ACTA ICHTHYOLOGICA ET PISCATORIA
Vol. XV, Fasc. 1 Szczecin 1985

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Fish biology

AN ATTEMPT TO APPLY BAJKOV'S FORMULA TO ESTIMATION OF FOOD UPTAKE OF COD IN THE SOUTHERN BALTIC

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The cod annual food consumption as well as indices of gross food conversion were calculated, in weight and energy units, based upon mean daily coefficients for the years 1977–1981; the coefficients were arrived at by using Bajkov's formula for cod in various age groups. The results obtained are compared with data reported by other authors, those obtained with different methods and for cod from different areas. The differences between the results obtained when using Bajkov's formula and those involving a simple weight method are stressed.

INTRODUCTION

Studies on feeding of cod have been carried out in the Baltic since 1972. The aim of those studies has been two-fold: to determine trophic relationships affecting the population on the one hand and to find out how big is the population's pressure exerted on various prey species on the other, with a particular reference to the economically important plankton feeders such as herring and sprat. Results of earlier studies have already been published (Załachowski et al., 1976; Załachowski, 1977); further detailed results will be reported soon. The present work is aimed at considering some methodological problems. The study employs an index of the amount of food consumed daily, the index being estimated based upon Bajkov's method (Bajkov, 1935); the gut evacuation time is calculated from the formula given by Jones (1974).

Within the recent years, several papers on cod food uptake estimation were published (Daan, 1973; Jones, 1974, 1978; Lišev and Uzars, 1981; Jobling, 1982). All those authors used an array of methods, both experimental and based on materials obtained from natural habitats. In some cases, the results obtained diverged considerably (Bagge, 1981). Thus the reliability of results obtained with Bajkov's method as applied to the Baltic cod presents itself as a problem. To elucidate it, mean results from a 5-year period of studies (1977–1981) are compared with the available literature data. Not only the daily ration is included, but also the annual food consumption in weight units and energetic value of the food consumed are calculated as well as indices of food weight and energy conversion to growth. The last index is particularly useful in comparisons with results of some experimental projects. In the present paper, the attention is also turned to differences in estimates of food amount and of importance of various items, the differences arising when a comparison between the results of Bajkov's method and those of the simple weight one and the consumption coefficient is made.

MATERIALS AND METHODS

Over the period of 1977–1981, stomachs of 8902 individuals of cod caught in the Southern Baltic in the subareas 25 and 26 were examined. The samples were collected in various seasons each year; fish specimens were collected in each season from each fishing ground over the depth range of 20–100 m. Detailed information as to the temporal and spatial patterns of sampling is given in other papers by the present author (in preparation).

The stomach content was determined by reconstructing, from weight standards, the mass of each food item (organisms assigned to various size groups). The amount of food consumed over 24 h was calculated from Bajkov's formula (Bajkov, 1935):

$$D = w \frac{24}{t}$$

where: D = weight of food taken in over 24 h
w = stomach content weight
t = gastric evacuation time

The mass reconstructed from weight standards and expressed as $^0/_{000}$ of fish weight (the consumption index of Fortunatova, 1964) was substituted to „w". The daily food ration thus obtained, expressed also as ‰ fish weight, will be called further on the „daily coefficient" (following Novikova, 1962).

When calculating the evacuation time, „t", three differentiating factors were considered: initial meal size, fish size, and quality of the food consumed. The following equation, given by Jones (1974), served as a basis for the calculations:

$$(M^{0.54} - x^{0.54})\,175L^{-1.4} = Q \cdot 0.54t \cdot 10^{0.035(To-Tc)}$$

where:
- M = initial weight (g) of the food swallowed by fish (during time t = 0)
- x = food weight (g) at dissection of fish (during time t > 0)
- L = fish length (cm)
- Q = a coefficient denoting evacuation time of 1 g of food from a 40 cm long fish
- t = time (h) during which food weight in the stomach changes from M to x
- To = water temperature, as observed when fish was digesting the food
- Tc = standard temperature to which the value of Q is referred.

The above equation was simplified to

$$t = \frac{M^{0.54} \cdot 175L^{-1.4}}{Q}$$

after the following assumptions had been made:
1. „t" is the evacuation time when x = 0;
2. the cod food evacuation time should be reduced by half, more or less, that is by the duration of „inefficient digestion"; at that stage, as observed by Karpevič and Bokova (1936) and confirmed by Tyler (1970), hard elements of food remain in stomachs for almost as long as the part (about 80%) of food that is „efficiently digested". Bearing in mind this assumption, 0.54 was deleted from the denominator;
3. the mean temperature during fish feeding is 6°C.

The transformed equation could be applied to calculate evacuation time after still another assumption had been adopted, namely that the food content weight as reconstructed from weight standards equals „M".

