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Benthic fishes of the Elephant Island shelf (BIOMASS III, October—November 1986 and February 1987)

ABSTRACT: 24 species of 8 fish families were found to occur on the shelf of Elephant Island during austral spring and summer of 1986/87 season. *Notothenia gibberifrons* was a predominant species (78—83% per catch). The presence of *Champsocephalus gunnari* and *Chaenocephalus aceratus* (15—20% per catch) almost completed fish composition profile. A pronounced decrease of *Notothenia rossi* (0.03—0.04% per catch) was noticed. Some specimens of *Champsocephalus gunnari* were characterized by a spawning-time shifted by almost half a year comparing to the remaining part of its population.

Key words: Antarctica, fishes, BIOMASS III.

1. Introduction

Antarctic fish species inhabiting the shelves of particular islands probably could be spatially separated into more or less distinct populations (Siegel 1980; Kock 1981, 1986; Gubasch 1982; Skóra 1985; Sosiński 1985). Therefore it is important to collect further detailed data on local fish resources.

Relatively detailed information of South Georgia ichthyofauna is available. In contrast, rather few papers appeared which describe the Elephant Island region in this respect; these papers mostly concern the fishes of industrial significance (Romer and Andrzejak 1979; Skóra 1979, 1985; Kock 1981, 1986; Kock, Duhamel and Hureau 1985; Sosiński 1985). Observations carried out during recent expedition (1986—87) provided new data on qualitative and quantitative composition of ichthyofauna, the population structure of particular fish species, their maturation and feeding intensity.

2. Material and methods

Results were obtained basing on quantitative and qualitative analysis of 22 bottom catches carried out on the shelf of Elephant Island by r/v "Profesor Siedlecki" during Polish Antarctic Expedition "BIOMASS III". 17 trawls have been done in austral spring — between 26.10.1986 and 16.11.1986 (Fig. 1); 5 trawls have been done three months later, in austral summer — between 13 and 14.02.1987 (Fig. 2). The catches were carried out in standard manner using bottom trawls equipped with a small-meshes inlet (mesh diameter — 40 mm). Fish sample analysis consisted of: taxonomic identification, the evaluation of weight and quantitative share of the species, mass-scale fish measurements of total length (according to the principle of roundoff to the closest unit down) and the detailed ichthyological analysis of chosen samples. Every specimen was measured, the degree of gonad maturity was established according to the scale of Everson (1981), and the degree of stomach filling was defined according to five-step scale (0 — empty, 4 — full, 2 — half filled, 3 and 1 intermediate degrees of filling). Following numbers of specimens representing each species were examined: 336 of *Champsocephalus gunnari*, 250 of *Chaenocephalus aceratus*, 543 of *Notothenia gibberifrons*, 103 of *Notothenia neglecta*, 98 of *Nototheniops larseni* and 51 of *Nototheniops nudifrons*.

