Some observations on the Iceland scallop *Chlamys islandica* (Müller) in Norwegian waters

BY

KRISTIAN FREDRIK WIBORG
Fiskeridirektorates Havforskningsinstitutt

INTRODUCTION

In 1961 Fiskeridirektoratets Havforskningsinstitutt started exploring the natural resources of edible bivalves in Norwegian coastal waters. One of the species in question was the Iceland scallop, *Chlamys islandica* (Müller), which was known to occur in considerable quantities in some fjords in northern Norway (Sars 1878, Storm 1878—80, Sparre Schneider 1881, Kiær 1906, Soot Ryen 1924). There is also information on the occurrence of this species in adjacent waters, the Barents and White Seas (Filatova 1957, Zenkevich 1956, Ivanova 1957).

The present paper is based on material collected in the coastal areas of northern Norway in May-June of 1961 and 1962.

MATERIAL AND METHODS

In 1961 some dredgings with a six foot Baird scallop dredge (Baird 1955) were made in the Balsfjord near Tromsø, and in the Kvænangen fjord farther north. In 1962 exploratory dredgings were carried out with a four foot Baird mussel dredge (Baird 1959) between the Vestfjord and Kirkenes.

All scallops taken were measured with a sliding rule in five mm groups (e. g. 13—17 mm), the measure taken being the height, from the hinge to the edge of the shell. A number of scallops was also measured with regard to length and breadth.

In samples of 100 specimens, selected according to the percentage size distribution (height), the number of concentric rings on the upper valve was also counted. Scallops with conspicuous rings were selected for growth studies, the distance from the apex to the edge of the dark rings measured to the nearest mm.

The total volumes of a number of scallops of various size groups (usually five from each five mm group) have been measured by dis-

placement, by the method of Baird (Baird 1958). Before measuring, the meat had been removed from the shells, which were afterwards filled with a plaster mass.

Total weight, weight of adductor muscle plus gonad, and of empty shells, were determined on scallops of various size groups, (usually of ten specimens from each five mm group) by means of a balance, adjustable to 100 or 500 gr. The sex of the scallops was determined visually in the field by the colour of the gonads, individuals with whitish gonads being taken as males, and those with pink gonads as females. The determinations were later confirmed by microscopical investigations on smears from gonads, both fresh and preserved in formalin.

DESCRIPTION

Chlamys islandica belongs to the order Anisomyaria, family Pectinidae. In common with most pectinids it has a nearly circular shell, a little higher than long, laterally compressed (Fig. 1). The relative proportions vary both with increasing size and from one locality to another.

The two valves are nearly equal, the ear on the right (lower) valve has a deeper incision than the left one. The valves have a number of radial ribs provided with tiny transversal ribs like a rasp. The shell may sometimes be folded, with 3—6 ribs in each fold. The colour of the shell varies from nearly white, to grey, bright red or yellow, violet, or brown, the growth rings sometimes being more intensely coloured. The mother

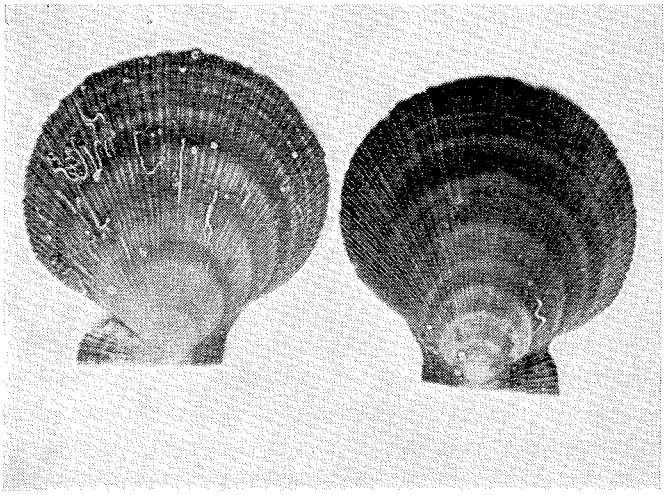


Fig. 1. The Iceland scallop (*Chlamys islandica* (O. F. Müller). ~~Left~~ Right: upper (left) valve, ~~right~~ left: lower valve (right valve).

of pearl layer on the inside of the valves may also be intensely coloured. The mantle edge or velum is usually more or less pigmented, sometimes with black pigment in transversal bands.

In sexually mature specimens the female gonads have a pink colour, the male ones are whitish coloured.

DISTRIBUTION

Chlamys islandica is a sub-arctic or northerly boreal species, occurring along the western and northern coasts of Norway, along western and northern Spitsbergen, Bear Island, Hopen Island, Murman coast, White Sea, west coast of Novaja Zemlja, Kara Sea, around the Jan Mayen Island, Iceland, East and West Greenland, east coast of North America and Canada from Cape Cod, to, and including the Parry Islands. It is also recorded along the Bering Strait, Bering Sea, Okhotsk Sea and is said to occur along the coast of Alaska southwards to Puget Sound (data from Sars 1878, Jensen 1912, Dall 1921, Madsen 1949, Zenkevich 1956, Ivanova 1957, Ockelmann 1958). According to Jensen (1912) only subfossil shells have been found at the Faroes, while Ockelmann (1958) says that it lives there. However, he does not give any authority for this statement.

