Arch. FischWiss.	33	1/2	43 – 68	Berlin, November 1982

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Biological investigations on *Notothenia ramsayi* Regan 1913 (Pisces, Notothenioidei, Nototheniidae)

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with 13 figures and 7 tables

Received March 25, 1982

Kurzfassung

Biologische Untersuchungen an *Notothenia ramsayi* Regan 1913 (Pisces, Notothenioidei, Nototheniidae)

Notothenia ramsayi Regan 1913 ist die am weitesten verbreitete Art ihrer Gattung auf dem Schelfgebiet vor Argentinien. Sie wurde von 36°S bis 55°S angetroffen.

Während der 31. Reise des FFS "Walther Herwig" in die argentinischen Gewässer wurde Daten- und Probenmaterial von *Notothenia ramsayi* gesammelt, das Aufschluß über die Abhängigkeit der Verbeitung von Tiefe und Temperatur, jahreszeitliche Verschiebung der Laichzeit von Nord nach Süd, unterschiedlichen Längenaufbau des Bestandes im nördlichen und südlichen Teil des Untersuchungsgebietes, Wachstum, Längen-Gewichtsbeziehung, Größe des Bestandes, Nahrung und die Beziehung zu ihren kommerziell genutzten, potentiellen Räubern gibt.

Abstract

Notothenia ramsayi Regan 1913 is the most common species of its genus on the shelf off Argentina. It was found between 36°S and 55°S.

During the 31st cruise of FRV "Walther Herwig" in the waters off Argentina, data and samples of *Notothenia ramsayi* were taken, which give some information about dependence of the distribution on depth and temperature, different spawning-times in the north and the south, different length-composition of the stock in the northern and southern parts of the investigation area, growth, length-weight relationship, size of the stock, nutrition and the relationship with commercially exploited potential predators.

1. Introduction

Nototheniа is the largest genus of the family Nototheniidae. Although it has a number of Antarctic representatives, its center of distribution is in the waters off southern South America (DE WITT, 1966). *Notothenia (Patagonotothen,* BALUSHKIN, 1976) *ramsayi* is the most abundant of 14 species on the Patagonian shelf (NORMAN, 1937; HART, 1946). Little is known on its biology and ecological status. Only HART (1946) gives some information on growth, food, distribution and predators.

In 1978 FRV "Walther Herwig" carried out an extensive research program off the Argentine coast (EHRICH, 1980). This cruise gave the opportunity to collect samples and data on *Notothenia ramsayi* for more comprehensive biological and ecological studies. The paper presented here is part of the studies on the biology and population dynamics of Antarctic and Subantarctic Notothenioidei (see FREYTAG, 1980; KOCK, 1981) of the Federal Republic of Germany.

2. Material

The cruise consisted of three sections, each with a somewhat differing region of investigation:

section I	: 06.05. - 30.06.1978	40 to 55°S
section II	: 15.07. - 17.09.1978	35 to 55°S
section III	: 26.09. - 21.11.1978	36 to 55°S

More detailed information on the sections is given by WAGNER (1978), EHRICH & MOMBECK (1979) and MESSTORFF & KOCK (1978). Hydrographical data and station list were published by CIECHOMSKY et al. (1979).

Most of the samples for the laboratory studies were taken during the second section, the southern winter. For distribution studies additional data from the 1st Argentine-cruise of FRV "Walter Herwig" in 1966 were taken into account. For fisheries a 200 ft. bottom trawl with herring cod-end (40 mm) and smaller meshed liner (8 mm) was used. For direct comparisons all hauls were standardized to kg/30 min. Population size was estimated by "swept area" method (see EHRICH, 1980).

For further calculations three subareas were chosen:

- subarea "N" : comprises data from the stations north of 42°S
- subarea "M" : comprises data from the stations between 46 and 52°S
- subarea "B" : comprises data from the Burdwood Bank; the boundaries are 53°30' to the north and 63°30' to the west

Total length (TL) of all specimens was measured to the nearest cm below, gutted weight to the nearest g below. To obtain the length frequency distribution in the distinct ranges of depth, the length frequency distributions of all hauls within the strata (see EHRICH, 1980) were combined.

For age determination whole otoliths were examined in glycerine with reflected light against dark background. Scales were examined with transmitted light. The maturity stages were determined after MAIER (1908). A separation into males and females was done only from stage II onwards, because it was found to be impossible to sex juveniles correctly.

877 stomach contents were examined. The determination of the food items was confined to superior taxonomic classifications like Gammaridea, Polychaeta etc.. A more exact determination was mostly impossible due to the advanced stage of digestion. The percentage of each group of food animals was calculated by the "points method" after HYNES (1950). Water temperatures were measured by means of Nansen bottles.

3. Results

3.1. Distribution and density and its dependence on temperature

3.1.1. Distribution

N. ramsayi was found on the Patagonian shelf from 35°58'S in the north to 55°S in the south (which is the southern edge of the Burdwood Bank; see Fig. 1 - 3) from 65 to 960 m. To the west the species enters the Straits of Magellan but does not appear on the Chilean side (THOMPSON, 1916).

The species was not evenly distributed over the covered area. Centers of abundance were located north of 42°S and on Burdwood Bank with a large area of lower fisch density in between.

The maximum of vertical abundance was observed from 100 to 400 m (Fig. 4). With greater depths fish density normally decreased sharply (except in subarea "N" in autumn, which was due to a large catch at 635 m).

The length frequency distributions in the different depth zones in southern winter (section II of the cruise) are shown in Fig. 5. Subarea "N" is characterized by the predominance of specimens of 15 - 20 cm length over the whole depth range, whereas in subareas "M" and "B" individuals were more evenly distributed over the whole observed length range of 4 to 37 cm. Specimens <10 cm were only observed in shallower waters down to 100 m depth in subarea "N" and 130 m in subareas "M" and "B". With increasing depth the proportion of fishes >20 cm increases. Specimens of this size live at depth of 200 to 600 m (see HART, 1946).

