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Vertical Structure of *Sebastes mentella* Concentrations in the Pelagic Open Part of the Irminger Sea

by

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Abstract

Object of the investigations is *Sebastes mentella* inhabiting the pelagial of the open Irminger Sea.

The paper aims at studying the structural peculiarities of redfish inhabiting the upper (0-500 m) and lower (500-1 000 m) layers of the Irminger Sea pelagial by means of natural marks (parasites, pigmented patches), as well as by comparing other biological parameters of fish.

Results from the studies on *S. mentella* parasite fauna, occurrence of pigmented patches on skin and in muscular tissue of fish are presented for different years; the length-age composition, linear and weight growth rates, absolute and relative growth, rate of maturity at age and at size, feeding of redfish from different size groups caught at different depths in the Irminger Sea pelagial are analysed.

Absolute similarity of parasite fauna composition, similar degree of infestation by parasites of most species, analogous peculiarities of infestation by *Sphyrion lumpi* and by pigmented patches, significant similarity of linear and weight growth rates, as well as of maturity rates, indicate the common conditions for redfish habitat and prove the common origin and stock integrity of *S. mentella* in the upper (0-500 m) and lower (500-1 000 m) layers of its distribution in the Irminger Sea pelagial.

In summer (period of feeding), aggregations of *S. mentella*, distributed below 500 m depth off the Reykjanes Ridge, are formed due to a partial redistribution of specimens at the age 5-18 yr from the upper layer and to a complete leaving of redfish above 18 yr for larger depths.

The conclusion was drawn that it was inappropriate to use minor distinctions in occurrence of redfish with pigmented patches, being a consequence of age-dependent changes in fish and of apparent pathology of this phenomenon, as the criterion for *S. mentella* intraspecific differentiation. Somewhat reduction in the occurrence of *S. mentella* specimens with concretions of melanin in muscular tissue, distributed below 500 m depth, is also related to the age-dependent changes and to changing of ecological conditions of redfish habitat, and thus can not give evidence of the fact that the specimens from older age groups (inhabiting the larger depths, as other fish species) belong to another "type" or another population.

Aggregations of older age specimens, distributed during feeding at large depths, should be considered as the deep-sea component of a common reproductive proportion of *S. mentella* population in the Irminger Sea, but not a distinct stock or type ("pelagic deep-sea type *S. mentella*"), as assumed by some researchers.

The results obtained will be the basis of developing recommendations on the management of pelagic stock of the redfish *Sebastes mentella* from the Irminger Sea and adjacent waters.

Introduction

In the 1990s, the assumption of Icelandic researchers appeared that two stocks (types) of redfish (*Sebastes mentella* Travin), i.e. "oceanic" and "deep-sea", inhabit a layer up to 1 000 m in the pelagial of the Irminger Sea (Anon., 1998). In this event, the first ("oceanic *S. mentella*") inhabits a wide range of depth from 50 to 700 m, and the second one ("pelagic deep-sea *S.mentella*") dwells only at the depth below 500m. Icelandic scientists (Magnusson, 1991; Magnusson *et al*., 1995) based their opinion of availability of two types of *S. mentella* on five criteria of difference in: 1) intensity of red colour of fish body; 2) length composition; 3) length of first-maturing fish; 4) thickness of neck; 5) infestation by *Sphyrion lumpi*, occurrence of pigmented patches on skin and in muscular tissue of fish.

Positive experience of applying the parasitologic data when studying intraspecific structure of marine fish has been accumulated during recent decades. Such data and other natural marks were used to distinguish local groupings of redfish from *Sebastes* genus in the Northwest Atlantic (Perlmutter, 1953; Templeman, 1959; Templeman and Squires 1960; Sindermann, 1961; Yanulov, 1962), intraspecific differentiation of *S. mentella* over most area (from the Barents Sea to the coast of Canada) (Bakay, 1997; Bakay, 1999), as well as *S. mentella* from the Irminger Sea and adjacent areas (Templeman, 1967; Gaevskaya, 1984; Bakay, 1988, 1989).

The paper presents results from *S. mentella* studies for purpose of analyzing the fifth criterion suggested by Icelandic scientists to differentiate the redfish stocks, i.e. infestation by *S. lumpi*, occurrence of pigmented patches on skin and availability of melanin (melanocytes) in muscular tissue of fish caught at different depth in the Irminger Sea pelagial. Qualitative and quantitative compositions of the parasite fauna of redfish caught from both layers studied in different years were compared.

To verify the 2nd and the 3rd criteria for differentiation of the redfish stocks inhabiting different depths, the comparative analysis of length-age composition and maturity rates (by size and age), was done. Besides, results from the comparative analyses of linear and weight growth rates, absolute and relative growth, as well as feeding peculiarities of redfish from different size groups caught in a wide range of depths of the Irminger Sea pelagial, were used as additional criteria.

According to the data from the Russian and international trawl-acoustic surveys in recent years, feeding aggregations of *S. mentella* are distributed in the wide area – in both NEAFC Regulatory areas and NAFO Regulatory Area. Investigations of vertical structure of redfish aggregations in the Irminger Sea pelagial will help to study the mechanism of forming redfish feeding concentrations in the Labrador Sea pelagial. The results obtained will be the basis of developing recommendations on the management of the pelagic stock of *S. mentella* in the Irminger Sea and adjacent waters.

Material and Methods

Results from parasitologic studies on *S. mentella* from the Irminger Sea since 1983 are used in the paper. All organs and tissue (except for blood) of fish were studied by method of complete parasitologic dissection (Dogiel, 1933; Bykhovskaya-Pavlovskaya, 1985). In 1983 and 1999, to compare parasite fauna of *S. mentella* from the depth above 500 m and below 500 m in the Irminger Sea pelagial, the samples were taken at the same site and with a minimum interval in time. In total, 250 individuals of redfish were examined. In June-July 1999, during the international trawl-acoustic survey (TAS) on redfish stock in the Irminger Sea, 2 532 indiv. of *S . mentella* (963 indiv. were caught from the depth above 500 m and 1 569 indiv. - below 500 m) to study occurrence of *Sphyrion lumpi* and pigmented patches on skin and to elucidate peculiarities of infestation by *S. lumpi*. Location of alive copepods of *S. lumpi* and remains of the parasite presence were considered for each of the four zones of redfish body examined according to the scheme described (Fig.1) (Bakay and Karasev, 1995).

To determine occurrence of *S. mentella* with melanin (melanocytes) in muscular tissue, 1 037 indiv. of fish were examined. In order to exclude methodical errors when estimating occurrence of these phenomena by different researchers, the paper presents the materials gathered only by the Russian party and the following factors were used as indicators for a level of invasion by parasites:

- *S. lumpi* prevalence - a proportion (%) of fish, infested by the parasite, of the total amount of the fish examined;
- Abundance index - the number of the parasite/1 fish examined.

Biological material of deepwater redfish was sampled in accordance with the method used in PINRO (Anon., 1980). Data obtained during research scientific and research fishing cruises in June/July, 1995-1999 on materials sampled along the vertical distribution of redfish are analysed. Materials on redfish were collected in the international waters of the Irminger Sea in the Reykjanes Ridge area between 28ºW-37ºW and from 57º30' N to the borders of the 200-mile zones of Iceland and Greenland from the catches taken by mid-water trawls from the depths of 100 m to 900 m. Age samples included 10 specimens of males and 10 specimens of females per each length class. Fish age was determined by scales. Age data were recalculated for the whole length frequency. Linear and weight growth rates were calculated by the observed data. The volume of the analysed material is presented in Table. 1.

Results and Discussion

1. Parasites and Pigmented Patches as Indicators of Vertical Structure of *Sebastes mentella* Aggregations

As a result of the studies on parasite fauna of *S. mentella* from the upper and lower layers of dwelling, there were found 17 species of parasites referring to five taxonomic groups, i.e. *Myxosporea* - 4, *Cestoda* - 6, *Trematoda* - 4, *Nematoda* -2, *Crustacea* -1 (Table 2) accounted for by a traditional accumulation of these parasites in fish from older age groups.

