

Studies on the Host Selection by *Anicetus beneficus*
(Encyrtidae, Hymenoptera), a parasite of *Ceroplastes*
rubens (Coccidae, Hemiptera)¹⁾

By

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Anicetus beneficus ISHII et YASUMATSU is an effective natural enemy of the red scale, *Ceroplastes rubens*, which is one of the most injurious insect pest of horticulture in Japan. Since the discovery of this parasitic wasp by Dr. YASUMATSU in 1946, several papers have been published, chiefly from the viewpoint of biological control by MINAMIKAWA (1954), TACHIKAWA (1951, 55), YASUMATSU and his collaborators (1949, 51, 53a, 53b, 53c, 54, 55), etc.

In Japan, there are three species of scales belonging to the genus *Ceroplastes*, viz. *C. rubens*, *C. pseudoceliferus* and *C. japonicus*. *A. beneficus* has been considered to be a special parasite on *C. rubens*.

Some of the investigators who treated with the problem of host selection in parasitic wasps divided the process of parasitization into several phases. The oviposition to the host body is an important phase of the process, and the emergence of a wasp from the host is its final result.

The author wishes to concern himself with the behavior of adult females of this wasp in selecting their host among the three scales.

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Materials and Methods

The wasps used in my experiments were collected chiefly from southern Japan, e. g. Kurume and Fukuoka in Kyushu, Kagawa and Tokushima in Shikoku. The host scales collected from these districts were kept in glass tubes, and emerged

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wasps were used for the experiments. The adult females were fed with undiluted honey.

At the experiment, a test female was put into a glass tube of 7.5cm in length and 1.5cm in diameter, to which two out of three species of *Ceroplastes* scales were offered for oviposition.

The ovipositing behavior of the wasps seemed to be normal under these conditions. The ovipositing behavior (viz. thrusting of the ovipositer into the host body) were recorded during two hours, and the percentages of ovipositing behavior against two species of scales were compared.

Experimental Results

First Experiment

A. beneficus repeats two generations in a year, the first emergence takes place in June and the second in September. On the other hand, host scales have one generation in a year, the new generation appearing in June or July. Therefore the first brood of this wasp commonly attacks the newly hatched small larvae of scales, and the second brood the matured adults.

In the first experiment, the first or summer generation of parasitic wasps and the host scales in young stage were used. The results are shown in Tables 1-3.

Table 1. Showing the difference in the tendency of host selection by the wasp of the first generation between *C. rubens* and *C. pseudoceliferus* of young stage

	R	RP	P	—	Total
Numbers of individuals	20 (29.0%)	13 (18.8%)	9(13.1%)	27(39.1%)	69(100%)
Numbers of times showing ovipositing behavior	156	(R)91 (P)67	31	0	345

R: Cases of ovipositing behavior against *C. rubens* only.

P: Cases of ovipositing behavior against *C. pseudoceliferus* only.

J: Cases of ovipositing behavior against *C. japonicus* only.

RP, RJ, PJ: Cases of ovipositing behavior against both species designated respectively.

—: Cases of no ovipositing behavior.

Table 2. Showing the difference in the tendency of host selection by the wasp of the first generation between *C. rubens* and *C. japonicus* of young stage

	R	RJ	J	—	Total
Numbers of individuals	19(54.3%)	3(8.6%)	0	13(39.1%)	35(100%)
Numbers of times showing ovipositing behavior	172	(R)38 (J)4	0	0	214

For abbreviations see Table 1.

Table 3. Showing the difference in the tendency of host selection by the wasp of the first generation between *C. pseudoceliferus* and *C. japonicus* of young stage

	P	PJ	J	—	Total
Numbers of individuals	16(80.0%)	0	0	4(20.0%)	20(100%)
Numbers of times showing ovipositing behavior	79	(P)0 (J)0	0	0	79

For abbreviations see Table 1.

It may be said that, although a large number of wasps thrust their ovipositors into *C. rubens* which is their original host, some individuals choose *C. pseudoceliferus* and a few attack *C. japonicus*, too.

Second Experiment

In the second experiment, the second or autumn brood of wasps and matured hosts were used. The results are shown in Tables 4-6.

Table 4. Showing the difference in the tendency of host selection by the wasp of the second generation between *C. rubens* and *C. pseudoceliferus* of matured stage

	R	RP	P	—	Total
Numbers of individuals	72(58.1%)	11(8.9%)	4(3.2%)	37(29.8%)	124(100%)
Numbers of times showing ovipositing behavior	305	(R)44 (P)22	13	0	384

For abbreviations see Table 1.