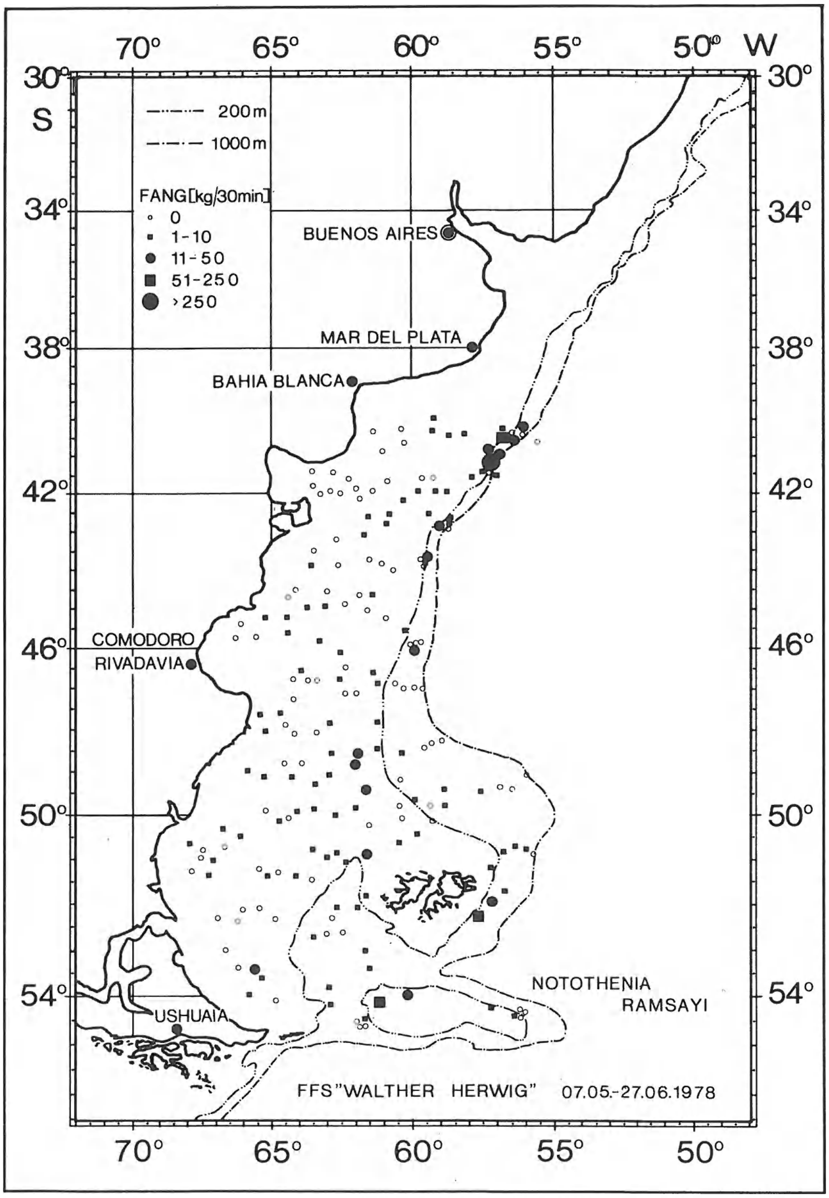

Fig. 1: Distribution of *Notothenia ramsayi* in the hauls of FRV "Walther Herwig" in south autumn 1978.

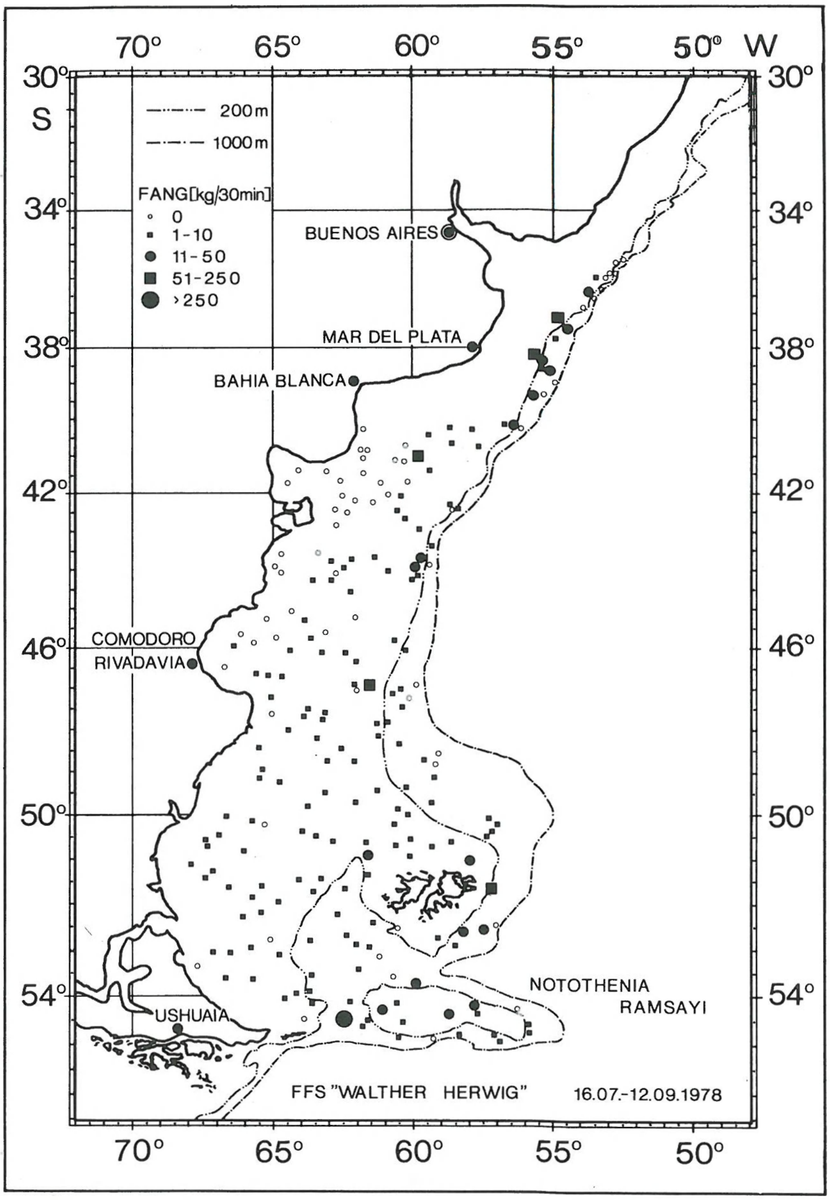

Fig. 2: Distribution of *Notothenia ramsayi* in the hauls of FRV "Walther Herwig" in south winter 1978.

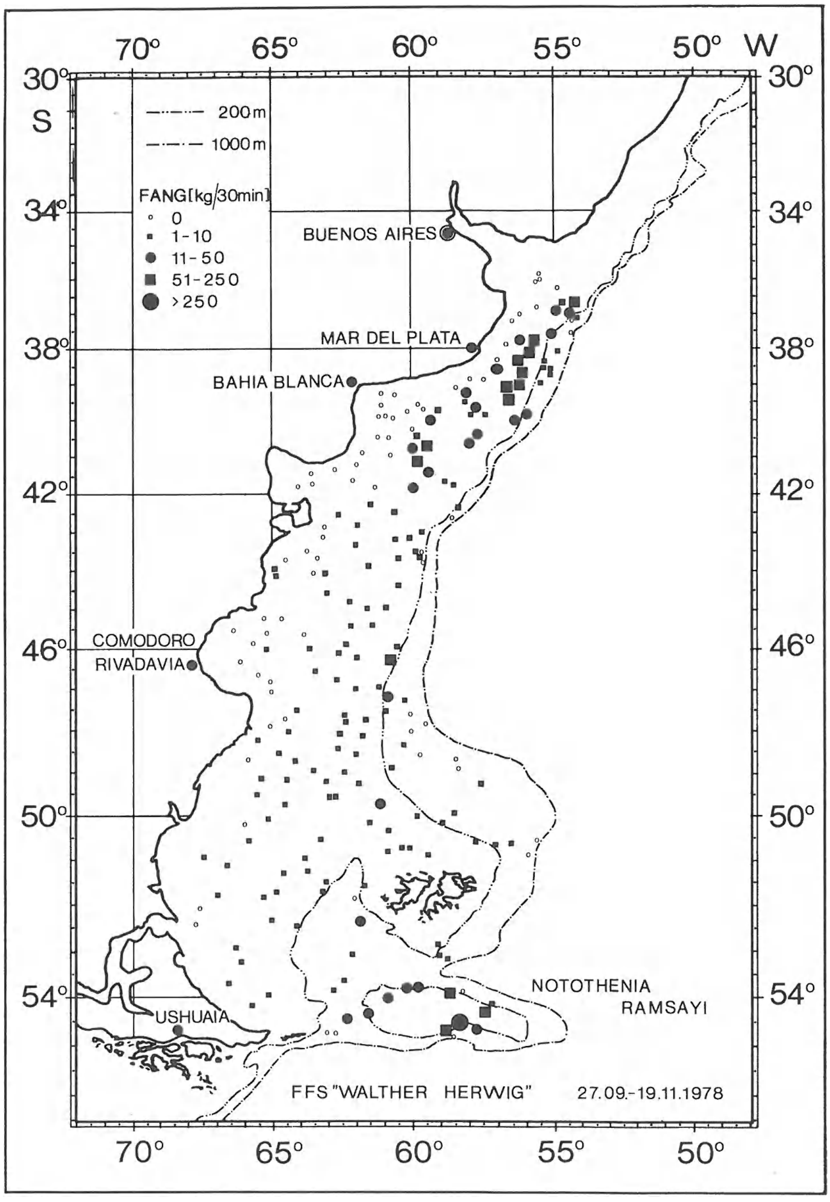

Fig. 3: Distribution of *Notothenia ramsayi* in the hauls of FRV "Walther Herwig" in south spring 1978.

