論文（Original Article）

Preliminary release experiments in laboratory and outdoor cages of *Dastarcus helophoroides* (Fairmaire) (Coleoptera: Bothrideridae) for biological control of *Monochamus alternatus* Hope (Coleoptera: Cerambycidae)

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Abstract

Dastarcus helophoroides was released on logs infested by *Monochamus alternatus* in three different ways: Release of adults under laboratory conditions (Experiment 1); Release of hatchlings under laboratory conditions (Experiment 2); Release of eggs in outdoor cages (Experiment 3). Percent parasitism in Experiment 1 totaled only 7.9 %, which was probably due to few adults actually ovipositing on the logs. In Experiment 2, total percent parasitism was 63.2 %, and 35 % of released hatchlings succeeded in parasitizing hosts. These experiments revealed that laboratory-reared *D. helophoroides* could be used to parasitize *M. alternatus* artificially. Percent parasitism in Experiment 3 totaled 49.7 %. Survival of *M. alternatus* was 45.9 % in logs onto which *D. helophoroides* eggs were released, while that in control logs was 96.4 %, which confirmed the effect that *D. helophoroides* can have on *M. alternatus* survival. However, percent parasitism greatly differed among the logs. When many *M. alternatus* had already emerged before the hatching of the released eggs began in the logs, the percent parasitism tended to be low. Thus good synchronization of release with the vulnerable host stage was considered to be important for successful release.

Key words : *Dastarcus helophoroides, Monochamus alternatus*, release experiments, biological control, parasitoid

Introduction

Dastarcus helophoroides (=longulus) (Fairmaire) (Coleoptera: Bothrideridae) is a parasitoid of cerambycid beetles (Lieu, 1944; Gao and Qin, 1992). Adult females deposit egg clusters on the walls of host galleries in tree stems (Gao and Qin, 1992). Hatchlings, 0.7 mm in body length, seek and paralyze hosts. Larvae that successfully parasitize a host lose their legs and begin to grow rapidly, feeding externally on the host. The mature larva spins a cocoon and pupates, then overwinters as an adult.

D. helophoroides is an important natural enemy of *Anoplophora glabripennis* (Motsch) and A. nobilis Ganglbauer, two cerambycid borers of poplars (*Populus* spp.) and willows (*Salix* spp.) in China (*Gao* and Qin, 1992). In Japan, it is known to be a parasitoid of the Japanese pine sawyer, *Monochamus alternatus* Hope, which is the primary vector of the pinewood nematode, *Bursaphelenchus xylophilus* (Steiner and Buhrer) (Taketsune, 1982; Inoue, 1993). *D. helophoroides* parasitizes the larvae, pupae, and teneral adults of *M. alternatus* in dead pine trees. Percent parasitism reported in field studies ranged from 31.4% (Taketsune, 1982) to between 14.9% and 19.5% (Inoue, 1993) and 58% (Okamoto, 1999).

Although *D. helophoroides* is found in Japan in Honshu and Kyushu, parasitism of *M. alternatus* has been observed only in Okayama and Hiroshima Prefectures in Honshu. Because parasitism by *D. helophoroides* is one of the main mortality factors in the above region (Taketsune, 1982; Okamoto, 1999), this species is expected to act as a biological control agent. Nevertheless, only a few studies have been done on the biological control of *M. alternatus* using this parasitoid (Miura, 2000).

I conducted three preliminary release experiments of *D.*

原稿受付：平成15年4月14日 Received Apr. 14, 2003　原稿受理：平成15年10月2日 Accepted Oct. 2, 2003

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helophoroides using cut pine logs inhabited by *M. alternatus* immatures to determine whether this parasitoid could be used in biological control: Experiment 1 -- Adults were released on logs under laboratory conditions; Experiment 2 -- Hatchlings were released on logs under laboratory conditions; and Experiment3-- Eggs were released on logs in outdoor cages. The percent parasitism by *D. helophoroides* of *M. alternatus* was recorded in each experiment. Problems in using the parasitoid for field release against *M. alternatus* are discussed.

