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STUDIES ON THE EGG PARASITES OF THE SMALLER BROWN PLANTHOPPER, *LAODELPHAX STRIATELLUS* (FALLÉN) (HEMIPTERA : DELPHACIDAE) III. LONGEVITY AND FECUNDITY OF *ANAGRUS* NR. *FLAVEOLUS* WATERHOUSE (HYMENOPTERA : MYMARIDAE)

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Synopsis

ÔTAKE Akio (Shikoku Agric. Exp. Sta., Zentûzi) Studies on the egg parasites of the smaller brown planthopper, *Laodelphax striatellus* (FALLÉN) (Hemiptera : Delphacidae). III. Longevity and fecundity of *Anagrus* nr. *flaveolus* WATERHOUSE (Hymenoptera : Mymaridae). Jap. J. Ecol. **19**, 192—196 (1969).

Longevity and fecundity of the mymarid, *Anagrus* nr. *flaveolus*, were observed at 26°C under the illumination of 18 hours.

Longevity of the adult parasites was variable. Roughly speaking, the mean duration of the adult life was 3 days in both sexs.

The mean number of the deposited eggs was about 23, but the variation in fecundity was also remarkable. There was recorded a group of wasps of high reproductivity, in which 36 or more eggs were deposited. It was noteworthy that oviposition had been made nearly within one day after the emergence of the wasp. The progeny that originated from an unmated female were all males, but there was no difference in fecundity between parthenogenetic reproduction and gametogenetic one.

No correlation was detected between longevity and fecundity.

Devices for handling this minute parasite were presented.

Introduction

In Zentûzi, Japan, *Anagrus* nr. *flaveolus* is mentioned as an important egg parasite of *Laodelphax striatellus*, a vector of the rice stripe virus (ÔTAKE, 1967).

In this paper, longevity and fecundity under laboratory conditions are dealt with as a part of the studies on the biology of this parasite.

Methods

Observations were carried out at 26°C under the illumination of 18 hours.

Small pieces of a glass tube with plugs of moist cotton were prepared. On the plug, a host egg containing a female wasp just before emergence or a pair of hosts containing parasites of different sexs were placed.

When the adult emergence took place in a container with a female wasp alone, the wasp was immediately transferred into a test tube. A piece of cotton soaked with a sugar solution was attached to the wall of the test tube, then the opening of the tube was plugged, with a holed plastic plug, and a wheat seedling bearing fresh eggs of *Laodelphax striatellus*, inserted through the hole, was fixed with a piece of moist soil.

The test tube thus equipped was partly covered with a thin and semi-transparent nylon bag to preven the drought of the seedling roots and kept horizontally in a wire frame. For the purpose of shading, a piece of black cloth was attached over the bottoms of the tubes in the frame, so that the wasps were hindered from getting apart from the seedlings.

The devices described above are illustrated in Fig. 1.

As for the glass container with parasites of both sexs, the wasps were retained to finish copulation for several hours after their emergence, then transferred into a test tube equipped in the same way as mentioned above.

Until the death of wasps was ascertained, the wheat seedlings were exchanged with fresh ones every morning. If a wasp was discovered on a seedling being remoned from the tube, it was quickly returned by use of the wet tip of a needle. Cotton soaked with a sugar solution was also exchanged at that time.

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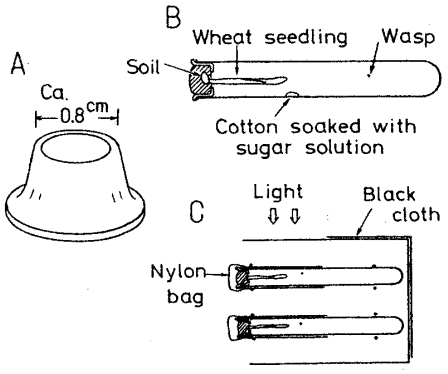

Fig. 1. Devices for studying the longevity and fecundity of *Anagrus* nr. *flaveolus*
A : plastic plug with a hole. B : test tube in which a wheat seedling bearing host eggs was set and a parasite was released. C : wire frame and test tubes kept horizontally.