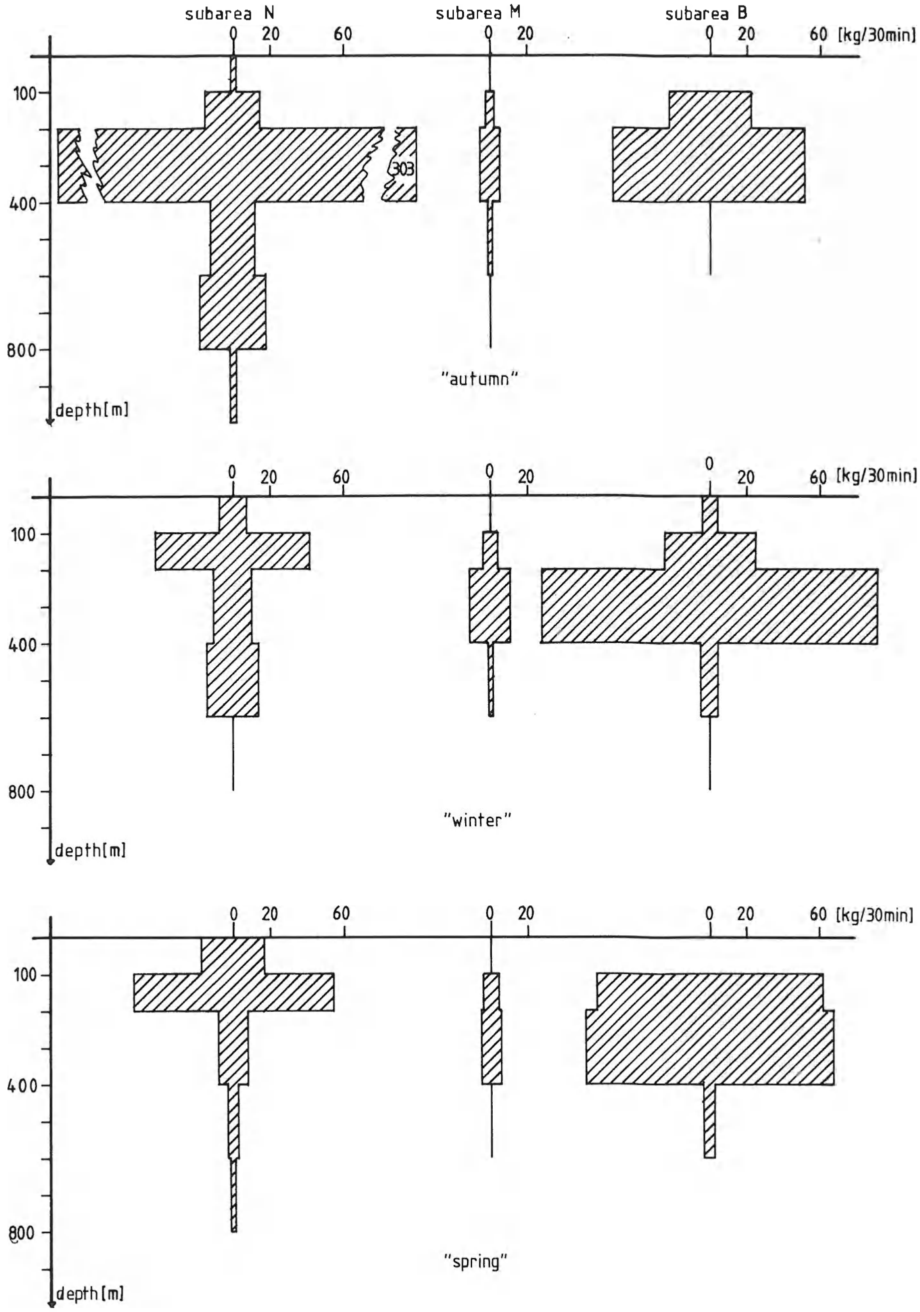

Fig. 4: Dependence of density of population [kg/30 min] on the depth in the three seasons and for the three subareas.

