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Age Structure of Roughhead Grenadier (*Macrourus berglax*) in the Northwest Atlantic, 1985

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Abstract

Keys for converting roughhead grenadier (*Macrourus berglax*) length distributions into age were made using samples collected in a bottom trawl survey in NAFO Div. 0B, 2G, 2H and 3K in 1985 at 610–1 240 m depths. Ageing was done on scales using polarized transmitted light. Age structure of catches from all these Divisions were found to be similar. Linear growth was expressed by exponential functions and the von Bertalanffy formula, and weight by exponential functions and the Gompertz formula. Length-weight relationships were satisfactorily described by exponential functions. The materials confirmed the relatively slow growth and multiaged structure of *M. berglax* in the sample area.

Key words: Age determination, growth, length distributions, Roughhead grenadier, Roundnose grenadier

Introduction

It is more difficult to age deepwater fishes, specifically Macrouridae, than those from the upper ocean layers, since the rings are hardly visible on their body structures such as scales, otoliths, gill covers. According to the opinion of most investigators, the reason for this is the seasonal phenomena are not pronounced at the greater depths. However, by using special methods (e.g. polarized light and chemical actions on such structures) it has been demonstrated that growth rings are in fact observable (Savvatimsky *et al*., 1977). French investigators have observed that rings exist on otoliths of fish caught at 4 700 m depth (Rannou, 1975). The electron microscope study found the otolith structure of bathypelagic macrourus (*Coryphaenoides guntheri*) to be similar to the otolith structure of fish from upper layers; the rings showing rhythmical variations in growth corresponding to the seasonal cycles (Rannou and Thiriot-Quievreux, 1975).

The rings on macrourus scales, which are regarded as yearly ones, are distinguishable when using polarized transmitted light. According to Hureau *et al*. (1979), having applied different methods for age determination, *Macrourus berglax* has a prolonged life cycle and multiaged populational structure, which are typical for deepwater fishes. However, the published information on *M. berglax* age and growth is fragmentary and does not give a clear idea of age and population structure.

Yanulov (1962) reports that a female of this species (70.5 cm long), caught at the northern coast of Norway, was at age 16 years. The Norwegian investigators regard the *M. berglax* to reach ages of 25 (Eliassen, MS 1983) and 30 years (Bakken *et al*., 1975). According to our data, fish 48–70 cm long caught by a bottom trawl in December 1982 in the Lofoten Isles area were at ages 8–17 years (Savvatimsky, 1986). Females of this species, 67–89 cm long and 1 950–4 700 g in weight, from the Iceland area, were at ages 17–25 years (Savvatimsky, 1971). Similarly, fish samples ranging from 41 to 86 cm in length at ages 8–18 years, with the specimens from 62 to 75 cm and ages 12–15 years predominant, were found in catches taken on the Dohrn Bank, not far from the eastern coast of Greenland (Kosswig, MS 1979).

Limited information on age and growth rate of *M. berglax*, inhabiting the Northwest Atlantic is available in scientific literature. Such information has been based on sparse material, and the scientists have applied different methods for growth estimation, which in our opinion has resulted in some discrepancies in the results obtained. According to scientists from Poland (Chrzan, 1969), analysis of 203 otoliths of *M. berglax* caught in the area of the Funk Island (Div. 3K) and Belle Isle Banks (Div. 2J) in May–June 1968, indicated fish ranging in length from 31 to 85 cm to be at ages 2–17 years. According to our data *M. berglax* caught in March 1959 by a bottom trawl on the northeastern slope of the Grand Bank (Div. 3L) at ages 3–16 years and a length range of 26–66 cm, in a total sample of 28 males and 63 females (Savvatimsky, 1971). Specimens of *M. berglax* caught by a long-line survey on the eastern Grand Bank area (Div. 3LN) in summer 1982 were much larger, the length ranging from 40 to 87 cm and ages 6–23 years (Savvatimsky, 1984).

In this paper an attempt is undertaken to add to the available information base on age, to elucidate the growth patterns, and to obtain an idea of age structure of *M. berglax* inhabiting the Northwest Atlantic.

Materials and Methods

Age samples were collected on board the R/V *Nikolai Kononov* (MB-0422) in October–December 1985 when conducting the bottom trawl survey for stock assessment of bottom fishes in the areas of the Baffin Land, Labrador and Notre Dame Bay (Table 1, Fig. 1).

TABLE 1. Areas, months and depths the age samples of *Macrourus berglax* were collected in 1985 (only fish with determined ages are tabulated).

Division	Month	Depth (m)	No. of males	No. of females
3K	Oct	930–1 100	174	125
0B	Nov	640–850	100	283
2G	Dec	610–1 150	80	170
2H	Dec	705–1 240	105	167
Total	Oct–Dec	610–1 240	459	745

