INFLUENCES OF FOOD QUALITY FOR *SITOPHILUS ORYZAE* (COLEOPTERA : CURCULIONIDAE) ON LIFE HISTORY OF *LARIOPHAGUS DISTINGUENDUS* (HYMENOPTERA : PTEROMALIDAE)

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Life history of *Lariophagus distinguendus* (Förster) parasitizing on *Sitophilus oryzae* (L.) bred on brown rice (SB) and polished rice (SP) was studied. Mean life span (± s.e.) of female *L. distinguendus* on SB was 10.3 ± 1.04 days and significantly longer than that on SP (7.7 ± 0.54 days). Although the total number of eggs laid per female parasitoid was not significantly different from each other (33.1 ± 4.35 and 22.1 ± 2.66 for that on SB and SP, respectively), the distribution pattern of female progeny throughout the life span of the parsitoid on SB differed from that on SP. Mean generation time of the parasitoid on SB was estimated to be somewhat longer than on SP. However, intrinsic rate of natural increase and net reproduction rate on SB were estimated to be 0.1382/day and 24.17/generation, which were higher than those on SP ; the statistics on SP were 0.1214/day and 11.66/generation, respectively. The results of present study suggested the quality of the food for *S. oryaze* can play a significant role in life history of the parasitoid and thus in the interaction between them.

INTRODUCTION

The controversy on the biological control of rice weevil, *Sitophilus oryzae* (L.), by pteromalid parasitoids at present status could be due to the insufficient information on the biology of pteromalids.

Biology of *Lariophagus distinguendus* (Förster), an ectoparasitoid of rice weevil and other stored product pests, has been studied (**Kascheff**, 1955 ; **Gonen** and **Kugler**, 1970 ; **Bellows**, 1985 ; **Ryoo** et al., 1990). **Hong** and **Ryoo** (1990) considered that *L. distinguendus* could suppress rice weevil population successfully at optimum temperature range (28° - 30°) of both the rice weevil and *L. distinguendus*. More informations are necessary to evaluate the parasitoid as a biological control agent at present status.

Influence of host species on the biology of their parasitoids has been recognized (**Vinson** and **Ivantch**, 1980). **Ashley** et al. (1974) reported that *Tricogramma sp.* showed significant higher value of population increase when *Heiothis zea* (Boddie) eggs was used as hosts than that when *Tricoplusia ni* (Hübner) eggs was used as hosts.

Also the food quality available for the host can affect the biology of parasitoids. **Altahtawy** et al. (1976) found that the bionomics of *Microplitis rufiventris* Kok. was significantly influenced by the food plant of its host, *Spodoptera littoralis* (Boisd.).

The rice weevil preferred brown rice as food to polished rice and showed higher increase rate of population on brown rice (**Arakaki** and **Takahashi**, 1982 ; **Cho** et al., 1988 ; **Sittisuang** and **Imura**, 1987), indicating that brown rice is more suitable as food for the rice weevil than polished rice. The relationship between the food quality for rice weevil and biology of *L. distinguendus* can be a valuable information for successful biological control of rice weevil by the parasitoid on various stored products. But few works has been conducted on this respect.

The purpose of present study was to examine the possible influences of the food quality for the rice weevil on the biology of *L. distinguendus*.

MATERIALS AND METHODS

Rice weevil

The rice weevil were collected from the stock culture maintained on polished rice in our laboratory (**Ryoo** and **Cho**, 1988). The weevils were then randomly devided into 2 groups. The one group was reared further 1 generation on brown rice (SB) and the other one was reared on polished rice (SP) for the same period. The resulting adults from the media were used in the experiments.

Lariophagus distinguendus

The parasitoid were collected from the stock culture (**Yoo** and **Ryoo**, 1989) and reared further 1 generation on the fourth instar of *S. oryzae* feeding on polished rice. The resulting adults less than 1 day old after emergence were used in the experiments.

Experimental method

A 5 g quantity of brown rice or polished rice, *Sativa oryzae* L. (variety "Chucheong"), was placed in a glass vial (2 cm dia, 8 cm height) and infested with 10 females of rice weevil reared on the same medium ; those from brown rice to brown rice and those from polished rice to polished rice.

