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# ENERGY BUDGET OF THE FRESH WATER CLAM *Corbicula fluminea*(MULLER) FROM GARMAT – ALI RIVER- IRAQ.

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## SUMMARY

energy budget was developed for *Corbicula fluminea* at 15, 20, 25 and 30 °C. Filtration rates at these temperatures were 3.039,4.021, 5.955 and 15.191 ml/mg dry wt/hr. oxygen consumption rates were 0.421, 0.539, 0.697 and 0.920 $\mu lO_2$/mg dry wt/hr. Assimilation efficiency were 49.11, 43.55,40.65 and 16.58 %. From these rates a scope for growth was meassured which is optimal at 25 $^{O}$C.

## INTRODUCTION

*Corbicula* is already known to be an important filter of phytoplankton and seston from the water column (Lauritsen, 1986a ; Leff *et al.* 1990 ; Boltovsky *et al.*1995). Recently, *Corbicula* has also been shown to collect food within the streambed through pedal-feeding (using cilia on the foot to collect subsurface organic matter ( Cleland , 1988 ; Reid *et al.* 1992).

The Asiatic clam *Corbicula fluminea* was first reported in the Pacific Northwest at the turn of the century (Burch , 1944 ; Counts,1981) and has since spread eastward, becoming a dominant benthic invertebrate (in biomass) in many of the major drainage basins in the United States(Mattice ,1979).Temperature is a major environmental factor that influences Invertebrate physiology and is important in determining geographic distributions (Kinne , 1970).

There have been several studies of *Corbicula* 's thermal tolerance (Mattice and Dye, 1975 ; Mattice , 1979 ; McMahon , 1979) . However, no one has investigated the influence of temperature on *Corbicula* 's growth and attempted to explain the pattern in terms of the underlying physiological processes. Filtration rates have been reported for *Corbicula fluminea* by Prokopovich (1969),Habel (1970),Auerbach *et al*(1977), Mattice (1979), Lauritsen(1986b),and Foe and Knight (1986a , b).

A thermal energy budget was developed for immature *Corbicula fluminea* at four different temperature,negative growth above 29°C, and high tissue growth termperatures as low as 16°C , growth was measured in the laboratory at two-degree increments between 16 and 32 °C (Foe and Knight,1986b).

In the Shatt Al- Arab river the mussel *C. fluminea* is the most widly distributed and easily accessible filter feeder in the intertidal and subtidal area.Abdul-Sahib *et al.* (1995) studied the monthly changes in density and secondary production of Asiatic clam *C.fluminea* togather with *C. fluminalis* in the Shatt Al-Arab river system.Abdullah *et al.*(2002) investigated the effect of termperature on the oxygen consumption of the clam *C. fluminea* in Garmat-Ali river.

The aim of the present work is to accumulate the data of oxygen consumption with further observation on population density,production,calorific content of tissues and food consumption, in order to find the energy flow of the clam *C. fluminea*

## MATERIAL AND METHODS

The energy budget of a population of organisums can be described using the LBP notation (Crisp,1984) in the equation:

$$C = R + P + F$$

and it applies to any system where all energy sources are included in the left-hand side and all energy sinks to the right-hand side. Upon rearrangement this reduces to

$$C - F = A = R + P$$

Where C is the amount of energy ingested, F is energy value of waste products (faecal and excretory material), R is the energy metabolically utilized, P is the energy incorporated into biomass of organsim(growth and gametes)and A is the caloric value of the food absorbed across the intestinal wall.

Physical factors used to calculate energy budget were mesured as follows:

C(cal/month) = filtration rates (ml/month) x algal concentration (cells/ml) x algal caloric content (cal/cell)

R (cal/month)=metabolic rate(ml$O_2$/month) x oxycaloric constant (4.86 cal/ml$O_2$)

P (cal/month) = tissue growth (mg/month) x caloric content of tissue (cal/mg)

A (Cal/month) = C (cal/month) x assimilation efficiency (%)

Each of these values was estimated as a function of temperature converted to caloric equivalents and combind to estimate *Corbicula* scope for growth efficiency at15, 20,25 and30 °C.