The effect of food quality on evacuation time is included by differentiating between the values of „Q" of three groups of food items in the following way:

Q = 0.20 for the *Annelida* and small *Crustacea*;
Q = 0.12 for the large *Crustacea (Mesidotea, Crangon)*;
Q = 0.086 for fish.

Those are empirical values obtained by Jones (1974) who fed his experimental fish at 6°C with food consisting of *Nereis* (0.20) and *Crangon* (0.12) (using the continuous feeding in both cases), and saithe flesh (0.086) (the single meal approach).

In view of the fact that the method described assumes different rates of evacuation (Q) of different types of food, for each cod group studied the daily intake of each item was calculated first, the total daily intake being obtained as the sum total of those partial values.

RESULTS

1. Food composition and daily ration

Mean values (for the 5 years of studies) of daily intake of each food item are presented in Table 1. The table contains data calculated separately for six equal cod length classes within 5–65 cm as well as for the seventh class (fish length exceeding 65 cm). Only about 10 out of 39 food components identified play any significant role in the food; those important items are: *Antinoella sarsi* among the *Annelida; Mysis mixta*, the amphipods (both species of *Pontoporeia* and *Gammarus sp.*), and *Mesidotea entomon* among the *Crustacea*; the *Gobiidae, Clupea harengus*, and *Sprattus sprattus* among the fishes, and to a lesser extent *Enchelyopus cimbrius* and *Gadus morhua*. Some other items are important in the food of the smallest cod.

The total daily coefficient is at its highest in the first length class and decreases with increasing fish length, at first (within 5–35 cm) rapidly, and slows down later on to reach the lowest value in the last length class grouping the largest fish individuals. Changes in the daily coefficient with fish length are presented in Fig. 1 against the values of consumption index, calculated from the same materials. As shown in the figure, the two

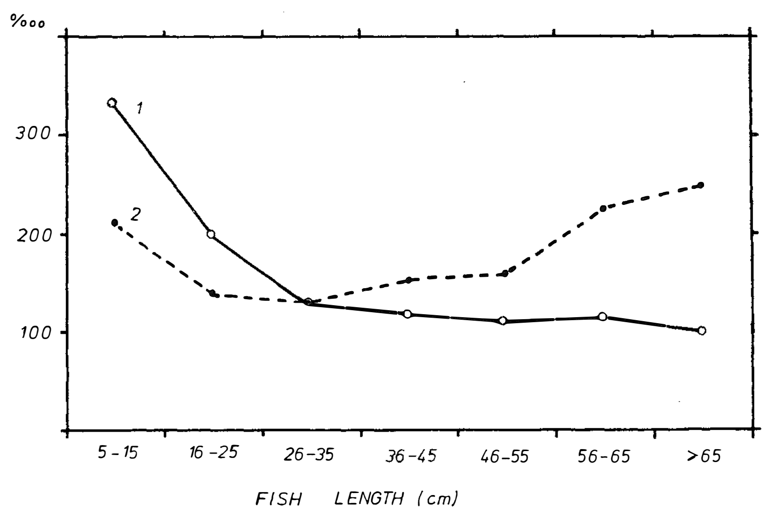

Fig. 1. Amount of food (in °/ooo body weight) taken up by cod in various length classes. 1 = daily coefficient; 2 = consumption index.

Table 1

Mean daily consumption (in $^{o}/_{ooo}$ body weight) of items recorded in food of cod of various size in 1977–1981