All species of *Myxosporea* (*Myxidim incurvatum*, *M. obliquelineolatum*, *Leptotheca adeli*, *Pseudalataspora sebastei*), two species of *Cestoda* (*Diphyllobothrium sp. pl*, *Grillotia sp. pl*.) and one copepod *Sphyrion lumpi* meet to a great extent requirements for parasites served as indicators of intraspecific structure of fish. The most of the above parasites (except *Mytxidim incurvatum*) are specific to redfishes of *Sebastes* genus.

As may be seen from Table 2, the obtained data indicate a complete similarity of parasite fauna composition of *S. mentella* inhabiting the upper and lower layers in each pair of the samples compared and obtained both in the 1980s and in the year of 1999. Infestation (prevalence and abundance index) of redfish by parasites of most species that are from both layers is also at the same level. Higher level of invasion in redfish from the lower level by helminths of only some widely spread species (*Bothriocephalus scorpii*, *Phyllobothrium sp.pl*., *Lecithophyllum bothriophoron*, *Anisakis simplex l*.), acquired with food, is accounted for by a traditional accumulation of these parasites in fish from older age groups.

The materials pooled according to *S. mentella* infestation by *S. lumpi*, obtained from three vessels during the international TAS in 1999 (Sigurdsson *et al*., 1999), do not prove the Icelandic researchers' opinion (Magnusson, 1991; Magnusson *et al*., 1995) of a considerable difference in infestation by *S. lumpi* in redfish from the upper and lower layers in the Irminger Sea pelagial. Besides, the Russian data given in Tables 2-4 indicate a similar level of the parasite invasion of redfish small specimens from the upper layer and of large ones from the lower one at different sites of the area investigated. Minor differences registered by us are not statistically reliable.

A comparison between the infestation by *S. lumpi* in different parts of redfish body indicates an essential similarity of indicators for infestation of fish from the upper and lower layers (Table 3). Some differences in the infestation of the third zone examined are accounted for by a very rare occurrence of parasite in this zone and from difficulties in revealing the remains of *S. lumpi* presence there. Besides, infestation by *S. lumpi* in redfish females always exceeded that in males from both layers in all sub-areas of the TAS area (Table 4).

The assumption that infestation by *S. lumpi* is less in large specimens of redfish from the lower layer should be considered incorrect. Underestimation of remains of the copepod presence, remaining on redfish body surface for a long time, is obvious. It is rather difficult to determine their presence on body, however they are easily found as dark-brown concretions when dissecting a muscular tissue (Bakay and Karasev, 1995). In our opinion, reliability of using *S. lumpi* as a natural mark consists just in this; once settled the parasite remains in fish for a long time and, probably, up to the end of host's life.

Slightly lower infestation by alive *S. lumpi* is registered at 600-1 000 m depth (Table 2), where the largest specimens of *S. mentella* are predominant, results from a higher resistance of adults as far as their integument and scale are less accessible to penetration of slow-moving nauplii of the parasite females with a short period of this life cycle stage (Squires, 1966). Besides, no optimum conditions for the parasite existence are available at large depths (below 500 m) (Squires 1966; Pedchenko 1992).

As for the second condition of the fifth criterion used to distinguish "deep-sea" redfish, i.e. low occurrence of *S. mentella* with pigmented patches on skin at the depth below 500 m, then this phenomenon results, in our opinion, from the following. Occurrence of redfish with pigmented patches on skin has been established to increase with age and attains maximum in fish at 39-42 cm length (at age 16-18) according to the data for 1983-1986 and in fish at 37-38 cm length (at age 15-17) - by the data for 1999 (Fig. 2, 3). In this case, a proportion of large (above 20cm^2) pigmented patches increases, in the background of which tumors of pigmentary tissue can occur (Bogovski *et al*., 1986; Bakay *et al*., 1987), probably contributing to fish death. This circumstance is one of the reasons of a sharp drop in occurrence of pigmented patches in large specimens of *S. mentella*. Prevalence of large pigmented patches in large specimens (Fig. 4) indicates their ability to increase in size during redfish life. It is undoubted that senescence of fish contributes to tumor development of pigmentary tissue (Bogovski *et al*., 1986; Bakay *et al*., 1987; Bogovski and Bakay, 1989a, 1989b). These data are in line with a conception of stages of origin of tumor growth in the background of pre-tumorous variations (Shabad, 1967).

Compared to 1983-1986, higher occurrence of anomalous pigmentation of skin in fish at 31-36 cm length in 0-500 m layer was observed in 1999, as well as an earlier commencement of rise (at 37-38 cm length and at age 15-16) and drop of its occurrence (Fig 2-3). In 1999, the author managed to compare a dynamics of this phenomenon in the redfish caught in the upper and lower layers in the Irminger Sea (Fig.3). It was established that at the depth below 500 m peak of occurrence of anomalous pigmentation on skin begins in fish at 37-38 cm length (at age 15-16). The second peak of occurrence (at 43-44 cm length) is accounted for, in the author's opinion, by a migration of large specimens above 39-40 cm long from the upper layer to the lower one. Migration to deep water is especially pronounced in redfish having large (above 10cm^2) pigmented patches (Fig.5). The second reason of a sharp drop, at the depth above 500m, of occurrence of *S.mentella* with anomalous pigmentation of skin among fish above 39-40cm in 1999 and above 41-42cm in 1983-1986, consists in this. Migration of redfish specimens from older age groups (above 17 yr) to large depths results in a high occurrence of fish with large and small pigmented patches there (Fig.5).

Peculiarities of pigmented lesions on redfish skin are the same in the upper and lower layers of dwelling. Thus, in males they are mainly localized on head (gill covers) and caudal fin, in females - along lateral sides (mainly under the first dorsal fin). Pigmented patches occur by 1.9 times more frequently in *S. mentella* males than in females both in deep and in shallow waters.

As for the reasons of occurring the melanomas (black pigmented patches) and pterinophores (red pigmented patches) in fish, no common opinion is available in literature or, probably, this item is not considered (Mawdesley-Thomas, 1971). Melanomas in some tropical fish species from *Cyprinodontae* family have properly been studied. Formation of melanomas in these fish species has been proved to be determined by a specific gene (Anders *et al*., 1984). Thus, the most probable reason for a high frequency of anomalies in growth of pigmentary tissue in reproductive proportion of *S. mentella* population in the Irminger Sea is, in our opinion, recombination of gene complexes caused by a pattern of reproduction of the population (Bakay *et al*., 1987; Bogovski and Bakay 1989).

The third condition of the 5th criterion, i.e. a low occurrence, at the depths below 500 m, of *S.mentella* specimens with an availability of melanin (melanocytes) in muscular tissue, was also noted by us compared to that registered in the upper layers (Table 4). However, the results obtained from analysis has indicated an inverse relationship between the occurrence of this phenomenon and length (age) of redfish (Fig. 6). Increased age, in its turn, results in changing of the redfish feeding pattern.

Thus, a proportion of fish below 31cm long with melanocytes in muscular tissue makes up 25%, attains maximum (42-43%) at 32-33 cm length and reduces up to 8-6% at 40-41 cm length of fish. No melanocytes were found in muscular tissue of redfish above 41cm long. It is known that *S. mentella* specimens below 31cm (under 10 yr) are represented by maturing for the first time or immature fish newly moved to the pelagial of the Irminger Sea from the slope on which they inhabited the layers at the bottom under other biotic and abiotic conditions, compared to the pelagial. Redfish of 32-39 cm long (at age 12-16), in which melanocytes in muscular tissue occur most frequently, constitute the bulk of reproductive proportion of the population inhabiting the pelagial. Plankton crustaceans (*Copepoda Amphipoda*, *Euphausiida*) are mainly predominant in its feeding (Fig. 6), however, a proportion of fish objects, shrimps and young scallops increases with age. The latter serve as the bulk of feeding for *S. mentella* above 39 cm long (above 16 yr) when plankton crustaceans occur seldom.

