「森林総合研究所研究報告」(Bulletin of FFPRI), Vol.4, No.1 (No.394), 39 - 44, Mar. 2005

論　文（Original article）

Attraction of *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae) to logs bored by conspecific silent males

UEDA Akira [1)*] and KOBAYASHI Masahide [2)]

Abstract

We conducted a field experiment to evaluate the role of stridulation emitted by male *Platypus quercivorus* in the attraction of conspecifics. Logs bored by normal male beetles or silent male beetles, whose elytra were cut off at their ends, were placed in a beetle-infested forest. The attractiveness of each log was defined as the number of wild beetles captured on an adhesive paper on the outer side of the cage containing a log divided by the number of entrance tunnels bored on the same log. The attractiveness of logs bored by the silent males was similar to that of logs bored by the normal males. This suggests that the role of the stridulation on the attraction of conspecifics to logs bored by male beetles is negligible.

Key words : attraction, platypodid beetle, *Platypus quercivorus*, stridulation, sound

Introduction

Platypus quercivorus (Murayama) (Coleoptera: Platypodidae) is a monogamous ambrosia beetle and its male initiates boring a tunnel on oak trees or oak logs to form a gallery system (Kobayashi et al., 2001). Both male and female *P. quercivorus* beetle stridulates by rubbing its abdomen with the reverse side of the left elytron (Kinuura, 1994).

Concentrative boring (also called mass attack) of *P. quercivorus* has killed a large number of oaks in Japan since 1934 (Ito & Yamada, 1998). The concentrative boring is observed on a particular oak tree soon after the initial attack of *P. quercivorus* occurred on the tree (Ueda & Kobayashi, 2001a; Kobayashi & Ueda, 2003). In some platypodid beetles, the concentrative boring is elicited by an aggregation pheromone released by males (Madrid et al., 1972; Milligan, 1982; Milligan & Ytsma, 1988; Milligan et al., 1988).

We previously observed that the numbers of *P. quercivorus* beetles attracted to logs bored by males were larger than those attracted to unbored logs (Ueda & Kobayashi, 2001b). We speculated that this could be due to the release of a pheromone, to the odor of a log wafting out from entrance tunnels of the gallery systems, or to stridulation of the males.

Male *P. quercivorus* beetles in the entrance tunnels can identify conspecific females by their stridulation (which is different from that of males) and chase off other beetles (Ohya & Kinuura, 2001). Both male and female uses the stridulation to call the mate in the courtship (Ohya & Kinuura, 2001; Kobayashi & Ueda, 2002). However, no studies have examined whether *P. quercivorus* male stridulation attracts conspecifics.

To determine whether the stridulation of male *P. quercivorus* evokes the attraction, we compared the numbers of *P. quercivorus* beetles attracted to logs bored by normal or silent males (males in which the ends of the elytra were cut off) in the present study.

Materials and Methods

Preparation of bait logs for field trapping

Bait logs were prepared by inducing attacks by male *P. quercivorus* beetles on *Quercus serrata* logs by the same method described by Ytsma (1986). On 6 June 2002, a living *Q. serrata* tree that had not been infested by *P. quercivorus* was cut down from Wachi, Kyoto Prefecture and sawn into 15 logs that were between 14.7 and 19.0 cm in diameter and 50 cm long. The logs were autoclaved (90 min at 121˚C and 1.2 atm), because Ueda & Kobayashi (2004) showed that both the life span of male *P. quercivorus* beetle and the attractive period of the log bored by *P. quercivorus* males was longer on the autoclaved logs than on the untreated logs. The cut ends of the logs were sealed with paraffin (melting point: 54 to

原稿受付：平成 16 年 9 月 9 日 Received Sep. 9, 2004　　原稿受理：平成 16 年 12 月 24 日 Accepted Dec. 24, 2004
* Hokkaido Research Center, Forestry and Forest Products Research Institute (FFPRI), 7 Hitsujigaoka, Toyohira, Sapporo, Hokkaido 062-8516, Japan; e-mail: akira@ffpri.affrc.go.jp
1) Hokkaido Research Center, Forestry and Forest Products Research Institute (FFPRI)
2) Kyoto Prefectural Forestry Experimental Station