Table 5. Showing the difference in the tendency of host selection by the wasp of the second generation between *C. rubens* and *C. japonicus* of matured stage

	R	RJ	J	—	Total
Numbers of individuals	57(81.4%)	8(11.4%)	1(1.4%)	4(5.8%)	70(100%)
Numbers of times showing ovipositing behavior	415	(R)39 (J)23	11	0	488

For abbreviations see Table 1.

Table 6. Showing the difference in the tendency of host selection by the wasp of the second generation between *C. pseudoceliferus* and *C. japonicus* of matured stage

	P	PJ	J	—	Total
Numbers of individuals	12(20.0%)	5(8.3%)	8(13.3%)	35(58.3%)	60(100%)
Numbers of wasps showing ovipositing behavior	41	(P)13 (J)16	28	0	98

For abbreviations see Table 1.

In this series of experiment, almost all individuals thrust their ovipositors into *C. rubens*, whereas both *C. pseudoceliferus* and *C. japonicus* were rarely attacked.

Third Experiment

From the results of the first and second experiments, the remarkable differences in the tendency of host selection can be seen between the first and second broods of wasps, although it is not clear whether the difference are due to the different states of the host or to the different nature of seasonal broods of the parasite.

The third experiment was therefore designed to solve this problem. The host scales containing the wasps of the prepupal stage in their bodies were kept in the constant warm temperature of 25°C during the winter. Under this condition, wasps emerged in the spring about three weeks earlier than those in the natural condition, so that the matured host scales were still alive. Therefore, the experiment combining the first brood of wasps and the matured host scales could be performed. The results obtained by this experiment are shown in Tables 7-9.

Table 7. Showing the difference in the tendency of host selection by the wasp of the first generation between *C. rubens* and *C. pseudoceliferus* of matured stage

	R	RP	P	—	Total
Numbers of individuals	40(66.7%)	1(1.7%)	1(1.7%)	18(30.0%)	60(100%)
Numbers of times showing ovipositing behavior	202	(R)1 (P)1	1	0	205

For abbreviations see Table 1.

Table 8. Showing the difference in the tendency of host selection by the wasp of the first generation between *C. rubens* and *C. japonicus* of matured stage

	R	RJ	J	—	Total
Numbers of individuals	46(76.7%)	2(3.3%)	2(3.3%)	10(16.7%)	60(100%)
Numbers of times showing ovipositing behavior	223	(R)10 (J)2	2	0	237

For abbreviations see Table 1.

Table 9. Showing the difference in the tendency of host selection by the wasp of the first generation between *C. pseudoceliferus* and *C. japonicus* of matured stage

	P	PJ	J	—	Total
Numbers of individuals	2(2.1%)	4(4.2%)	6(6.3%)	84(87.5%)	96(100%)
Numbers of times showing ovipositing behavior	6	(P)10 (J)7	9	0	32

For abbreviations see Table 1.

These Tables show that most individuals select *C. rubens*, whereas *C. pseudoceliferus* and *C. japonicus* are rarely attacked.

Discussion

From the results given in Tables 1-6, it may be said that the wasps of *A. beneficus* thrust their ovipositors into not only their normal host, *C. rubens*, but also into other species, *C. pseudoceliferus* and *C. japonicus*. The relative number of times in selecting the host scales differ between the first and second generations of wasps.

In the first generation, most individuals thrust their ovipositors into *C. rubens* whereas only a few into *C. pseudoceliferus*. It is very interesting that when the wasps are put into a glass tube, in which small twigs with *C. pseudoceliferus* and *C. japonicus* are previously placed side by side, all individuals which show the ovipositing behavior select *C. pseudoceliferus* only.

In the second generation, almost all individuals thrust their ovipositors into *C. rubens*, whereas both *C. pseudoceliferus* and *C. japonicus* are rarely attacked. When the selection experiment between *C. pseudoceliferus* and *C. japonicus* are performed, both hosts are attacked almost indiscriminately.

In the third experiment, which combine the wasp in the condition of the first experiment and the scales in the condition of the second experiment, almost all individuals select *C. rubens*, whereas both *C. pseudoceliferus* and *C. japonicus* are rarely attacked. In the selection experiment between *C. pseudoceliferus* and *C. japonicus*, both hosts are attacked indiscriminately. The results of the third experiment are very similar to those of the second experiment.

In spite of the similar condition of wasps, their host selection was very different in the first and third experiments. It may be suggested that the conditions of host scales, especially those correlated with the developmental stages of hosts, are very important in determining the differences of the behavior of host selection of this parasitic wasp.

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