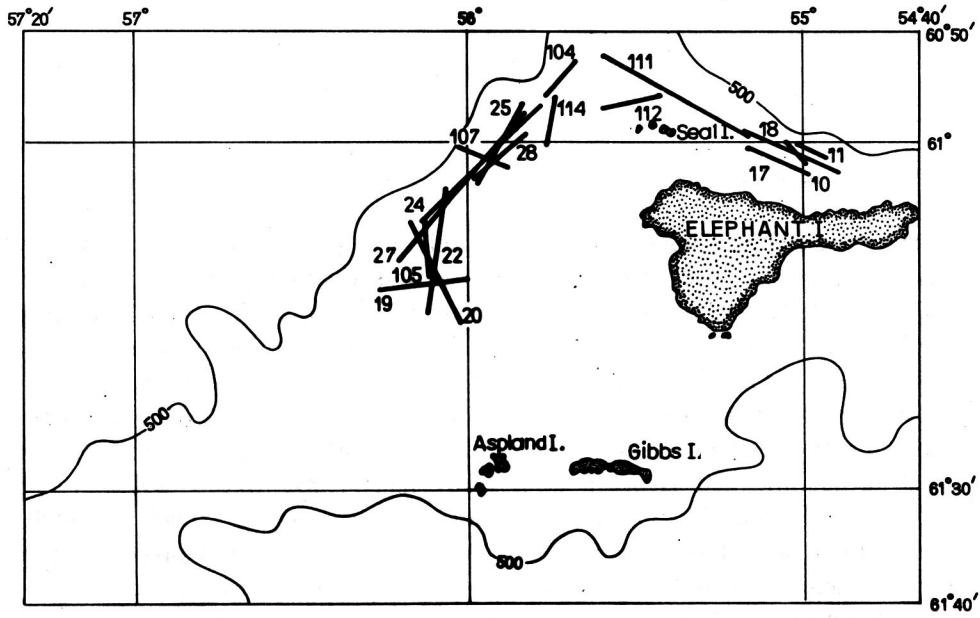

Fig. 1. Distribution of bottom trawlings in the area of Elephant Island in the period from 26 October to 16 November 1986

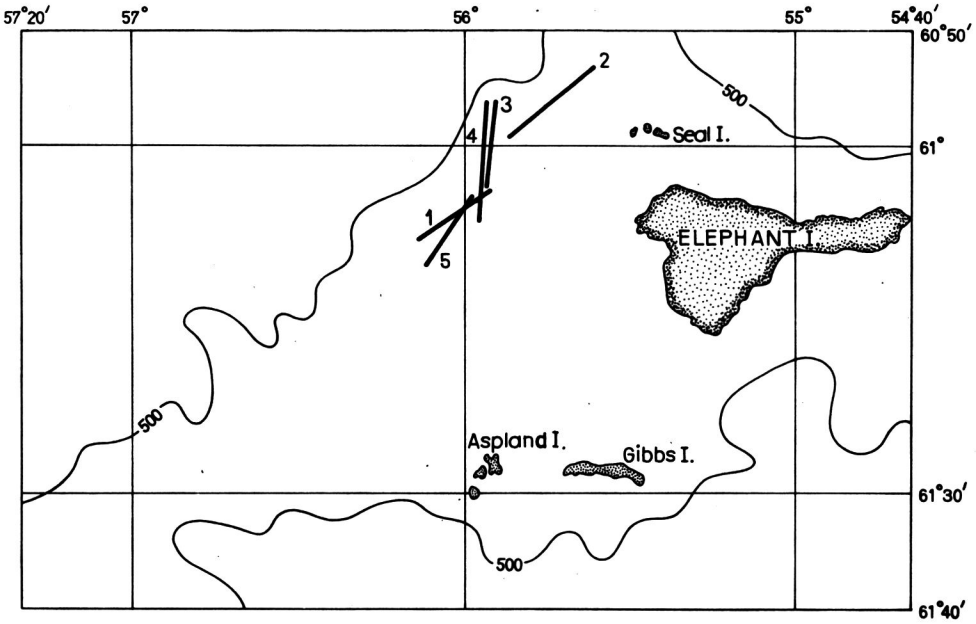

Fig. 2. Distribution of bottom trawlings in the area of Elephant Island in the period from 13 to 14 February 1987

Biological material was divided into two groups. Each of them was collected at various periods of the study and the results were analysed separately.

3. Results

24 species representing 8 families were recognized. The most abundant in species was the family of Nototheniidae — 11 species. Moreover 4 species of Channichthyidae, 3 species of Rajidae, 2 species of Bathydraconidae and 1 of Artedidraconidae, Myctophidae and Zoarcidae were recorded (Tabs 1 and 2). During the period of study *Notothenia gibberifrons* was the dominant species amounting to 78—83% of all catches (Fig. 3). Two other species, namely *Champsocephalus gunnari* and *Chaenocephalus aceratus* were present in smaller but significant quantities, i.e. 15—20% (Tabs 1 and 2). Frequency and abundance of other fish species were very low.

Detailed analysis were carried out on 7 most frequently caught species belong to the families Channichtyidae (3) and Nototheniidae (4).

