resident character in coastal areas, with a more sporadic, temporal gene exchange.

A significant gene flow particularly between adjacent herring populations is in agreement with the recent views of Smith & Jamieson (1986). They show that such a flow between different herring stocks in the North Atlantic area, normally distinguished by meristic characters largely phenotypically dependent on environment, must oppose the formation of genetically distinct populations with the status of subspecies or geographical races. The same applies between spring- and autumn-spawners which can change their spawning type due to environmental influence, as is also indicated by several examples in the above survey. The condition of isolation for species and subspecies formation is thus incomplete as regards the herring in, for instance the North Sea and Baltic Sea.

The consequence of gene flow is, according to Smith & Jamieson, that all herring populations continue to have a common genetic background. This means that a stock which has mostly disappeared through environmental influence or overfishing seems able to reform in suitable surroundings. "Extinct" stocks may re-appear. The risk of extensive gene loss is negligible.

This view of the relationships between herring populations, however, does not imply that genetic differences are totally lacking between and within stocks. Some such differences surely also exist for meristic characters, as probably between the herring in the Gulf of Bothnia and the Atlanto-Scandian herring of the Norwegian west coast and Iceland. Features such as growth and lifespan, too, must be mentioned here as partially hereditary. Yet the gene flow between pelagic herring stocks in the marine environment is obviously far greater than between populations in species of higher land animals. This is due to the water exchange in both horizontal and vertical directions, as well as to the abundant offspring and migrations passively or actively related to hydrographical factors.

We know that the cod in the investigated area display genetic differences between stocks as regards, for instance, haemoglobin types and enzymes. This seems inconsistent, since cod have pelagic eggs which far outnumber the benthic eggs of herring. But the mature cod are probably normally more locally bound to water areas of the investigated region (cf. Otterlind, 1985 b) than the more pelagic herring.

Changes as to genetic differences of a local cod stock may sometimes be conditioned by active or passive mass immigrations, for instance from the west to the southern Baltic (cf. Otterlind, op. cit. pp. 14 and 7). A possible reason for the genetic differences of cod here may be a repeated selection, through environmental factors such as salinity and oxygen content during the early recruitment in and to pronounced transition areas. Such areas are the Kattegat and the Baltic, where hydrographical conditions change particularly in the bottom waters and between the surface layer and the deep water.

The dispersal of herring and an effective genetic exchange between different populations must be favoured by the stronger schooling behaviour and more pelagic life of the herring. Thus this behaviour combined with migrations seems to give a greater genetic exchange than the number of eggs, the egg and larval drift of cod with the currents, and the migrations of young cod.

There is frequently no great spatial separation between spring- and autumn-spawning stocks of herring, but the different spawning times can exhibit variations in their period, for instance through sizeable changes in water temperature or food supply. A gene flow between the types is possible particularly when the temporal isolation ceases due to large shift in spawning time. This may occur more easily in the Baltic and Belts than in the North Sea area, because of greater temperature variation as well as a biological production period which - especially in the Baltic - is shorter and presumably often more variable in quality, primarily in the central and northern parts of the region.

The spawning types are morphologically and ecologically more distinguished in the Kattegat-North Sea area and, no doubt these differences are partly genetically conditioned. The closer resemblance between spring- and autumn-spawners in the Arkona Basin, compared with the spawning types in northern Öresund and adjacent parts of Kattegat, may reflect a smaller genetic difference because of more frequent transition from one spawning type to the other. Problems concerning such transition should be studied especially in connection with meteorologically extreme years in the Baltic region.

Acknowlegement

The author wishes to express his gratitude to the Staff of the Institute of Marine Research, Lysekil, for valuable assistance. Thanks go in particular to Ms. May Carlsson for working up the herring samples and making the age determinations, and to Ms. Ann-Christin Rudolphi for otolith readings, table arrangements and drawings.

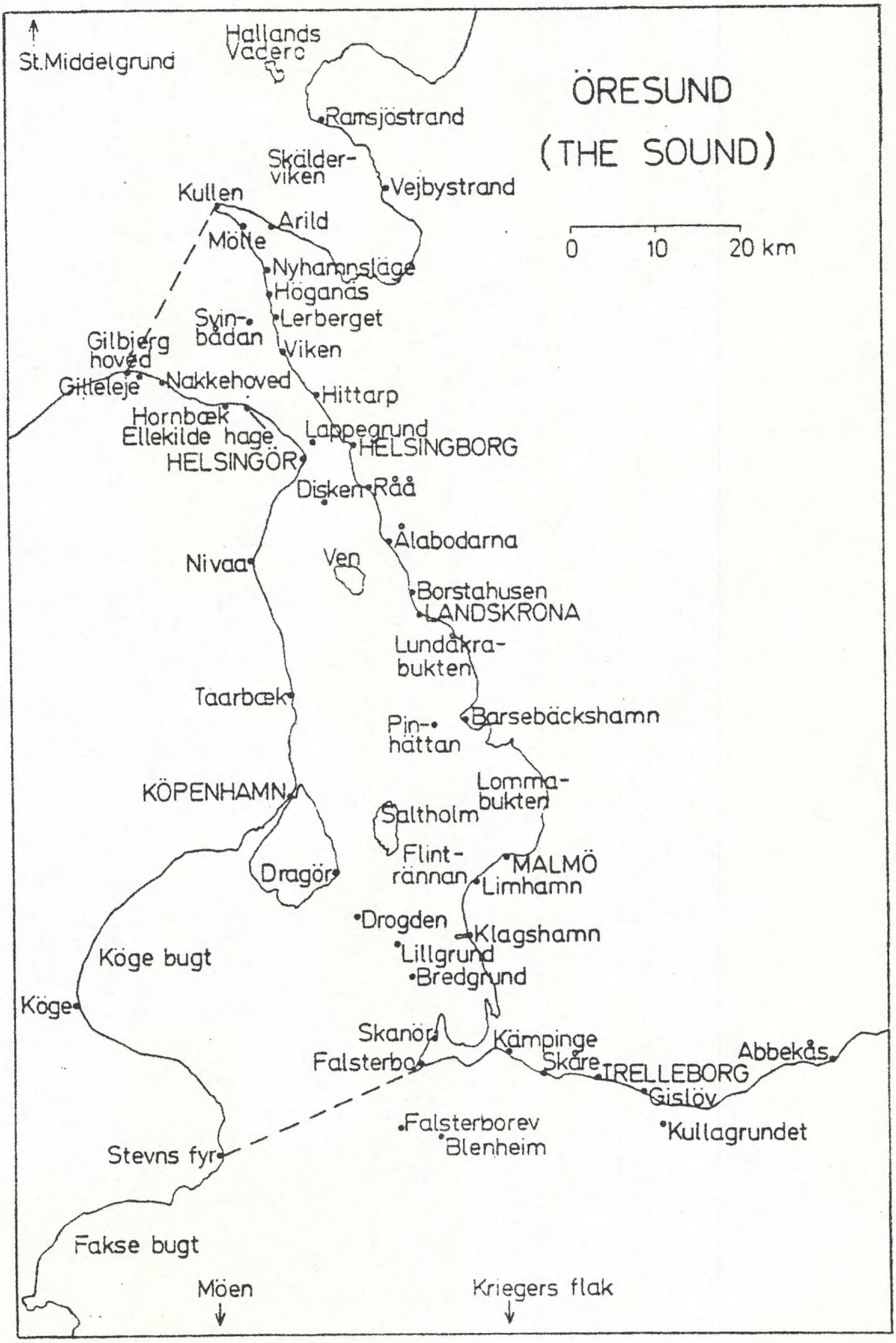

Fig. 1. Map showing the investigation area, Öresund (the Sound), and adjacent waters, with localities mentioned in the text.

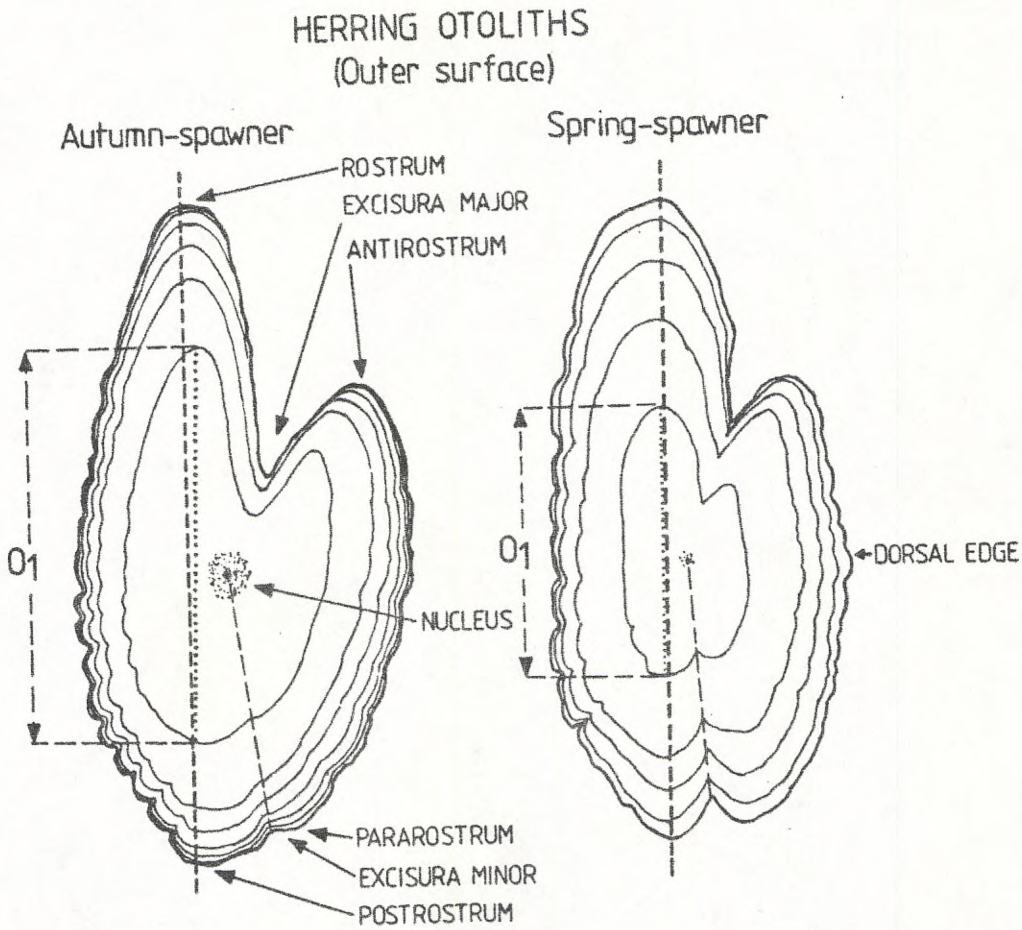

Fig. 2. Demonstration of differences between otoliths of autumn-and spring-spawning herring, and of the method of measuring the first growth zone (O_1).

<u>Legend common to Figs. 3-7</u>: Relation between mean numbers of vertebrae (VS) and mean numbers of keeled scales (K_2, from the ventral fins to the anal opening). Sample numbers as in Tabl. 1-5. Symbols for spring- and autumn-spawners of the same sample are connected with a line in Figs. 3-5 and 7. The symbols used are explained in Fig. 3

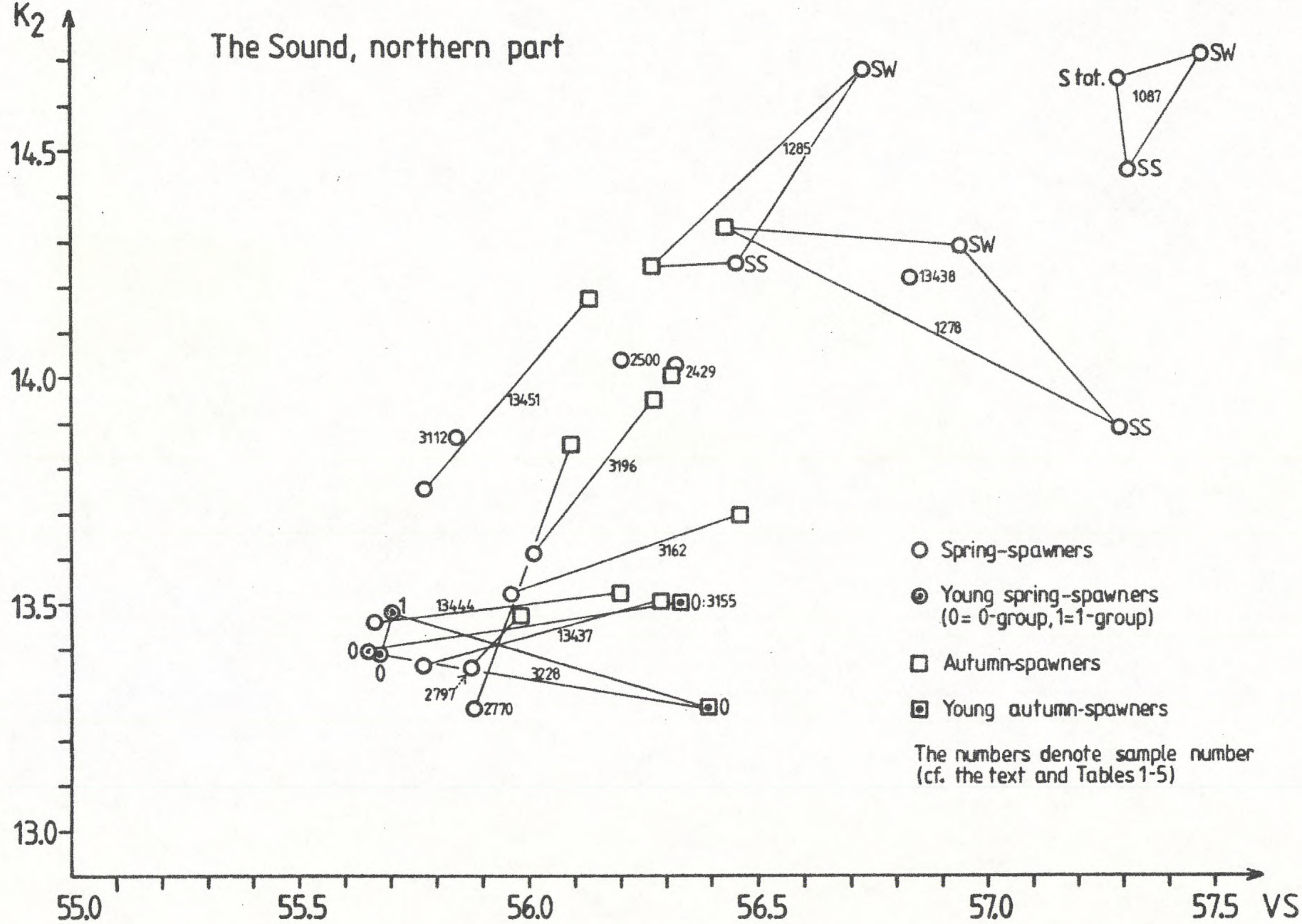

Fig. 3. Relation between mean numbers of VS and K_2. Samples from Öresund, northern part and adjacent waters (Helsingborg-Skälderviken).

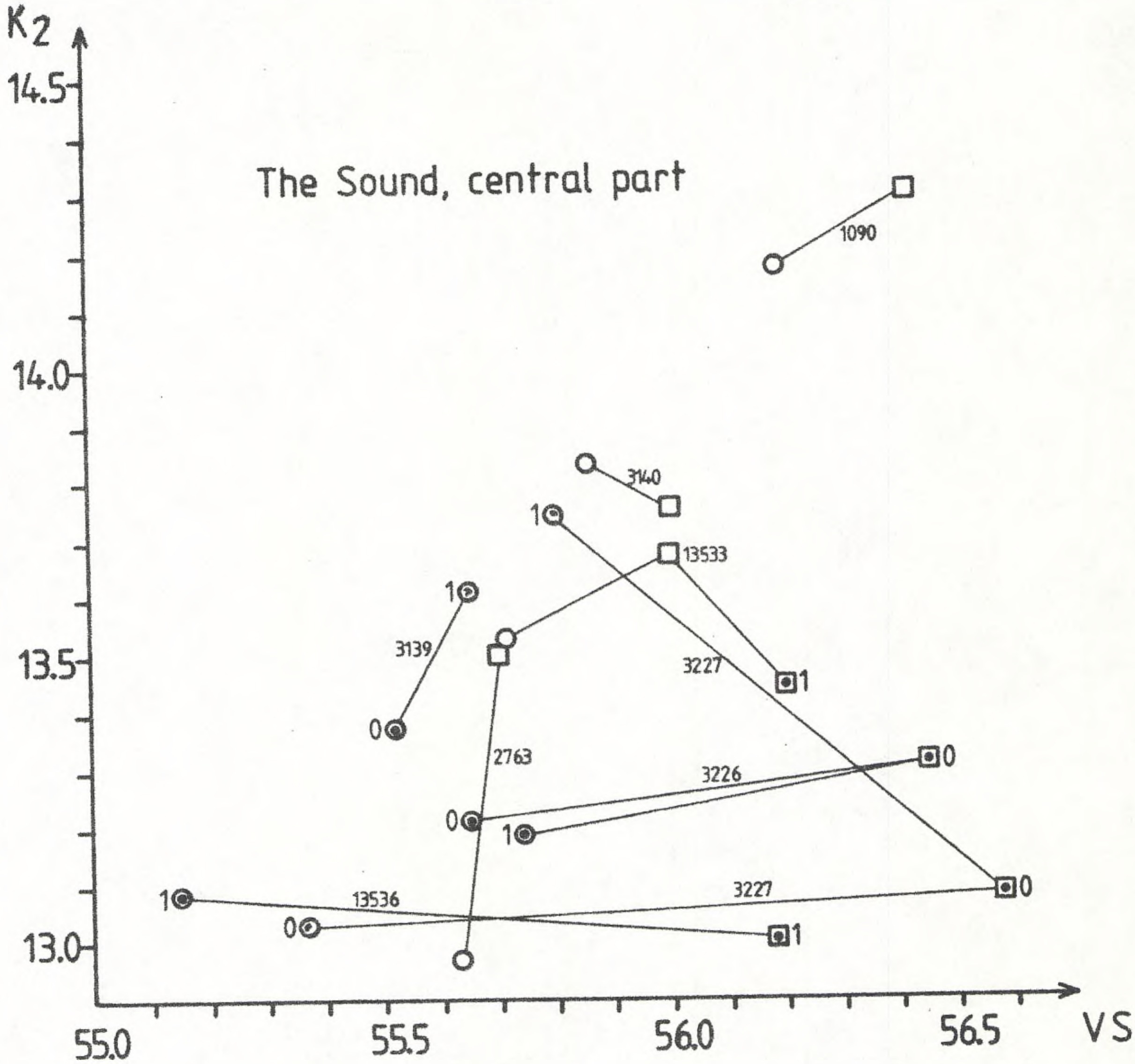

Fig. 4. Relation between mean numbers of VS and K_2. Samples from Öresund, central part (Helsingborg-Lomma Bay).

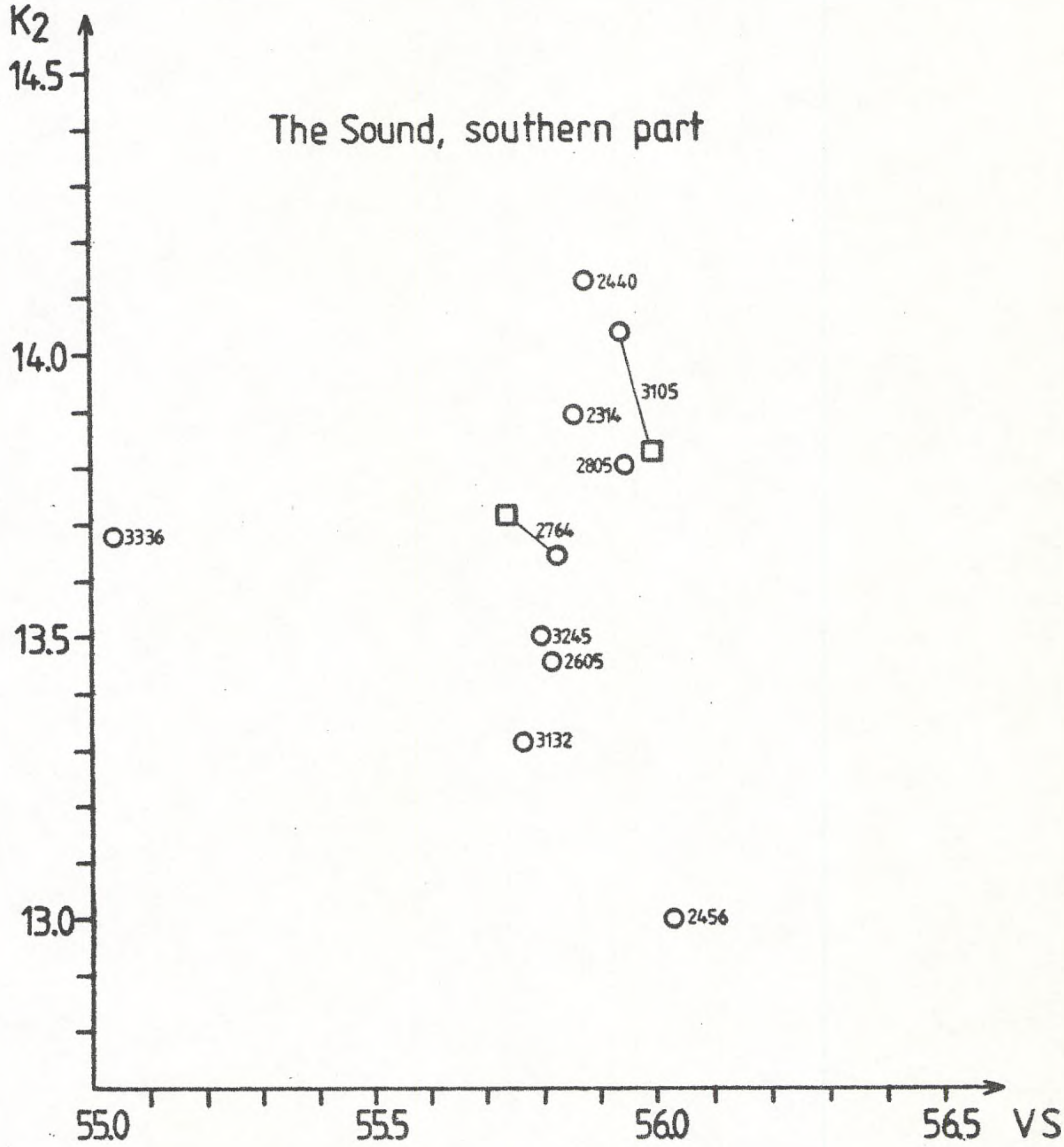

Fig. 5. Relation between mean numbers of VS and K_2. Samples from Öresund, southern part (Malmö-Falsterbo).