Clams of 7 to 30 mm shell length were collected from subtidal population of Garmat - Ali river. Clams employed in the growth and filtration.

Monthly tissue growth was measured from monthly mean length (Abdul-Sahib *et al.*, 1995) and dry tissue weight equation:

Log weight =2.8905 log length −1.7498 (r = 0.98 ,n = 80 )(Abdullah *et al.* 2002)

The caloric value of the tissue was determined by a C 400 adiabatic bomb calorimeter. The mean caloric value was 5.14 cal /mg (N = 5).

Filtration was measured in a static system consisting of a series of 30 ml glass containers (1-2 individuals in each). Clams were fed during the thermal acclimation on period culture of *Chlorella* at a concentration of 3 x $10^5$ cell / ml. Incubator was used to control temperatures for each experiment. After an hour of continuous feeding the cells concentration were determined with a hemacytometer . Filtration was calculated from the formula of Fox *et al.* (1937).

$$F = \frac{\ln C_1 - \ln C_2}{W} \quad \frac{V}{T}$$

Where F is filtration rate (ml/mg-hr), $C_1$ the mean *Chlorella* density of three control containers without clams after 60 minutes (cells/ml), $C_2$ the *Chlorella* density after 60 minutes of clam filtration (cells/ml), V the container water volume /ml ) , T 60 minutes and W clam dry tissue weight.

Assimilation efficiency was determined by the Conover method (Conover,1966).

$$A = \frac{(F - E)}{(1 - E)F} \quad 100$$

Where F is the dry weight ratio of phytoplankton prior to ingestion and E is a similar ration for the feces.

The correlation between filtration rates (ml/mg- hr) and dry tissue weight (mg) based on the equation log Y = a + b log X

Where : Y dry tissue weight and X filtration rates.

$Q_{10}$ (temperature coefficients) was calculated for the range of temperature from 15 to 30 °C based on the equation:

$Q_{10} = ( V_2 / V_1 )^{10/(t2 - t1)}$

Where $V_1$ and $V_2$ are the velocities of the process at temperature $t_1$ and $t_2$, respectively (Grodzinski *et al* 1975).

Differences in filtration rates were analyzed with a one-way ANOVA and a least significant difference at 15,20,25 and 30°C .

The average caloric value of the *Chlorella* culture was determind to be 1.3 x $10^{-2}$ cal/ml of water.

The equations for calculating oxygen consumption of the clam *C. fluminea* were derived from Abdullah *et al* (2002).

## RESULTS

The rates of filtration plotted as a function of dried tissue weight at four temperatures degree are shown in(Table 1), the correlation coefficient of the filter lines were varied between 0.92 at 20 °C and 0.84 at 30 °C, and the slops varied between 0.19 at 15 °C and 0.26 at 30 °C .

The mean filtration rates for eight size classes was calculated from the regression equations at (Table I), and the results are shown in Table 2. The mean filtration rate obviously increased with the rising in temperatures and the increasing of body size.

The temperature coefficient ($Q_{10}$) was estimated at 3 temperature ranges (15-20, 20-25 and 25 - 30 °C). At the range 15 - 20°C the $Q_{10}$ values was ranging from 1.84 to 2.49 for the size classes 9-30 (mm) where as the values 2.34 to 2.50 and 7.43 to 8.10 were recorded for the same size classes at the ranges 20-25 C and 25-30 °C respectively. The general mean of $Q_{10}$ values was 4.15 (Table 3).

Differences in filtration rates were analyzed with a one - way ANOVA ($F_{3, 31} = 53.62$ $p < 0.05$ )with the four temperatures.A least significant difference test showed that there was no significant differences between 15, 20 , 25 °C and significant difference with 30 °C at the 5% level (Table 4).

Metabolic rates (Table 4) increased with rising temperature as the least significant difference test revealed statistical differences between each non adjacent pair.

Assimilation rates are listed in Table 4. Assimilation was constant over a range of temperature from 15 to 25. However , the efficiency dropped significantily at 30 °C ( p<0.05).