The length of *Champsocephalus gunnari* ranged between 15 and 50 cm. Fish length frequency distribution was characterized in spring by the presence

Table 1

Species composition of bottom trawlings on the shelf of Elephant Island, October—November 1986

(Family) Species	Share Number	%	Efficiency kg $1h^{-1}$	ind. $1h^{-1}$	Efficiency kg km^{-2}	ind. km^{-2}
(Artedidraconidae)						
Artedidraco scottsbergi Lönnberg	1	0,004	+	0,7	0,1	4,8
(Bathydraconidae)						
Parachaenichthys charcoti (Vaillant)	3	0,01	0,25	1,15	1,45	7,85
(Channichthyidae)						
Chaenocephalus aceratus Lönnberg	2461	9,22	42,53	83,17	298,49	592,05
Champsocephalus gunnari Lönnberg	1695	6,35	10,12	104,07	70,78	722,96
Chionodraco rastrospinosus De Witt et Hureau	5	0,02	0,88	1,95	6,0	13,18
Pseudochaenichthys georgianus Norman	12	0,04	0,86	1,26	6,12	8,78
(Harpagiferidae)						
Harpagifer antarcticus Nybelin	7	0,03	0,05	10,3	0,25	56,1
(Myctophidae)						
Gymnoscopelus sp.	3	0,01	0,1	4,5	1,2	34,7
(Nototheniidae)						
Dissostichus mawsoni Norman	4	0,01	0,65	0,53	4,5	3,68
Notothenia gibberifrons Lönnberg	22081	82,7	187,29	645,71	1316,16	4560,28
Notothenia neglecta Nybelin	106	0,4	6,96	6,78	45,87	42,44
Notothenia rossii Richardson	8	0,03	1,05	0,88	7,4	6,1
Nototheniops larseni (Lönnberg)	140	0,52	0,33	8,98	2,38	61,68
Nototheniops nudifrons (Lönnberg)	152	0,57	0,6	17,77	3,94	117,91
Pagothenia bernacchi (Boulenger)	2	0,007	0,8	0,8	5,55	5,5
Trematomus eulepidotus Regan	5	0,02	0,05	1,35	0,55	9,2
Pleuragramma antarcticum Boulenger*	+	+	+	0,8	+	5,4
Ophthalmolycus concolor (Roule et Despax)	3	0,01	0,2	2,1	1,2	14,3
(Rajidae)						
Bathyraja eatoni (Günther)	1	0,004	0,7	0,9	5,0	6,2
Bathyraja maccaini Springer	12	0,04	0,8	1,12	5,45	7,77
Bathyraja sp. 2	3	0,01	0,33	0,47	2,4	3,2
Total	26704	100,0	254,55	895,29	1784,79	6284,08

Fishes found only in the trawl wings meshes.

Table 2

Species composition of bottom trawlings on the shelf of Elephant Island, February 1987

(Family) Species	Share Number	%	Efficiency kg $1h^{-1}$	ind. $1h^{-1}$	Efficiency kg km^{-2}	ind. km^{-2}
(Bathydraconidae)						
Gymnodraco acuticeps Boulenger	7	0,02	0,2	2,8	1,4	25,2
Parachaenichthys charcoti (Vaillant)	3	0,01	0,2	1,3	2,0	11,6
(Channichthyidae)						
Chaenocephalus aceratus Lönnberg	1845	6,09	154,52	184,3	1390,68	1658,66
Champsocephalus gunnari Lönnberg	4236	13,98	75,14	404,62	676,24	3641,58
Chionodraco rastrospinosus De Witt et Hureau	42	0,14	7,15	9,3	64,75	83,5
(Nototheniidae)						
Dissostichus mawsoni Norman	13	0,04	2,0	3,8	18,35	33,85
Notothenia gibberifrons Lönnberg	23519	77,64	839,1	2290,02	7551,42	20608,62
Notothenia kempi Norman	6	0,02	1,1	2,7	10,0	24,0
Notothenia neglecta Nybelin	17	0,06	8,25	4,65	74,6	41,9
Notothenia rossii Richardson	11	0,04	8,25	2,95	74,4	26,2
Notothenia squamifrons Günther	6	0,02	+	2,7	0,4	24,0
Nototheniops larseni (Lönnberg)	539	1,78	2,4	47,92	21,58	431,2
Nototheniops nudifrons (Lönnberg)	43	0,14	1,1	18,4	10,2	165,8
(Rajidae)						
Bathyraja sp.	6	0,02	2,4	2,7	21,6	24,0
Total	30293	100,0	1101,81	2978,16	9917,62	26800,11