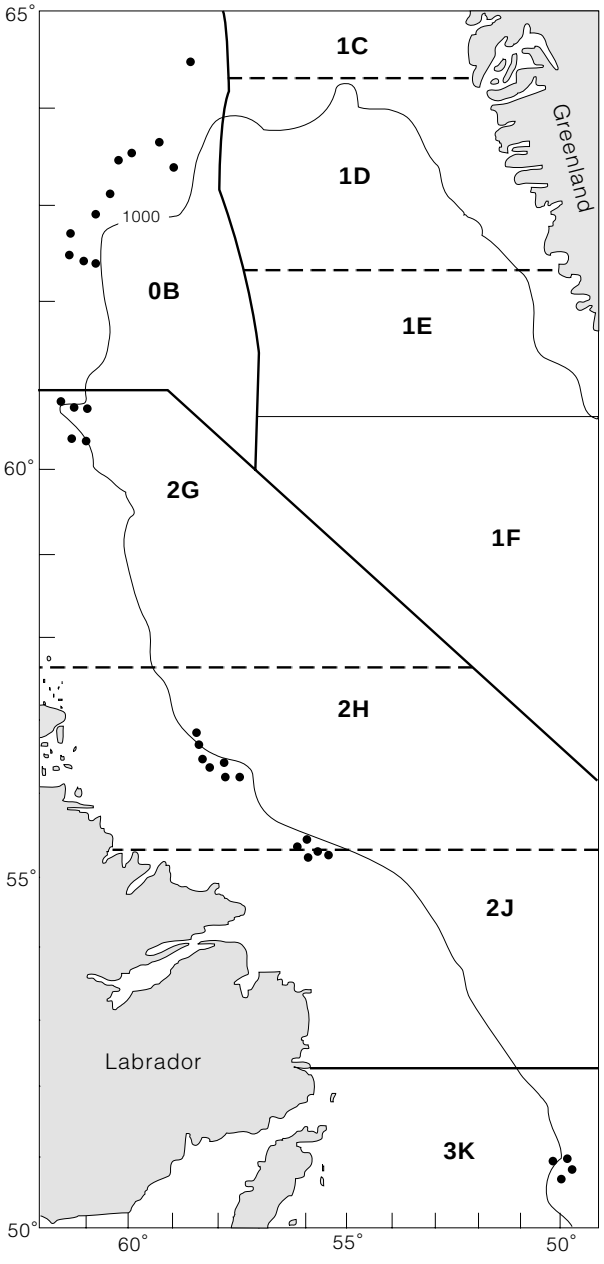

Fig. 1. Map of sampling stations in 1977-85. The shaded areas in the circles denote years in which sampling has been carried out, and the 'exploded' parts of the circles show years in which small shrimp (groups 1 and 2) have been dominating.

Macrourus berglax were measured from tip of snout to the end of tail accurate to the nearest centimetre and total weights were recorded accurate to the nearest 10 g. For convenience of statistical processing of materials, only the undamaged specimens of fish with unbroken tails were taken from catches. Scales were taken between fish dorsal fins from an area above the lateral line. Ages were determined from scales with the use of polarized light, by placing the scales between two polarizing filters. Alternating dark and light rings were considered as yearly rings, ring numbers from this method were found to coincide with numbers found by other methods, not only in Macrouridae but also in other fishes (Savvatimsky, 1971). The rings were counted on lateral sides of scales free of the small thorns and combs (Fig. 2). It should be noted that a preliminary soaking of scales in silver nitrate solution promotes contrast between rings (Fig. 3) for precise age reading.

Fish were pooled into 3 cm length classes (21–23, 24–26, etc.), and mean values of weight were found for each size-class. Mean length and weight from each age-class was also obtained. Linear growth was estimated by the von Bertalanffy formula, and the linear and exponential relationship by the Gompertz formula (Ricker, 1979). The length and weight exponential relationships were also obtained. The relationships and their formulae are given in Fig. 4–6. Yearly length and weight increments have been obtained as a difference between length and weight calculated for two adjacent year-classes.