The wheat seedling taken out was kept in another test tube. Planthopper nymphs which hatched from unparasitized eggs were then counted daily. When the hatching of the nymphs was nearly over, the seedling was dissected and the parasitized eggs removed from it were put on a sheet of moist filter paper for rearing until they developed to the stage at which their sexes became morphologically distinct (ÔTAKE, 1968).

Prior to the study mentioned above, a preliminary test was carried out. In this test, a single female wasp or a pair of wasps of both sexes were released in a test tube at the bottom of which a wheat seedling bearing fresh eggs of the planthopper was set. The seedling was not exchanged and the wasps were observed every day through the wall of the test tube. (The exchange of cotton soaked with sugar liquid, however, was done daily.) The test was stopped on the seventh day, though some of the test tubes still contained living wasps. The seedlings were then dissected and the parasitized eggs removed from them were arranged on sheets of moist filter paper.

Results

The results of the observations are summed up in Table 1.

Longevity was 3.4 and 2.6 days in average in unmated and mated females, respectively. The difference in mean longevity may be explicable from the evidence that the occurrence of long-lived individuals with a life-span of 6 or more days was more frequent in the unmated group than in the mated group, but it is

Table 1. Longevity and fecundity of *Anagrus* nr. *flaveolus*, with changes in number of progeny daily produced (26°C, illumination of 18hrs.)

(1) Release of a single female

Tube no.	Longevity (days)	No. of progeny daily produced								Total no. of progeny			
		1*	2	3	4	5	6	7	8	♀	♂	Sex undetermined**	Total
1	3	13	1	0						0	14	0	14
2	6	28	0	7	1	0	0			0	36	0	36
3	3	1	0	0						0	1	0	1
4	1	28								0	28	0	28
5	1?	0								0	0	0	0
6	3	24	0	1						0	22	3	25
7	3	23	0	5						0	26	2	28
8	7	18	0	3	0	0	0	0		0	21	0	21
9	5	8	0	3	0	0				0	10	1	11
10	8	21	2	6	1	0	0	0	0	0	26	4	30
11	1	25								0	22	3	25

(2) Release of a pair of both sexes

Tube no.	Longevity (days) ♀	♂	No. of progeny daily produced								Total no. of progeny			
			1	2	3	4	5	6	7	8	♀	♂	Sex undetermined	Total
12	2	8	21	0							5	13	3	21
13	?(>1)	5	0	0							0	0	0	0
14	2	2	21	5							5	21	0	26
15	2	1?	14	1							0	12	3	15
16	1	1	7								4	3	0	7
17	2	3	24	0							20	3	1	24
18	1	1	1								1	0	0	1
19	Escaped	1	16	1	4 (Unknown because of the escape of the female)						(14	5	2	21)
20	3	5	13	3	0						7	5	4	16
21	5	1	17	2	0	0	0				14	3	2	19
22	1	4	22								4	12	6	22
23	8	?(>1)	33	1	3	1	0	0	0	0	29	7	2	38
24	3	4	30	0	4						21	11	2	34
25	2	2	26	0							21	4	1	26
26	1	4	24								20	0	4	24

* 1, 2, 3, ··· mean the first, second, third, ··· days of the observation, respectively.
** Mainly individuals which were mortally wounded at the time of being taken out.

doubtful whether the difference was more than by chance.

Longevity in the male was 3.2 days in average.

Because of the daily exchange of wheat seedlings, it was possible to demonstrate how oviposition activity changed with the advance of the wasp's age. Table 1 clearly shows that the parasite deposited most of the storage of her eggs on the first day of her emergence.

It is also demonstrated in Table 1 that there was a wide variation in fecundity but no significant difference in fecundity between parthenogenetic reproduction and gametogenetic one.