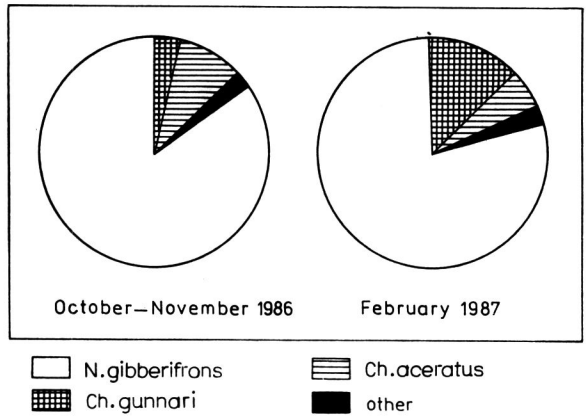

Fig. 3. Species composition of bottom trawlings in the area of Elephant Island, in the season 1986/87

of two frequency peaks (20 and 30 cm). Three length frequency peaks were observed in summer. Moreover, they were shifted to higher values (24, 28 and 33—34 cm) (Fig. 4). Average fish length calculated for particular period of the study changed only slightly. The average fish length was found to be 26.8 cm in spring and 29.0 cm in summer. The sex ratio found during the first period was 1:1. However, in February females predominated and the ratio was 2:1. All stages of gonad maturity were recognized in fishes of the spring trawls (Tab. 3). Large ripe specimens of the length of 45—46 cm as well as some spent specimens of the length of 38, 40 and 45 cm were found. Intensity of fish feeding was significant (Tab. 4) and the main food item was krill.

The second rather numerously occurring white blooded fish was *Chaenocephalus aceratus*. The distribution of length classes did not exhibit any significant fluctuations during both periods of study. More than half of fishes of the length between 12 and 69 cm were represented by the specimens of the classes between 42 and 54 cm (Fig. 4). The average length increased during the period of study from 43.9 to 45.6. Sex ratio was found to be constant 1:1. The gonads maturated during three month period of the study that was shown mainly by the increase of the frequency of the third stage (Tab. 3). Almost all analysed specimens exhibited empty alimentary tracts with reason is suggested to be the evacuation of intenstinal content during trawling to the surface (Tab. 4).

The third species of the family Channichthyidae, *Chionodraco rastrospinosus*, was not analysed in detail because of the scarcity of the material. The only parameter estimated was the length frequency in particular length classes. The length of fishes caught in February ranged from 36 to 44 cm with the dominant number belonging to 37 cm class (Fig. 4).

Table 3

The percentage share of different maturity stages of gonads in some fish species.
(M — males; F — females; T — both sexes together).

Species	Sex	Period									
		Spring					Summer				
		Maturity stage									
		1	2	3	4	5	1	2	3	4	5
Champsocephalus gunnari Lönnberg	M	82,0	15,0	0,0	1,0	2,0	86,0	7,0	7,0	0,0	0,0
	F	27,4	67,0	3,8	0,9	0,9	71,9	7,0	21,0	0,0	0,0
	T	53,9	41,7	1,9	1,0	1,5	78,0	7,0	15,0	0,0	0,0
Chaenocephalus aceratus Lönnberg	M	61,8	27,9	8,8	1,5	0,0	29,4	52,9	17,6	0,0	0,0
	F	51,6	34,7	13,7	0,0	0,0	13,5	48,1	36,5	0,0	1,9
	T	55,5	31,7	12,2	0,6	0,0	19,8	50,0	29,1	0,0	1,2
Notothenia gibberifrons Lönnberg	M	40,9	26,2	0,9	17,8	14,2	13,5	53,8	32,7	0,0	0,0
	F	34,4	58,3	3,2	0,5	3,7	4,2	68,7	27,1	0,0	0,0
	T	37,7	42,0	2,0	9,3	9,0	9,0	61,0	30,0	0,0	0,0
Notothenia neglecta Nybelin	M	12,2	75,5	12,2	0,0	0,0					
	F	7,4	24,1	68,5	0,0	0,0					
	T	9,7	48,5	41,7	0,0	0,0					
Nototheniops nybelini (Balushkin)	M	96,4	3,6	0,0	0,0	0,0					
	F	21,7	76,8	1,4	0,0	0,0					
	T	43,3	55,7	1,0	0,0	0,0					
Nototheniops nudifrons (Lönnberg)	M	100,0	0,0	0,0	0,0	0,0					
	F	10,3	0,0	89,7	0,0						
	T	49,0	0,0	51,0	0,0	0,0					

