Energetic values of the body of *Macoma balthica* L. from the Gulf of Gdańsk*

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Abstract

Energetic values of *Macoma balthica* from 6 stations situated in the Gulf of Gdańsk have been determined. The values were measured directly by combustion in a microbomb calorimeter and indirectly by calculation based on the biochemical composition. No statistically significant differences between the values obtained by both methods have been observed. The average total energetic values from a microbomb and those calculated from the biochemical composition for the same material were equal to 22.6 ± 1.75 kJ·g^{-1} d.w. and 22.58 ± 1.75 kJ·g^{-1} d.w., respectively. A correlation between the energetic value and the lipid content has been found.

1. Introduction

The investigations of *Macoma balthica* population in the Gulf of Gdańsk have so far dealt with the production and growth rate (Ostrowski, 1976; Wenne, Klusek, 1985), reproduction cycle (Wenne, 1985) and condition, and biochemical composition (Wenne, Styczyńska-Jurewicz, 1985) The energetic value of *Macoma balthica* from the Gulf of Gdańsk has been usually calculated on the basis of biochemical composition. Very high lipid content (up to 36.18% of dry body weight) and, consequently, high energetic value were observed (Wenne, Styczyńska-Jurewicz, 1985). Beukema and de Bruin (1979) established that the energetic values of *Macoma balthica* body from the Dutch Wadden Sea obtained by this method can be higher than the values obtained by a direct method based on combustion in a calorimetric microbomb.

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The purpose of the present paper was to compare the energetic values obtained by combustion in a calorimetric microbomb with those calculated from the biochemical composition and to present a microgeographic differentiation of these values. In addition, the paper aimed at establishing whether there is a correlation between the energetic values and the lipid content.

2. Material and methods

Material for investigations was collected in July 1981 and during a period April–June 1982 from 6 stations located in the Gulf of Gdańsk (Fig. 1). About 50 individuals of similar length (*ca* 17 mm) were sorted out from each haul. They were stored in sea