According to Sars (1878) *C. islandica* is mainly distributed in Norwegian waters from Lofoten to Vadsø. Farther south it is more scarce. Storm (1900) found a large bed of this species along the northern shore of the island Tautra in the Trondheimsfjord, at depths down to 75 m. Nordgaard (1903) reports the finding of a single specimen of 45 mm at the entrance of the Lysefjord near Stavanger, and of single small specimens in the Alverstrømmen and Radøy sounds north of Bergen. Information on localities where living scallops had been found in this century was kindly supplied by the Tromsø Museum, and during the cruises fishermen and others also reported on beds of scallops. In many of these localities however, only empty shells were found during the present investigation. Living scallops were only found in fjords which had one or more shallow sills, 10—15 m deep or less, at the entrance (Fig. 2). The beds of Iceland scallops charted in 1962 are the following:

1) The Balsfjord beds, covering an estimated area of 70—100,000 m². The scallops were found at 30—40 m, on a sandy bottom partly covered with shells and stones. The density of scallops decreased inwards in the fjord. The innermost part of the Balsfjord has not yet been investigated.

2) In the Andamsfjord a small bed is situated in a narrow sound at 18—35 m depth. The bottom is poorly suited for dredging being very

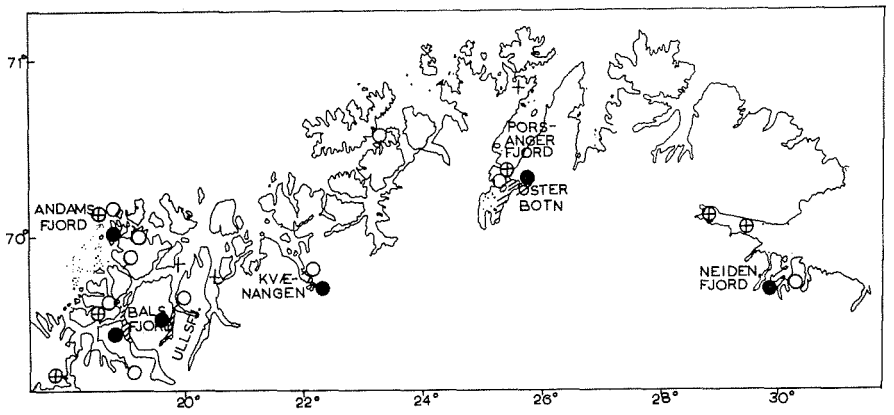


Fig. 2. Beds of *Chlamys islandica* located in northern Norway in 1962 (hatched areas and filled circles). Areas with empty shells and a few small living scallops — open circles, extinct bedscircles with cross, negative stations — crosses.

uneven with steep clefts and stones. The tidal currents are also very strong.

3) In the inner part of the Ulfsfjord, the Sørfjord, scallops were found inside a sill of ten m, at 40—60 m depth on even, sandy bottom. Most of the catch, up to 9/10, consisted of empty shells. Further inwards the bottom in some places is more uneven, clayey, with stones. The scallops were larger than farther out, and the percentage of living scallops greater (Cp. Fig. 11 page 50).

4) In the innermost part of the Kvænangen fjord there is a small bed at 25—40 m near a small island. The scallops have a very thin shell, and are usually overgrown with sponges. This bed was studied sixty years ago by Kiær (1906).

5) In the Porsangerfjord the size of the scallop beds may be compared with that of the Balsfjord. The innermost part of the fjord, the Østerbotn, is separated by a number of sills from the outer part. Near the bottom the temperature may be below 0° C for part of the year. The scallops live mainly at 40—60 m, but a rich bed was also found on a slope running from 20 to 60 m.

6) In the fjord system on the southern side of the Varanger fjord (Neiden Fjord) there are several small beds, at 10—30 m depth. The bottom consists partly of clay, with projecting boulders. For detail charts see: Wiborg 1962.

No attempt has yet been made to estimate the quantity of scallops on the various beds. In the Balsfjord a four feet mussel dredge was usually filled with scallops in a haul of 10 minutes, including setting and hauling. Half the catch consisted of living scallops, which numbered 200—300. In the Balsfjord, the dredge was completely filled with living scallops, 400—500 specimens, five minutes being allowed for the total haul.

ECOLOGY

C. islandica may occur from four to 250 m of depth or even more, but real beds are most often found between 15 and 60 m. The substratum usually preferred is sand, gravel, shells, stones and sometimes clay. According to fishermen the scallops are said to lie freely on the bottom and even undertake migrations, moving into deeper water during the summer and back again in winter (Soot Ryen 1924). Similar to other pectinids, *C. islandica* is able to swim by opening and closing the valves quickly. I have observed swimming both in aquaria and when the scallops have been caught and thrown overboard into the sea. Young scallops swim more frequently and swiftly than the older ones. On the beds however, I have most often found the scallops attached with a thin bundle of byssus to the substratum or to each other. When dredged from a clayey bottom, the scallops were attached to stones which had probably projected from the bottom.