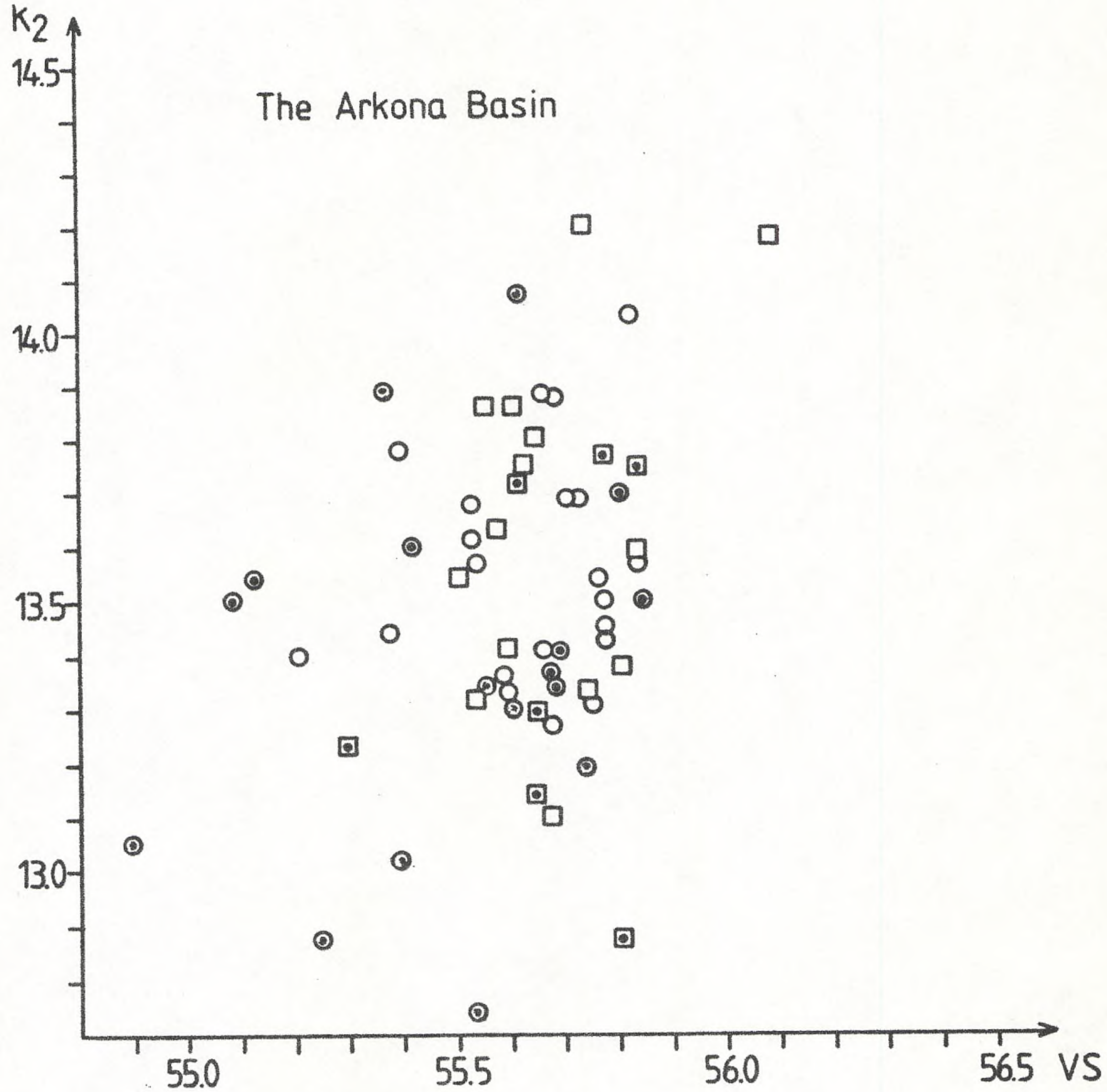

Fig. 6. Relation between mean numbers of VS and K_2. Samples from the Arkona Basin. The total means of trawl-caught samples include young fish which are also accounted for separately here. Their influence on the total means is usually insignificant, however, as the wr-group values of Table 4 indicate.

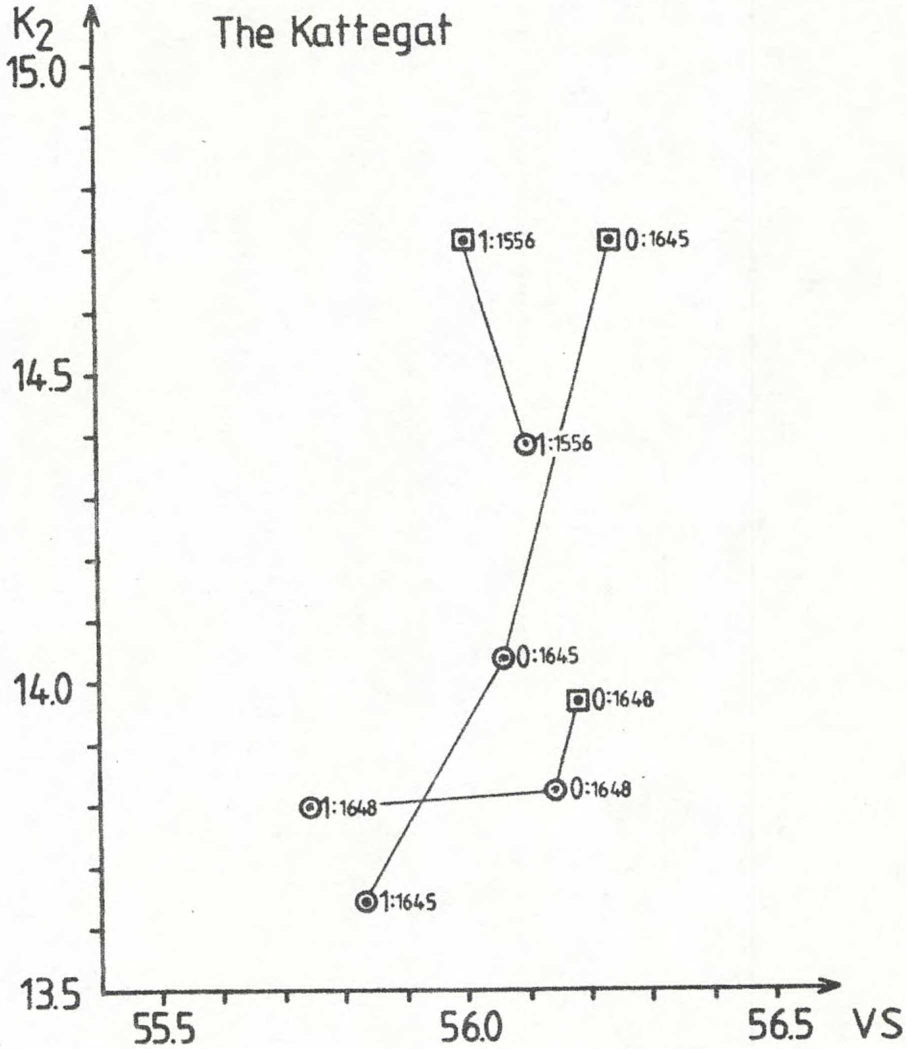

Fig. 7. Relation between mean numbers of VS and K_2. Samples of young herring from open Kattegat.

Legend common to Figs. 8-18: Growth and nematode infestation. Total length (cm) of the individual herring plotted against the number of winter-rings (wr) on its scales, autumn-spawners (A) to the left and spring-spawners (S) to the right. ● = A with nematodes, + = A without nematodes, ○ = S with nematodes, x = S without nematodes. - (at a symbol) = spawning-type somewhat uncertain (in Figs. 9 and 18 it has an other meaning and a vertical dash denotes uncertainty). For further comments see the text.

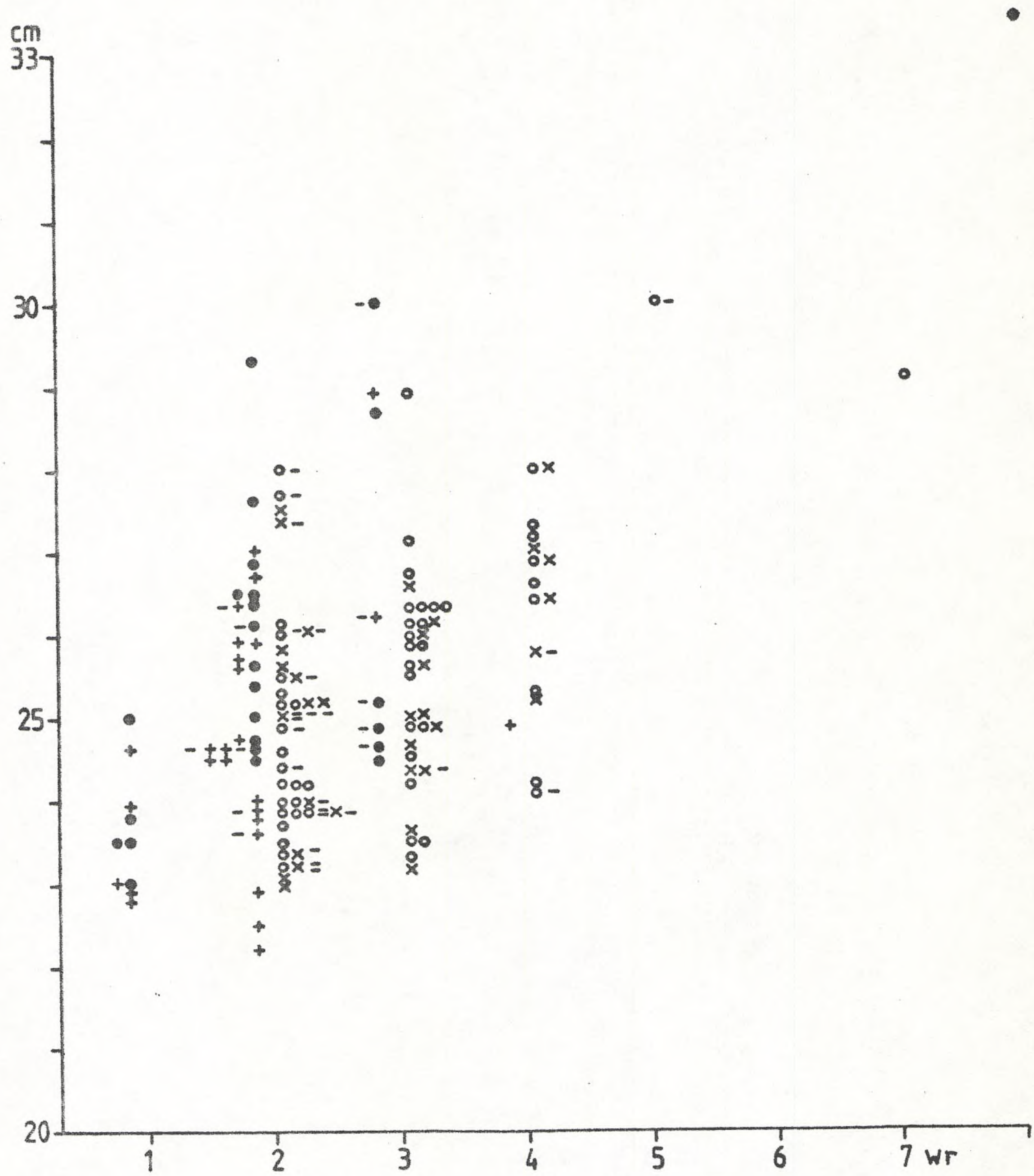

Fig. 8. Growth and nematode infestation. Sample no. 2797, Mölle, Öresund, northernmost part, 1981.09.10, net-caught. The sample is probably made up by a mixture of herring from southern Kattegat and soutwestern Baltic.

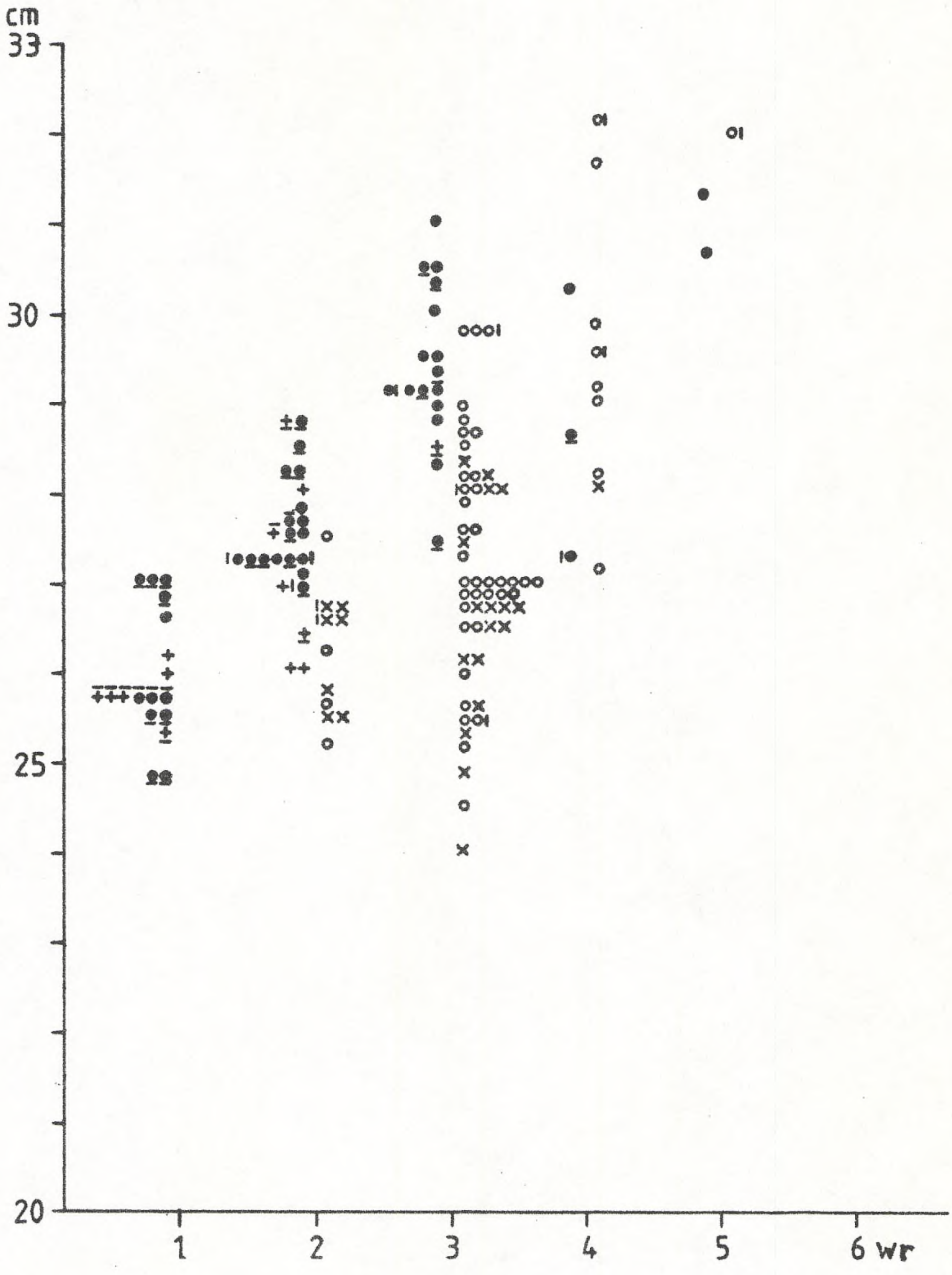

Fig. 9. Growth and nematode infestation. Sample no. 3196, Mölle, 1983.02.09, net-caught. - (at a symbol) denotes O_1-values ≥ 75 units (cf. p. 20) and a vertical dash denotes uncertainty as to spawning type.

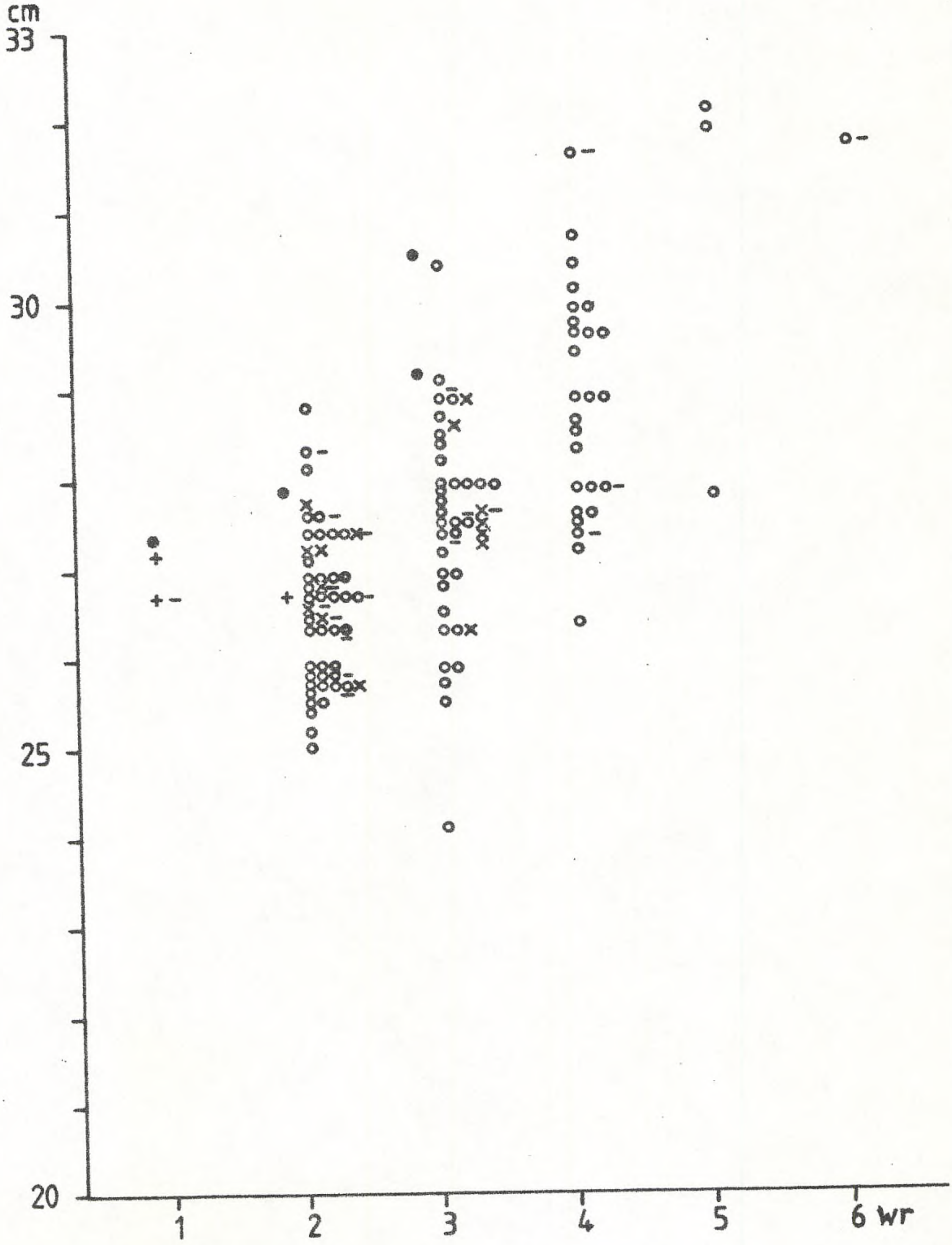

Fig. 10. Growth and nematode infestation. Sample no. 13438, Mölle, 1984.03.13, net-caught.

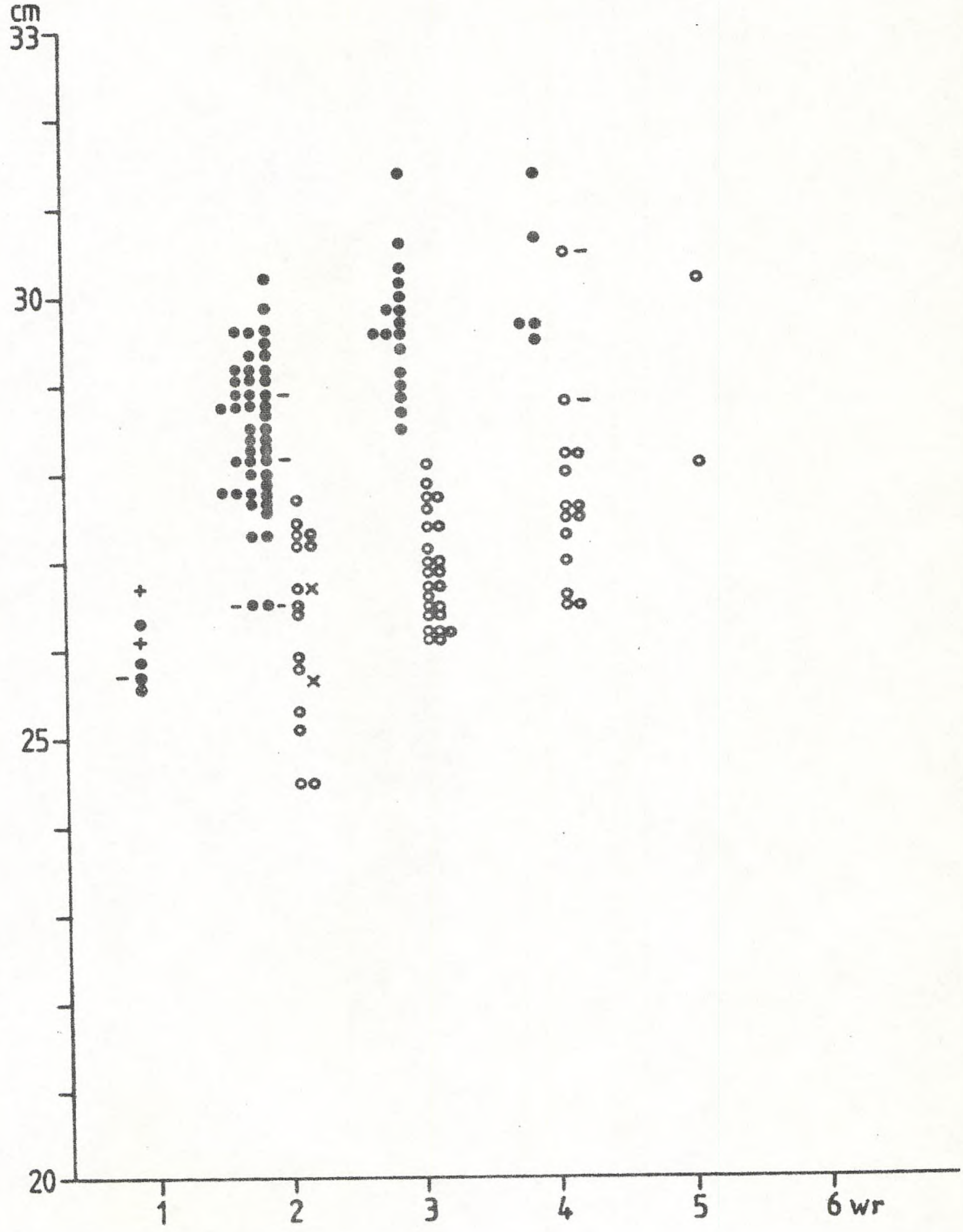

Fig. 11. Growth and nematode infestation. Sample no. 13444, Mölle, 1984.03.14, net-caught.

