

VARIATION OF GROWTH RATE OF *Corbicula japonica* IN LAKE JUSAN

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1. INTRODUCTION

Corbicula japonica is an important inland fishery resource in Japan. Hydrodynamic and water quality effect on growth of *C. japonica* (Baba et al., 1999; Umeda et al., 2010; Pracoyo et al., 2011). Population growth simulation with regard to hydrodynamic and water quality condition will provide valuable information in order to obtain a sustainable fishery of this species.

An individual model is widely chosen as a basic element to simulate the population dynamic regarding its flexibility to take into account the environmental heterogeneity (Morales et al., 2006). An individual growth of *C. japonica* is properly simulated by the dynamic energy budget (DEB) model (Pracoyo et al., 2011), however in order to apply to population growth simulation, variability of parameters effecting on growth must be considered and quantified.

2. GROWTH EXPERIMENTS

Lake Jusan, located in Aomori Prefecture, is habitat of *C. japonica*. Growth experiments (after Azuma, unpublished data) were done at several points in Jusan (Fig. 1). *C. japonica* was put in a cage which has dimension of 48×32×30 cm. Every cage contained of 160-180 *C. japonica* which the diameter varied from 5 mm to 19 mm. Two cages were put in every experiment points. All samples grew naturally without any treatments. In the end of experiments, the diameter of all samples was measured and averaged. Experiments were conducted in 2007 (June 6th to October 11th) and 2008 (June 27th to October 1st).

3. DEB MODEL

DEB theory (Kooijman, 2009) describes energy flux of an individual organism. Energy from assimilation ($\dot{p}_A$) is stored in reserve (E) from which it is utilized for maintenance, growth and reproduction. A fixed fraction κ of the utilized energy ($\dot{p}_C$) is used for growth ($\dot{p}_G$) and somatic maintenance ($\dot{p}_M$), with a priority for maintenance. The remaining $(1-\kappa)$ is directed to maturity maintenance ($\dot{p}_J$) and maturation ($\dot{p}_R$). After reaching puberty, energy for maturation is stored into reproduction reserve E_R and emptied at spawning. During starvation ($\kappa\dot{p}_C > \dot{p}_A$), growth stops and utilized energy equals to maintenance. For prolong starvation and E is empty, maintenance is paid from E_R , and then if E_R is empty, body volume shrinks to pay maintenance.

Table 1 shows the model variables and equations. Effect of temperature on physiological rates is expressed

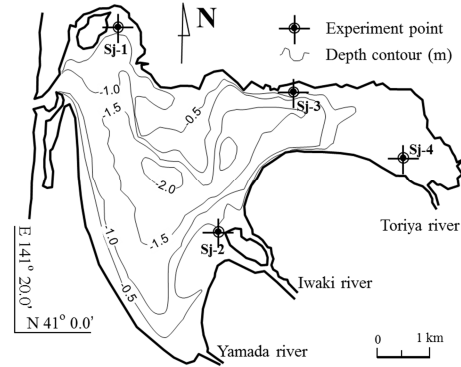


Fig. 1 Location of growth experiment points in Jusan

by temperature dependence coefficient. Structural volume (V) refers to volume of dry flesh, excluding shell, and can be calculated with regard to diameter by using shape coefficient (δ): $V = (\delta L)^3$.

Diameter refers to the longest diameter. Conversion of total fresh weight including shell to dry flesh volume was done by using two coefficients: 1 g fresh weight = 0.026 g dry flesh (Nakamura et al., 1988); volume specific dry flesh weight is 0.2 g cm⁻³ (Ren et al., 2008). From dry flesh volume and diameter relationship, then the shape coefficient was obtained as 0.302.

Table 1. Equations of the DEB model

Equation	Definition
$k(T) = k_i e^{\left(\frac{T_A - T_i}{T_i}\right)} \left(1 + e^{\left(\frac{T_{AL} - T_{AL}}{T_i}\right)} + e^{\left(\frac{T_{AH} - T_{AH}}{T_i}\right)} \right)^{-1}$	Temperature dependence
$\dot{p}_C = k(T) \cdot \frac{[E]}{[E_G] + \kappa \cdot [E]} \left(\frac{[E_G] \cdot \left\{ \dot{p}_{Am} \right\} \cdot V^{2/3}}{[E_m]} + \dot{p}_M \right)$	Utilization rate
$\dot{p}_A = k(T) \cdot f \cdot \left\{ \dot{p}_{Am} \right\} \cdot V^{2/3}$	Assimilation rate
$f = \frac{X}{X + X_K}$	Functional response
$\dot{p}_M = k(T) \cdot \left[\dot{p}_M \right] \cdot V$	Maintenance rate
$\dot{p}_J = k(T) \cdot \min(V, V_p) \cdot \left[\dot{p}_M \right] \cdot \frac{1 - \kappa}{\kappa}$	Maturity maintenance rate
$\frac{dE}{dt} = \dot{p}_A - \dot{p}_C$	Reserve dynamic
$\frac{dE_R}{dt} = (1 - \kappa) \cdot \dot{p}_C - \dot{p}_J$	Repro. reserve dynamic
$\frac{dV}{dt} = \frac{\kappa \cdot \dot{p}_C - \dot{p}_M}{[E_G]}$	Struc. volume dynamic

