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# Effect of Temperature on Egg Maturation and Longevity of the Egg Parasitoids *Ooencyrtus nezarae* (Ishii) (Hymenoptera: Encyrtidae)

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*Ooencyrtus nezarae* is an egg parasitoid of several hemipteran including the bean bug, *Riptortus clavatus* and is a good candidate for biological control of pest bugs. The present study focused the effects of temperature on egg maturation and longevity of *Ooencyrtus nezarae* as well as the interactive effect of temperature and food on its longevity. Egg maturation increased with increasing adult age, reaching a peak (between 5–10 days), thereafter declined with further advancement in age. It also increased with increasing temperature though the egg maturation ceased to occur at 35 ºC. The longevity of *O. nezarae* was dependent on temperature and food availability. The longest longevity occurred at 15 ºC providing with honey and the lowest longevity occurred at 30 ºC providing with water. This study provides the biological information of *O. nezarae* which can be useful for biological control program as well as for its efficient mass rearing.

## INTRODUCTION

Understanding of the reproductive attributes is essential for the successful augmentation of the parasitoid for its economical use as a biological control agent. Temperature affects many key life events in the reproductive performance, particularly fecundity (Hentz *et al*., 1998; Ivanovic and Nenadovic, 1999; Sagarra *et al*., 2000a). Carroll and Quiring (1993) found that potential fecundity (number of eggs matured) and realized fecundity (number of eggs laid) are both influenced by temperature.

One major factor that can affect the field efficacy of parasitoids released in biological control programs is the longevity of adult parasitoids. Increased longevity could potentially enhance biological control performance of parasitoids by increasing fecundity through an increase in searching time for suitable hosts and/or increase in egg maturation (Heimpel and Jervis, 2005). Many studies have shown that rising temperature significantly reduces longevity and fecundity of parasitoids (Sagarra *et al*., 2000b; Matadha *et al*., 2004).

*Ooencyrtus nezarae* (Ishii) (Hymenoptera: Encyrtidae) is a polyphagous egg parasitoid of at least 11 phytophagous Hemiptera species including *Riptortus clavatus* (Thunberg), *Megacopta punctatissima* (Montandon), and *Homoeocerus unipunctatus* (Thunberg) in Japan (Hirose *et al*., 1996). The effect of temperature on development of *O. nezarae* has been studied by Numata (1993). Teraoka and Numata (2000) studied the effect of different food source on longevity of *O. nezarae* and (Aung *et al*., 2009) also proved that food source was significantly influenced egg maturation and *longevity* of *O. nezarae* (even for starved females). However, the influence of temperature on fecundity and longevity of this parasitoid as well as the interactive effect of food availability and temperature on their longevity has not yet been cleared. An understanding of the effects of temperature on longevity and reproduction of *O. nezarae* is essential for the development of rearing and shipping procedures that would ensure high survival rate and effectiveness of the released parasitoids. In the current study, we describe the influence of temperature on longevity and the egg maturation as well as the interaction effect of temperature and food availability on longevity of *O. nezarae* to optimize its quality and efficiency in the laboratory.

## MATERIALS AND METHODS

We used *R. clavatus* collected from Kyushu University campus and *O. nezarae* obtained from the laboratory cultures maintained at Kyushu University as described by Takasu and Hirose (1988). We kept the *R. clavatus* culture in plastic cages (22×16×20 cm) providing with water, soybean seeds and its seedlings.

We took one pair of *O. nezarae* from the culture and put them into each test tube (1.5 cm diameter and 10.5 cm long) with one *R. clavatus* egg which was glued on filter paper at 25 ºC (16L:8D). The parasitoids which emerged from one host with a ratio of 1 male: 3 females were used for the experiment.

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On the day of emergence, each female parasitoid was put into each test tube (1.5 cm diameter and 10.5 cm long) containing droplets of honey. Those females were kept at five different temperature conditions, 15, 20, 25, 30 and 35 °C (16L:8D). Females were dissected and the numbers of mature eggs were counted under a binocular microscope on every five days intervals starting from day–1 until day–25. Fifteen females were dissected for each treatment.

To examine the effect of food on female longevity, newly emerged individual females were divided into two groups. The first group was put into a test tube which contained water source and the second group was provided with honey source. Both of the two groups were kept at five different temperatures 15, 20, 25, 30, and 35 °C (16L:8D). The longevity was checked daily and fifteen females were replicated for each treatment. We used Stat View (SAS Institute, 1998) for data analysis.

