THE AGEING VALIDATION OF THE LUMPSUCKER (*Cyclopterus lumpus*)
AND THE AGE COMPOSITION OF THE LUMPSUCKER IN ICELANDIC LUMP-
SUCKER FISHERIES

by

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ABSTRACT

The importance of making an ageing validation for the lumpsucker (*Cyclopterus lumpus*) is stressed. Problems in ageing and population studies of the lumpsucker are discussed. The routine method of ageing lumpsucker is described and evidence for its appliances is provided from microphotography and long term studies of a lumpsucker population.

EXTRAIT

L’importance de vérifier la determination d’âge de lompe est expliqué. Les problems de détermination d’âge et des études de populations de lompe sont discuté. Le méthod de routine pour la determination d’âge est décrite et des preuves de microphotographie et des études de long durée sur une population de lompe sont présentée.
INTRODUCTION

The lumpsucker (Cyclopterus lumpus) belongs to the family Cyclopteridae and is the only species of the genus cyclopterus. It has a distribution over the North Atlantic being most common in the oceans between Canada, Iceland, Greenland and Norway. The lumpsucker spawns in the sublittoral zone on rocky substrate where the male guards the eggmasses until the fry hatch. The fry spend about a year in the littoral zone switching over to pelagic living in their second year of life. During most of its lifespan C. lumpus has an epipelagic way of existence in oceanic regions returning to the shore only to spawn.

The lumpsucker has gained considerable importance as a commercial fish species in the North Atlantic, because of the roe that is used as caviar substitute.

In Iceland the lumpsucker has been caught for domestic uses for centuries but the export of lumpsucker roe started on a small scale 1945.

In 1976 the export was about 22000 barrels of salted roe, but the average catch 1971-1980 was c.a. 15000 barrels. Iceland holds about 70% of world sales in this product at present and this fishery is of considerable importance for many Icelandic fishermen.

Since it is only the roe that is utilized, the fishing effort is almost entirely directed towards mature females on the spawning grounds and they are caught there with gillnets.

The Icelandic government issued a regulation on this fishery 1976, limiting fishing time, boat size, mesh size in the lump-sucker gillnets and number of nets per boat.

Lumpsucker fishermen must apply for a licence every year and send in a catch report after the fishing season ends.

In Iceland the main spawning season differs a little from one coastal region to another with peaks generally occurring in April-May.

By regulation the shallow water fisheries of lumpsucker are divided into 6 regions, the fishing periods being 3 months in each, but starting at different dates.

The age structure and population dynamics of the lumpsucker
has been worked on in Iceland since 1971 (dr. Sigfús Schopka 1971-1973 and the author of this article 1974-1981). Outside Iceland the ageing of the lumpsucker has been worked on for example: in Norway (Mirseth 1970), Denmark (Bagge 1967) and Canada (Cox 1922).

Those that have worked on this species do not all agree on the age structure of the lumpsucker populations. Sæmundsson (1926), considers the lumpsucker to be at least 5-6 years old at maturity and mentions that scientists in Canada have come to similar conclusions. (Probably Cox 1922).

Schopka (1974), considers the age at maturity to be 3-4 years and that very small proportion of the stock spawns more than once. In Denmark Ole Bagge (1964 and 1967), describes the age composition of the C. lumpus in the North sea and the Baltic sea such that spawning North sea fish include the age groups IV-IX, dominated by the age groups V and VI and that only males are represented in age group IV and that the males still are dominating in the age group V.

Age verification for C. lumpus is obviously necessary. In this article an attempt is made to validate a certain method of ageing that has been used by the author since 1975 for lump-sucker in commercial catches in Icelandic waters.

The age structure in a lumpsucker stock is described by taking the age structure in commercial catches of a certain area, namely Skjálfandaflói in Northern Iceland, as an example.

As the main aim of this article is to describe and validate an ageing method, estimates of population size will not be set forward at present, but problems that concern ageing and population studies of lumpsucker will be discussed.

In this article only females are taken as examples, except in fig. 19, where the length frequency distribution of both sexes are given.

PROBLEMS CONCERNING THE AGEING AND THE POPULATION STUDIES OF THE LUMPSUCKER

The otoliths (sagitta) are the only bone structures that can be used for large scale age determination on lumpsucker stocks. Annuli are also formed in, for example, the vertebral
centra but they are more difficult to interpret and their preparation is time consuming.