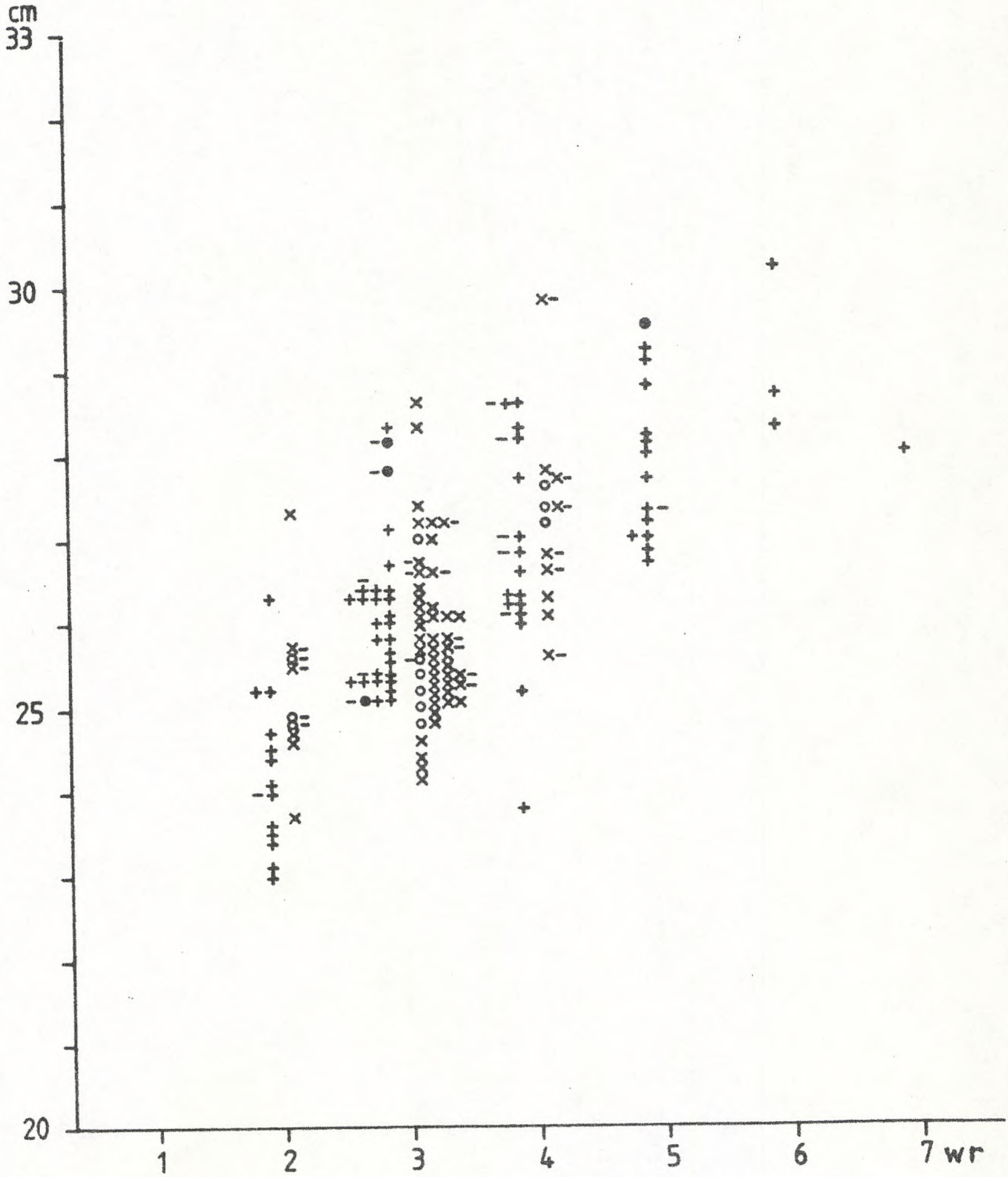

Fig. 12. Growth and nematode infestation. Sample no. 2599, Blenheim, S Falsterbo, northwestern Arkona Basin, 1980.09.17, net-caught.

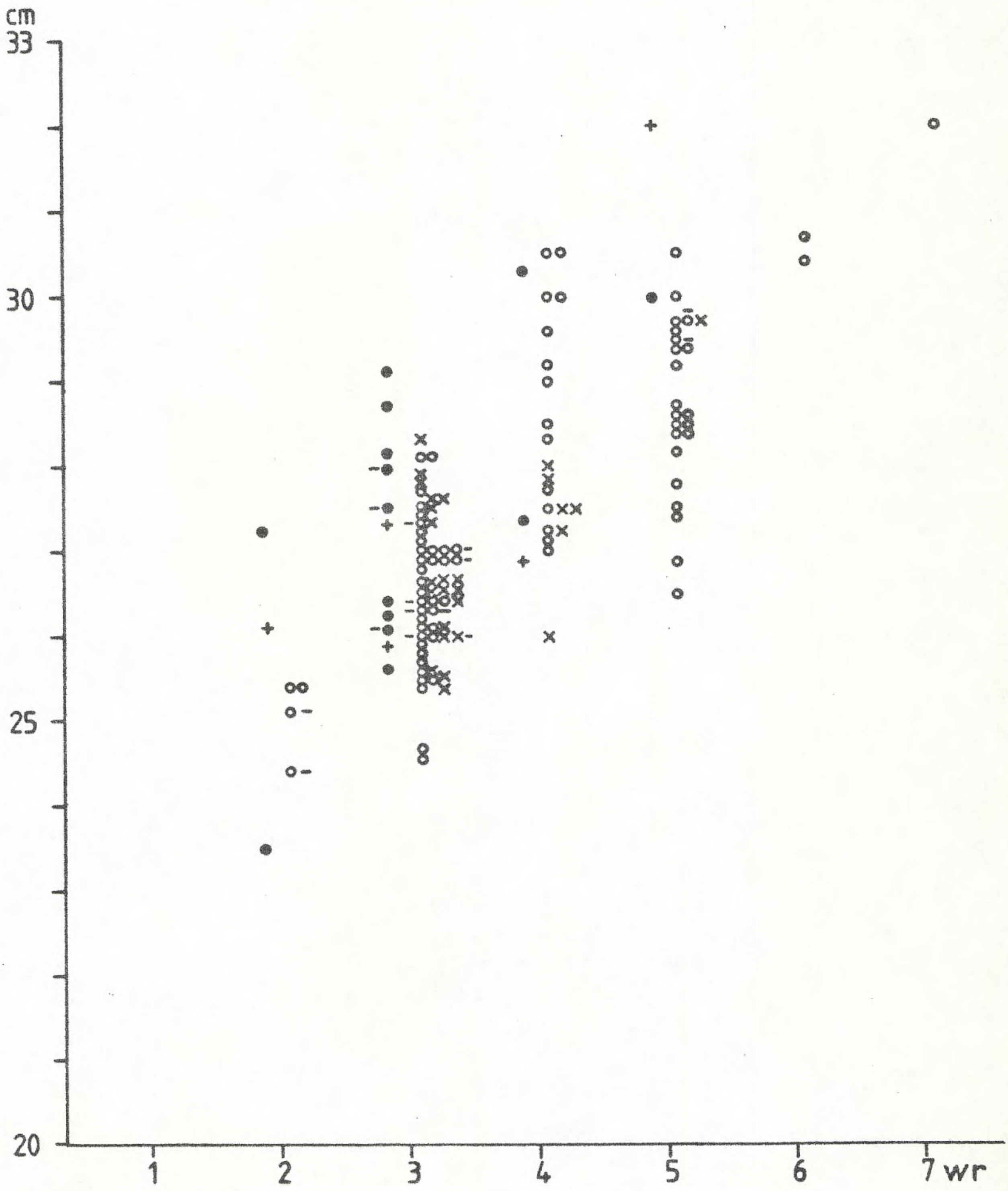

Fig. 13. Growth and nematode infestation. Sample no. 3130, Blenheim (cf. Fig. 12), 1982.10.04, net-caught.

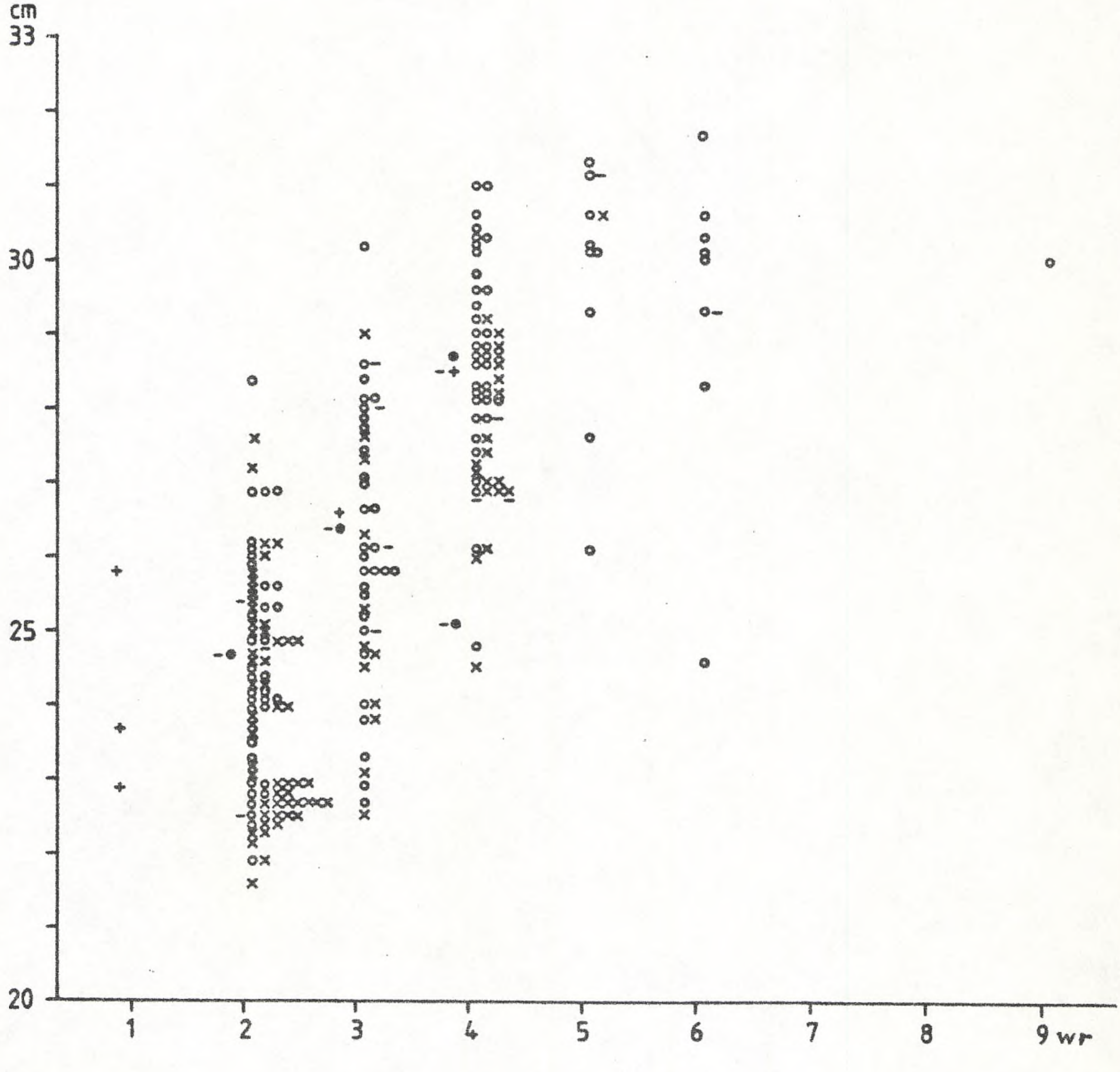

Fig. 14. Growth and nematode infestation. Sample no. 2896-2898 (assortments 0-2), S Trelleborg, 1982.02.05, trawl-caught.

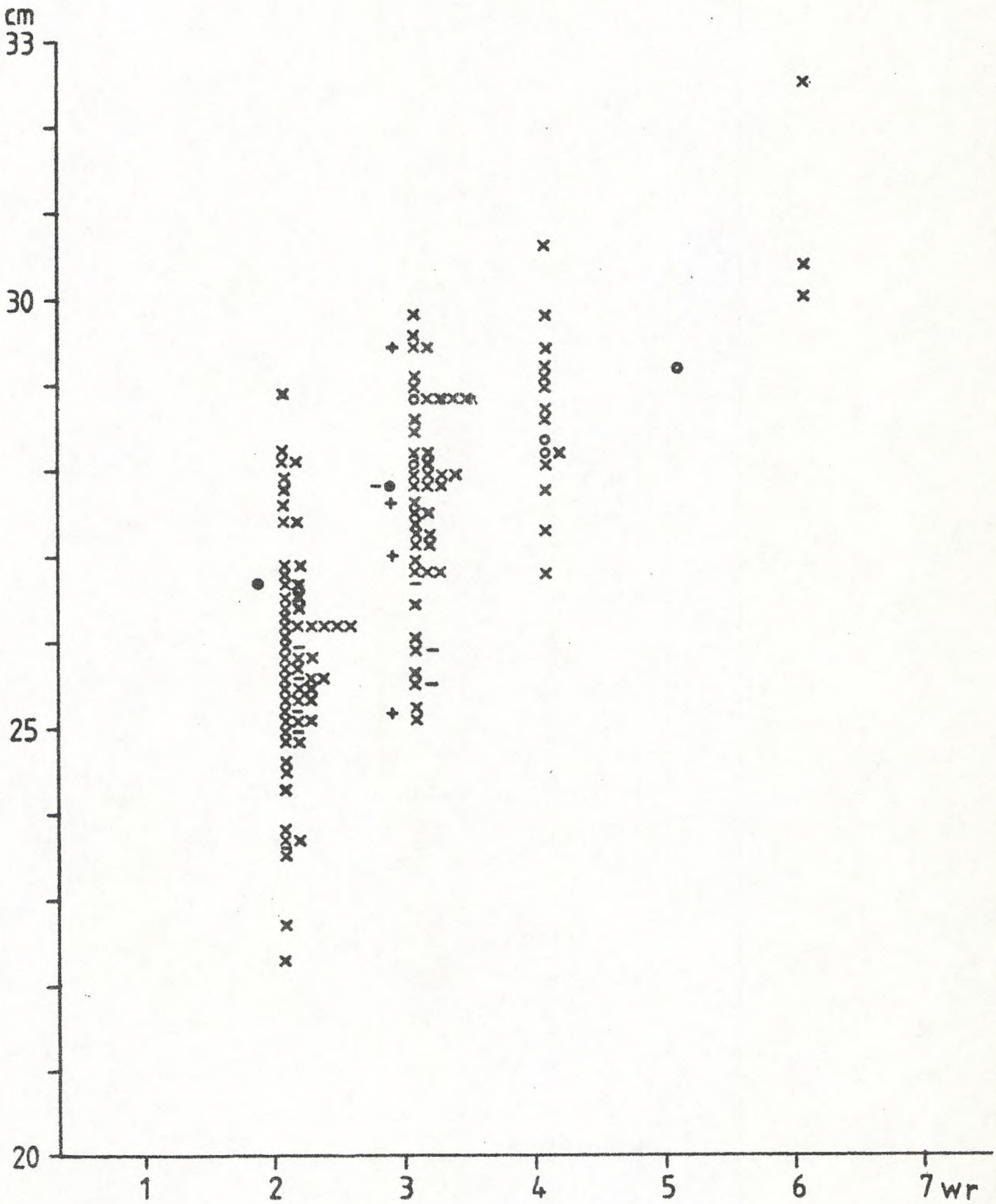

Fig. 15. Growth and nematode infestation. Sample no. 2529-2534 (assortments 0-1), SE Trelleborg, 1980.03.31, trawl-caught.

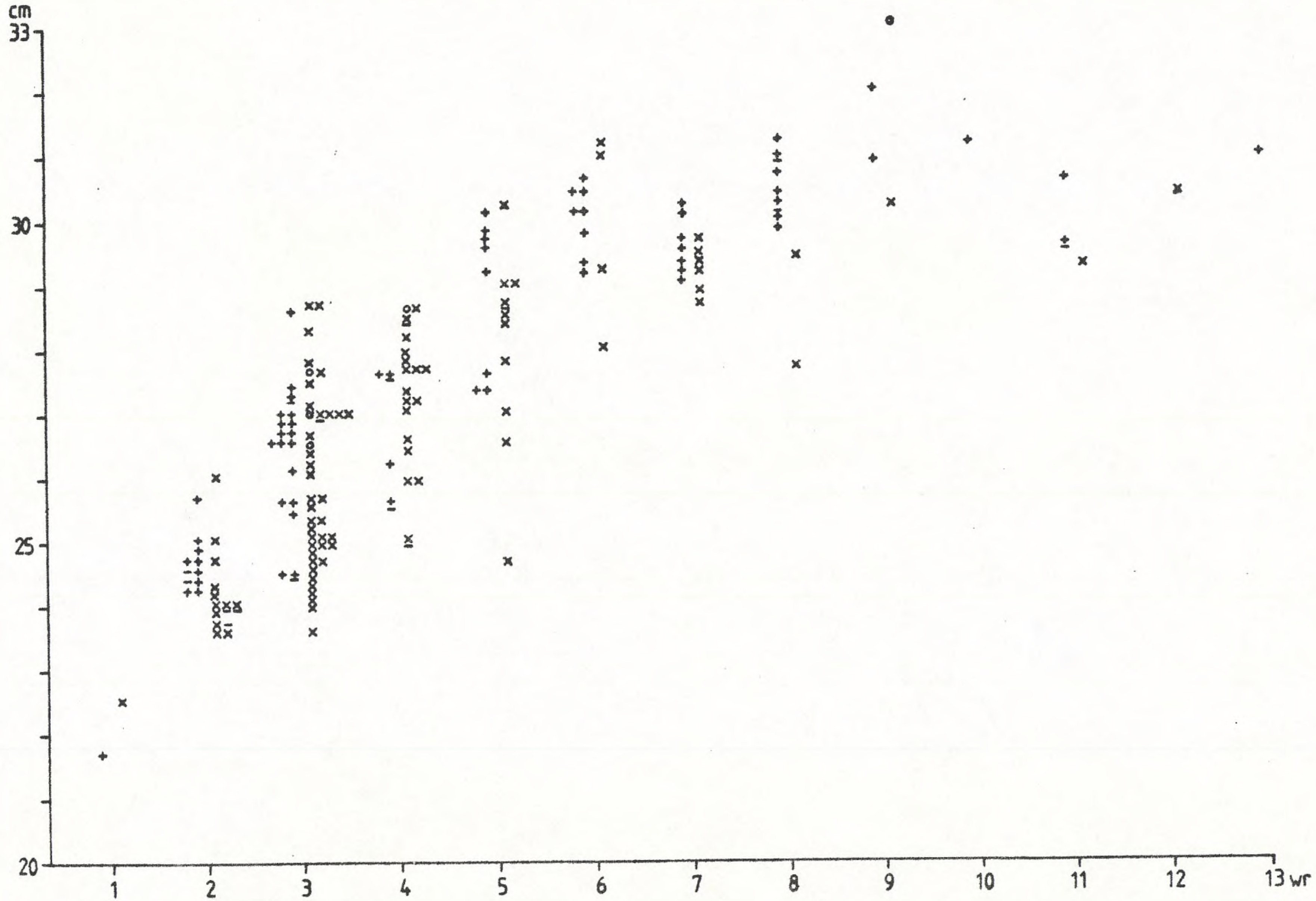

Fig. 16. Growth and nematode infestation. Sample no. 2734-2739 (assortments 0-1), SE Ystad, 1981.05.07, trawl-caught.

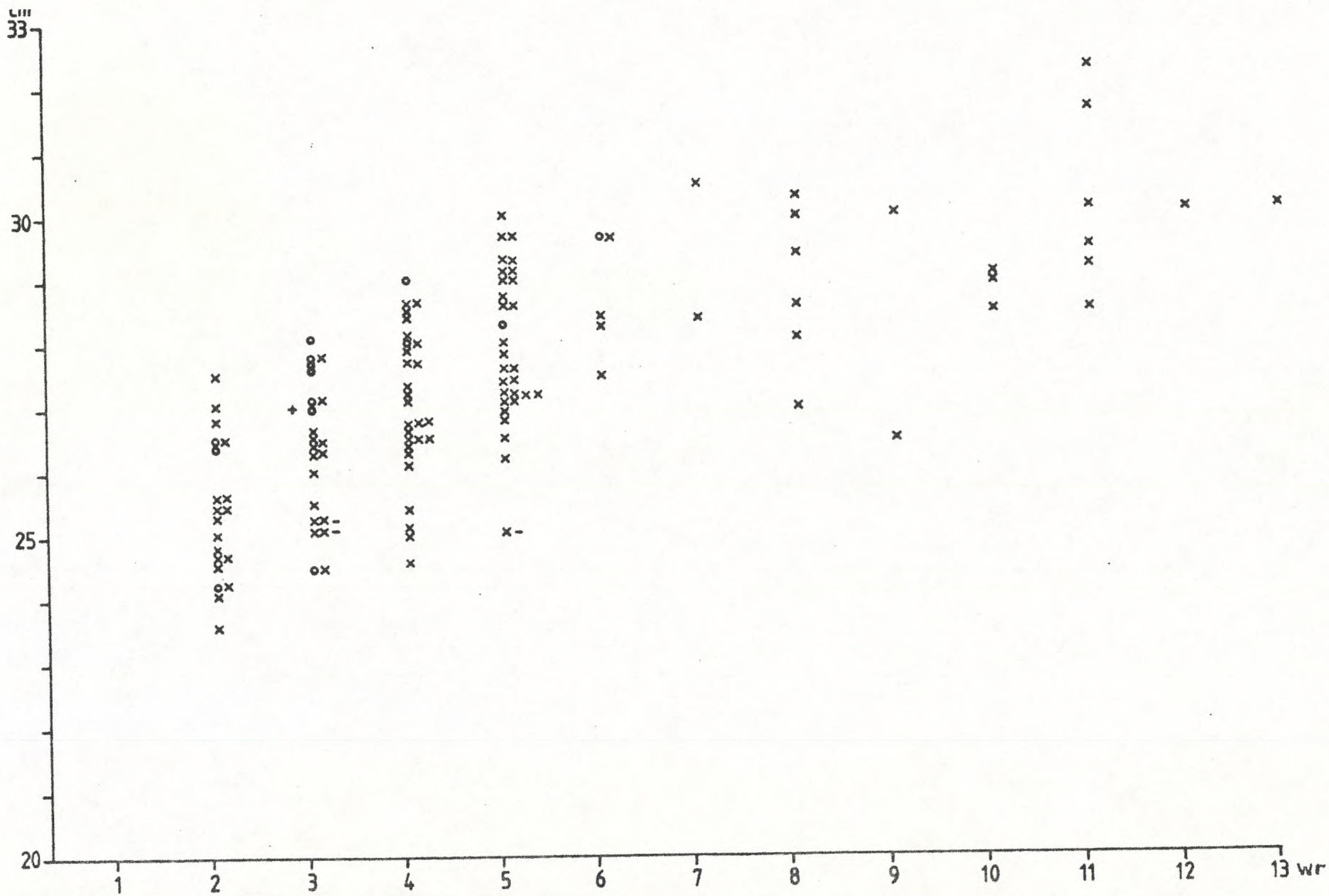

Fig. 17. Growth and nematode infestation. Sample no. 3265, Skåre, W Trelleborg, 1983.05.20, net-caught.