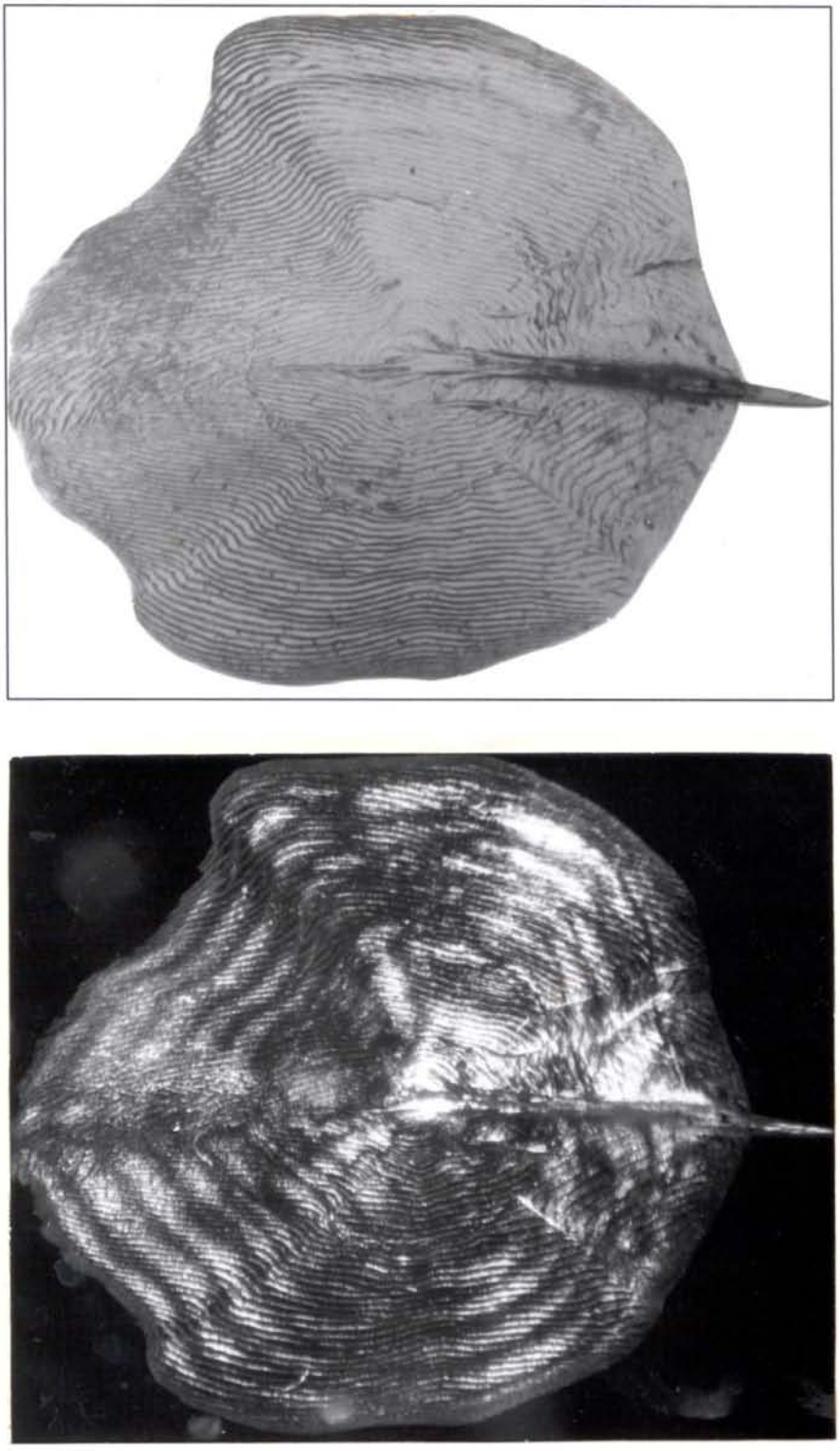

Fig. 2. Scale of *Macrourus berglax* in normal (upper) and polarized (lower) transmitted light. Sample from Div. 3K, female, total length 37 cm, weight 220 g, age 6 years.

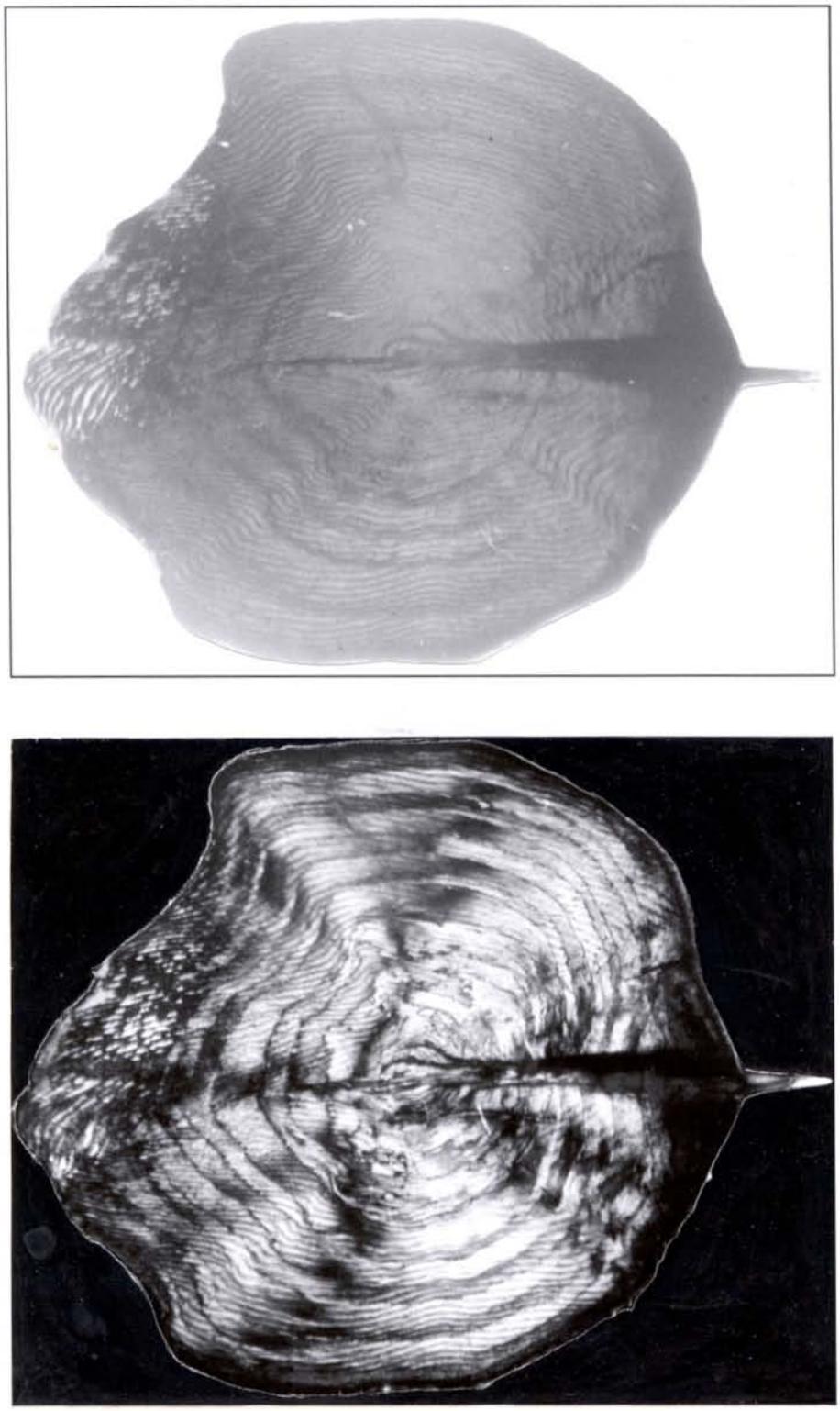

Fig. 3. Scale of *Macrourus berglax*, soaked for 2 hours in a 1% solution of silver nitrate in normal (upper) and polarized (lower) transmitted light. Sample from Div. 3K female, total length 37 cm, weight 220 g, age 6 years.

