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The influence of sex and maturity stage of krill (*Euphausia superba* Dana) upon the content and composition of its lipids

ABSTRACT: Using a thin layer chromatography the content and composition of krill lipids was examined in different sex and maturity stages. The content of lipids decreased in the following sequence: immature males — females with eggs — juvenile specimens — spent females — mature males. In females the differences concerned mainly phospholipids and waxes, in males — triacylglicerols; this fact proves the different utilisation of lipids for reproduction in both sexes.

Key words: Antarctica, krill, lipids.

Introduction

Content and composition of krill lipids fluctuate in annual cycle (Kołakowska, unpubl.). It is probably caused both by the difference in food accessibility and by the developmental stage of individual specimens, constituting the sample examined. The studies by Stępnik (1982, unpubl. data) and Ettershank (1983) proved a wide variability of krill shoal structure in an annual cycle. Clarke (1980), studying lipids of *E. superba* caught in February and March in the region of South Georgia, proved that females with eggs contain more lipids, whereas mature males and immature specimens have less lipids. This observation has been confirmed by Seather, Ellingsen and Mohr (1985); they have compared lipids coming from different parts of male and female bodies, and they have found that females contain two times more lipids than males. The data contained in the above mentioned papers are not sufficient to explain the problem of the influence of biological factors on the composition of krill lipids. It is also noteworthy that the researches were carried out on frozen krill 1—3 years after the actual fishing, which might have significantly changed the composition of krill lipids (Kołakowska 1986). The aim of this paper was the comparison of lipids in different phases of krill development, using krill of various maturity stage coming from the same fresh catch.

Material and methods

Krill (*Euphausia superba* Dana) which was caught in the Admiralty Bay in February, March and December of 1986 was examined. Immediately after fishing krill was classified according to sex and maturity stage. The sample consisting of some 200 to 300 specimens was homogenized into homogenous mass and taken for determination. Extraction of lipids was conducted by Bligh-Dyer method. The composition of lipids was defined with thin-layer chromatography and content of carotenoids on the basis of absorbancy of lipid extracts, according to the procedure presented in the earlier paper (Kołakowska 1986). The iodine value was estimated with Hanus method according to PN-78/C-94281. Specimens coming from the same catch were compared.

Results

Researches were carried out on two samples of krill taken in February and on two samples taken in March and December, respectively. Particular total samples differed according to content of lipids, composing subsequently: 7.89; 6.02; 6.35 and 4.55 g/100 g wet weight. The results obtained are similar (Tabs. 1, 2, 3, 4). In general, females were richer in lipids than males (in two from three examined samples). Mature females contained twice as much lipids as mature males. Significant differences occurred also among females and males. The most significant differences were found between mature and immature males. The immature ones contained 60% more lipids and were the richest in lipids sex/maturity krill group. On the other hand smaller differences were observed between mature females and spent females without eggs. The females lost about 25% of lipids together with eggs (Tab. 4). Differences in lipid composition concerned in general the phospholipids and unsaponifiable substances. Females contained more phospholipids than other specimens; about 10—15% more than males. Together with the laying of eggs females lost several to a dozen or so percent of phospholipids, mainly of phosphatidylcholine. On the other hand, the decrease in lipids in mature males, in comparison with immature males, was connected with the decrease of triacylglicerols. Krill maturity stage had a significant influence on the waxes fraction. It seems however (Tabs. 1—3) that it concerned mainly sterols and hydrocarbons. Juvenile specimens and immature males compared with mature specimens

Table 1

Contents and composition of krill lipids

Sampling date	Krill sample	Lipids % wet weight	LJ iodine value	Carotenoids μg/g		Lipid classes (% of lipids)					
				wet weight	lipids	PL	ch + 1,2 DG	1,3DG	WKT	TG	W
19.02.1986	total (C)	7.886	133.78	23.16	293	48.4	2.8	3.7	2.0	40.1	3.0
	males (M)	9.76	—	21.93	213	49.1	3.3	3.6	1.8	39.6	2.6
	gravid females (Fe)	8.27	—	34.13	685	54.4	4.7	4.2	2.1	29.7	4.8
	spent females (Fe/b)	6.30	—	27.27	432	48.6	5.6	5.1	5.0	27.6	7.9
	juveniles (J)	6.92	—	21.93	306	54.3	3.6	3.7	2.6	31.9	3.8
24.02.1986	total (C)	6.02	136	23.64	391	52.6	3.8	4.7	2.8	31.8	4.2
	immature males (Mn)	6.79	130.62	24.25	339	49.1	4.1	3.9	2.9	36.0	3.7
	mature males (Md)	2.22	159.12	38.29	1734	48.1	5.8	5.5	5.8	26.9	7.7
	gravid females (Fe)	6.01	137.84	25.27	419	55.6	3.4	3.9	3.3	30.7	3.1
	spent females (Fe/b)	4.32	140.83	28.64	662	51.8	6.0	4.3	2.9	31.0	3.9
	juveniles (J)	6.49	134.41	21.84	319	50.3	4.0	4.2	2.2	35.5	3.6
3.03.1986	total (C)	6.35	127	24.70	340	46.8	3.8	4.4	2.3	39.6	3.0
	immature males (Mn)	8.14	—	24.12	259	54.7	3.6	3.9	2.8	31.1	3.0
	juveniles (J)	6.17	—	—	—	54.3	4.4	4.1	2.6	30.7	3.7
12.12.1986	total (C)	4.55	121	20.02	962	59.6	4.0	3.2	4.1	24.6	4.5
	immature males (Mn)	5.46	109	24.00	662	59.0	4.5	3.2	3.6	25.9	3.9
	mature males (Md)	2.69	80	11.80	1288	62.6	4.4	3.8	4.0	20.4	4.3
	gravid females (Fe)	5.64	123	26.2	533	64.0	2.0	2.3	3.2	25.2	3.6
	spent females (Fe/b)	4.41	135	19.4	783	52.9	5.0	3.6	5.5	26.8	6.2