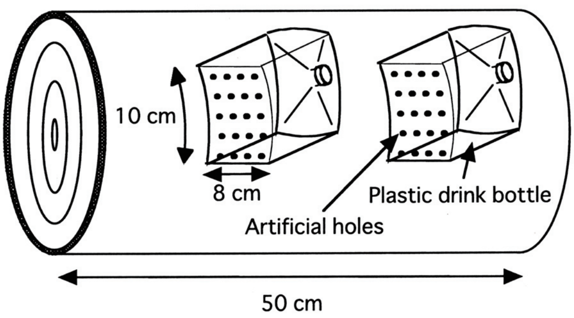

Fig. 1. Method for inducing attack of an oak log by male *P. quercivorus*. Plastic drink bottles covered two arrays of artificial holes. Males were released into the bottles through the mouths of the bottles. The bottles were removed at the beginning of field trapping.

56 ˚C) to reduce drying of the logs.

On 10 June, 20 (5 x 4) artificial holes (2 mm in diameter x 10 mm in depth) were burrowed with an eyeleteer in each of two rectangular areas of 10 x 8 cm on the surface of each log (Fig. 1) to facilitate the borings by the beetle. Each array of holes of 10 logs was covered with a cap made of a top portion of a rectangular plastic drink bottle to prevent the beetles from escaping. The caps were glued to the log with silicone adhesive ('Silicone-Sealant 8000' , Cemedine Co. Ltd., Tokyo). About 100 holes of 0.5 mm in diameter were punched on each cap for ventilation. Five logs for control were not covered with caps, because no beetles were released on these logs. All the logs were stored in the laboratory without temperature control for 16 days until male *P. quercivorus* emerged from *Q. crispula* logs that had been killed by *P. quercivorus* attack in the previous year in Ayabe, Kyoto Prefecture and had been stored in a shed in a nursery.

Approximately 1,000 males were collected between 22 and 26 June just after they emerged from the *Q. crispula* logs. The collected beetles were stored in plastic cups with wet tissue papers in a room maintained at 12 ˚C. On 26 June, three hundreds males were made silent by cutting off of the ends of the elytra with forceps, while the males were picked at all directions by the thumb and the forefinger of another hand. Although only the left elytron is used for stridulation (Kinuura, 1994), cutting of both elytra took less time because of no need for identifying left and right elytron of the beetles that were weakened as times went by in the fingers, and was therefore considered less stressful to the beetles. Male *P. quercivorus* were released into the caps through the bottle mouths, and the lids were replaced. Thirty silent males were released into each bottle on 5 logs (a total of 60 males per log), and 20 normal males were released into each bottle on the other 5 logs (a total of 40 males per log). The number of silent males was greater because they were expected to suffer a higher mortality due to the cutoff of the elytra. The logs were kept overnight in the laboratory without temperature control.

Field trapping

On 27 June, the logs were taken to a forest at Izumicho, Ayabe, Kyoto Prefecture (30˚27' N, 135˚25' E, 270 m a.s.l.), where *P. quercivorus* damage to oak trees began in 1998 (Kobayashi et al., 2000), and each log was placed in a cage. The cages, designed by Ueda & Kobayashi (2001b), were made by placing 4-legged steel stool (40 cm diameter x 58 cm high) upside down in a nylon net bag (mesh size 0.5 mm). Fifteen cages were placed on 50-cm-high wooden chairs arranged at 2-m intervals along a contour line. An 8-cm-wide adhesive paper ('Kamikirihoihoi' , Earth Biochemical Co. Ltd., Tokyo) was wrapped around each cage at 30 cm high from the bottom of the cage with the sticky side facing outwards. The bait logs were placed vertically in the cages after removing both the caps and the beetles that still did not bore in, and the net bags were tied at the top. The logs were arranged in the order of a log with silent males, a log with normal males, and a log without beetles. Wild *P. quercivorus* captured on the adhesive paper were removed and counted every day. The cages were rotated every day (i.e., the cage at position 1 and the log inside it were moved to position 2, etc.) to minimize the effects of cage position on the number of captured beetles. Field trapping was conducted from 27 June to 4 July 2002.