Being a filter feeder, the Iceland scallop is most abundant in areas with strong currents, in some areas completely covering the bottom. The scallops are usually accompanied by a rich epiflora and -fauna. The plants are mainly red algae, both calcareous and foliaceous, but filamentous brown algae have also been found. The larger scallops are always found below the Laminaria zone. — In addition to the algae the scallops are often overgrown with bryozoans, hydroids, barnacles, *Anomia* shells, tubiferous annelids and sponges. The epigrowth may sometimes be very dominant and even exceed the weight of the scallop. One might wonder whether this fouling sometimes might outweigh the elasticity of the ligamentum and prevent the opening of the shell. Experiments however showed that the most heavy epigrowth did not prevent the shell from opening, even in the air.

Nordgaard (quoted by Soot Ryen 1924) lists 20 species of bryozoans found on *C. islandica*, and Kiær (1906) mentions the animals commonly occurring on the scallop banks.

The bottom temperature on the scallop banks may vary considerably. In the Balsfjord the temperature in the 10—50 m layer usually varies

between 4° and 7° C during the year, and in a fjord near to the Andamsfjord (see p 41) the temperature at 25 m level may reach 9.0 °—9.5° C for two weeks during the summer (Sælen 1950). In the Ulfsfjord the scallop beds are situated at a depth of 40—60 m inside a sill of ten m. At 100 m the temperature varies between 1° and 8.5° C during the year, reaching 9° C for a short time at the 50 m level (Sælen 1950). In the Østerbotten in the Porsangerfjord negative bottom temperatures are recorded during part of the year (Dragesund & Hognestad 1960). The data given agree with those found in adjacent waters. In the Barents Sea the temperature range of the scallop is from —1.34° to 8° C (Miloslavskaja 1958); on the southwest coast of Iceland the maximum temperature is 9.3° C in August (Jensen 1912).

At the Norwegian coast the Iceland scallops are found in the fjords were the salinity is comparatively low. In the Balsfjord the maximum salinity at 50 m was about 33.5 o/oo, in the Ulfsfjord nearly the same (Sælen 1950). But where the scallops occur in the open sea, such as in the Barents Sea or near Jan Mayen Island, the salinity on the banks may reach 34.7—34.9 o/oo.

As mentioned on page 40 the scallops have now disappeared from some localities where it had previously been found. In the innermost part of the Varangerfjord large beds were present before 1930, but later no living scallops have been found there.

The extinction of the scallop beds may be correlated with changes in the environmental conditions, e.g. a sudden rise in temperature. As in generally known, there has been a steady rise in temperature in the northern waters inclusive of the Barents Sea, beginning about 1930. This change may not have influenced the temperature in fjords with a shallow sill at the entrance, and the scallops found here have therefore survived. It might be expected that the scallops would again spread to in the outer parts of these fjords when the conditions came to an equilibrium. This seems, however, not to be the case. Just outside the sill were usually found a few small living scallops with a maximum size of 50 mm and a supposed age of 4—5 years. Simultaneously a large quantity of empty shells of all sizes were present. This fact seems to indicate a mass depletion of the beds some time ago, and later on the scallops settling there are destroyed after a few years because of unfavourable conditions. Sudden variations in temperature and/or salinity may also account for the great percentage of empty shells on the Ulfsfjord beds just inside the sill.

PROPAGATION

Ockelmann (1958) asserts that *C. islandica* according to Pelseneer (1935) is a hermaphrodite. The latter, however, does not mention this species at all. Under the heading "Hermaphroditisme normal" (Pelseneer 1935 p. 416) the following species are included: "*P. maximus*, *jacobaeus*, *asper*, *pyxidatus*, *nux*, *aequisulcatus*, *opercularis*, *glaber*, *flexuosus*, *magellanicus*, *irradians* et quelques especes indeterminées".

Among 12 adult *C. islandica* investigated Ockelmann (loc. cit.) found four to be in a hermaphroditic stage, but three of these had very little sperm, and only one with ripe sperm and large oocytes. Of nine adult scallops from the Jan Mayen area, six were reported to be females, three — males. Ockelmann is of the opinion that *C. islandica* is a protandric hermaphrodite.

I have investigated more than a thousand *C. islandica* during the summer, when the gonads were well developed. The latter could easily be divided into two cathegories, either of whitish or pink colour. The percentage of the two kind was usually near 50/50, sometimes with a surplus of white gonads. Smears from the gonads were investigated in a

Table 1. Number of mature and immature specimens of *C. islandica* at three localities in May—June 1962.

