On the Longevity and Parasitic Activity of Adult *Gonatocerus* sp. (Hymenoptera : Mymaridae)※

Tadashi MIURA ※※

Gonatocerus sp. (Hymenoptera : Mymaridae)
成虫の生存期間および寄生活動について

三　浦　　正

Introduction

The green rice leafhopper, *Nephotettix cincticeps* Uhler, is an important insect pest of rice, and is also the vector of rice dwarf virus. It is recorded in Japan that there are six species of egg parasites in the green rice leafhopper, that is, two trichogrammatidae species (*Paracentrobia andoi* (Ishii)[1], *Chaetostiricha aurulenta* Duott[2]) and four Mymaridae (*Ooctonus* sp., *Lymaenon* sp., *Anagraus* sp. and *Gonatocerus* sp.[3]).

In western Japan, especially the Chugoku district, the dominant species in egg parasites of the green rice leafhopper are *Paracentorobia andoi* (Ishii[1]) and *Gonatocerus* sp. (Miura[4]). The mode of life in *Paracentrobia andoi* (Ishii[1]) has been reported by Sasaba and Kiritani[5], Vungsilabutr[6] and Miura[7]. There is little information about *Gonatocerus* sp. (Orita and Miura[4,9,10]). This paper reports the results of laboratory experiments with the reproductive activity, life duration, and parasitic activity of adult *Gonatocerus* sp..

Materials and Methods

The host and *Gonatocerus* sp. used in the present experiment were produced in the laboratory of Shimane University. To obtain the host eggs for parasites, adult of *Nephotettix cincticeps* Uhler were collected from the paddy fields at Matsue and released in the rearing cage, in which there were rice plants of seedling stage. *Gonatocerus* sp. used in the present experiment was the strain obtained after adult emergence from eggs of *Nephotettix cincticeps* Uhler, and they were increased in the laboratory using the eggs of *Nephotettix cincticeps* Uhler as the host. In the present experiment, the handling of parasites was as follows. A pair or a female of *Gonatocerus* sp., immediately after the emergence, was released into the glass tube (2×8 cm) and provided honey or water only. Thereafter, the rice plants of seedling stage with the eggs of *Nephotettix cincticeps* Uhler were put into the glass tube within 3 days after deposition (Figure 1). The host eggs placed in the glass tube were attacked by female *Gonatocerus* sp. during 24 hours, and these host eggs were

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renewed daily (at 24-hour intervals). The exchange of host eggs was continued until the death of female *Gonatocerus* sp.. The adults of F1 generation of the parasite were collected after rearing the host eggs attacked by *Gonatocerus* sp..

The series of experiment was carried out using the glass cabinet controlled at 28±1°C with a 14 hour photoperiod in the insectarium.

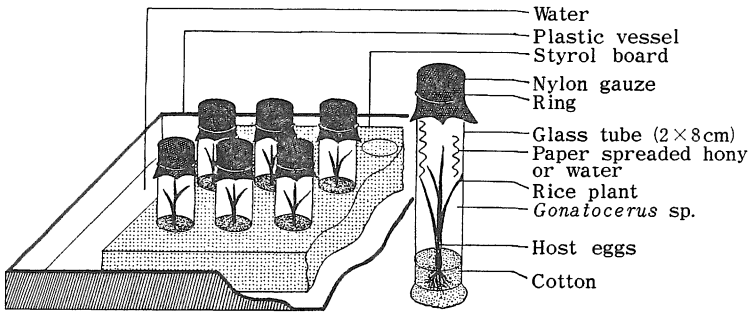

Figure 1. Apparatus for rearing the eggs of leafhopper and *Gonatocerus* sp.

Results

1) *Reproduction of Gonatocerus* sp.

In the rearing of *Gonatocerus* sp. in the laboratory, as a result, it is cleared that increasing this species could be done by bisexual reproduction and parthenogenesis. The F1 generation of this species in parthenogenesis consisted entirely of males. This indicates that *Gonatocerus* sp. is arrhenotokous parthenogenesis type.

2) *Longetviy of adult Gonatocerus* sp.

As shown in Table 1, the longevity of the adult parasite was 11−14 days in honey feeding. There was no difference in longevity between the male and female. On the other hand, the longevity of the adult parasite was only 4−5 days in water feeding, and there was also no difference in longevity between the male and female. Likewise, in both feedings of honey and water, there was no difference in longevity between the mated- and unmated females.

Table 1. The longevity of adult *Gonatocerus* sp.