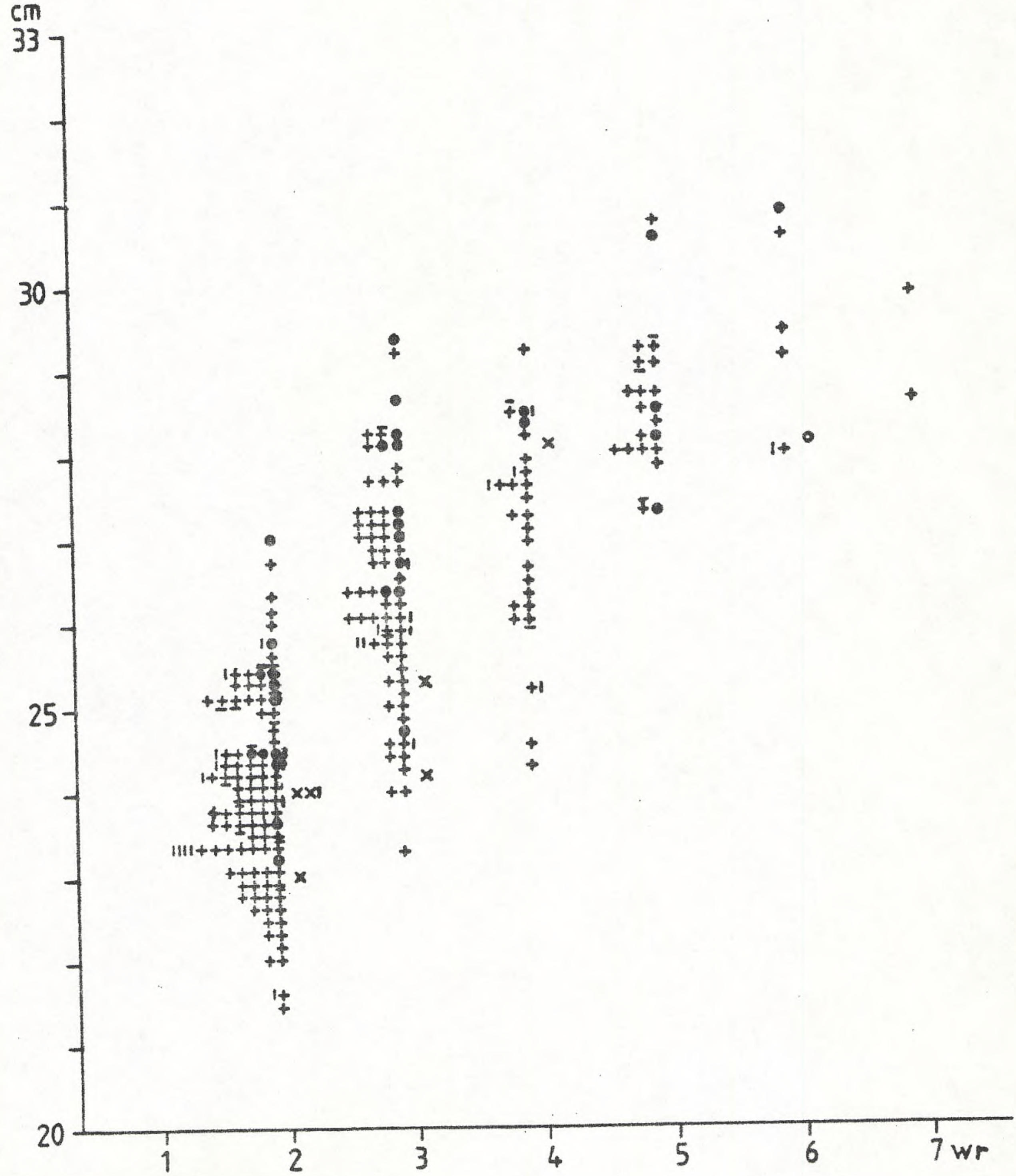

Fig. 18. Growth and nematode infestation. Sample no. 3129, Gislöv, E Trelleborg, 1982.09.20, net-caught. - (at a symbol) denotes O_1-values $\geq$ 75 units (cf. p. 20), and a vertical dash denotes uncertainty as to spawning type.

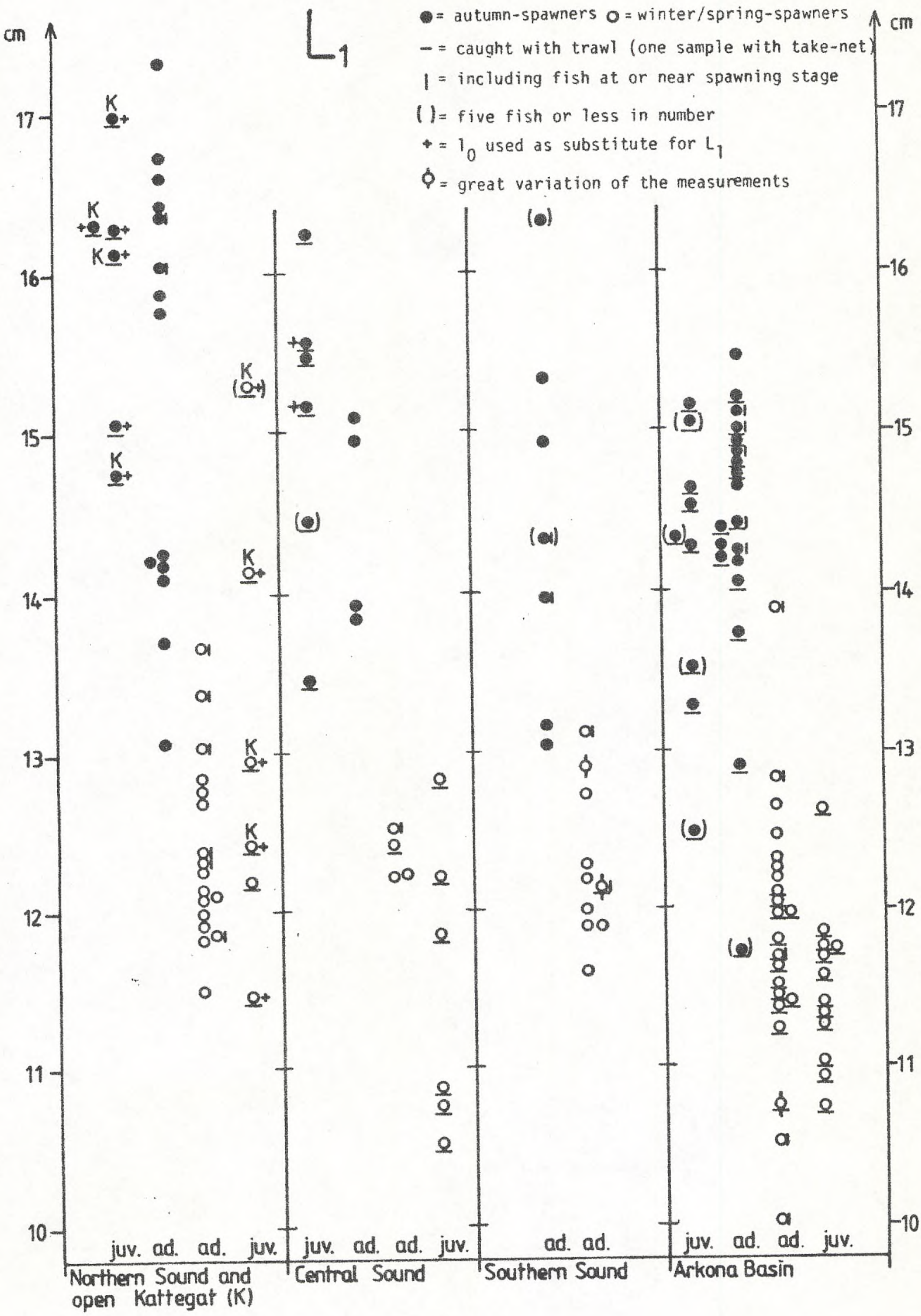

Fig. 19. Mean values of L_1 (estimated total length at the time of laying-down of the first winter-ring on the scales) for young (juv.) and old (ad.) winter/spring- and autumn-spawning herring according to Tables 1-5. For details see the text.

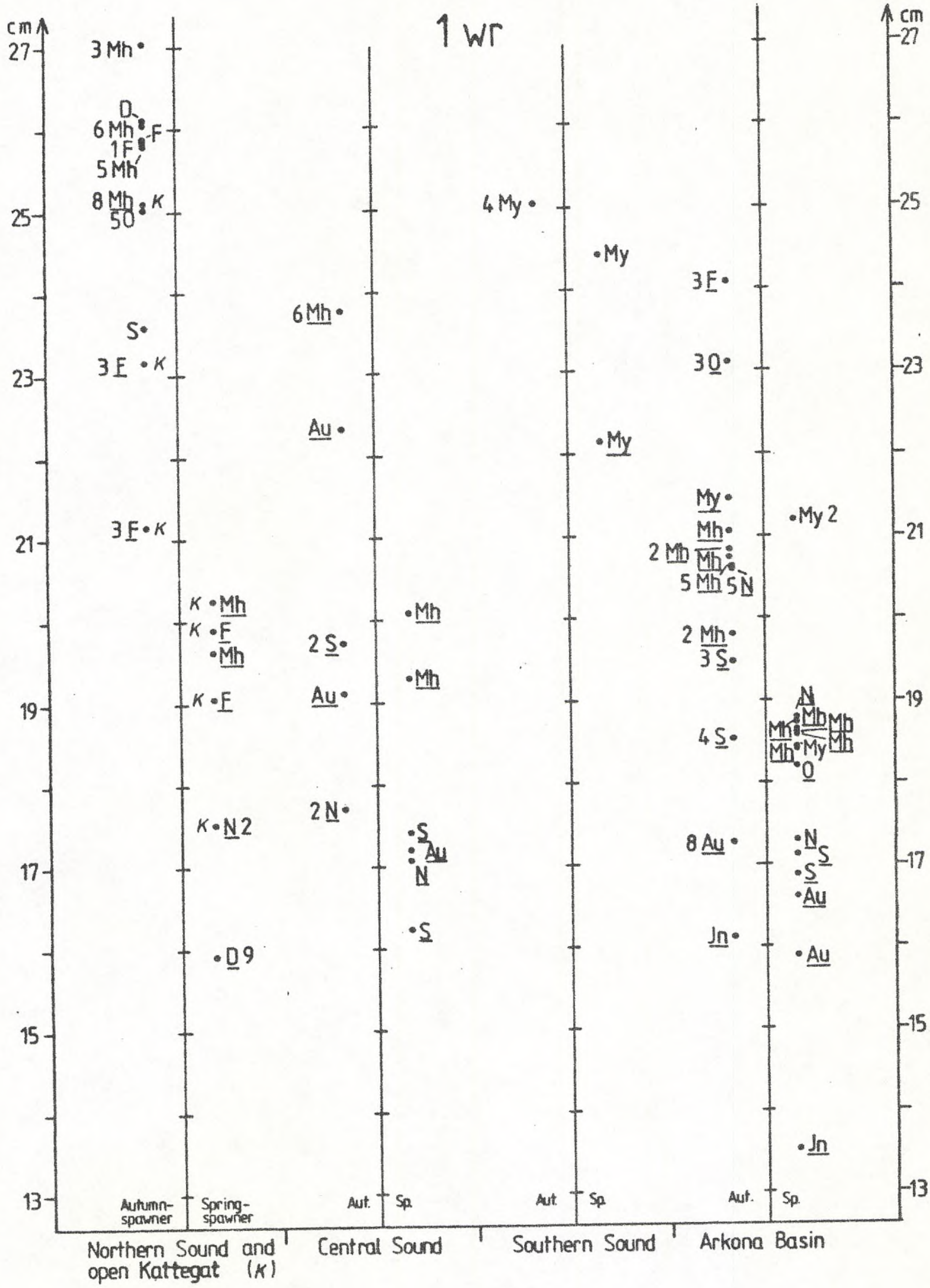

Fig. 20. Mean values of total length of autumn- (left) and spring- (right) spawning herring with one complete winter-ring on the scales in the main parts of the investigated area. The abbreviated names of sample-month have been used as symbols (if underlined the sample is taken with trawl or other non-selective gear). Figures denote number of fish in small samples usually not included in Tables 1-5. Samples from June (Jn) have the first ring just laid-down. For details see the text.

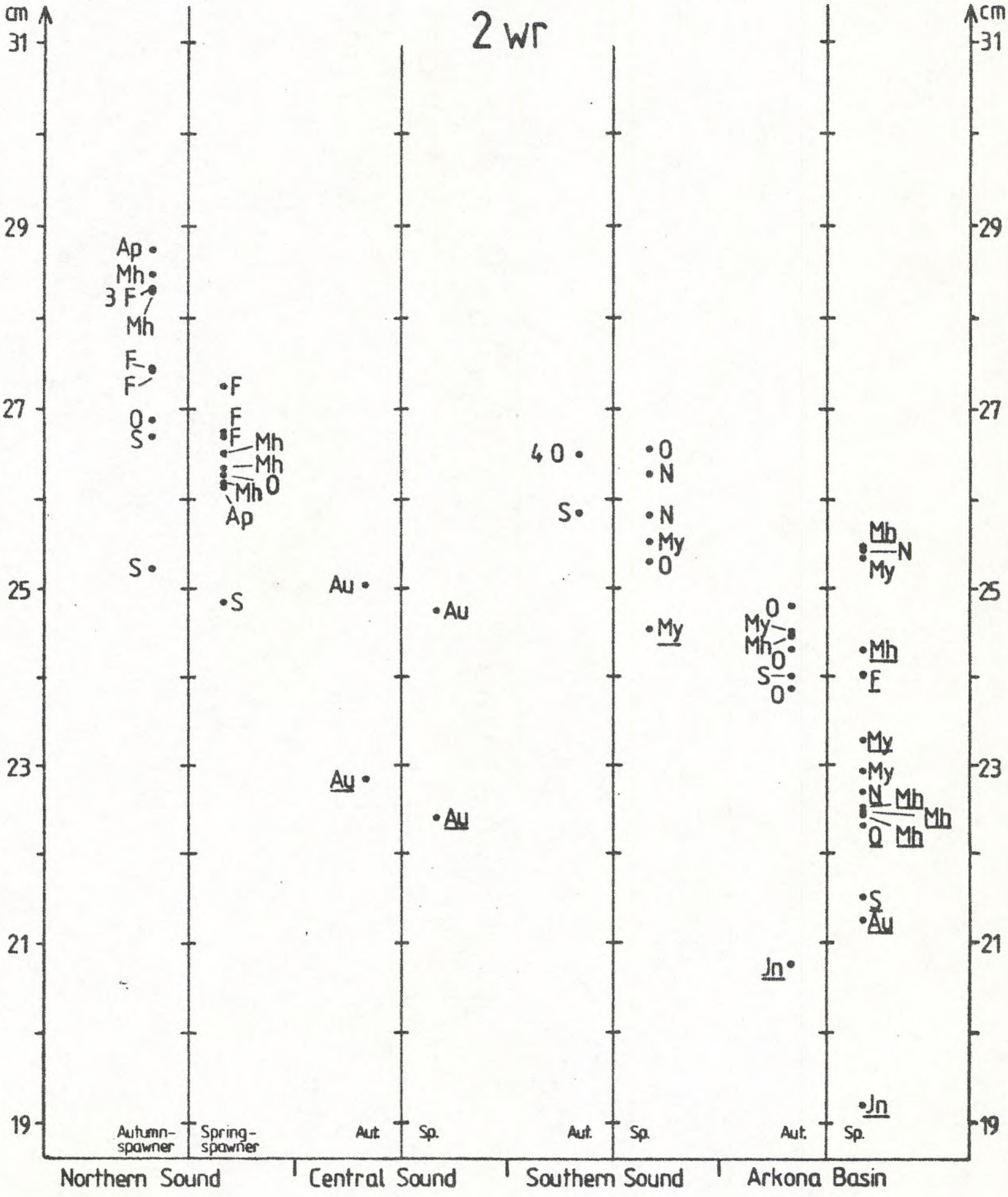

Fig. 21. Mean values of total length of herring with two complete winter-rings on the scales in the main parts of the investigated area. For legends see Fig. 20 and the text.

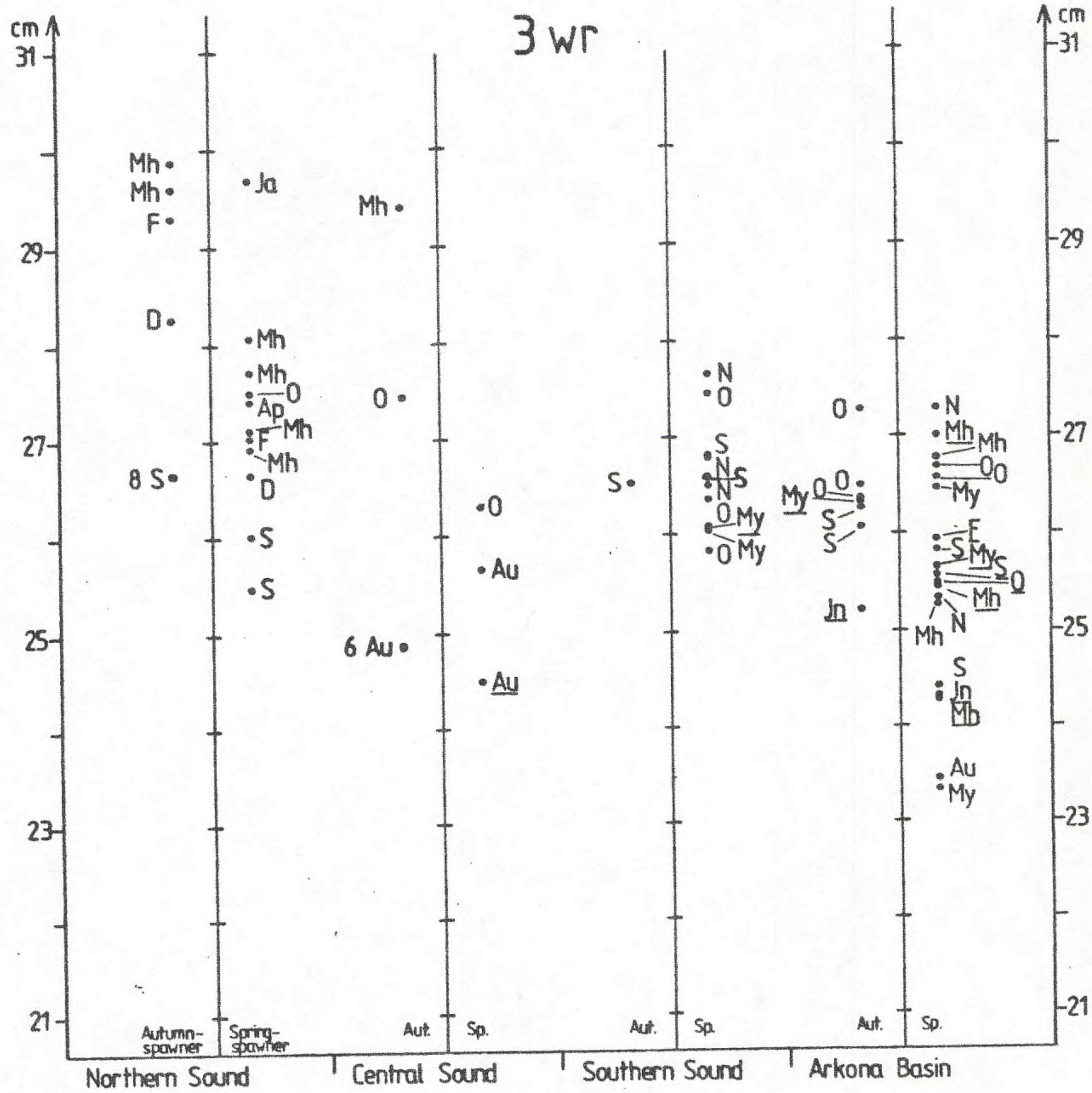

Fig. 22. Mean values of total length of herring with three complete winter-rings on the scales in the main parts of the investigated area. For legends see Fig. 20 and the text.

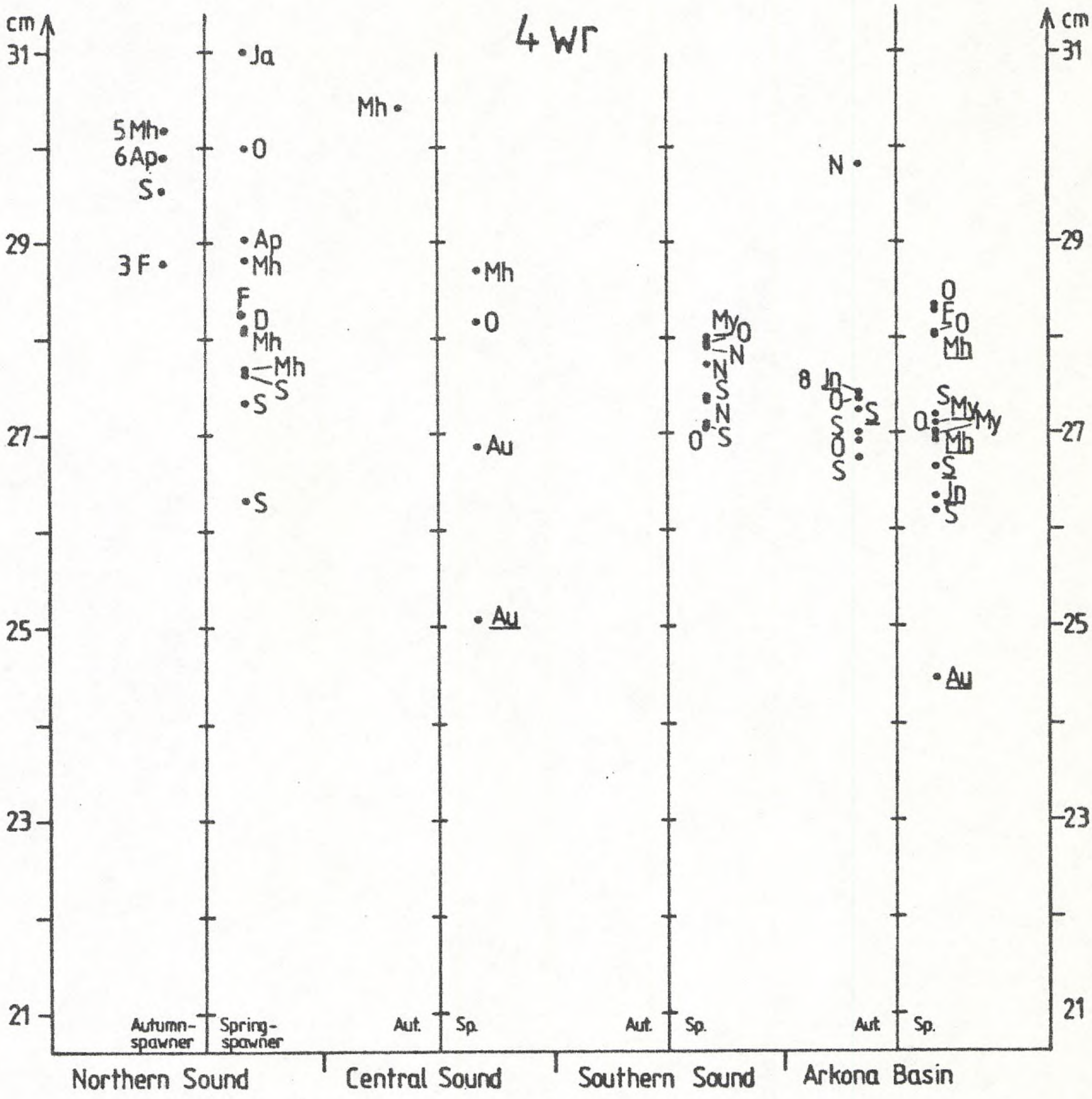

Fig. 23. Mean values of total length of herring with four complete winter-rings on the scales in the main parts of the investigated area. For legends see Fig. 20 and the text.

