

Andrzej KOMPOWSKI

Stock monitoring and biology

STUDIES ON THE COMPOSITION OF THE STOCK OF  
*CHAENOCEPHALUS ACERATUS* (LÖNNBERG, 1906), PISCES, *CHANNICHTHYIDAE*,  
IN THE REGION OF SOUTH GEORGIA AND SOUTH SHETLANDS

BADANIA NAD STRUKTURĄ STADA BORELA *CHAENOCEPHALUS ACERATUS*  
(LÖNNBERG, 1906), PISCES, *CHANNICHTHYIDAE*  
Z REJONU PD. GEORGII I PD. SZETLANDÓW

Institute of Fisheries Oceanography and Protection of Sea,  
Szczecin

Structure of *Chaenocephalus aceratus* stock in the region of south Georgia is constantly fluctuating, depending on the strength of recruited generations. The stock is heavily exploited, contrarily to the region of Elephant Is. and King George Is., where fishing is not so intensive. Growth rate of *Chaenocephalus aceratus* in the region of Elephant Is. (preliminary results) is similar as in the region of South Georgia.

INTRODUCTION

White-blood fishes are of considerable importance for the fishery in Antarctic region. *Chaenocephalus aceratus* is one of the most important fishes, occurring abundantly in the Atlantic sector of Antarctica. In the region of South Georgia this fish has been heavily exploited by Polish fishery since 1976. Intensive exploitation of this fish began in the region of South Shetlands as late as 1978/79, and the fishing grounds near these islands are not fished as regularly as those of South Georgia. Knowledge on the fish stock composition is necessary for rational management. Observations of this composition have been initiated together with the exploitation i.e. since 1976.

The objective of this work was to analyse the data obtained from the monitoring of *Chaenocephalus aceratus* stocks for the past few seasons, with consideration given to earlier data.

## MATERIALS AND METHODS

Fish samples were collected randomly from the catches made with a bottom trawl. Materials from the region of South Georgia collected in 1985/86 originated from the catch of m.t. "Carina". Other materials originated from sampling catches by r.v. "Profesor Siedlecki". Sampling sites are presented in Fig. 1.

Semi-automatic teasing boards (belonging to an American research team with which we were cooperating) were used to measure fish length in 1986/87 and 1987/88 in the region of South Georgia. This device rounded up the length to the nearest 1 cm class. In the region of South Shetlands as well as in the region of South Georgia in 1985/86, fish were measured in a traditional way, giving the result to the nearest lower length class (every 1 cm). The differences between the two methods were small in view of the fish length and could have been disregarded. Sex was identified examining the gonads. All fish with gonads in the I stage of maturity (in 1983/84 and 1985/86 according to Maier's scale, and in other seasons according to Everson's 5-stage scale) were classified as "immature". Age was determined from otoliths according to Kompowski (in print). List of the parameters considered and of the materials used is presented in Tab. 1.