Height of shell, mm	Balsfjord			Andamsfjord			Ulfsfjord		
	♂	♀	immature	♂	♀	immature	♀	♂	immature
30			all	0	0	2	9	4	13
35	2	2	21	1	1	4	14	7	1
40	11	7	15	6	4	1	15	16	
45	18	8	2	8	8	1	27	36	
50	23	15		12	6		30	28	
55	30	23		7	4		25	35	
60	36	47		6	4		20	21	
65	58	56		11	10		30	35	
70	41	34		34	16		18	20	
75	20	19		18	20		9	7	
80				26	25		3	4	
85				26	33		2	2	
90				28	48				
95				9	16				
100				1	1				
105				0	2				
Total	208	194		168	185		183	208	
	+31	+17		+15	+13		+18	+ 8	

fresh state under the microscope. The white gonads invariably contained sperm in different degrees of development, the pink ones immature eggs. Immature individuals had a very slim mesosoma of a yellowish colour.

No hermaphrodites have hitherto been observed. This does not exclude the possibility that in Norwegian waters hermaphroditism may exist in a small percentage of individuals. In *Modiola modiolus*, in which the sexes are also separate, hermaphroditism has been observed in 2—8 o/oo of the individuals (Wiborg 1946).

Sexual maturity has been investigated in relation to size in three localities (Table 1).

The individuals in Balsfjord and Andamsfjord were all mature at a size of 50 mm, those in the Ulfsfjord already at 40 mm. From the number of growth rings it was assumed that in the Balsfjord 20 percent of the individuals were mature at an age of three years, 93 percent at four years of age, whereas all the five year old scallops were mature. In the Ulfsfjord 86 percent of the scallops seem to be mature when three years old, but reservations have to be made on the age determination.

In Norwegian waters the spawning has not been observed directly. In the Balsfjord the gonads of *C. islandica* were fairly well developed. In the male gonads some of the spermatozoa were mobile while in the females the eggs were immature. The same picture was observed in the middle of June 1962. Spent scallops have been found in the Balsfjord at the beginning of August. (P. Hognestad, pers. comm.). The larvae are thought to be pelagic.

SIZE AND AGE DISTRIBUTION OF THE SCALLOPS ON THE VARIOUS BEDS

In Fig. 3 are shown size distributions of scallops from various localities. As the dredge used had meshes 45 mm square, it might be expected that scallops smaller than 60 mm high were not quantitatively. Nearly all the scallops, however, were attached by byssus, either to each other or to empty shells, stones or other subjects. The smaller scallops were most often attached to the inner side of empty shells. It is therefore assumed that the samples are fairly representative of the population present.

In most localities the majority of the scallops have a height of 60 mm or more, in the Porsangerfjord even 80 mm. Small scallops are scarce, except in the fjord system adjacent to the Varangerfjord, where there are secondary peaks at 25 and 50 mm. This may be related to the fact mentioned earlier that the smaller scallops are found mainly in shallow

waters. The sample in the Korsfjord was taken in a dredging at a depth from 24 to ten m.

The open columns represent size distributions of scallops found outside the sill of the fjords investigated. These scallops had a normal growth, but were only 4—5 years old. It is assumed that the variations in temperature and/or salinity in these beds may sometimes be destructive to the scallops, and that they are therefore depleted at intervals. Large quantities of empty shells of all sizes usually accompanied the small living scallops found. In a longitudinal section of the inner Ulfsfjord (Sørfjord) an increasing size of the scallops from the outer to the inner part (Fig. 4) was accompanied by a decreasing quantity of empty shells. According to Sælen (1950) the temperature variations at 50 m level in the inner part of the Sørfjord are not so marked as near the sill.

Fig. 3. Size distributions of Iceland scallops from various localities in northern Norway. Black columns — size distributions on the main beds, open columns — small scallops found just outside the sill of the fjord.

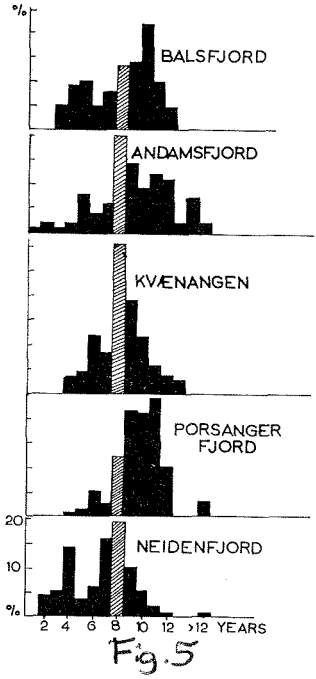


Fig. 5

Fig. 4. Size distribution of Iceland scallops in a longitudinal section of the Inner Ulfsfjord. Outermost station to the top.

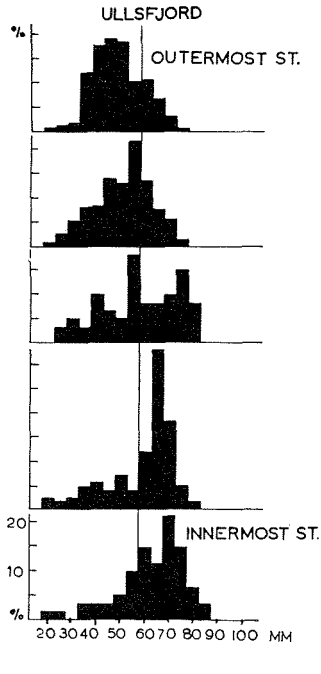


Fig. 5. Age distribution of Iceland scallops in various localities.

