

Piotr BYKOWSKI, Maria KOWALCZUK

Sea Fisheries Institute,
Al. Zjednoczenia 1,
81-345 Gdynia, POLAND

Fluoride content in the Antarctic krill (*Euphausia superba* Dana) in relation to its biological condition and to the fishery region

ABSTRACT: An attempt at assessing the correlation between the content of fluoride in the Antarctic krill from various fishery and its biological condition was carried out. Fluoride was determined with the Dołan method, which was modified by the present authors. No statistically significant correlation was found between the degree of sexual maturity and fluoride content. There was no decisive statistical relation between the body weight and body length of individuals and the content of fluoride in the Antarctic krill.

Key words: Antarctic, krill, fluoride content.

1. Introduction

Fluoride content in the Antarctic krill ranges widely from 800 to 2000 ppm/sm (Soevik, Braekkan 1979, Schneppenheim 1980, Christians 1980, Christians 1981, Szewielow 1981). The range of the value cannot be only a result of using various analytic methods for estimating fluoride content. It may be assumed that it ensues from differences in the biological condition of the investigated krill.

So far, there have appeared in the literature two papers concerning the relation between the biological condition of krill and its fluoride content. Hempel et al. (1981) recorded high fluoride content (1460—1730 ppm/sm) in the larvae of krill. Christians (1982) recorded a linear relationship between the individual body weight and the fluoride content in the body. Our preliminary results (Kowalczuk, Bykowski 1981) indicated the presence of a relationship between the degree of sexual maturity of individuals and the content of fluoride; higher content of this element was recorded in more mature individuals. No relation between

the fishery region and the content of fluoride in krill was then recorded. Presently, the results obtained in three fishing seasons (1981, 1983, 1984) were analysed. The aim of this work was an attempt at determining the relationships between the fluoride content and biological parameters for material originating from various fishery region at various times of the season.

2. Material and methods

The investigated material was the fresh krill or krill frozen just after fishing. It was fished in various fishery regions during the 1981 BIO-MASS-FIBEX Expedition, the Fifth Polish Antarctic Expedition in 1981, the voyage of m/t "Arcturus" in 1983 and during the 1983/1984 BIOMASS-SIBEX Expedition. Samples of about 1000 g were taken from the fishery catches.

The content of fluoride in the krill was determined with the Dolan method modified in the Institute of Marine Fisheries (Kowalczyk, Kostuch, Bykowski 1982). It consists in decomposing of a homogenized sample with a buffered solution of 5.5 pH (NaCl, CH₃COOH, sodium citrate and sodium versenate) during a ten minute period at 363° K and measuring the concentration of fluoride ions in a solution by means of an ion-selective electrode (type ORION 9409).

The dry weight contents was determined by drying the sample at 378° K till a constant weight was obtained.

The biological characteristics of the material was carried out according to commonly accepted methodology in a sample of 100 individuals chosen randomly. The methodology comprised: measuring the mean body length of an individual (ML), its body weight (MWR) and determining the phase of sexual maturity (J — juveniles, ND — immature, D — mature) (Wolnomiejski et al. 1979).

The statistical calculations of the results were carried out in the Computer Centre of the Institute of Marine Fisheries.

3. Results and discussion

The results obtained in three fishing seasons in various fishery regions of the western sector of Antarctica for the krill of high variability of biological parameters are presented in Table 1:

- a) length ML from 24.3 to 54.8 mm
- b) weight MWR from 97 to 1397 mg

c) sexual maturity from 0% of mature individuals to 94% of mature individuals.

The lack of correlation between the fluoride content and the fishery region is again confirmed.