The vials were then stored at an incubator conditioned to 28 ± 0.5°C and 70 - 75 % R.H. After 24 hours, all the adults were removed from the vials and the vials, including eggs laid during the time, were stored for 20 days under the same conditions. The resulting fourth instars of rice weevil (**Yoo** and **Ryoo**, 1989) were uses as hosts for the parasitoid. The density range of hosts per vial obtained by this method were ranged from 15 to 42.

Four pairs of the parasitoid were introduced into each vial containing the hosts. After 24 hours, the adult parasitoids were removed from the vials and the vials, containing parasitoid eggs laid during the time, were stored further at the same conditions. The number of treated vials were 20 for each host medium. Every 24 hour, the vials were examined and the emerging parasioids were sexed and recorded. The procedure was continued for 3 weeks after the last adult emerged.

Thirty pairs of the parsitoids emerging from each of the 2 host media, which were selected in a random manner, were individually transferred to new vials containing the same host medium from which they had developed.

Every 24 hour until all the females died, the living parsitoids in a vial were transferred to a new vial containing the same host medium as before. The old vials, containing parasitoid eggs during the time, were then stored at the same conditions and the sex and number of parasitoids emerging were recorded every day. The procedure was continued for 3 weeks after the last adult emerged and then the grains in the vials were dissected to estimate the number of instars dead during the development. Life table of *L. distinguendus* on the 2 host media were constructed based on the female life span and the female progeny per female per day. In this procedure, the mortality of the parasitoid during development was neglected for convenience. The possible error due to the mortality could be compensated by using the actual number of female progeny emerging instead of the number of eggs laid per female. The life talbe statistics statistics of the Lotka-Volterra equations (see **Birch**, 1948) were estimated with a simple basic program for personal computer.

RESULTS AND DISCUSSION

Developmental period of female *L. distinguendus* on SB at 28 C was estimated to be 16.0 ± 0.7 days (**Ryoo** et al., 1990), which was similar to that on SP at present studies ; 15.8 ± 0.9 days. On both host media, male development faster than female about 1 day. Development of *L. distinguendus* parasitizing on *Callosobruchus maculatus* (F.) or *C. chinensis* (L.) showed similar features (**Bellows**, 1985). **Van den Assem** (1971) reported that average instar durations of the parasitoid on **Sitophilus granarius** (L.) at 25°C were 22/23 and 18/19 days for female and male, respectively, which are similar to that on rice weevil (**Ryoo** et al., 1990). Influence of host size on the development has also been reported to be negligible (**Bellows**, 1985), which suggests that development of the parasitoid is not affected by the host species or food for the host.

Sex ratio of the parsitoids emerging also seemed not to be influenced by the host media and were 0.72 and 0.77 on SB and SP, respectively.

Mean (± s.e.) life span of female on SB was estimated to be 10.3 ± 1.03 days ans significantly different from that on SP, which was 7.7 ± 1.04 days (Wilcoxon 2 sample test Z = 2.62 ; P < 0.01 ; (Fig. 1).

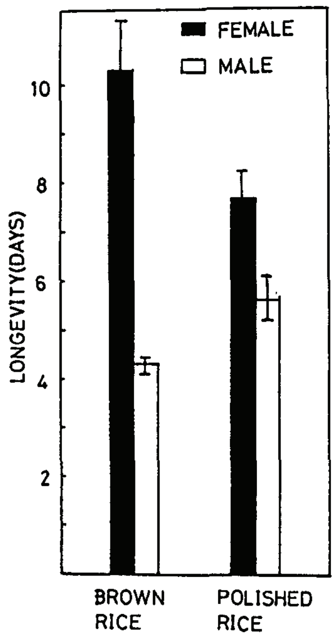

Figure 1 : Life span of adult *Lariophagus distinguendus* in days (± s.e.) on *Sitophilus oryzae* bred on brown rice and polished rice.

The age specific surval rate of female on SP (Fig. 2) was similar to that reported on *C. maculatus* (**Bellows**, 1985), but female on SB indicated other feature. The female laid eggs from the first day on her life span to the last day. Therefore, the oviposition period was dependent on the life span and females having developed on SB showed longer oviposition period than that on SP (Fig. 4). This result indicates that life span and oviposition period of the female parasitoid can be affected by the host media. On the other hand, the mean life span of male was not affected by the host media and significantly shorter than that of female on both SP and SB ; mean life span on SB and SP were 4.3 ± 0.8 and 5.7 ± 1.98, respectively. Because the life span of starved male was similar to that on SP and SB (personal observations), male seemed not to take food after emergence and thus no effect of the food for host can be demonstrated (see also **Bellows**, 1985).