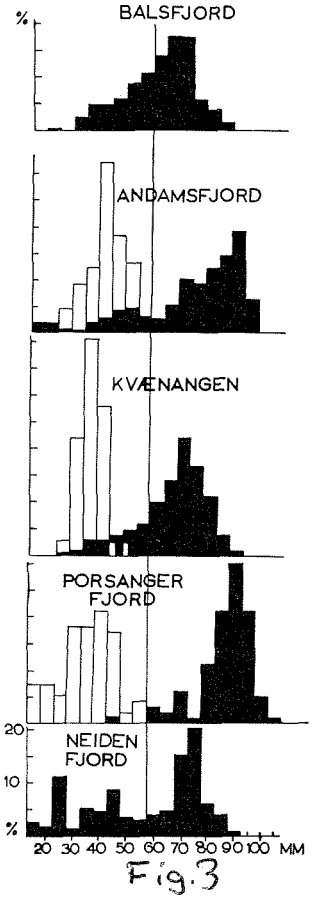


Fig. 3

As is generally known, the concentric rings found on the shell of bivalves may as a rule be interpreted as annual zones, especially when the individuals are not subjected to too many changes in the surrounding medium.

In the Iceland scallops there are often very conspicuous dark and light rings see (Fig. 1 page 39). The dark rings are usually finished by a thin, sharp line which may have some relation to the spawning. The light rings seem to be formed during winter and spring (October—May) and then gradually change into the darker zones. If the spawnings takes place in July—August, the first annual rings will represent at most half a year. In June the smallest scallops found in the beds were usually 15 mm in height, those in the fjords east of Varanger ten mm. The latter had an outer growth zone 3—5 mm wide. If the pelagic larvae of *C. islandica* settle in comparatively shallow water, and afterwards move into deeper water, secondary rings are likely to be formed. Reservations have therefore to be made as to the interpretation of the first one or two zones. Age distributions from various localities are given in Fig. 5. For the readings the upper (left) valves have been used. A large number of age groups are present, and the scallops are assumed to be from two to 12 years old or more. There is a fairly good agreement between the size and age distributions, except for the Andamsfjord. On most of the beds there is a peak at eight years, in the Porsangerfjord at 9—11 years.

As mentioned above, the small scallops found outside the sills in the Kvænangen, Porsangerfjord and Andamsfjord were supposed to be 2—5 years old.

GROWTH

In an attempt to study the growth of *C. islandica* the rings on the shell have been measured to the nearest millimetre from the apex of the shell to the edge end of the dark zones. In Fig. 6 each growth zone is represented as a mean of 20—50 measurements, somewhat less for ten or more zones.

In the localities investigated the growth seems to be approximately the same up to an age of five years, with an annual growth of 7—8 mm. In Kvænangen the growth is slow, decreasing after the tenth year. In the Korsfjord the growth is better until the seventh year, but then decreases rapidly. In the Andamsfjord the scallops have the best growth, especially after the seventh year. Individual scallops may grow ten mm or more per year during 8—9 years.

The volumes of the scallops from two localities have been measured by displacement (Fig. 7). The empty shells were filled with plaster

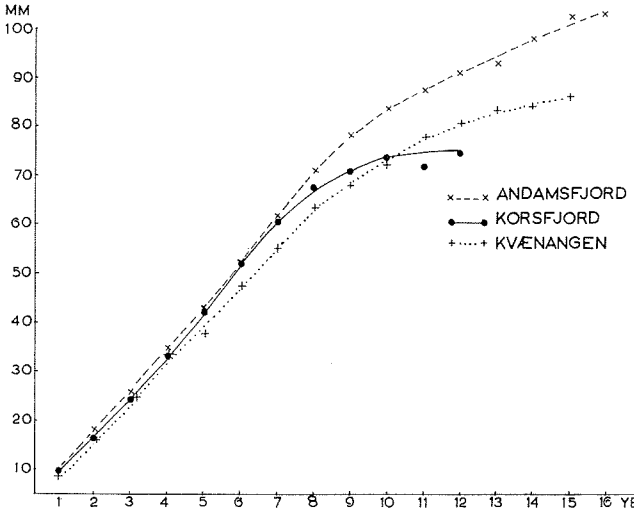


Fig. 6. Growth curves for Iceland scallops worked out from measurements of the growth rings.

