On adaptive of egg size at early clutches in *Daphnia*

Shuichi Ando, Dieter Ebert, Yasuhiko Kashima and Jin Yoshimura
Dept. Systems Eng., Shizuoka University and Zoology Inst., University of Basel, Swiss
a7099@sec.eng.shizuoka.ac.jp

INTRODUCTION

The size and number tradeoff is known in the egg size of *Daphnia*. The expected optimal egg size is constant over the reproductive attempts or clutch numbers. However, the observed egg sizes in the early clutches are known to be much smaller than this expected optimal egg size. The first clutch has a smallest egg size and the egg size becomes bigger with clutch numbers. This is the major mystery of Daphnia life history.

We suggest one solution to this mystery of reproductive strategies, assuming that young females are with less reproductive ability, so for them it may cost more to grow large eggs. They begin to reproduce while immature (before reaching maturity).

MODEL

When the reproductive investment is constant, the clutch size N[s] equal to reciprocal of egg size s (N[s]=1/s). The offspring fitness O[s] increases asymptotically with the egg size (Fig. 1). Then parental fitness P[s] denote

P[s] = O[s] * N[s] = O[s] / s (1)

And the function of parental fitness shows convex curve like Fig. 1. It is the optimal egg size when the parental fitness takes the peak (Then the optimal egg size is 0.2). But in this computation, the optimal egg size is always constant regardless of clutch numbers.

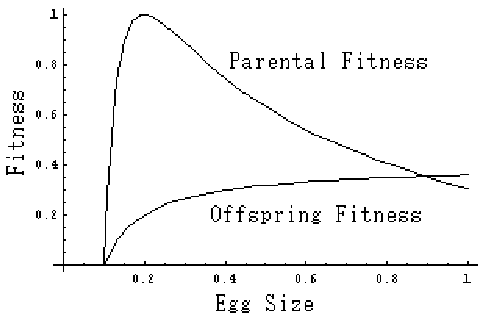

Fig. 1 Parental fitness and offspring fitness

Next, consider the variation of resource use efficiency that is needed to grow eggs. At the early clutches, a female parent has to waste more investment to produce a bigger egg than an experienced female at later clutches. This cost difference becomes bigger when the final egg size becomes larger. The relationship between egg size and productive investment will become non-linear (Fig 2).

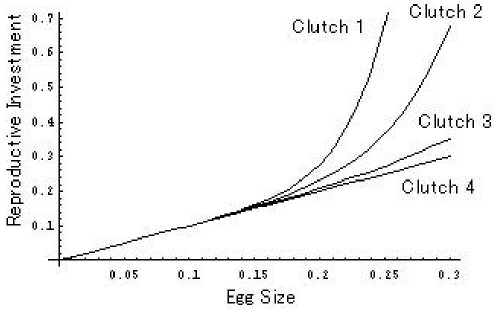

Fig. 2 The relationship between egg size and reproductive investment for different clutch

CONSEQUENCE

K[s] denotes the function of reproductive cost. Then clutch size N[s] is replaced by

N[s] = 1 / K[s] (2)

and therefore

P[s] = O[s] * N[s] = O[s] / K[s] (3)

Thus, we compute the optimal egg size for every clutches (Fig. 3).

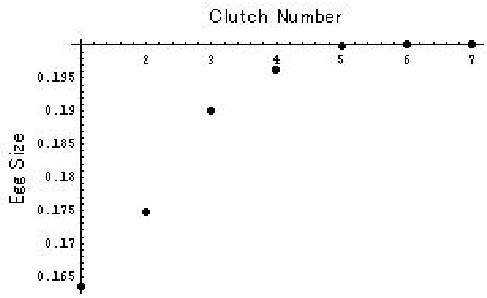

Fig. 3 The optimal egg size for every clutches

It is obvious that the optimal egg size is smaller in the early clutches. And around fourth clutches, the optimal egg size becomes almost close to 0.2.

DISCUSSION

This model is very simple and clear, and it gives a specific answer to the mystery of *Daphnia* reproductive behavior. But these hypotheses are inconclusive. First, is it true that the reproductive cost curve is non-liner? Second, does female parent start reproduction while immature? Thus, we have to wait an empirical test of this hypothesis. Now, we examine an another model that contains the environmental conditions.