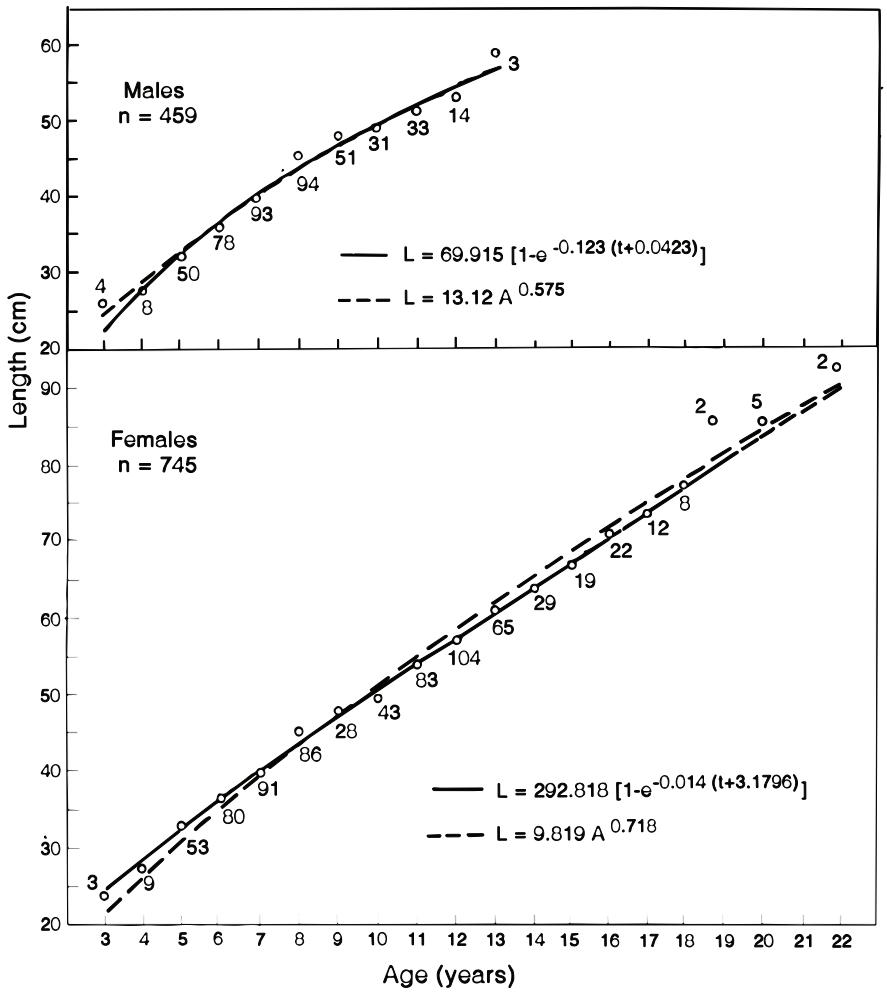

Fig. 4. Linear growth of *Macrourus berglax* from Div. 0B, 2GH and 3K, 1985. Digits on the curves are the number of fish analyzed.

Age composition of catches for *M. berglax* from Div. 0B, 2GH and 3K have been estimated by summarized length frequencies for 1969–89, using the length-age keys (Tables 2, 3 and 4). The keys were developed using age samples obtained in 1985.

Results and Discussion

Many difficulties in reading Macrouridae age from otoliths and scales have been reported previously (Savvatimsky, 1971, 1984; Savvatimsky *et al.*, 1977). In general, it is not difficult to count rings on otoliths and scales in small fish, however, age reading in larger fish is more complicated since many rings are present and they lie close to each other. The most complicated area is in the rings in the central part of scales, where especially in larger fish, they may constitute 1–2 years for each ring.

Age of a small number of fish caught in different areas of the Canadian coast are given in Table 1 and Fig. 1. In a comparison of the growth rates (age curves), separately for females and males by different areas, no reliable differences were found, therefore, all age samples were pooled into one, including 459 males and 745 females. Using this single sample, the age-length keys were developed (Tables 2–4) for subsequent conversion of length distribution (Table 5) into age and for analyzing age structure of *M. berglax* catches in Div. 0B, 2GH and 3K (Table 6). Age structures were found to be similar. Mean age for males in Div. 0B, 2GH and 3K were 7.7, 8.6 and 8.5 and for females 10.9, 10.4 and 10.7, respectively. A notable difference was that age composition of catches (for both males and females) from Div. 0B had single modal frequencies, while from Div. 2GH and 3K they were bimodal. The reasons are not known.

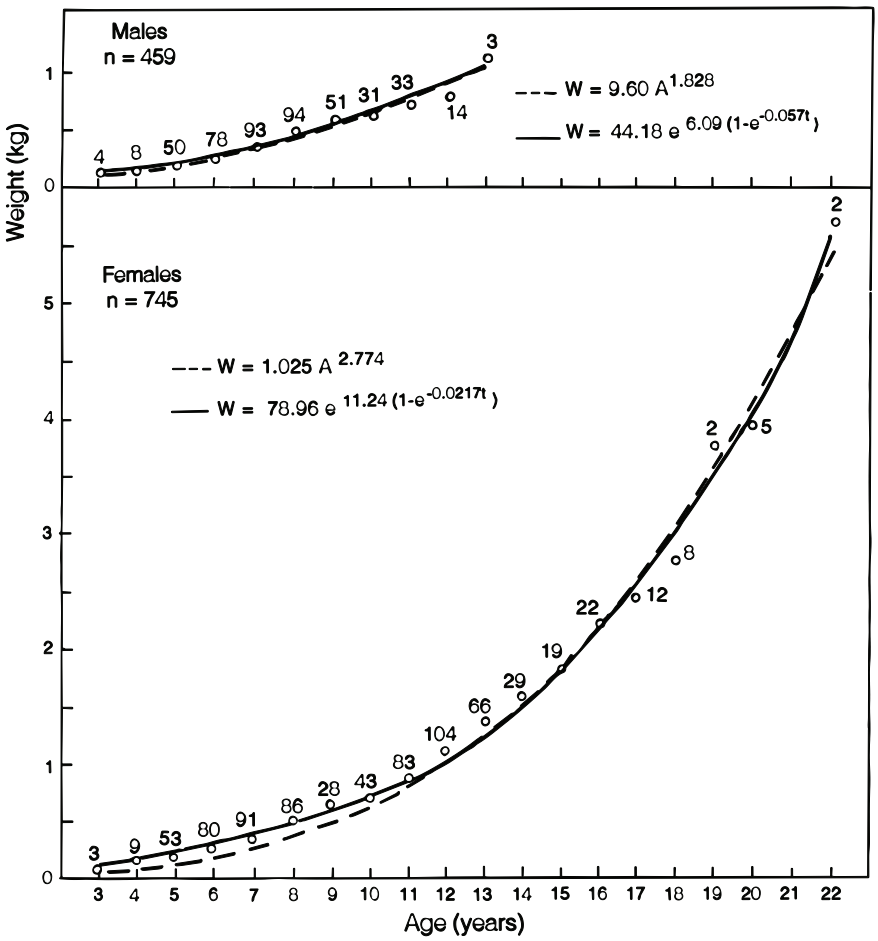

Fig. 5. Growth in weight of *Macrourus berglax* from Div. 0B, 2GH and 3K, 1985. Digits on the curves are the number of fish analyzed.