Materials and methods

Experiment 1: Release of *D. helophoroides* adults under laboratory conditions

I collected five *D. helophoroides* adults from dead *Pinus densiflora* Sieb et Zucc stems at Hinase-cho, Okayama Prefecture (lat 34°44'N, long 134°16'E, approx. 50 m asl) in June 1997. The adults were reared in the laboratory at the Kansai Research Center, Forestry and Forest Products Research Institute (Kyoto, Japan) at 25 ℃ under 16 h light 8 h darkness. The method used for rearing the adults was as described by Ogura et al. (1999). Briefly, the adults were reared in a plastic Petri dish (9.5 cm in diameter, 2.3 cm in height) with a dried *M. alternatus* larval corpse for food, a block of pine wood (1.5 × 1.5 × 5.0 cm) with a hole drilled in it (0.9 cm in diameter, 4.0 cm in length) for oviposition site, and some absorbent cotton moistened with tap water provided in a small plastic container (2.0 cm in diameter and 1.2 cm in height) on a filter paper.

Adults began to oviposit immediately after introduction to the rearing container, and the eggs moved to other Petri dishes. When the eggs eclosed, live *M. alternatus* larvae, which were collected from dead P. *densiflora* at Kansai Research Center, were put in the dishes. Hatchlings of *D. helophoroides* parasitized the host and were reared under the conditions described above. Emergence of the adult *D. helophoroides* began in July 1997 and 97 were obtained by August 1997. Adults were divided into five groups of 18 to 20 individuals and each group was reared in one Petri dish. Those adult parasitoids were used for the release experiment after August 1998, when they began to oviposit.

Released adults included both sexes because I did not determine the sex of all adults. The sex of *D. helophoroides* can be determined only by observing the abdominal sternite of the second segment from the terminalia on pupae (Ogura et al., 1999). Thus pupae need to be removed from their cocoons and observed with a binocular microscope. However, this procedure causes a major mortality in the pupae and thus I could not determine the sex of all released adults. Nevertheless, the sex ratio of released adults was expected to be almost 1:1 because the proportion of males among 43 *D. helophoroides* pupae determined was 0.56, which equates to a sex ratio of nearly 1:1 (χ^2_{cal}= 0.58, $P > 0.05$) (Urano, unpublished data).

P. densiflora trees felled at the Kansai Research Center in June and July 1998 were cut into 40 logs of 20 cm length and mean diameter of 9.0 cm (range 6.2-11.0 cm). Each log was placed in a glass jar (18 cm in diameter, 24 cm in height) with a cover of wire gauze. *M. alternatus* adults that emerged from dead *P. densiflora* trees at the Kansai Research Center in June 1998 were reared in plastic containers (40 cm wide, 25 cm deep, and 30 cm high) and allowed to mate freely. Then, a single female *M. alternatus* was put into each glass jar and allowed to oviposit for one week on the log in the laboratory. The logs in glass jars were kept in the laboratory to enable larval development to proceed at room temperature (range 8 ℃ - 34 ℃). Thirty logs were used in Experiment 1 and the other 10 logs were used in Experiment 2.

D. helophoroides adults were introduced into the jars at three different times; August, September, and November 1998 (Table 1). Ten glass-jar contained logs were used at each time. I released 9 to 10 adult parasitoids on each log and they were allowed to oviposit for 10 to 16 days under the conditions described above. The released adults were recovered from the logs and kept in Petri dishes until the next release. After recovering the adults, logs were left in the jar for between 20 days and one month under the conditions described above to allow for parasitism and development of *D. helophoroides* broods to proceed. Then I debarked and dissected the logs to assess the numbers and stages of *M. alternatus* and *D. helophoroides* in each log.