The mentioned above indicates that a low occurrence of redfish with melanocytes in muscular tissue at the depths below 500m, where a proportion of the largest fish species grows essentially, is a consequence of changing by redfish its ecological conditions and variations in age. The latter is expressed in moving of redfish older specimens (above 17 yr - nearly by 100%) from the upper 500-meter layer to large depths. Therefore, low occurrence of redfish with melanocytes in muscles at the depths below 500 m, compared to that in the upper layer, cannot be the criterion of belonging *S.mentella* specimens from older age groups to another type ("oceanic deep-sea *S. mentella*") or to another population, as assumed by some researchers (Anon., 1998).

Different intensity of red colour of *S. mentella* body that, as Icelandic scientists believe, may serve as the first from the criteria for distinguishing the redfish from the Irminger Sea pelagial into two types ("oceanic" and "deep-sea"), is, in our opinion, also a consequence of age variations typical of the redfish from this population.

2. Biological Characteristics and Peculiarities of Formation of Vertical Structure of *Sebastes mentella* Aggregations in the Irminger Sea Pelagial

Length-age composition. In 1995-1999, the length of both males and females varied from 24 to 48 cm in the upper 0-500 m layer. Males 33-38 cm long and females 34-39 cm long constituted the basis of catches. Males dominated in all catches (64.5 %). Redfish length in the 500-900 m layer varied in the same range like in the upper layers. However, the basis of catches consisted of larger fish with the dominating length of males 33-44 cm and of females - 35-45 cm. A portion of males in catches was less - 38.3 %, that was connected with the domination of females among fish longer 35 cm (Fig. 7).

In the layer of 0-500 m the age of redfish varied from 5 to 17 in males and from 4 to 17 in females. Specimens older than 17 year old were not found. In the 500-900 m layer fish at the age of 5 to 25 were caught. The increase of older specimens -males and females at the age of 12-18 - was registered in catches (Fig. 8).

Variation of the length-age composition in dependence on the depth was found as specific to other deepwater species of the North Atlantic, in particular, to rock grenadier (Savvatimsky, 1992b) and roughhead grenadier (Savvatimsky, 1992a). distribution of fish of older ages to the depth. Variations by depth in the length-age composition of redfish aggregations are apparently caused by a redistribution of fish from older age groups to larger depths and by a complete leaving of fish above 18 yr for the depths below 500 m.

Growth rate. Absolute and relative fish increments at the age of 8 constituted 1.6-1.7 cm and 3.8-6.6% in males, and 1.0-2.1 cm and 2.1-7.4% in females. After maturation of the main mass of fish (the age is 12-13), the linear growth became slower, the increment varied within the ranges of 1.4-1.7 cm and 3.7-4.2%. (Table 5) Redfish linear growth rate became slower with the age, whereas the annual absolute weight increment increased.

In the 500-900 m layer in the age groups from 8 to 20, the absolute and relative increments fluctuated from 1.1 to 1.9 cm and 3.1 to 4.7%, correspondingly, in males, and 1.1 to 1.9 cm and 3.2 to 4.9%, correspondingly, in females. Beginning from the age of 21, rates of linear increments of both males and females decreased to 0.7-1.2 cm and 1.8-2.3%. Maximal weight increment was registered for fish at the age of 14-19, then the increment decreased (Table 6).

The difference between mean lengths (2-5 mm) and weights (10-41 g) in fishes of the same age for two layers is small and keeps within the measurement error. The comparative analysis of length-weight characteristics in the layers of 0-500 and 500-900 m has shown that redfish at the age of 6-17 have the similar rates of linear and weight growth within the whole vertical distribution (Fig. 9 and 10).

Maturation rate. In the upper pelagic 500 m layer, the mature males were registered for the first time at the length of 26 cm, whereas females - at the length of 27 cm. Maturation of males (100%) ceased at the age of 13 at the length of 37 cm, and that of females - at the age of 14 at the length of 38 cm. In the area of the Reykjanes Ridge in the 500-900 m layer, the spawning part of the population has been recruited as follows: males - at the age of 7-14 at the length of 26-37 cm, and females - at the age of 8 to 15 at the length of 28-38 cm (Fig. 11 and 12). Thus, in two investigated pelagic layers, 100% maturation of redfish takes place at the similar lengths of fish.

Feeding. Plasticity of redfish feeding in the Irminger Sea pelagial is high. The redfish food spectrum is wide, with the representatives of *Crustacea* (*Copepoda*, *Hyperiidea*, *Euphausiacea*, shrimp), mollusks (*Gonatus fabricii*) being predominant in it, and to a less extent represented by fish species of mesopelagic complex (*Myctophidae*, *Paralepidae*). The analysis of redfish feeding by size group for 0-500 and 500-900 m layers revealed significant distinctions in the feeding of redfish from different size groups. In the upper 500 m layer, small-size immature fish of 26-30 cm long most actively fed on *Crustacea*. With an increase of fish length a proportion of *Copepoda*, *Hyperiidea* and *Euphausiacea* in the diet of redfish reduced by 2-4 times, and a presence of shrimp, squid and fish objects simultaneously increased in feeding (Table 7).

Similar variations in the feeding structure are noted for redfish in a 500-900 m layer, where fish objects, shrimp and squid constitute the bulk of the diet for large-size fish of 41-50 cm long. Minor growth of occurrence of *Hyperiidea* in the diet of large-size fish took place due to deep-sea *Parathemisto libelio*. It is undoubtedly that while growing the redfish start to feed on larger and movable food objects. Large-size redfish is more adapted to feeding on mesopelagic fish and molluscs dwelling the deep layers that is the most effective for fish growth. This trend of food preference for different length-age groups was also noted in redfish from *Sebastes* genus in the Northwest Atlantic (Konchina, 1985).

During feeding (June-July), crustaceous zooplankton is mainly distributed in the upper 400 m layer of the Irminger Sea pelagial. Concentrations of squids and mesopelagic fish are registered at the depths below 400 m (Pavlov, 1992). Distribution of food organisms by depths conditions a wide range of redfish vertical distribution off the Reykjanes Ridge western slope. In this case, small-size redfish, feeding on crustaceous zooplankton, are mainly distributed in the pelagial upper layers. Redfish from older age groups, feeding on mesopelagic fish and macroplankton, dwell larger depths. Such pattern of distribution of redfish length-age groups by depth, undoubtedly, contributes to reduction of food competition within the population, more complete and efficient utilization of food supply, and indicates the ecological and trophic plasticity of this species.

Results from the feeding analysis indicate the food preference for different length-age groups to be maintained irrespective of redfish distribution by depth. Thus, small-size fish at the depths below 500 m prefer crustaceous zooplankton, and redfish from older age groups feed on mesopelagic fish and macrozooplankton in a 0-500 m layer. Such food preference is probably maintained by means of regular vertical feeding migrations. Thus, the feeding analysis for redfish length groups does not confirm the opinion of a number of researchers in that the redfish from the 0-500 and 500-1 000 m layers are separated and no exchange is available between them.

Conclusion

1. Results from studies on *S. mentella*, obtained during the 1980s and 1990s, indicate a complete similarity of parasite fauna composition and infestation by species most parasites of redfish from the upper (above 500 m) and lower (500-1 000 m) layers of its dwelling in the Irminger Sea pelagial.

2. According to the results from long-term studies, availability of *Sphyrion lumpi* in fish is a rather reliable parasitologic mark when considering not only alive copepods, but also the remains of their presence, as far as they remain in fish, probably, up to the end of host's life. The data available on infestation by *S. lumpi* indicate the level of invasion and peculiarities of infestation of *S. mentella* from both layers of its dwelling to be the same at different sites of the area.

3. Slight decrease in occurrence of *S. mentella* specimens with pigmented patches on skin seems to be a consequence of age variations in fish and obvious pathology of this phenomenon. Therefore, it is inexpedient to use it as criterion for intraspecific differentiation of fish.

4. Somewhat drop in occurrence of *S. mentella* specimens with melanin in muscular tissue at the depth below 500 m can also be related to age variations and changing of ecological conditions for redfish habitation, and, therefore, cannot give evidence of belonging of *S. mentella* specimens from elder age groups to another "type" or another population.

5. Results of investigations of length-age structure of the *Sebastes mentella* aggregations within the whole vertical distribution show that the formation of concentrations deeper than 500 m takes place because of the partial redistribution of fish at the age of 5-18 and full sinking down of redfish older than 18 from the upper pelagic 500 m layer to the large depth.