Fig. 8. Weight analyses of Iceland scallops from the Andamsfjord, June 1962. Continuous curve — total weight, broken curve — empty shells, dotted curve — adductor muscle plus gonad, lower curve with crosses — gonad. →

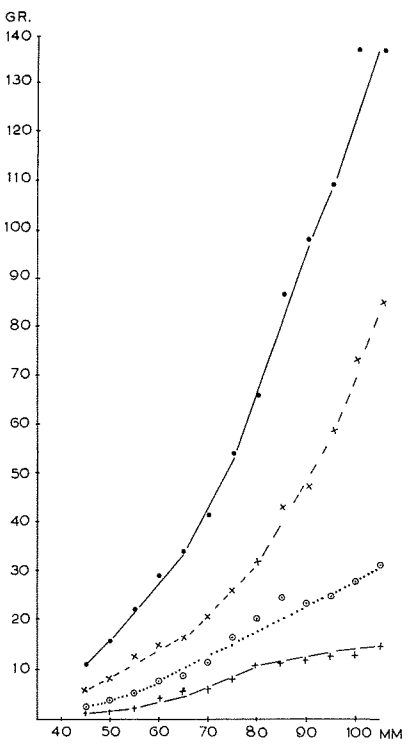
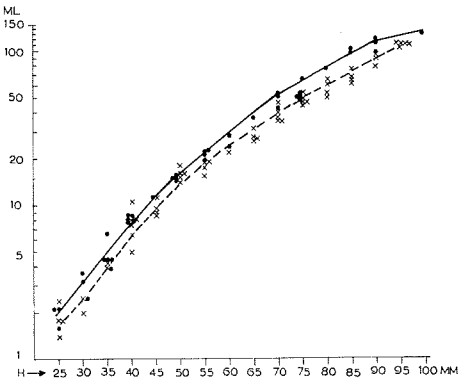


Fig. 7. Individual volume measurements of Iceland scallops in relation to height, from the Andamsfjord (dots and continous curve) and the Kjøfjord (crosses and broken curve).



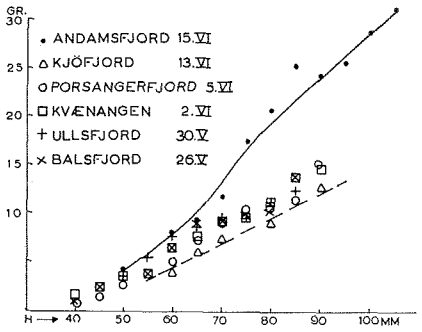


Fig. 9. Weight of adductor muscle plus gonad in relation to height of shell in Iceland scallops from various localities in northern Norway, June 1962.

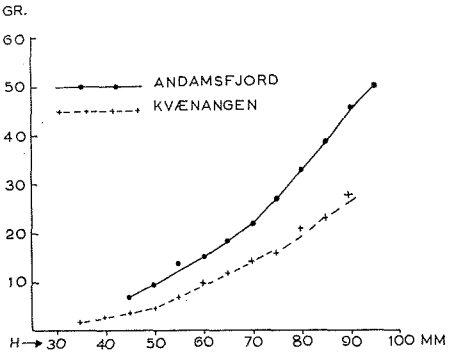


Fig. 10. Weight of empty shells in relation to height of shell in Iceland scallops from two localities in northern Norway.

(plasteline) before the measurement. As a rule, five scallops from each five mm group were measured.

The volume increases from 1.8 ml in scallops 25 mm high to 130 ml in 100 mm scallops. From a size of 45 mm to 90 mm the volume is increased approximately ten fold.

The Andamsfjord scallops have a comparatively larger volume than those from the Kjøfjord (Neidenfjord).

Between the volume and the height of the scallops there is a relation $V = L^3.k$, from which the volume can be calculated. k is a factor which has been found by experience to average 0.114 for the Kjøfjord scallops and 0.128 for those in the Andamsfjord.

From a commercial point of view it is of interest to know both the total weight of the scallops and the weight of the meat. During the cruise in May—June 1962 a number of weight analyses were made in the field. Usually ten specimens from each five mm group were investigated. All epigrowth was removed before weighing. The meats and empty shells were as far as possible freed of surplus liquid by drying in a handkerchief or on filter paper. The measurements are necessarily crude, but have been considered sufficient to give an impression of the approximate weight variations. In the Andamsfjord, where the scallops were found to have the best quality of all the localities investigated, the total weight increased from ten gr in 45 mm scallops to 140 gr in specimens 100 mm high. (Fig. 8). The edible part, adductor muscle plus gonad, has a more even increase in weight, from two to 30 gr within the same size interval. The gonad accounts for about half of the meat weight. In scallops of commercial size, 60 mm or more, the yield of meat is a maximum of 20—25 percent of the total weight during the pre-spawning period

of March—August and later is probably not more than 10—15 per cent.

The weight of the meat in relation to the size of the scallops from various localities is shown in Fig. 9.

The weight of the shells in relation to size may vary from one locality to another. Andamsfjord and Kvænangen have been chosen as examples (Fig. 10). In the Andamsfjord the currents are stronger than in the Kvænangen fjord, and the salinity may also be somewhat higher.