The otoliths of the C. lumpus are very small compared to those of the gadoid fishes and this has made ageing rather difficult and contributed to the confusion that has been around this matter. The length of a lumpsucker otolith is about 0.30-0.50 mm in the first year and the largest otoliths of mature fish hardly ever reach 2.0 mm in length, whereas the otoliths of f. ex. cod are about 10 x larger. The reason for this is probably reduction of bony structures due to adaptation to pelagic environment without the buoyancy of a swimbladder.

This species shows considerable degree of sex dimorphism as the male is very much smaller than the female at the same age. As this difference is well established at maturity it is obvious that it starts at young stages and that different growth curves have to be constructed for each sex. The sexes differ also in migratory patterns and behaviour which may cause a different natural mortality.

At present only the roe is of considerable commercial value and the lumpsucker fishery is almost entirely directed towards the female fish on the spawning grounds. There is rather little bycatch of male lumpsuckers, when the female lumpsuckers are caught, as the mesh sizes in gillnets suitable for fishing the females ranges between 10 1/2" - 11 1/2" but for the male it is 6 3/4" - 7 1/2". Fishing mortality is therefore very different for each sex and generally, in working of data, they have to be treated separately. Obtaining individuals of the age classes 2, 3 and 4 for this research has been very difficult, as these live epipelagically far off the coast, and this has delayed the ageing validation work a great deal.

It is evident from results of tagging experiments (Schopka 1974, Bagge, 1965, authors unpublished results) that the lump-sucker homes for certain spawning grounds where it has spawned before. A question therefore arises concerning the existence of local subpopulations.

Estimates of the effects of fishing could be biased by the fact that this fishery is very unevenly distributed. Some remote areas have hardly any or no fishing intensity but others that are more accessible by small boats may have very high
fishing intensity.

MATERIALS AND METHODS

In "The ageing of Fish" 1973, J. Williams and B.C. Bedford state that if otoliths are to be used for age determination it is necessary to establish that:

1) a recognizable pattern can be seen in the otolith either by viewing it directly by ordinary light, or after some method of preparation, e.g. burning or staining.

2) a regular time scale can be allocated to the visible pattern.

To describe this ageing method, photographs are produced of otoliths and of acetate replicas of otoliths, to show ring structures. For allocation of time scale the observation of a stock over a number of years has given the best results in detecting strong year classes as modes in length frequency curves.

As said before data from age classes 2-4 is rather scarce but one has tried to adjust the points to Von Bertalanffy curve and the relatively few measures. The mean length of the formation of the first winter ring is well manifested by sampling of young lumpsuckers during the first winter.

Length frequency curves are treated by the deviation from mean method (Sund, 1930, Skúladóttir, 1979) and the results compared with the results from the described ageing method.

Collection of material

Organized data collection from the lump sucker catches in Icelandic waters started 1970 (Sigfús Schopka). Collection of material for this research was resumed by the author of this article in 1975 but the present system of measuring, collecting otoliths, and obtaining information on catch/effort from the various regions started in 1976.

Otoliths from mature specimens along with measurements are obtained from lumpsuckers caught by lumpsuckers gillnets on spawning grounds during the spawning season and from trawl during other seasons. Otoliths from immature lumpsuckers were collected from fish caught by trawl, pelagic trawl, and 0-1
groups were collected from seaweed, by diving and from floating objects. In some cases centra from the vertebrae were also collected.

The routine procedure for ageing lumpsucker
The method as it is now, is to clean the sagitta of the otoliths and dehydrate in alcohol and as the alcohol has evaporated, they are immersed in suitable oil, e.g. almond oil for a few days and then read immersed in oil in a black cup under stereomicroscope using 30-50 x magnification.

Lumpsuckers otoliths have also been read in water (which author finds not suitable), alcohol (fair but evaporates too quickly) and glycerol (not as good as almond oil or immersion oil). The best way to keep otoliths for a long period of time is in 95% alcohol.

Measurements of year rings
For back calculations of year rings the measurements of radii in whole otoliths, were \( r_n \) is the distance from the center of nucleus to the edge of each successive winter zone, was done by a measuring eyepiece in a stereomicroscope calibrated with stage micrometer, magnification generally being about 50 x and the accuracy about 0.01 mm.