It is pointed out that all of the females which lived to the age of 7 to 8 days ceased to reproduce in the latter half of their life. The occasional occurrence of long-lived individuals, therefore, is said to be meaningless from the viewpoint of population propagation of the parasite.

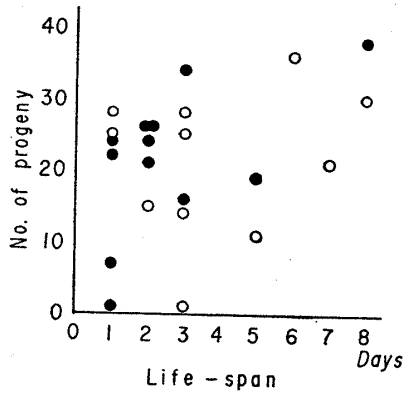

Fig. 2. Relationship between the life-span of the female wasp of *Anagrus* nr. *flaveolus* and the number of progeny produced
Each white circle represents an unmated female and the black one a mated female.

The relationship between the fecundity and the longevity of the adult females is illustrated in Fig. 2. Tube Nos. 5 and 13 are omitted from the figure, since in these cases, the female wasps were regarded to have been dead before begining to oviposit. Moreover, Tube No. 15, in which the male died within one day after its release and the progeny produced were all males, was belonged to the group of unmated females. It can be said from Fig. 2 that the total number of pro geny produced by a female was hardly related to the span of her life.

Table 2. Results of the preliminary test (26°C, illumination of 18 hrs.)
Cases in which the death of the female wasps was not ascertained are omitted.

(1) Release of a single female

Tube no.	Longevity (days)	No. of progeny ♀	♂	Sex undetermined	Total
2	4	0	29	0	29
3	5	0	21	3	24
4	2	0	11	1	12
5	>7	0	35	5	40
8	>7	0	37	0	37
10	3	0	11	2	13
11	6	0	23	1	24
12	3	0	36	2	38
14	3	0	15	3	18
16	1	0	22	2	24
17	1	0	0	0	0
19	1	0	17	0	17
20	1	0	8	1	9

(2) Release of a pair of both sexes

Tube no.	Longevity (days) ♀	♂	No. of progeny ♀	♂	Sex undetermined	Total
24	6	? (>6)	20	10	8	38
25	2	? (>6)	21	3	6	30
26	>7	4	21	6	0	27
27	2	? (>6)	12	3	1	16
28	1	1	0	0	0	0
29	4	2	25	9	3	37
30	4	6	27	9	3	39
32	2	6	22	5	3	30
33	2	2	22	5	3	30
34	2	? (>5)	14	2	4	20
35	5	>7	21	0	0	21
38	4	>7	18	2	3	23
41	1	? (>4)	0	16	2	18
43	>7	Escaped	0	31	4	35
44	1	? (>5)	21	6	1	28

In the preliminary test, it was fairly difficult to confirm the minute wasps within the test tubes through their glass walls, so that the dead bodies of the parasites were often failed to be found. However, some data concerning the tubes in which the life and death of the female wasps were ascertained are available (Table 2). Although the average duration of the adult life is impossible to calculate because the test was discontinued on the way, it is pointed out that in this preliminary test, too, there were some wasps which lived for 6 days or more. In Tube Nos. 17 and 28, oviposition did not take place in spite of the fact that the wasps certainly lived one day after their emergence.

The data in Tables 1 and 2 are pooled for analysing the individual variation in fecundity, and a histogram was obtained as shown in Fig. 3. The shape of the frequency distribution drawn in Fig. 3 seems to be reasonably apart from normality. It is paticularly noteworthy that 16 per cent of the total cases were individuals of high fecundity which had deposited 36 or more eggs during their life-span.