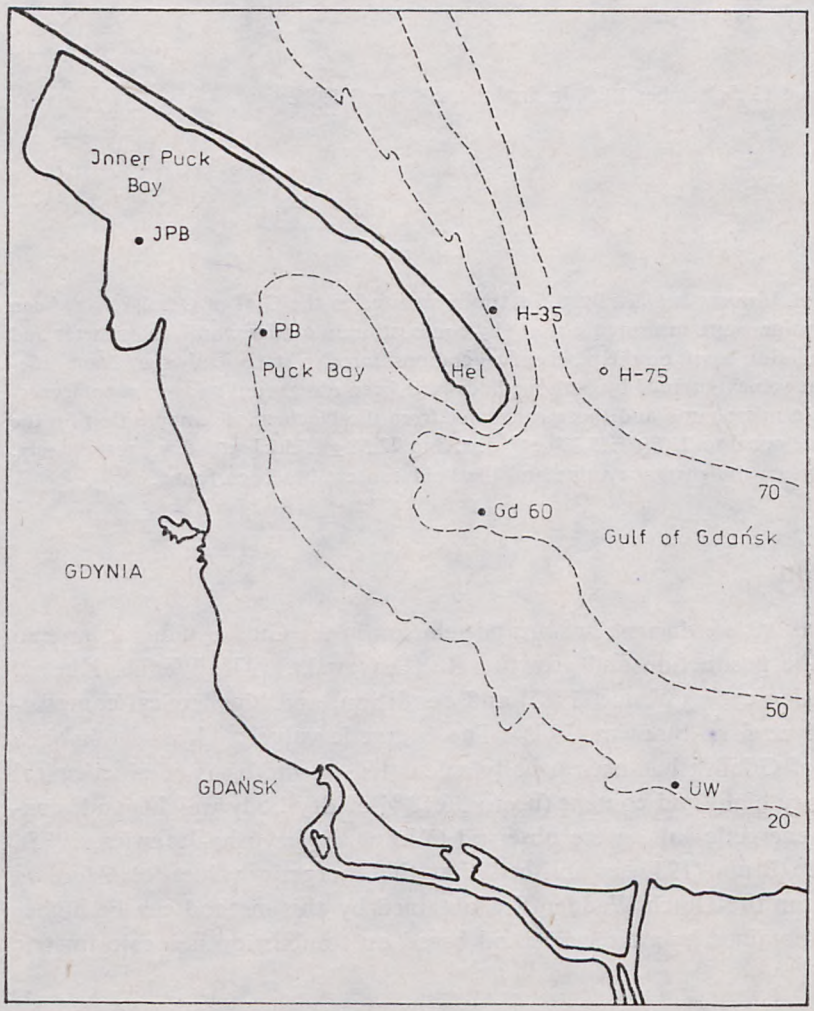

Fig. 1. Map of the Gulf of Gdańsk with marked points of sample collection

water at 4°C for 24 hours to clean mantle cavities. Bivalves were sorted according to sex (about 20 male and female individuals in each sample) followed by separation of body from a shell. The material was dried at 60°C to constant weight and homogenized. The energetic values were calculated on the basis of biochemical composition (content of lipids, carbohydrates, nitrogen and ash) using standard conversion factors: 39.57 $J \cdot mg^{-1}$ for lipids, 23.65 · J mg^{-1} for proteins and 17.16 $J \cdot mg^{-1}$ for carbohydrates (Wenne, Styczyńska-Jurewicz, 1985). This method was employed for the determination of energetic values for 10 samples.

A model KMB-2 calorimetric microbomb of Phillipson type (Prus, 1968; Klekowski, Bęczkowski, 1973) was used for the determination of energetic values by a direct method. This method was utilized for the analysis of 25 samples of *M. balthica* (including 10 samples for which the energetic value was determined from the biochemical composition).

For each type of material 3–6 combustions were carried out, followed by the calculation of the average values. For 1 mg of dry material total energetic value (in $kJ \cdot g^{-1}$ dry weight), energetic value of organic matter (in $kJ \cdot g^{-1}$), and ash content obtained from the microbomb after combustion of sample were calculated.

The lipid content was determined in all 25 samples and the ash content (by combustion in a furnace at 520°C) in 20 samples (Wenne, Styczyńska-Jurewicz, 1985; data published earlier).

3. Results and discussion

The energetic values of the same material of *M. balthica* obtained by combustion in a microbomb calorimeter were equal on the average to 22.06 ± 1.75 $kJ \cdot g^{-1}$ of dry weight with ash and to 23.58 ± 1.59 $kJ \cdot g^{-1}$ of ash-free dry weight, whereas the respective values computed from the biochemical composition amounted to 22.58 ± 1.75 and 24.13 ± 1.54 $kJ \cdot g^{-1}$ (Table 1). No statistically significant differences between the values determined by both methods were found (Wilcoxon-Mann test, according to Gubler, Genkin, 1969). The energetic values of organic compounds of *M. balthica* from the Dutch Wadden Sea calculated from the biochemical composition by Beukema and de Bruin (1979) were higher (23.03–24.83 $kJ \cdot g^{-1}$ d.w.) than those obtained by combustion in a microbomb (22.02–22.69 $kJ \cdot g^{-1}$ d.w.), the difference amouting to 6% of the average value (1.47 $J \cdot mg^{-1}$ d.w.).

The observed energetic values of *M. balthica* from the Gulf of Gdańsk (over 26 $kJ \cdot g^{-1}$ d.w.) are higher than the values reported for this species from other geographic regions as well as compared with other Bivalvia species (Table 2). It should also be pointed out that other *Bivalvia* species, *eg Cardium glaucum* and *Mytilus edulis* from the Gulf of Gdańsk can be characterized by relatively high energetic values (Pazikowska, Szaniawska, in; Wołowicz, Szaniawska, in preparation).

On the basis of results obtained from combustion in a calorimetric microbomb the differences in energetic values of *Macoma balthica* dependent on the place of occurrence (Fig. 2) were observed.

Table 1. Energetic values of *M. balthica*

Station	Date	Sex	Energetic values [kJ·g^{-1}]			
			total		dry organic mass	
			1	2	1	2
IPB	82/05/21	♀	20.94	21.69	22.51	23.32
	82/05/21	♂	21.69	21.44	23.59	23.32
	82/06/29	(−)	21.56	21.82	22.99	23.27
	81/07/09	(−)	20.23	20.18	22.27	22.22
PB	82/04/29	♂	23.99	21.82	25.94	23.59
	82/05/21	♂	22.44	21.44	24.29	23.21
	82/06/29	♀	21.44	20.85	22.99	22.36
H-75	81/05/21	♀	23.07	22.36	24.24	23.49
	81/07/14	♀	25.08	22.24	26.00	23.05
H-35	81/07/14	♂	25.38	26.72	26.52	27.92
Average ±SD			22.58 ±1.7538	22.06 ±1.7593	24.13 ±1.5455	23.58 ±1.5927