The way these radii were measured is shown in fig. 11 as the irregularity of the otoliths make it necessary to measure these in a certain way all the time.

Acetate replicas of otoliths
The otoliths were mounted on a glass-slide or other suitable objects with epoxy glue. Grinding was done with Arkansas stone observed under stereomicroscope. The grinded otoliths were edged in 0.1 M HCl for 2-7 minutes depending on the size of the otolith.

The cellulose acetate film was made by dissolving filters of cellulose acetate in acetone which was left in a petridish for the acetone to evaporate. The thickness of the acetate films was 0.07-0.08. A drop of acetone was put on a grinded and edged otolith and then a small piece of acetate film was
put on top of it. When dry the film was plucked from the otolith, put on a glass-slide and held in place with a coverslip and cellotape.

The acetate replicas were examined microscopically under a phase contrast microscope and photographed by Leica or Pentax cameras with adapters. One disadvantage that follows the use of phase contrast microscopy becomes apparent, that is how the edges of some of the subjects become blurred.

When possible photographs were also taken of the grinded otoliths to see if the edges revealed any structures. Some photographs were taken through stereomicroscope of otoliths immersed in oil both whole and grinded (and of vertebrae from different year classes, although not discussed in this paper).

RESULTS

Microphotography

Pictures no 1-9 were taken by phase contrast microscope and no 10 by a stereomicroscope. These show otoliths or acetate replicas of otoliths from different age groups of lump-suckers.

The otoliths no 1-9 are all on the same scale and demonstrate the difference in size and number of ring structures. Pictures 1-3 are all from the same individual, 1.1 cm long 0-group fish caught in Nov. 1980. No 1 a whole otolith (sagitta) immersed in oil, no 2 the other sagitta grinded to the centrum in epoxy resin, and no 3 the acetate replica of the grinded otolith.

Otolith no 4 and the acetate replica on no 5 are from a 3.0 cm long male lump-sucker caught 1.7. '80. It has a distinct winter zone and some second year summer growth.

The 0 group and I group are readily distinguished at this time of the year by size and appearance as the 0 group is brown and tadpole like, but the other is taking on the form of their parents.

In these photographs it can be seen that the summer and winter zones are formed by concentric shells or circles that
are wider during summer and narrower and more contrasting in winter. The winter zones are characterized by the several narrow and contrasting ring structures in succession.

As the lumpsucker is at least through long periods of its life adapted to the sublittoral environment where the tidal influence is great, one is tempted to associate these ring structures with the lunar month periods but this needs further investigation.

In fig. 6 two winter zones can be seen. This is an acetate replica of an otolith from a 10.4 cm female caught 20.11. '80 so the third winter zone should be forming at the edge but it could be blurred by the phase contrast effect.

No 7 is an acetate replica of an otolith from an immature 22 cm long female caught in a pelagic trawl in August 1980. Here 3 winter zones can be seen but the 1st winter zone might be read as two with very little summer growth. Fig. 8 shows an acetate replica of an immature female 30 cm long caught in February 1981. This individual shows a large summer growth in its forth year and a winter zone at the edge.

No 9 is from a mature female 41 cm long caught on the spawning grounds 7.7. '80 and could have spawned more than once. In this otolith there is an interesting breaking up and recon- struction of pattern between winter zones 5. and 6. which could be due to reabsorption of otolith. The first spawning could have happened after the 5th winter and this individual would then be spawning for the third time.

No 10 is an otolith, immersed in oil, of a 32 cm immature female caught 27.5. '78 north off Iceland showing its appearance through stereo microscope. This individual was aged as 4 years old.

Measurements of otoliths, year-rings and meanlength of different age classes

The drawing on fig. 11 shows how the distance from center to each successive year ring (or the radii) are measured.

To illustrate the sequence of annual ring formation in the lumpsucker otoliths two graphs are formed, fig. 12 and 13. On the first r₁-r₈ are plotted against each year of age and the second r₁ and r₅-r₈ are plotted against the mean length of each year class at the formation of each winter ring and a straight
line drawn through these points being dotted where the means are uncertain.