The laboratory rates for *Corbicula* filtration , assimilation and oxygen consumption rates have been converted to caloric equivalents per month. The converted data is presented in (Table 5). The energy budget data for *Corbicula fluminea* maintained at four temperature regimes (15, 20, 25 and 30 °C). Ingested food and metabolic rate were increased with the raising of temperatures. Ingested food and metabolic rate varied between 74.337, 4.525 cal/month at 15 °C and 153.455, 9.102 cal/month at 30 °C, respectively, production and assimilation obviously increased with the rising of temperatures from 15 to 25° C.

The energy available for growth or the scope for growth represent the energy balance of an animal under a given set of conditions. It is determined by subtraction of total metabolism (R) from assimilated food (A) after conversion to energy equivalents.

The values of scope for growth obtained positive at four temperature (Table 5).

## DISCUSSION

Filtration rates were not significanly different at 15 and 25°C but increased rapidly thereafter with rising temperature to 30°C .Several authors have reported filtration data for *Corbicula*. The values measured by Haines(1979); Prokopovich(1969) and Habel (1970) were lower than those

Table(1)Relationship between dry tissue weihgt (mg ) and filtration rates (ml/mg- hr) of *C. fluminea* at four degree of temberatures.

| Temp.($^{O}$c ) | Equations | r | n |
|---|---|---|---|
| 15 | Log Y = 0.4377+ 0.1903 log X | 0.89 | 23 |
| 20 | Log Y = 0.5253 + 0.2343 logX | 0.92 | 22 |
| 25 | Log Y = 0.7008 + 0.2436 log X | 0.87 | 21 |
| 30 | Log Y = 1.1236 + 0.2561 log X | 0.84 | 25 |

**Table( 2) Mean filtration rates for eight size classes of *C. fluminea* at four degree of temperatures.**

| Size classes (mm) | Mean dry weight (mg) | Filtration rates (ml/mg- hr) | | | |
|---|---|---|---|---|---|
| | | 15°C | 20°C | 25°C | 30°C |
| 9 | 10.196 | 4.262 | 5.775 | 8.840 | 24.091 |
| 12 | 23.419 | 4.993 | 6.018 | 10.825 | 29.809 |
| 15 | 44.636 | 5.645 | 8.162 | 12.667 | 35.163 |
| 18 | 75.608 | 6.240 | 9.235 | 14.402 | 40.244 |
| 21 | 118.055 | 6.792 | 10.252 | 16.053 | 45.109 |
| 24 | 173.665 | 7.310 | 11.222 | 17.636 | 49.796 |
| 27 | 204.109 | 7.799 | 12.154 | 19.161 | 54.332 |
| 30 | 331.009 | 8.264 | 13.053 | 20.636 | 58.740 |

**Table( 3) Van't Hoffs $Q_{10}$ for three temperature ranges for eight size classes of *C. fluminea*.**

| Size classes (mm) | Mean dry weight (mg) | $Q_{10}$ | | |
|---|---|---|---|---|
| | | 15-20 °C | 20-25°C | 25-30°C |
| 9 | 10.196 | 1.84 | 2.34 | 7.43 |
| 12 | 23.419 | 1.98 | 2.38 | 7.58 |
| 15 | 44.636 | 2.09 | 2.41 | 7.71 |
| 18 | 75.608 | 2.19 | 2.43 | 7.81 |
| 21 | 118.055 | 2.28 | 2.45 | 7.90 |
| 24 | 173.665 | 2.36 | 2.47 | 7.97 |
| 27 | 204.109 | 2.43 | 2.49 | 8.04 |
| 30 | 331.009 | 2.49 | 2.50 | 8.10 |

General mean of $Q_{10}$ = 4.15

**Table( 4 )Filtration, oxygen consumption rates, and assimilation rates for *Corbicula fluminea* as afunction of temperature.**

| Temp. (°C) | Filtration rates (ml/mg- hr) | | Metabolic rate ( $\mu l O_2$ /mg-hr ) | | Assimilation (%) | |
|---|---|---|---|---|---|---|
| | $\overline{X}$ | $\overline{N}$ | $\overline{X}$ | $\overline{N}$ | $\overline{X}$ | $\overline{N}$ |
| 15 | 3.039 a | 23 | 0.421 a | 22 | 49.11 a | 10 |
| 20 | 4.021 a | 22 | 0.539 a b | 22 | 43.55 a | 13 |
| 25 | 5.955 a | 21 | 0.697 b c | 22 | 40.65 a | 15 |
| 30 | 15.191 b | 25 | 0.920 c | 22 | 16.58 b | 11 |