6. The revealed similarity in the rate of linear and weight growth, absolute and relative increments and maturation rate of redfish in the 0-500 m and 500-900 m layers is one of the illustrations that they belong to the common reproductive part of the Irminger Sea redfish population.

7. Diet analysis has shown that food preferences of different age-length redfish groups do not change according to fish distribution by depth. Small immature individuals of 26-30 cm length prefer to feed on crustaceous zooplankton. With linear growth in redfish, the proportion of shrimp, squids and fish increases. Large mature fish of 41-50 cm length feed largely on mesopelagic fish and macrozooplankton. Older fish are better adapted to greater depths, which makes feeding more efficient, reduces intraspecies food competition and enhances the utilization of food supply by redfish stock. Food preferences in different length groups of redfish at various depths are catered due to regular vertical feeding migrations.

8. Thus, results from parasitologic studies, as well as similar peculiarities of infestation by *S. lumpi* and availability of pigmented patches, pattern of feeding, considerable similarity in rates of linear and weight growth and maturation indicate similar conditions for dwelling of redfish and give evidence in favour of the same origin and integrity of *S. mentella* stock from the upper (0-500 m) and the lower (500-1 000 m) layers in the Irminger Sea pelagial. In this context the redfish concentrations distributed in the depths below 500 m must be considered a deep-sea component of the reproductive part of the *S. mentella* population in the Irminger Sea pelagial.

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Table 1. Analysed material volume from the Irminger Sea in 1995-1999.

Volume of measurements	Layer, m	
	0-500	500-900
Spec. measured	14128	63259
Maturation analysis, spec.	3705	6711
Age, spec.	520	2158

Table 2. Parasite fauna of *S. mentella* from different layers in the Irminger Sea by the data for 1983, 1986 and 1999.

Parasites	27 June 1999				July 1986				April 1983			
	190-290 ?		550-805 ?		120-200 ?		650-700 ?		200-400 ?		510-600 ?	
	n=25, l=30-38 cm L=35,2 cm		n=30, l=40-47 cm L=42,4 cm		n=20, l=29-40 cm L=34,7		n=16, l=36-43 cm L=39,4 cm		n=139, l=28-40 cm L=35,0 cm		n=20, l=35-43 cm L=38,6 cm	
	$57^{0}57'$ N, $36^{0}42'$ W				$59^{0}18'$N, $36^{0}14'$W		Reykjanes Ridge		$60^{0}44'$-$62^{0}05'$ N $29^{0}07'$-$32^{0}55'$ W		$61^{0}40'$N, $29^{0}10'$W	
	P.p.	A.i.	P.p.	A.i.	P.p.	A.i.	P.p.	A.i.	P.p..	A.i	P.p.	A.i.
Myxidium incurvatum	8,0	+	6,7	+	5,0	+	6,25	+	5,0	+	5,0	+
M. obliquelineolatum	4,0	+	6,7	+	10,0	+	6,25	+	2,2	+	5,0	+
Leptotheca adeli	8,0	+	6,7	+	-	-	-	-	-	-	-	-
Pseudalataspora sebastei	4,0	+	3,3	+	-	-	-	-	-	-	-	-
Bothriocephalus scorpii	8,0	0,08	16,7	0,17	15,0	0,15	12,5	0,19	13,7	0,16	10,0	0,10
Hepatoxylon trichiuri pl.	-	-	-	-	-	-	-	-	1,4	0,01	5,0	0,05
Scolex pleuronectis pl.	8,0	0,08	6,7	0,10	30,0	0,75	12,5	0,25	10,8	0,16	10,0	0,15
Phyllobothrium sp. pl.	8,0	0,20	26,7	0,67	-	-	-	-	3,6	0,06	5,0	0,10
Diphyllobothrium sp. pl.	4,0	0,04	3,3	0,03	-	-	-	-	-	-	-	-
Grillotia sp. pl.	4,0	0,04	6,7	0,07	5,0	0,05	-	-	1,4	0,01	5,0	0,05
Derogenes varicus	-	-	-	-	-	-	-	-	1,4	0,01	5,0	0,05
Podocotyle reflexa	4,0	0,04	3,3	0,03	5,0	0,05	6,25	0,12	-	-	-	-
Anomalotrema koiae	4,0	0,04	3,3	0,03	-	-	-	-	-	-	-	-
Lecithophyllum bothriophoron	4,0	0,04	26,7	0,40	-	-	-	-	4,3	0,06	5,0	0,05
Anisakis simplex l.	100,0	11,00	100,0	12,0	65,0	4,25	93,7	5,69	76,3	5,68	90,0	6,60
Hysterothylacium aduncum	8,0	0,08	6,7	0,07	15,0	0,15	18,7	0,25	4,3	0,05	10,0	0,10
Sphyrion lumpi [1]	14,0	0,22	10,1	0,12	15,0	0,20	12,5	0,19	12,2	0,16	10,0	0,15

NOTE: P.p – Prevalence of parasite, %; A.i – Abundance index; [1] - infestation by alive copepods of *S. lumpi*; [2] - infestation with alive *S. lumpi* and remains of its presence.

Table 3. Prevalence of parasite in *Sebastes mentella* with *Sphyrion lumpi* by zones of fish investigations (by the data for 1999).

Zones investigated*	Prevalence of parasite, %			Abundance index		
	Males	Females	Total	Males	Females	Total
I	25,3 28,9	34,8 32,8	29,1 30,5	0,4 0,4	0,6 0,6	0,5 0,5
II	6,0 9,5	13,0 11,6	8,8 10,4	0,1 0,1	0,2 0,2	0,1 0,1
III	0,7 0,2	1,8 0,8	1,1 0,4	0,002 0,001	0,018 0,010	0,010 0,005
IV	2,1 1,0	17,1 14,9	8,2 6,7	0,02 0,01	0,3 0,3	0,1 0,1
All the fish examined	31,1 35,4	53,1 47,0	40,3 40,2	0,5 0,5	1,1 1,0	0,7 0,7

Note: Prevalence of infestation with *S. lumpi* is given with allowance for its presence. At the depths above 500 m – over line; at the depths below 500 m – under line; * see Fig. 1.

Table 4. Occurrence of *phyrion lumpi*, pigmented patches on skin and availability of melaninin muscular tissue of *Sebastes mentella* at different depth of the Irminger Sea pelagial (by the data from RV "AtlantNIRO", June/July 1999).

	Subarea A			Subarea B			Subarea D			Subarea E			The entire area		
External lesions	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
Fish examined, indiv.	- / 97	- / 65	- / 162	447 / 729	316 / 498	763 / 1227	57 / 86	43 / 71	100 / 157	58 / 15	42 / 8	100 / 23	562 / 927	401 / 642	963 / 1569
% of fish with external lesions	- / 34,0	- / 61,5	- / 45,1	40,5 / 41,3	68,7 / 61,6	52,2 / 49,6	43,8 / 50,0	65,1 / 57,7	53,0 / 53,0	39,6 / 33,3	69,0 / 75,0	52,0 / 47,8	40,7 / 41,2	68,3 / 61,4	52,2 / 49,5
% of fish with pigmented patches	- / 11,3	- / 23,1	- / 16,0	16,3 / 10,6	31,3 / 19,3	22,5 / 14,1	14,0 / 17,4	34,9 / 31,0	23,0 / 23,6	19,0 / 6,7	30,9 / 75,0	24,0 / 30,4	16,4 / 11,2	31,7 / 21,7	22,7 / 15,5
% of fish infested by *S. lumpi*	- / 28,9	- / 46,1	- / 35,8	31,1 / 36,5	53,2 / 48,0	40,2 / 41,2	31,6 / 34,9	53,5 / 42,2	41,0 / 38,2	31,0 / 26,7	52,4 / 37,5	40,0 / 30,4	31,1 / 35,4	53,1 / 47,0	40,3 / 40,2
Melanocytes in musculas															
Fish examined, indiv.	- / 42	- / 30	- / 72	137 / 229	95 / 124	232 / 353	17 / 29	8 / 21	25 / 50	9 / 15	17 / 8	26 / 23	163 / 315	120 / 183	283 / 498
% of fish with melanocytes	- / 23,8	- / 16,7	- / 20,8	28,5 / 16,2	27,4 / 19,4	28,0 / 17,3	23,5 / 34,5	25,0 / 23,8	24,0 / 30,0	22,2 / 13,3	23,5 / 25,0	23,1 / 17,4	27,6 / 18,7	26,7 / 19,7	27,2 / 19,1

Note: Subareas are given according to the ICES areas (ICES CM 1993/G:6); at the depths above 500 m– over line; at the depths below 500 m – under line;

no investigations were done – minus over line.