These age groups are selected because their mean length at the formation of certain winter rings can be closely approximated by sampling. It has been very difficult to obtain the age classes 2-4 at wintertime to determine the mean length of each age group.

The means from age groups 1 and 5-9 show the lengths at the formation of winter-rings, but the means for age groups 2-4 are from individuals caught in late August so their summer-growth may not all be finished, although the mean size of the otoliths is very close to the average total radius length for each year class as measured from grown individuals. They are also too few in numbers to draw any conclusions from them. For estimation of the mean lengths of age classes 1-4 much more data has to be collected from immature fish.

An attempt is made to find the approximate length at age 2-4 by fitting the known age lengths to the von Bertalanffy curve - Beverton's method, graph on fig. 14. The results are shown in table 1 and are used to plot length at age against age in a graph on fig. 15.

A method of back calculations from radii and lengths hasn't, as of now, been useful for the lumpsucker otoliths.

Results from ageing compared to length frequency distribution treated by deviation from mean method

The results from ageing female lumpsuckers, from commercial catches in Skjálfandaflói in North of Iceland 1976-1979, is shown in fig. 16.

The mean length of each age class in these samples is shown in Table 2.

The selection of the fishing gear (the gill nets) does influence the main lengths for age classes especially age class 5 as it is 1-2 cm larger than length frequency curves indicate where no selection is offered.

Length frequency distribution from the same data is treated with the deviation from mean method fig. 17
West and North of Iceland when migrating to the spawning grounds during March-April 1976-1978 are also treated with those method fig. 18.

These three graphs do all show that 1976 a comparatively large year class is recruited to the spawning stock at the North coast as five years old (by the ageing theory described) and can be detected in commercial catches for next three years at least. As the small mesh sizes in the trawl does not select within the spawning stock, the mean length of the 5 years old recruits in 1976 should be closer to 37 cm than 38 or 39 cm and the mean length of 6 years olds in 1977 should be close to 40 cm but this could vary between years.

Results from tagging experiments in Iceland

Dr. S. Schopka started tagging experiments on lumpsuckers in 1971 and reported on the results (Schopka 1974).

Of the 6665 lumpsuckers tagged and released in this period 680 lumpsuckers had been recaptured in August 1. 1974 or 10.2%, but returns after one year at liberty were only 0.2%-0.9%.

Tagging experiments carried out 1975-1979 by author (unpublished results) gave very similar results.

The fact that recaptures after a year or more at liberty are very scarce has been used by some authors as evidence for a short lifespan and that very small portion of the population returned to spawning grounds for a second or third spawning. This does not agree with the fact that modes in the length frequency curves show big age classes with rather little average growth between years.

Although tagging experiments have shown very important facts about migration and homing to same spawning ground where they have spawned at in previous year (Schopka 1971 and 1974, Bagge 1964 and 1967 and unpublished results from author's tagging experiments) the returns after one year or more at liberty are too few relatively for use in population dynamics. The most likely reason for such few returns after one year or more at liberty are:

1) shedding which is supported by
   a) numerous findings of loose tags both on shore and in nets
b) findings of fish with a hole through the first dorsal fin (the crest)
c) fish that have been caught after a year of liberty and observed by author show a distinct lesion around the thread that holds the tag.

2) Tagging mortality:
It has been shown (Schopka 1974 and Bagge 1967) that direct mortality from tagging is very little or negligible. There is though a possibility of indirect or delayed mortality caused by tagging as the lesion around the thread seems to increase with time.

The information that follows returned tags is often quite unreliable especially measurements as may be expected when unskilled persons do them without directions.

It is virtually impossible that fish caught in trawl in late winter on its way to the spawning grounds will grow at all from the time it is tagged until it is caught again after a few days or weeks but there is frequently a change in length of -10 to +10 cm. So in Table no 3, I have only used the information from returns after one year at liberty and where investigations and measurements have been done by trained persons. These returns are too few at present to make any conclusions from, and it is important to find a suitable tagging method for lumpsucker.

CONCLUSIONS

Although it is difficult to prove this theory for some immature age groups the mean length at the formation of first winter ring is easily demonstrated and it is clear that in the spawning stock, strong age classes can be seen from length frequency curves that coincide with the results of the ageing method described.

It can therefore be concluded that this ageing method is at least valid for determination of the age structure within the spawning stock.