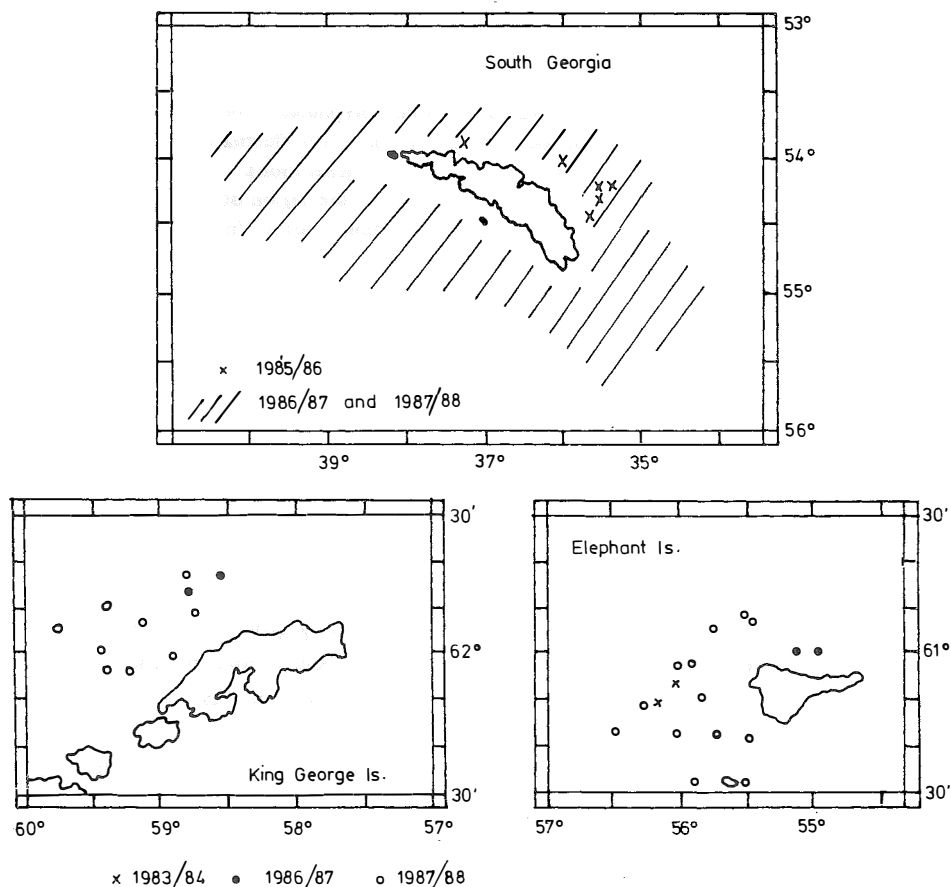


Fig. 1. Sampling stations

Table 1

List of observations on *Chaenocephalus aceratus*

Region and season	Mass measurements	Age determination	Sex determination
South Georgia			
1985/86	1643	291	—
1986/87	8582	534	—
1987/88	2919	289	—
Totally S. Georgia	13144	1114	—
Elephant Is.			
1983/84	173	54	54
1986/87	1834	233	233
1987/88	550	92	92
Totally Elephant Is.	2557	379	379
King George Is.			
1986/87	252	94	—
1987/88	270	156	—
Totally King George Is.	522	250	—
T o t a l	16223	1743	379

## RESULTS

**Length and age distribution of *Chaenocephalus aceratus* in the region of South Georgia in 1985/86 – 1987/88.**

Studies in the fishing season 1986/86 were carried out from the m.t. "Carina". This trawler caught *Chaenocephalus aceratus* only in the north-east part of South Georgia shelf. Fishing was concentrated on the spawning ground north-east of Cumberland Bay. Length of the fish caught ranged from 17 to 72 cm (Fig. 2). Percentage of juvenile fish, 17–37 cm in length, was fairly small, about 5% of all measured specimens. To some extent this was probably due to the fact that m.t. "Carina" used trawls of large mesh size, in accordance with the recommendation by the CCAMLR\*. Notwithstanding low numbers

\*CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources, with the seat in Hobart, Australia.

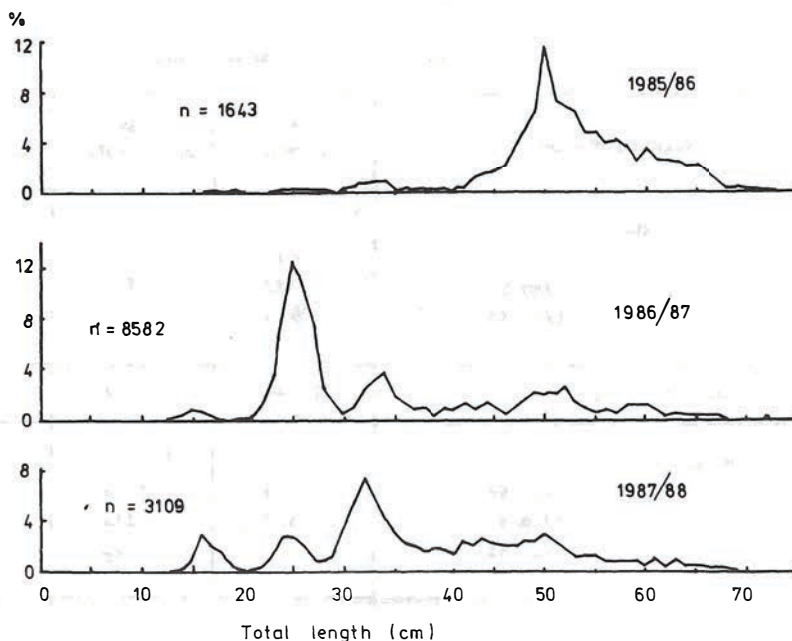


Fig. 2. Length of *Chaenocephalus aceratus* caught in the region of South Georgia in 1985/86, 1986/87 and 1987/88 fishing season

of the juvenile fish, three length classes could have been distinguished: 17–19, 23–28 and 30–34 cm. Most of the fish caught were fairly large, 42–68 cm in length, the modal value of 50 cm being well distinguishable (Fig. 2).

Age determination revealed that the exploited stock was mostly composed of age groups VI, VII and VIII (Fig. 3). Earlier study (Kompowski in print) showed that groups VII and VIII corresponded to strong generations born in 1978 and 1977.

