New Technique of Filtration Rate Measurement In Flow Through System With Constant Concentration Of Algae

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Abstrak

Sebuah tekhnik baru pengukuran tingkat filtrasi bivalvia telah dirancang dan digunakan untuk mengukur filtrasi dari Pecten maximus L. Prinsip penghitungan teknik pengukuran filtrasi ini adalah menghitung penurunan konsentrasi fitoplankton dalam media pengukuran. Alat ini selanjutnya diuji untuk menghitung konsumsi fitoplankton dalam hubungannya dengan berat kering P. maximus L. Hasil pengukuran dinyatakan dalam persamaan alometrik ($Y=aX^b$). Konsumsi fitoplankton untuk populasi Brest, Saint Breiux, Scotlandia dan Irlandia berturut-turut adalah sebagai berikut : $85,17 X^{0,12}$, $97,18 X^{0,16}$, $85,98 X^{0,18}$ dan $75,70 X^{0,18}$.

Kata kunci : *laju filtrasi, scallop, berat kering*

Abstract

A flow through system for measuring filtration rate of bivalve is described. The principle of measurement was to calculate the decrease of algal concentration in the water medium where the experimental animal was placed. The measuring system was tested to calculate the phytoplankton consumption related to dry body weight of scallop Pecten maximus L. coming from different populations. This correlation is expressed by allometric equation ($Y=aX^b$). Allometric equetion of Brest, Saint Brieux, Scotland, Ireland populations are : $85.17 X^{0.12}$, $97.18X^{0.16}$, $85.98X^{0.18}$ and $75.70X^{0.18}$ successively.

Key words: *filtration rate, Scallop, dry body weight*

Introduction

The fitration rate of an animal is a parameter of great ecological importance. Having determined the filtration rate and knowing the concentration of suspended particles in the water, it is possible to calculate the amount of food retained by the gills and ingested by the animal, as long as no true pseudofaeces are produced.

The filtration rate has been determined by so called "Direct method" which attemps to separate and to measure the exhalant flow, as well as "in direct method" which is measuring the removal of suspended particle from non-volume of water per unit time. The system that setup in this experiment is in "direct method". The theoretical basis of the equation for the calculation of filtration rate using an indirect method has been discussed by several authors amongst others: Bayne *et al.* (1976) and Winter (1978). The crucial problem of the main disadvantages of indirect method is the continuosly changing food concentration in the experimental medium.

In this present study, it is important to overcome that problem by setting up the measurement system which is able to maintain the concentration of food in the experimental medium as well as to keep a homogenous suspension within the experimental chamber.

Materials and Methods

The apparatus (measuring system) is developed based on the works of Winter (1973) and presented diagrammatically in the Figure 1. The experimental animal is placed in the transparent cuve plexiglass (1) with 30 cm height and 20 cm diameter. It is filled with seawater filtered by 0.2 micrometer pore size, to eliminate all particles other than algae distributed during the experiment. The water volume is 6 liters. The experimental animal is placed on a perforated support (2). The stirrer magnetic (3) is placed under the support that makes the experimental to be homogen.

The distribution of algae is conducted by a peristaltic pump (4) and the water medium has

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aerated by a diffuser (5). A cylinder cuve made of PVC (6) assured the transparent cuve being dark. It is intended to avoid the multiplication of algae during the experiment due to the light that might penetrate into the experimental cuve. The concentration of algae in the experimental cuve is controlled by the optic density.

A glass tube (7) is filled with an algal suspension, where the concentration is determined before, is homogenized by a diffuser. A tube made of PVC covers this tube glass, to avoid the penetration of the light.

The ragulation of algal concentration in the experimental tube is maintained by an electric system : an intensity of light (8) which is regulated by a voltage regulator (9) will cross the experimental tube and will be received by photoelectric cell (10) and it is a function of the algal concentration of the experimental medium (40 millions cells $.L^{-1}$). This concentration is setup at every beginning of the experiment and when the concentration is decreased to a certain point, the peristaltic pump will start in operation to fill the experimental tube with the fresh algae until the initial concentration is achieved. This measurement system could maintain the algal concentration around 4 %.