PL — phospholipids, DG — diacylglicerols, TG — triacylglicerols, Ch — cholesterol, W — waxes, WKT — free fatty acids.

Table 2

Composition of krill lipids (in %); sample of 24.02.1986

Krill sample	PC		PE		PJ	SM
	Total	LPC	Total	LPE		
total (C)	62.54	trace	24.74	5.15	7.56	trace
immature males (Mn)	61.30	trace	22.29	—	10.22	6.19
mature males (Md)	60.0	trace	33.0	—	6.66	trace
gravid females (Fe)	62.70	trace	21.20	—	6.43	9.64
spent females (Fe/b)	60.43	trace	21.58	—	11.99	5.99
juveniles (J)	56.94	—	20.75	—	18.0	4.31

PC — phosphatidylcholine
PE — phosphatidylethanolamine
LPC — lysophosphatidylcholine
LPE — lysophosphatidylethanolamine
PJ — phosphatidylinositol
SM — sphingomyelin

contained less than half of these compounds. Females, after laying of eggs, were losing several percent of these compounds, probably mainly hydrocarbons. The preliminary estimation of chromatographic separation of these compounds (Tab. 3) indicates that they are unsaturated hydrocarbons. Females contained the highest amount of carotenoids and juvenile specimens contained the least (Tab. 1). These differences amounted to about 40%.

Table 3

Composition of waxes fraction in krill (in %) sampling on 24.02.1986

Krill sample	Ech	other waxes	Hydrocarbons	
			S	US
TOTAL (C)	20.89	14.92	64.18	
Immature males (Mn)	29.16	14.58	56.25	trace
Mature males (Md)	9.37	20.93	10.41	59.37
Gravid females (Fe)	11.40	22.98	17.24	48.27
Spent females (Fe/b)	18.0	30.49	51.22	
Juveniles (J)	59.40	10.90	29.70	

S — saturated; US — unsaturated; Ech — cholesterol esters

Table 4

Decrease (in %) in lipids of krill caused by the change in maturity stage

Chane direction	Sampling date (1986)	Decrease (%)		
		total lipids	PL	TG
Fe — Fe/b	19.02.	24	11	7
	24.02.	28	7	0
	12.12.	22	17	6
Mn — Md	24.02.	64	2	25
	12.12.	51	6	21

Fe — gravid females
Fe/b — spent females
Mn — immature males
Md — mature males
PL — phospholipids
TG — triacylglicerols

Discussion

This paper confirmed that the content of lipids and their composition depends on sex and maturity stage of krill. The content of lipids decreased in the following sequence: immature males — females with eggs — juveniles — females without eggs — mature males. The results obtained are only partly compatible with earlier results of Clarke (1980), Shibata (1983) and Saether, Ellingsen and Mohr (1985). Females of the present study had really more lipids than males, but only mature ones. On the other hand not fully mature males contained high amount of lipids, the highest in all examined krill stages. It can be supposed that mature males lost lipids as a result of spawning. Since losses concerned triacylglicerols it were mainly — energetic ones. On the other hand females lose together with eggs less lipids, but they are physiologically important phospholipids and hydrocarbons. Judging from the iodine value and the amount of carotenoids, which has decreased in spent females, one can suppose that these compounds were lost together with eggs.

It is evident that the analysis of lipids can be an useful instrument in the investigations of krill biology.

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Streszczenie

Porównano zawartość i skład lipidów samic, samców i osobników niedojrzałych kryla. Wykazano, że ilość lipidów malała w następującej kolejności: samice niedojrzałe — samice z jajami — osobniki młodociane — samice bez jaj — samce dojrzałe. Generalnie samice zawierały więcej (nawet dwukrotnie) lipidów niż samce. Samce dojrzałe miały o około 60% mniej lipidów niż niedojrzałe, a samice po złożeniu jaj — o 25% mniej lipidów. Straty lipidów samic (na reprodukcję) dotyczyły fosfolipidów i wosków, natomiast u samców — triacylgliceroli, czyli u tych ostatnich były to straty głównie energetyczne.