In the fishing season 1986/87 sampling fishing was made by r.v. "Profesor Siedlecki" over the whole island shelf. Fish length ranged from 13 to 72 cm. Juvenile fishes predominated, 13–37 cm in length. They represented 67.4% of all fish measured. Three length groups could have been distinguished: 13–17, 22–29 and 31–36 cm (Fig. 2). Fishes 22–29 cm in length were very numerous (modal value 25 cm). Otolith analyses revealed that these juvenile fishes belonged to age group II, i.e. were born in 1984. This group represented 43.7% of the whole sample. The sample was also composed of age groups I and III (Fig. 3). Big fishes, over 40 cm in length, were less numerous. They belonged to age groups IV–XI.

In the fishing season 1987/88 the experimental catch by r.v. "Profesor Siedlecki" was composed of fish 11–71 cm in length (Fig. 2). Juvenile specimens predominated, sexually immature, belonging to three length classes: 14–18, 22–27 and 28–37 cm (Fig. 2), the

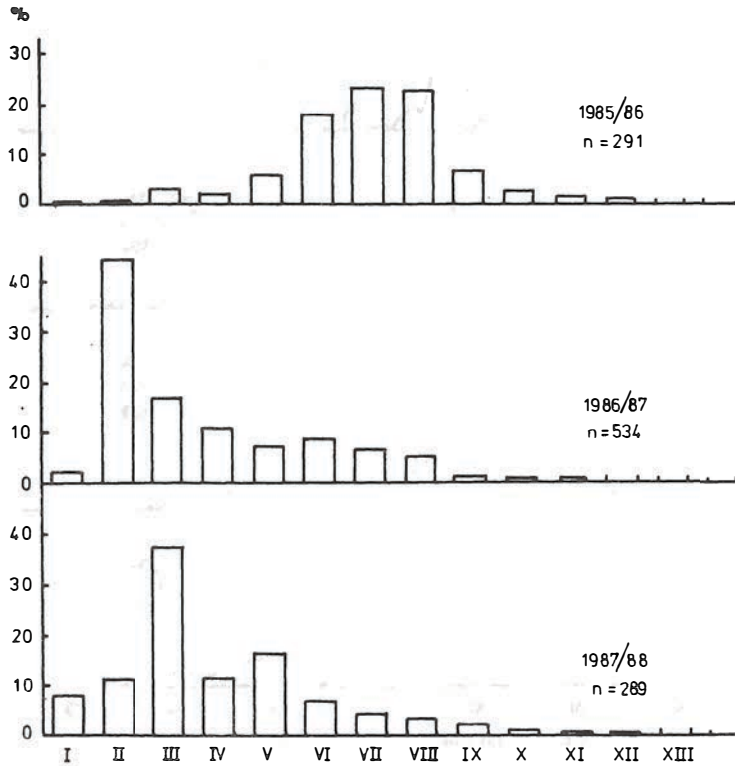


Fig. 3. Age of *Chaenocephalus aceratus* caught in the region of South Georgia in 1985/86, 1986/87 and 1987/88 fishing season

respective modal values being 16, 24 and 33 cm. Fish 28–37 cm in length were especially numerous. They belonged to the same strong year-class born in 1984 i.e. age group III (it was age group II in the previous fishing season). Bigger fishes were represented by age groups IV to XI (Fig. 3).

The materials were very abundant. Due to this, it was possible to analyse the relationship between length of the fish caught and depth (Fig. 4). Generally, average length of the fish decreased with depth. In the depth range 50–150 m this length was 43.4 cm, at 151–250 m it was 37.5 cm, and at 251–500 m it was 33.0 cm. Similar depth distribution was observed in the previous fishing season (Skóra and Sosiński 1987). Hence, we can speak here of a certain regularity, at least during the Antarctic summer.