SHELL PROPORTIONS

In bivalves the proportions of the shell of a certain species may vary from one locality to another, and also with increasing size. Such variations have been studied e.g. in *Mytilus edulis* (Soot Ryen 1927) and *Modiola modiolus* (Wiborg 1946). In *C. islandica* the shell proportions have been studied in scallops from the Kjøfjord and the Andamsfjord beds. From each five mm size group the length, height and breadth of ten individuals, if available, have been measured. The relations height: length and breadth have been calculated for each size group and plotted against height (Figs. 11 and 12). Small scallops (ten mm or less in height) are nearly circular, but are higher (H/L increases) at a size of 20—30 mm. With increasing size the scallops again grow comparatively longer, *i. e.* more circular. The changes are, however, relatively small, and there is no essential difference between the scallops in the two localities.

The proportion height: breadth is more variable, the shells getting broader with increasing size. The change is most conspicuous between heights of 15 to 40 mm. The scallops from the Andamsfjord are broader than those from the Kjøfjord. The latter locality may be considered as representative of most of the other localities investigated.

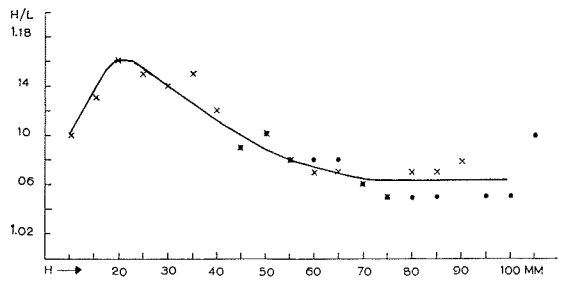


Fig. 11. The height/length relationship plotted against height in Iceland scallops from the Andamsfjord (dots) and Kjøfjord (crosses) beds.

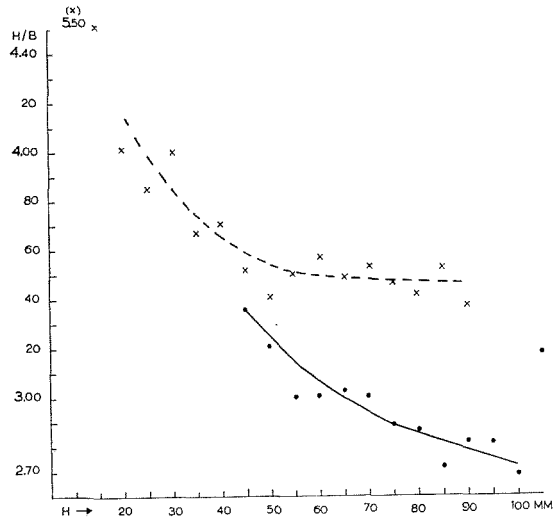


Fig. 12. The height/breadth relationship plotted against height in Iceland scallops from the Andamsfjord (dots and continuous curve) and the Kjøfjord (crosses and broken curve).

COMMERCIAL EXPLOITATION

The Iceland scallops have hitherto mainly been used as bait in the local fisheries. Practically nothing has been fished for human consumption. Attempts are now being made to interest the industry. Instructions for fishing and handling the scallops have been worked out, various methods of culling and storing the meats tried, and dishes prepared. A certain quantity of frozen meats, raw and steamed, which was brought into the market, has been accepted with enthusiasm by the restaurants.

It is to be hoped that the beds of Iceland scallops found may support a small industry.

With the comparatively slow growth of the scallops one might fear that the beds may soon become exhausted. In most of the beds, however, there are places where it is impossible to dredge, and the scallops found there, may be sufficient to secure the recruitment.

To insure a rational exploitation a minimum size limit of 60 mm will probably be necessary. A minimum mesh width in the dredges will also be of importance. Small scallops ought to be returned to the beds as soon as possible.

It is to be expected that more beds of Iceland scallops will be found in other fjords in northern Norway, and it might also be possible to find suitable beds in the Barents Sea and along the coasts of Spitzbergen and Jan Mayen.

SUMMARY

An investigation has been started on the Iceland scallop, *Chlamys islandica* (O. F. Müller). In northern Norway this species is mainly found in fjords with a narrow sill at the entrance and on a bottom with sand, gravel or shells in 10—60 m of depth. Some scallop beds (known from earlier times) have been extinguished during recent years, probably because of climatic changes. The Iceland scallop is sexually mature at a shell height of 30—45 mm and a supposed age of 3—5 yeras. The sexes are separate, spawning taking place in July—August. In the localities investigated, the size of the scallop varied between ten and 105 mm, with maximum abundance at 45—90 mm.

Distinct growth rings have been interpreted as annual rings. Usually, scallops from two to 12 years old are present in the beds, the majority being eight or more years in age. The annual growth has been estimated to 5—10 mm during the first seven years, gradually decreasing to 1—2 mm in the older scallops. The shell proportions change with increasing size, the scallops getting relatively thicker, broader. The volume varies from about ten ml in scallops 45 mm high to 70 ml in 80 mm scallops, the total weight from ten gr to 65 gr in the same size interval. The weight of the edible meat, adductor muscle plus gonad, constitutes 15—25 per cent of the total weight. In commercial sized scallops (60—100 mm) the meat weighs from five to 30 grams.