Table 1. Outline of *Dastarcus helophoroides* adult release test in the laboratory

Date of release	No. of logs	No. of released adults[1]	Date adults removed	No. of dead adults[2]	Date of deissection of the logs
Aug.5, '98	10	97 (9～10)	Aug.21, '98	2	Sept.10, '98
Sept.14, '98	10	94 (9～10)	Sept.24, '98	0	Oct.12, '98
Nov.4, '98	10	93 (9～10)	Nov.18, '98	2	Dec.17, '98

[1] Figures in parentheses indicate the number of adults released per log
[2] No. of adults that died during each release period

Experiment 2: Release of *D. helophoroides* hatchlings under laboratory conditions

Ten glass-jar contained logs inhabited by *M. alternatus* were prepared as described above and kept in the laboratory until 1999, then used for the release of *D. helophoroides* hatchlings. Hatchlings used in this experiment were offspring of the adults used in Experiment 1. I released 10 hatchlings on the bark surface of each log from April to June 1999 (Table 2); the logs were kept at 25 ℃ under 16 h light 8 h darkness. Debarking and dissecting of the logs were done 20 to 50 days after release.

Table 2. Outline of *Dastarcus helophoroides* hatchling release test in the laboratory

Log No.	No. of released adults	Date of release	Date of deissection of the logs
1	10	Apr.23, '99	June 4, '99
2	10	Apr.23, '99	June 4, '99
3	10	Apr.23, '99	June 4, '99
4	10	Apr.26, '99	June 4, '99
5	10	Apr.26, '99	June 4, '99
6	10	May 17, '99	July 6, '99
7	10	June 4, '99	July 6, '99
8	10	June 14, '99	July 6, '99
9	10	June 14, '99	July 6, '99
10	10	June 14, '99	July 6, '99

Experiment 3: Release of *D. helophoroides* eggs in outdoor cages

P. densiflora trees were felled at the Kansai Research Center in July 1999 and cut into 1 m logs. A total of 16 logs were placed in a room of 25 ℃ under 16 h light 8 h darkness. Sixteen mated *M. alternatus* females that emerged from dead *P. densiflora* trees in June 1999 were released in the room for two weeks and allowed to oviposit on the logs. The logs were individually put in bags made of nylon gauze (120 x 50 cm) to avoid attack by small bark beetles. Then they were placed in separate outdoor cages (75 cm wide, 75 cm deep, 180 cm high; 1 mm mesh) in September 1999 and kept until the following year.

I collected 80 *D. helophoroides* adults from dead *P. densiflora* trees at Wake-cho in Okayama Prefecture (lat 34˚49'N, long 134˚ 08'E, approx. 100 to 200 m asl) in May 1999 and reared them in the laboratory at room temperature (range 7 ˚C-35 ˚C) using the same method as outlined for Experiment 1. Releases of eggs were conducted from late April to late May 2000 (Table 3). The wood blocks containing *D. helophoroides* egg masses were taken out from the rearing Petri dishes and put in a 10 x 10 cm nylon-mesh bag, then fixed to each log with a staple gun. The nylon bags had a mesh spacing of almost 0.5 mm, which allowed the hatchlings to go through it and move into the logs. The number of eggs released ranged from 52 to 298 (Table 3). The logs were kept in separate outdoor cages, then debarked and dissected about 40 days after the release. Two logs served as controls; they were placed in the outdoor cages about 150 m away from the cages where the releases were done. The control logs were dissected in mid June.

For *M. alternatus* in the dissected logs I recorded the number of each of the following: living larvae, pupae, adults, emergence holes, parasitized individuals, and individuals that died due to unknown factors. Percent parasitism was calculated by dividing the number of parasitized *M. alternatus* by the sum of the above categories.

Table 3. Outline of *Dastarcus helophoroides* egg release test in outdoor cages

Log No.	Diameter (cm)	Date of release	No. of eggs released	Date of deissection
1	8.2	Apr.28, '00	54	June 14, '99
2	14.7	Apr.28, '00	66	June 15, '99
3	10.2	May 12, '00	66	June 22, '99
4	7.5	May 23, '00	52	June 4, '99
5	15.5	May 23, '00	91	June 4, '99
6	14.2	May 23, '00	283	July 4, '99
7	13.5	May 23, '00	297	July 5, '99
8	14.2	May 30, '00	206	July 4, '99
9	12.7	May 30, '00	236	July 4, '99
10	12	May 30, '00	298	July 5, '99
11	11.6	May 30, '00	258	July 5, '99
12	8.9	May 30, '00	126	July 5, '99
13	11.7	May 30, '00	107	July 5, '99
14	11.1	May 30, '00	151	July 4, '99
Cont. 1	11.2	—	—	June 15, '99
Cont. 2	12.6	—	—	June 15, '99