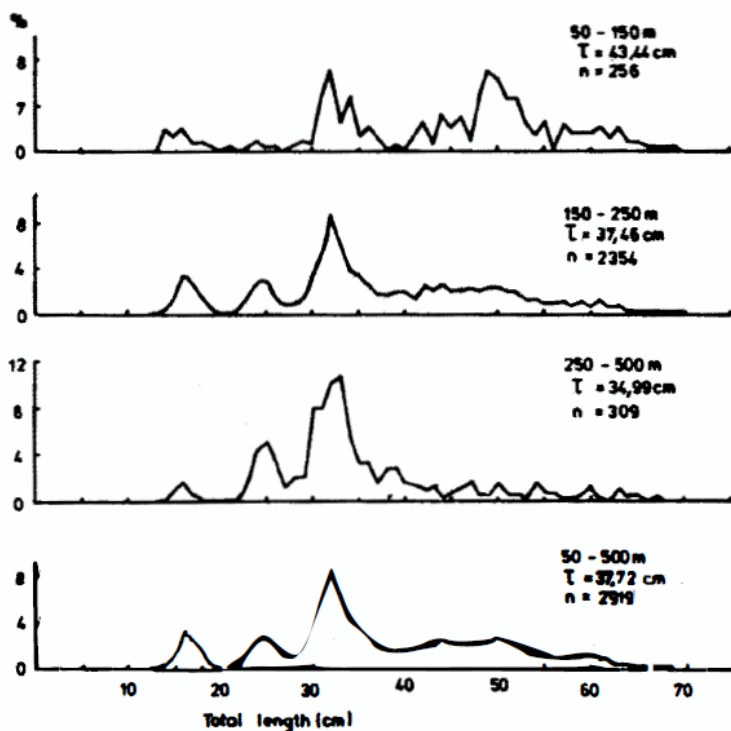


Fig. 4. Length of *Chaenocephalus aceratus* at different depth of South Georgia shelf in 1987/88

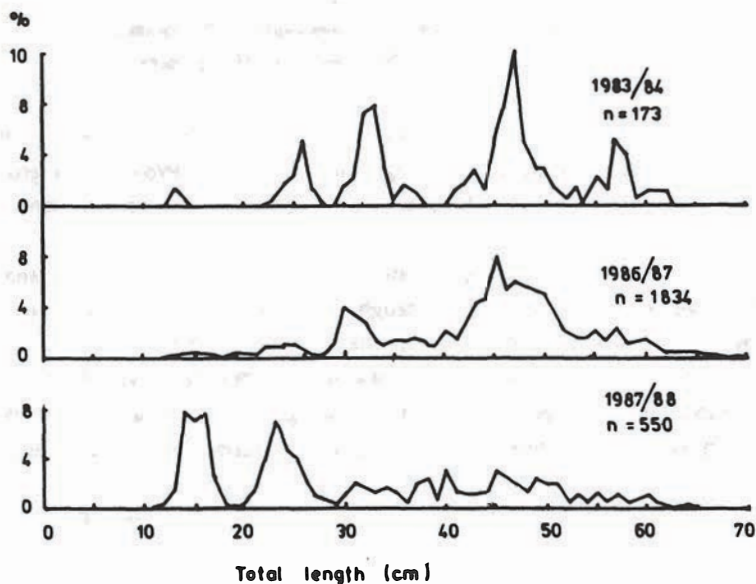


Fig. 5. Length of *Chaenocephalus aceratus* caught in the region of Elephant Island in 1983/84, 1986/87 and 1987/88 fishing season

### Size and age composition of *Chaenocephalus aceratus* catches from the vicinity of Elephant Island in 1983/84, 1986/87 and 1987/88

Fishes caught by r.v. "Profesor Siedlecki" west of the island in December 1983 (within SIBEX\* project) were 13–62 cm in length. Length groups were easily distinguishable (Fig. 5); their modal values were 13, 26, 47 and 57 cm. Age of the fish caught was I–VIII. One specimen only belonged to age group XI (Fig. 6). The materials were not numerous (173 fishes were measured, and age was determined for 54).

Two years later, sampling fishing by r.v. "Profesor Siedlecki" was performed on the shelf north and west of the island. Length of the fish caught ranged from 14 to 68 cm (Fig. 5). Fishes 44–55 cm long were most numerous, length class 45 cm being the dominating one. As regards younger fish, specimens 28–33 cm long were most numerous, the modal length being 30 cm. Otolith analyses revealed that age groups I–XII were caught, with the domination of age groups IV, V and VI (Fig. 6).