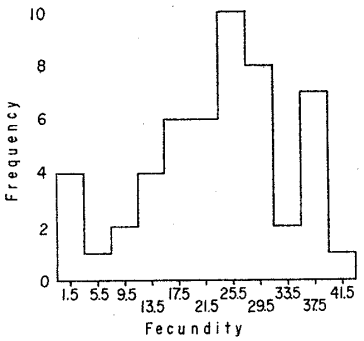

Fig. 3. Histogram showing the frequency distribution of the total numbers of eggs deposited by *Anagrus* nr. *flaveolus*
Data excepting for Tube nos. 5, 13 and 19 in Table 1 and all the data in Table 2 are pooled for the calculation of frequency distribution.

The mean fecundity of 22.9 eggs was calculated from the pooled data (tubes of Nos. 5, 13 and 19 in Table 1 are omitted).

It is clear from Tables 1 and 2 that unmated females always produced male progeny alone. Sex ratios in the progeny from mated females were variable, but there was a tendency that the females had a majority of the total progeny in gametogenesis.

Discussion

Very few studies on the longevity and fecundity of mymaried parasites have been published. So far as the writer knows, only two papers are available on the subject: first, BALDUF (1928) on *Polynema striaticorne* GIRAULT parasitic in the egg of the buffalo tree hopper, *Ceresa bubalus* FABR., and secondly, KUWAYAMA (1935) on *Anaphes nipponicus* KUWAYAMA attacking the egg of the rice leaf-beetle, *Lema oryzae* KUWAYAMA. Difficulty in handling minute and delicate wasps of this family may be mentioned as one of the main reasons for retarding basic biological and ecological studies of these wasps. If this would be true, the devices to handle *Anagrus* presented by the writer in this paper may result in some technical advance.

Through his ovary examination, BALDUF (1928) concluded that *Polynema striaticorne* had a capacity of parasitizing at least 18 to 20 host eggs in rather rapid succession. In the case of *Anaphes nipponicus* studied by KUWAYAMA (1935), the state of things is more complex; this polyparasitic species has a tendency that the more the number of parasites bred in a single host, the smaller the body size of the emerged wasp becomes. The evidences were clarified through the measurement and dissection of 15 individuals by KUWAYAMA that the number of eggs stored in the ovaries fairly well correlated with the body size of the female wasp, and that 48, 10 and 28.2 were respectively the maximum, minimum and average numbers of eggs found in the ovaries (a small number of immature eggs were often included). KUWAYAMA(1935) also observed no difference in shape between the egg still retained in an ovary and that detected within a host embryo. This seems to mean that in *Anaphes nipponicus*, too, the eggs which have matured in the ovaries are laid down into host eggs within a short period after the emergence of the wasp.

It is interesting that, as mentioned above, the results obtained by BALDUF (1928) and KUWAYAMA (1935) concerning the oviposition of *Polynema striaticorne* and *Anaphes nipponicus*, respectively, coincide to a considerable extent with those presented in this paper as to *Anagrus* nr. *flaveolus*.

KUWAYAMA(1935) observed that the adult of *Polynema striaticorne* lived for about 5 days when reared on a honey solution at room temperature in mid-July. Adult longevity in this species was said to have further been prolonged at lower temperatures. Therefore, it can be recognized that *Anagrus* nr. *flaveolus* is somewhat short-lived compared with *Polynema striaticorne*.

It is ascertained in this paper that in *Anagrus* nr. *flaveolus*, all progeny are males when parthenogenetic reproduction takes place. That this phenomenon is common to mymarid species that are normally bisexual but are able to reproduce parthenogenetically has been pointed out by CLAUSEN (1940, p. 104).

Acknowledgements

The writer wishes to express his gratitude to Mr. TATSURO KONO, Chief of our laboratory, for offering valuable suggestions.