Table 5. Mean length, absolute and relative increments of lenght for males and females of redfish in the layers 0-500, 500-900 m in the Irminger Sea in 1995-1999.

Age, yaers	0-500 m				500-900 m			
	Mean Length	Increment		No.of spec	Mean length	Increment		No.of spec
		cm	%			cm	%	
				Males				
6	-	-	-	-	24.7	-	-	9
7	25.7	-	-	16	26.0	1.3	5.3	31
8	27.4	1.7	6.6	10	27.5	1.5	5.8	18
9	28.6	1.2	4.4	11	28.6	11.1	4.0	28
10	30.1	1.5	5.2	19	30.2	1.6	5.6	43
11	31.3	1.2	4.0	26	31.5	1.3	4.3	48
12	32.5	1.2	3.8	32	32.6	1.1	3.5	51
13	34.0	1.5	4.6	72	34.1	1..5	4.6	76
14	35.4	1.4	4.1	50	35.4	1.3	3.8	60
15	36.8	1.4	3.9	52	37.0	1.6	4.5	101
16	38.3	1.7	4.6	22	38.8	1.8	4.9	57
17	40.0	1.7	4.4	10	40.2	1.4	3.6	155
18	-	-	-	-	42.1	1.9	4.7	95
19	-	-	-	-	43.4	1.3	3.1	97
20	-	-	-	-	44.5	1.1	2.5	62
21	-	-	-	-	45.5	1.0	2.2	48
22	-	-	-	-	46.3	0.8	1.8	40
23	-	-	-	-	47.5	1.2	2.3	18
24	-	-	-	-	48.2	0.7	1.5	10
				Females				
6	-	-	-	-	24.3	-	-	15
7	25.6	-	-	15	26.0	1.7	7.0	31
8	27.5	1.9	7.4	9	27.6	1.6	6.2	35
9	28.4	0.9	3.6	13	28.7	1.1	4.0	30
10	30.4	2.1	7.4	13	30.3	1.6	5.6	45
11	31.5	1.1	3.6	14	31.4	1.1	3.6	34
12	32.5	1.0	3.2	7	32.5	1.1	3.5	47
13	33.8	1.3	4.0	27	34.1	1.6	4.9	48
14	35.3	1.5	4.4	30	35.7	1.6	4.7	77
15	36.8	1.5	4.2	34	36.9	1.2	3.4	100
16	38.3	1.5	4.1	15	38.5	1.6	4.3	62
17	39.7	1.4	3.7	23	40.2	1.7	4.4	116
18	-	-	-	-	42.1	1.9	4.7	82
19	-	-	-	-	43.3	1.2	2.9	88
20	-	-	-	-	44.7	1.4	3.2	79
21	-	-	-	-	45.6	0.9	2.0	67
22	-	-	-	-	46.5	0.9	2.0	54
23	-	-	-	-	47.5	1.0	2.2	53
24	-	-	-	-	48.5	1.0	2.1	28
25	-	-	-	-	49.5	1.0	2.1	13
26	-	-	-	-	50.4	0.9	1.8	7

Table 6. Mean weight, absolute and relative increments of weight for males/females of redfish in the layers 0-500, 500-900 m in the Irminger Sea in 1995-1999.

Age, yaers	0-500 m				500-900 m			
	Mean Weight	Increment g	Increment %	No.of Spec.	Mean weight	Increment g	Increment %	No.of spec
				Males				
7	222	-	-	16	209	-	-	31
8	241	19	8.6	10	253	46	21.1	18
9	284	43	17.8	11	280	27	10.7	28
10	330	46	16.2	19	332	52	18.6	43
11	395	65	19.7	26	369	37	11.1	48
12	434	39	9.9	32	423	54	14.6	51
13	513	79	18.2	72	488	65	15.4	76
14	575	62	12.1	50	569	81	16.6	60
15	648	73	12.7	52	636	67	11.8	101
16	729	81	12.5	22	739	103	16.2	57
17	751	22	3.0	10	836	97	13.3	155
18	-	-	-	-	955	119	14.2	95
19	-	-	-	-	1045	90	9.4	97
20	-	-	-	-	1112	67	6.4	62
21	-	-	-	-	1167	55	4.9	48
22	-	-	-	-	1240	73	6.3	40
23	-	-	-	-	1273	33	2.7	18
24	-	-	-	-	1348	75	5.9	10
				Females				
6	-	-	-	-	170	-	-	15
7	215	-	-	15	212	42	24.7	31
8	241	26	12.1	9	253	41	19.3	35
9	280	39	16.2	13	291	38	15.0	30
10	338	58	20.7	13	324	33	11.3	45
11	393	55	16.3	14	365	41	12.7	34
12	425	32	8.1	7	422	57	15.6	47
13	497	72	16.9	27	505	83	19.7	48
14	575	78	15.7	30	599	91	18.6	77
15	659	84	14.6	34	648	49	8.2	100
16	745	86	13.1	15	774	126	19.4	62
17	784	39	5.2	23	832	52	7.5	116
18	910	126	16.1	3	965	124	16.0	82
19	-	-	-	-	1065	104	10.4	88
20	-	-	-	-	1161	85	9.0	79
21	-	-	-	-	1212	61	4.4	67
22	-	-	-	-	1295	80	6.8	54
23	-	-	-	-	1334	51	3.0	53
24	-	-	-	-	1385	45	3.8	28
25	-	-	-	-	1441	59	4.0	13

Table 7. Diet of *Sebastes mentella* by length groups in the Irminger Sea in 1995-1999, %.

Food composition	Depth, m	Length groups, cm				
		26-30	31-35	36-40	41-45	46-50
Calanus	0-500	40,4	17,1	13,6	43,4	-
	500-1000	16,7	20,0	9,0	1,7	-
Euphausiids	0-500	34,8	12,4	8,2	33,8	-
	500-1000	25,0	24,4	6,0	3,4	-
Themisto	0-500	62,9	64,1	38,6	35,9	-
	500-1000	25/0	35,6	38,8	39,0	50,0
Sagitta	0-500	2,2	0,4	1,6	14,5	-
	500-1000	8,3	-	1,5	-	-
Shrimp	0-500	6,7	17,9	26,1	4,8	-
	500-1000	-	8,9	35,8	47,4	58,3
Squid	0-500	16,8	32,9	34,2	26,9	-
	500-1000	33,3	48,9	34,3	18,6	-
Fish	0-500	3,3	3,8	10,6	7,8	-
	500-1000	16,0	15,6	25,5	35,6	31,0
Other species	0-500	-	7,3	7,8	7,0	-
	500-1000	-	2,2	4,5	3,8	2,0

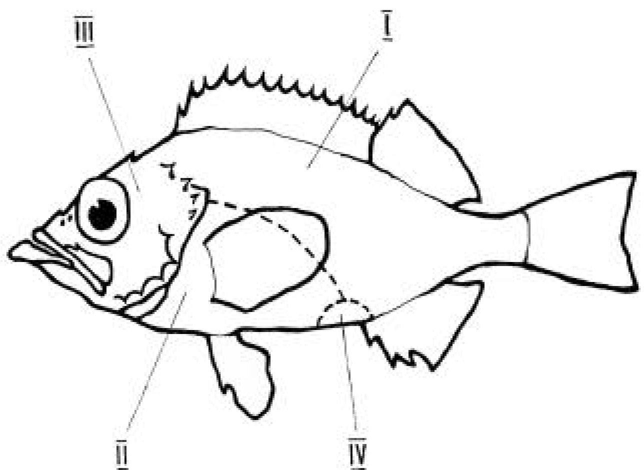

Fig. 1. Parcelling the body surface out the zones of lesion localization: I – dorsal (“fillet “) and caudal part, II – ventral part, III – head, IV – anal part.