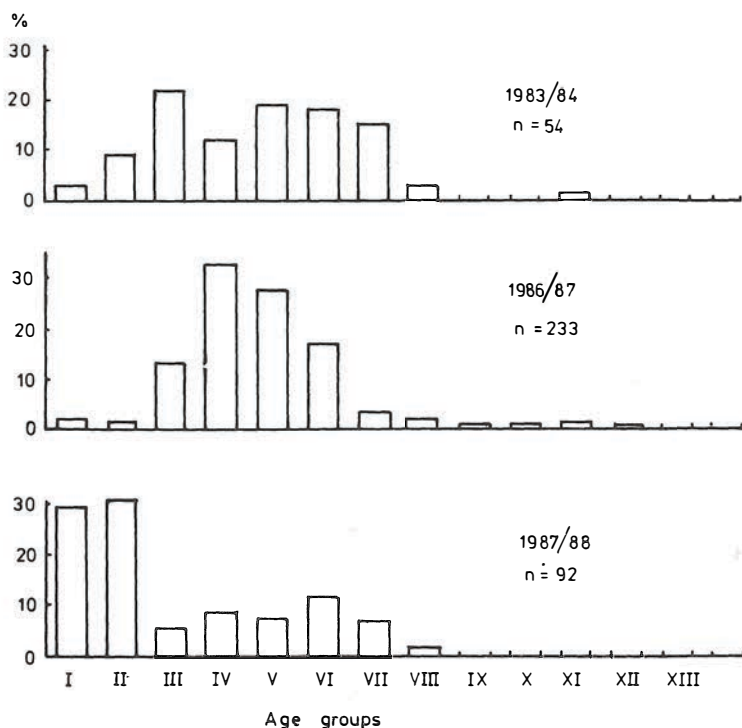


Fig. 6. Age of *Chaenocephalus aceratus* caught in the region of Elephant Island in 1983/84, 1986/87 and 1987/88 fishing season

\* SIBEX – Second International BIOMASS Experiment 1983/84.

Table 2

Average length in age groups of *Chaenocephalus aceratus* from the region of Elephant Is.  
with attention given to „immature fish“, females and males (l.t. in cm)

Age group	„Immature fish“					Males					Females				
	X	s	Number of age determination	Number recalculated to mass measurements	Range of variation	X	s	Number of age determination	Number recalculated to mass measurements	Range of variation	X	s	Number of age determination	Number recalculated to mass measurements	Range of variation
I	15.1	1.1	35	169	13–17										
II	24.1	1.6	37	179	20–28										
III	31.1	1.2	22	222	28–33	32.6	0.5	2	11	32–33	31.4	1.0	2	36	31–34
IV	41.7	3.4	50	427	34–47	44.4	2.1	17	109	37–47	45.7	2.5	7	58	40–49
V	48.5	3.0	24	166	43–57	46.9	2.7	38	224	39–51	50.2	2.8	23	122	45–55
VI	50.2	—	6	30	48–56	47.6	3.5	28	141	40–58	54.7	3.1	34	177	47–62
VII						48.3	0.8	6	22	47–49	56.3	3.9	24	95	49–65
VIII						51.0	—	1	5	—	59.5	5.0	14	42	51–66
IX						62.0	—	1	2	—	62.1	1.2	3	7	61–64
X											66.5	—	2	2	64–69
XI											60.1	—	2	16	60–61
XII											64.0	—	1	1	—



In the next season (1987/88), r.v. "Profesor Siedlecki" made 9 experimental catches west and north-west of the island shelf. Fish 12–64 cm long were caught. More than half were juvenile individuals, 12–35 cm in length. Two length groups were easily distinguishable: 13–17 cm and 21–27 cm (Fig. 5), belonging to age groups I and II (Fig. 6). No noticeable modal lengths could have been distinguished as regards adult fish. The exploited stock was composed of age groups III–VIII (Fig. 6).

#### **Rate of growth of *Chaenocephalus aceratus* in the region of Elephant Island.**

Studies on *Chaenocephalus aceratus* in South Georgia (Gubsch 1980, Kock 1981, Kompowski in print) suggested that growth rate was different in males and females; females grew more rapidly, attained bigger size than males. Hence, it would be necessary to study the growth rate separately for the two sexes. However, *Chaenocephalus aceratus* attains sexual maturity rather late (Kock 1981, 1986, Kompowski in print, Gubsch and Hoffman 1987), so even in case of big specimens it is sometimes difficult to determine the sex. The problem has been solved in the same way as in the previous work (Kompowski in print): fishes were divided into three categories i.e. males, females and immature ones. The latter group embraced all fish with gonads in stage I of maturity. "Immature fish" were most numerous ( $n = 174$ ). There were 93 males and 112 females. Average length of age groups was calculated for each of these three categories (Tab. 2). "Immature fish" belonged to 6 age groups. Fishes defined as males or females belonged to age groups from III on. In age group III and IV average length of males and females was almost the same. Hence, it was assumed that rate of growth was the same in the first four years of life, and average lengths in these age groups were calculated for all fish, males, females and immature together.

Beginning from the age group V, average length of females was noticeably bigger than of males. Moreover, age groups V and VI still contained immature fish. It was assumed that as regards the latter, ratio between males and females was as 1:1. Consequently, half of immature fish were treated as males, and half as females, and average lengths were calculated for the two sexes accordingly. The results are presented in Table 3. However, the results should be treated as preliminary because the materials were not sufficiently abundant, especially as regards bigger fish. Still, it is interesting to compare these data with those obtained for South Georgia (Tab. 4). Rate of growth was very similar in both regions. The differences observed for some age groups could have resulted from scarcity of materials in the region of Elephant Island.