Food item	Length class (cm)						
	5–15	16–25	26–35	36–45	46–55	56–65	> 65
Annelida:							
Halicryptus spinulosus	–	0.01	0.02	0.01	–	–	–
Priapulus caudatus	0.17	0.40	0.32	0.05	0.04	–	–
Nereis diversicolor	26.01	4.49	1.66	0.34	0.02	–	–
Antinoella sarsi	109.73	83.52	27.60	21.17	11.44	3.10	0.02
Scoloplos armiger	–	0.04	–	–	0.00	–	–
Nemertini	0.16	–	–	–	–	–	–
Crustacea:							
Entomostraca	3.35	–	–	–	–	–	–
Mysis mixta	92.69	35.32	13.55	5.95	1.59	0.22	0.43
Neomysis vulgaris	19.61	0.38	0.25	0.07	0.00	0.00	0.01
Pontoporeia affinis	20.01	15.98	2.40	0.58	0.16	0.01	–
Pontoporeia femorata	5.99	1.23	6.21	4.63	2.18	0.40	–
Caliopius rathkei	–	–	–	0.00	–	–	–
Gammarus sp.	23.53	11.53	2.37	0.36	0.15	0.02	0.03
Corophium sp.	6.58	2.01	0.11	0.00	0.00	–	–
Hyperia galba	0.21	0.11	0.06	0.02	0.02	0.02	0.01
Diastylis rathkei	4.50	3.54	0.71	0.76	0.38	0.08	–
Jaera sp.	–	0.00	0.00	–	0.00	–	–
Idotea sp.	0.01	0.04	–	–	0.00	–	–
Mesidotea entomon	2.42	21.58	32.39	31.32	28.14	24.15	18.98
Crangon crangon	6.41	6.69	3.18	1.90	0.78	0.36	0.07
Bivalvia:	–	0.05	0.13	0.02	0.02	0.03	0.01
Pisces:							
Gobiidae	17.48	8.07	2.53	1.78	1.21	0.30	0.37
Sprattus sprattus	–	0.99	8.69	13.16	12.55	9.82	5.94
Clupea harengus	–	–	7.01	13.12	23.68	48.55	40.64
Clupeidae indeterm.	–	5.59	15.60	19.41	15.21	5.53	3.23
Osmerus eperlanus	–	–	–	0.14	0.21	–	–
Gasterosteus aculeatus	–	–	0.04	0.73	0.57	0.13	0.02
Syngnathus typhle	–	–	–	0.01	0.02	–	0.00
Belone belone	–	–	–	0.40	–	–	0.01
Ammodytidae	0.18	–	0.30	0.69	0.57	2.06	0.74
Rutilus rutilus	–	–	–	–	–	–	1.62
Pholis gunnelus	–	–	0.28	–	–	–	–
Lumpenus lampretaeformis	–	–	0.17	–	–	–	–
Zoarces viviparus	–	–	–	–	0.27	–	–
Platichthys flesus	0.44	–	0.01	0.03	0.01	1.10	1.12
Enchelyopus cimbrius	–	–	–	1.22	2.65	7.75	10.61
Gadus morhua	–	0.56	0.85	1.26	10.64	9.62	16.64
indeterminata	–	1.37	3.82	3.47	2.93	3.38	2.71
ova	–	–	0.14	–	–	–	–
Daily coefficient	339.48	203.50	130.40	122.60	115.44	116.43	103.21

coefficients not only differ in their numerical values, but they are also subject to differing trends of change. The consumption index, although decreasing initially down to its minimum in the 26–35 class, increases thereafter up to its highest values in the largest fish class. The curves representing changes in both coefficients cross in the 26–35 cm class. From that class on, the differences grow in two opposite directions and are at their largest in the extremal classes. The difference in the smallest cod class is 130 $^0/_{000}$ in favour of the daily coefficient, while in the largest class it is almost 150 $^0/_{000}$ in favour of the consumption index.

The daily coefficient vs. consumption index relationship presented in Fig. 1 results from the food composition being changed with fish growth. The young individuals food is

