Realized Fecundity of the Pine Needle
Gall Midge, *Thecodiplosis japonensis*

UCHIDA et INOUE

(Diptera: Cecidomyiidae)¹

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The pine needle gall midge, *Thecodiplosis japonensis* UCHIDA et INOUE, is an important forest pest in Japan and Korea. Seasonal changes in the density of this species were studied by KO (1969), YOSHIDA et al. (1973), SONE (1980), and SONÉ and TAKEDA (1983). SONE (1980) and SONÉ and TAKEDA (1983) reported that the individual number of the species drastically decreased before the formation of galls and during the period of third-stage larvae and pupae in the soil. They also reported that mortality before gall formation was caused by three major factors; the failure of females to realize their maximum fecundity, egg mortality, and mortality of hatched larvae. The life span of adults is only one day, so females copulate and oviposit soon after emergence. Mortality due to the failure to achieve the maximum fecundity was estimated as the difference between the initial number of ovarian eggs and the number of eggs actually deposited. The number of eggs that remained in the ovaries of the dead adults was regarded as ovarian egg mortality. It is not possible to evaluate the influence of predation and emigration on the population unless the maximum reproductive potential of an adult is clarified. In this study, newly emerged females of *T. japonensis* were allowed to oviposit under laboratory conditions to determine their reproductive potential.

Third-stage larvae were collected from a *Pinus thunbergii* stand in the Kamigamo Experimental Forest Station of Kyoto University from December 1976 to February 1977, and reared in the laboratory in pots containing forest soil and litter. In the following spring, emerging adults were captured in a trap consisting of a funnel covered at a narrower end by a tubular cage and standing up-

side-down on the surface of the soil. Mating pairs of newly emerged adults were placed into a nylon net cage containing one current shoot with 46 to 130 needles of 2–3 cm long, on which females were allowed to oviposit. After death all adults were collected and examined under a binocular microscope. The abdomen of each female was dissected to count the number of eggs remained in her ovaries. All needles were examined and the number of eggs deposited was counted.

The above-mentioned experiments were repeated 18 times during the period from 8 June to 21 June by caging a total of 76 males and 51 females. The mean fecundity was 146 eggs per female.

Table 1 shows the number of needles on a shoot, the percentage of needles on which eggs were deposited, the percentage of eggs deposited (realized fecundity), and the number of adults used in each replicate. In the field, a female usually deposits only one egg cluster on each pair of needles and avoids ovipositing on the needles with an egg cluster. But on current shoots with higher percentage of galled needles, two or more egg clusters are observed to be deposited on some needles. These field observations suggest that after females deposit on all needles in the cage, they deposit eggs again on needles on which they have oviposited. The percentage of needles with eggs was lower than 40 % in 16 out of the 18 replicates. About 76 % of the needles in the cage were oviposited in only two replicates (15 and 17), where females deposited eggs which accounted for 93 and 73 % of their initial ovarian eggs, respectively. In all replicates, only one egg cluster was found to be deposited on each pair of needles. Thus, it appeared that females were provided with a sufficient number of needles for ovipositing in each cage.

In this experiment, two or more females were allowed to deposit eggs on a single shoot in 16 replicates. Therefore, both potential and realized fecundities for each female could not be estimated in these replicates. The mean realized fecundity for each replicate varies from 3 to 93 %, with the average of 38 %, which was 15 % higher than that reported for the natural population of the species in the *P. thunbergii* stand at Kamigamo in 1977 (SONE, 1980). The number of eggs that remained in ovaries also varied greatly with the individual within a replicate, i.e., the maximum number of

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Table 1. The number of needles on a shoot, the percentage of needles on which eggs were deposited, the realized fecundity, and the number of adults used in each replicate of the laboratory experiments. Replicates indicated with the same alphabet letter were performed on the same day

Replicate	No. of needles on a shoot	% of needles with eggs	Realized fecundity (%)	No. of adults released in the cage	
				♂	♀
1 a	96	4.17	2.97	10	6
2 a	90	18.89	23.87	5	4
3 a	98	11.22	32.60	4	3
4 b	57	40.35	50.00	4	2
5 b	62	22.58	52.77	7	2
6 b	130	1.54	4.00	—	3
7 c	53	35.85	68.35	7	1
8 c	54	12.96	56.12	8	1
9 c	58	24.14	75.00	5	2
10 d	75	16.00	28.78	2	3
11 d	84	13.10	13.46	4	4
12 d	82	19.51	24.48	5	2
13 e	46	30.43	17.80	2	4
14 e	57	40.35	70.73	2	3
15 f	81	76.54	93.02	4	4
16 f	53	28.30	27.23	1	2
17 f	63	76.19	73.32	5	3
18 g	78	12.82	24.16	1	2

Table 2. The number of eggs that remained in the ovaries of each female after it died

Replicate	No. of eggs that remained in ovaries
1	172, 170, 162, 143, 142, 125
2	206, 120, 46, 14
3	132, 60, 54
4	146, 6
5	126, 16
6	145, 126, 104
7	75
8	54
9	29, 16
10	151, 32, 8
11	179, 118, 95, 71
12	154, 60
13	177, 158, 104, 69
14	66, 20, 6
15	14, 12, 10, 6
16	158, 136
17	76, 72, 50
18	176, 72

remained eggs was 206 and the minimum was 14 in the replicate 2; 146 and 6 in the replicate 4; and 151 and 8 in the replicate 10, respectively (Table 2).

SONE (1980) pointed out that ovipositing behaviour of this species was possibly influenced by weather conditions. KO and LEE (1975) showed that wind velocity affected the flight activity of *T. japonensis*. YUKAWA et al. (1976) also reported that weather, temperature, and wind velocity affected the activity of adults of the neolitsea leaf gall midge, *Pseudaspindylia neolitseae* YUKAWA. It is certainly to be considered that environmental factors affect the ovipositing behaviour of such short-lived and fragile insects as gall midges. In addition, the present study showed a wide individual variation in the realized fecundity among females which were allowed to oviposit under same conditions of a day.

A notable difference in the flight activity of mated females was observed in this study; some females were very active and repeatedly flew to locate needles, while others did not fly at all. This observation may relate the individual variation in the realized fecundity to the difference in the vigor. TOKUHISA (1981) also suggested that variation in the realized fecundity of the chestnut gall wasp, *Dryocosmus kuriphilus* YASUMATSU, was related to differences in the amount of energy expended by adults at the time of emergence.

KO (1977) collected females of *T. japonensis* in the field at intervals of one hour from 18:00 to 24:00 and counted the number of eggs that remained in their ovaries. By comparing the mean number of eggs retained in the ovaries at 18:00 with that at 24:00, he estimated that at least 80 % of their ovarian eggs were deposited in the field. However, oviposition of *T. japonensis* starts almost immediately after mating, which itself follows close

upon emergence, and thus females probably deposit eggs before 18:00 in the field (SONE, 1980). Therefore, KO (1977) probably underestimated the maximum realized fecundity of this species. In the present study, the highest value for the realized fecundity was 93 % in the replicate 15, where the number of eggs that remained in the ovaries of all four females were very small (Tables 1 and 2). The minimum number of eggs that remained in ovaries was 6, which was equivalent to 4 % of the mean fecundity, 146 per female.

From these results, the author concludes that the realized fecundity of a given population of *T. japonensis* would be influenced by not only weather conditions but also by the vigor of females constituting the population.

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