It is necessary to note that the age-length keys and size composition of catches should be taken from the same stock and in the same year, since these growth rates may vary. In this study, the length compositions of catches used were from a prolonged period (1969–89) (Table 5, 6), therefore, only a general indication of the population age structure was possible. A further drawback is that the trawl selectivity was not considered. In order to describe the general overall linear growth pattern, the von Bertalanffy formula was used. The relationship between fish length and age was the usual sigmoid shaped curve. Considering the fact that the data represented a relatively short age frequency, a simpler exponential function was also applied and similar results were obtained.

Fish growth in weight is frequently expressed by the exponential function by scientists, especially when analyzing a short age frequency. In cases where the complete age frequency of all or nearly all age-classes in a population are available, the formulae of von Bertalanffy or Gompertz are better applied since growth is allometric. Age frequencies in this study are described by both the exponential function and Gompertz formula (Table 7, Fig. 4, 5), because the sample represents rather short age frequencies.

The relationship between fish length and weight was assumed to be adequately expressed by the exponential function (Table 8, Fig. 6). Some differences were noted between males and females; the

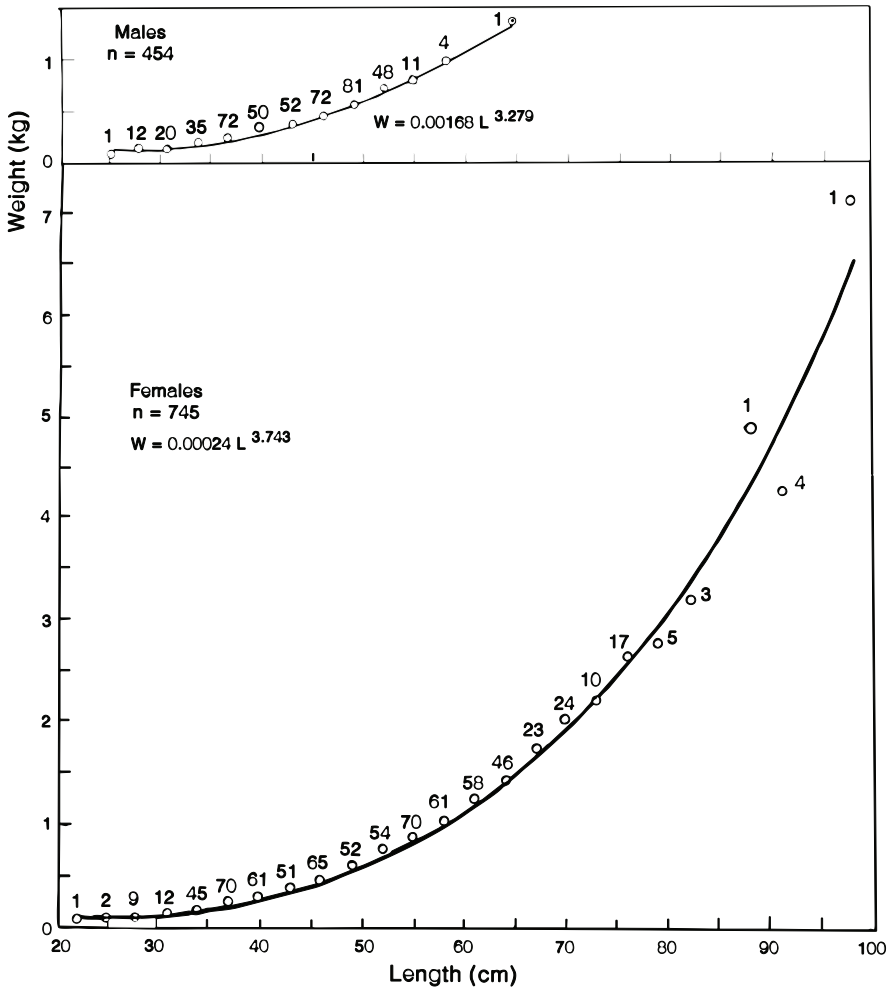

Fig. 6. Length-weight relationships of *Macrourus berglax* from Div. 0B, 2GH and 3K, 1985. Digits on the curves are the number of fish analyzed.

weight was somewhat larger particularly in small males compared to females at similar length, but these differences were not reliable since the length frequency for males was very short.

In general the available data suggest that the growth of *M. berglax* corresponds to growth patterns of most other pelagic fish. The typical sigmoid patterns were noted with decrease in increments of length and increase in increments of weight with age in both males and females. In order to determine the growth differences between males and females, the lengths and weights of similar age-classes at ages 3–13 years were compared. Males appeared to grow slower than females, as had been noted earlier (Savvatimsky, 1984). For example, according to the predictions from the observed relationships, in males at ages 9–10 years, the increments in length were 2.7–2.9 cm and increments in weight were 113–114 g; while in females the length increments were 3.5–3.7 cm and weights 128–152 g (Table 9). The general relationship in *M. berglax* in the length and weight of males compared to females, is that they are larger at an early age (3–5 years), similar to those observed in Greenland halibut (*Reinhardtius hippoglossoides*) from the Northeast Atlantic (Nizovtsev, 1991). However, the number of younger fish available in the samples obtained was very small, suggesting that this hypothesis should be tested using more representative material. Nevertheless, the materials presented here confirm a relatively slow growth of *M. berglax* and multiaged structure of its population.