Mating	Feeding	Sex	No. of adults used	Longevity (day)	
				Average	Range
Mated	Honey	♀	13	11.2	8−19
		♂	12	11.4	8−18
	Water	♀	10	4.6	1−15
		♂	10	4.5	1−13
unmated	Honey	♀	10	11.3	6−17
		♂	11	13.8	10−20
	Water	♀	10	3.8	1−10
		♂	10	3.7	1−11

Table 2. Average number of host eggs parasitized by *Gonatocerus* sp.

Mating	Feeding	No. of adults used	No. of parasitized host eggs	
			Average	Range
Mated	Honey	13	48.62	31−76
	Water	10	35.10	11−54
Unmated	Honey	10	51.70	30−72
	Water	10	32.70	16−60

3) *Number of host eggs parasitized by Gonatocerus* sp..

The number of the parasitized host eggs was measured by observation of parasites in the host eggs under microscope after rearing the host eggs attacked by *Gonatocerus* sp. (Table 2). The number of host eggs parasitized by mated female *Gonatocerus* sp. was

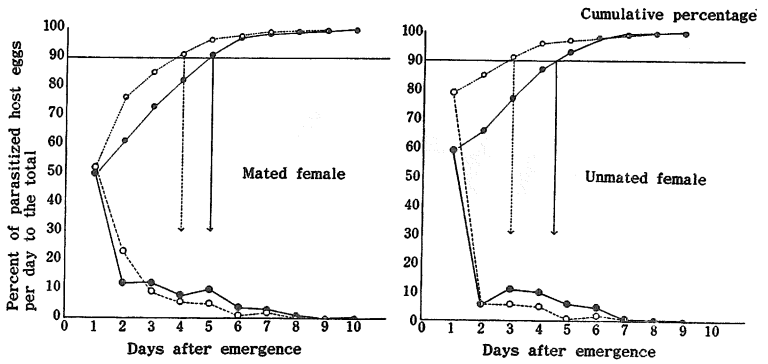

Figure 2. The effect of aging in adult *Gonatocerus* sp. on the number of parasitized host eggs.
●—● : Honey feeding, ○·····○ : Water feeding

Table 3. Number of host eggs parasitized by mated and unmated females of *Gonatocerus* sp.

Days after emergence	Mated female					
	Honey feeding (13 females)			Water feeding ((10 females)		
	No. of host eggs	No. of parasitized host eggs	Average No. of parasitized host eggs per head	No. of host eggs	No. of parasitized host eggs	Average No. of parasitized host eggs per head
1	888	313	24.1	645	184	18.4
2	675	73	5.6	342	82	8.2
3	553	78	6.0	107	31	3.1
4	722	52	4.0	122	21	2.1
5	472	62	4.8	150	18	1.8
6	525	28	2.2	88	5	0.5
7	616	17	1.3	52	6	0.6
8	579	8	0.6	48	3	0.3
9	432	0	0.0	58	1	0.1
10	306	1	0.1	46	0	0.0
11	272	0	0.0	68	0	0.0
12	143	0	0.0	60	0	0.0
13	115	0	0.0	37	0	0.0
14	63	0	0.0	22	0	0.0
15	90	0	0.0	19	0	0.0
16	63	0	0.0	—	—	—
17	51	0	0.0	—	—	—
18	48	0	0.0	—	—	—
19	41	0	0.0	—	—	—
Total	6654	632	48.7	1864	351	35.1

almost similar to that of unmated females. The number of host eggs parasitized by female in honey feeding was more than that in water feeding only. This indicates that the maturation of eggs in the ovary would be stimulated by honey feeding in *Gonatocerus* sp..

4) *Age and parasitic activity of Gonatocerus* sp..

Table 3 shows the number of parasitized host eggs and days after emergence in *Gonatocerus* sp..

Mated female : In honey feeding, the average number of parasitized host eggs was 48.6/day/head during the 10−day oviposition period. The parasitic activity was effective in the first day after emergence, and the average number of attacked host eggs was 24.1/head in the first day after emergence of *Gonatocerus* sp.. The oviposition of *Gonatocerus* sp. was continued for 9 days in water feeding only, and the average number of parasitized host eggs was 35.1/head/day. The average number of parasitized host eggs was 18.4/head in the first day after emergence in water feeding only.

Unmated female : The average number of parasitized host eggs was 51.7/day/head during 9 days of oviposition period in honey feeding, and in the first day after emergence, the average number of parasitized host eggs was 30.5/head. In water feeding, the average number of parasitized host eggs was 32.7/day/head during 8 days of oviposition period, and in the first day after emergence, the average number of parasitized host eggs was 25.7/head.