The dependence of fluoride (C_f) on the values of particular biological parameters was analysed statistically. The presence of linear correlation

Table I

Fluoride content in the krill in respect to its biological condition and fishery region

N°	Date of catch	Fishery region	Biological condition					Fluoride (ppm/sm)	
			ML (mean)	MWR (mean)	Abundance of individuals				Dry weight (mean)
					J	N	D		
			mm	mg	%	%	%		%
1	2.03.81	61°01' S: 55°05' W	52.7	1221	0	6	94	20.71	1832
2	17.02.81	64°56' S: 65°06' W	54.8	1397	0	11	89	22.22	1962
3	27.12.83	64°08' S: 65°11' W	46.3	794	0	19	81	22.40	1105
4	29.12.83	63°48' S: 61°31' W	42.8	607	0	21	79	24.51	989
5	26.12.83	62°46' S: 62°39' W	45.9	784	0	24	76	23.05	1182
6	9.03.81	63°06' S: 58°47' W	50.0	1058	0	50	50	23.99	1163
7	23.12.83	61°39' S: 58°01' W	38.1	419	2	48	50	19.20	1380
8	27.12.83	61°19' S: 63°58' W	41.7	563	0	52	48	23.46	980
9	5.03.81	62°56' S: 57°31' W	46.4	834	0	61	39	22.99	1538
10	25.02.81	62°02' S: 59°45' W	50.5	1094	1	63	36	23.84	1503
11	11.04.81	53°50' S: 37°29' W	39.5	484	0	98	2	22.53	1222
12	12.03.81	63°30' S: 60°58' W	42.7	659	3	83	14	22.88	1106
13	7.01.84	60°59' S: 55°10' W	40.1	502	7	82	11	22.41	1238
14	30.12.83	62°47' S: 60°50' W	34.6	338	17	63	20	22.14	1141
15	8.12.83	62°30' S: 54°21' W	31.5	224	17	59	24	17.25	1391
16	17.12.83	60°46' S: 47°15' W	24.3	97	87	13	0	16.49	758
17	2.01.84	62°50' S: 57°09' W	27.3	144	87	12	1	15.16	989
18	6.01.84	60°59' S: 55°16' W	29.4	174	74	26	0	18.49	1284
19	4.01.84	61°01' S: 55°13' W	31.1	236	65	33	2	19.90	1332

between these values and the fluoride content was assumed. The coefficients of linear correlation (r) and determination coefficient (r^2) for the following relations were calculated:

$$\text{I } C_f = f(D)$$

$$\text{II } C_f = f(\text{MWR})$$

$$\text{III } C_f = f(\text{ML}).$$

The results are presented in Table II. Only the relation $C_f = f(D)$ (0% of mature individuals) satisfies the statistical criteria for accepting the hypothesis of the lack of correlation (Volk 1965). In two other cases the values

Table II

Values of the coefficient of correlation and coefficient of determination for the discussed relations; $N = 19$, $\alpha = 0.05$, maximal value $r_{\max} = 0.468$ at the assumed lack of correlation (Volk 1965)

Relation	r	r^2	$r - r_{\max}$
I $C_f = f(D)$	0.43	0.19	$r_I < r_{\max}$
II $C_f = f(MWR)$	0.65	0.42	$r_{II} > r_{\max}$
III $C_f = f(ML)$	0.59	0.34	$r_{III} > r_{\max}$

D — % of mature individuals in an average sample.

of the correlation coefficient and the determination coefficient, which were, approximately, $r = 0.5-0.6$ and $r^2 = 0.3-0.4$. did not allow to interpret decisively the obtained results. A precise interpretation of the relations would require further research, among others some changes in the methods of preparing samples (investigations were carried out on samples originating from industrial catches) as well as a deeper statistical analysis.

4. Conclusion

1. Lack of relation between the fluoride content in the krill and the fishery region was confirmed.

2. No correlation between the degree of sexual maturity and the fluoride content was observed.

3. No decisive relation between the weight or length and fluoride content of an individual was found.

4. Data on the biological condition of the krill fished industrially are useless for estimation of the fluoride concentration in the material.