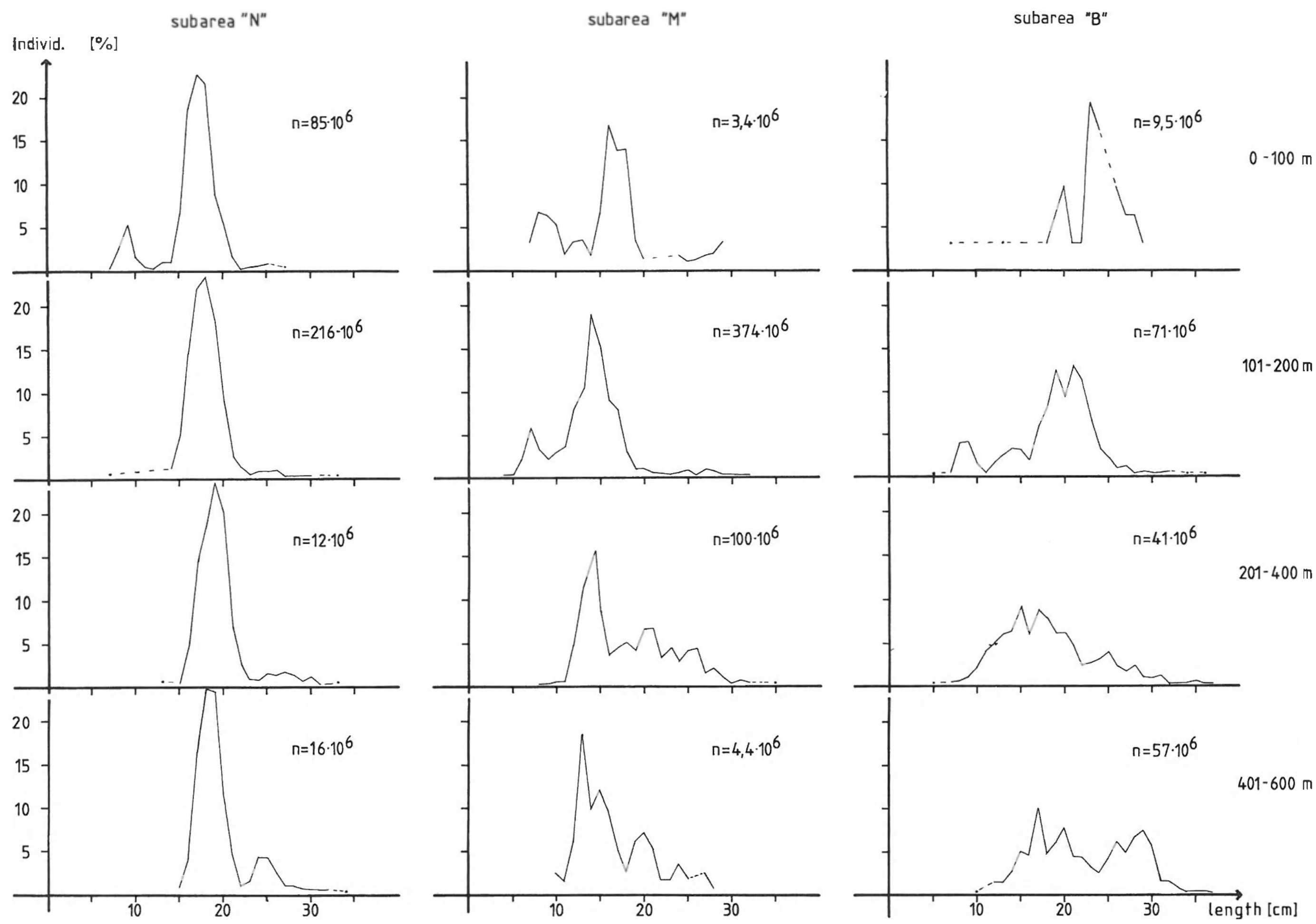

Fig. 5: Length-composition of the stock in winter, separated after depth and subarea. n gives the total number of specimens in each case.

Table 1: Mean-catch [kg/30 min], dependent on depth [m] and temperature [°C]; number of hauls (in brackets)

temp. \ depth	0-100 m	101-200 m	201-400 m	401-600 m	601-800 m	801-1000 m
2.0 - 2.9					0.00 (5)	0.3(14)
3.0 - 3.9	1.60 (2)	4.90 (1)	22.80 (3)	64.40 (8)	1.50(14)	0 (2)
4.0 - 4.9	1.80 (3)	22.03 (7)	35.03(25)	5.00(19)	0.40 (3)	0 (1)
5.0 - 5.9	1.88(11)	7.18(48)	9.77(20)	9.00 (2)	0 (1)	
6.0 - 6.9	3.79(22)	4.20(54)	16.00 (1)			
7.0 - 7.9	0.40(25)	1.84 (8)				
8.0 - 8.9	2.43(29)	0.20 (9)				
9.0 - 9.9	0.16(20)	0.30 (3)				
10.0 - 10.9	0.57 (9)					
11.0 - 11.9	0 (11)	0 (11)				
12.0 - 12.9	0 (4)					
13.0 - 13.9	0 (1)					
14.0 - 14.9	0 (3)					
15.0 - 15.9	0 (3)					
16.0 - 16.9	0 (2)					

3.1.2. Dependence on temperature

The distribution and abundance of *N. ramsayi* is obviously highly correlated with the water temperature. Although bottom temperatures in the investigated area ranged from 2.0 to 16.9° C, higher abundance was only observed from 3.0 to 6.9° C (Table 1). Areas with higher temperatures were thinly populated and those with more than 11° C were avoided. Stations with temperatures ≥11° C were all located in shallow waters from 30 to 60 m. In deeper waters with high temperatures (101 – 200 m : 8.0 – 9.9° C and 11.0 – 11.9° C) catches were extremely low.

3.2. Stock size

The stock assessment was carried out as a mean of all cruise legs and separately for the three sections and subareas to show an eventual difference between the sections (Table 2). On the total shelf *N. ramsayi* was found on 293,230 nm² (which is 87.42% of the investigated area). For this area a mean stock size (catchable biomass) of 97,909 t or 1.9×10^9 specimens was computed.

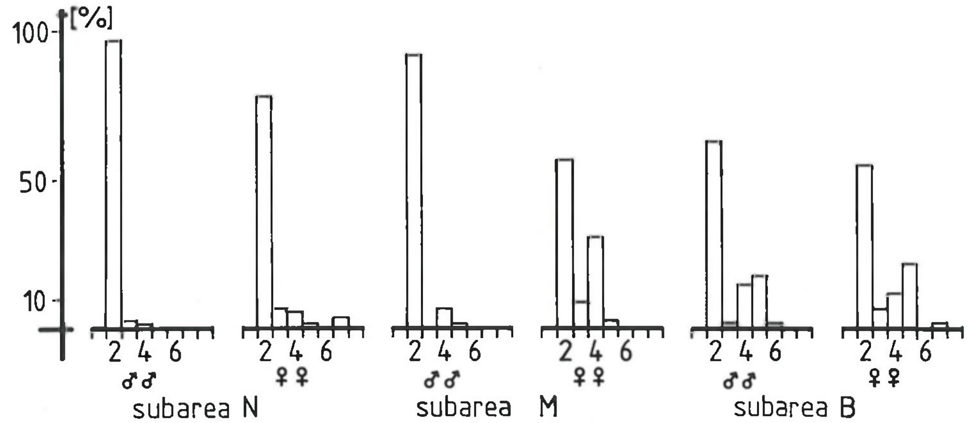

Fig. 6: Percentage of each maturity stage in the subareas in winter, separated after males and females.

Table 2: Catchable biomass in tons and per unit area [kg/nm^2], separately for the three subareas and the three seasons and totally for the whole area and time

subarea	cruise-section	biomass	hauls	area	density
"N"	south autumn	12,811 t	37	20,829 nm^2	615 kg/nm^2
	south winter	18,241 t	45	23,627 nm^2	772 kg/nm^2
	south spring	50,465 t	75	49,554 nm^2	1018 kg/nm^2
"M"	south autumn	8,395 t	90	114,526 nm^2	73 kg/nm^2
	south winter	12,965 t	84	118,428 nm^2	109 kg/nm^2
	south spring	14,918 t	79	113,321 nm^2	132 kg/nm^2
"B"	south autumn	17,085 t	13	17,890 nm^2	955 kg/nm^2
	south winter	9,868 t	19	26,001 nm^2	617 kg/nm^2
	south spring	41,900 t	17	25,425 nm^2	1648 kg/nm^2
total area	total time	97,909 t	654	293,230 nm^2	334 kg/nm^2

The calculations of biomass for the three subareas and the three seasons show considerable differences in biomass as well as in density. The stock seems to increase during the time from autumn to spring.

3.3. Reproduction

From July to September most of the specimens in subarea "N" were in maturity stage II (♀♀: 78 %; ♂♂: 97 %). Their otoliths show hyaline nuclei. In contrast to that a larger proportion of fish on Burdwood Bank were already in stages IV and V (♀♀: 35 %; ♂♂: 33 %) whereas their otoliths exhibit opaque nuclei (see also Fig. 6). This may indicate a difference in spawning time from austral autumn in the north to spring in the south. The data are in accordance with HART (1946) who describes spawning south of 44°30'S in spring and with CIECHOMSKY & WEISS (1976) who found *Notothenia* larvae of 4 to 50 mm length in the area 43 to 55°S only from mid October to beginning of January.

Specimens at maturity stages IV and V show a distinct sexual dimorphism: the anal and ventral fins and the throat of the males turn deep black.