The consumption of phytoplankton of the experimental animal then calculated based on the secrease of the volume of water in the glass tube. The debit of the water pumped by the peristaltic pump is fixed at 4 ml $.min^{-1}$. It is to avoid the extreme variation of the algal concentration in the experimental medium.

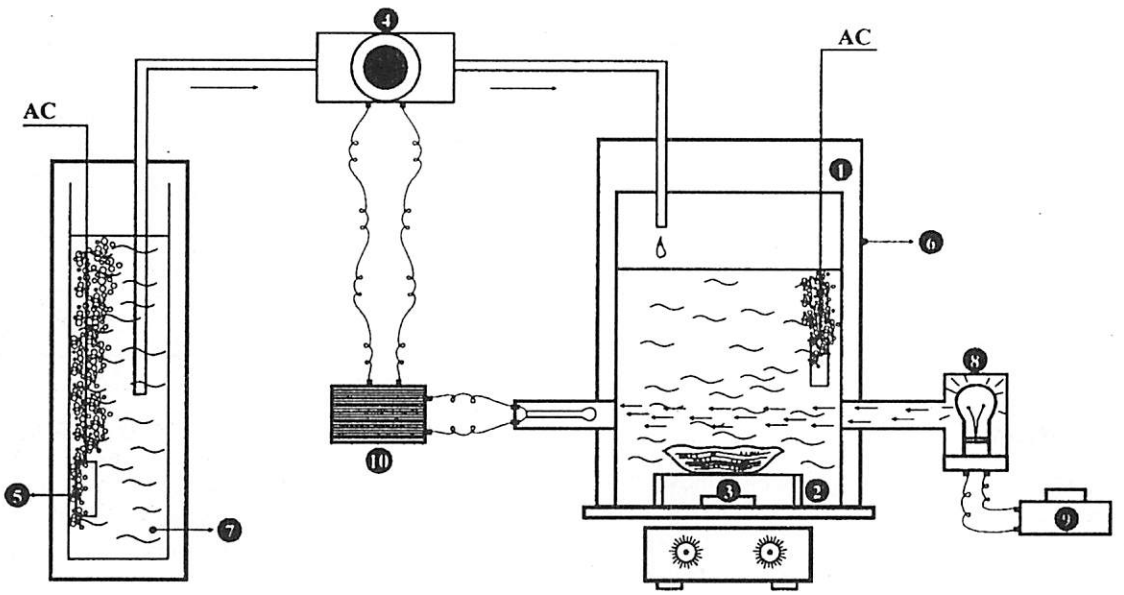

Fig.1. Apparatus for the Measurement of Phytoplankton Consumption.

Calculation of The Filtration Rate

The filtration rate is calculated based on the number of algae (NI) added to the experimental medium as the compensation of the algae consummed by the experimental animal :

$$NI = \Delta Vs \times Cx$$

Where :

- ΔVs = volume of water added to the experimental tube (ml)
- Cx = concentration of algae in the glass tube

Meanwhile, since the sensitivity of the system having a light variation (4%) so a correction factor (R) should be applied in counting the real number of phytoplankton consummed (N2) by the experimental animal :

$$N2 = N1 - R$$

The correction factor is calculated from the real concentration of algae in the experimental tube at the end of the experiment.

$$R = (Cet_1 \times Vet_1) - (Cet_0 \times Vet_0)$$

Where :

- Cet_0 and Cet_1 = concentration of algae in the experimental medium at t_0 and t_1 (cell.ml^{-1})
- Vet_0 and Vet_1 = volume of the experimental medium at t_0 and t_1 (ml)

Finally the consumption rate of the experimental animal expressed in number of cell per hour is obtained by dividing the number of cell consumed (N2) by the duration of the experimental (Δt) which is $t_1 - t_0$:

$$C + N2 : \Delta t$$

Filtration Rate Measurement

The filtration rate is calculated by measurement of the consumption of phytoplankton of scallop coming from Brest, Saint Brieux, Scotland and Ireland. The consumption of phytoplankton is expressed in relation to the dry body weight. Calculation of dry body weight is by drying the meat of the experimental animal desecting after the experiment is done, in an oven at 80° C during 48 hours or until the constant weight is achieved.