Keywords: *Corbicula japonica*, growth rate, DEB model, Lake Jusan

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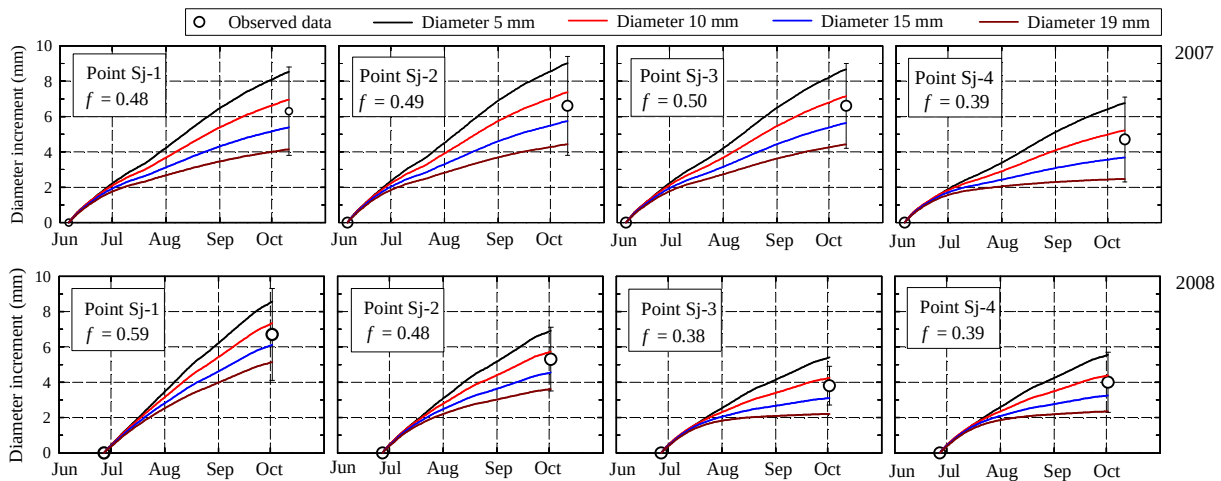


Fig. 2 Variation of functional response, f obtained from DEB simulation for 2007 and 2008 data. Bars is $\pm$ SD.

4. RESULTS AND DISCUSSIONS

An individual DEB model was performed, and all parameters refer to Pracoyo et al., (2011) except the scaled functional response, f , which is a free fitting parameter. Four diameters are chosen to represent the sample: 5 mm, 10 mm, 15 mm, and 19 mm. With those diameters, results of DEB model compared to observed data are shown in **Fig.2**. The f varied from 0.38 to 0.5.

One of possible explanations on variation of f is about food competition. This is indicated as the higher f was found in the lower population density (**Fig. 3**), which is the average population density around the experiment points in 2007 and 2008.

The half saturation constant, X_k is environment-specific variable which is a free fitting parameter. Once the X_k is decided, then f depend only on X . Pouvreau et al. (2006) found a significant different of X_k on simulation of *Crasostrea gigas* growth, and then they postulated that adaptive mechanism within a species is a factor affecting this variability. Another explanation was given by Ren et al. (2008) who found variability of X_k due to depth; the different ratio of chlorophyll-a : phytoplankton carbon was supposed to be the factor affecting on variability of X_k . The later opinion is likely closer to the definition of f as a food availability parameter (Kooijman, 2000), which vary from 0 to 1 which is condition of no food an food always available, respectively. It is therefore the smaller f indicates the less amount of energy, end then indicates food/energy competition. Difference of f was also used to identify the occurrence of food competition on bivalve in Dutch coastal waters (Cardoso et al., 2006).

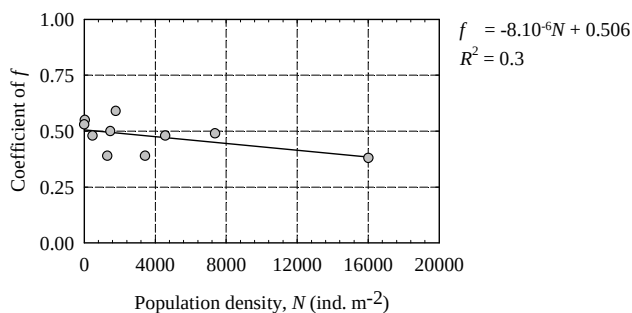


Fig. 3 Variation of f due to population density

5. CONCLUSION

The growth rate of *C. japonica* varies, and this variation is affected by population density. The slower growth is found in high population density, indicated the food competition.

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