Counting of entrance tunnels

After collecting the captured beetles on the last day of the field trapping, while the logs were still in the field, we counted the number of entrance tunnels bored by the released males. The males made two types of entrance tunnels. Most entrance tunnels extended from the artificial holes and others were new ones started at the surface of the bark. The sum of these two types of entrance tunnels was defined as the number of entrance tunnels bored by the released males. To determine whether an artificial hole was extended, we removed a chip of wood with a cleaver from the top of the hole successively until we reached the bottom of the hole, at which the cross-section disappeared. The extended artificial holes could be distinguished from the unused artificial holes by their perfect circular cross-sections and greater depths more than 10 mm, because the unused artificial holes had the irregularly circular cross-sections and disappeared at 10 mm in depth.

Analytical method

The Mann-Whitney *U*-test was used to determine

Table 1. Mean diameter of logs used in the field trapping, mean numbers of entrance tunnels bored by released males, mean numbers of wild *P. quercivorus* captured, and mean male ratio of wild *P. quercivorus* captured.

Log	n	Diameter of log (cm)	No. of males released	No. of entrance tunnels bored	No. of wild *P.quercivorus* captured	Male ratio of wild *P. quercivorus* captured
With silent males	5	16.1 (0.6)	60	15.0 (3.0)	11.2 (1.8)	0.69 (0.09)
With normal males	5	16.3 (0.8)	40	24.0 (2.0)	21.0 (2.6)	0.71 (0.06)
Without beetles	5	16.9 (0.7)	0	0	8.0 (2.1)	0.67 (0.07)*

Numbers in parentheses indicate standard errors.
* n = 4, because data of one of the logs was excluded where only two *P. quercivorus* were captured.

whether a number of the entry tunnels bored differed between the logs with silent males and the logs with normal males. The Kruskal-Wallis test was applied to test the significance of differences on the total numbers and the male ratio of wild *P. quercivorus* captured on the adhesive paper between the treatments of logs. Because we previously found a strong correlation between the numbers of *P. quercivorus* attracted to logs and the numbers of entrance tunnels (Ueda & Kobayashi, 2001b, 2003), the attractiveness of a log was defined as the total number of wild *P. quercivorus* captured divided by the number of entrance tunnels in the log at the end of the trapping. This number was expressed as the number of wild *P. quercivorus* captured per tunnel, and the Mann-Whitney *U*-test was applied to test the significance of differences between the logs with silent males and the logs with normal males. StatView (ver. 5.0) software (SAS Institute, 1998) was used for these analyses.

Results

Each log with silent males or normal males had at least 2 entrance tunnels with a living male on the final day of the field trapping. The mean number of entrance tunnels bored by the released males was smaller on the logs with silent males than on those with normal males (Table 1), but the difference was not significant (Mann-Whitney *U*-test, $U = 4$, $P = 0.072$).

There were significant differences on the number of wild *P. quercivorus* beetles captured between the treatments of logs (Kruskal-Wallis test, $H = 9.2$, $P = 0.01$), and the mean number was the smallest on the logs without beetles (Table 1). The male ratios of wild *P. quercivorus* beetles captured were not different between the treatments of logs (Table 1, Kruskal-Wallis test, $H = 0.3$, $P = 0.85$). The numbers of wild *P. quercivorus* beetles captured positively correlated with those of entrance tunnels (Fig. 2).

The numbers of wild *P. quercivorus* captured per entrance tunnel were 0.86 ± 0.23 (mean ± SE) for the logs with silent males and 0.88 ± 0.09 for the logs with normal males (Fig. 3). These numbers were not significantly different (Mann-Whitney *U*-test, $U = 8$, $P = 0.35$).