During the measurement the intesity of light from the light source should be assured can penetrate across the experimental medium and can be read by photoelectric cell. Besides that the temperature should be kept in a constant value (12° C).

Result And Discussion

The result of measurement that stated in the allometric equation and expressing the relationship with dry body weight is presented in the table 1, Figure 2,3,4 and 5.

Population	N	Allometric Equation $C = aX^b$	r	SD
Brest	32	$85.17X^{0.12}$	0.60	0.031
Saint Brieux	31	$97.18X^{0.16}$	0.70	0.011
Scotland	30	$85.98X^{0.18}$	0.86	0.020
Ireland	33	$75.70X^{0.18}$	0.86	0.020

During the last decades many data cocerning filtration rates of filter feeding bivalves have been recorded (see Winter, 1969, 2973, 1976; Bayne *et al.* 1976; Hibbert, 1977; Riva and Masse, 1983). All of these authors stated that consumption of phytoplankton increases with increasing body size (dry-tissues weight in g.) See Figure 2,3,4 and 5.

Those figures indicate that the consumption of phytoplankton of all populations having positive relationship with dry body weight (tested by test of coefficient correlation (Snedecor and cohrant, 1957).

The value of **(b)** from this experiment is between 0.12-0.18, indicate that the influence of weight to the consumption of phytoplankton having positive **(b)** value. It means that the consumption of phytoplankton is increased proportionally with the weight of the experimental animals. This result is in agreement with the findings of the following authirs: Rao (1953), Theede (1963), Winter (1969) and Vahl (1973 a, b). Nevertheless, eventhough the values of **(b)** are positives but they are relativelly small. This findings are posible due to the experimental animals are the adult one. According to *Segal et al.* (1953), Winter (1973) and Thompson and Bayne (1974) the value of **(b)** increase rapidly within the young animal.

From this result, indicate that the apparatus setup for meassuring of comsumption of phytoplankton perform very good function. Anyhow some precaution should be taken especially concerning the mobility of alge, in this experiment using *Dunaliella primolecta.* Another precautions should be taken into consideration are the darkenees and the cleaness of the experimental medium.

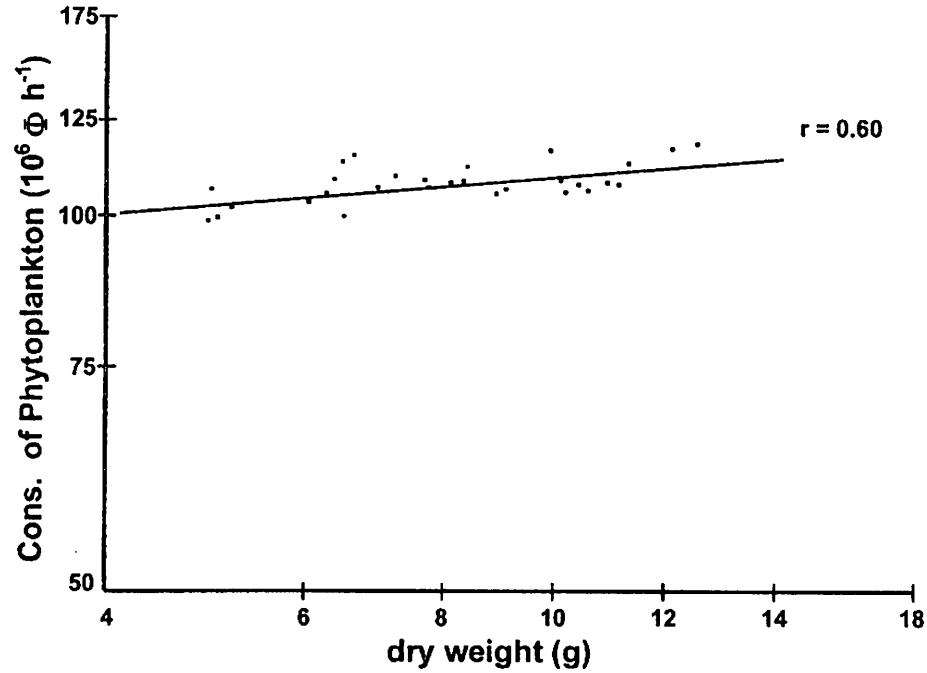

Fig.2. Relationship Between Consumption of Phytoplankton and Dry Body Weight of Scallop *Pecten maximus L.*. Natural Population of Bay of Brest.