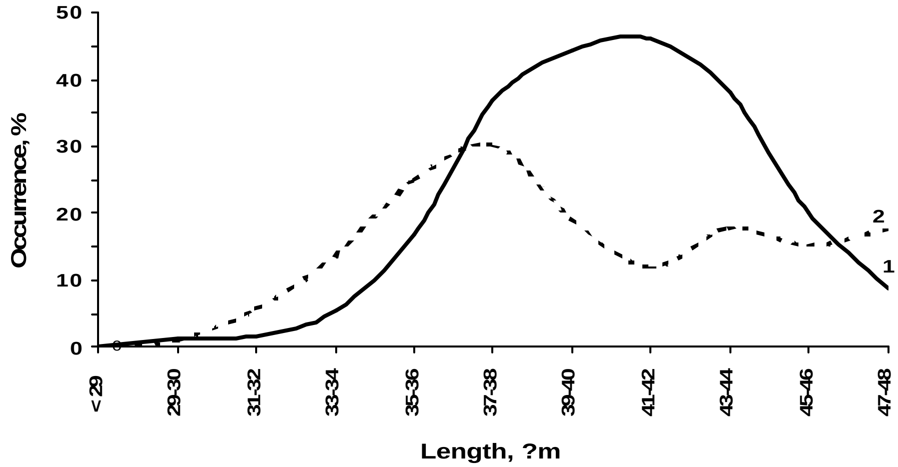

Fig. 2. Occurrence of *S. mentella* with pigmented patches on skin at different lengths in the Irminger Sea in 1983-1986 in 0-500 m layer (1) and in 1999 in 0-1000 m layer (2).

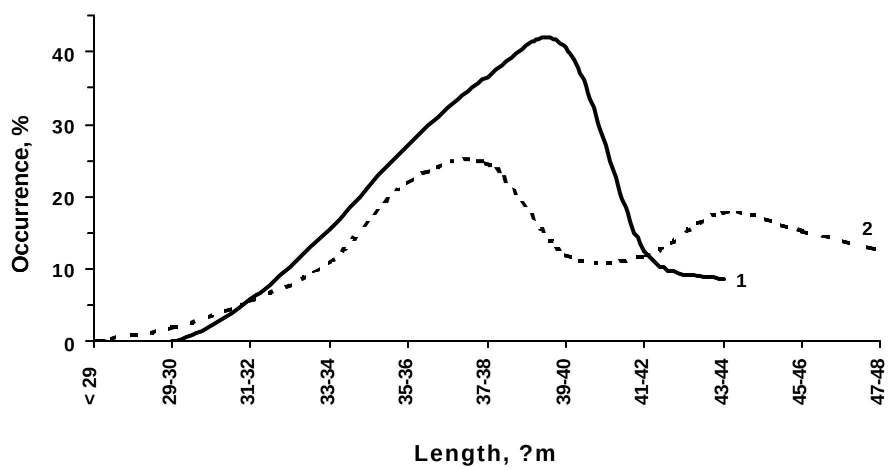

Fig. 3. Occurrence of *S. mentella* with pigmented patches on skin at different length caught at the depths above 500 m (1) and below 500 m (2) in the Irminger Sea during the year of 1999.

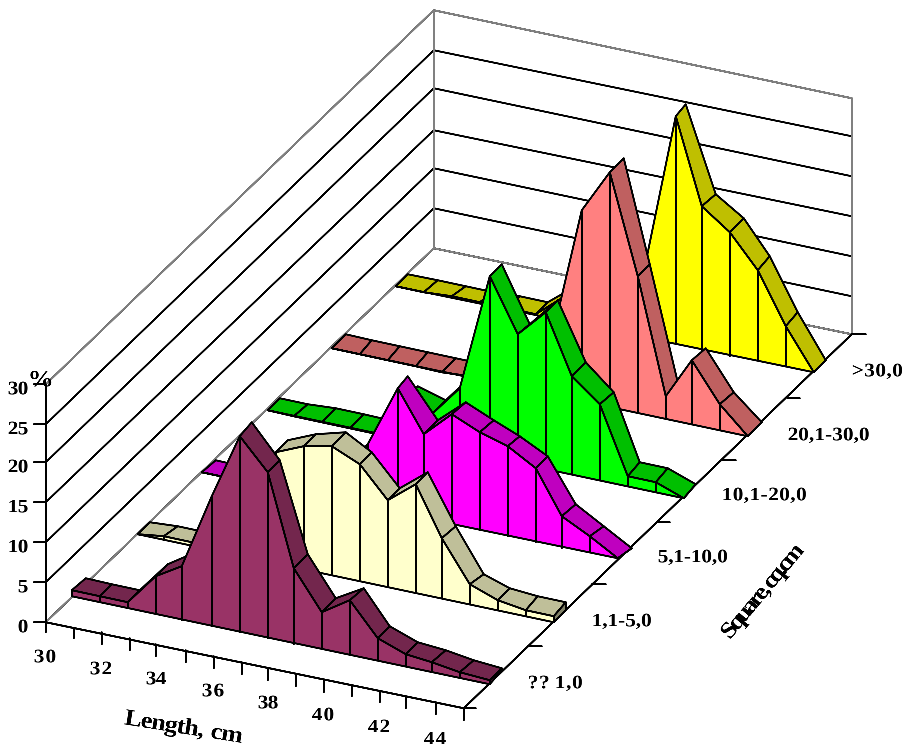

Fig. 4. Occurrence of different-size pigmented patches on skin of *Sebastes mentella* from the Irminger Sea depending on fish length.

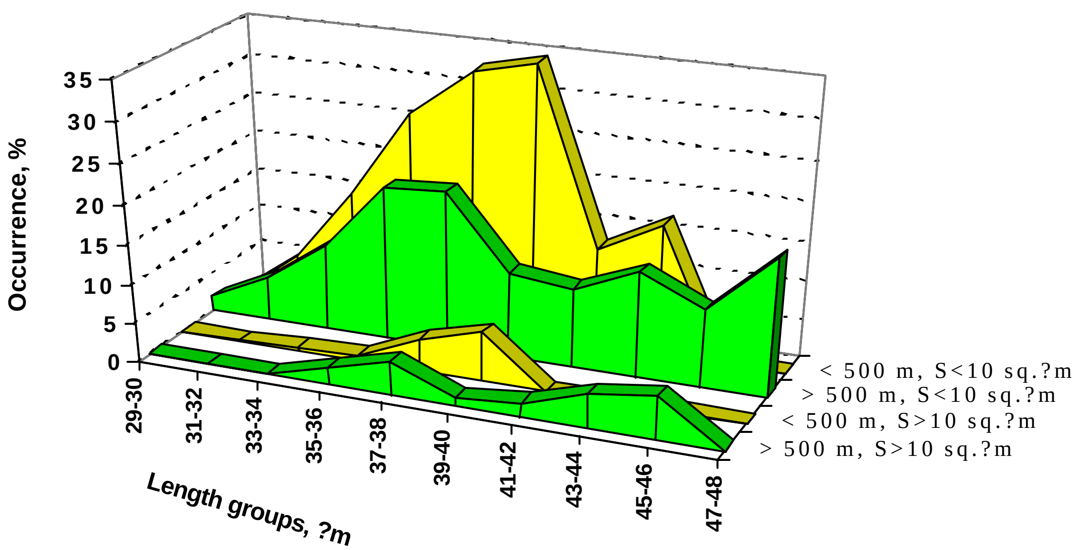

Fig. 5. Occurrence of S. mentella specimens with pigmented patches of different size depending on fish length at different depths of the Irminger Sea (1999).