The oviposition of *Gonatocerus* sp. was active in the first day after emergence, and the ratios of parasitized host eggs in the first day to the total parasitized host eggs during the life duration of female were as follows : mated female : 49.5% (honey feeding) and

Unmated female

Honey Feeding (10 females)			Water feeding (10 females)		
No. of host eggs	No. of parasitized host eggs	Average No. of parasitized host eggs per head	No. of host eggs	No. of parasitized host eggs	Average No. of parasitized host eggs per head
1133	305	30.5	611	257	25.7
937	33	3.3	522	20	2.0
760	59	5.9	286	21	2.1
604	50	5.0	174	15	1.5
673	30	3.0	118	4	0.4
523	25	2.5	84	5	0.5
405	6	0.6	41	4	0.4
494	7	0.7	26	1	0.1
410	2	0.2	27	0	0.0
353	0	0.0	63	0	0.0
211	0	0.0	—	—	—
158	0	0.0	—	—	—
99	0	0.0	—	—	—
66	0	0.0	—	—	—
83	0	0.0	—	—	—
56	0	0.0	—	—	—
17	0	0.0	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
6982	517	51.7	1952	327	32.7

Table 4. Sex-ratio of F1 generation of *Gonatocerus* sp. used in the present study

Feeding	Female (A)	Male (B)	Total	$\frac{(A)}{(A)+(B)} \times 100$
Honey	365	174	539	67.72
Water	229	92	321	71.34
Total	594	266	860	69.06

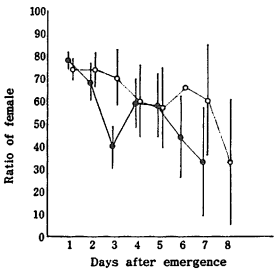

Figure 3. The effect of aging of parents on the sex-ratio of F1 generation in *Gonatocerus* sp.
●—● : Honey feeding, ○·····○ : Water feeding
● : 95% Cofidence limit

52.4% (water feeding); unmated female: 59.1% (honey feeding) and 78.6%(water feeding) (Figure 2). The host eggs parasitized within 5 days after emergence were 90% or more of the total parasitized eggs. From this, it is considered that *Gonatocerus* sp. used in the present experiment were in the pro-ovigenic category. The longevity of *Gonatocerus* sp. was extended and the number of parasitized host eggs was increased by honey feeding; however, the period of parasitic activity was not influenced by the change of feeding materials.

5) *The sex-ratio of F1 generation produced from the bisexual reproduction.*

The sex-ratio of F1 generation of *Gonatocerus* sp. after rearing the parasitized host eggs by mated female is shown in Table 4. The ratio of appearance of female and male parasites was 69.06 and 30.94, respectively. The number of female in F1 generation of *Gonatocerns* sp. tended to decrease with aging of parent wasps.

Discussion

It is considered that *Gonatocerus* sp. of the mymarid wasp (Mymaridae) may be widely distributed over the rice crop region of Southeastern Asia, because they have an important role as a natural enemy for some leafhoppers. There is a little information dealing with the distribution of this species in Tohoku district has been reported by Orita[8], and that in Chugoku district by Miura[4]. The distribution of *Gonatocerus* sp. in Southeastern Asia was reported by Yasumatsu[11], Hirashima et al.[10], Miura et al.[13] (Thailand) and Chandra[14] (Philippin). However, there is little information concerning the classification and ecological investigation of *Gonatocerus* sp.. It is obvious that the reproductive mode of mymarid wasp was complex and different between species (Raatikainen[15], Jacson[16], Otake[17,18,19,20], New[21], Orita[22])

As described previously, *Gonatocerus* sp. would be increased in both reproductive modes of bisexual reproduction and parthenogenesis. This species is included in the arrhenotokous parthenogenesis type in which the produced F1 generation consisted entirely of males. The reproductive mode of *Gonatocerus* sp. used in the present experiment was the same as that of *Anagrus* nr. *flaveolus* waterhous reported by Otake[19]. It is clear that the parasites having these reproductive modes (bisexual reproduction and parthenogenesis) may be useful for biological control.

The longevity of adult *Gonatocerus* sp. fed honey was 11—14 days under the certain environment controlled at 28±1°C with a 14-hour photoperiod. On the other hand, under

the same condition the longevity of *Gonatocerus* sp. was 4—5 days when they were fed water only. It may be considered that the longevity of adult *Gonatocerus* sp. would be shorter in an ordinary paddy field than in the water feeding of this study, because there are remarkable changes of weather in a natural paddy field.

There was little difference of longevity between mated and unmated adults. The parasitic activity of *Gonatocerus* sp. from bisexual reproduction did not differ from that of the female from parthenogenesis. In both females from bisexual reproduction and parthenogenesis, the number of parasitized host eggs per head was greater in honey feeding than that in water feeding only. In the experiment with *Alaptus pallidicornis* of mymarid wasp, New[21] reported that any feeding lengthened the longevity of adult parasites, but did not effect the increase of oviposition. In the present experiment with *Gonatocerus* sp., it is probable that the honey feeding could effect the increase of mature eggs in the ovary.