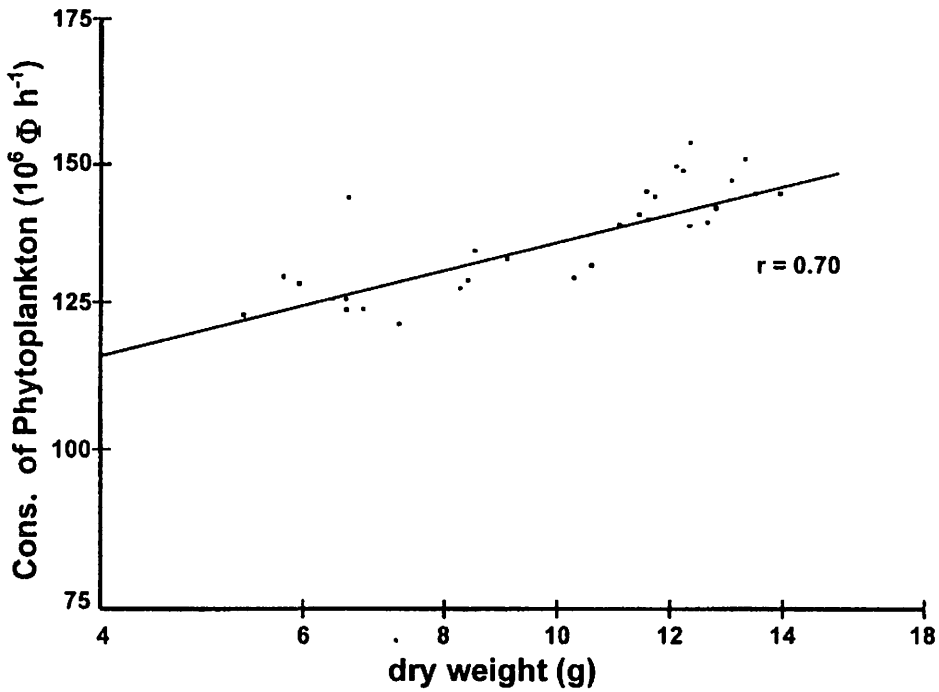

Fig.3. Relationship Between Consumption of Phytoplankton and Dry Body Weight of Scallop *Pecten maximus L.*. Natural Population of Bay of Saint Brieux.