Table 4

The percentage share of different degrees of stomach filling in some fish species

Species	Period									
	Spring					Summer				
	Degree of stomach filling									
	0	1	2	3	4	0	1	2	3	4
Champsocephalus gunnari	37,4	17,5	24,8	17,5	2,9	49,0	28,0	14,0	8,0	1,0
Chaenocephalus aceratus	90,2	1,8	2,4	2,4	3,0	89,5	1,2	2,3	4,7	2,3
Notothenia gibberifrons	52,1	33,2	11,5	2,8	0,9	15,0	35,0	31,0	17,0	2,0
Notothenia neglecta	50,5	38,8	8,7	1,0	1,0					
Nototheniops nybelini	47,4	27,8	13,4	10,3	0,0					
Nototheniops nudifrons	3,9	23,5	52,9	13,7	5,9					

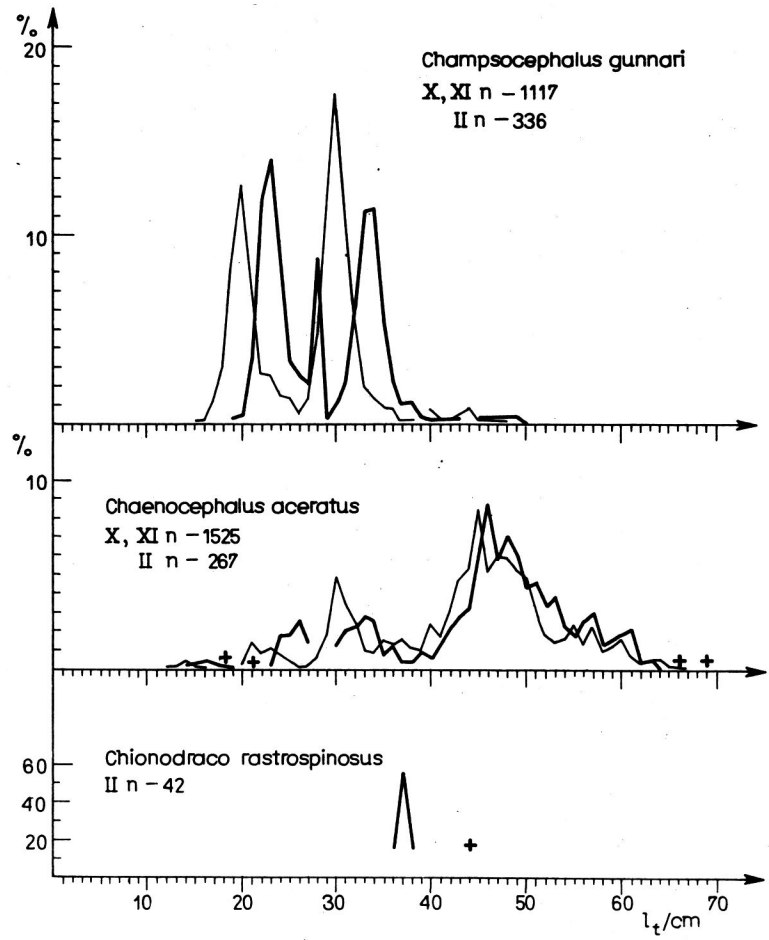

Fig. 4. Length-frequency distribution of mass-occurring Channichthyidae in bottom trawlings on the shelf of the Elephant Island in the season 1986/87
In the case of double line diagrams the thin line denotes the results from October—November, the thick one — those from February