It is supposed that the scallop beds already mapped will support a minor commercial fishery.

ACKNOWLEDGEMENTS

Valuable assistance and information has been given by the leader of the Biological Station, Tromsø Museum, P. T. Hognestad, and by the curator at the Tromsø Museum, Mr. B. Christiansen. To the officers and crew of the R/V "Asterias", in charge captain T. Karlsen, I also owe my sincere thanks for their untiring assistance.

LITERATURE CITED

Baird, R. H. 1955. A preliminary report on a new type of commercial escallop dredge. *J. Cons. int. Explor. Mer.* 20: 290—294.

— 1958. Measurements of condition in mussels and oysters. *Ibid.:* 23: 249—257.

— 1959. A new dredge for catching mussels and oysters. ICES, Shellfish committee C. M. No. 105.

Dragesund, O. & Hognestad, P. 1960. Småsildundersøkelsene og småsildfisket 1959/60. *Fiskets Gang:* 703—714. *Fisken pg Havet* 3: 1—12.

Dall, W. H. 1921. Summary of the marine shellbearing molluscs of the northwest coast of America etc. *Smithson. Inst. U. S. National Mus. Bull.* 112: 1—217.

Filatova, E. A. 1957. Zoogeograficheskoje rajonirovanie severnykh morej po rasprostraneniju dvustvorchatykh molliuskov. *Trud. Inst. Okean.* 23: 195—215.

Ivanova, S. S. 1957. Kachestvennaja i kolichestvennaja kharakteristika bentosa Onezhkovo zaliva Belovo morja. *Materiali po kompleksnomu izucheniju Belovo Morja* I: 355—380.

Iversen, T. 1936. Sydøstgrønland Jan Mayen. Fiskeriundersøkelser. *Fiskeridir. Skr. Havundersøk.* 5 (1): 1—171.

Jensen, A. 1912. Lamellibranchiata. *Dan. Ingolf-Exped.* II, 5: 1—119.

Kiær, H. 1906. Om dyrelivet i Balsfjorden. *Tromsø Mus. Aarsh.* 28: 13—46.

Madsen, F. J. 1949. Marine Bivalvia. *Zoology, Iceland* IV, 63: 1—116.

Miloslavskaja, N. M. 1954. O. raspredelenii dvustvorchatykh molliuskov vostochnovo Murmana etc. *Dokl. obsch. Sobr. Ak. Nauk. SSSR.* 99, 4: 633—635.

— 1958. Temperaturnyj faktor v raspredelenii dvustvorchatykh molliuskov vostochnovo Murmana. *Trud. Murm. biol. st.* 4: 140—150.

Nordgaard, O. 1904. Studier over naturforholdene i veslandske fjorde I. Hydrografi. *Bergens Mus.* Årb. 1903, 8: 1—48.

Ockelmann, W. K. 1958. Marine Lamellibranchiata. *Medd. Grønland.* 122 (4): 1—256.

Pelseneer, P. 1935. Essai d'ethologie d'après l'étude des mollusques. *Publ. Fdn. Agathon de Potter Acad. roy. Belg.* No. 1.

Sars, G. O. 1878. *Mollusca regionis Arcticae Norvegiae.* Christiania.

Soot Ryen, T. 1924. Faunistische Untersuchungen im Ramfjorde. *Tromsø Mus. Aarsh.* 45 (1922), 6: 1—106.

— 1927. Studies on the shell-proportions of some Norwegian Mytilidae. *Nyt Mag. Naturv.* 65: 321—338.

Sparre Schneider, J. 1881. Undersøgelser over dyrlivet i de arktiske fjorde. *Tromsø Mus. Aarsh.* 4: 37—70.

Storm, V. 1878, 1879, 1880. Bidrag til Kundskab om Throndhjemsfjordens Fauna. *K. norske vidensk. selsk. Skr.*

— 1900. Oversigt over Throndhjemsfjordens Fauna: *Beretning fra Arbeidskomiteen for Throndhjems biologiske Station:* 1—20.

Sælen, O. H. 1950. The hydrography of some fjords in northern Norway. *Tromsø Mus. Årsh.* 38: 70 (1): 1—102.

Thorson, G. 1933. Investigations on shallow water animal communities in the Franz Joseph Fjord (East Greenland) and adjacent waters. *Medd. Grønland* 100 (2): 1—68.

Wiborg, K. F. 1946. Undersøkelser over oskjellet (*Modiola modiolus* (L.)) I. *Fiskeridir. Skr.* Havundersøk. 8 (5): 1—85.

— 1962. *Haneskjellet, Chlamys islandica* (O. F. Müller) og dets utbredelse i noen nordnorske fjorder. *Fiskets Gang:* 640—646. *Fisken og Havet* 3 (5): 17—23.

Zenkevich, L. A. 1956. *Morja SSSR, ikh fauna i flora.* Moskva. 424 p.