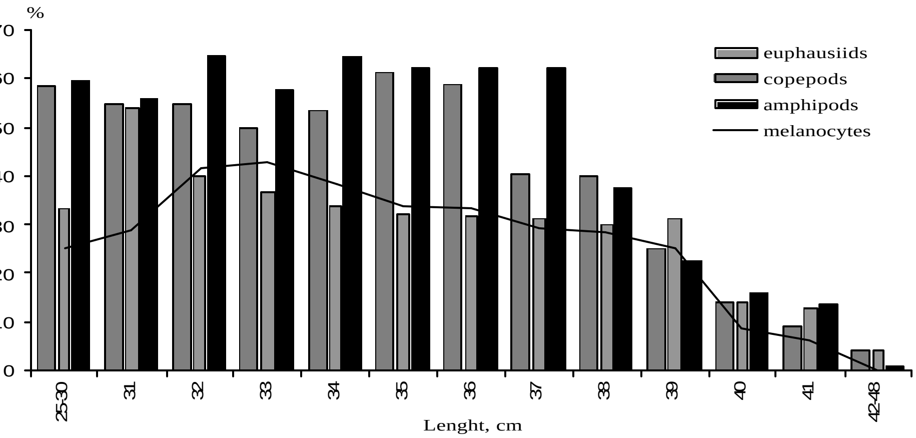

Fig. 6. Occurrence of *S. mentella* with melanocytes in muscular tissue and of some components in its feeding depending on fish length.

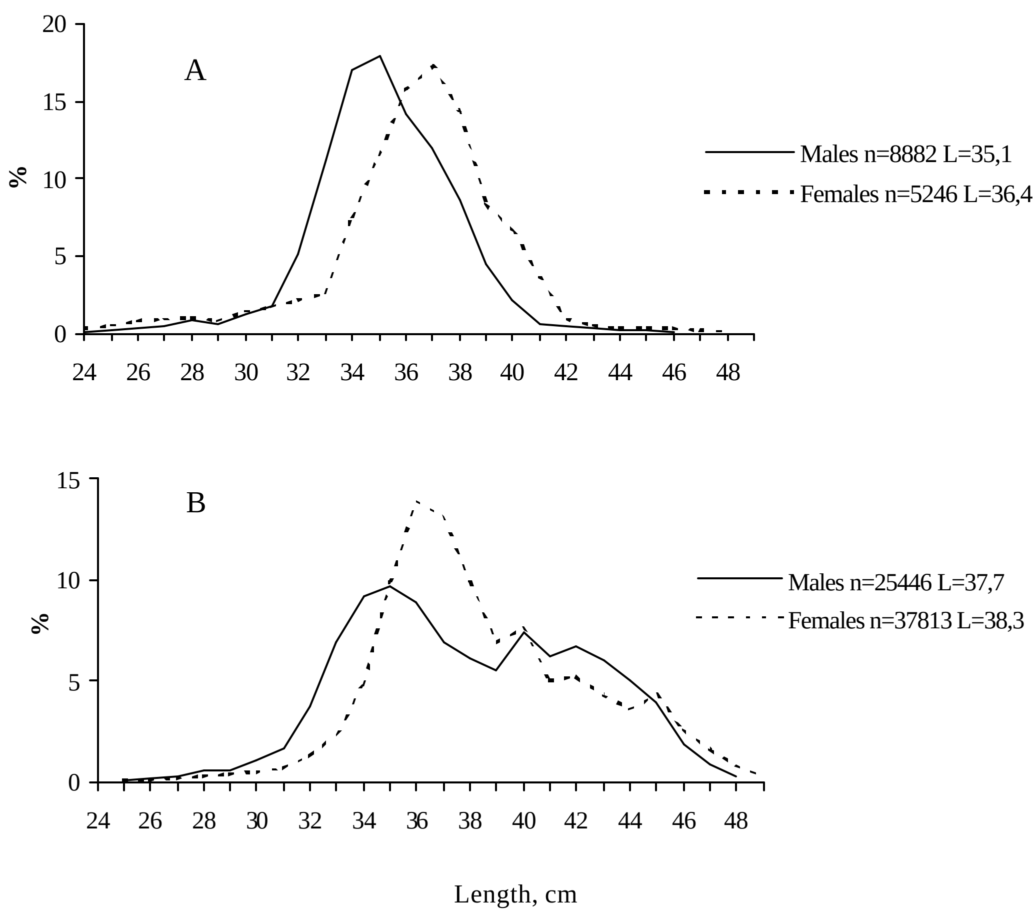

Fig. 7. Length composition of redfish in the layers 0-500 m (A), 500-900 m (B) in the Irminger Sea in 1995-1999.

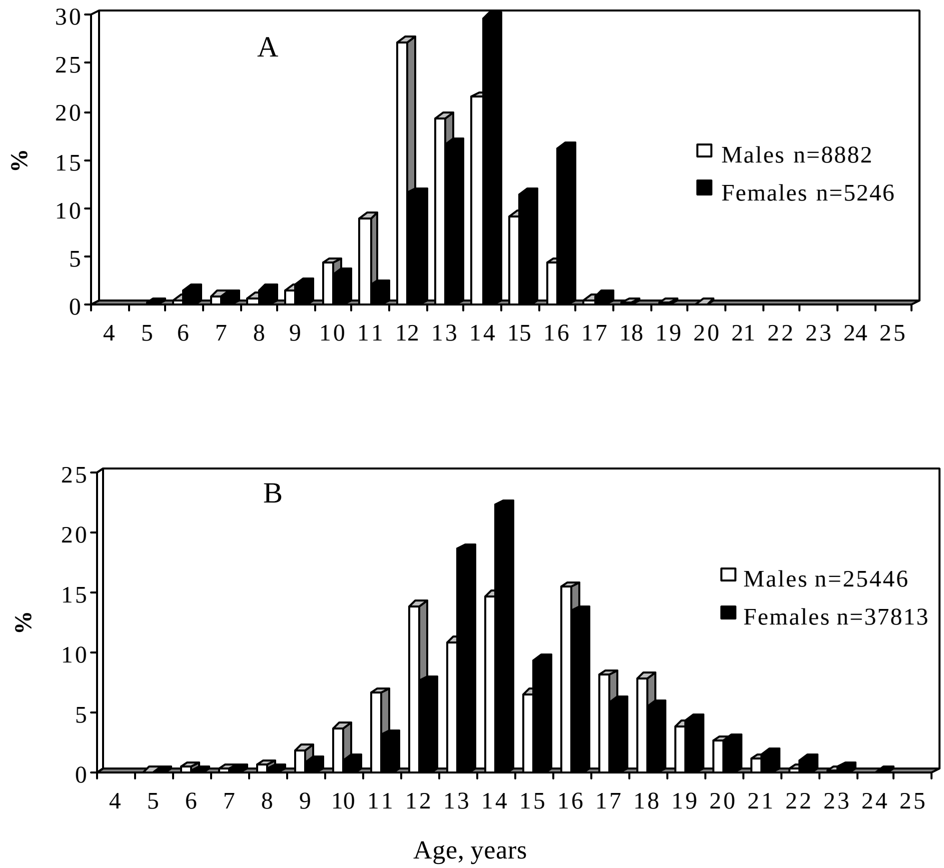

Fig. 8. Age composition of redfish in the layers 0-500 m (A), 500-900 m (B) in the Irminger Sea in 1995-1999.

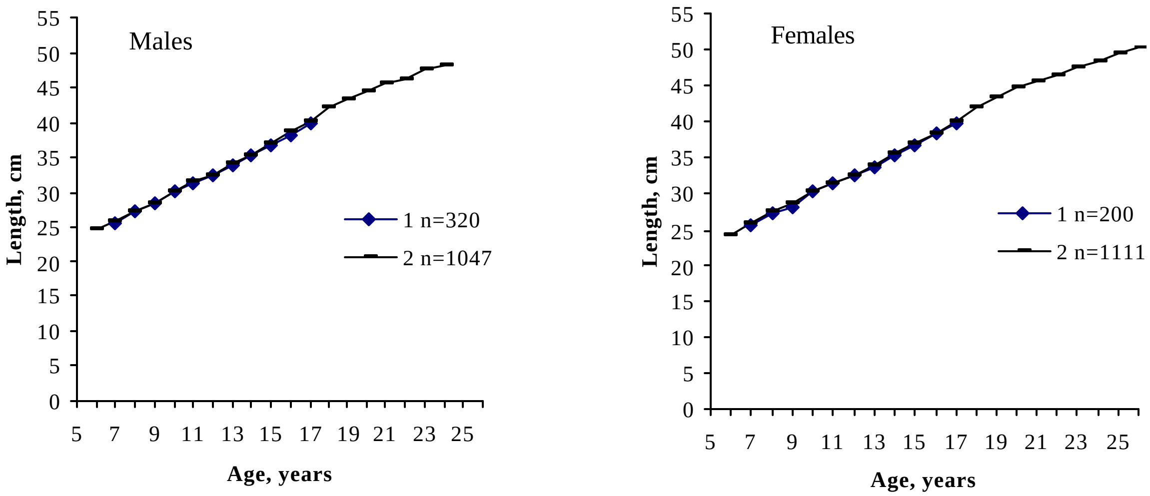

Fig. 9. Linear growth of redfish males and females in the layers 0-500 m (1), 500-900 m (2) in the Irminger Sea in 1995-1999.