Among Nototheniidae, *Notothenia gibberifrons* was the dominant species. The measurements carried out during both study periods revealed constant structure of its length classes in the population (Fig. 5). The length ranged between 11 and 48 cm. Most of fishes (75%) belonged to the 24—36 cm class. The difference of the mean fish length between two periods of study was found to be less than one centimeter (spring — 30.6 cm, summer — 31.4 cm). The analysis of gonads revealed the end of spawning-time (Tab. 3). However, some males (17.3%) were still ripe but there were almost no ripe females (0.5%). In February maturing stages dominated. The sex ratio was almost 1:1. Spring feeding of *Notothenia gibberifrons* was not intense (Tab. 4), whereas the summer one was enhanced.

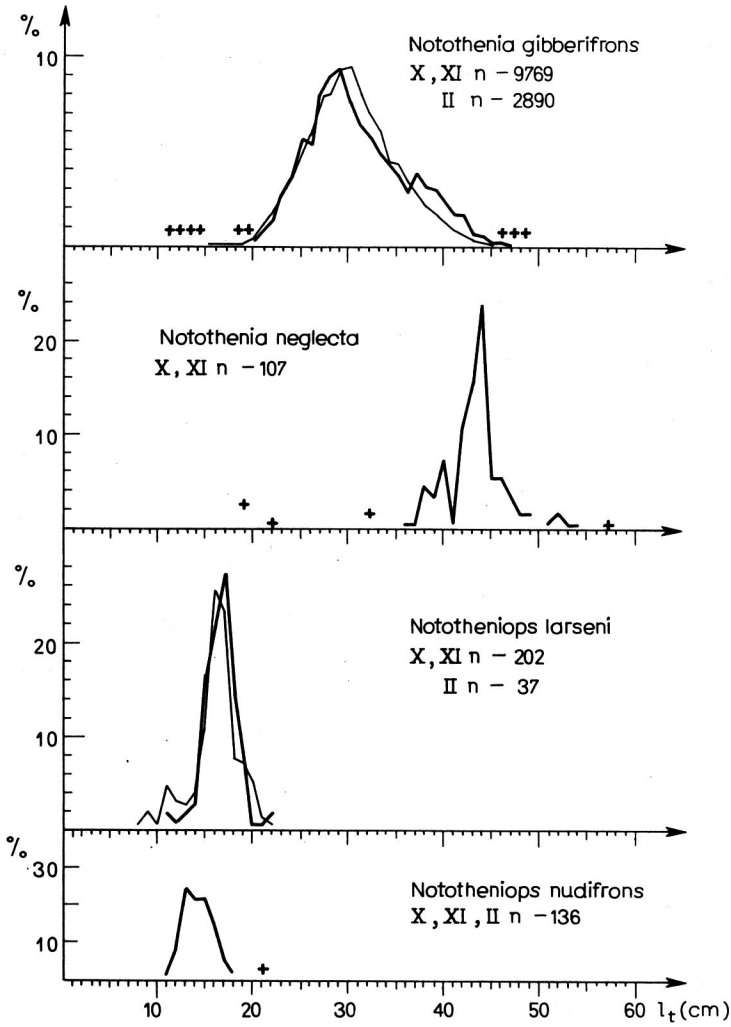

Fig. 5. Length-frequency distribution of mass-occurring Nototheniidae in bottom trawlings on the shelf of the Elephant Island in the season 1986/87
Explanations as in Fig. 4

The next Nototheniidae species regarded as a significant one for this region is *Notothenia neglecta*. However, its mass occurrence was not registered. The length of fishes in a small spring sample ranged from 19 to 58 cm (average — 43 cm). 43 and 44 cm were the dominant length classes. Most of the examined gonads represented first stage of maturation (Tab. 3). Sex ratio was maintained on the level of 1:1. Feeding was not intense, the digestive tracts of fishes were mostly empty (Tab. 4).