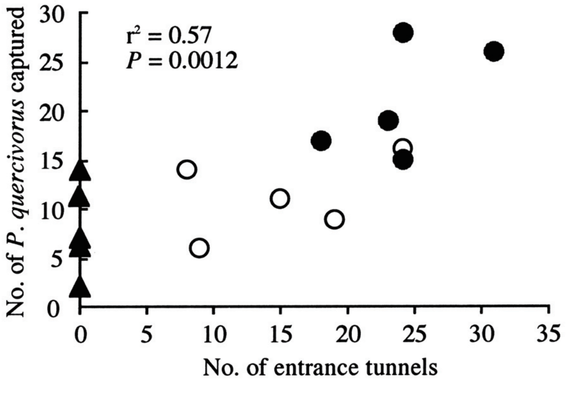

Fig. 2. Relationship between the numbers of entrance tunnels and the numbers of wild *P. quercivorus* beetles captured. ○ : log with silent males, ● : log with normal males, ▲ : log without beetles.

Discussion

The numbers of *P. quercivorus* beetles captured

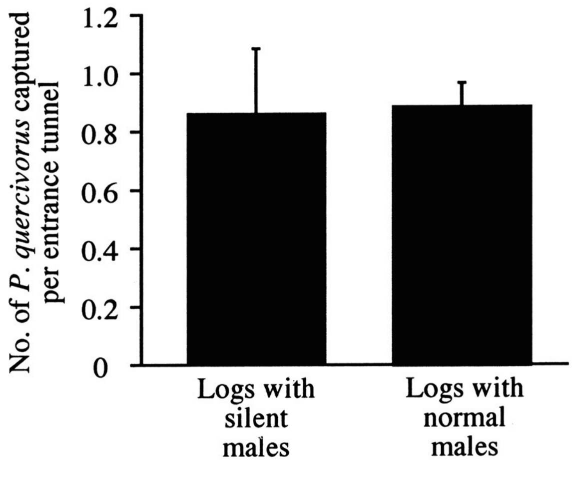

Fig. 3. Mean numbers of wild *P. quercivorus* beetles captured per entrance tunnel on logs with silent males or normal males. Bars indicate standard errors.

were significantly different between the treatments of logs, and the mean number of *P. quercivorus* beetles captured was the smallest on the logs without boring of the males, supporting our observation that *P. quercivorus* beetles were attracted to logs bored by *P. quercivorus* males (Ueda & Kobayashi, 2001b, 2003). The numbers of *P. quercivorus* beetles captured positively correlated with those of entrance tunnels, confirming the positive correlation between the number of *P. quercivorus* beetles attracted to logs and the number of entrance tunnels (Ueda & Kobayashi, 2001b, 2003).

Much less number of *P. quercivorus* beetles was captured on the logs bored by silent males than on the logs bored by normal males. This was caused by the smaller number of entrance tunnels on the logs with silent males than those with normal males. We released more silent males than the normal males, because we assume that the silent males would have been weakened by cutting the ends of their elytra. However, the boring performance of the silent males was poor beyond our expectations.

In the present study we compared the numbers of *P. quercivorus* beetles attracted to logs bored by normal or silent males in order to examine whether *P. quercivorus* males use stridulation to attract conspecifics. If stridulation attracts conspecifics, the numbers of *P. quercivorus* beetles captured per entrance tunnel on the logs with normal males would be expected to be larger than those on logs with silent males. However, the mean number of *P. quercivorus* beetles captured per entrance tunnel on the logs with silent males was similar to that on the logs with normal males. This result indicates that the silent males were just as able as the normal males to attract conspecifics. Thus, it is suggested that the role of stridulation on the attractiveness is negligible. Further studies are now needed to evaluate other hypotheses for the attraction of conspecifics (Ueda & Kobayashi, 2001b), i.e., whether the attraction of conspecifics is due to an aggregation pheromone or host odors.

Acknowledgments

We thank Ms. Ai Nozaki and Mr. Minoru Hagita, Kyoto Prefectural Forestry Experimental Station, for their help in the laboratory and field work, and Dr. Kenichi Ozaki of Hokkaido Research Center, Forestry and Forest Products Research Institute for his review of the manuscript.

References

Ito, S. and Yamada, T. (1998) Distribution and spread of the mass mortality of oak trees, J. Jpn. For. Soc., **80**, 229-232 (in Japanese, with English abstract).

Kinuura, H. (1994) Mass mortality of oak trees, and ecology of *Platypus quercivorus*. Ringyou-to-yakuzai, **130**, 11-20 (in Japanese)*.