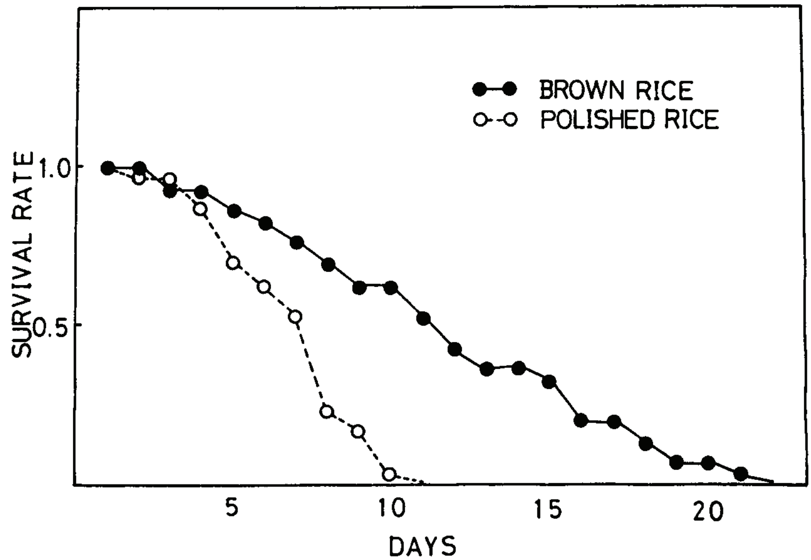

Figure 2 : Age specific survival rate of female *Lariophagus distinguendus* on *Sitophilus oryzae* bred on brown rice and polished rice.

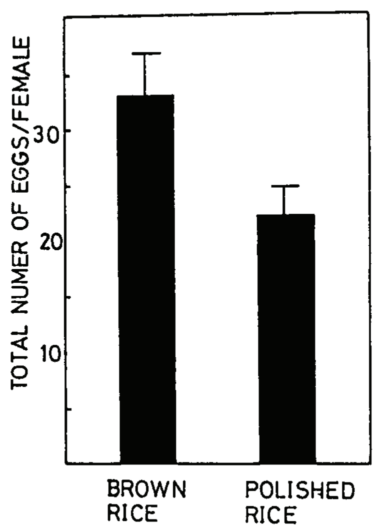

Figure 3 : Total number of eggs laid per female *Lariophagus distinguendus* on *Sitophilus oryzae* bred on brown rice and polished rice.

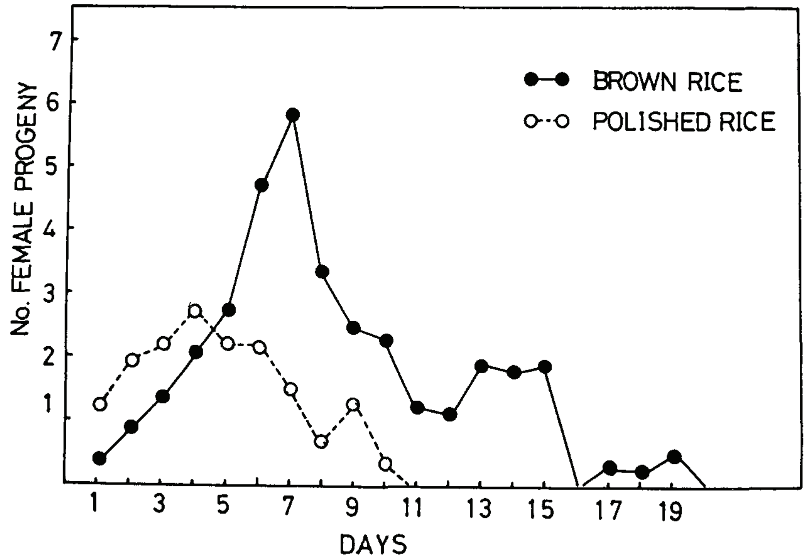

Figure 4 : Distribution of the number of female progeny produced per female *Lariophagus distinguendus* during her life span on *Sitophilus oryzae* bred brown rice and polished rice.