From the results of the present experiment, it is clear that adult *Gonatocerus* sp. could attack 50—70% of the total number of parasitized host eggs in the first day after emergence, and thereafter the parasitic activity would gradually weaken. As shown in Figure 3, the number of host eggs parasitized in second and third days after emergence was more in honey feeding than that in water feeding only. Similarly, it is obvious that the time when 90% of the total number of parasitized host eggs laid was 1—2 days later in honey feeding than that in water feeding only.

The sex-ratio of F1 generation from bisexual reproduction was 69.04 and 30.94 in female and male respectively, in this study using *Gonatocerus* sp.. The female of F1 generation from bisexual reproduction tended to decrease with the aging of parent wasps. This should be the topic of a separate study.

Summary

1) *Gonatocerus* sp. was increased in both mades of bisexual reproduction and arrhenotokous parthenogenesis.

2) The longevity of adult *Gonatocerus* sp. was 11—14 days and 4—5 days in honey feeding and water feeding, respectively, under the condition controlled at 28±1°C with a 14-hour photoperiod. There are no differences in longevity between male and female, or between mated and unmated females.

3) *Gonatocerus* sp. did attack 50—70% of the total number of parasitized host eggs in the first day after emergence, and thereafter their parasitic activity fell down gradually.

4) The sex-ratio of F1 generation in *Gonatocerus* sp. from bisexual reproduction was 69.04 and 30.94 in female and male, respectively.

References

1. ISHII, T. : Kontyu **12** : 179—181, 1938.
2. DOUTT, R. L. : Acta. Hymenopterologica **1** : 305—314, 1961.
3. ESAKI, T. and HASHIMOTO, S. : Publ. Ent. Lab. Dept. Agr. Kyushu Univ. **6** : 17—25, 1935.
4. MIURA, T. : Odokon-Chugoku **19** : 43—49, 1977.
5. SASABA, T. and KIRITANI, K. : App. Ent. Zool. **7** : 83—93, 1972.
6. VUNGSILABUTR, P. : Esakia **11** : 29—51, 1978.
7. MIURA, T. : Bull. Fac. Agr. Shimane Univ. **12** : 36—40, 1978.

8. ORITA, S. : Proc. Assoc. Pl. Prot. Hokuriku **17** : 67—69, 1969.
9. MIURA, T. : Bull. Fac. Agr. Shimane Univ. **10** : 43—48, 1976.
10. MIURA, T. : Bull. Fac. Agr. Shimane Univ. **10** : 49—55, 1976.
11. YASUMATSU, K., WONGSIRI, T., NAVAVICHIT, S. and TIRAWAT, C. : Plant Prot. Serv. Tech. Bull., Dept. Agr. of Thailand and UNDP/ FAO THA. **24** : 1—21, 1975.
12. HIRASHIMA, Y., AIZAWA, K., MIURA, T. and WONGSIRI, T. : Esakia **13** : 1—20, 1979.
13. MIURA, T., HIRASHIMA, Y. and WONGSIRI, T. : Esakia **13** : 21—44, 1979.
14. CHANDRA, G. : IRRN. **13** (5) : 20—21, 1979.
15. RAATIKAINEN, M. : Ann. Agr. Fenn. **6** : 149, 1967.
16. JACSON, D. J. : Trans. R. Ent. Soc. Lond. **110** : 533—554, 1958.
17. OTAKE, A. : Bull. Shikoku Agr. Exp. Sta. **17** : 91—103, 1967.
18. OTAKE, A. : Bull. Shikoku Agr. Exp. Sta. **18** : 161—169, 1968.
19. OTAKE, A. : Jap. J. Ecol. **19** : 192—196, 1969.
20. OTAKE, A. : Appl. Ent. Zool. **5** : 95—104, 1970.
21. New, T. R. : Trans. Soc. Brit. Ent. **18** : 181—193, 1969.
22. ORITA, S. : Bull. Hokuriku Agr. Exp. Sta. **14** : 91—124, 1972.

摘　　要

1）*Gonatocerus* sp. は両性生殖および産雄単性生殖をする．

2）成虫の生存期間は温度28±1°C，14時間日長の一定条件下における飼育によると，蜂蜜給与の場合で，平均11～14日，水だけ与えた場合で，平均４～５日であった．そして雌と雄，交尾した成虫と交尾しない成虫の間には生存日数の差はなかった．

3）本種の寄生活動は，雌の羽化初日に全被寄生寄主数の50%から70%の寄主を攻撃し，２日目以後は低下した．

4）本種の両性生殖をした雌による F_1 世代の性比は，雌69.06：雄30.94の割合であった．