Nototheniops larsent is a common small nototheniid species of this region. The length frequency distribution of this species did not varied significantly

through the period between spring and summer (Tab. 3). The length of fishes ranged from 8 to 22 cm with spring average of 16.1 cm and summer average of 16.6 cm. The sex and maturity stages were determined for the spring sample only. Females outnumbered twice the males. Males were mostly immature, some of them exhibited a low degree of gonad maturity (Tab. 3). Feeding of fishes was not intense and almost half of them had empty stomachs (Tab. 4).

Nototheniops nudifrons appeared rather regularly in the catches. Its length ranged from 11 to 21 cm with the average of 14.8 cm. The number of males and females was equal. Analysis of gonads revealed that all males were immature * whereas most of females had gonads in the third maturity stage (Tab. 3). Feeding of fishes was intense and only 3.9% of them empty digestive tracts.

4. Discussion and conclusions

The present investigations of the ichthyofauna of Elephant Island region revealed that benthic fishes were dominated by *Notothenia gibberifrons*, a species whose behaviour and trophic relations are distinctly connected with the shelf bottom habitat. The other nototheniid species of similar biology and ecological preferences like *Notothenia rossii*, *Notothenia neglecta*, *Notothenia kempi*, *Notothenia squamifrons* and *Nototheniops nudifrons* occurred in very low quantities. An especially significant decrease of the population size was noticed in the case of *Notothenia rossii* which was an abundant species between 1978 and 1981 (Kock 1986). First signs of its decrease were registered in 1983 (Kock 1986). The present results seem to confirm this phenomenon. Also the share of white-blooded fishes was now lower comparing to the last years data. White-blooded fishes were earlier more abundant and even the dominant species of ichthyofauna of this region (Romer and Andrzejak 1979).

Natural factors affecting the changes of Antarctic ichthyofauna composition are difficult to be established at this moment. South Georgia fish resources could be a good example of the influence of commercial catches on the changes in the fish fauna. Especially endangered are the populations of species whose biological characteristics makes them susceptible to the increase of catching mortality. Thus the changes of length (or age) frequency distribution are considered as an important indicator of the condition and reproduction abilities of fish population.

* because of the small size of gonads an error is possible — that can lower the maturity stage estimation by approx. one unit.

Champsocephalus gunnari, in the present study was characterized by almost the same length class frequency distribution as its population studied in the 1978/1979 season Skóra 1979). The present results are also similar (to a somewhat lesser extent) to the results of Kock (1986) obtained for fishes caught between 1983 and 1985. The smallest fishes were observed in the season 1980/81 when the most numerous frequency classes were those of 14, 22 and 26 cm (Kock, Duhamel and Hureau 1985). *Champsocephalus gunnari* reaches sexual maturity at the length of 32 cm (Sosiński 1985). Thus the trend of the length increase of this species observed in last years evidences for the reinforcement of the spawning group.

Chaenocephalus aceratus was the traditional component of fish catches in the region of Elephant Island. The first data on the length frequency classes were registered in 1977—1979 (Skóra 1979; Kock, Duhamel and Hureau 1985). Small specimens then dominated of the length range from 13 to 22 cm. Similarly was in season 1980/1981 (Kock, Duhamel and Hureau 1985). In the season 1983/1984 the length frequency maximum was shifted to the value of 27 cm (Kock, Duhamel and Hureau 1985). In next years the maximum was shifted to the value of 43—49 cm (Kock, Duhamel and Hureau 1985). Thus, the population of this species is getting older. The recruiment of young generation is weak. This process may subsist since in the ichthyoplankton of this area the abundance of juvenile *Chaenocephalus aceratus* is very low (Skóra 1988).

The amount of information referring to *Chionodraco rastrospinosus* is not sufficient to draw serious conclusions. It could be pointed out, however, that the frequency distribution of this species is comparable with similar data obtained for fishes collected in the season 1978/1979 (Skóra 1979). However the quantitative share of *Chionodraco rastrospinosus* in the catches was now reduced.