5. Резюме

В работе анализировались данные о содержании фтора в антарктическом криле (*Euphausia superba* Dana), полученные в материале, собранным в различных местах ловли в 1981, 1983 и 1984 годах. Пробы, подвергнутые исследованиям, происходили из ловли промышленным тралом и характеризовались с биологической точки зрения (длина, масса, половая зрелость особей) в соответствии с методикой, принятой в Польше. Содержание фтора определялось методом Долана в нашей собственной модификации при использовании коноселективного электрода.

Были приняты попытки определения корреляции между содержанием фтора и биологическими параметрами криля. Определено отсутствие статистически значимой корреляции между содержанием фтора и степенью половой зрелости особей исходного продукта. Не выступает также однозначная статистическая зависимость между массой, длиной особи и уровнем фтора для средних проб промышленной ловли. В это же время подтвердились более ранние данные об отсутствии зависимости между содержанием фтора и районом ловли.

6. Streszczenie

W pracy przeanalizowano wyniki zawartości fluoru w krylu antarktycznym (*Euphausia superba* Dana) uzyskane w materiale zebrany na różnych łowiskach w latach 1981, 1983, 1984. Poddane badaniom próby pochodziły z zaciągów przemysłowych, były scharakteryzowane pod względem biologicznym (długość, masa, dojrzałość płciowa osobników) zgodnie z przyjętą w Polsce metodyką. Zawartość fluoru oznaczano metodą Dolana w modyfikacji własnej przy użyciu elektrody jonoselektywnej.

Podjęto próby określenia korelacji pomiędzy zawartością fluoru a parametrami biologicznymi kryla. Stwierdzono brak statystycznie istotnej korelacji pomiędzy zawartością fluoru i stopniem dojrzałości płciowej surowca. Nie występuje też jednoznaczna statystyczna zależność pomiędzy masą, długością osobnika a poziomem tego pierwiastka dla średnich prób pochodzących z połowów przemysłowych. Potwierdzono wcześniejsze wyniki świadczące o braku zależności pomiędzy zawartością fluoru a rejonem połowów.

7. References

1. Christians O., Leinemann M. 1980 — Untersuchung über Fluor im Krill (*Euphausia superba*) — Inform. Fischw., 6: 254—260.
2. Christians O., Leinemann M., Manthey M. 1981 — Neue Erkenntnisse über den Fluorgehalt im Krill (*Euphausia superba* Dana) — Ibid. 2: 70—72.
3. Christians O., Birnbaum A., Leinemann M., Manthey M., Ohlenschäger J. 1982 — Verarbeitung und Produktentwicklung — Arch. Fisch. Wiss., 33, (Beih. 1): 143—170.
4. Hempel G., Manthey M. 1981 — On the fluoride content of larval krill (*Euphausia superba*) — Meeresforsch., 29: 60—63.
5. Kowalczyk M., Bykowski P. 1981 — Fluor w krylu i produktach z kryla — Sprawozdanie z badań V Polskiej Morskiej Ekspedycji Antarktycznej MIR, Gdynia, 152—158.
6. Kowalczyk M., Kostuch S., Bykowski P. 1982 — Determination of the fluoride content of krill by a modified Dolan's method — Brom. Chem. Toks., 15: 121—124.
7. Schneppenheim R. 1980 — Concentration of Fluoride in Antarctic Animals — Meeresforsch., 28: 179—182.
8. Soevik T., Braekkan O. R. 1979 — Fluoride in Antarctic Krill (*Euphausia superba*) and Atlantic Krill (*Meganyctiphanes norvegica*) — J. Fish. Board Can., 36: 1414—1416.
9. Szewielow A. 1981 — Fluoride in Krill (*Euphausia superba* Dana) — Meeresforsch., 28: 244—246.
10. Volk W. 1965 — Statystyka stosowana dla inżynierów — WTN, 213 pp.
11. Wolnomiejski N., Witek Z., Czykieta H. 1977 — Metody i kryteria biologicznej oceny przemysłowych skupień kryla antarktycznego — Studia i Materiały MIR, Ser., A, 25: 27—64.