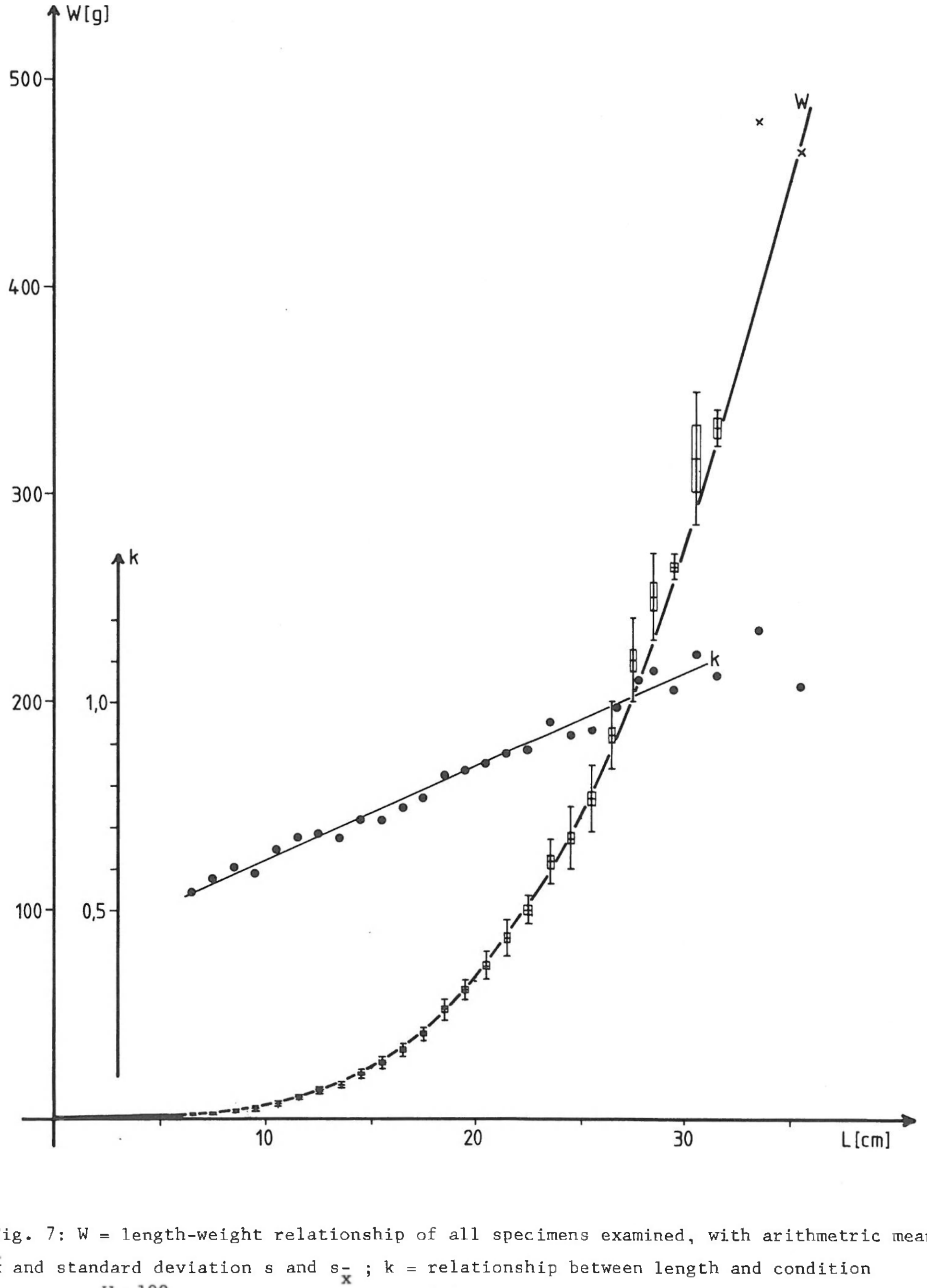

Fig. 7: W = length-weight relationship of all specimens examined, with arithmetic mean $\bar{x}$ and standard deviation s and $s_{\bar{x}}$; k = relationship between length and condition factor $k = \frac{W \cdot 100}{L^3}$ with arithmetic mean (●).

3.4. Age and growth

3.4.1. Length-weight relationship

Lenght and gutted weight data from 633 specimens of 6 to 35 cm TL were collected from subareas "N" and "M". The lengh-weight relation $W = a \cdot L^b$ was calculated as follows (see Fig. 7):

$$W = 0.002244 \cdot L^{3.4422}\ g;\ p < 0.001$$

The length-weight coefficient $k = \frac{W \cdot 100}{L^3}$ increases with length of fish from about 0.55 at 6 cm to about 1.1 at 30 cm after the linear function:

$$k = 0.3971 + 0.02254 \cdot L;\ p < 0.01$$

(see also Fig. 7).

3.4.2. Age determination and growth

After SHCHERBICH (1975) the 1st of July was appointed as birthday for *N. ramsayi*.

Age determination by otoliths proved to be the easiest and most reliable method. Comparisons of readings on otoliths and scales gave a good correspondence (EKAU, 1979). In otoliths and scales of southern stations the growth zones were more distinct than in specimens from the north. Fig. 8 shows an otolith with relatively well-defined growth zones. The centre of otoliths from the north were hyaline in every case.

Fig. 9 shows a scale on which the winterrings are marked. On scales of *N. ramsayi* the winterrings seem to be built up by interrupting the growth of sclerites and not only by reducing the growth-rate.

Otolith material from Burdwood Bank was rather small (100 otoliths). Therefore the age composition based on the combined length frequency distributions is only given for subareas "N" + "M" (Fig. 10). Specimens from Burdwood Bank were much older at the same size than in subareas "N" and "M". While in the latter subareas no individuals older than age group V were observed, the samples from Burdwood Bank consisted of specimens up to eleven years.

The age-length-key (Tab. 3), based on the readings of otoliths from the whole area except the Burdwood Bank, was used to calculate the v. Bertalanffy growth-curve separately for males and females (see Fig. 11):

$$♂♂\ L_t = 35.56 \cdot (1 - e^{-0.3472\,(t - 0.2281)})$$

$$♀♀\ L_t = 44.35 \cdot (1 - e^{-0.2220\,(t - 0.0635)})$$

Preliminary calculations of k for fish of Burdwood Bank (after length-back-calculation based on scales) gave values of 0.128 for males and 0.145 for females.

Fig. 8: Sagittae of a female of subarea "N", 26 cm long, 4 years old. The otolith is about 7.3 mm long.

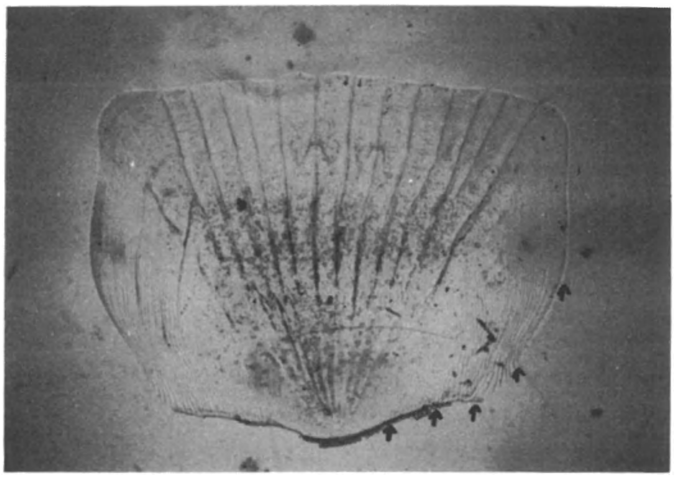

Fig. 9: Scale of a female of subarea "N", 31 cm long, 5 years old. The radius of the scale is about 6.5 mm; the winterrings are marked.