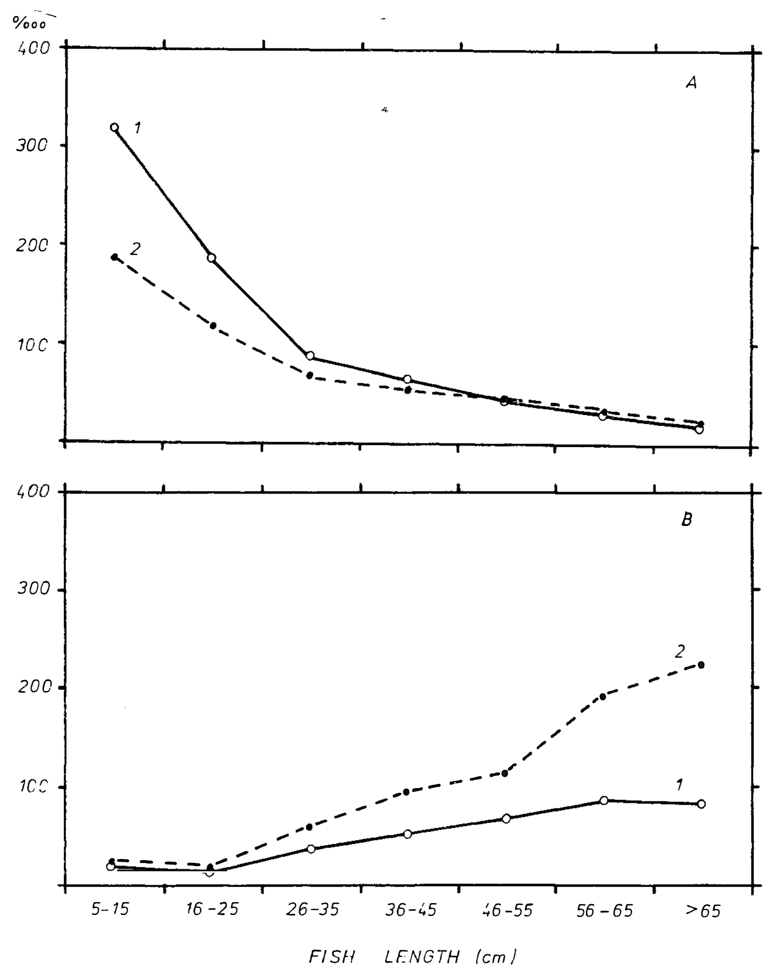

Fig. 2. Consumption (in $^0/_{000}$ body weight) of invertebrates (A) and fish (B) by cod in various length classes. 1 = partial daily coefficient; 2 = partial consumption index.

dominated by invertebrate fauna as opposed to fish prevailing in the food of older cod. The importance of the two groups of food items is assessed differently depending on which method of the two compared is being used. This is illustrated by Fig. 2. In the case of food invertebrates, the daily coefficient is clearly higher than the consumption index (except for the last three length classes), and the opposite is true with respect to fish in the food. The reason lies in differential, food-quality dependent, evacuation time, as used when calculating the daily coefficient. As identical evacuation rates (Q) were assumed for annelids and small crustaceans, the relation between partial daily coefficients and consumption index is similar in both groups of invertebrates (Fig. 3A, B). The evacuation rate of large crustaceans was assumed to be intermediate between the two groups mentioned and the fish. As a result, partial values of the daily coefficient and consumption index are very close to each other (Fig. 3 C). In those length classes (from 46 cm on) containing the cod eating only large crustaceans and fish, there is no clear-cut difference between values of the two coefficients as obtained for invertebrates (Fig. 2 A).

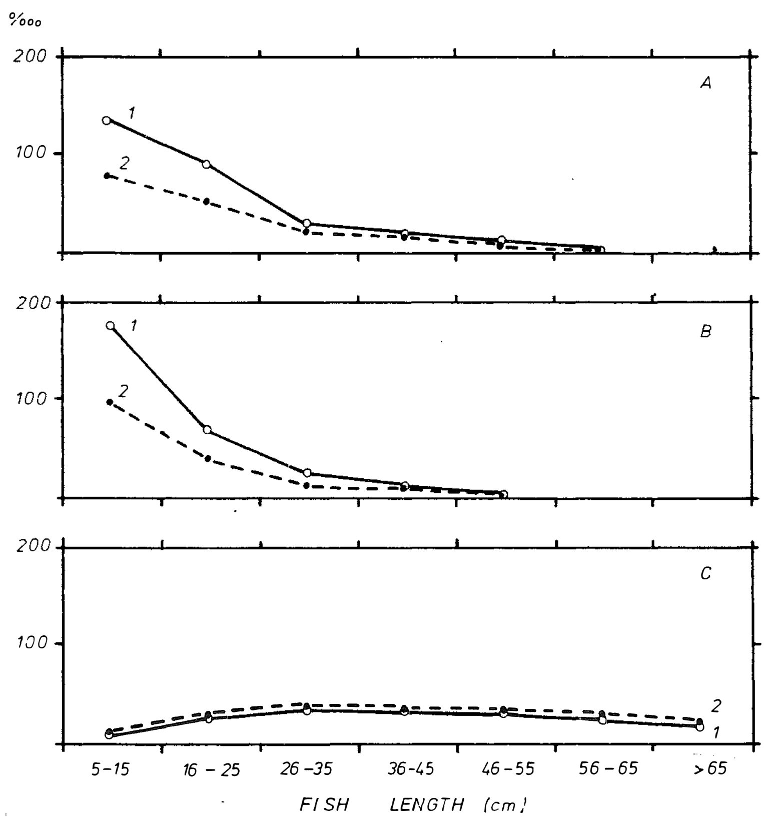

Fig. 3. Consumption (in $^{o}/_{ooo}$ body weight) of the *Annelida* (A), small crustaceans (B), and large crustaceans (C) by cod in various length classes. 1 = partial daily coefficient; 2 = partial consumption index.

2. Annual food consumption and gross efficiency

Based on the daily coefficients discussed above and on cod growth rate data from the Southern Baltic, food coefficients were calculated for various age classes. As the daily coefficients are 5-yr means, mean fish lengths in each age class, as given by a number of authors (Kosior, 1976; Kosior, 1983 unpubl.; Steffensen and Bagge, 1983) in their papers on cod growth rates in various calendar years are used in calculations. The mean weights in age classes are calculated from lengths, using the table given by Chrzan (1962). The food coefficient calculation method is presented in Table 2. The results obtained show the coefficient values to increase gradually from 6 in age classes II and III to about 15 in classes VII and VIII.