Although there are only age groups 5-10 in fig. 16 there are individuals up to 12 years of age found in samples from
the commercial fishery and some spawn at the age of 4, although very few (less than 1%).

The theory that the female lumpsucker is recruited to the spawning stock at the age of 3, does not fit in with the Beralanffy growth curve fig. 14. But the theory that the lumpsucker is recruited at age 5 does fit this curve and evidence from microphotography favours this theory also.

ACKNOWLEDGEMENTS

I am greatly indebted to several members of the staff of the Marine Research Institute who gave me invaluable help and encouragement during the preparation of this paper.
REFERENCES


Table 1.

Mean lengths for age groups 1-9 as found in samples, mean length adjusted by fitting the Bertalanffy curve, mean radii for different year rings as found in samples of each age group and the number of fish from which the above mean lengths are derived.

<table>
<thead>
<tr>
<th>Age</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean length</td>
<td>2.0</td>
<td>3.0</td>
<td>9.0</td>
<td>30.0</td>
<td>39.0</td>
<td>40.9</td>
<td>43.0</td>
<td>44.7</td>
<td>45.5</td>
</tr>
<tr>
<td>Adjusted mean length</td>
<td>2.0</td>
<td>13.0</td>
<td>20.0</td>
<td>31.0</td>
<td>37.0</td>
<td>41.0</td>
<td>44.0</td>
<td>45.0</td>
<td>46.0</td>
</tr>
<tr>
<td>( r_n ) in samples</td>
<td>0.19</td>
<td>0.31</td>
<td>0.39</td>
<td>0.50</td>
<td>0.58</td>
<td>0.62</td>
<td>0.67</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>No of fish</td>
<td>60</td>
<td>24</td>
<td>12</td>
<td>4</td>
<td>414</td>
<td>492</td>
<td>294</td>
<td>88</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 2.

Mean lengths of age classes 5-12 spawning in Skjálfandaflóa 1976-1979 and number of females measured or aged in the area.

<table>
<thead>
<tr>
<th>Age</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Number aged</th>
<th>Number measured</th>
</tr>
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<tr>
<td>1976</td>
<td>38.5</td>
<td>39.5</td>
<td>42.4</td>
<td>43.2</td>
<td>46.4</td>
<td>45.0</td>
<td>51.0</td>
<td>52.0</td>
<td>143</td>
<td>200</td>
</tr>
<tr>
<td>1977</td>
<td>38.0</td>
<td>39.7</td>
<td>42.0</td>
<td>43.5</td>
<td>43.3</td>
<td>44.7</td>
<td>50.0</td>
<td></td>
<td>253</td>
<td>263</td>
</tr>
<tr>
<td>1978</td>
<td>37.8</td>
<td>39.9</td>
<td>42.3</td>
<td>44.3</td>
<td>45.0</td>
<td>46.6</td>
<td>43.6</td>
<td></td>
<td>621</td>
<td>150</td>
</tr>
<tr>
<td>1979</td>
<td>38.3</td>
<td>40.2</td>
<td>42.7</td>
<td>44.2</td>
<td>46.0</td>
<td>46.4</td>
<td>48.4</td>
<td></td>
<td>278</td>
<td>1088</td>
</tr>
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Table 3.

Some recaptures after 1 year of freedom. Both tagging and recapturing in Skjálfandaflói.