Legend common to Figs. 24-37: In these figures ten (in one case eight) otoliths each from 12 investigated samples are selected and presented as contour drawings (in two cases one series each of spring- and autumn-spawners from one and the same sample). The Figs. 24 and 32 are for comparison and refer to samples not listed in the Tables 1-5. At each individual otolith the number of complete winter-rings (read on the scales) is noted. On the lower part of the otoliths the gonad stage is printed. The drawings give an idea of the great variation of the shape of the otoliths and sometimes also of different growth. Magnification about 11 x.

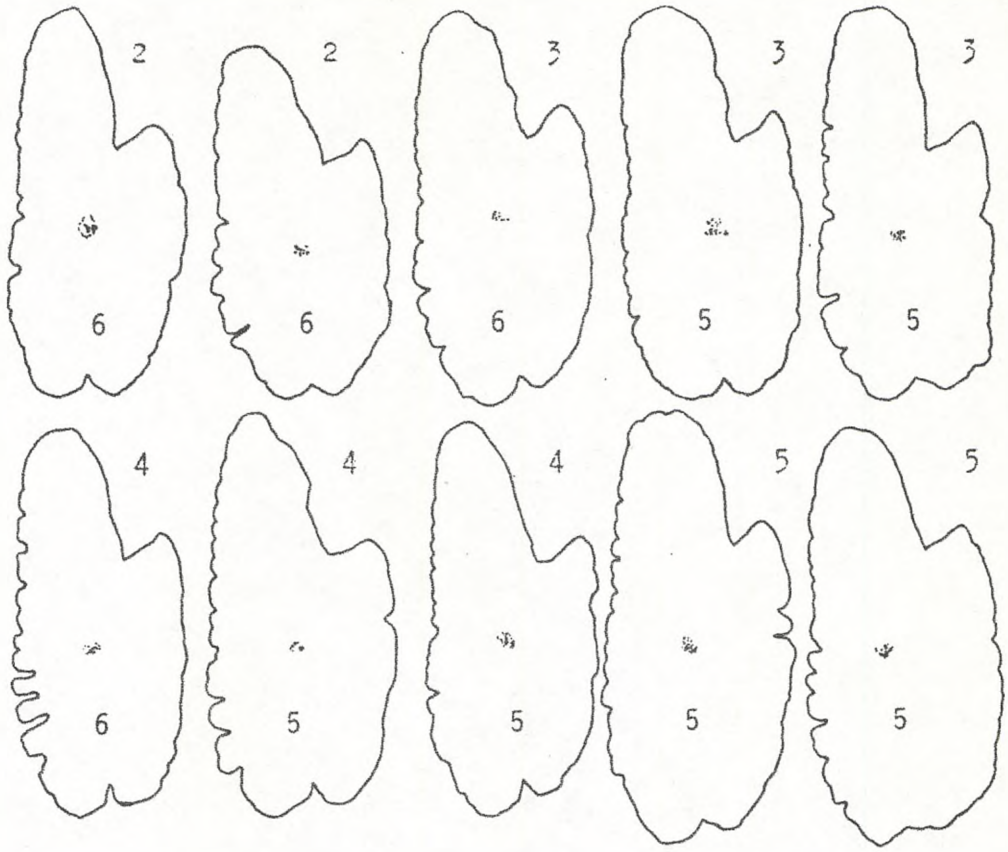

Fig. 24. Sample no. 1288 (100 fish, not in the tables), S Marstrand, Swedish west coast, 1975.04.01. "Skagerrak spring-spawners", VS 56.5, K_2 13.9 (according to Rosenberg & Palmén, 1982), nematode infestation: 100%.

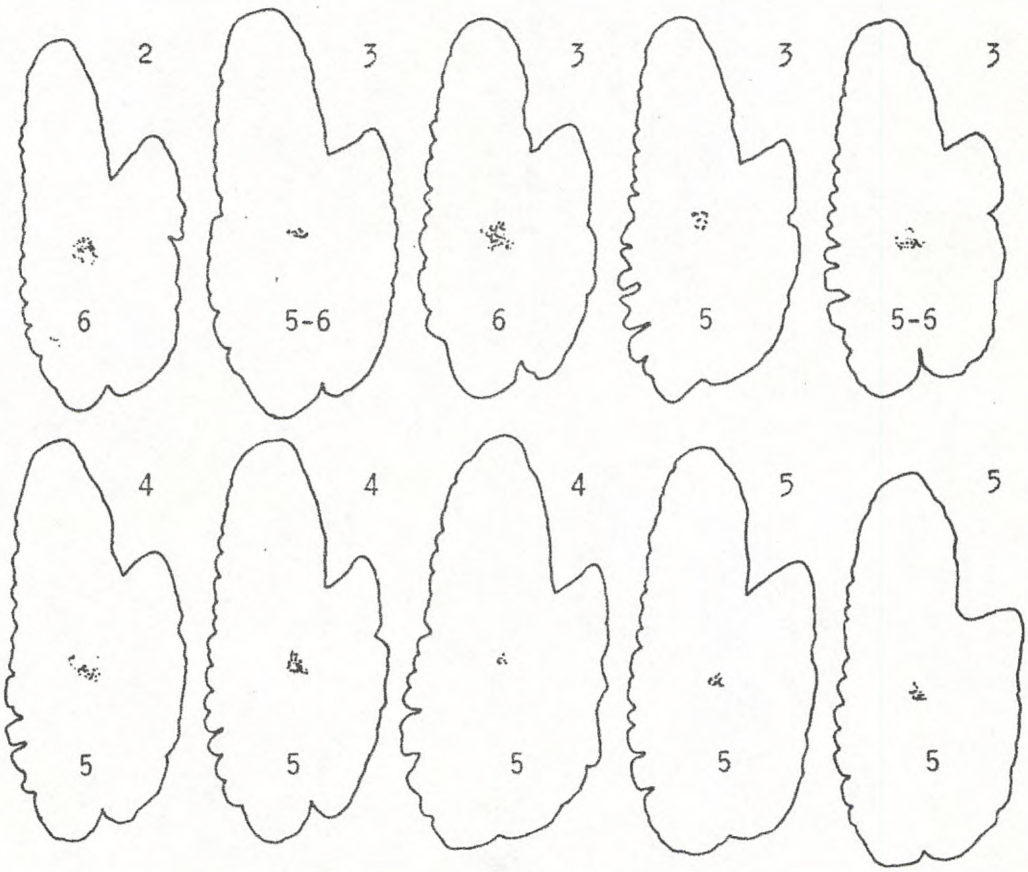

Fig. 25. Sample no. 1087, Mölle, Öresund, northernmost part, 1972.01.28. Winter/spring-spawners (all of "SW-type"), nematode infestation: c. 98%.

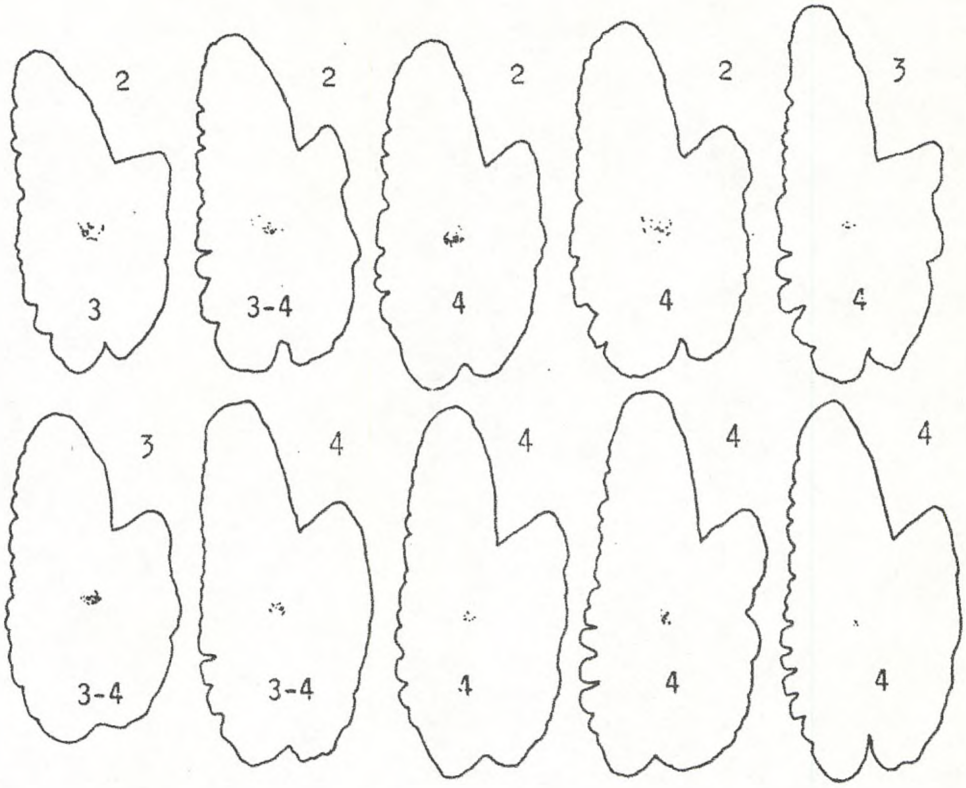

Fig. 26. Sample no. 13444, Mölle, 1984.03.14. "Kattegat spring-spawners", nematode infestation: 96.4%.

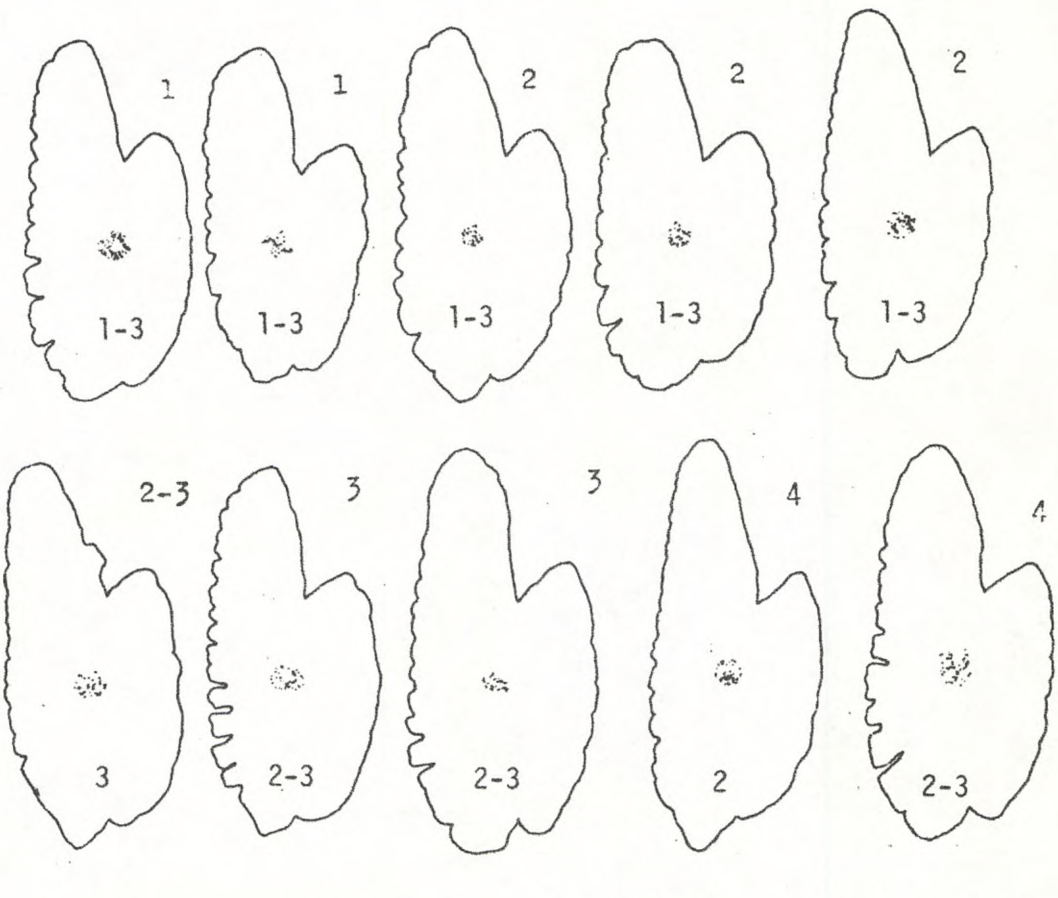

Fig. 27. Sample no. 13444, Mölle, 1984.03.14. Autumn-spawners, nematode infestation: 97.3%.

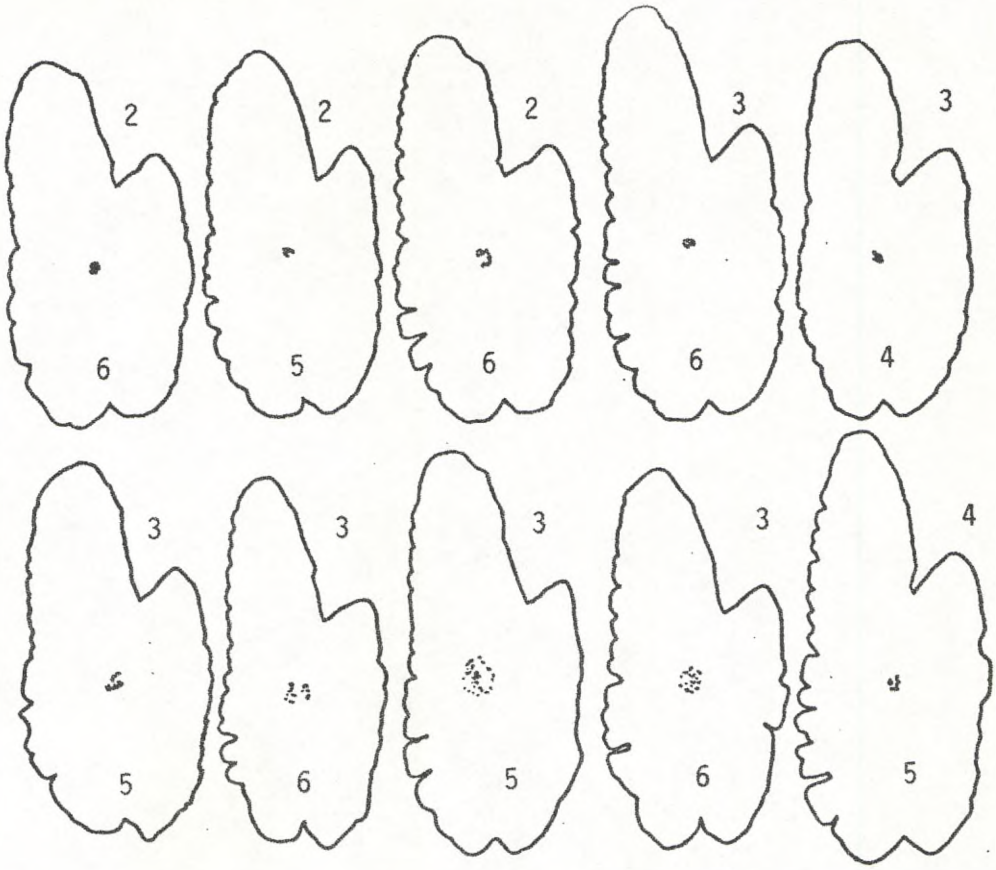

Fig. 28. Sample no. 1278, Höganäs, Öresund, northern part, 1975.02.02. "Skagerrak spring-spawners" (all of "SS-type"), nematode infestation: 100%.

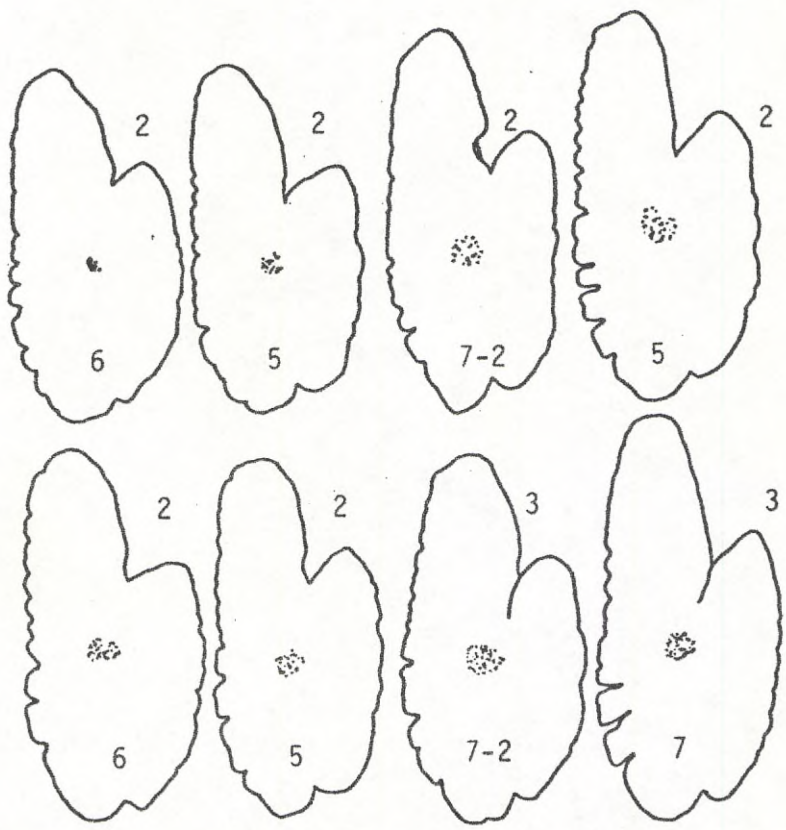

Fig. 29. Sample no.1278, Höganäs, 1975.02.02. According to the otoliths primary autumn-spawners, now winter/spring-spawners, nematode infestation: 100%.

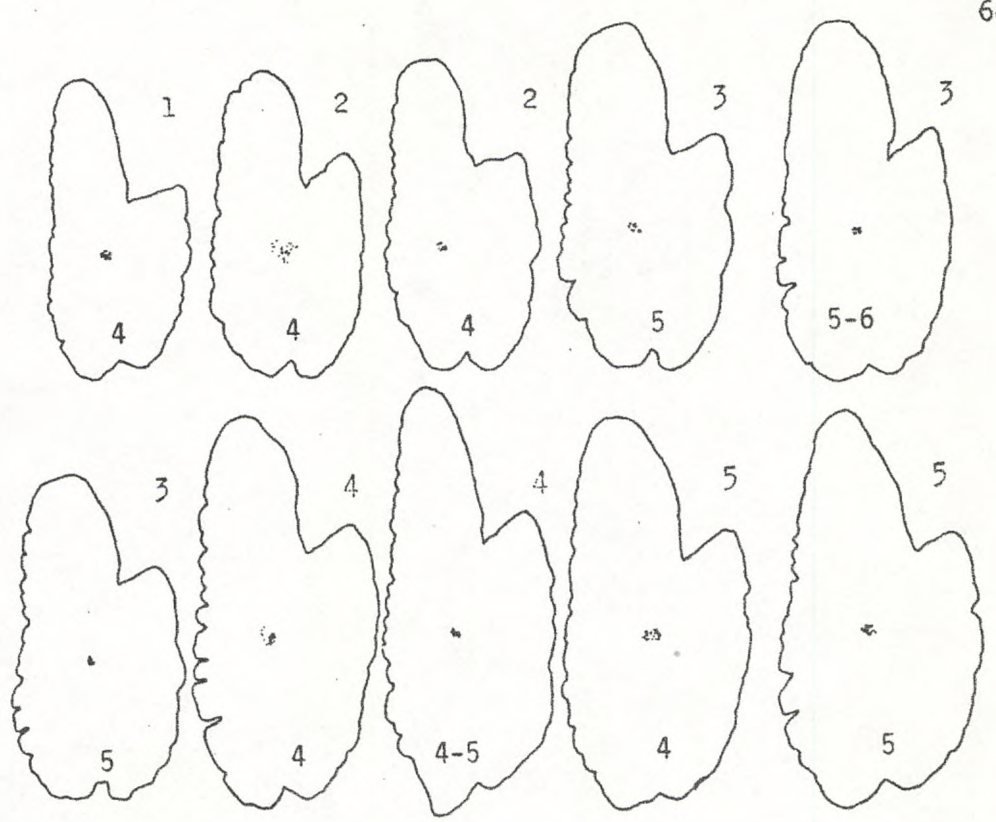

Fig. 30. Sample no. 3245, Klagshamn, Öresund, southern part, 1983. 05.03. Spring-spawners, nematode infestation: 34.6%.

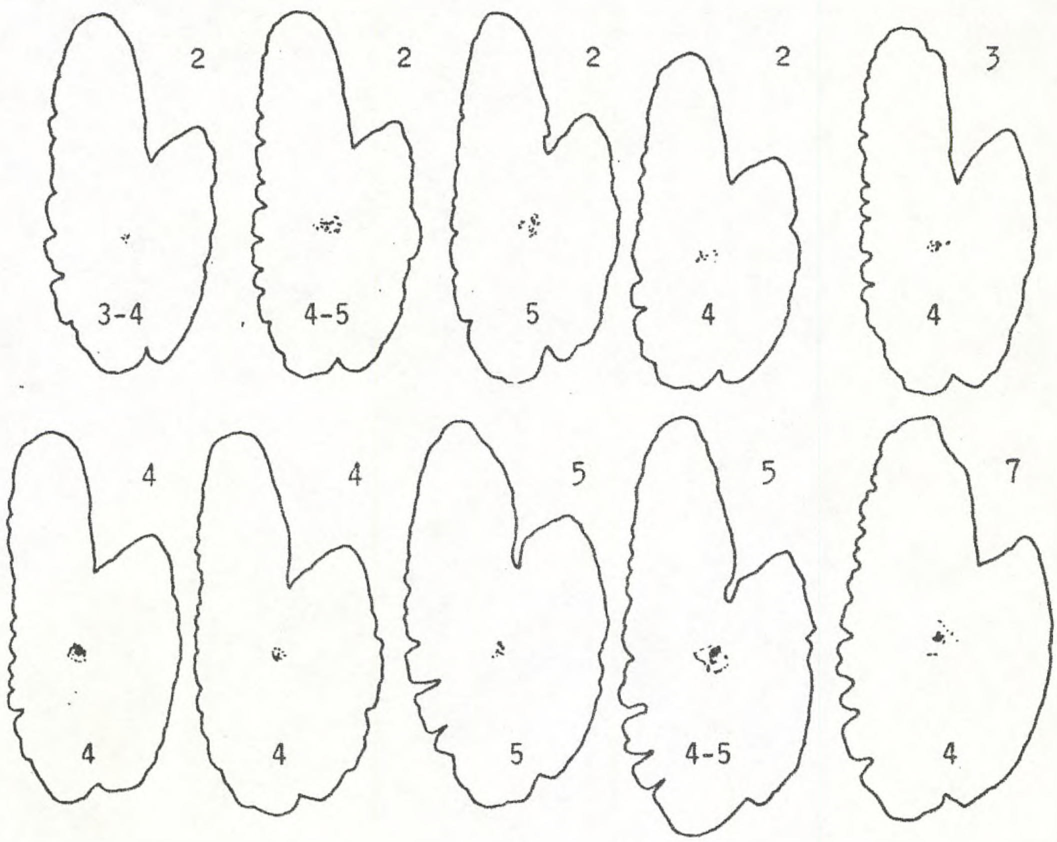

Fig. 31. Sample no. 2764, Lillegrund, W Klagshamn, 1981.09.03. Autumn-spawners, nematode infestation: 57.1%.