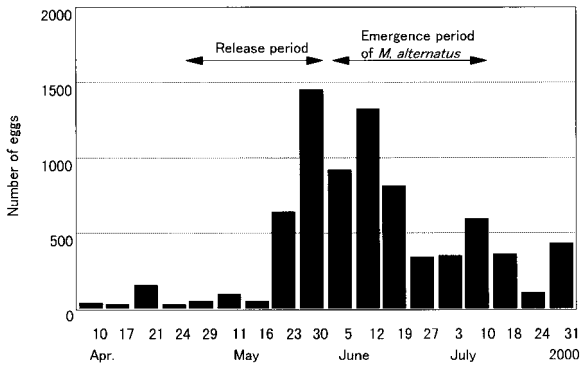

Fig. 1. Number of eggs oviposited by adults of laboratory-reared *D. helophoroides* from April to July 2000.

Although oviposition of the parasitoids began on April 10, the number of eggs was relatively low for the first month (Fig. 1). This rapidly increased in late May and peaked from the end of May to early June. That is why the number of logs used in the release experiment was low in the early part of the period (3 logs till May 12) and large in the latter part (11 logs on May 23 and 30). Figure 1 indicates the number of eggs laid until the end of July, but oviposition was observed continuously to late August.

Emerging *M. alternatus* adults in each cage were collected daily till dissection of the logs. Emergence of *M. alternatus* from the logs began immediately after the release period (Fig.1). Based on the laboratory trials, June 15 was assumed to be the day by which all parasitoids'eggs released on May 30 had hatched. This means that the host adults emerged before June 15 would be less affected by the released parasitoids than those emerged later. Thus the percentage of the host adults that had

emerged before June 15 to the total number of adults was calculated for each log and its influence on the percent parasitism was estimated.

Results

Experiment 1: Release of *D. helophoroides* adults under laboratory conditions

Out of 76 *M. alternatus* larvae found in the dissected logs, 6 in total were parasitized and so overall percent parasitism was just 7.9% (Fig. 2). Young *M. alternatus* larvae feed on the phloem and mature larvae bore into the xylem, where they form pupal chambers at the end of their tunnels, they then overwinter in the larval stage. Five larvae were parasitized under bark while only 1 was parasitized in xylem in this experiment. Because no *D. helophoroides* eggs could be found, the number of eggs oviposited by released adults was not determined.

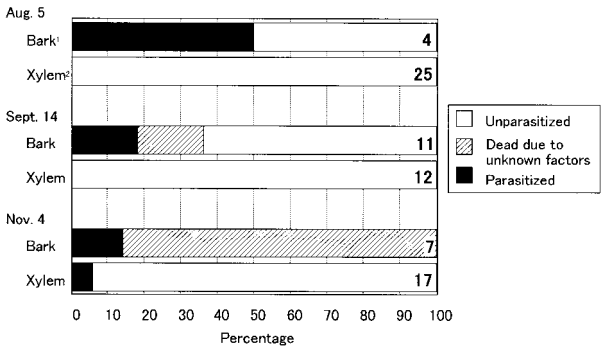

Fig. 2. Percentages of live (unparasitized) and dead *M. alternatus* larvae as a result of each *D. helophoroides* adult release. Numbers on each bar indicate the total number of *M. alternatus* larvae in each location. [1] Host larvae infesting under bark. [2] Host larvae bored into xylem.

Locations and sizes of the 6 parasitized hosts, together with the developmental stages and numbers of *D. helophoroides* on the hosts are shown in Table 4. All of the hosts were mature larvae as indicated by head capsule widths (Kojima and Katagiri, 1964). Multiple *D. helophoroides* larvae fed on each host. In one case 25 larvae were found to have parasitized a single host. However, all of them were young larvae and none matured because the host had decayed. Developmental stages of parasitoids found in the logs of November release (cocoons and pupae) were more advanced than in other tests because the period from release to log dissection was longer (Table 1).