<table>
<thead>
<tr>
<th>Date of release</th>
<th>Date of recapture</th>
<th>Length of release</th>
<th>Length of recapture</th>
<th>Growth in cm</th>
<th>Sex</th>
<th>Age at recapture</th>
<th>No. of tagging</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/5/76</td>
<td>19/4/77</td>
<td>28</td>
<td>30</td>
<td>2</td>
<td>♂</td>
<td>7</td>
<td>IE6972</td>
</tr>
<tr>
<td>22/6/77</td>
<td>13/4/78</td>
<td>28</td>
<td>31</td>
<td>3</td>
<td>♂</td>
<td>8</td>
<td>IP 1</td>
</tr>
<tr>
<td>11/6/77</td>
<td>5/5/78</td>
<td>39</td>
<td>40</td>
<td>1</td>
<td>♀</td>
<td>7</td>
<td>IE 9679</td>
</tr>
<tr>
<td>24/5/77</td>
<td>28/4/78</td>
<td>35</td>
<td>35</td>
<td>0</td>
<td>♀</td>
<td>6</td>
<td>IE 9453</td>
</tr>
<tr>
<td>28/6/77</td>
<td>30/5/78</td>
<td>42</td>
<td>44</td>
<td>2</td>
<td>♀</td>
<td>8</td>
<td>IE 9742</td>
</tr>
<tr>
<td>2/6/78</td>
<td>30/5/79</td>
<td>34</td>
<td>40</td>
<td>6</td>
<td>♀</td>
<td>6</td>
<td>IP 417</td>
</tr>
</tbody>
</table>
Fig. 1-3. Otoliths from a young lumpsucker age group 0, length 1.1 cm, unsexed, caught 26. Oct. 1980. No. 1 whole otolith immersed in oil, No. 2, otolith in epoxy resin grinded to its center and edged in HCl. no 3 acetate replica of no 2. 113 x enlargement phase contrast.

Fig. 4-5. An otolith (no 4) and its acetate replica (no 5) from a young lumpsucker, age group 1. Length 3.0 cm, male, caught 1/7/80. 113 x enlargement phase contrast.

Fig. 6. Acetate replica, of an otolith from an immature lumpsucker, length 10.4 cm female, age group 2 (+summer growth). Caught in a pelagic trawl 20/11/81. 113 x enlargement phase contrast.

Fig. 7. An acetate replica of an otolith from an immature female lumpsucker. Length 22 cm, age group 3, caught 15/8/80 (pelagic trawl). 113 x enlargement phase contrast.
Fig. 8. An acetate replica of an otolith from an immature female lumpsucker. Length 30 cm, age group 4, caught 13/2/81 (pelagic trawl). 113 x enlargement phase contrast.

Fig. 9. An acetate replica of an otolith from a mature female on spawning ground. Length 41 cm, age group 7. Caught in gillnets 7/7/80. 113 x enlargement phase contrast.

Fig. 10. Is taken by a stereomicroscope, otolith immersed in oil, from an immature female, length 32 cm, age group 4. Caught in gillnets 27/5/78. (On different scale from the other pictures). 39 x enlargement.

Fig. 11. A drawing showing how the year rings are measured.
Fig. 12. The distance (or radius) from center to successive year-rings plotted against age. The data is from measurements of year-rings in 80 otoliths from 1-8 year old fish. (Table no 1).
Fig. 13. $r_1 - r_8$ plotted against length of each age group 1-8 (Table 1). The straight line is drawn between the points for age 1 and 5-8, as there are hardly enough data to decide the lengths for age groups 2, 3 and 4 (in parentheses).
Fig. 14. $n(L - l_+)$ plotted against age. The L asymptotic length is found by plotting $l_{t+1}$ against $l_t$ for the age groups 5-9 in a Walford graph. Only the points for $l_1$ and $l_5 - l_8$ were used to make the straight line.

As in the graph on fig. 13 the points for $l_2$, $l_3$ and $l_4$ are in parentheses because of insufficient length measures in these age groups. The point $l_4$ is very close to the straight line though.

In table 1 the adjusted mean lengths are derived from the straight line in this graph.

If the female lumpsuckers recruited at 3 years of age, the straight line would be like the broken one (with open triangles) in fig. 14 which does not go near the first point in the graph.
Fig. 15. Length in cm against age. Constructed from the adjusted mean lengths, black triangles, and mean length from samples, open triangles (Table 1).
Fig. 16. The age composition of female lumpsuckers in the commercial catches (gillnets) in Skjálfandafloi. % of numbers against age classes 5-10+. (Oldest individuals 13 years old).
Fig. 17. Deviation from mean on length frequency of aged and measured female lumpsuckers in Skjálfandi. April-May 1976-1979 (gillnets).
Fig. 18. Deviation from mean on length frequency distribution of female lumpsuckers caught in trawl during February-April, 1976-1978 on trawling grounds North of Iceland. These lumpsuckers are migrating to the spawning grounds. The mesh size in the trawl offers no selection on the spawning stock of lumpsucker.
Fig. 19. Graph showing the length frequency distribution of males and females in spawning migration. Caught in trawl on trawling grounds North and West of Iceland during February-April 1978.