Reference

1) BALDUF, W. V.: Ann. ent. Soc. Amer. **21**, 419—435 (1928) 2) CLAUSEN, C. P.: Entomophagous insects. 688pp., McGraw-Hill, New York and London(1940) 3) KUWAYAMA, S.: Rpt. Hokkaido Agr. Exp. Sta., No. **33**, 80pp. (1935) (In Japanese) 4) ŌTAKE, A.: Bull. Shikoku Agr. Exp. Sta., No. **17**, 91—103 (1967) 5) ŌTAKE, A.: Bull. Shikoku Agr. Exp. Sta., No. **18**, 161—169 (1968)

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摘　　要

大竹昭郎：ヒメトビウンカの卵寄生バチに関する研究 Ⅲ. *Anagrus* nr. *flaveolus* WATERHOUSE の寿命と産卵力.

ヒメトビウンカはイネ縞葉枯病の媒介こん虫として知られるが，その卵寄生バチの主要なものとして *Anagrus* nr. *flaveolus*（ホソバネヤドリコバチ科）が挙げられる．ここでは，26°C, 18時間照明という条件の下で観察されたこの種類の成虫の寿命と産卵力について報告する．

成虫の寿命には変異が大きかったが，砂糖水をあてがった場合，平均寿命は雌雄ともに約3日であった．平均産卵数は約 23 であったが，これも変異が大きかった．36あるいはそれ以上をうむ個体もあった．いちじるしい点として，このハチは羽化後1日以内にほとんど全部の卵をうみ終ることが観察された．単為生殖によってうみ出された卵は，すべて雄であった．単為生殖と両性生殖との間には産卵力に差はなかった．成虫の寿命と産卵力との間には相関は認められなかった．

このハチは非常に小さく繊細なので，以上の観察をおこなうために特殊な装置が考案された．

BEHAVIOUR OF POST-HIBERNATING FEMALE HORNETS, *VESPA*, IN THE PRE-NESTING STAGE, WITH SPECIAL REFERENCE TO INTRA- AND INTERSPECIFIC DOMINANCE RELATIONSHIPS*

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Synopsis

MATSUURA, Makoto (Kibi-cho, Wakayama Pref.) Behaviour of post-hibernating female hornets, *Vespa*, in the pre-nesting stage, with special reference to intra- and interspecific dominance relationships. Jap. J. Ecol. **19**, 196—203 (1969). Biological studies on hornets of the genus *Vespa* in Japan I.

Biosociological studies on the Japanese hornets of the genus *Vespa* have been carried out by the author since 1957. The present paper deals with the behaviour of post-hibernating female of *Vespa* species in the pre-nesting stage.

The hibernated females depart from their hibernacula during the period from early April to early June in the following order : *V. xanthoptera-mandarinia-crabro flavofasciata-analis insularis-tropica pulchra*.

Fertilized females spend time in taking their own food, mainly tree sap of *Quercus* trees, for a short period before searching for nesting sites. On the other hand, unfertilized ones seeking tree sap can be observed until July, but they perish without founding nests.

Both intra- and interspecifically a distinct linear dominance order is recognized among the females visiting tree sap. Each individual can obtain tree sap according to the order established among them. A positive correlation between the social rank relationships and development of their ovaries, as reported in *Polistes* wasps, was not definitely confirmed.

Introduction

Although the species of the genus *Vespa* are the largest and most typical social wasps, their biology and ethology have so far been studied less intensively than other related groups, such as *Vespula* and *Polistes*, apparently for their ferocious disposition and scarcity in the North-temperate Region. There is only one species, *V. crabro* in temperate Europe, which has also secondarily dispersed to North America, where no endemic species occurred. In contrast, Japan is more favourable for the study of this genus, being inhabited by 8 species. Since 1957, the author has been engaged in biosociological studies on this group and obtained some information through the observations of their lifecycle.

The post-hibernating female wasps (= queens) search for tree sap before devoting themselves to seek nesting sites. At the tree apertures where the secretion is abundant, they assert their territorial right by driving away the visitors of the same or different species from the place. The present paper, being the first of the serial reports, deals with their life in the pre-nesting stage and the fate of unfertilized females, with special reference to the intra- and interspecific dominance among the

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* Biological studies on hornets of the genus *Vespa* in Japan. I.