島根大農研報 (Bull. Fac. Agr. Shimane Univ.) **16** : 172−176, 1982

Comparative Studies on the Biology of Dryinid Wasps in Japan

(I) Preliminary Report on the Predacious and Parasitic Efficiency of *Haplogonatopus atratus* ESAKI et HASHIMOTO (Hymenoptera : Dryinidae)

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日本産カマバチ類の生態に関する比較研究
(1) クロハラカマバチの捕食と寄生効果についての予報

北　村　憲　二

Although the biological studies of Japanese dryinid wasps were made by Esaki et al.[1),2),3)] and Nishioka,[4)] our knowledge of their bionomics still insufficient. The six species of Dryinidae, viz. *Haplogonatopus atratus* ESAKI et HASHIMOTO, *H. japonicus* ESAKI et HASHIMOTO, *Pseudogonatopus fulgori* (NAKAGAWA), *P. flavifemur* ESAKI et HASHIMOTO, *Echthrodelphax bicolor* ESAKI et HASHIMOTO, and *Tetradontochelys sakaii* (ESAKI et HASHIMOTO) are known to occur in the paddy field of Shimane Prefecture through my survey has been conducted since 1978.

Among them, *H. atratus* was the most dominant species. Therefore, the predacious and parasitic efficiency of this species on rice planthoppers was first studied as described below.

Materials and Methods

Host species : The stock cultures of *H. atratus* was maintained in the laboratory by providing with the nymphs of *Laodelphax striatellus* FALLÉN and *Sogatella furcifera* HOVÁTH as hosts ; fresh and full gravid females were used in this experiment. The evaluation of *H. atratus* as a natural enemy was tested on the above host species.

Rearing methods : Different stages of the host nymphs from 1st to 5th instar were separated into the five groups, and 30 nymphs of each group were kept in a glass jar (12.5 cm high and 9 cm in diameter) providing with about 20 rice seedlings. A single female of 2−5 day old *H. atratus* was released into each jar and the nymphs were exposed to a parasite for 24 hours. After 24 hours of exposure, she was removed from the jar, and predation and parasitization were examined. The rearing jar were kept at three different temperatures, 20°C, 25°C and 30°C, under 16 hours lighting.

Predation and parasitization : Causes of death of planthoppers were divided into the two categories ; predation and parasitization. Predation was checked by wounds made on host bodies. Parasitization was confirmed by appearence of the larval sac on host body, or by

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dissecting of host, which had wounds but not showing the larval sac, to determine eggs or larvae of the parasite.

Results and Discussion

After the rice planthoppers that expose to the parasites, I observed that once the hosts were attacked by *H. atratus*, external wounds were found on their abdomen. According to the degree of wounds, their symptom can be classified into two types as follows :

Lacerated wound type : Host abdomen with blackish-brown wound gnawed by the mandibles of parasite.

Punctated wound type : Host abdomen with wound of the same color, but it is a slight one as compared with that of the above type.

Predacious activity

The relation of each symptom of the external wound on host by predacious activity of parasite and the survival rate of hosts in shown in Figure 1. When *L. striatellus* was used