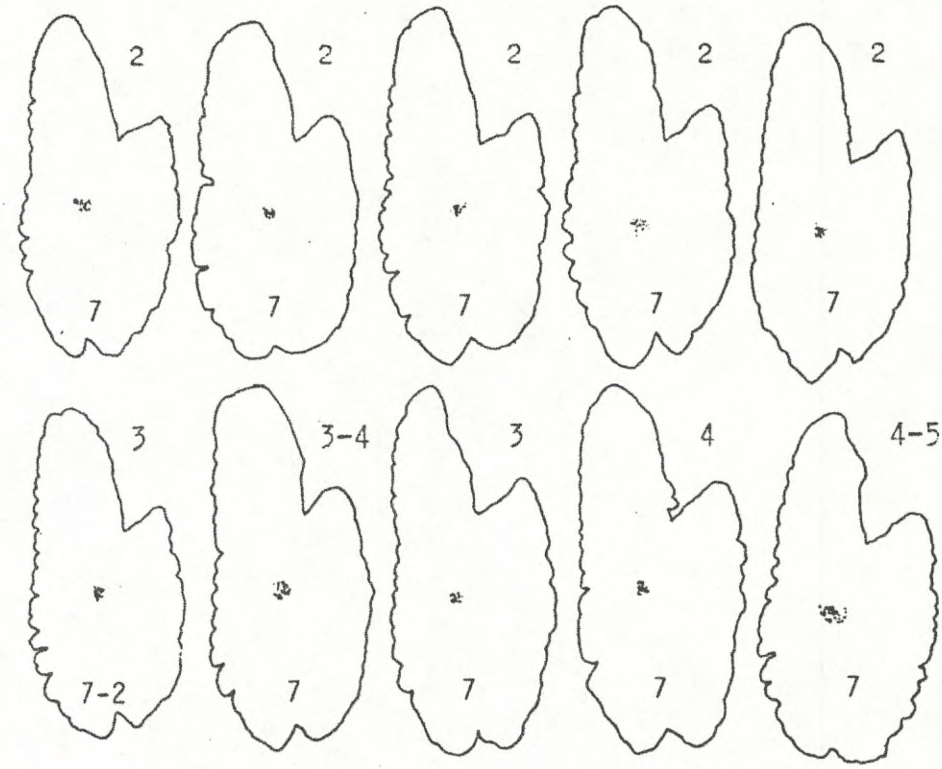

Fig. 32. Sample no. 15-16/77 from Inst. f. Hochseefischerei, Rostock (100 fish, not in the tables), Greifswalder Bodden, Rügen, 1977.05. 03-04. "Kattegat spring-spawners/Rügen-herring", VS 55.54, K_2 12.95, nematode infestation unknown.

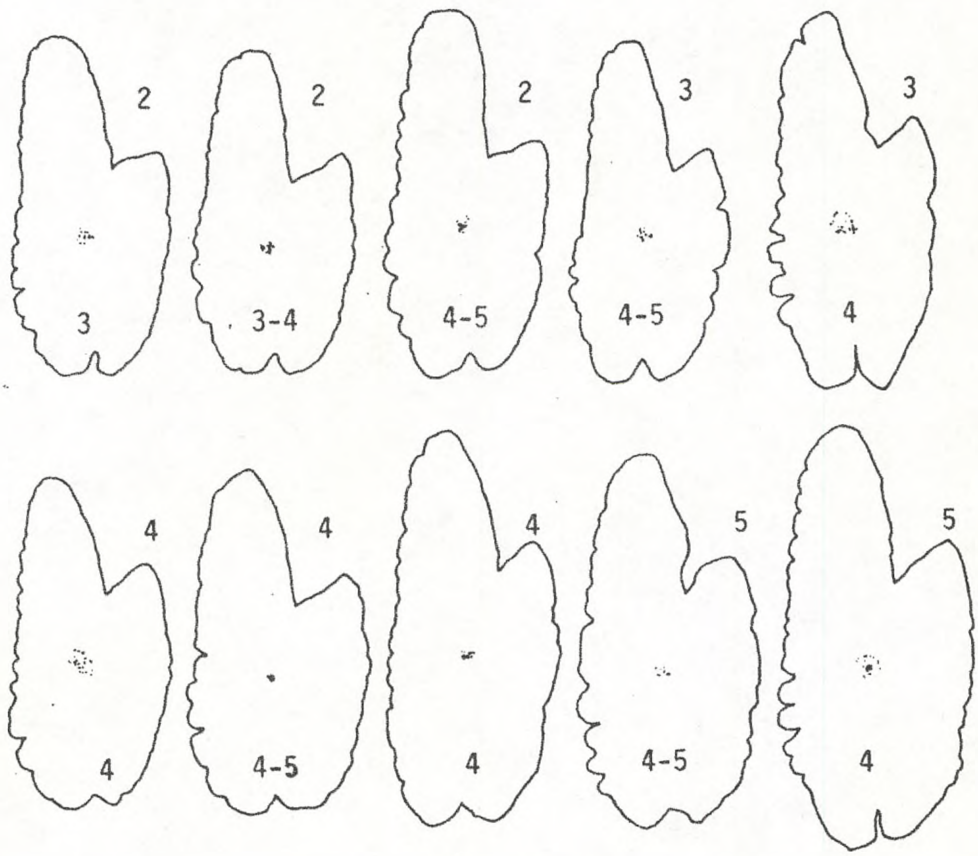

Fig. 33. Sample no. 2896-2898, S Trelleborg, 1982.02.05. "Kattegat spring-spawners/Rügen-herring". All otoliths from nematode infested fish. Nematode infestation: assortment 0: 82.5%, ass. 1: 46.4%, ass. 2: 37.7%.

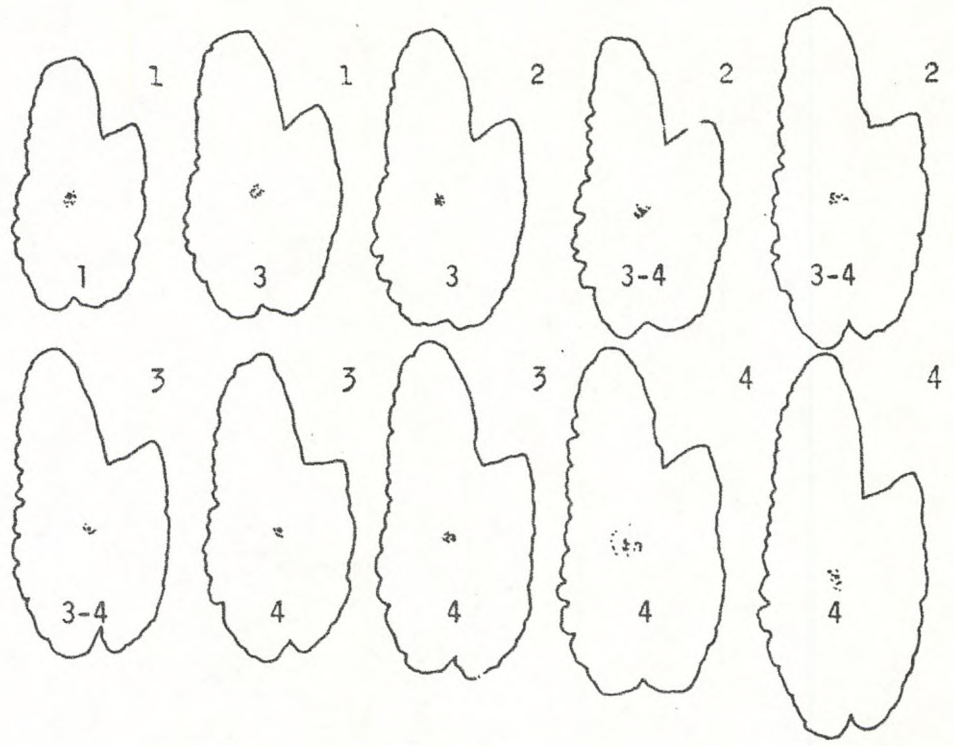

Fig. 34. Sample no. 2933, S Trelleborg, 1982.03.29. Spring-spawners, nematode infestation c. 8% (fish > 22 cm).

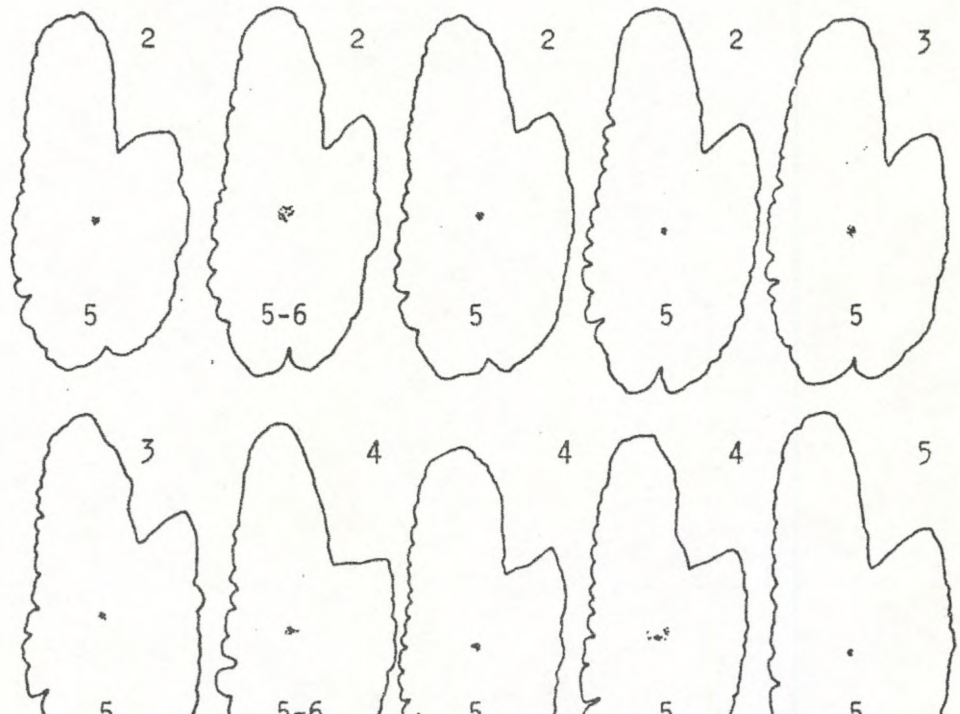

Fig. 35. Sample no. 3265, Skåre, W Trelleborg, 1983.05.20. Spring-spawners, nematode infestation: 11.6%.

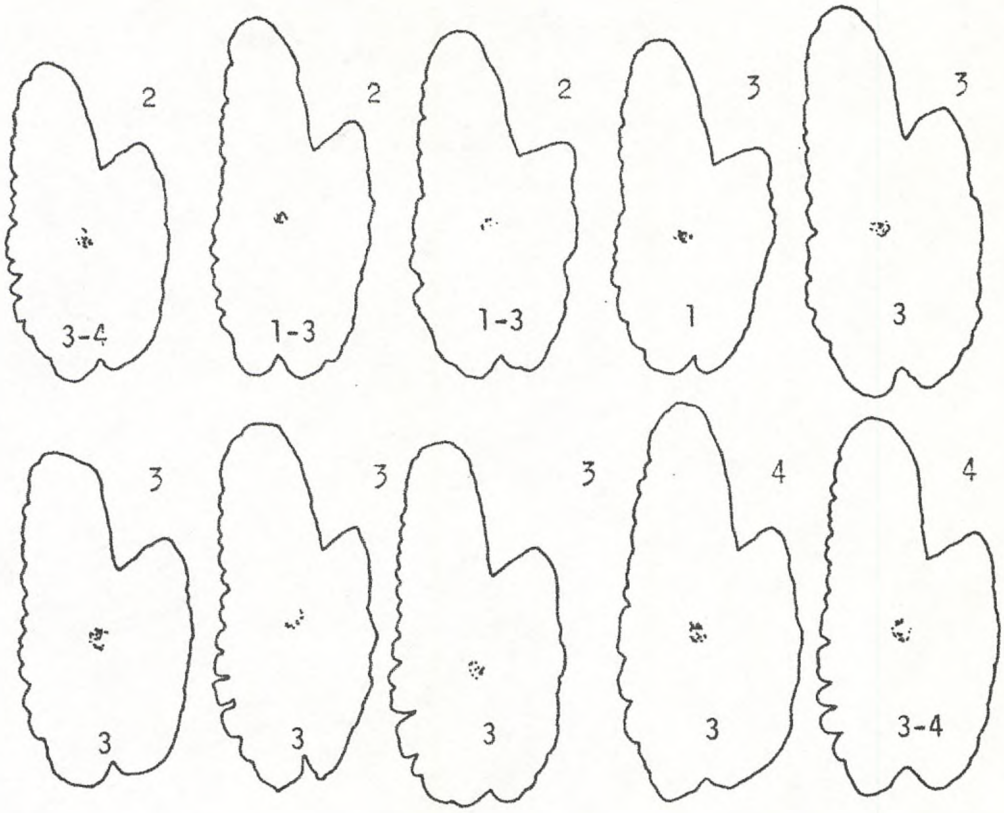

Fig. 36. Sample no. 2599, Blenheim, S Falsterbo, 1980.09.17. Spring-spawners, nematode infestation: 16.4%.

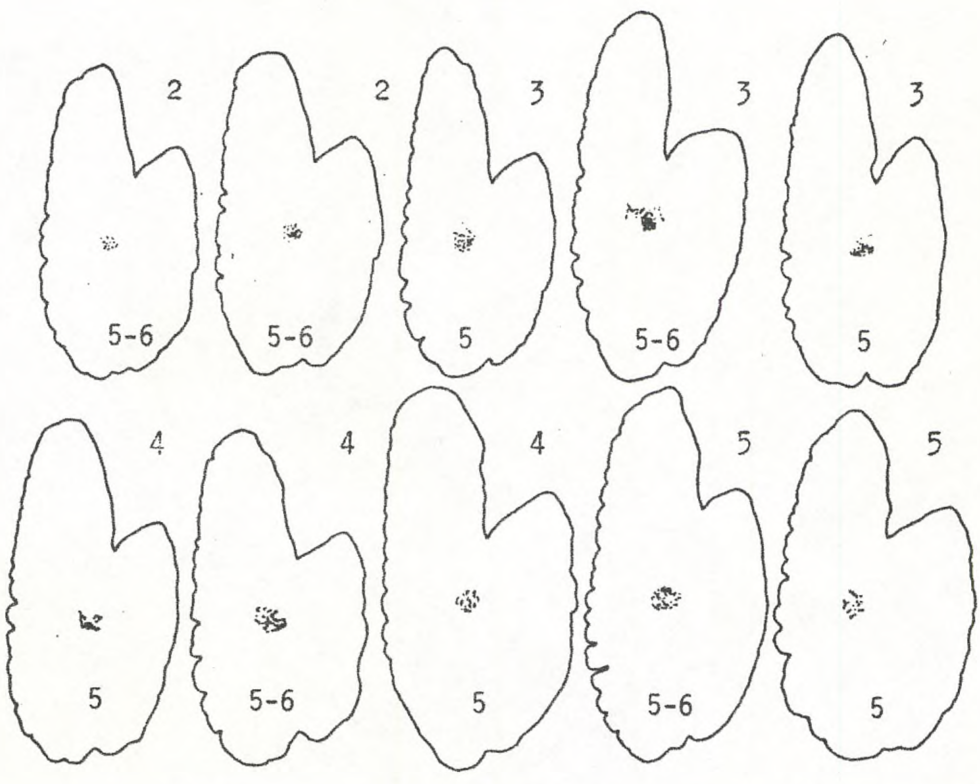

Fig. 37. Sample no. 3129, Gislöv, E Trelleborg, 1982.09.20. Autumn-spawners, nematode infestation: 14.2%.

TABLE 1. THE SOUND, NORTHERN PART

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	 01	 VS	 K2	AGE (WR) - GROUP MEAN WR	 1	 L1	 01	 VS	 K2	REMARKS
2797:151, N MöLLE 56 1 12 2 1981-09-10 Md:182:21.5-29.5 (33.0):24-25	S:88, 58.3 1-3 2-3-4-5-7	12.26 85:2.13	61.50 28:4.62	55.88 83:0.86	13.36 80:0.88	2	24.83 37:1.35	13.16 37:1.96	62.60 10:5.44	56.00 35:0.94	13.36 33:0.96	NEM 61.4%
						3	25.48 35:1.31	11.70 34:1.89	62.11 9:3.06	55.66 32:0.83	13.32 34:0.88	
	A:52, 34.4 3-45 1-2-3-4-5-8	14.24 52:3.02	70.47 19:8.44	55.98 49:0.83	13.47 49:0.74	2	25.21 31:1.53	13.70 31:2.76	70.69 13:8.51	56.00 30:0.83	13.45 29:0.78	NEM 44.2%
3112:167, N MöLLE 56 1 12 2 1982-09-15 Md:178:24.0-28.0 (30.5):25.5-26.5	S:160, 95.8 2-45 2-3-4-5	11.93 151:1.52	61.10 51:4.04	55.84 157:0.69	13.87 154:0.88	3	26.05 126:0.83	11.96 119:1.38	61.10 41:3.77	55.85 123:0.69	13.96 122:0.87	NEM 30.0%
	A:7, 4.2 4-45 2-3	14.22 6:1.52	69.50 4	55.43 7:0.53	13.83 6:0.98							NEM 28.6%
2770:110, N MöLLE 56 1 12 2 1981-09-18 Md:117:23.5-31.5:-	S:60, 54.6 2-34(45) 2-3-4-5-6	11.84 60:2.02	62.40 20:3.98	55.88 58:0.68	13.27 56:0.70	4	27.66 29:1.49	11.07 29:1.48	62.57 14:4.27	55.93 29:0.65	13.42 26:0.76	NEM 70.0%
	A:47, 42.7 4-45 2-3-4-5-6-7	14.19 47:2.49	69.24 17:8.39	56.09 45:0.67	13.85 46:1.01	2	26.74 17:1.35	15.59 17:1.84	71.00 4	56.13 15:0.64	13.69 16:0.87	NEM 74.5%
2429:86, N S KULLEN 56 2 12 3 1979-10-24 Md:162:22.5-31.5: 26.5	S:46, 53.5 2-45 2-3-4-5	12.72 45:1.26	63.95 41:5.69	56.32 44:0.74	14.02 43:0.74	2	26.23 19:0.83	12.80 19:0.95	65.88 17:3.97	56.37 19:0.60	13.95 19:0.78	NEM 47.8%
						3	27.42 19:1.22	12.75 19:1.09	63.58 19:4.73	56.00 17:0.71	14.12 17:0.70	
	A:35, 40.7 5-6 1-2-3-4	16.05 35:2.07	73.15 33:5.20	56.31 36:0.98	14.00 31:0.68	2	26.89 23:1.32	15.78 23:1.76	72.64 22:3.50	56.30 23:1.15	14.00 19:0.67	NEM 57.1%
3162:166, N MöLLE 56 1 12 3 1982-12-22 Md:166:24.0-30.5: 27.0	S:140, 84.3 3-4 2-3-4-5-6	11.50 139:1.73	60.68 105:4.25	55.96 137:0.77	13.52 135:0.79	3	26.67 96:0.94	11.21 96:1.82	60.35 71:4.51	55.93 94:0.78	13.48 93:0.80	NEM 60.7%
	A:26, 15.7 1-23 1-2-3	16.73 24:2.93	76.19 26:7.39	56.46 24:0.59	13.69 26:0.79	1	26.15 12:0.74	18.99 11:1.28	80.58 12:5.28	56.42 12:0.51	13.67 12:0.89	NEM 38.5% A-TYPE (TOT)
	A:11, 6.6 1-23 2-3		69.18 11:2.27	56.56 9:0.73	13.64 11:0.67	3	28.32 6:1.35	13.88 6:1.90	69.83 6:1.17	56.40 5:0.55	13.83 6:0.41	NEM 26.9% 01< 75
	A:15, 9.0 1-13 1-2		81.33 15:5.18	56.40 15:0.51	13.73 15:0.88	1	26.15 12:0.74	18.99 11:1.28	80.58 12:5.28	56.42 12:0.51	13.67 12:0.89	NEM 11.5% 01≥ 75

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	 O1	 VS	 K2	AGE (WR) - GROUP MEAN WR	 1	 L1	 O1	 VS	 K2	REMARKS
1087:100, N MöLLE 56 1 12 2 1972-1-28 Md:135:26.5-32.5 (34.0):30.5	S:100,100.0 5-6 2-3-4-5--8	13.58 99:1.70	62.24 82:5.44	57.29 99:0.72	14.66 96:0.81	3	29.72 58:1.12	13.48 37:1.20	62.22 32:4.19	57.29 38:0.80	14.81 36:0.71	NEM 98.0% S-TYPE (TOT, INCL SS+SW-TYPE)
	(SS):13,13.0 5-6 3-4-5	13.37 13:1.18	61.64 11:5.89	57.31 13:0.75	14.46 13:0.78	3	29.67 6:1.32	13.38 6:1.00	63.25 4	57.67 6:0.52	14.67 6:0.52	SS-TYPE (SEP)
	(SW):36,36.0 5-6 3-4-5-6-7	13.68 36:1.59	61.00 30:4.48	57.47 36:0.65	14.71 35:0.79	3	30.21 11:1.22	13.50 11:1.58	61.60 10:4.60	57.36 11:0.81	15.10 10:0.74	SW-TYPE (SEP)
						4	31.06 14:1.17	13.99 14:1.82	61.18 11:3.31	57.57 14:0.51	14.50 14:0.65	
1278:100, N HöGANÄS 56 1 12 2 1975-02-02 Md:150:25.0-30.5: 26.5,(28.5)	SS:19,19.0 4-6 2-3-4	12.33 19:2.37	62.60 10:7.76	57.29 17:0.77	13.89 18:0.83	2	27.34 7:0.89	13.61 7:1.19	66.60 5:5.18	57.29 7:0.95	14.00 7:0.82	NEM 100% SS-TYPE (SEP)
	SW:17,17.0 4-6 2-3-4-5	13.05 17:2.14	61.56 9:7.30	56.94 17:0.83	14.29 17:0.69	2	26.76 7:0.91	13.16 7:1.68	67.67 3	56.86 7:0.90	14.14 7:0.69	NEM 100% SW-TYPE (SEP)
	A :15, 15.0 5-6 2-3-4	16.34 14:2.34	75.63 8:8.03	56.43 14:0.65	14.33 15:0.72	2	27.41 11:0.56	16.62 10:2.08	74.33 6:9.03	56.30 10:0.48	14.27 11:0.65	NEM 100%
3196:135, N MöLLE 56 1 12 2 1983-02-09 Md:178:(14.0) 24.0-32.0:26.5	S:71, 52.6 4 2-3-4-5	11.98 69:2.06	58.74 43:5.11	56.01 71:0.78	13.61 67:0.63	3	27.08 52:1.31	11.69 51:1.84	58.26 34:5.30	55.90 52:0.72	13.67 49:0.63	NEM 70.4%
	A:59, 43.7 1-3 1-2-3-4-5	15.93 58:2.59	75.15 54:6.96	56.27 56:0.65	13.95 56:0.67	2	27.41 22:0.76	15.27 22:2.48	72.55 20:6.92	56.45 20:0.69	13.95 19:0.85	NEM 74.6% A-TYPE (TOT)
	A:25, 18.5 13-3 1-2-3-4-5	14.10 25:1.91	67.90 21:3.19	56.36 22:0.58	13.92 24:0.78	2	27.00 11:0.63	13.44 11:1.58	65.89 9:3.41	56.67 9:0.50	14.10 10:1.10	NEM 72.0% O1< 75
	A:34, 25.2 1-13 1-2-3-4	17.31 33:2.15	79.76 33:4.18	56.21 34:0.69	13.97 32:0.59	1	25.88 16:0.67	18.27 16:1.35	81.80 15:4.41	56.31 16:0.70	13.94 16:0.57	NEM 67.6% O1≥ 75
						2	27.82 11:0.66	17.10 11:1.74	78.00 11:3.00	56.27 11:0.79	13.78 9:0.44	
2500:106, N KULLEN-HELSINGBORG 56 2 12 3 1980-02-19 Md:183:(24.0) 25.0-31.0:26.0	S:99, 93.4 4 2-3-4-7	12.78 99:1.57	62.24 93:3.74	56.20 98:0.80	14.04 89:0.80	2	26.68 80:0.77	12.86 80:1.29	62.39 76:3.77	56.33 79:0.75	14.04 72:0.83	NEM 70.7%
	A:7, 6.6 4 1-2-3-4	13.07 7:3.02	73.17 6:7.73	56.33 6:0.52	13.40 5:0.55	2	28.27 3	12.23 3	76.00 2			NEM 85.7%