To obtain data reflecting the actual efficiency of food utilisation for growth, weight units were given caloric equivalents. The food weights were divided into three groups (Table 3) according to proportions resulting from Table 1. In the case of macroplanktonic and benthic invertebrates, the following equivalent was used: 1 g wet weight equals an average of 0.8 kcal (as based on data reported by Salonen et al., 1976; and Ackefors, 1975). For lean and fat fish, the equivalents – as based on data reported by Klejmenov (1971) – are 0.9 and 1.5 kcal, respectively. The energy contents of small and medium cod were assessed at 0.9 kcal/g, 1.0 kcal/g being the caloric value of large cod. When looking for energy equivalents of fish (both predators and their prey), seasonal changes in the chemical composition of tissues were considered. The results are contained in Table 4. The food coefficient ($F/\Delta B$) increases with age from about 6 to c. 18 and is higher than that obtained from weight ratio (Table 2) by 0.2–3.0 depending on cod age. The reverse of the coefficient, i.e., the index of gross food conversion (K_1) decreases with age from 0.16 to 0.06.

DISCUSSION

The method used in the study is based on numerous assumptions. If only one of them turns out false, the results are rendered erroneous. The error may increase when also other assumptions are not confirmed by the reality. Therefore it is important to ask whether the method's reliability can be tested. This seems to be possible only by comparison with other authors' results, and/or with other methods, including experimental ones.

The comparative material is relatively scarce. Daily rations (daily coefficients) found for other water bodies are not a proper point of reference as they may be different not only due to a different method used, but also by virtue of a different feeding dynamics exhibited by cod living under other conditions. Such differences occur, for instance, between the present results and those obtained by Daan (1973) for the North Sea cod; he used a method similar to that of Bajkov but employing different assumptions of the evacuation time. Similarly to the present results, Daan's daily coefficient decreased with

Table 2

Food coefficient (F/ΔB) estimates for the Southern Baltic cod as based on mean values for 1977–1981

Age	I	II	III	IV	V	VI	VII	VIII
Length class (cm)	5–25	26–35	26–45	46–55	46–55	56–65	>65	>65
Mean length (cm)	20	29	38	46	53	61	67	73
Mean weight (g) "B"	75	227	499	856	1304	1953	2565	3320
Annual weight increment, ΔB (g)	75	152	272	357	448	649	612	755
Mean daily coefficient (°/ooo)	271.49	130.40	126.50	115.44	115.44	116.43	103.21	103.21
Daily ration (g)	2.04	2.96	6.31	9.88	15.05	22.74	26.47	34.27
Annual ration (g)	743.2	1080.4	2304.0	3606.2	5493.3	8300.1	9661.6	12508.6
Mean annual ration, F (g)		911.8	1692.2	2955.1	4549.7	6896.7	8980.9	11085.1
Food coefficient, F/ΔB		6.0	6.2	8.3	10.2	10.6	14.7	14.7

Table 3

Percentage contribution of three food item groups differing in their energetic value (approximate values assumed from Table 1).

Age	I	II	III	IV	V	VI	VII	VIII
Invertebrates (0.8 kcal/g)	95	70	60	40	40	25	20	20
Fat fish (1.5 kcal/g)	0	30	35	50	50	60	50	50
Lean fish (0.9 kcal/g)	5	0	5	10	10	15	30	30

Table 4

Estimates of annual food consumption (kcal) and indices of gross food conversion (calculations based on data in Tables 2 and 3)

Age	I	II	III	IV	V	VI	VII	VIII
Consumption of invertebrates (kcal)	564	605	1106	1154	1758	1660	1546	2001
Consumption of fat fish (kcal)	0	486	1210	2705	4120	7470	7246	9381
Consumption of lean fish (kcal)	33	0	104	325	494	1121	2609	3377
Total annual consumption (kcal)	597	1091	2420	4184	6372	10251	11401	14759
Mean annual consumption, F (kcal)		844	1755	3302	5278	8311	10826	13080
Annual body weight increment, ΔB (kcal)		137	245	321	403	649	612	755
$F/\Delta B$		6.2	7.2	10.3	13.1	12.8	17.7	17.3
$\Delta B/F$		0.161	0.139	0.097	0.076	0.078	0.056	0.058

increasing fish size, its range, however, being larger (530 – 50 $^0/_{000}$); it was only the values obtained for the medium-size cod that approached the average ones in the Baltic. Lišev and Uzars (1981) applied a completely different approach based on the daily feeding intensity rhythm. Their daily coefficients ranged within 100–225 $^0/_{000}$ and 60–80 $^0/_{000}$ for samples collected during intensive feeding and for cod with poorly filled stomachs, respectively. Their first range is covered by the present author's long-term mean and the other is lower, which can be explained by the fact that the fish of a lower than average feeding intensity had been studied.