1 – calculated from biochemical composition; 2 – obtained from combustion in a calorimetric microbomb; ♀ – females; ♂ – males; (−) not sorted out

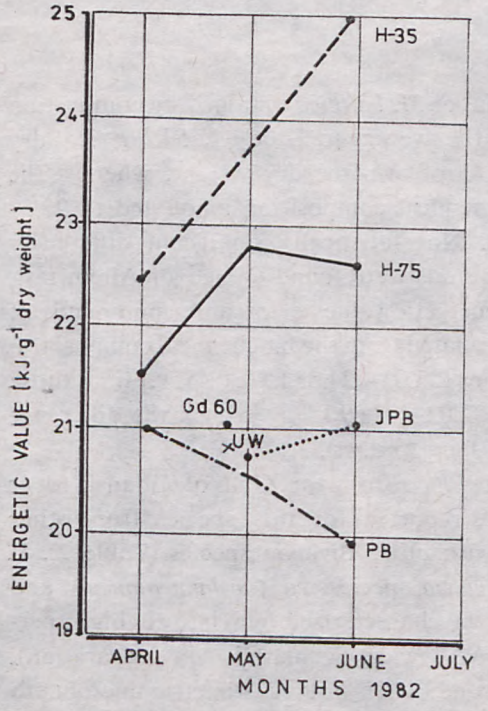

Fig. 2. Energetic values of *M. balthica* from various regions of the Gulf of Gdańsk in 1982

Table 2. Energetic value of the body dry weight and ash-free dry weight of the *Bivalvia*

Species	Region	Body dry weight [kJ·g^{-1}]	Ash-free body dry weight [kJ·g^{-1}]	Author
Macoma balthica	Gulf of Gdańsk	20.23–25.38[a] 20.18–26.72[b]	22.27–26.52[a] 22.22–27.92[b]	Szaniawska, Wołowicz, Wenne, 1986
Macoma balthica	Dutch Wadden Sea	· ·	23.03–24.83[a] 22.02–22.69[b]	Beukema de Bruin, 1979
Macoma balthica	Scotland	16.12–19.05[b]	18.92–21.48[b]	Chambers, Milne, 1975
Donax vittatus	Scotland	18.13–23.03[a]	·	Ansell, 1972
Donax trunculus	Algeria	16.33–18.84[a]	20.52–24.38[a]	Ansell *et al.*, 1980
Donax incarnatus	India	17.79–20.18[a]	·	Ansell *et al.*, 1973
Donax spiculum	India	19.34–20.05[a]	·	Ansell *et al.*, 1973
Scrobicularia plana	North Wales	·	20.47–22.02[a] 20.47–22.02[b]	Hughes, 1970 Hughes, Wuycheck, 1971
Mytilus edulis	Gulf of Gdańsk	19.16–22.12[b]	·	Pazikowska, Szaniawska, in preparation
Modiolus sp.	·	19.26[b]	·	Cummins, Wuycheck, 1971
Dreissena polimorpha	Poland (lake)	17.33–22.69[b]	·	Stańczykowska, Ławacz, 1976
Chlamys septemradiata	Scotland	17.58–20.72[a]	·	Ansell 1974
Cerastoderma glaucum	Italy England	16.62–21.02[b] 13.36–17.79[b]	20.85–23.24[b] 20.01–22.19[b]	Ivell, 1979 Ivell, 1979
Enisis minor		·	14.65[b]	Cummins, Wuycheck, 1971
Nucula turgida	Dublin Bay	15.90–21.34[a]	·	Davis, Wilson, 1983

[a]–computation from biochemical composition; [b]–microbomb calorymetry

In both years of investigations the highest energetic values reaching 26.72 kJ·g^{-1} d.w. (total with ash) were noted at the station H-35 and at the station H-75 (23.69 kJ·g^{-1} d.w.). At the same time, during the period April–July an increase of energetic values of *M. balthica* from 22.98 to 26.72 kJ·g^{-1} d.w. (H-35) and from 21.56 to 22.24 kJ·g^{-1} d.w. (H-75) was observed in this region. The energetic values of *Macoma balthica* from the remaining investigated regions were lower and constant. The lowest energetic values were noted in the Inner Puck Bay (IPB): 20.23 kJ·g^{-1} d.w. in 1981 and 21.43 kJ·g^{-1} d.w. with ash in 1982.

