実験室内での Eodiaptomus japonicus の生残（英文）

Survival of *Eodiaptomus japonicus* in the Laboratory

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Abstract

The planktonic calanoid copepod *Eodiaptomus japonicus* was reared in the laboratory without predators using the water of Lake Biwa as a food source. Survival in the laboratory was almost always higher than that in the field. Physical and/or biological disturbances absent from the laboratory probably killed *E. japonicus* in the field.

Key words: Laboratory rearing, Lake Biwa, Planktonic copepod, Survival

Introduction

The calanoid copepod *Eodiaptomus japonicus* (Burckhardt) is a dominant zooplankter in Lake Biwa (Kawabata, 1987a). Kawabata (1993) has calculated its mortality rate in the field from 1984 to 1986, obtaining large values during certain periods. Predation by the cyclopoid copepod *Mesocyclops dissimilis* Defaye et Kawabata, previously identified as *M. thermocyclopoides*, was suggested as the cause of high mortality of *E. japonicus* in the field (Kawabata, 1991; Defaye and Kawabata, 1993). It is hence necessary to know whether *E. japonicus* survive in the absence of predators.

Measuring natural development times, Kawabata (1989) has reared *E. japonicus* in the laboratory without predators using lake water as a food source. However, mortality rates during the rearing were not reported. In the present study, Kawabata's (1989) data were newly analyzed to calculate the mortality rates. Additional observations were also performed in the present study at the temperatures different from those in Kawabata (1989).

Methods

Table 1 shows the developmental stages and temperatures examined by Kawabata (1989). *E. japonicus* was collected by vertical net haul, and lake water was collected twice a week with a Van Dorn sampler from the epilimnion in the pelagic area of the north basin of Lake Biwa. For observing survival in the ith stage, each of about ten individuals in the $(i-1)$th stage was introduced into a 100 ml Erlenmeyer flask filled with the lakewater filtered through a 40 μm nylon netting. The netting excluded some of the larger phytoplankters, which are not grazed by juvenile *E. japonicus* (Kawabata, 1987b), and the filtered lakewater hence contained their natural food. Survival or death of each individual was recorded twice a day from molting into the ith stage to molting into the next or death. Culture was performed in a thermostatic room under a 12:12 h LD cycle at the temperatures close to those in the field. The filtered lakewater was kept in a 10 l capacity glass jar in the culture room, and the water in the flasks was changed every day. By similar methods, development from hatching to naupliar stage II or III

平成6年9月16日受理

Table 1. Instantaneous per capita mortality rates (d^{-1}) of *Eodiaptomus japonicus* developmental stages measured in the laboratory in the absence of predators.

	NIV	NVI	CI	CIII	CIV	CV
10℃						
n	0	0	1	0	1	0
mean			0.04		0.00	
range						
15℃						
n	0	0	3	1	2	7
mean			0.06	0.00	0.03	0.00
range			0-0.10		0-0.05	0-0.02
20℃						
n	1	2	6	1	0	6
mean	0.11	0.03	0.03	0.00		0.01
range		0-0.06	0-0.09			0-0.02
25℃						
n	0	0	0	1	0	2
mean				0.00		0.00
range						0-0

(NII/NIII) was also studied by Kawabata (1989) for 2.2 d at 22℃ and for 1.2 d at 27℃.

Instantaneous per capita mortality rate α can be calculated with the equation:

$$\alpha = (\ln N_i - \ln N_{i+1})\ t^{-1},$$

where $\ln N_i$ is the number of the individuals molting into the ith stage, and t is mean duration of the ith stage.

Additional observations were made for NIII, NVI and copepodid stage III (CIII) at 7℃ in March 1988, and for NIII and NVI at 8℃ in April 1988. Survival or death was recorded every day for 10 d, and the mortality rates were accordingly calculated for 10 d irrespective of molting. The water in the flasks was changed every other day. Otherwise, methods were as in the above rearing.

Results

The instantaneous per capita mortality rates of NIV-CV *E. japonicus* were small in the laboratory rearing without predators at 10-25℃, the mean±SD being 0.02±0.03 d^{-1} (Table 1). Only one out of 34 mortality rates exceeded 0.1 d^{-1}. Of frequently observed stages CI and CV, CI showed higher mortality than CV. Mortality rates from hatching to NII/NIII were 0 d^{-1} at 22 ℃ and 0.07 d^{-1} at 27℃.

In additional observations, instantaneous per capita mortality rates (d^{-1}) were 0.01 in NIII, 0.02 in NVI and 0 in CIII at 7℃, and 0 in NIII and 0.01 in NVI at 8℃.

Discussion

In the field juvenile *E. japonicus* showed large instantaneous per capita mortality rates during May to July of both 1984 and 1985, the mean±SD being 0.18±0.13 d^{-1} (n=42) (Kawabata, 1993). For the other months, the mortality rates in the field were 0.04±0.13 d^{-1} (n=120). Thus

the mortality of juvenile *E. japonicus* in the laboratory was almost always lower than that in the field (see Results).

Differences in survival between copepods in the field and those reared in the laboratory are the consequences of environmental discrepancies between the field and laboratory. Survival will be raised in the laboratory if copepods are protected from physical and/or biological disturbances. Survival may be lowered in the laboratory with inadequate food conditions and/or accumulated excretions.

There are two possible causes that raised *E. japonicus* survival in the laboratory. One is large predatory loss in the field, which will be studied in a following paper. The other is calm water and presence of walls in flasks: copepods do not have to swim hard to stay in the desired positions.

Instantaneous per capita mortality rates have been reported for the following diaptomid copepods reared in the laboratory from hatching to adulthood: *Diaptomus clavipes* fed on enriched natural food at 20-25℃, 0.07 d^{-1} (Gehrs and Robertson, 1975); *Eudiaptomus gracilis* fed on the natural or enriched natural food at 12-20℃, 0.00-0.03 d^{-1} (Zánkai, 1978); *Diaptomus dorsalis, D. floridanus* and *D. mississipiensis* fed on the natural food at 20-25℃, 0.00-0.01 d^{-1} (Elmore, 1983). The high survival of *E. japonicus* and other diaptomid species suggests physical and/or biological protection in the laboratory.

Acknowledgements

This work was carried out while I was a member of Otsu Hydrobiological Station, Kyoto University, to whom I am grateful for the working space and facilities provided. I also thank Dr. T. Narita and other researchers of OHBS for discussions.

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