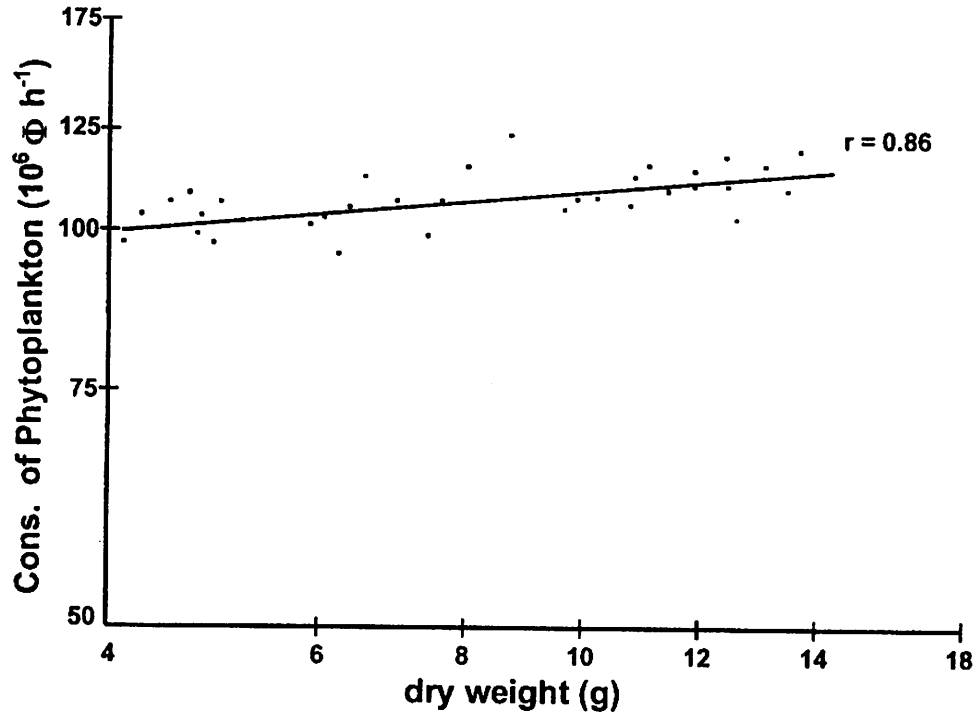

Fig. 4. Relationship Between Consumption of Phytoplankton and Dry Body Weight of Scallop *Pecten maximus L.*. Population imported from Scotland growing in the Bay of Brest.

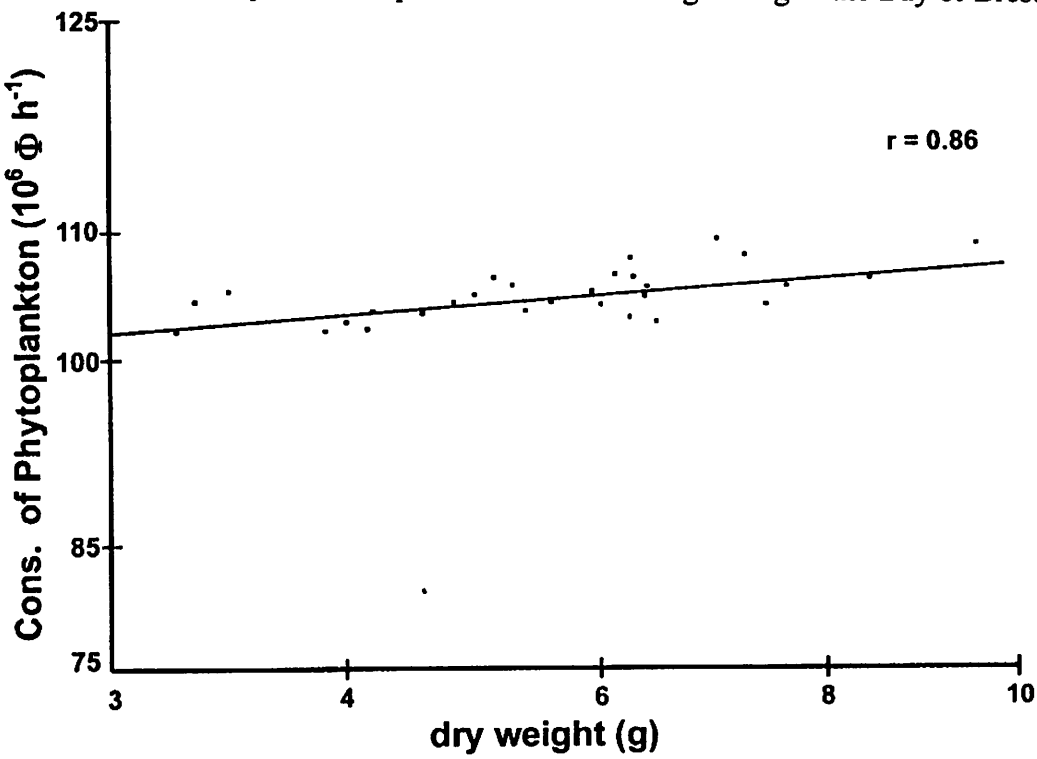

Fig. 5. Relationship Between Consumption of Phytoplankton and Dry Body Weight of Scallop *Pecten maximus L.*. Population imported from Ireland growing in the Bay of Brest.

Conclusion

The apparatus for measuring the consumption of phytoplankton setup in this experiment giving the good result. The value of (**b**) is relativelly low due to size of animal measured is relativelly bigger size. The consumption of phytoplankton increases with body size.

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