The dominant species of Elephant Island region, namely *Notothenia gibberifrons* was studied many times. The highest number of large specimens was caught between 1975 and 1978 (Kock, Duhamel and Hureau 1985). From 1979 to 1981 juvenile, sexually immature specimens of the body length ranging from 15 to 21 cm dominated in the catches (Skóra 1979; Kock, Duhamel and Hureau 1985). 1983/84 season was characterized by bimodal distribution of the frequency in particular length classes. Maxima of dominating length frequency classes were identified at 25 and 41 cm (Kock, Duhamel and Hureau 1985). Recent results confirm the data presented for 1984/85 season (Kock, Duhamel and Hureau 1985). The population consists of sexually mature specimens and the lack of catching pressure could be a factor improving its regeneration.

The data characterizing the other studied species were collected for the first time. These species are also influenced by catches and it is highly probable that the present characteristics of their populations does not fully

correspond to the original situation. The obtained data could be, however, useful in comparative studies concerning other regions and periods of time.

The observation of maturation process of all studied species revealed the presence of ripe specimens of *Champsocephalus gunnari* in spring. This could be an evidence of the presence within the population of reproductively retarded specimens. It would suggest a kind of reproductive security mechanism that could be utilized when the main part of the larval population face the environmental conditions unfavourable for the development. It is noteworthy that normally *Champsocephalus gunnari* in the region of Elephant Island spawns between March and May, that is a bit later than in the regions of South Georgia and Kerguelen Islands (Sosiński 1985).

Prolonged spawning period as compared with the earlier observations (Siljanova 1981) was registered also in the case of *Notothenia gibberifrons*. Probably this species spawns also in early spring and not only in winter as it was previously supposed.

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6. Streszczenie

W omawianym rejsie badawczym r/v "Profesor Siedlecki" wykonał w rejonie Wyspy Elephant 22 zaciągi denne (rys. 1, 2), których skład połowu poddano jakościowej i ilościowej analizie. Złowione gatunki ryb (tab. 1, 2) były typowymi dla rejonu. Dominował *Notothenia gibberifrons* w ilości 78—83%. Skład w znacznym stopniu uzupełniały *Champsocephalus gunnari* i *Chaenocephalus aceratus*. Ich ilość wahała się w granicach 15—20%. Innych gatunków było mało (rys. 3). W stadzie *Champsocephalus gunnari* zauważono tendencję wzrostu ilości dojrzałych płciowo osobników powyżej 32 cm długości ciała, przy której typy tego gatunku po raz pierwszy przystępują do tarła. Drugi białokrwisty gatunek, *Chaenocephalus aceratus*, charakteryzował się niskim udziałem ryb młodych (rys. 4). Zjawisko to koreluje z brakiem występowania w ichtioplanktonie jego form juvenilnych.

Wśród Nototheniidae potwierdzono radykalny zanik wcześniej licznie występującego *Notothenia rossii*. Dominujący gatunek — *Notothenia gibberifrons* — charakteryzuje się obecnie składem rokującym dobre warunki reprodukcji. Ponad 50% osobników to ryby dojrzałe płciowo (rys. 5). Dane o pozostałych gatunkach zebrano po raz pierwszy. Ponieważ i one w znacznym stopniu podlegają wyłowowi należy sądzić, iż odnotowany stan ich populacji i stad nie w pełni odpowiada naturalnemu. Dane te będzie można wykorzystać zapewne jako porównawcze dopiero po zebraniu podobnych informacji w innych rejonach lub innym czasie.

W przeprowadzonych badaniach nad procesem dojrzewania gatunków do tarła zanotowano występowanie u *Champsocephalus gunnari* osobników o opóźnionym w stosunku do większości, okresie odbywania tarła o ok. pół roku (tab. 3). Zaobserwowano także, iż okres rozrodu u *Notothenia gibberifrons* jest wydłużony i tarło prawdopodobnie ma również miejsce w początkowych miesiącach wiosny (tab. 3).