Experiment 2: Release of *D. helophoroides* hatchlings under laboratory conditions

Because this experiment was conducted in the year following oviposition by *M. alternatus*, more than half of the larvae were found in pupal chambers constructed in the xylem, and pupae were also observed (Table 5). Two *M. alternatus* adults emerged from the logs before dissection. All larvae under the bark except for individuals that had died from unknown factors were parasitized. In the xylem, 7 out of 8 larvae and 2 out of 5 pupae were parasitized. Overall percent parasitism was 63.2 % (Fig. 3), which was much greater than that in Experiment 1.

Table 4. Location and size of each host, together with developmental stages and numbers of *Dastarcus helophoroides* on each host collected from adults released onto logs

Host No. (Release time of D.h[1])	Location	Host head width(mm)	Developmental stage of D.h.	No. of D.h. on each host
1 (Aug. 5)	Bark[2]	3.95	Full-grown larvae and cocoons	6
2 (Aug. 5)	Bark	3.95	Cocoons	2
3 (Sept. 14)	Bark	—	Young larvae	25
4 (Sept. 14)	Bark	4.10	Cocoons	5
5 (Nov. 4)	Bark	4.15	Cocoon and exarate pupae	3
6 (Nov. 4)	Xylem[3]	3.90	Cocoons and exarate pupae	5

[1] *D. helophoroides*
[2] Host larvae infesting under bark
[3] Host larvae bored into Xylem

Locations, stages and sizes of the 12 parasitized hosts, together with the developmental stages and numbers of *D. helophoroides* on the hosts are shown in Table 5. The head capsule width of host larvae was slightly larger than in Experiment 1 (Table 4), and all larvae had fully matured. Most of the parasitoids had constructed cocoons while a few had already emerged when the logs were left for a relatively long time before dissection. Between 1 and 5 parasitoids were observed on a single host. The total number of *D. helophoroides* found on the hosts was 35, which indicates 35% of released hatchlings successfully parasitized hosts.

Experiment 3: Release of *D. helophoroides* eggs in outdoor cages

Mean percent parasitism was 49.7 % but differed considerably among the logs (range 0 % - 100 %) (Fig. 4). The survival rate of *M. alternatus* in the logs released with the parasitoids was 45.9 %, while that in control logs was 96.4 % (total number of live and dead *M. alternatus* was 92 and

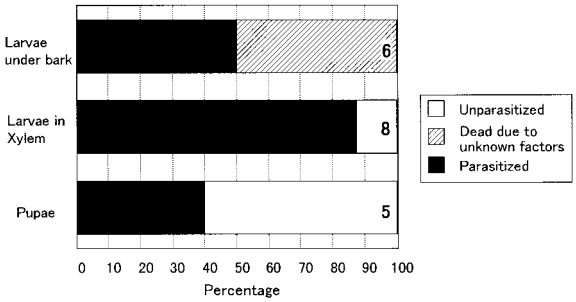

Fig. 3. Percentages of live (unparasitized) and dead *M. alternatus* larvae and pupae as a result of *D. helophoroides* hatchling release. Numbers on each bar indicate the total number of *M. alternatus* larvae in each stage and location.

Table 5. Locations, stages and sizes of each host,together with developmental stages and numbers of *Dastarcus helophoroides* on each host collected from hatchlings released onto logs

Host No.	Location	Developmental stage of host	Host head width(mm)	Developmental stage of D.h[1]	No. of D.h. on each host
1	Bark[2]	Larva	—	Cocoons	5
2	Xylem[3]	Larva	—	Cocoons	3
3	Xylem	Larva	—	Cocoon	1
4	Xylem	Larva	—	Cocoons	4
5	Xylem	Larva	4.50	Adults	4
6	Bark	Larva	4.05	Cocoons	3
7	Xylem	Larva	4.00	Cocoons	5
8	Xylem	Larva	3.90	Cocoons	4
9	Xylem	Pupa	4.00*	Cocoon	1
10	Xylem	Pupa	3.75*	Cocoons	2
11	Bark	Larva	4.25	Exarate pupae	2
12	Xylem	Larva	4.45	Cocoon	1

[1] *D. helophoroides*
[2] Host larvae infesting under bark
[3] Host larvae bored into xylem
* Head width of a larval exuvium retained by a pupa