TABLE 2. Combined length-age key of male *Macrourus berglax* from Div. 0B, 2G, 2H and 3K, 1985.

Length (cm)	Age (years)											Total No.	Average weight (g)
	3	4	5	6	7	8	9	10	11	12	13		
24–26	1	–	–	–	–	–	–	–	–	–	–	1	60
27–29	3	6	2	1	–	–	–	–	–	–	–	12	79
30–32	–	2	17	1	–	–	–	–	–	–	–	20	114
33–35	–	–	25	10	–	–	–	–	–	–	–	35	138
36–38	–	–	5	49	18	–	–	–	–	–	–	72	179
39–41	–	–	1	16	33	–	–	–	–	–	–	50	237
42–44	–	–	–	1	39	12	–	–	–	–	–	52	303
45–47	–	–	–	–	3	60	7	2	–	–	–	72	379
48–50	–	–	–	–	–	22	38	16	6	–	–	81	477
51–53	–	–	–	–	–	–	6	14	22	6	–	48	604
54–56	–	–	–	–	–	–	–	–	4	7	–	11	733
57–59	–	–	–	–	–	–	–	–	1	1	2	4	883
60–62	–	–	–	–	–	–	–	–	–	–	–	–	1 055
63–65	–	–	–	–	–	–	–	–	–	–	1	1	1 256
Total numbers	4	8	50	78	93	94	51	31	33	14	3	459	
Average weight (g)	114	124	171	241	326	484	585	630	703	783	1 162		
Average length (cm)	26.3	27.8	32.2	36.1	39.9	45.3	47.9	49.2	51.0	52.9	59.0		

TABLE 3. Combined length-age key of female *Macrourus berglax* from Div. 0B, 2G, 2H and 3K, 1985.

Length (cm)	Age (years)																				Total No.	Average weight (g)
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
21–23	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	60
24–26	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	69
27–29	1	6	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	109
30–32	–	2	9	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12	137
33–35	–	–	30	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	45	179
36–38	–	–	12	41	17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	240
39–41	–	–	–	18	40	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	61	303
42–44	–	–	–	5	33	13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	51	383
45–47	–	–	–	–	1	54	5	5	–	–	–	–	–	–	–	–	–	–	–	–	65	487
48–50	–	–	–	–	–	16	19	13	4	–	–	–	–	–	–	–	–	–	–	–	52	628
51–53	–	–	–	–	–	–	4	24	19	7	–	–	–	–	–	–	–	–	–	–	54	764
54–56	–	–	–	–	–	–	–	1	43	23	2	1	–	–	–	–	–	–	–	–	70	894
57–59	–	–	–	–	–	–	–	–	13	33	11	4	–	–	–	–	–	–	–	–	61	1 056
60–62	–	–	–	–	–	–	–	–	4	31	20	3	–	–	–	–	–	–	–	–	58	1 256
63–65	–	–	–	–	–	–	–	–	–	7	26	7	6	–	–	–	–	–	–	–	46	1 463
66–68	–	–	–	–	–	–	–	–	–	2	6	6	6	3	–	–	–	–	–	–	23	1 758
69–71	–	–	–	–	–	–	–	–	–	1	1	8	3	9	2	–	–	–	–	–	24	2 029
72–74	–	–	–	–	–	–	–	–	–	–	–	–	3	4	3	–	–	–	–	–	10	2 237
75–77	–	–	–	–	–	–	–	–	–	–	–	–	1	6	6	4	–	–	–	–	17	2 665
78–80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	–	1	–	–	5	2 764
81–83	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	3	3 225
84–86	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
87–89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	4 930
90–92	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	1	4	4 317
93–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
99–101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	7 160
Total numbers	3	9	53	80	91	86	28	43	83	104	66	29	19	22	12	8	2	5	–	2	745	
Average weight (g)	79	111	183	251	322	491	622	694	894	1 111	1 351	1 583	1 831	2 203	2 460	2 772	3 771	3 911	–	5 739		
Average length (cm)	24.0	27.3	32.9	36.4	39.6	44.9	47.9	49.5	53.8	57.5	61.2	63.8	66.9	70.8	73.5	76.9	85.5	85.2	–	93.0		

TABLE 4. Combined length–age key of male and female *Macrourus berglax* from Div. 0B, 2G, 2H and 3K, 1985.

Length (cm)	Age (years)																				Total No.	Average weight (g)
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
21–23	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	60
24–26	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	79
27–29	4	12	4	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	114
30–32	–	4	26	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	32	138
33–35	–	–	55	25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	179
36–38	–	–	17	90	35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	142	237
39–41	–	–	1	34	73	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	111	303
42–44	–	–	–	6	72	25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	103	379
45–47	–	–	–	–	4	114	12	7	–	–	–	–	–	–	–	–	–	–	–	–	137	477
48–50	–	–	–	–	–	38	57	28	10	–	–	–	–	–	–	–	–	–	–	–	133	604
51–53	–	–	–	–	–	–	10	38	41	13	–	–	–	–	–	–	–	–	–	–	102	733
54–56	–	–	–	–	–	–	–	1	47	30	2	1	–	–	–	–	–	–	–	–	81	883
57–59	–	–	–	–	–	–	–	–	14	34	13	4	–	–	–	–	–	–	–	–	65	1 055
60–62	–	–	–	–	–	–	–	–	4	31	20	3	–	–	–	–	–	–	–	–	58	1 256
63–65	–	–	–	–	–	–	–	–	–	7	27	7	6	–	–	–	–	–	–	–	47	1 462
66–68	–	–	–	–	–	–	–	–	–	2	6	6	6	3	–	–	–	–	–	–	23	1 758
69–71	–	–	–	–	–	–	–	–	–	1	1	8	3	9	2	–	–	–	–	–	24	2 029
72–74	–	–	–	–	–	–	–	–	–	–	–	–	3	4	3	–	–	–	–	–	10	2 237
75–77	–	–	–	–	–	–	–	–	–	–	–	–	1	6	6	4	–	–	–	–	17	2 664
78–80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	–	1	–	–	5	2 763
81–83	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	3	3 224
84–86	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
87–89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	4 930
90–92	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	1	4	4 317
93–95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
99–101	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	7 160
Total numbers	7	17	103	158	184	180	79	74	116	118	69	29	19	22	12	8	2	5	–	2	1 204	
Average weight (g)	97	118	177	246	324	487	601	662	840	1 073	1 343	1 582	1 831	2 204	2 460	2 771	3 771	3 910	–	5 739		
Average length (cm)	25.3	27.5	32.6	36.3	39.7	45.1	47.9	49.3	53.0	57.0	61.1	63.8	66.9	70.8	73.5	76.9	85.5	85.2	–	93.0		

TABLE 5. Length composition (%) of *Macrourus berglax* in the catches by bottom trawl in Div. 0B, 2GH and 3K, 1969–89.