## RESULTS AND DISCUSSIONS

The number of mature eggs increased with an increase in adult age, reaching a peak (between 5–15 days) and thereafter declined with further advancement in age and at the same time it also increased with increasing temperature (Fig. 1) but the eggs did not mature at 35 °C. The maximum number of mature eggs was largest at 20 °C until day–10 but it gradually decreased significantly with increasing temperature ($p<0.001$) (Tukey–kramer HSD test). The longevity of the female parasitoid decreased with increasing temperatures ($p<0.001$). There was also a significant interactive effect of temperature and food on the longevity of *O. nezarae* (Table 1).

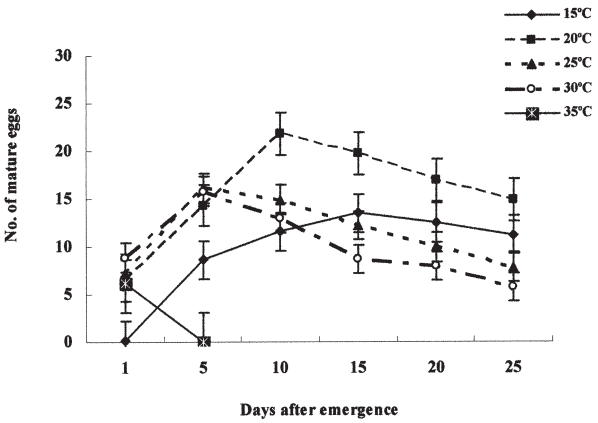


**Fig. 1.** Changes in the number of mature ovarian eggs in adult females of *O. nezarae* at different temperatures. Bars indicates standard errors.

**Table 1.** Effect of food and temperature on longevity of the egg parasitoid *O. nezarae*

| Food source | Longevity (Days) | | | |
|---|---|---|---|---|
| | 15 °C | 20 °C | 25 °C | 30 °C |
| Water | 12.39c | 5.74b | 3.35a | 3a |
| Honey | 175.67d | 76.53c | 40.42b | 29.16a |
| | P values | | F values | |
| Temperature | 0.001 | | 61.86 | |
| Food source | 0.001 | | 12.85 | |
| Temperature x food source | 0.001 | | 79.90 | |

Mean values followed by the similar letters between rows are not significantly different at $p<0.001$ by survival analysis.

The reduced in egg production observed at temperature extremes could be due to the lower number of ovarioles produced at high temperatures, and low rate of oogenesis at low temperatures (Huey *et al*., 1995). Increased voracity with increase in temperature due to higher metabolic rate and the metabolic need (Marinkovic *et al*., 1986; Cluster *et al*., 1987; Hoffmann and Parsons, 1989; Biins and Ratte, 1991) could be responsible for the increase in egg production under 27.8 °C. However, the decrease in egg output beyond this temperature, despite increased voracity, might be as a result of less efficient utilization of ingested food at higher temperature (Soares *et al*., 2003).

In the present study, the influence of temperature on the egg maturation of the parasitoid agrees with previous studies (Apostolos and Robert, 2008; Rosenheim and Rosen, 1992). Extreme low and high temperatures may reduce their survival, retard their development and / or suppress their reproduction. A lot of research demonstrated that temperature had significant effect on the longevity of parasitoids (Lysyk, 1991; Dyer and Landis, 1996; McDougall and Mills, 1997; Uckan and Ergin, 2003) and there was also a interactive effect of temperature and feeding treatment on the longevity of some parasitoids (Chong and Oetting, 2006; Sagarra *et al*., 2000a; Liu and Tsai, 2002). Our study is also consistent with the previous studies and the longevity of *O. nezarae* decreased with increasing temperature and the interaction of temperature and food had significant effect on the longevity.

Several recent studies have shown that fecundity peaked at some medium temperature (Seal *et al*., 2002; Agboka *et al*., 2004; Foerster and Butnariu, 2004; Matadha *et al*., 2004). According to our finding, the delayed period of peak for egg maturation occurred with decreasing temperature and the maximum egg maturation occurred at 20 °C. However the effect of temperature on the actual progeny production is not clear yet and further investigation should be made for precise information of the effect of temperature on the fecundity of *O. nezarae*.

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