Mean number of eggs laid per female parasitoid during the life span was presented in Fig. 3. Total number of eggs of the parsitoid on SB was 33.1 ± 4.35 and not significantly higher than that on SP, which were 22.1 ± 2.66. **Gonen** and **Kugler** (1970) reported somewhat higher value of the parasitoid on rice weevil feed on wheat ; an average of 39.4 eggs per female. Apparently, the number of eggs per female was affected by the host media, but the variations between individual was so high that the influence might not be clearly shown. **Bellows** (1985) observed that the size of the female parasitoid is of importance in reproduction of the parsitoid. During this experiment, variable size of female parasitoid emerging was found from both the host media, which could probably be resulted in high variation in the number of eggs per female *L. distinguendus.*

The age specific curves of female progeny per female per day, however, was affected by the host media (Fig. 4). On SB, the oviposition period was 19 days with the peak on 6th days, whereas that on SP was 10 days with the peak on 4th day. Initially, the number of female progeny on SP was somewhat higher than that on SB, but after 5th day on the relationship was reversed and the net reproduction rate on SP was significantly lower than that on SB (Table 1). Whether the higher number of female progeny of the younger female on SP could be attributed to an inherent phenomenon of the parasitoid's adaptation to less suitable hosts for compensating lower net reproduction rate or to mearly a experimental error is not yet clear.

Table 1 showed the life table statistics of *L. distinguendus* on SB and SP. Generation time of the parsitoid on both media was similar, but other statistics were higher on SB than on SP, indicating that host developing on brown rice is more suitable for development of the 'parasitoid population than that on polished rice.

Table 1 : Life table statistics of Lariophagus distinguendus parasitizing on *Sitophilus oryzae* bred on brown rice and polished rice

	N	Generation time	Intrinsic rate of rate/day	Net reproduction rate/generation
Brown rice	30	23.69	0.1382	24.17
Polished rice	30	20.45	0.1214	11.66

Van den Assem (1970) and **Bellows** (1985) discussed that the host size can play a major role in the life history of the parasitoid. The size of fourth instar of the rice weevil, which was estimated by body length and body height, seemed not to be influence by the host media, but body weight of the host was significantly heavier when it had developed on brown rice than that when it had developed on polished rice : the mean ($\pm$ s.e.) of the weight on brown rice was 2.49 $\pm$ 0.16 mg, whereas it was 2.02 + 0.11 mg on polished rice ($t = 2.42$; $df = 58$; $P < 0.05$, unpublished data). Whether the differences in the life history of *L. distinguendus* can be attributed the differences in the body weight of host in relation to the host media are not yet clear. **Van den Assem** (1970) and **Bellows** (1985) showed that host size can play a major role in the life history of the parsitoid through sex ratio.

The results of the present study indicated that biology of *L. distinguendus* can be influenced by the food quality for the host, *Sitophilus oryzae*, through the female life span and distribution of female progeny per female per day. In order to control of *S. oryzae* biologically by using the parsitoid, therefore, informations on the life history of the parasitoid in different host species and also different media for the host.

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INFLUENCES DE LA QUALITE DE L'ALIMENTATION DE *SITOPHILUS ORYZAE* SUR LE CYCLE DE VIE DE *LARIOPHAGUS DISTINGUENDUS*

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RESUME

Nous avons étudié le cycle de vie de *Lariophagus distinguendus* qui parasite le *Sitophilus oryzae* élevé sur du riz brun (SB) et du riz poli (SP). La durée de vie moyenne (± s.e.) des femelles de *L. distinguendus* sur SB était de 10,3 ± 1,04 jours et était nettement plus longue que sur SP : 7,7 ± 0,54 jours. Bien que le nombre total d'oeufs pondus ait été semblable dans les deux cas (respectivement 33,1 ± 4,35 et 22,1 ± 2,66 pour SB et SP), le schéma de distribution des oeufs pendant toute la durée de vie a présenté certaines différences. Le taux de croissance intrinsèque et le taux de reproduction net sur SB ont été estimés à 0,1382 et 24,17 qui se sont avérés plus élevés que ceux sur SP, pour lequel les estimations donnaient respectivement 0,1214 et 11,66. Les résultats de la présente étude ont donc suggéré que la qualité de l'alimentation de l'hôte peut jouer un rôle significatif sur le cycle de vie du déprédateur et donc dans l'interaction entre l'hôte et le déprédateur.