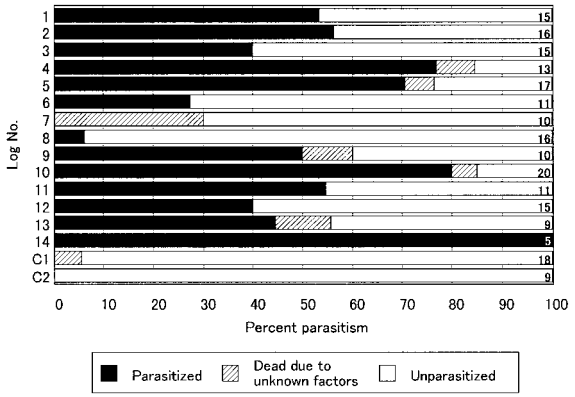

Fig. 4. Percentages of live (unparasitized) and dead *M. alternatus* as a result of the release of *D. helophoroides* eggs in outdoor cages. The number of live *M. alternatus* includes emerged adults. Numbers on each bar indicate the total number of *M. alternatus* in each log. "C1" and "C2" are control logs.

91 in the released logs, respectively, and 26 and 1 in the control logs respectively).The proportion of live *M. alternatus* in the released logs was significantly lower than that in the control logs (Fisher exact test, $P < 0.0001$).

Because *D. helophoroides* hatchlings paralyze their host and feed on it, the developmental stage of host remains that were collected from the logs indicates the stage when the host was paralyzed by hatchlings. When the parasitoid's eggs were released before 12 May, all hosts parasitized were larvae (Fig. 5). The percentage of pupae parasitized increased in the logs on which eggs were released in late May, with adult hosts appearing in the logs released onto on May 30. Substantial numbers of *M. alternatus* had already eclosed within the logs at the end of May and then been parasitized before coming out of the log.

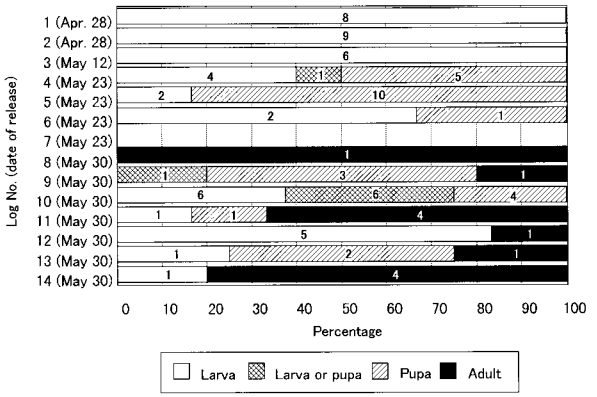

Fig. 5. Percentage of each developmental stage of *M. alternatus* parasitized by *D. helophoroides* from eggs released in outdoor cages. Numbers of hosts in each developmental stage are indicated on the bar.

The total number of *D. helophoroides* found in dissected logs was 265, averaging 18.9 per log (range 0-63) (Fig. 6). Developmental stages consisted of full-grown larvae or cocoons. I released 2301 eggs, of which 11.5 % successfully developed. The number of eggs released early in the experiment on logs No.1 to 5 were relatively low because the number of eggs produced by the adults was small. The percentage of parasitoids that developed ranged from 20 % to 30 % except for log No.4 in which it was 75 %. In the other logs, although the number of eggs released was much greater, the percentage of mature larvae was less than 20 %, except for log No. 10 (21 %).

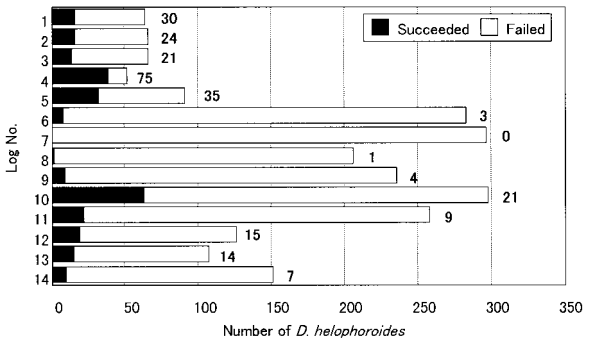

Fig. 6. Number of released *D. helophoroides* eggs that succeeded or failed in parasitism and development in outdoor cages. Numbers on the bars indicate the percentages of *D. helophoroides* that succeeded in developing. The sum of parasitoids that succeeded and failed in development is the number of eggs released on each log.