Length (cm)	Div. 0B			Div. 2GH			Div. 3K		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
21–23	+	0.6	0.7	+	0.3	0.3	+	0.4	0.4
24–26	1.4	0.5	0.7	0.8	0.2	0.4	0.9	0.7	0.7
27–29	5.1	1.0	2.0	1.8	0.8	1.2	1.8	1.0	1.3
30–32	2.9	1.6	2.0	2.2	1.8	1.9	2.6	1.8	2.1
33–35	6.8	2.9	4.0	4.8	2.7	3.5	4.3	2.3	3.0
36–38	10.4	5.4	6.6	6.3	4.1	4.9	5.9	4.1	4.7
39–41	12.1	5.0	6.8	8.7	5.2	6.4	8.6	5.1	6.2
42–44	13.9	5.5	7.8	10.1	6.8	7.9	12.0	6.1	8.1
45–47	16.6	6.3	8.9	15.4	9.7	11.7	15.9	8.4	11.0
48–50	13.2	7.6	9.0	19.7	10.9	14.0	20.0	9.2	12.9
51–53	8.5	8.7	8.6	14.8	9.3	11.1	14.8	9.1	11.0
54–56	5.3	7.3	6.7	8.8	9.5	9.1	7.8	8.3	8.0
57–59	2.8	9.3	7.5	4.4	10.6	8.1	4.1	9.6	7.5
60–62	–	9.8	7.7	+	7.7	5.5	–	8.9	6.1
63–65	0.8	7.6	5.7	2.1	7.1	5.1	1.3	7.4	5.1
66–68	–	7.7	5.7	–	4.9	3.5	–	6.8	4.7
69–71	–	5.6	4.1	–	3.3	2.2	–	4.6	3.1
72–74	–	3.5	2.5	–	2.2	1.5	–	3.6	2.2
75–77	–	2.5	1.8	–	1.5	1.0	–	1.4	1.0
78–80	–	0.9	0.7	–	0.8	0.5	–	0.9	0.5
81–83	–	0.5	0.4	–	0.4	0.2	–	0.3	0.2
84–86	–	–	–	–	–	–	–	–	–
87–89	–	0.1	0.1	–	0.1	0.1	–	0.1	0.1
90–92	–	–	–	–	+	+	–	0.1	0.1
93–95	–	–	–	–	–	–	–	–	–
96–98	–	–	–	–	–	–	–	+	+
21–98	99.8	99.9	100.0	99.9	99.9	100.0	100.0	100.0	100.0
Average length (cm)	43.3 ±0.27	54.6 ±0.26	51.6 ±0.22	46.4 ±0.20	53.0 ±0.23	50.7 ±0.17	46.1 ±0.11	53.9 ±0.13	51.3 ±0.10
Number of fish	848	2 275	3 159	1 450	2 365	3 883	4 329	7 521	12 048

TABLE 6. Age composition (%) of *Macrourus berglax* in the catches by bottom trawl in Div. 0B, 2GH and 3K, 1969–89.

	Div. 0B			Div. 2GH			Div. 3K		
(years)	Males	Females	Total	Males	Females	Total	Males	Females	Total
3	2.7	1.0	1.6	1.3	0.4	0.8	1.3±	0.8	1.1
4	2.8	1.2	1.7	1.1	0.9	1.0	1.2	1.3	1.2
5	9.1	4.3	5.5	6.2	4.1	4.8	6.1	3.8	4.6
6	13.8	6.2	8.2	9.0	5.7	6.8	8.5	5.4	6.5
7	21.8	8.3	11.8	15.5	9.0	11.3	16.8	8.4	11.3
8	20.5	9.2	12.1	20.6	13.4	15.8	21.5	11.6	15.0
9	9.0	3.9	5.5	12.6	5.4	8.1	12.8	4.7	7.6
10	5.4	6.3	5.6	8.3	7.7	7.8	8.5	7.1	7.5
11	7.4	10.8	10.2	12.6	12.8	13.0	12.1	11.7	12.1
12	5.2	15.9	13.1	8.6	15.9	13.1	7.8	15.8	12.8
13	2.2	11.8	9.2	4.3	10.2	7.7	3.3	11.2	8.1
14	_	6.2	4.7	_	4.7	3.2	_	5.7	3.9
15	_	4.9	3.6	_	3.4	2.3	_	4.4	3.0
16	_	5.4	3.9	_	3.3	2.2	_	4.4	3.0
17	_	2.6	1.9	_	1.6	1.1	_	2.1	1.4
18	_	1.3	0.9	_	0.9	0.6	_	1.0	0.6
19	_	0.2	0.1	_	0.1	0.1	_	0.1	0.1
20	_	0.4	0.3	_	0.4	0.3	_	0.5	0.3
Average age (years)	7.73 ±0.08	10.87 ±0.07	10.03 ±0.06	8.60 ±0.06	10.44 ±0.06	9.80 ±0.05	8.51 ±0.03	10.69 ±0.04	9.94 ±0.03
Average length (cm)	43.32 ±0.27	54.57 ±0.26	51.55 ±0.22	46.37 ±0.20	53.04 ±0.23	50.73 ±0.17	46.09 ±0.11	53.94 ±0.13	51.25 ±0.10
Average weight (g)	436.3	1 041.3	878.2	532.4	927.8	793.4	519.5	992.8	833.7
Number of fish	848	2 275	3 159	1 450	2 365	3 883	4 329	7 521	12 048

TABLE 7. Mean length and weight of males and females of *Macrourus berglax* from Div. 0B, 2GH and 3K, 1985.