Bagge (1981) presented a very interesting comparison: based upon his analyses of gut contents of the Southern Baltic and Belt Sea cod he calculated daily rations using methods described by Daan (1973) and Jones (1974, 1978). The results of the two methods differed considerably, those rations obtained following Jones being clearly higher. Bagge published the complete set of data for his analyses of stomach content so it was possible to use his data (thanks to his kind consent to do so) to calculate daily rations with the method described above. As the method uses Jones' (1974) assumptions with respect to evacuation time, it could be expected that the results would be closer to those obtained by Bagge with Jones' method. This was in fact the case, although the curve plotted from the present author's results (Fig. 4) runs lower than expected. Among possible causes of that, two can be mentioned. Bagge's materials include the actual stomach contents, while the present method reconstructs the weight of the stomach

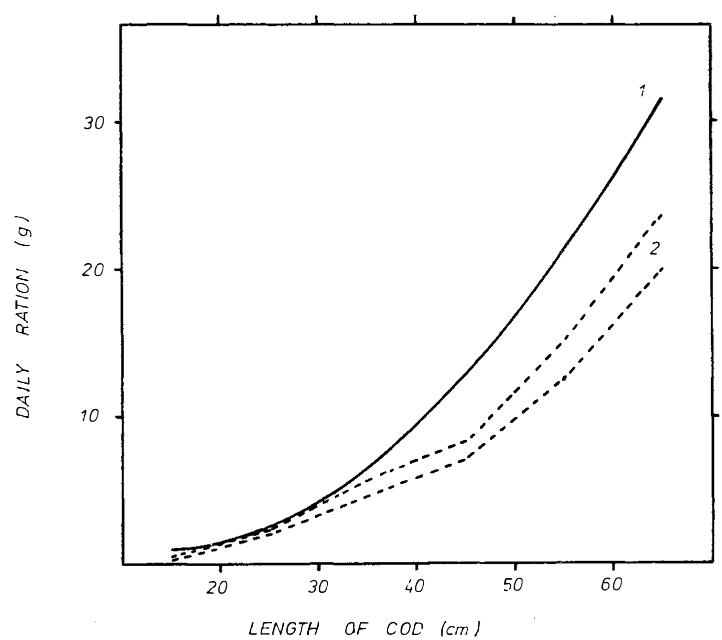

Fig. 4. The Southern Baltic cod daily ration as calculated from Bagge's data (Bagge, 1981). 1 = Jones' method (Bagge, 1981); 2 = Bajkov's method

content. Therefore, the calculations include a probable level of food digestion (in two versions, hence two curves), but it might have been actually different. Another cause may lie in a different value of „Q". Bagge took Q = 0.15 for the cod larger than 41 cm, while the present study assumes Q= 0.086 for food consisting of fish prevailing in the large cod's food. Had Bagge's value of „Q" been used, the curves compared would have been much closer to each other.

Jones (1978) himself calculated, using two methods, annual food requirements of cod in the North Sea and off the Faeroes, and obtained discrepant results. Depending on an individual cod weight (500–3000 g), he estimated the annual energy consumption from food at 4–20 thou. kcal per individual when the estimation was based on stomach content weights (the method mentioned above), and at 3–14 thou. kcal when the estimation was based on the energy budget equation derived from the well-known Winberg formula. The present author's results („total annual consumption" in Table 4) for cod of the same size (from the third year of life on) are almost identical with those obtained by Jones from the energy budget equation. The food energy content vs. cod weight relationship is analogous in its nature, too. The relationship, presented in its logarithmic form in Fig. 5, is expressed by a formula

$$F = aW^b$$

The exponent „b", according to Jones (1978), equals 0.92 and 0.8–1.3 for the North Sea and the Faeroes, respectively. The exponent for the Baltic (0.89) is covered by that range.