Relationship between the percentages of *M. alternatus* emerging before June 15, 2000 and the percent parasitism by *D. helophoroides* on logs No. 4 to 14 is shown in Figure 7. Logs No. 1 to 3 were excluded from the data since these logs were dissected early (Table 3) and only a few emerging host adults

were collected. I collected 61 adults from 11 logs and 22 adults had emerged before June 15. The percentage of host emergence was 0 % in logs No. 4, 5, 10, and 14, which showed a high percentage of parasitism (Fig. 7). Thus, throughout the release period there were relatively large numbers of hosts exploitable by the parasitoids in these logs. Conversely, the percentages of emergence in logs No. 7 and 8 were relatively high and the percent parasitism was low.

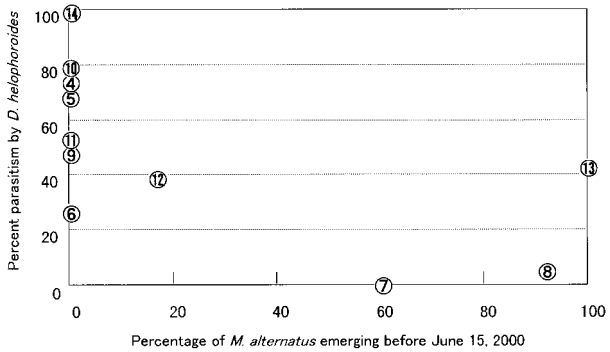

Fig. 7. Relationship between the percentages of *M. alternatus* emerging before June 15, 2000 and the percent parasitism by *D. helophoroides* on logs No. 4 to 14.

Discussion

Percent parasitism of *M. alternatus* as a result of adult release onto logs in the laboratory was 7.9%, much lower than expected. One possible reason for this was that only a few adults actually oviposited on the logs. I observed only 6 parasitized hosts on 5 logs, despite finding a total of 76 *M. alternatus* boring in 30 logs. Although adult *D. helophoroides* were released after confirmation of oviposition in Petri dishes, the sex of each adult was not determined and oviposition by each female was not confirmed. Thus, there may have been only a few fertile females among the 9 - 10 *D. helophoroides* adults released. Another possible reason was the release period of 10 to 16 days. A release of a longer period (about one month) may have increased the number of eggs deposited on each log.

Parasitism by *D. helophoroides* in Experiment 1 was mostly concentrated on the host larvae under the bark (Fig. 2) probably because it was easier for hatchlings to access host larvae under the bark than those in the xylem. A large proportion of host larvae under the bark died from unknown factors in Experiment 1 (Fig. 2), as well as in Experiment 2 (Fig. 3). The most probable mortality factor was cannibalism, which is one of the main mortality factors of *M. alternatus* larvae under bark (e.g., Togashi, 1990). However, some of them may have been parasitized by *D. helophoroides* and then died in the course of development.

Percent parasitism in Experiment 2 was 63.2 %, which was much higher than that in Experiment 1. A large proportion of *M. alternatus* larvae and pupae that were present in the xylem were parasitized as well as larvae present under the bark (Fig. 3), unlike in Experiment 1. It is clear that *D. helophoroides* hatchlings released on the bark surface crawled into the host tunnels in the xylem and searched for hosts, which were then parasitized. On the other hand, the released adults in Experiment 1 were found on the surface or under the bark of the logs and not in the tunnels in the xylem, which was the same for *D. helophoroides* adults collected from dead P. densiflora stems in the field. Thus, adult females were not likely to intrude in the logs by itself but to oviposit under the bark or in crevices of the outer bark of the logs.