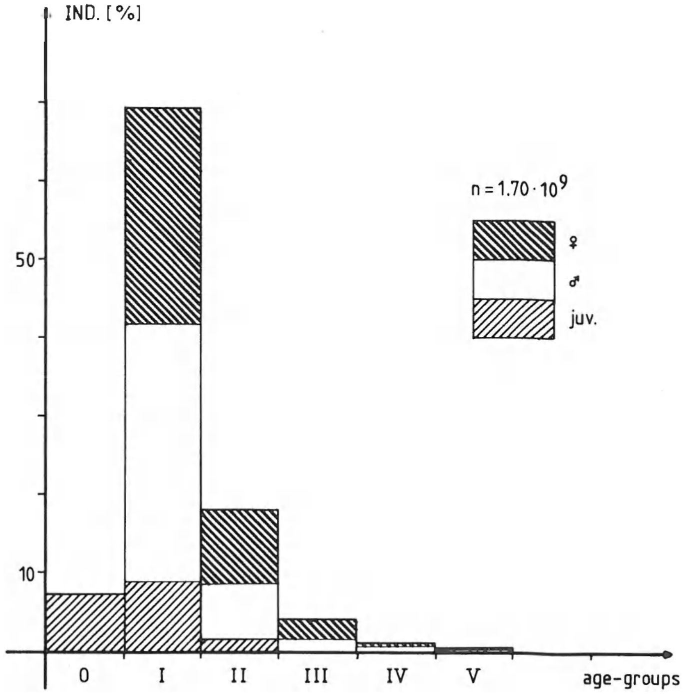

Fig. 10: Age composition of the stock.

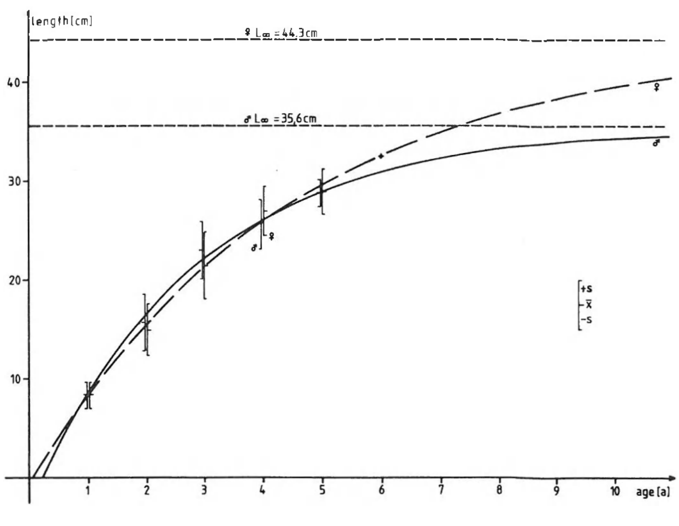

Fig. 11: Calculated v.Bertalanffy length-growth-curve for *Notothenia ramsayi*; mean length $\bar{x}$ and standard deviation s for each age group and sex are shown (males - left side; females - right side).

Table 3: Age-length-key of otolith-readings; total area except Burdwood Bank

length	age groups											
	0		I		II		III		IV		V	
[cm]	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
6.5	6	7										
7.5	9	9										
8.5	9	10	1	1								
9.5	8	8	1	2								
10.5	4	4	4	7								
11.5			8	15								
12.5			14	17								
13.5			11	18		1						
14.5			11	23		2						
15.5			19	22		3						
16.5			25	23	4	5						
17.5			16	13	1	4						
18.5			8	11	2							
19.5			6	6	4	8						
20.5			6	4	6	12	1	1				
21.5			2		9	8						
22.5			2		10	4	2	3				
23.5					8	4	7	4				
24.5					10	10	3	6				
25.5					10	8	4	8		1		
26.5					6	3	7	8	1	3		
27.5					3	1	6	7	1	1		
28.5					1		1	8	1			
29.5							1	8	3			
30.5								4	1	4		
31.5								2		2		
32.5												1
33.5							1					
Σ n	36	38	134	164	74	73	33	59	7	11		1
x̄ ♂	8.36		15.66		22.95		25.68		28.79			
s	1.268		2.833		2.868		2.455		1.380			
x̄ ♀	8.32		14.90		21.31		26.89		28.86		32.50	
s	1.270		2.608		3.435		2.519		2.336		-	

Table 4: Arithmetric mean ($\bar{x}$), standard deviation of the arithmetic mean ($s_{\bar{x}}$) and range (←x→) of the meristic measurements, in comparison to the range of x found by REGAN (1913) and NORMAN (1937); n = number of specimens; for gill raker: up. = upper arch, lo. = lower arch, to. = total arch

		subarea "N"			subarea "M"			REGAN 1913	NORMAN 1937	subarea "B"		
		$\bar{x} \pm s_{\bar{x}}$	n	←x→	$\bar{x} \pm s_{\bar{x}}$	n	←x→	←x→	←x→	$\bar{x} \pm s_{\bar{x}}$	n	←x→
vertebrae		50.30 ± 0.0455	153	48 - 51	50.49 ± 0.0699	82	49 - 52			51.28 ± 0.1584	25	50 - 53
fin-rays	D 1	6.85 ± 0.0327	123	6 - 7	6.82 ± 0.0312	168	6 - 8	7 - 8	6 - 8	7.11 ± 0.0816	27	6 - 8
fin-rays	D 2	34.86 ± 0.0613	118	33 - 36	34.81 ± 0.0601	106	33 - 36	34 - 36	34 - 37	34.44 ± 0.1717	27	32 - 36
fin-rays	A	33.47 ± 0.0626	117	31 - 35	33.51 ± 0.0707	107	32 - 35	32 - 34	31 - 35	33.07 ± 0.1503	27	31 - 34
fin-rays	P	26.48 ± 0.0670	115	25 - 28	26.73 ± 0.0691	108	25 - 28			27.44 ± 0.1630	27	25 - 29
grill-rakers	up.	11.96 ± 0.1211	105	9 - 15	11.71 ± 0.1912	72	8 - 15			13.37 ± 0.3297	27	10 - 17
grill-rakers	lo.	22.46 ± 0.1305	112	20 - 26	22.53 ± 0.1679	79	19 - 26	21 - 25	16 - 25	25.35 ± 0.2599	26	23 - 28
grill-rakers	to.	34.36 ± 0.1816	105	29 - 39	34.24 ± 0.2718	71	30 - 39			38.73 ± 0.4789	26	35 - 44

3.5. *Meristic characters*

Meristic data were collected by REGAN (1913) and NORMAN (1937). Results found during our studies are in agreement with those investigations (Table 4). The region investigated by REGAN and NORMAN is comparable to subarea "M". It appeared that means $\bar{x}$ and the ranges of most of the meristic characteristics in subarea "B" were higher than in the northern areas.

3.6. *Position in ecosystem*

3.6.1. Stomach contents analysis

A total of 877 stomachs was examined. Of these 138 stomachs were empty (≙ 15.7 %). The most important food items were crustaceans: Gammaridea, Copepoda, Euphausiacea and Decapoda. In addition Ophiurae and Polychaeta were rather important (see Table 5).