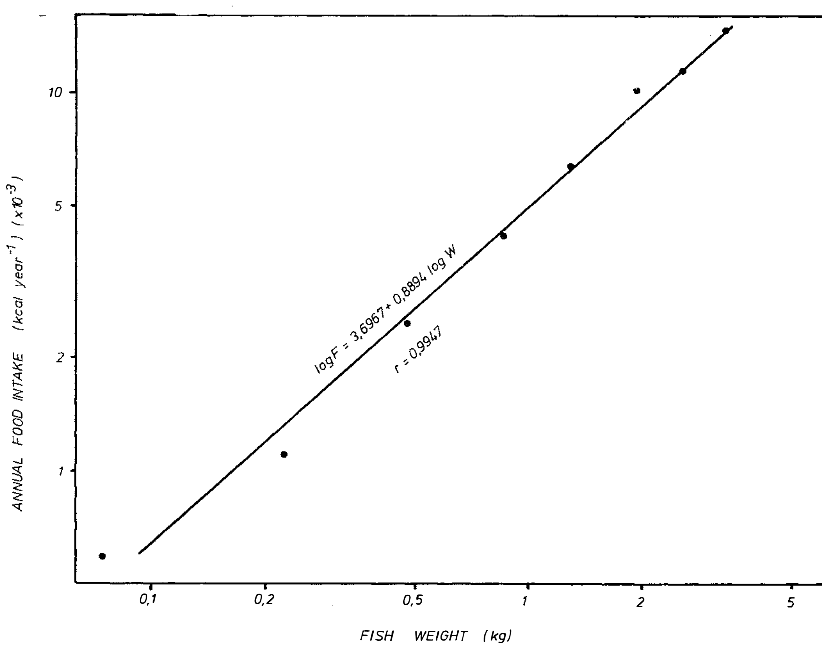

Fig. 5. Annual food intake (F) as related to cod individual weight (W).

Also the coefficient „a" assumes comparable values: in the North Sea, it ranges within 9–16 when the cod weight is expressed in grams. When the formula from Fig. 5 is transformed so that W is given in grams, log a = 1.0285, hence a = 10.68. Jones made his calculations for the North Sea and assumed the mean water temperature to be 8°C, i.e., by 2°C higher than that assumed for the Baltic. By using Jones' conversion $10^{0.035(To-Tc)}$ (see „Materials and methods"), the Baltic data can be adjusted to 8°C. Then „a" will equal 12.55 and will be in the centre of Jones' range of values.

Comparisons of energy uptake with food may, however, lead to „jumping to conclusions", similarly to the situation when daily coefficients are compared, as the amount of taken energy is dependent on the fish habitat and conditions therein. This was demonstrated by Jobling (1982) who estimated the energy taken up by cod in the North Sea, off the Faeroes, and in Balsfjorden. The fjord cod, living under more severe conditions, took up less energy, which was reflected in their slower growth and, probably, lower fecundity. The data presented by Jobling show, however, that the gross efficiency index (K_1) was, in spite of greatly differing growth rates, similar in the three regions studied. It decreased with age and ranged, for cod age classes II-VII, within 0.197–0.045, 0.119–0.046, and 0.146–0.065 in the North Sea, off the Faeroes, and in Balsfjorden, respectively. The author's data for the Baltic („Δ B/F" in Table 4), when the cod growth rate is much lower than that in the North Sea and similar to that in Balsfjorden, range – for the same age classes – within 0.161–0.056, i.e., correspond rather closely to the values obtained from the data of Jobling who used a completely different method.

Comparative data for the Baltic can be found in Lipska et al. (1980); they refer to the food coefficient as calculated from oxygen consumption indices, determined experimentally. The experiments were carried out at 11°C, the food coefficient (calculated from weight ratio) incerasing from 8 to 19 within the age range of II-VI. The author's values („F/ ΔB" in Table 2) show an increase from 6 to 11 within the same age brackets; they were, however, calculated for 6°C. Should the food consumption be increased by 49.6% (as indicated by the conversion formula $10^{0.035(To-Tc)}$), the values for 11°C would range within 9–16 and would approach those obtained by Lipska et al.

The above review shows the results obtained when using Bajkov's method as applied in a version described in this paper to be, in their order of magnitude, close to those arrived at by other authors using other methods, be it experimental or experimental-field ones. Small differences occurring in individual comparisons are fully understandable and can stem either from different feeding conditions for cod in various areas or from differing experimental conditions. An added probability of differences is generated when food rations and fish size increments are expressed in energy units, owing to the inadequacy of energy equivalent calculations from the chemical composition of tissues (Jobling, 1983). Bearing all this in mind one can assume that, at the present level of knowledge on methods of cod food ration calculation, Bajkov's approach yields reliable results. The method's advantage is the fact that it can be applied to various food items separately. The importance of this fact is illustrated by Figs 1–3. They show that food ration assessment from the entire stomach content (regardless of respective contributions of various items) may lead not only to incorrect estimates of feeding intensity, but also to errors in assessing the role of each item in feeding. The accuracy of the method seems to be related mostly to what the evacuation time in the formula is substituted by; for this reason, further studies on the food evacuation process should improve the method.