Experiments 1 and 2 proved the possibility that we could make laboratory-reared *D. helophoroides* parasitize *M. alternatus*. If field release of *D. helophoroides* for controlling *M. alternatus* is to be considered, release of adults will be the most practical method because release of hatchlings is too labor intensive. However, the percent parasitism in the adult release experiment was very low (Experiment 1), probably because the reproductive potential of the released adults was low. Thus, further studies on conditions most suitable for rearing adults for field oviposition are required.

The egg release in outdoor cages confirmed the effect that *D. helophoroides* can have in suppressing *M. alternatus* populations because almost half of the *M. alternatus* in the logs were killed by the parasitoids (Fig. 4). However the percent parasitism differed greatly among the logs. Although *D. helophoroides* can exploit larvae, pupae, and teneral adults of *M. alternatus* in pupal chambers in the xylem, parasitism of emerged adults does not occur. Emergence of *M. alternatus* from the logs began on June 3, as soon as the release of parasitoids had finished (Fig. 1). Thus, it is likely that many *M. alternatus* had already eclosed in the logs when hatching of parasitoids released on May 30 began. In fact, parasitism on adult hosts was observed only in the logs released on May 30 (Fig. 5). Moreover, many *M. alternatus* had already emerged before hatching of the released eggs began on several logs and few exploitable hosts remained in the logs where releases were made in late May (Fig. 7). If eggs could have been released onto all logs by mid May, the percent parasitism may have been higher.

The number of released eggs was low until mid May and then increased (Fig. 1 and Table 3). However the percent parasitism did not increase in the logs released on in late May (Fig. 4). The low percent parasitism in these logs was mainly due to the emergence of adult *M. alternatus* as mentioned above. Parasitism in logs No. 4 and 5 was greater than 70 % despite the low number of released eggs (52 and 91, respectively). On the other hand, release of the largest number of eggs (298) in log No. 10 resulted in observed parasitism of 80

%. Consequently, approximately 50 or 60 eggs per 1 m length of stem could be effective enough when the timing of release is suitable.

A common problem with the experiments both in the laboratory and in outdoor cages was how to control the oviposition period of laboratory-reared *D. helophoroides* adults for good synchronization with host life span. In a recent study, Ogura (2002) revealed that the preoviposition period of adults reared at 28 ˚C was 147 days on average. This may enable us to prepare sufficient eggs for release through the year. There is still a need to clarify the relationship between climatic factors and the oviposition period of *D. helophoroides* in the field for the field release of adults.

Acknowledgements

I thank Dr. N. Ogura, of the Forestry and Forest Products Research Institute, for valuable advice on the rearing method of *D. helophoroides*. Thanks are also extended to K. Miura, Y. Nakashima, T. Abe, and Y. Okamoto, of the Okayama Prefectural Forest Experiment Station, for their valuable support collecting materials.

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マツノマダラカミキリ生物的防除のための実験室内および野外網室におけるサビマダラオオホソカタムシの予備的放飼試験

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要　旨

サビマダラオオホソカタムシのマツノマダラカミキリ穿入丸太に対する放飼試験を以下の３通りの方法で行った。試験１．実験室内における成虫放飼、試験２．実験室内における孵化幼虫の放飼、試験３．野外網室内における卵放飼。試験１における寄生率は全体で7.9％と低く、これは実際に供試丸太に産卵した成虫の個体数が少なかったことによるものと考えられた。試験２における寄生率は63.2％で、全放飼個体の35％が寄生に成功した。これらの結果からサビマダラオオホソカタムシを人為的にマツノマダラカミキリに寄生させることが可能であることが明らかとなった。試験３における寄生率は49.7％であった。マツノマダラカミキリの生存率は試験丸太で45.9％であったのに対し、対照区では96.4％と、明らかな放飼の効果が認められた。しかし、寄生率は丸太ごとに大きくばらついており、卵の放飼後間もなくマツノマダラカミキリ成虫が羽化脱出した丸太では寄生率の低い傾向が認められた。したがってサビマダラオオホソカタムシの高い寄生率を得るためには、卵の放飼時期を寄生可能な寄主ステージに同調させる必要があるものと考えられた。

キーワード：サビマダラオオホソカタムシ、マツノマダラカミキリ、放飼試験、生物的防除、捕食寄生者

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