#### **Length and age composition of *Chaenocephalus aceratus* in the region of King George Island**

In the fishing season 1986/87, the experimental catches by r.v. "Profesor Siedlecki", were carried out in February 1987 on the shelf north-east of the island. Fish length ranged from 10 to 65 cm. About 40% of all fish caught were specimens 14–37 cm in length. Three length groups were easily distinguishable: 14–17 cm, 22–26 and 29–31 cm (Fig. 7). Otolith analyses revealed that these fishes belonged to age groups I, II and III

Table 3

Average length in age groups of *Chaenocephalus aceratus* from the region of Elephant Is.  
after the division of „immature fish” to males and females (l.t. in cm). Explanation in the text

Age group	Males					Females				
	$\bar{X}$	s	Number of age determination	Number resalculated to mass measurements	Range of variation	$\bar{X}$	s	Number of age determination	Number resalculated to mass measurements	Range of variation
I	15.1	1.1	35	169	13–17	15.1	1.1	35	169	13–17
II	24.1	1.6	37	179	20–28	24.1	1.6	37	179	20–28
III	31.2	1.2	26	269	28–34	31.2	1.2	26	269	28–34
IV	42.6	3.4	74	594	34–49	42.6	3.4	74	594	34–49
V	47.3	2.9	50	307	39–57	49.5	3.0	35	205	43–55
VI	47.9	3.5	31	156	40–58	54.3	3.3	37	192	47–62
VII	48.3	0.8	6	22	47–49	56.3	3.9	24	95	49–65
VIII	51.0	–	1	5	–	59.5	5.0	14	42	51–66
IX	62.0	–	1	2	–	62.1	1.2	3	7	61–64
X						66.5	–	2	2	64–69
XI						60.1	–	2	16	60–61
XII						64.0	–	1	1	–

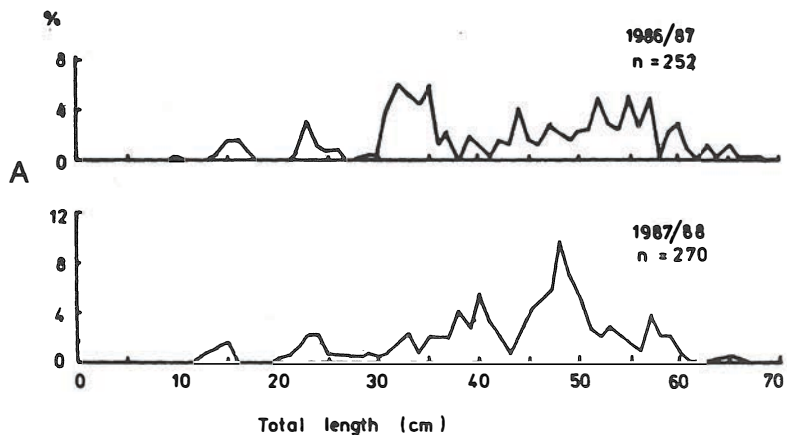


Fig. 7. Length of *Chaenocephalus aceratus* caught in the region of King George Island in 1986/87 and 1987/88

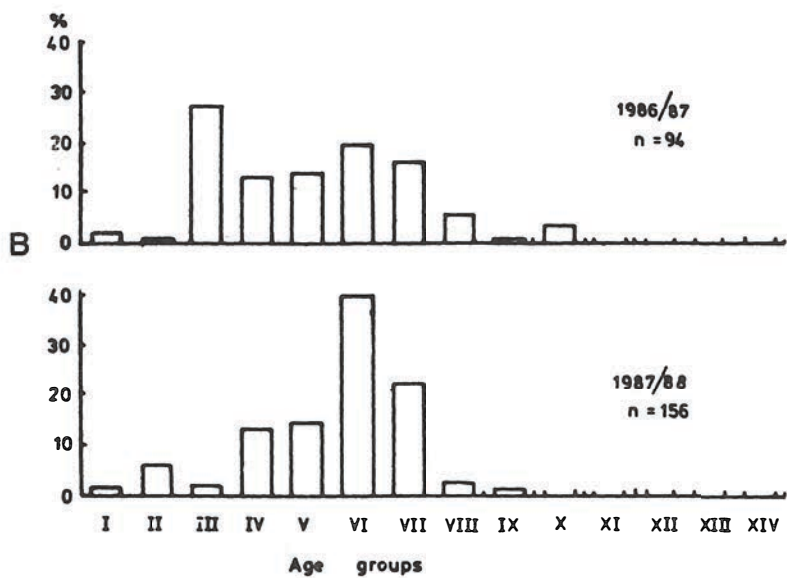


Fig. 8. Age of *Chaenocephalus aceratus* caught in the region of King George Island in 1986/87 and 1987/88

Table 4

Average length in age groups of *Chaenocephalus aceratus*  
in the region of South Georgia and Elephant Island (l.t. in cm)