Values with the same letter are statistically not different at the 5% level

**Table( 5 ) Asummary of data for ingested ration, metabolism,assimilation, production and growth (cal/month) for *Corbicula fluminea* at four different temperatures degrees.**

| Temp °C | Ingested ration C | Metabolism R | Production P | Assimilation A | Scope for growth A-R |
|---|---|---|---|---|---|
| 15 | 74.337 | 4.525 | 27.154 | 36.51 | 31.985 |
| 20 | 92.117 | 5.987 | 30.973 | 40.12 | 34.133 |
| 25 | 129.438 | 6.953 | 44.192 | 52.62 | 45.667 |
| 30 | 153.455 | 9.1022 | 29.981 | 25.44 | 16.338 |

reported in the present study. However. both Haines and Prokopovichs rates may represent stressed animals as the authors report some mortality during experiments. In contrast, most of our values are comparable to those reported by Mattice(1979).An important difference throgh,is that Mattice reported filtration rates was greatest at 24 °C while we found that *Corbicula*'s potential filteration rate increased steadily through 30 °C.However, actual clam ingestion rates decreased at the higher temperature in the grow out experiment as activity levels fell faster than filtration rates rose.Filtration rates from this study ranged from 3to 15 ml/(clam-hr) at 15-30°C for clams from Garmat –Ali river . Laboratory filtration rates reported in the literature for *C. fluminea* vary considerably: 20-150 ml $g^{-1}$– $h^{-1}$ at 20-24 °C (Prokopovich ,1969) ;11 ml/(clam-hr) at 20 °C (Habel,1970) ; 816 ml/(clam-hr) at room temperature (Auerbach et al,1977); 200-800 ml/(clam-hr) at 18 –27 °C (Mattice, 1979); and 3-13 ml/(clam-hr) at 16-30 °C (Foe and knight,1986b).Metabolic rates obviously increased with the rising of temperature. Oxygen consumption data for *Corbicula* indicate that our values are somewhat higher than previous estimates (Habel,1970 ,McMahon,1979). Some of this difference may be explained by fact that other studies used specific metabolism is known to be inversely proportional to body size (Zenthen,1947).It is interesting that McMahon's data indicated a decrease in metabolic rate at 30 °C for both acclimated and nonacclimated individuals.This decrease may indicate thermal stress..Assimilation was constant over a range of temperature from 15 to 25 °C .However, the efficiency dropped significantly at 30°C ($p<0.05$) ,which we interpret as the result of the clam entering a zone of thermal stress. Lauritsen(1986) reported similar assimilation values for *Corbicula* feeding on monoalgal diets of *Chlorella* (33%) and *Scenedesmus*(45.4%) .The values of scope for growth obtained positive at four temperature described in this study. Scope for growth may be positive, when surplus energy is a vailable for growth and or reproduction; it may also be nagative, in such case weight is lost due to the utilization of energy reserves in the tissues (Widdows, 1978).A scope for growth model which predicts optimal *Corbicula fluminea* growth near 20 °C (Foe and knight,1986b).

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# ميزانية الطاقة لمحار المياه العذبة *Corbicula fluminea* (MULLER) من نهر كرمة علي، العراق

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**الخلاصة**

تم توضيح ميزانية الطاقة للمحار *Corbicula fluminea* في اربعة درجات حراره 15 ، 20 ، 25 ، 30 م° . فقد كان معدل الترشيح لهذه الدرجات الحرارية3.039، 4.021، 5.955، 15.191 ملليتر لملغم وزن جاف في الساعة ومعدلات استهلاك الاوكسجين كانت 0.421، 0.539، 0.697، 0.920 مايكروليتر اوكسجين لملغم وزن جاف في الساعة بينما كانت كفاءة التمثيل 49.11 ، 43.55، 40.65 ، 16.58 % . ومن هذه المعدلات تم حساب النمو والذي كان مثاليا في درجة حرارة 25 م°.