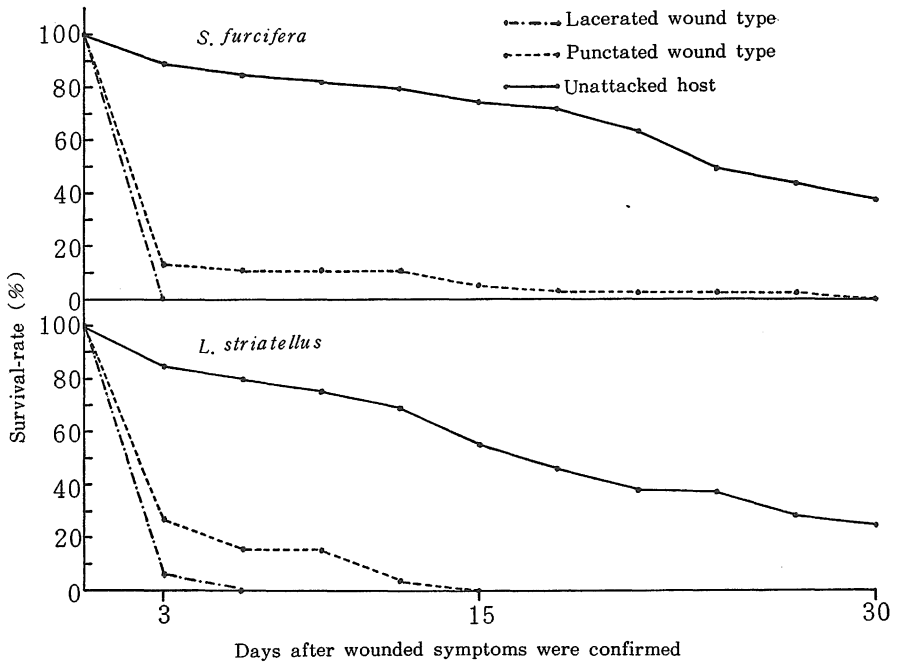

Fig. 1 Survival-rate of the hosts based on difference of the wounded types

as a host, mortality of hosts after 3 days since they were attacked, including 1st to 5th instar, was 94.3% in the lacerated wound type, and 73.1% in the punctated wound type, whereas in *S. furcifera*, they were 100% in the lacerated wound type and 86.8% in the punctated wound type. When the two types were compared, the longevity of attacked host with the punctated wound type was a little longer than that of the other type. In either case, most of the host which had both symptom of the lacerated wound type and the punctated wound type died within 1—3 days.

Table 1 Rate of predation of *Haplogonatopus atratus* on *Laodelphax striatellus** and *Sogatella furcifera**

Hosts species	Degree of wound	Hosts having the wounds	
		numbers	%
L. striatellus	lacerated wound	53	11.8
	punctated wound	26	5.8
	Total	79	17.6
S. furcifera	lacerated wound	45	10.0
	punctated wound	38	8.4
	Total	83	18.4

* Host nymphs were exposed to a single female parasite for 24 hours

Table 2 Rate of parasitization of *Haplogonatopus atratus* on the wounded hosts of *Laodelphax striatellus** and *Sogatella furcifera**

Hosts species	Degree of wound (No. hosts having wounds)		Rate of parasitization	
			numbers	%
L. striatellus	lacerated wound	(53)		
	punctated wound	(26)	4	0.9
	Total	(79)	4	0.9
S. furcifera	lacerated wound	(45)	2	0.4
	punctated wound	(38)	2	0.4
	Total	(83)	4	0.9

* Host nymphs were exposed to a single female parasite for 24 hours

Rate of predation of *H. atratus* on *L. striatellus* and *S. furcifera* is shown in Table 1, and rate of parasitization on the hosts having wounds is shown in Table 2. Waloff[6] and Subba Rao[5] pointed out that the mortality of host by a predacious activity of dryinid wasps plays an important role as well as by parasitic activity. Hosts that showing symptom of external wound had very low rate of parasitism, only 0.9% (4/450) both in *L. striatellus* and *S. furcifera*, while the rate of predation was 17.6% in *L. striatellus* and 18.4% in *S. furcifera*.

Parasitic activity

Although the eggs of *H. atratus* were deposited within the host body, the symptom of parasitism could not be recognized until the sac appeared on the side of the abdomen of host. The larval sac was usually appeared on the host after about 8 days (at 25°C, K. Kitamura unpubl.) since parasite attacked, and gradually enlarged in accordance with the development of parasite, and consequently host died soon after the mature larva emerged from the sac.

Tables 3 and 4 show the parasitic rates of *H. atratus* on the two host species. The parasitic rate of the hosts which died before the forming of larval sac was 9.1% in *L. striatellus* and was 11.8% in *S. furcifera*. The parasitic rate of *H. atratus* on the host having the larval sac was 28.2% in *L. striatellus* and 24.4% in *S. furcifera*. The total parasitic rate (the combined rate of the hosts having the larval sacs and the hosts died before having the larval sacs) was 37.3% in *L. striatellus* and 36.2% in *S. furcifera*. Esaki and Hashimoto[1] reported that *L. striatellus* is a host of *H. atratus*. According to my observation, in the paddy field, the parasite mainly attacks *L. striatellus*. However, I obtained the same rate of parsitism on both hosts (*L. striatellus* and *S. furcifera*) in the laboratory experiment.

Within the range of temperature tested, there was no significant correlation between the

Table 3 Parasitic rate of *Haplogonatopus atratus* on *Laodelphax striatellus**

Temp. (C)	Larval instar of host	No. of hosts used	Hosts died before** having larval sacs		Hosts having larval sacs		Total	
			numbers	%	numbers	%	numbers	%
20	1	30	7	23.3	10	33.3	17	56.7
	2	30	6	20.0	11	36.7	17	56.7
	3	30	4	13.3	14	46.7	18	60.0
	4	30	4	13.3	2	6.7	6	20.0
	5	30	5	16.7			5	16.7
	Total	150	26	17.3	37	24.7	63	42.0
25	1	30	1	3.3	19	63.3	20	66.7
	2	30	1	3.3	11	36.7	12	40.0
	3	30	2	6.7	20	66.7	22	73.3
	4	30	1	3.3	11	36.7	12	40.0
	5	30	1	3.3	12	40.0	13	43.3
	Total	150	6	4.0	73	48.7	79	52.7
30	1	30	1	3.3	2	6.7	3	10.0
	2	30	1	3.3	5	16.7	6	20.0
	3	30	1	3.3	1	3.3	2	6.7
	4	30			4	13.3	4	13.3
	5	30	6	20.0	5	16.7	11	36.7
	Total	150	9	6.0	17	11.3	26	17.3
Total		450	41	9.1	127	28.2	168	37.3