	Males			Females			Total		
Age (years)	Observed length (cm)	Observed weight (g)	No.	Observed length (cm)	Observed weight (g)	No.	Observed length (cm)	Observed weight (g)	No.
3	26.3	114.1	4	24.0	79.2	3	25.7	96.5	7
4	27.8	123.9	8	27.3	110.6	9	27.5	117.8	17
5	32.2	171.2	50	32.9	183.2	53	32.6	177.0	103
6	36.1	240.6	78	36.4	250.5	80	36.3	245.5	158
7	39.9	326.0	93	39.6	322.2	91	39.7	324.3	184
8	45.3	484.4	94	44.9	491.0	86	45.1	487.4	180
9	47.9	585.4	51	47.9	622.0	28	47.9	601.2	79
10	49.2	630.4	31	49.5	693.7	43	49.3	662.1	74
11	51.0	702.9	33	53.8	894.2	83	53.0	839.5	116
12	52.9	782.5	14	57.5	1 110.5	104	57.0	1 072.8	118
13	59.0	1 161.7	3	61.2	1 350.8	66	61.1	1 342.7	69
14	_	_	_	63.8	1 583.1	29	63.8	1 583.1	29
15	_	_	_	66.9	1 831.2	19	66.9	1 831.2	19
16	_	_	_	70.8	2 203.2	22	70.8	2 203.2	22
17	_	_	_	73.5	2 460.1	12	73.5	2 460.1	12
18	_	_	_	76.9	2 771.8	8	76.9	2 771.8	8
19	_	_	_	85.5	3 770.8	2	85.5	3 770.8	2
20	_	_	_	85.2	3 910.5	5	85.2	3 910.5	5
22	_	_	_	93.0	5 738.5	2	93.0	5 738.5	2
Total	39.0	387.2	459	50.1	869.9	745	47.0	697.5	1 204

TABLE 8. Length–weight relationship of *Macrourus berglax* from Div. 0B, 2GH and 3K, 1985.

	Males		Females		Total	
Length	Observed weight (g)	No.	Observed weight (g)	No.	Observed weight (g)	No.
21–23	–	–	60.0	1	60.0	1
24–26	100.0	1	69.0	2	79.3	3
27–29	118.7	12	108.6	9	114.1	21
30–32	139.3	20	137.0	12	138.2	32
33–35	179.2	35	179.2	45	179.0	80
36–38	234.0	72	240.3	70	236.9	142
39–41	304.3	50	302.6	61	303.4	111
42–44	375.9	52	383.0	51	379.4	103
45–47	467.6	72	486.9	65	477.0	137
48–50	589.3	81	627.6	52	604.2	133
51–53	697.7	48	764.2	54	732.9	102
54–56	819.0	11	893.7	70	882.9	81
57–59	1 035.0	4	1 056.1	61	1 054.7	65
60–62	–	–	1 256.3	58	1 256.3	58
63–65	1 415.0	1	1 463.1	46	1 461.9	47
66–68	–	–	1 758.4	23	1 758.4	23
69–71	–	–	2 028.7	24	2 028.7	24
72–74	–	–	2 237.1	10	2 237.1	10
75–77	–	–	2 664.7	17	2 664.7	17
78–80	–	–	2 763.6	5	2 763.6	5
81–83	–	–	3 224.6	3	3 224.6	3
84–86	–	–	–	–	–	–
87–89	–	–	4 930.0	1	4 930.0	1
90–92	–	–	4 317.0	4	4 317.0	4
93–95	–	–	–	–	–	–
96–98	–	–	7 160.0	1	7 160.0	1
Total	417.6	459	869.9	745	697.3	1 204

TABLE 9. Length (cm) and weight (g) increments of *Macrourus berglax* from Div. 0B, 2GH and 3K, 1985.

Age	Linear growth, von Bertalanffy		Linear growth, L = aA^ b		Weight growth, W = a A^ b		Weight growth, Gompertz	
(years)	Males	Females	Males	Females	Males	Females	Males	Females
3–4	5.58	3.83	4.45	4.96	49.5	26.4	37.9	40.7
4–5	4.93	3.77	3.99	4.62	61.0	41.1	47.3	49.9
5–6	4.36	3.72	3.66	4.37	72.0	58.6	57.9	60.7
6–7	3.85	3.67	3.41	4.17	82.7	78.8	70.0	73.6
7–8	3.40	3.61	3.21	4.00	93.1	101.6	83.5	88.8
8–9	3.01	3.56	3.04	3.86	103.2	126.8	98.3	106.7
9–10	2.66	3.51	2.90	3.74	113.2	152.4	114.3	127.6
10–11	2.35	3.46	2.78	3.64	123.0	184.4	131.4	152.0
11–12	2.08	3.41	2.68	3.55	132.6	216.7	149.4	180.3
12–13	1.84	3.36	2.58	3.47	142.1	251.2	168.1	212.9
13–14	–	3.32	–	3.39	–	287.9	–	250.4
14–15	–	3.27	–	3.32	–	326.8	–	293.3
15–16	–	3.22	–	3.26	–	367.9	–	342.3
16–17	–	3.18	–	3.20	–	411.0	–	398.0
17–18	–	3.13	–	3.15	–	456.2	–	461.0
18–19	–	3.09	–	3.10	–	503.5	–	532.1
19–20	–	3.04	–	3.06	–	552.7	–	611.9
20–21	–	2.98	–	3.02	–	610.0	–	695.0
21–22	–	2.97	–	2.98	–	651.3	–	807.3

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