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PRÓBA ZASTOSOWANIA WZORU BAJKOVA DO SZACOWANIA ILOŚCI POKARMU POBIERANEGO PRZEZ DORSZA W POŁUDNIOWYM BAŁTYKU

STRESZCZENIE

Praca zawiera opis metody stosowanej w celu oszacowania dobowych racji pokarmowych dorszy w oparciu o analizę zawartości żołądków. W metodzie tej posługiwano się wzorem Bajkova (1935), a czas ewakuacji wyliczano według wzoru podanego przez Jonesa (1974) biorąc pod uwagę trzy czynniki różnicujące: długość ryb, rodzaj pokarmu i początkowe wypełnienie przewodu pokarmowego. Czwarty czynnik – temperaturę – uwzględniono jako wartość średnią, równą 6°C. Masę zawartości żołądków odtwarzano za pomocą standardów wagowych. Tą metodą wyliczono średnie współczynniki dobowe dla 8902 dorszy złowionych w latach 1977–1981. Uzyskane wyniki (tab. 1) porównano z tymi jakie daje zastosowanie wskaźnika spożycia i metody udziału wagowego. Okazało się, że wskaźnik spożycia zaniża poziom intensywności żerowania młodych dorszy (żywiących się fauną bezkręgową), a zawyża u starszych – żywiących się rybami. Analogicznie – metoda udziału wagowego przecenia znaczenie dużych form pokarmowych (ryb), nie docenia zaś znaczenia form małych (wieloszczety, drobne skorupiaki). Wielkość omawianych różnic ilustrują rysunki 1–3. Następnie wyliczono roczne spożycie pokarmu dorszy z różnych grup wieku i współczynnik pokarmowy (tab. 2), zaś po zastosowaniu zróżnicowanych ekwiwalentów energetycznych dla trzech grup składników (tab. 3), oszacowano także roczne zapotrzebowanie energii dla dorszy z różnych grup wieku (tab. 4, rys. 5) i ogólną przemianę pobranej energii na wzrost (tab . 4 „B/F"). Wszystkie wymienione wskaźniki porównano z podobnymi, uzyskanymi przez innych autorów różnymi metodami, w tym także metodami eksperymentalnymi. W większości przypadków różnice były niewielkie i mogły wynikać albo z odmienności warunków życia dorszy zasiedlających różne zbiorniki wodne, albo z różnicy warunków stwarzanych w badaniach eksperymentalnych. Przemawia to za wnioskiem, że metoda Bajkova, w wersji opisanej w tej pracy, może być stosowana do szacowania ilości pokarmu zjadanego przez dorsze i dawać wiarygodne wyniki.

Влодимеж Залаховски

ПОПЫТКА ИСПОЛЬЗОВАНИЯ МЕТОДА БАЙКОВА ДЛЯ ОЦЕНКИ КОЛИЧЕСТВА ПИЩИ, ПОЛУЧАЕМОЙ ОСОБЯМИ ТРЕСКИ В ЮЖНОЙ ЧАСТИ БАЛТИЙСКОГО МОРЯ

Р е з ю м е

Работа содержит описание метода, применяемого для оценки суточной кормовой порции трески, основываясь на анализе содержимого желудков. За образец брали формулу Байкова (1935), а время эвакуации вычисляли по формуле Джонеса (1974), учитывая три различных фактора: длину рыб, сорт корма и начальное наполнение желудочно-кишечного тракта. Четвёртый фактор - температуру, приняв как среднюю величину, вывели равной 6°С. Массу содержимого желудков воспроизвели с помощью весовых стандартов. Этим методом вычислены средние суточные коэффициенты для 8902 особей трески, выловленных с 1977 по 1981 гг. Полученные результаты (табл.1), сравнивались с теми, которые даёт применение показателей потребления и метода весового содержания. Оказалось, что показатель потребления занижает уровень интенсивности кормления молодых особей трески (питающихся безпозвоночной фауной) и завышает его у старших особей, питающихся рыбами.

Аналогично - метод весового содержания переоценивает значение больших пищевых форм (рыб), и недооценивает значение малых форм (полихетов, мел-

ких ракообразных). Величину указанных различий иллюстрируют рисунки 1–3. Затем было вычислено годовое потребление пищи особями трески в разных возрастных группах и пищевой коэффициент (табл.2), а после применения дифференцированных энергетических эквивалентов для трех групп компонентов (табл.3) дана оценка годовой потребности энергии для особей трески в разных возрастных группах (табл.4 рис.5) и общему превращению усваиваемой энергии в зависимости от роста (табл.4, „B/F").

Все перечисленные показатели сравнивались с похожими, полученными другими исследователями с применением различных методов, включая экспериментальные. В большинстве случаев различия были небольшие и могли вытекать или из различий в условиях жизни особей трески, обитающих в разных водоёмах, или из различий в условиях, создаваемых в экспериментальных условиях.

В заключение можно добавить, что метод Байкова в версии, описанной в этой работе, может быть использован для оценки количества пищи, потребляемой особями трески и может дать достоверные результаты.

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Received: 20 VI 1984