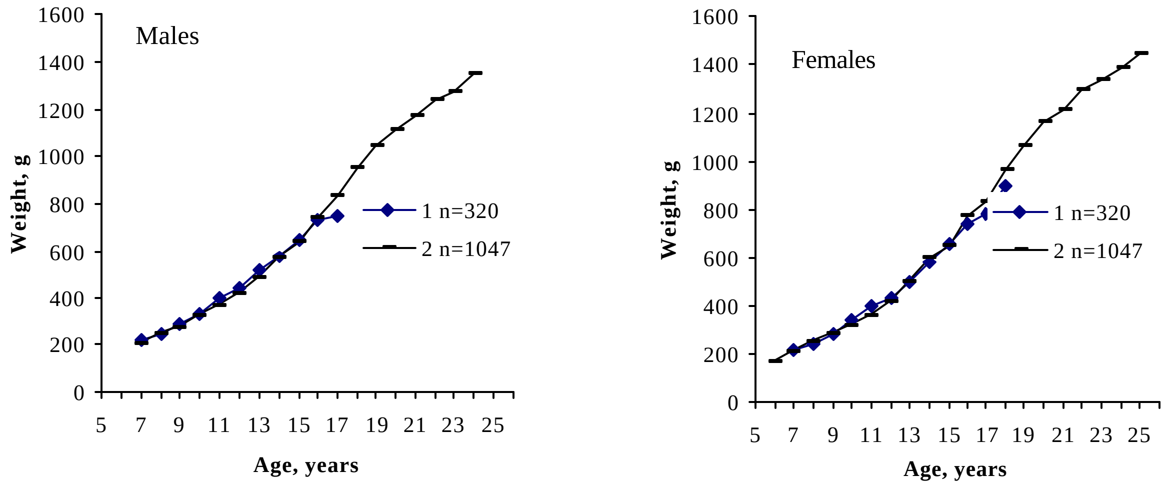

Fig. 10. Weight growth of redfish males and females in the layers 0-500 m (1), 500-900 m (2) in the Irminger Sea in 1995-1999.

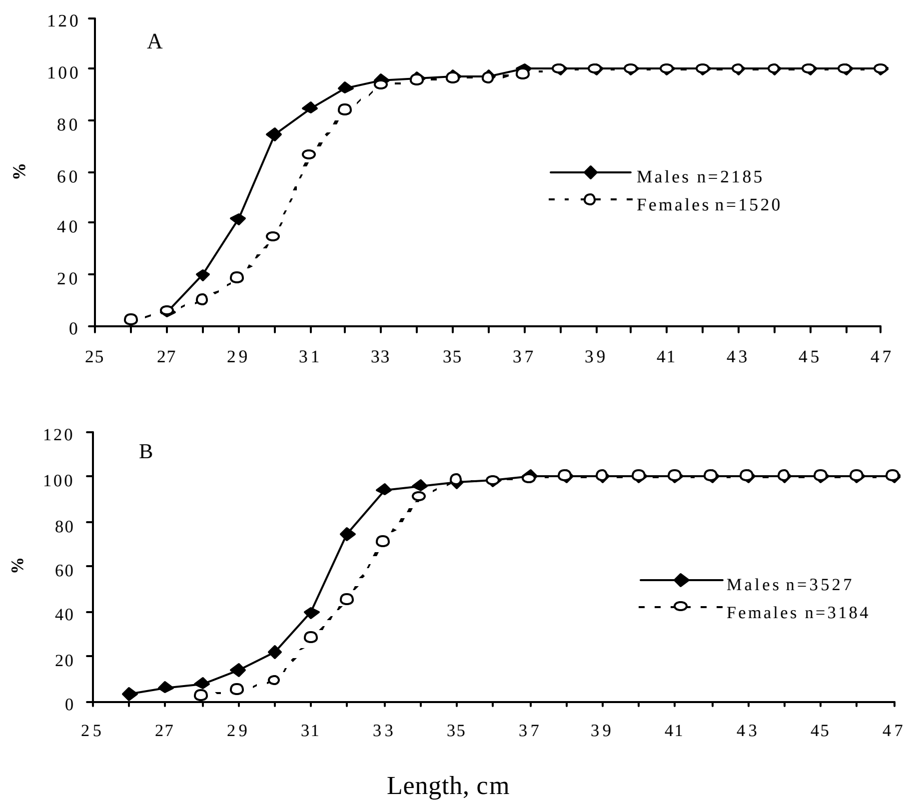

Fig. 11. Maturation of males and females of redfish by length groups in the layers 0-500 m (A), 500-900 m (B) in the Irminger Sea in 1995-1999.

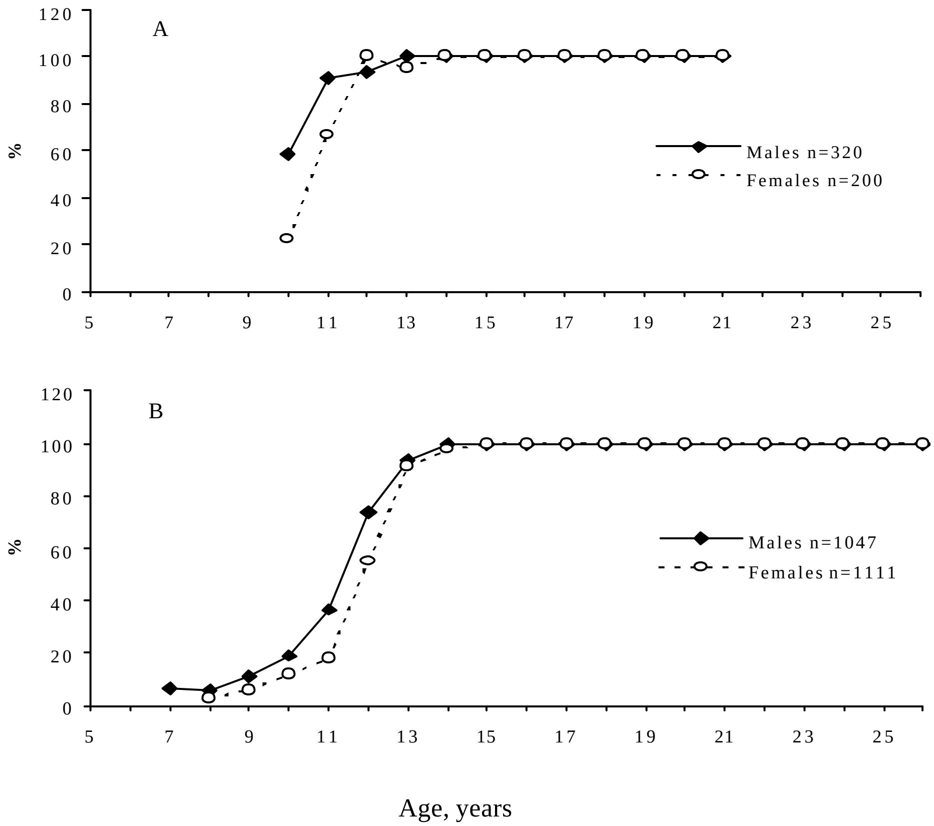

Fig. 12. Maturation of males and females of redfish by age groups in the layers 0-500 m (A), 500-900 m (B) in the Irminger Sea in 1995-1999.