Age groups	South Georgia		South Georgia		Elephant Island	
	♂	♀	♂	♀	♂	♀
I	—	15.0	17.5	17.5	15.1	15.1
II	—	23.0	25.2	25.2	24.1	24.1
III	29.0	31.0	31.7	31.7	31.2	31.2
VI	36.0	37.0	38.8	38.8	42.6	42.6
V	40.0	43.0	45.0	45.0	47.3	49.5
VI	46.0	49.0	49.5	51.8	47.9	54.3
VII	50.0	55.0	51.6	51.6	48.3	56.3
VIII	51.0	59.0	53.5	59.9	51.0	59.5
IX	51.0	61.0	53.5	60.4	62.0	62.1
X	52.5	62.0	—	62.8	—	66.5
XI	52.0	68.0	—	63.3	—	60.1
XII	—	65.0	—	63.6	—	64.0
Source	Gubsch, 1980*		Kompowski in print		Present study	

\* Length obtained from the graph.

respectively (Fig. 8). Fishes belonging to age group III were most numerous. Among bigger specimens, over 39 cm in length, there were no dominating length classes. The fishes belonged to age groups IV–X (Fig. 8).

In the 1987/88 season r.v. "Profesor Siedlecki" performed control catches in the same place. Fish length was 35–60 cm. A few modal lengths were distinguishable, 40 and 48 cm fish being most numerous (Fig. 7). Otolith studies showed that fishes belonging to age group VI and VII were dominating (Fig. 8).

Materials from the region of King George Is. were not abundant, so they probably did not reflect the real composition of the fish stock.

## DISCUSSION

Studies by Siegel (1980) on parasitic fauna of Channichthyidae in Atlantic sector of Antarctica showed that four different stocks of *Chaenocephalus aceratus* occurred in this area: in the region of South Georgia, South Orkneys, Elephant Island, King George Island and other islands in the south-west part of South Shetland group. In the region of South Georgia composition of *Chaenocephalus aceratus* stock has been observed systematically since the 1975/76 fishing season (Kock 1981, 1986, Gubsch 1980, Gubsch and Hoffman 1987, Kompowski 1984, 1985, 1988 in print, Ślósarczyk et al. 1984, Sosiński et al. 1987). This work is a continuation of these studies. Long observation period, 1975/76–1987/88, made it possible to distinguish a few periods differing as to the composition of the exploited stock (Kompowski in print). In 1975/76–1977/78, big, sexually mature fish dominated. In 1978/79 and 1979/80, strong year classes of 1976, 1977 and 1978 were recruited into the exploited stock, and these were most numerous. In 1980/81–1983/84, gradual stock aging took place as the recruitment was very small. Further observations (Kompowski in print and the data presented here) suggest that in 1984/85–1986/87 only one new generation (born in 1984) was fairly strong. It seems that composition of *Chaenocephalus aceratus* stock in the region of South Georgia fluctuates depending on the strength of year classes recruited into this stock. These changes are

Table 5

Estimates of *Chaenocephalus aceratus* stock biomass with the method of „swept area” and % large (over 60 cm) fish in the catch. South Georgia region

Season	Biomass (t)	Season	% of fish > 60 cm *
1975/76	18 719	Kock, 1981	—
1976/77	7 595	Ślósarczyk et al., 1984	20,8
1977/78	5 192	Ślósarczyk et al., 1984	21,8
1977/78	18 399	Kock, 1981	—
1978/79	4 047	Ślósarczyk et al., 1984	3,4
1980/81	7 720	Ślósarczyk et al., 1984	3.2
1981/82	10 013	Ślósarczyk et al., 1984	3.9
1982/83	—	—	—
1983/84	—	—	12.2
1984/85	11 542	Kock, 1986	8.0
1985/86	—	—	15.3
1986/87	8 628	Sosiński et al., 1987	3.3
1987/88	6 209	Mucha, Zaporowski, 1988	4.7

\* 1976/77 – 1984/85 – calculated from the materials of the author (Kompowski, in print), 1985/86 – 1987/88 calculated from the materials of this study.

especially noticeable when proportion of big individuals (over 60 cm in length, mostly females) is taken into account (Tab. 5). These fish, so important for stock reproduction, were very numerous in mid-seventies. Afterwards, their number decreased rapidly, and remained on a low level, with the exception of 1983/84 and 1985/86 fishing season. This agrees with the observations by Kock (1986). Biomass estimates for consecutive fishing seasons also showed considerable fluctuations (Tab. 5). For instance, in the last season 1987/88, biomass decreased compared to the preceeding season. This trend was confirmed by the estimates made separately with the hydro-acoustic method (Kalinowski 1988). The latter showed a double biomass decrease in 1987/88 compared to 1986/87. Accuracy of the estimates given in Tab. 5 is not sufficient as suggested by the differences in the estimates for 1977/78 given by Kock (1981) and Słószarczyk et al. (1984). Also estimates made with the hydro-acoustic method differ from those obtained with the method of swept area.