Fig. 12 demonstrates a preference for Copepoda, Euphausiacea and Gammaridea in small specimens. The percentage of Copepoda decreases with increasing fish-length from 37 % over 13 % and 8 % to nil. Percentage of Gammaridea also decreases while the proportion of Euphausiacea is more or less constant. From about 15 cm length onwards the percentage of bigger food-animals like *Pleuroncodes* spec., Polychaeta, Ophiurae and "others" is increasing to about 50 %. With increasing length the food spectrum becomes more diverse.

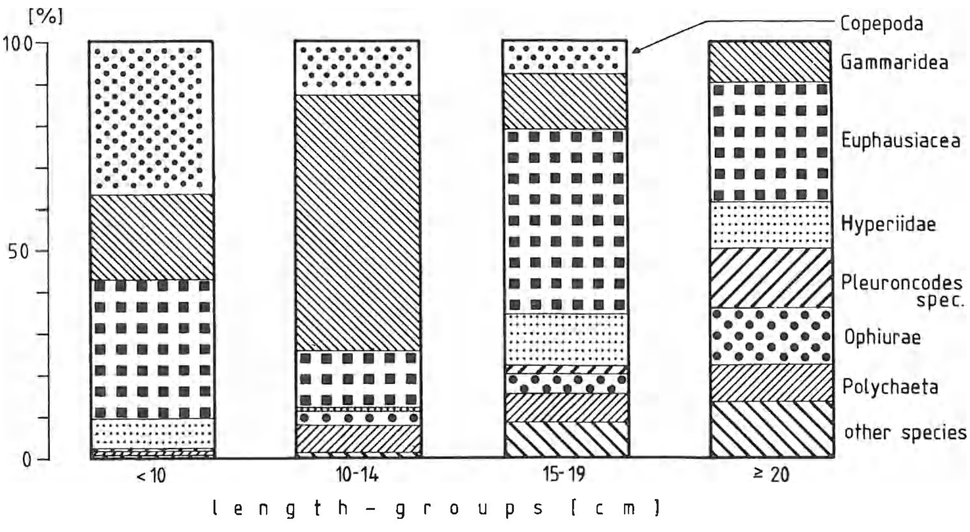

Fig. 12: Dependence of percentage of food-animals at stomach contents on fish-length.

Table 5: Frequency table of the food animals; given are the percentages of the stomachs (from 739 filled stomachs), in which each food animal appeared

Pisces	: Zoarcidae, *Illuocoetes fimbriatus*	0.14 %
	indet.	0.81 %
Echinodermata	: Ophiurae, indet.	5.82 %
Mollusca	: Scaphopoda, indet.	0.14 %
	Gastropoda, indet.	2.03 %
	Bivalvia, indet.	0.95 %
	Cephalopoda, indet.	0.41 %
Crustacea	: Calanoidea, indet.	14.07 %
	Ostracoda, indet.	0.54 %
	Gammaridea, indet.	29.09 %
	Hyperiidae, indet.	3.38 %
	Caprellidae, indet.	0.14 %
	Tanaidacea, indet.	0.95 %
	Isopoda: *Serolis* spec.	2.57 %
	indet.	4.47 %
	Euphausiacea, indet.	34.64 %
	Decapoda: *Pleuroncodes* spec.	3.92 %
	Majidae, indet.	0.41 %
Scyphozoa	: indet.	0.54 %
Polychaeta	: Ampharitidae, indet.	0.41 %
	Polynoidae, indet.	0.27 %
	indet.	8.53 %
Bryozoa	: indet.	0.41 %
Chaetognatha	: *Sagitta* spec.	0.68 %

There were also found: Pantopoda, Holothuroidea, Porifera, Hydroidea and Anthozoa, each 0.14 %.

Especially in bigger specimens food composition changes in relation to area. The importance of the Euphausiacea increases from the north to the south (see Fig. 13). On Burdwood Bank it seems that *N.ramsayi* is restricted to Euphausiacea (54 %), Hyperiidae (19 %) and *Pleuroncodes* spec. (17 %; together 90 %). In subarea "M" Isopoda (28 %) and Polychaeta (18 %) play a big part, as well as Euphausiacea (32 %; together 78 %). In the north the main groups are: Ophiurae (32 %), Polychaeta (10 %) and Gammaridea (33 %; together 75 %). Besides these a lot of other small groups may serve as food in the north. These data are only from the specimens > 15 cm because at about 15 cm there should be the change in food-composition from small to bigger specimens (see Fig. 12).

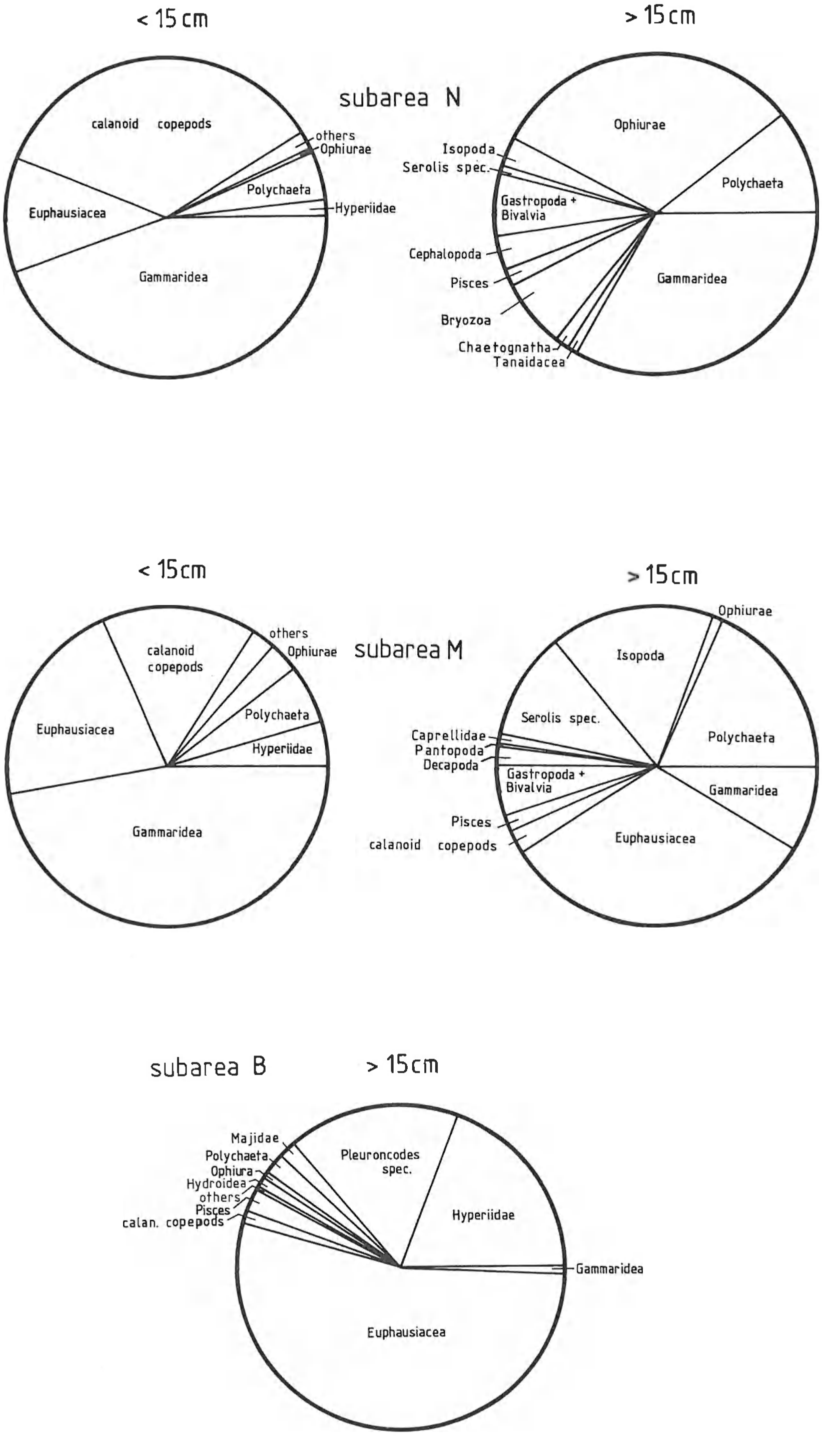

Fig. 13: Percentage of food-animals at stomach contents in the three subareas, separated after fish-length. Data from winter, few from spring.