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	O1	VS	K2	AGE (WR) - GROUP MEAN WR	1	L1	O1	VS	K2	REMARKS
1285:100, N /SKÄLDERVIKEN/ MöLLE 56 2 12 3 1975-03-04 Md:157:24.0-33.5: 26.0,29.5	SS:13,13.0 4-56 2-3-4-5	12.12 13:1.96	59.57 7:7.55	56.45 11:0.82	14.25 12:0.87	3	27.75 6:1.25	11.17 6:1.89		56.67 6:0.82	14.80 5:0.84	NEM 100% SS-TYPE (SEP)
	SW:30,30.0 5-6 2-3-4-5-6	12.85 30:1.71	61.59 27:4.79	56.73 30:1.01	14.68 28:0.61	2	26.19 8:0.31	12.94 8:1.45	60.00 8:5.10	56.50 8:0.93	14.57 7:0.53	NEM 96.7% SW-TYPE (SEP)
						3	28.02 16:0.94	13.32 16:1.18	62.79 14:4.04	56.87 16:1.09	14.81 16:0.66	
	A:34, 34.0 7-72 2-3-5-6-7	16.40 34:1.63	75.23 31:4.65	56.27 33:0.57	14.24 29:0.91	3	29.92 21:0.90	16.61 21:1.81	76.14 21:4.59	56.25 20:0.55	14.47 19:0.96	NEM 100%
13437:144, N SKÄLDERVIKEN 56 2 12 4 1984-03-09 Md:170:25.0-30.5: 27.5	S:99, 68.8 3-45 2-3-4-5-6	12.08 93:1.81	60.07 45:6.72	55.77 96:0.67	13.36 94:0.79	3	27.13 41:0.81	12.05 39:1.31	59.94 16:3.21	55.60 40:0.59	13.44 36:0.73	NEM 99.0%
	A:36, 25.0 13-3 1-2-3-4	16.31 35:1.93	77.31 32:7.30	56.29 35:0.62	13.50 34:0.75	2	28.30 24:0.89	16.15 24:1.89	75.85 20:7.13	56.17 23:0.65	13.33 24:0.64	NEM 83.3%
13438:142, N MöLLE 56 1 12 3 1984-03-13 Md:192:(24.0) 25.0-32.0:27.0	S:96, 67.6 5-67 2-3-4-5	12.38 95:1.92	59.70 56:5.48	56.83 90:0.94	14.22 89:0.89	2	26.48 38:0.86	13.48 38:1.80	62.03 29:3.77	57.03 37:1.01	14.45 33:0.87	NEM 89.6%
	A:5, 3.5 13-2 1-2-3	16.72 5:3.28	78.00 5:8.00									NEM 80.0%
13444:137, N MöLLE 56 1 12 3 1984-03-14 Md:150:24.0-31.0: 27.5	S:56, 40.9 3-4 2-3-4-5	12.09 54:1.98	61.42 36:4.95	55.67 52:0.73	13.46 52:0.78	2	26.32 18:1.00	13.69 18:1.16	64.50 16:3.37	55.82 17:0.81	13.59 17:0.62	NEM 96.4%
						3	26.94 22:0.61	11.81 21:1.63	59.60 15:3.58	55.50 20:0.61	13.35 20:0.93	
	A:73, 53.3 13-23 1-2-3-4	15.90 66:1.86	74.99 67:6.46	56.20 69:0.74	13.52 73:1.03	2	28.50 46:0.83	15.86 43:1.77	74.68 41:6.59	56.18 44:0.76	13.54 46:1.00	NEM 97.3%
						3	29.62 16:0.74	15.56 13:1.76	74.00 15:4.71	56.31 16:0.70	13.69 16:1.20	
13451:157, N SKÄLDERVIKEN 56 1 12 4 1984-04-02 Md:171:23.5-32.0: 27.5	S:123, 78.3 3-56 2-3-4-5	11.88 119:1.80	60.96 76:5.87	55.77 115:0.71	13.76 113:0.76	2	26.17 30:1.15	12.80 30:2.09	64.68 25:4.61	55.83 29:0.76	13.76 29:0.64	NEM 100%
						3	27.52 30:1.01	12.00 30:1.26	59.95 21:5.21	55.48 29:0.57	13.85 27:0.53	
						4	29.02 57:1.12	11.29 54:1.51	58.25 28:5.92	55.89 53:0.72	13.73 52:0.87	
	A:32, 20.4 1-3 1-2-3-4-5	15.77 32:2.36	76.60 30:6.21	56.12 33:0.55	14.17 29:0.85	2	28.78 21:0.93	16.18 21:2.44	77.44 18:3.70	56.14 21:0.57	14.26 19:0.87	NEM 100%

TABLE 2. THE SOUND, CENTRAL PART

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	O1	VS	K2	AGE (WR) - GROUP MEAN WR	1	L1	O1	VS	K2	REMARKS
2763:148, N VEN 55 5 12 4 1981-08-24 Md:148:22.5-30.0: 24.5	S:122, 82.4 1-34 2-3-4-5-6	12.21 108:1.54	60.73 37:5.91	55.63 104:0.75	12.97 97:0.88	2	24.71 39:0.72	12.52 37:1.20	59.12 8:3.64	55.69 32:0.74	12.97 32:0.93	NEM 52.5%
						3	25.66 44:0.93	12.14 37:1.52	62.71 14:3.89	55.61 36:0.84	13.00 32:0.80	
	A:10, 6.8 1-4 1-2-3	13.85 10:2.73		55.70 10:1.16	13.50 10:0.85	2	25.03 6:1.30	13.17 6:2.48		56.17 6:0.98	13.67 6:0.82	NEM 50.0%
13533:143, TS VEN 55 5 12 4 1984-08-29 Md:169:15.5-31.0: 23.5	S:109, 76.2 Im,23 1-2-3-4-5-7	12.42 106:1.34	63.29 76:4.82	55.71 105:0.77	13.52 105:0.69	2	22.38 46:1.16	12.72 46:1.18	64.02 44:4.58	55.82 45:0.81	13.50 46:0.78	NEM 5.5%
						3	24.55 45:0.95	12.35 44:1.39	63.92 24:3.55	55.64 44:0.78	13.55 42:0.63	
	A:25, 17.5 Im,3-4 1-2-3-4-5	14.97 25:1.52	74.35 23:5.90	56.00 23:0.67	13.67 24:0.82	2	22.81 7:1.50	14.74 7:1.29	74.17 6:6.34	55.83 6:0.75	13.57 7:0.53	NEM 16.0%
3140:120, N VEN 55 5 12 4 1982-10-14 Md:120:24.0-31.5: 26.0	S:97, 80.8 2-34 2-3-4-5	12.22 86:1.77	60.75 73:3.53	55.86 95:0.78	13.83 89:0.71	3	26.28 76:1.04	12.36 68:1.71	60.66 59:3.21	55.87 75:0.76	13.85 71:0.75	NEM 52.6%
	A:14, 11.7 2-45 1-2-3-5-6	13.91 13:1.38	71.91 11:6.25	56.00 14:0.78	13.75 12:0.62	3	27.42 9:2.02	14.10 9:1.16	69.86 7:2.73	56.11 9:0.93	13.71 7:0.76	NEM 64.3%
1090:100, N RÅÅ, S HELSINGBORG 55 5 12 4 1972-03-14 Md:199:26.5-33.5: 29.0;30.5	S:32, 32.0 4-7 3-4-5-6-7-8	12.52 30:1.77	61.35 17:6.16	56.19 32:0.90	14.17 29:1.23	4	28.67 11:0.64	12.55 11:1.34	63.67 6:4.72	56.27 11:0.65	14.40 10:1.58	NEM 93.8%
						5	29.56 13:1.21	12.14 12:1.55	60.57 7:6.40	56.23 13:1.01	14.27 11:0.90	
	A:41, 41.0 7-72 2-3-4-5-6-8	15.09 39:2.01	69.55 29:5.47	56.42 38:0.92	14.30 40:0.79	3	29.40 12:0.66	15.12 12:1.95	72.86 7:4.88	56.18 11:0.75	14.42 12:0.51	NEM 97.6%
						4	30.43 14:0.84	15.48 14:1.64	70.23 13:4.07	56.15 13:0.69	14.14 14:0.77	

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	 O1	 VS	 K2	AGE (WR) - GROUP MEAN WR	 1	 L1	 O1	 VS	 K2	REMARKS
2764:129, N LILLEGRUND 55 3 12 4 1981-09-03 Md:134:25.0-32.5: 27.0	S:90, 69.8 2-34(45) 2-3-4-5--10	12.18 88:1.43	61.50 32:5.22	55.83 86:0.88	13.64 78:0.85	4	27.39 50:1.18	11.81 48:1.40	60.83 24:5.33	55.91 46:0.91	13.78 41:0.82	NEM 43.3%
	A:35, 27.1 4-5 2-3-4-5--8	13.99 34:1.80	69.44 9:5.50	55.74 34:0.75	13.71 34:0.97	2	25.85 13:0.73	14.16 13:1.83	74.00 3	55.42 12:0.67	13.33 12:1.07	NEM 57.1%
3105:113, N KALKGRUND-OSKARS- GRUND SW 55 3 12 5 1982-09-07 Md:132:24.0-31.5: 27.0	S:98, 86.7 2-34(45) 2-3-4-5-6-7	12.29 95:1.73	62.92 61:4.62	55.94 97:0.73	14.04 93:0.81	5	28.05 47:1.26	12.40 45:1.82	62.93 28:5.81	55.89 47:0.73	14.09 44:0.88	NEM 53.1%
	A:11, 9.7 4-45 1-2-3-4-5	14.93 11:1.49	72.90 10:5.32	56.00 11:1.26	13.82 11:0.60							NEM 72.7%
3132:141, N NE LILLEGRUND 55 4 12 5 1982-10-08 Md:141:24.0-30.5 (32.5):26.5	S:133, 94.3 2-45 2-3-4-5-6-9	11.90 131:1.57	60.92 96:4.73	55.77 131:0.84	13.31 123:0.83	3	26.32 92:0.85	11.99 91:1.61	61.20 69:4.20	55.82 90:0.74	13.32 84:0.84	NEM 48.1%
						4	27.03 22:0.99	11.48 22:1.30	60.20 15:6.29	55.45 22:0.67	13.48 21:0.81	
2605:147, N S SKANöR 55 2 12 3 1980-10-23 Md:147:23.5-28.5: 25.5	S:125, 85.0 2-4(45) 2-3-4-6	11.62 110:1.75	59.81 97:5.60	55.82 121:0.85	13.45 118:0.94	2	25.32 33:0.78	12.52 30:1.81	61.12 25:4.81	56.09 33:0.84	13.31 32:0.97	NEM 21.6%
						3	25.84 86:0.84	11.39 74:1.50	59.67 67:5.61	55.71 84:0.82	13.52 80:0.95	
	A:4, 2.7 3-5 2	14.35 4	65.00 2	56.75 4	13.75 4	2	26.77 4	14.35 4	65.00 2	56.75 4	13.75 4	NEM 75.0%
2440:120, N N LILLEGRUND 55 4 12 5 1979-10-30 Md:248:25.0-30.5: 26.5	S:113, 94.2 3-5 2-3-4-5	13.11 111:1.61	65.89 80:3.79	55.88 112:0.87	14.13 108:0.60	2	26.58 32:0.86	14.07 32:1.81	67.84 19:3.52	56.29 31:0.78	14.17 30:0.59	NEM 59.3%
						3	27.49 62:0.96	12.84 61:1.28	65.48 48:3.33	55.77 62:0.82	14.20 60:0.61	
	A:4, 3.3 23,5,72 2-3-5	16.33 4	71.75 4	56.25 4	14.00 3							NEM 75.0%
3336:149, N LILLEGRUND 55 4 12 5 1983-11-08 Md:149:25.0-29.0: 26.5	S:129, 86.6 3-4 2-3-4-5	11.90 122:1.95	61.60 93:4.92	55.04 129:0.95	13.68 127:0.67	3	26.81 42:0.83	11.89 42:1.13	60.84 31:3.78	55.05 42:0.79	13.70 40:0.56	NEM 72.1%
						4	27.36 65:0.94	11.35 60:2.01	60.43 46:4.91	54.86 65:1.00	13.63 65:0.72	

TABLE 3, CONT.

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	T O T A L M E A N L1	O1	VS	K2	A G E (W R) - G R O U P M E A N WR	1	L1	O1	VS	K2	REMARKS
2456:86, N W SKANÖR 55 3 12 3 1979-11-09 Md:143:24.0-31.0: 26.5	S:77, 89.5 3-4 2-3-4-5	12.74 77:1.76	63.04 74:4.43	56.03 75:0.64	13.00 74:0.81	2	26.28 34:1.07	13.07 34:1.88	64.45 33:3.72	56.12 33:0.55	12.97 33:0.77	NEM 90.9%
						3	27.64 32:1.38	13.01 32:1.28	63.13 30:3.68	56.06 31:0.68	13.03 30:0.76	
	A:7, 8.1 2-4,72 3-4-5	13.19 7:1.72	63.50 6:7.26	55.83 6:0.98	12.71 7:0.76							NEM 100%
2805:137, N FLINTRÄNNAN 55 2 12 2 1981-11-10 Md:137:23.5-30.5: 26.0	S:125, 91.2 3-45 2-3-4-5-6-7	12.00 119:1.64	62.26 27:3.82	55.95 122:0.74	13.80 111:0.74	2	25.84 32:1.04	12.73 32:1.36	66.43 7:2.07	56.00 32:0.72	14.13 30:0.78	NEM 92.0%
						3	26.47 40:1.05	11.87 37:1.48	60.37 8:2.88	55.74 39:0.64	13.46 35:0.66	
						4	27.92 42:1.10	11.60 40:1.91	61.08 12:3.42	55.98 41:0.79	13.86 36:0.64	
	A:6, 4.4 4,45,72 2-3-4-7	13.05 6:0.94	68.00 2	56.20 5:0.84	14.20 5:0.84							NEM 100%
3245:156, NB KLAGSHAMN 55 3 12 5 1983-05-03 Md:203:20.5-32.5: 25.0	S:153, 98.1 34-56 1-2-3-4--8	12.13 150:1.86	62.04 103:6.29	55.80 153:0.71	13.50 153:0.84	1	22.08 16:0.81	14.33 16:0.73	68.71 14:2.37	55.81 16:0.75	13.37 16:1.09	NEM 34.6%
						2	24.47 74:1.29	12.31 73:1.47	61.86 56:5.41	55.72 74:0.75	13.43 74:0.78	
						3	26.12 45:1.52	11.12 44:2.03	58.81 27:7.26	55.84 45:0.67	13.58 45:0.87	
2314:144, N LILLEGRUND 55 4 12 5 1979-05-23 Md:210:23.0-29.0: 25.0	S:132, 84.6 3-4(45) 1-2-3-4--8	12.89 130:2.28	63.64 75:5.07	55.86 131:0.74	13.89 105:0.75	1	24.49 45:0.83	14.52 45:2.12	67.42 24:2.95	56.09 45:0.67	13.85 39:0.84	NEM 32.6%
						2	25.56 53:0.82	12.56 53:1.47	62.33 39:4.71	55.91 53:0.77	14.02 44:0.73	
						3	26.05 25:1.02	11.65 24:1.83	61.88 8:3.87	55.48 25:0.65	13.65 17:0.61	
	A:8, 5.6 3,34 1-2-4-5	15.26 8:2.68	70.17 6:1.47	55.50 8:0.76	13.80 5:0.84	1	24.96 5:0.93	15.28 5:3.53	69.67 3	55.40 5:0.55		NEM 37.5%

TABLE 4. THE ARKONA BASIN

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	 O1	 VS	 K2	AGE (WR) - GROUP MEAN WR	 1	 L1	 O1	 VS	 K2	REMARKS
2757-2762:399, T 22'SE-S TRELLE- BORG 55 1 13 1 1981-06-02 Md:2277:10.0-33.5: 13.0	S:310, 77.7 Im,2-3,72 1--13	11.98 296:0.69	61.21 243:1.95	55.67 299:0.29	13.27 189:0.38	2	19.17 90:0.70	11.48 86:1.29	60.16 73:2.87	55.77 86:0.43	13.09 46:0.56	NEM 0.6%, (A 0:1.8, A 1:1.7)
						3	24.27 74:0.84	11.96 68:1.04	60.97 58:3.07	55.68 72:0.49	13.11 64:0.54	
						4	26.34 53:0.85	12.21 52:0.78	63.02 46:2.45	55.84 51:0.44	13.51 51:0.50	
	A:82, 20.6 Im,2-34 1--12	14.80 81:0.74	70.49 71:1.64	55.59 82:0.30	13.41 51:0.38	2	20.78 30:0.47	14.04 29:0.82	69.56 25:1.87	55.53 30:0.32	13.18 22:0.37	NEM.0%
						3	25.23 13:0.83	15.22 13:0.71	70.09 11:1.50	55.92 13:0.51	13.54 13:0.48	
13534:194, TS S TRELLEBORG 55 1 13 1 1984-08-30 Md:396:14.0-29.5: 16.0	S:158, 81.4 Im,2-34 1-2-3-4--7	11.79 153:1.38	61.07 123:4.69	55.66 152:0.89	13.88 135:0.84	2	21.25 30:0.89	12.30 30:1.16	62.21 24:5.42	55.75 28:0.97	13.75 28:0.93	NEM 3.8%
						3	23.43 34:1.20	12.05 33:1.30	61.08 25:4.55	55.72 32:0.77	13.87 30:0.51	
						4	24.48 18:2.15	11.47 18:1.74	60.89 9:5.56	55.50 18:0.86	13.56 16:0.51	
	A:14, 7.2 Im,2-4 2-3-4-5-6	13.74 14:1.48	67.86 7:2.85	56.08 13:0.95	14.18 11:0.98							NEM 14.3%
2599:150, N BLENHEIM 55 2 12 5 1980-09-17 Md:163:22.5-30.0: 25.5	S:73, 48.7 2-34 2-3-4	12.46 69:1.82	62.79 62:4.32	55.74 69:0.74	13.31 65:0.86	3	25.83 52:0.94	12.20 49:1.94	62.26 42:4.11	55.73 48:0.82	13.32 44:0.88	NEM 16.4%
						4	27.19 12:1.07	13.08 11:1.23	63.91 11:5.39	55.58 12:0.51	13.17 12:0.94	
	A:76, 50.7 34-45 2-3-4-5-6-7	14.65 71:1.81	68.56 71:4.71	55.53 70:0.77	13.32 74:0.81	3	26.10 28:0.88	14.65 25:1.21	68.07 28:4.63	55.46 28:0.84	13.29 28:0.81	NEM 5.3%
						4	26.74 16:1.30	14.46 15:2.01	66.75 16:4.86	55.67 15:0.72	13.40 15:0.99	
3129:221, N S GISLÖV 55 1 13 1 1982-09-20 Md:288:21.5-30.5: 24.5 (26.5)	S:7, 3.2 2-56 2-3-4-5-6	12.83 6:2.18	66.50 6:4.93	55.67 6:0.87	13.71 7:1.11							NEM 14.3%
	A:212, 95.9 4-56 2-3-4-5-6-7	14.87 207:1.39	70.57 198:4.16	55.50 212:0.69	13.54 199:0.83	2	24.01 99:1.11	14.83 98:1.26	70.86 94:4.18	55.60 99:0.73	13.56 95:0.82	NEM 14.2%
						3	26.33 63:1.29	15.00 63:1.53	70.50 58:3.89	55.44 63:0.62	13.49 59:0.80	

TABLE 4. CONT.