The reason of spatial differentiation and seasonal variability of energetic value, lipid content, and condition indices is availability of food mainly (Wenne, Styczyńska-Jurewicz, 1985). Planktonic diatoms constitute 2/3 of food of *M. balthica* and the parameters well reflecting food availability are phytoplankton concentration and

chlorophyll content (Hummel, 1985, in press). The values of these parameters are lowest in the IPB, higher in the Puck Bay (PB) and central part of the Gulf of Gdańsk (Latała, 1982; Pliński *et al.*, 1982). Particularly high energetic values of *M. balthica* on the outer slope of the Hel Peninsula (H-35) can be associated with carrying large amounts of food by a strong demersal current.

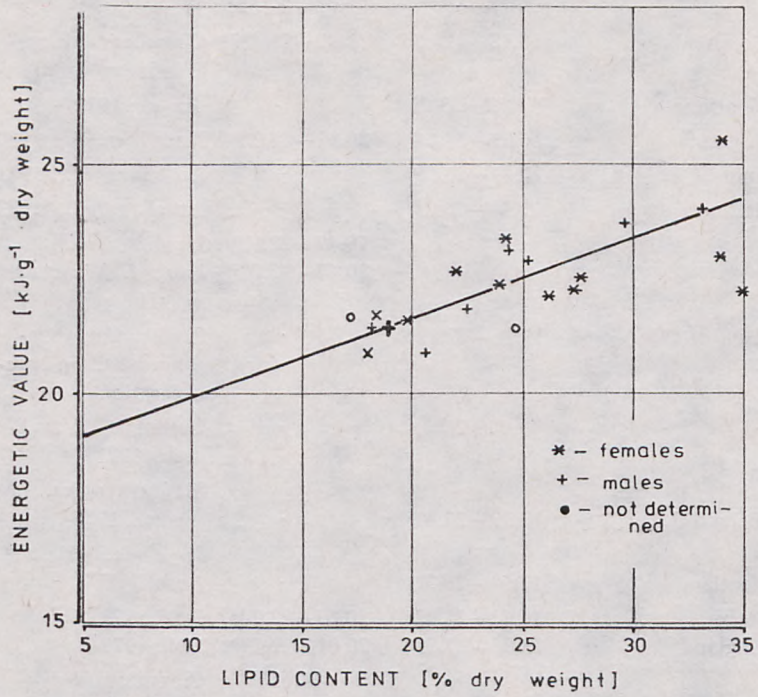

Fig. 3. Dependence of the energetic value of *M. balthica* from the Gulf of Gdańsk on the lipid content

A distinct dependence was observed between the total energetic value of *M. balthica* body obtained on the basis of combustion in a microbomb and the lipid content. It can be described by an equation $y=0.17x+18.19$, where y – energetic value (in $kJ \cdot g^{-1}$ d.w.), x – lipid content (in % d.w.), and the correlation coefficient is equal to 0.79 (Fig. 3), $p<0.001$.

M. balthica accumulated lipids, which content reached 36.18% d.w. (station H-35 in years 1981–1982; Wenne, Styczyńska-Jurewicz 1985). This dependence is not so distinct for other bivalves, *eg M. edulis* from the Gulf of Gdańsk accumulates glycogen as a supply material; only during reproduction period the lipid content increases to 23.5% and equals to 17.3% on the average (Pazikowska, Szaniawska, in preparation).

On the basis of experimental calorimetric data it was established that during the investigation period no significant differences occurred between the energetic values of females and males of *M. balthica*. The average total energetic values determined on

the basis of 7 samples for females and males were equal to 22.17±0.41 and 22.89 ±1.97 kJ·g^{-1} d.w., respectively. The content of mineral compounds in *M. balthica* body was low, the average obtained from combustion in a calorimetric microbomb amouting to 5.2±1.1% and from combustion in a muffle furnace – 6.3±1.7%. On the average, the values obtained from combustion in a muffle furnace were higher by 21.1%. Lower values obtained from combustion in a calorimetric microbomb were most probably due to scattering of some ash during flash combustion. The difference was smaller in comparison with the results of Beukema and de Bruin (1979), where it ranged from 20 to 40%.

4. Summary

The energetic values for samples of *Macoma balthica* collected in 1981 – 1982 were determined by combustion in a microbomb calorimeter and compared with those computed from the biochemical composition. No significant differences were found between the results obtained by both methods. The lowest energetic values of *M. balthica* were observed in the Inner Puck Bay and the highest – on the outer slope of Hel Peninsula (station H-35). The total energetic values of *M. balthica* over 26 kJ·g^{-1} d.w. are considerably higher from those reported so far for this species as well as for other *Bivalvia* species. The dependence of energetic values of *Macoma balthica* body on the lipid content can be described by certain equation.

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