3.6.2. Community analysis

The degree of cohabitating between *N. ramsayi* and six other species was examined by an index, which gives the percentage of stations on which two species (or more) appear together (after BALOGH, 1958). Here it is used as a standard for the overlapping of the distribution areas of six predators with that of *N. ramsayi*, and which therefore actually may be its potential predators (see Table 6).

According to HART (1946), *N. ramsayi* is of great importance as food for hake (*Merluccius* spp.), Merluza de cola (*Macruronus magellanicus*) and other fish on the continental shelf off Argentina. Furthermore *N. ramsayi* was found in the stomach of hake by ANGELESCU et al. (1958 and 1969) and in the stomach of *Dissostichus eleginoides* by KOCK (1978 and pers. comm.). But there are no quantitative data.

Due to the relative small stock size of 98,000 t in comparison to those of its potential predators: *Merluccius* spp. 2,100,000 t, *Micromesistius australis* 1,200,000 t, *Macruronus magellanicus* 800,000 t, *Salilota australis* 250,000 t, *Genypterus blacodes* 300,000 t and *Dissostichus eleginoides* 120,000 t (EHRICH, 1980) and the very different degrees of cohabitating with these predators (see Table 6), *N. ramsayi* should have only a regional importance as food for the six species. In subarea "N" the highest degree exists between *N. ramsayi* and *Merluccius* spp. (48%). In subarea "M" all species have a relatively high index of about 50%, except *D. eleginoides* with 30%. In subarea"B" only *Micromesistius australis* and *D. eleginoides* reach a high index of 51 and 68%.

This may indicate a regional importance of *N. ramsayi* as food for other fish as assumed by ANGELESCU et al. (1958, 1969) for hake.

4. Discussion

A change in mode of life from pelagic to bottom living at a length of about 15 cm, i.e. after the first year in subareas "N" and "M", which has also been described for *Notothenia rossii marmorata* (OLSON, 1954) and *N. neglecta* (EVERSON, 1970; HUREAU, 1970), and may be indicated by a change in food organisms at that length, could explain the almost complete lack of specimens <10 cm (≙ age group 0) in our material, so that they were not accessible to our trawling. Although small *N. ramsayi* were occasionally encountered in catches from shallower waters (see Fig. 5), high water temeratures at least in subareas "N" and "M" make it rather impossible that these areas form habitats for O-group *N. ramsayi*.

Bottom water temperatures in shallow waters of subarea "N" were steadily declining from autumn to spring (EKAU, 1979: Fig. 5 - 7). The shift in density towards shallower waters from autumn to spring (Fig. 4) may thus

Table 6: Index of coordination (after BALOGH, 1958) in the three subareas for the three seasons and the total time between *Notothenia ramsayi* and six of his commercially used predators: *Merluccius ssp. (Merl.)*, *Macruronus magellanicus (Macr.)*, *Micromesistius australis (Micr.)*, *Salilota australis (Sali.)*, *Genypterus blacodes (Geny.)* and *Dissostichus eleginoides (Diss.)*; n gives the number of stations.

		Merl.	*Macr.*	*Micr.*	*Sali.*	*Geny.*	*Diss.*	n
subarea "N"	south autumn	41	12	12	6	26	24	37
	south winter	43	11	5	7	23	11	45
	south spring	53	9	8	8	28	12	75
	total time	48	10	8	7	26	14	157
subarea "M"	south autumn	60	44	44	53	43	30	90
	south winter	82	43	36	68	51	31	84
	south spring	63	58	54	39	47	29	79
	total time	68	48	45	54	47	30	253
subarea "B"	south autumn	25	0	33	0	0	50	13
	south winter	18	18	50	5	0	73	19
	south spring	15	8	69	0	0	77	17
	total time	19	11	51	2	0	68	49

Table 7: Growth-parameters of *Nototheria ramsayi* and some other Nototheniids

Species	L_∞	W_∞	K	P	t_0	Origin
Trematomus hansoni	46.02	1353	0.222	2.48	0.1245	SHUST & PINSKAYA, 1978*
Trematomus bernachii ♂	23.0		0.36			PAULY, 1979 (a. WOHLSCHLAG, 1962)
∅		309	0.29	1.95		Environmental Temperature:
♀	30.7		0.22			-1.9° C
Notothenia gibberifrons	52.9	1615	0.15	2.38	0.7	KOCK, 1981 (a. BORONIN et al.,1979)
Notothenia neglecta ♂	39.5	1728	0.129	2.35	-0.8	KOCK, 1981 (a. EVERSON 1970 a)
♀	45.5	2744	0.091	2.40	-1.7	KOCH, 1981 (a. EVERSON 1970 a)
Notothenia ramsayi ♂	35.56	490	0.347	2.23	0.2281	Mean Environmental Temperature:
♀	44.35	1047	0.222	2.37	0.0635	4.7° C

*calculated after data from the authors

be explained by migration of *N. ramsayi* into areas with now suitable temperatures. Stock assessment may have been biased by those migrations to an unknown extent and may therefore explain among others the considerable differences in stock assessments for the subareas and seasons.

Growth in *N. ramsayi* is somewhat different from other Nototheniids. KOCK (1981) gives a synoptical table of growth data for Antarctic Nototheniids. Those mostly reach a bigger asymptotic length and have a slower growth-rate. The species similar to *N. ramsayi* are listed in Table 7. *Trematomus hansoni* and *T. bernachii* are rather similar in asymptotic length L_∞ and growth coefficient k. According to the "Index of Growth Performance", which should be a better standard to compare growth of fish (PAULY, 1979), the most similar species are *Notothenia neglecta* and *N. gibberifrons*. Most other Patagonian *Notothenia*-species are much smaller than *N. ramsayi* (HART, 1946), data about their growth have not been published.

N. ramsayi preyed on a diverse spectrum of food organisms:
euphausiids, hyperiids, *Pleuroncodes*, gammarids, isopods, ophiurids and polychaetes. Prey selection thus obviously occurs only on a general taxonomic category level (crustaceans) and is primarily influenced by the abundance of potential prey organisms in the area. In contrast to HART (1946), who reported a large proportion of fish (46%) in stomachs of *N. ramsayi* in autumn and winter from an area corresponding to subarea "M", only 1.6 respectively 2.2% of the stomachs contained fish.

5. Acknowledgements

This work was supported by Prof. Dr. K. LILLELUND (Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg) and Prof. Dr. D. SAHRHAGE (Institut für Seefischerei, Bundesforschungsanstalt für Fischerei, Hamburg). My gratitude also goes to Dr. S. EHRICH and P. CORNUS for their help during the evaluation of material and data. I would like to thank Dr. K. -H. KOCK for the revision of this paper.

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