* Host nymphs were exposed to a single female parasite for 24 hours
** Hosts having symptoms of wound were excluded

Table 4 Parasitic rate of *Haplogonatopus atratus* on *Sogatella furcifera**

Temp. (C)	Larval instar of host	No. of hosts used	Hosts died before** having larval sacs		Hosts having larval sacs		Total	
			numbers	%	numbers	%	numbers	%
20	1	30	1	3.3			1	3.3
	2	30	3	10.0	14	46.7	17	56.7
	3	30	16	53.3	4	13.3	20	66.7
	4	30	5	16.7	8	26.7	13	43.3
	5	30	10	33.3	3	10.0	13	43.3
	Total	150	35	23.3	29	19.3	64	42.7
25	1	30	1	3.3			1	3.3
	2	30			1	3.3	1	3.3
	3	30			11	36.7	11	36.7
	4	30	2	6.7	19	63.3	21	70.0
	5	30			4	13.3	4	13.3
	Total	150	3	2.0	35	23.3	38	25.3
30	1	30	2	6.7	5	16.7	7	23.3
	2	30	3	10.0	14	46.7	17	56.7
	3	30	1	3.3	10	33.3	11	36.7
	4	30			11	36.7	11	36.7
	5	30	9	30.0	6	20.0	15	50.0
	Total	150	15	10.0	46	30.7	61	40.7
Total		450	53	11.8	110	24.4	163	36.2

* Host nymphs were exposed to a single female parasite for 24 hours
** Hosts having symptoms of wound were excluded

parasitic rate and temperature. When the different instars of host nymphs were exposed to the parasite, it cleared that all instars of host nymphs were parasitized, but there was no correlation between parasitic rate and host nymphs at different instars. Considering to the reason, it probably due to that degree of parasitism was depend on individually efficiency or behavior of *H. atratus*, of which only a single female was used in each test, rather than other factors.

When the activities of predation and parasitization were compared, mortality of hosts by parasitization was considerably higher than that by predation. Combining of its parasitic and predatory activity, mortality on the two hosts species were 54.9% in *L. striatellus* and 54.6 % in *S. furcifera*. However, my present experiments were conducted within the confined space in the laboratory, these attacking rates seems to be higher than those occur in the natural fields.

Acknowledgements

In preparing this report, I am deeply indebted to Drs. T. Miura and Y. Maeta of Laboratory of Insect Management, Shimane University for their valuable guidance. Assistance of Mr. M. Morishita for present study is sincerely acknowledged. My gratitude is also due to Dr. T. Ishihara of Ehime University for critical reading the manuscript. I am greatful to Professor Emeritus K. Yashumatsu of Kyushu University for identification the specimens of Dryinidae.

Summary

A dryinid wasp, *Haplogonatopus atratus* destroys the hosts by predation and parasitization (oviposition). Mortality by predation and parasitization was examened by exposing 30 nymphs for 24 hours to a single female. The great majority of wounded host nymphs were died within 1−3 days after predation. Eggs were not usually found in the hosts died of predation. Mortality by predation 17.6% in *Laodelphax striatellus* and 18.4% in *Sogatella furcifera*. Mortality by parasitism was 37.3% in *L. striatellus* and 36.2% in *S. furcifera*. The combined mortality by predation and parasitization reached up to about 60% in both host species.

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摘　　要

クロハラカマバチ *Haplogonatopus atratus* は雌成虫の捕食と寄生によって，寄主のウンカ類を死亡させる．捕食と寄生による死亡率はクロハラカマバチ1雌を寄主仔虫30頭に24時間さらすことによって調べた．捕食によって傷をうけた仔虫の大部分は捕食後1～3日後に死亡した．これらの寄主個体内からは寄生蜂の卵は少数しか発見できなかった．本種1頭の雌の捕食率はヒメトビウンカで17.6%，セジロウンカで18.4%，寄生率は37.3%と36.2%であった．捕食と寄生による死亡率は両寄主間で差異はなく，共に約60%であった．