According to Kock (1986) stock of *Chaenocephalus aceratus* in the region of South Georgia is under considerable effect of the fishery. This species is susceptible to overfishing, the more so that juvenile fish constitute large percentage of the catch. Kock is of the opinion that the minimal mesh size of 80–120 mm, introduced in 1984 for other fish species, shall have no greater effect. *Chaenocephalus aceratus*, similarly as *Pseudochaenichthys georgianus*, distends gill covers and fins during catches, so that gear selectivity is very reduced.

Stock of *Chaenocephalus aceratus* is also endangered by the destruction of larvae and postlarvae (0 age group) which occur in krill shoals (Kompowski 1980, Kock 1982a, Słószarczyk 1983) and are fish out with the latter.

As regards the protective measures, Kock (1986) advocates that a 12 mile zone should be introduced around South Georgia, in which fishing would be prohibited. Most spawning grounds of *Chaenocephalus aceratus* as well as of *Pseudochaenichthys georgianus* are located within this zone. Relatively even distribution of *Chaenocephalus aceratus* over the shelf (Kock 1986) decreases fishing pressure on condition that the latter operates only in some parts of the shelf.

In the region of South Shetlands, *Chaenocephalus aceratus* stock was not monitored as systematically as in the region of South Georgia. Still, studies embraced a fairly long period. They were initiated by Kock (1981) who observed this fish near Elephant Is. and the other part of South Shetlands in 1975/76, 1977/78 and 1978/79. This author presented also the results of studies made in the region of Elephant Is. in 1980/81, 1983/84 and 1984/85 (Kock 1982b, 1986). Hence, 8 fishing seasons were covered together with our observations. It appeared that similarly as in South Georgia, length distribution of *Chaenocephalus aceratus* stock was characterized by a few peaks. This is especially true of the left-hand side of the curves, corresponding to the catches of juvenile fish. Kock (1981) ascribed the first four peaks to age groups I–IV. Our otolith studies confirmed this. Age of older fish was also determined. Although the materials from the region of Elephant Is. were not so numerous as from South Georgia (Kompowski in print), it seems that rate of growth was similar in the two regions. Stock composition in 8

fishing seasons confirmed earlier conclusion by Kock (1986) that *Chaenocephalus aceratus* stock in the region of South Shetlands was under moderate impact of the fishery.

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*Andrzej Kompowski*

BADANIA NAD STRUKTURĄ STADA BORELA (*CHAENOCEPHALUS ACERATUS*  
Lönnberg, 1906); *PISCES, CHANNICHTHYIDAE*)  
Z REJONU Pd. GEORGII I Pd. SZETLANDÓW

STRESZCZENIE

Ryby do badań pobierano losowo z połowów dokonywanych włokiem dennym (rys. 1, tab. 1). Wyniki niniejszych badań (rys. 2 i 3) z sezonów połowowych 1985/86–1987/88 oraz dane literaturowe z lat wcześniejszych, obejmujące okres aż do sezonu 1975/76 wstecz (m.in. tab. 5) świadczą o stałych fluktuacjach struktury eksploatowanej części stada borela w rejonie Pd. Georgii. Zmiany te zależą przede wszystkim od obfitości uzupełniających tę część stada pokoleń. W ostatnich czterech latach tylko jedno pokolenie – urodzone w 1984 r. jest pokoleniem w miarę obfitym liczebnie. O silnym wpływie rybołówstwa na stado świadczy utrzymująca się od sezonu 1978/79 niska proporcja dużych ryb >60 cm, którymi są prawie wyłącznie samice (tab. 5).

W rejonie Pd. Szetlandów struktura długościowa stad charakteryzuje się podobnie jak w rejonie Pd. Georgii występowaniem odrębnych grup ryb o zbliżonych długościach, co jest szczególnie wyraźne gdy chodzi o młode ryby (rys. 5 i 7). Badania otolitów (rys. 6 i 8) wykazały, że te grupy długościowe odpowiadają poszczególnym grupom wieku. Wstępne wyniki badań szybkości wzrostu boreli z rejonu Elephant Is. (tab. 2, 3 i 4) świadczą o tym, że jest ona podobna jak w rejonie Pd. Georgii, przy czym samice rosną szybciej (i żyją dłużej) niż samce.

Author's address:  
Instytut Oceanografii Rybackiej i Ochrony Morza  
Akademia Rolnicza  
ul. Kazimierza Królewicza 4  
71-550 Szczecin, Polska (Poland)

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