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	T O T A L M E A N L1	 O1	 VS	 K2	A G E (W R) - G R O U P M E A N WR	 1	 L1	 O1	 VS	 K2	REMARKS
3131:148, T 10'S TRELLEBORG 55 1 13 1 1982-09-23 Md:177:21.0-30.0: (25.5) 27.5	S:125, 84.5 2-4 2--14	10.76 116:2.17	59.69 55:7.93	55.52 125:0.80	13.68 107:0.84	3	25.67 27:1.20	12.39 25:1.01	61.74 19:4.51	55.63 27:0.84	14.12 24:0.61	NEM 6.4%
						4	26.63 14:1.13	12.13 13:2.63	64.00 7:5.45	55.79 14:0.97	13.92 12:1.08	
ASSORTMENT 1 (MAX 10 FISH/KG)						5	27.13 25:1.63	10.65 22:1.92	63.00 7:8.60	55.36 25:0.76	13.48 21:0.98	
	A:23, 15.5 7,72 2--10	14.41 20:2.42	71.38 21:5.38	55.73 22:0.88	14.20 20:0.70	4	27.23 7:0.85	15.48 5:1.30	72.29 7:5.82	55.67 6:1.37	14.29 7:0.76	NEM 4.3%
3164:151, TS 9'W HAMMERODDE 55 1 14 3 1982-09-29 Md:151:10.0-26.0: -	S:122, 80.8 1,3-4 0-1-2-3--8	11.39 97:1.85	59.36 70:6.26	55.66 119:0.87	13.41 106:0.75	2	21.43 26:1.97	11.54 26:1.87	59.43 21:5.47	55.65 26:0.69	13.48 25:0.65	NEM 1.6%
						3	24.44 14:1.22	11.62 14:1.65	62.33 9:3.71	56.00 14:1.04	13.29 14:0.99	
	A:20, 13.3 1-45-72 0--7	15.01 15:1.00	70.92 13:3.62	55.74 19:0.73	13.32 19:0.89							NEM 0%
2804:164, N W KULLAGRUNDET 55 1 13 1 1981-10-02 Md:174:21.5-30.5: (24.0) 26.0	S:15, 9.2 4-56 2-3-4-6	13.89 15:1.55	65.40 5:5.59	55.20 15:0.94	13.40 15:1.12							NEM 0%
	A:143, 87.2 4-56(7) 2-3-4-5--8	15.11 130:1.38	69.86 64:3.86	55.62 140:0.64	13.75 132:0.83	2	24.33 56:1.04	15.07 54:0.99	70.54 24:3.76	55.55 56:0.57	13.70 53:0.77	NEM 12.6%
						3	26.34 39:1.14	15.34 34:1.76	70.94 16:3.62	55.61 38:0.72	13.88 34:0.73	
						4	27.37 22:0.96	14.71 21:1.36	67.77 13:4.66	55.91 22:0.61	13.82 22:0.85	
3130:131, N BLENHEIM 55 2 12 5 1982-10-04 Md:131:23.5-32.0: 26-27	S:112, 85.5 23-45 2-3-4-5-6-7	12.20 104:1.67	62.43 81:4.88	55.83 109:0.86	13.58 100:0.78	3	26.64 62:0.93	12.34 60:1.76	62.40 43:4.47	55.93 61:0.85	13.63 56:0.82	NEM 75.0%
						4	28.32 20:1.32	11.79 16:1.23	61.83 12:4.22	55.50 20:0.95	13.45 20:0.69	
						5	28.51 23:1.30	12.02 21:1.47	62.21 19:5.41	55.82 22:0.79	13.53 17:0.87	
	A:18, 13.7 4,45 2-3-4-5	14.20 18:1.80	70.00 16:4.87	55.83 18:0.51	13.59 17:0.87	3	27.29 10:1.24	14.40 10:1.46	68.56 9:3.21	55.70 10:0.48	13.40 10:0.97	NEM.72.2%

TABLE 4. CONT

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	O1	VS	K2	AGE (WR) - GROUP MEAN WR	1	L1	O1	VS	K2	REMARKS
2817-2820:294, T TRELLEBORG 55 1 13 1 1981-10-15 Md:1370:15.0-30.5: -	S:285, 96.9 1-45 1-2-3-4-5-6	11.54 285:1.04	60.79 122:2.89	55.72 279:0.40	13.69 267:0.35	2	22.31 103:0.67	10.89 103:1.08	60.12 40:2.40	55.84 101:0.40	13.79 97:0.37	NEM 28.4%, (A 0:59.3, A 1 :37.9, A 2: 5.5, A 3:2.6)
						3	25.55 61:0.70	11.96 61:1.27	61.64 11:5.01	55.62 61:0.43	13.59 56:0.44	
ASSORTMENT 0-3	A:9, 3.1 3,7 1-2-3-4-5	14.21 9:1.68	70.56 6: -	55.56 9:0.58	13.87 8:0.58							NEM 55.6%
2802:136, N SW SKARE 55 2 13 0 1981-10-22 Md:136:21.0-30.5: 23.5 (27.0)	S:17, 12.5 23-56 2-3-4-5	12.25 17:2.42	62.57 7:6.19	55.53 15:0.99	13.57 14:0.65	4	26.81 8:1.39	12.71 8:1.97	61.25 4	55.75 8:0.89	13.50 6:0.84	NEM 33.3%
	A:101, 74.3 4-67 2-3-4-5-6-7	14.22 101:2.04	68.45 44:3.63	55.60 93:0.75	13.86 94:0.80	2	23.91 36:1.04	14.48 36:1.26	68.14 14:2.85	55.76 33:0.66	13.66 35:0.76	NEM 23.8%
						3	26.47 29:1.18	14.78 29:1.14	69.27 11:3.26	55.41 27:0.89	14.04 28:0.69	
						4	26.93 24:1.21	13.44 24:2.46	68.00 12:5.08	55.52 21:0.68	13.78 23:0.95	
3337:134, N S SKARE 55 2 13 0 1983-10-29 Md:134:24.5-31.0: 26.5	S:119, 88.8 3-45 2-3-4-5-6	12.29 99:1.74	61.68 84:4.05	55.66 116:0.91	13.78 106:0.70	3	26.59 36:0.90	12.16 34:1.39	61.24 29:3.84	55.47 36:1.08	13.78 27:0.64	NEM 85.7%
						4	28.00 63:1.24	12.15 48:1.87	60.51 41:3.06	55.69 61:0.85	13.74 61:0.70	
	A:7, 5.2 4-72 2-3-4-5	14.23 6:1.69	67.50 6:7.09	55.57 7:0.98	13.60 5:0.89							NEM 85.7%
2466:93, N SKARE 55 2 13 0 1979-11-12 Md:151:24.0-32.0: 26.0	S:83, 89.3 3-4 2-3-4-5-6-7	12.66 82:1.32	62.95 76:4.18	55.82 82:0.86	14.03 70:0.80	2	25.49 22:0.76	13.09 22:1.19	63.79 19:3.41	55.95 21:0.86	14.21 19:0.71	NEM 66.3%
						3	27.31 36:0.97	12.82 36:1.15	63.32 34:3.91	55.75 36:0.81	14.10 31:0.79	
	A:9, 9.7 72 2-3-4	15.47 9:1.16	69.56 9:4.28	56.22 9:0.83	14.00 8:1.07	4	29.82 6:0.74	15.90 6:1.15	69.50 6:5.24	55.83 6:0.41	13.60 5:1.14	NEM 88.9%
3154:166, TS S ABBEKAS 55 1 13 4 1982-11-30 Md:328:13.0-30.5: 23.5	S:158, 95.2 3-45 0-1-2-3--11	11.40 154:1.59	59.92 129:4.82	55.77 150:0.80	13.45 152:0.75	2	22.67 49:1.21	11.53 47:0.96	59.21 43:4.02	55.68 47:0.86	13.41 46:0.72	NEM 19.6%
						3	25.35 74:1.69	11.16 74:1.77	59.95 60:4.74	55.91 70:0.76	13.41 73:0.81	
	A:8, 4.8 1-34,72 1-2-3--15	12.93 8:0.64	72.43 7:5.19	55.37 8:1.19	13.00 6:0.63							NEM 12.5%

TABLE 4, CONT.

SAMPLE DATA	TYPE:n, % GONAD ST AGE(WR)-GR	TOTAL MEAN L1	TOTAL MEAN O1	TOTAL MEAN VS	TOTAL MEAN K2	AGE (WR) - GROUP MEAN WR	1	L1	O1	VS	K2	REMARKS
2896-2898:221, T S TRELLEBORG 55 1 13 1 1982-02-05 Md:799:20.5-32.0: - ASSORTMENT 0-2 (MAX 17 FISH/KG)	S:211, 95.5 34-45 1-2-3-4--9	12.06 209:0.87	60.40 123:2.33	55.76 198:0.47	13.54 192:0.42	2	24.08 92:0.90	11.97 92:0.92	59.42 57:2.49	55.63 41:0.42	13.56 86:0.46	NEM 61.1%, (A 0:82.5, A 1:46.4, A 2:37.7)
						3	25.92 42:0.69	11.90 42:1.05	60.67 21:2.45	55.87 54:0.63	13.50 36:0.51	
						4	28.27 57:0.95	12.13 56:1.06	61.20 35:3.20	55.70 10:0.67	13.54 50:0.60	
	A:9, 4.1 2-45 1-2-3-4	14.41 9:0.99	71.33 9:2.76	55.33 9:0.54	14.00 9:0.27							NEM 55.6 %
2701-2706:484, T W BORNHOLM STRAIT 55 1 14 1 1981-03-05 Md:3755:9.0-29.5: 13.0,18.5	S:405, 83.7 Im,3-56 0-1-2-3--10	11.45 330:0.82	60.28 254:2.41	55.70 383:0.30	13.69 357:0.30	2	22.52 64:0.58	11.63 64:1.24	60.26 50:2.83	55.67 63:0.42	13.62 61:0.44	NEM 9.1%, (A 0:54.5, A 1:3.1)
						3	25.43 96:0.61	11.43 96:0.91	62.15 66:2.37	55.64 90:0.44	13.93 75:0.39	
	A:73, 15.1 Im,2-3 0-1-2-3--8	15.20 34:0.49	70.73 33:1.20	55.55 71:0.33	13.86 69:0.39	2	24.48 12:0.74	15.47 12:0.68	69.91 11:2.50	55.25 12:0.68	14.18 11:0.82	NEM 0%
3220:190, TS S ABBEKÅS 55 1 13 4 1983-03-08 Md:1187:10.0-28.0: 12.5 (16.5)	S:172,90.5 Im,3-45 0-1-2-3-4-9	11.64 116:1.47	60.36 86:5.01	55.59 169:0.76	13.33 152:0.75	2	22.49 31:1.58	11.56 31:1.23	59.29 21:4.78	55.90 31:0.83	13.40 30:0.72	NEM 6.4%
						3	25.34 29:1.24	11.42 29:1.66	60.31 13:5.68	55.72 29:0.84	13.64 28:0.73	
	A:12, 6.3 Im,3 0-1	12.50 2	64.50 1	55.67 12:0.89	13.10 10:0.74							NEM 0%
2385:147, TS S TRELLEBORG 55 1 13 1 1979-03-27 Md:636:10.0-32.5: 13.5, 18.5	S:135, 91.8 Im,3-45 0-1-2-3--9	12.11 110:1.60	62.58 86:5.01	55.77 128:0.85	13.43 114:0.65	2	25.49 33:1.96	13.00 33:1.52	64.77 26:4.51	55.66 32:0.60	13.30 27:0.72	NEM 8.1%
						3	26.78 27:1.92	11.86 27:1.43	63.80 15:3.76	55.84 25:0.85	13.58 24:0.65	
	A:11, 7.5 Im,23,7-72 0-1-2-3	14.91 7:0.93	70.57 7:2.23	55.64 11:0.92	13.80 10:0.79							NEM 0%
2933:162, TS S TRELLEBORG 55 1 13 1 1982-03-29 Md:557:11.0-28.0: (13.0),19.0,22.0	S:145, 89.5 Im,3-45 0-1-2-3-4	11.24 108:1.85	59.09 78:5.84	55.39 143:0.87	13.78 118:0.80	2	22.49 46:1.81	10.93 45:2.07	58.79 28:6.10	55.57 46:0.86	13.83 41:0.80	NEM 3.4%
						3	24.24 19:1.53	11.24 19:1.84	58.36 11:6.22	55.47 19:0.77	13.63 19:0.76	
	A:9, 5.6 Im 0-1-3	11.75 4	69.50 2	55.67 9:1.32	13.63 8:0.92							NEM 0%

TABLE 5 A. YOUNG HERRING: THE KATTEGAT

SAMPLE DATA	TYPE:n, %	1 0	1 1	01	L1	VS(0)	VS(1)	K2(0)	K2(1)	REMARKS
1645:103, TS NW KULLEN 56 1 12 1 1980-02-13 Md:8.5-26.5:13.0	S:58, 56.3	12.97 36:1.47	19.04 14:0.82	59.57 14:4.20		56.06 36:0.75	55.83 12:0.58	14.03 33:0.81	13.64 11:0.92	
	A:26, 25.2	16.14 21:1.66	21.17 3			56.24 21:0.70		14.71 21:1.23		
1648:105, TS ST MIDDELGRUND 56 4 12 1 1980-02-14 Md:10.5-30.0:16.5	S:56, 53.3	14.13 15:1.76	19.90 24:1.04	59.50 18:4.58		56.14 14:0.53	55.74 23:0.54	13.82 11:0.60	13.79 19:0.85	
	A:33, 31.4	16.33 30:1.63	23.17 3	73.33 3		56.18 28:0.86		13.96 27:0.81		
1556:106, TS YTTRE LAHOLMSBUKTEN 56 3 12 3 1979-03-13 Md:14.5-30.0:19.0	S:69, 65.1	15.25 2	20.25 50:2.15	61.05 43:4.28			56.10 50:0.71		14.38 45:0.96	NEM 6.0%(3/50): 1 WR,23-25 CM
	A:13, 12.3	17.00 5:1.17	25.12 8:0.88	76.63 8:5.21		56.60 5:0.55	56.00 8:0.53		14.71 7:0.76	
3410:99, TS S MORUPS BANK 56 5 12 1 1983-11-22 Md:141:11.5-24.5: 12.0, 14-15	S:40, 40.4	12.42 36:0.56	17.50 2			55.24 34:0.96				NEM 50.0%(1/2): 1 WR,18.0 CM
	A:49, 49.5	14.77 49:0.79				55.75 48:0.84				

TABLE 5 B. YOUNG HERRING: THE SOUND

SAMPLE DATA	TYPE:n, %	1 0	1 1	O1	L1	VS(0)	VS(1)	K2(0)	K2(1)	REMARKS
13533:143, TS N VEN 55 5 12 4 1984-08-29 Md:169:15.5-31.0: 23.0-23.5	S:109, 76.2									CF TAB 2
	A:25, 17.5		22.28 10:1.57	77.00 10:4.88	15.48 10:1.56		56.20 10:0.63		13.44 9:0.88	
13536:150, TS N VEN 55 5 12 4 1984-08-29 Md:150:19.0-31.5	S:102, 68.0		17.20 14:0.73	62.69 13:5.31	11.85 14:1.30		55.15 13:1.07		13.08 13:1.04	SELECTED SAMPLE (10 FISH/CM-GROUP), CF 13533
	A:33, 22.0		19.15 11:1.49	69.36 11:5.97	13.49 11:1.70		56.18 11:0.75		13.00 11:0.77	
3152:118, TS LUNDÅKRABUKTEN 55 4 12 5 1982-09-23 Md:610:8.5-25.5: 10.0	S:112, 94.9	10.55 92:0.84	16.24 15:2.87	58.62 13:7.39	10.55 15:2.20	55.26 89:0.85	55.67 15:0.62			
	A:4, 3.4	14.13 4								
3139:127, TS LOMMABUKTEN 55 4 12 5 1982-09-23 Md:554:9.0-25.0: 10.5,17.0-17.5	S:114, 89.8	10.92 55:0.82	17.42 52:0.92	58.68 47:5.41	10.88 51:1.50	55.52 54:0.72	55.65 52:0.81	13.37 8:0.52	13.61 38:0.72	
	A:8, 6.3	13.32 6:0.67	19.75 2	75.50 2	14.45 2	56.33 6:0.52				
3409:143, TS LUNDÅKRABUKTEN 55 4 12 5 1983-11-18 Md:918:10.0-19.0: 12.0,15.0	S:61, 42.7	12.37 50:0.78	17.12 10:1.06	57.30 10:5.72	10.77 10:1.54	55.56 48:0.80	54.70 10:1.76			
	A:73, 51.1	15.18 71:1.01	17.75 2	56.00 2		55.48 67:1.02				
3155:114, TS W HÖGANÄS 56 1 12 2 1982-12-02 Md:888:9.0-27.5: 10.5	S:97, 85.1	11.48 87:1.00	15.91 9:3.32	56.57 7:8.04	10.76 8:2.45	55.66 86:0.66	55.89 9:0.60	13.39 33:0.66	13.60 5:0.55	
	A:13, 11.4	15.05 12:0.98				56.33 12:0.49		13.50 8:0.76		
3226:151, TS LUNDÅKRABUKTEN 55 4 12 5 1983-03-24 Md:1025:10.0-28.5: 13.0,18.5	S:112, 74.2	12.85 51:1.25	19.31 36:1.45	63.00 34:4.82	12.23 36:1.42	55.65 49:0.83	55.74 34:0.75	13.21 43:0.71	13.19 32:0.64	
	A:33, 21.9	15.53 33:1.40				56.45 33:0.79		13.31 29:0.85		NEM 3.0% (1/33):0 WR, 15.2 CM.

TABLE 5 B, CONT.

SAMPLE DATA	TYPE:n, %	1 0	1 1	01	L1	VS(0)	VS(1)	K2(0)	K2(1)	REMARKS
3227:188, TS N VEN 55 5 12 4 1983-03-24 Md:443:10.0-33.5: 11.0	S:164, 87.2	12.11 52:1.21	20.14 41:1.52	63.38 37:5.00	12.84 40:1.58	55.37 51:1.06	55.80 41:0.75	13.03 32:0.74	13.74 39:0.64	
	A:21, 11.2	15.60 13:1.38	23.78 6:2.96	77.20 5:6.94	16.25 6:2.50	56.58 12:0.51	56.67 6:0.52	13.08 12:0.90	14.00 5:0.71	NEM 10.5% (2/19):0 WR, 16.1 CM, 1 WR, 21.3 CM
3228:133, TS W HöGANÄS 56 1 12 2 1983-03-24 Md:684:8.5-27.0: 11.0	S:93, 69.9	12.48 42:1.47	19.64 23:1.35	61.30 23:5.76	12.19 23:1.51	55.67 42:0.85	55.70 23:0.76	13.39 31:0.62	13.48 23:0.85	
	A:34, 25.6	16.29 34:1.79				56.39 33:1.00		13.27 33:0.67		

TABLE 5 C. YOUNG HERRING: THE ARKONA BASIN
(Underlined sample numbers indicate samples represented also in tab 4)

SAMPLE DATA	TYPE:n, %	1 0	1 1	01	L1	VS(0)	VS(1)	K2(0)	K2(1)	REMARKS
<u>2757-2762</u>:399, T 22'SE-S TRELLEBORG 55 1 13 1 1981-06-02 Md:2277:10.0-33.5: 13.0,16.5	S:310, 77.7		13.56 64:0.85	61.04 50:4.19	12.62 64:0.86		55.34 61:0.53			
	A:82, 20.6		16.16 23:0.53	71.40 20:2.96	15.18 23:0.59		55.57 23:0.34			
<u>13534</u>:194, TS S TRELLEBORG 55 1 13 1 1984-08-30 Md:396:14.0-29.5: 16.0	S:158, 81.4		16.52 69:0.98	60.70 63:4.35	11.74 67:0.97		55.61 67:0.95		14.07 54:1.01	
	A:14, 7.2									CF TAB 4
13535:175, TS S TRELLEBORG 55 1 13 1 1984-08-30 Md:175:13.0-31.0	S:114, 65.1		15.91 36:1.26	59.19 21:4.45	10.95 34:1.52		55.41 34:0.70		13.60 30:0.93	SELECTED SAMPLE, (10 FISH/CM-GROUP), CF 13534
	A:34, 19.4		17.30 8:1.89	64.43 7:8.70	13.31 7:1.68		56.00 8:0.76		14.33 6:0.52	
3364:110, TS 26'S TRELLEBORG 54 5 13 2 1983-09-29 Md:610:8.0-24.0: 10.5,17.0	S:91, 82.7	10.41 50:0.94	16.90 35:1.01	59.73 26:4.85	11.27 35:0.96	55.26 50:0.85	55.46 35:0.85			
	A:13, 11.8	13.08 9:0.55	18.60 4	69.75 4	13.57 4	54.89 9:0.60	55.75 4			
2886:102, TS S TRELLEBORG 55 1 13 1 1981-11-10 Md:181:10.0-19.0: 11.0,17.5	S:85, 83.3	11.88 55:1.02	17.35 29:1.57	57.64 14:4.97	10.74 29:1.25	54.89(?) 53:0.72	55.08(?) 26:0.80	13.05 40:0.64	13.50 26:0.65	(?)=POSSIBLY MISCALCU- LATION
	A:3, 2.9	14.35 2								
<u>2701-2706</u>:484, T W BORNHOLM STRAIT 55 1 14 1 1981-03-05 Md:3755:9.0-29.5: 13.0,18.5	S:405, 83.7	12.92 70:0.97	18.75 128:0.69	58.85 116:3.50	11.32 126:1.04	55.60 65:0.66	55.80 122:0.36	13.30 60:0.52	13.70 124:0.36	
	A:73, 15.08	15.29 37:0.50	21.04 13:0.51	70.92 13:1.69	14.65 13:0.82	55.61 36:0.46	55.77 13:0.50	13.72 36:0.56	13.77 13:0.73	
<u>3220</u>:190, TS S ABBEKÅS 55 1 13 4 1983-03-08 Md:1187:10.0-28.0: 12.5 (16.5)	S:172, 90.5	12.72 56:1.14	18.70 53:1.38	60.88 51:4.99	11.85 53:1.42	55.39 54:0.71	55.54 52:0.67	13.02 43:0.80	13.33 48:0.63	
	A:12, 6.3	15.53 10:0.83	19.80 2	64.50 2		55.80 10:0.79		12.87 8:0.64		

TABLE 5 C, CONT.

SAMPLE DATA	TYPE:n, %	1 0	1 1	O1	L1	VS(0)	VS(1)	K2(0)	K2(1)	REMARKS
3225:70, TS S SANDHAMMAREN 55 1 14 0 1983-03-23 Md:281:10.0-30.0: 12.0	S:66, 94.3	12.37 57:0.95	18.44 8:1.06	60.12 8:4.61	11.57 8:0.98	55.73 56:0.82	55.57 7:0.53	13.19 42:0.86	13.87 8:0.64	
	A:3, 4.3	14.53 3								
2385:147, TS S TRELLEBORG 55 1 13 1 1979-03-27 Md:489:10.0-32.5: 13.5, 18.5	S:135, 91.8	13.09 24:1.30	18.89 46:1.34	60.80 44:5.12	11.74 45:1.21	55.67 21:0.91	55.84 45:1.00	13.41 22:0.59	13.50 36:0.61	
	A:11, 7.5	14.15 4	21.85 4	71.50 4	15.07 4					
2933:162, TS S TRELLEBORG 55 1 13 1 1982-03-29 Md:557:11.0-28.0: (13.0),19.0,22.0	S:145, 89.5	12.64 36:0.86	18.66 36:1.17	59.26 34:5.88	11.71 36:1.44	55.12 34:0.88	55.36 36:0.96	13.54 24:0.98	13.89 27:0.64	
	A:9, 5.6	14.52 5:1.77	20.85 2		14.35 2	55.60 5:1.67		13.50 4		
2529-2534:453, T SE TRELLEBORG 55 1 13 2 1980-03-31 Md:2942:11.0-32.5: 13.0,(17.5),19.0	S:394, 87.0	13.54 33:0.72	18.40 125:1.07	59.39 95:3.30	11.39 125:1.23	55.53 32:0.56	55.67 123:0.51	12.74 31:0.66	13.37 109:0.47	
	A:41, 9.1	15.09 14:0.65	20.72 13:0.71	69.00 12:1.59	14.31 13:0.90	55.64 14:0.47	55.83 12:0.56	13.14 14:0.63	13.75 12:0.95	
2734-2739:449, T 10'SE YSTAD 55 1 13 4 1981-05-07 Md:3538:9.0-30.5: 14.0,17.0	S:320, 71.3	13.42 75:0.95	18.49 108:0.69	58.11 88:3.42	11.03 108:1.21	55.24 75:0.58	55.67 105:0.46	12.88 33:0.51	13.36 74:0.38	
	A:115, 25.6	15.93 18:0.51	21.49 22:0.46	70.63 19:1.81	14.53 22:0.56	55.29 17:0.35	55.64 22:0.38	13.23 13:0.65	13.29 21:0.50	

TABLE 6. The number of herring samples infested by nematodes of *Anisakis* type (investigated number in parenthesis) and approximate infestation percentage of the individual samples, per month (cf. the text). A grand total of 187 samples have been examined from three areas of the southern Baltic in 1971-84.

	Arkona Basin		W Hanö Bay		E Hanö Bay	
January	1(1)	62 %	- -	-	2(8)	9-10 %
February	2(2)	57-66 %	2(2)	4-10 %	2(3)	1-24 %
March	15(17)	4-66 %	2(3)	11-20 %	5(9)	2-11 %
April	5(5)	10-23 %	7(8)	3-21 %	3(11)	1- 3 %
May	4(7)	0-12 %	6(9)	1-13 %	4(15)	1- 9 %
June	4(5)	1- 7 %	-(1)	-	-(3)	-
July	- -	-	-(1)	-	1(1)	1 %
August	1(2)	10 %	3(7)	1- 3 %	-(4)	-
September	6(7)	2-16 %	1(5)	1 %	1(7)	2 %
October	9(9)	3-92 %	2(4)	1- 8 %	1(5)	9 %
November	7(7)	5-73 %	4(4)	9-47 %	3(6)	1- 2 %
December	5(5)	23-43 %	2(2)	11-37 %	-2(2)	2- 5 %
Total	59(67)		29(46)		24(74)	

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