Kobayashi, M. and Ueda, A. (2002) Preliminary study of mate choice in *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae), Appl. Entomol. Zool, **37**, 451-457.

Kobayashi, M. and Ueda, A. (2003) Observation of mass attack and artificial reproduction in *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae), Jpn. J. Appl. Entomol. Zool, **47**, 53-60 (in Japanese, with English abstract).

Kobayashi, M., Ueda, A. and Nozaki, A. (2000) The influence of fallen trees on mass mortality of oak trees in Japan, Appl. For. Sci., **9**(2), 87-92 (in Japanese, with English abstract).

Kobayashi, M., Ueda, A. and Takahata, Y. (2001) Inducing infection of oak logs by a pathogenic fungus carried by *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae), J. For. Res., **6**, 153-156.

Madrid, F., Vité, J. P. and Renwick, J. A. A. (1972) Evidence of aggregation pheromones in the ambrosia beetle *Platypus flavicornis* (F.), Zeit. ang. Entomol., **72**, 73-79.

Milligan, R. H. (1982) Evidence for an aggregation pheromone in *Platypus apicalis* (Coleoptera: Platypodidae), In Galbreath, R. A. (ed.) "*Insect Pheromones and Their Application*" , *Entomology Division Report* 2, *New Zealand Department of Scientific and Industrial Research*, *Auckland*, 37-50.

Milligan, R. H. and Ytsma, G. (1988) Pheromone dissemination by male *Platypus apicalis* White and *P. gracilis* Broun (Col., Platypodidae), J. Appl. Entomol., **106**, 113-118.

Milligan, R. H., Osborne, G. O. and Ytsma, G. (1988) Evidence for an aggregation pheromone in *Platypus gracilis* Broun (Coleoptera: Platypodidae), J. Appl. Entomol., **106**, 20-24.

Ohya, E. and Kinuura, H. (2001) Close range sound communications of the oak platypodid beetle *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae), Appl. Entomol. Zool., **36**, 317-321.

SAS Institute (1998) StatView for PowerPC Version 5.0., SAS Institute, Cary, North Carolina.

Ueda, A. and Kobayashi, M. (2001a) Seasonal change of number of *Platypus quercivorus* (Murayama) and

P. calamus Blandford (Coleoptera: Platypodidae) landing on living trees, J. Jpn. For. Soc., **83**, 77-83 (in Japanese, with English abstract).

Ueda, A. and Kobayashi, M. (2001b) Aggregation of *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae) at oak logs bored by males of the species, J. For. Res., **6**, 173-179.

Ueda, A. and Kobayashi, M. (2003) Landing of *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae) on oak logs bored by male beetles with different densities, Appl. For. Sci., **12**, 137-142 (in Japanese, with English abstract).

Ueda, A. and Kobayashi, M (2004) Long-term attractiveness of autoclaved oak logs bored by male *Platypus quercivorus* (Murayama) (Coleoptera: Platypodidae) to male and female beetles, Bull. FFPRI, **3**, 99-107.

Ytsma, G. (1986) Inducing attack by male *Platypus* (Col., Platypodidae) on wood billets in the laboratory, J. Appl. Entomol., **102**, 210-212.

* This title is a tentative translation of the original Japanese title by the present authors.

無音の雄が穿入した丸太へのカシノナガキクイムシの誘引

上田 明良 1)*・小林 正秀 2)

要 旨

カシノナガキクイムシ雄成虫の発する摩擦音が，同種の誘引に果たす役割を評価するため、鞘翅先端を切除して摩擦音を出せなくした雄（無音雄）と普通の雄（有音雄）との誘引力を野外で比較した。被害地において、無音雄と有音雄がそれぞれ穿入した丸太を各網室に分け入れ、その外側に取り付けた粘着紙に捕獲された野外成虫数を、各丸太あたりの穿入孔数で除した値を誘引力として比較した。無音雄が穿入した丸太の誘引力は、有音雄が穿入した丸太の誘引力と同じであった。この結果から、カシノナガキクイムシ雄成虫の発する摩擦音が雄穿入丸太への誘引に果たす役割は、無視できるものと考えられる。

キーワード：誘引、ナガキクイムシ、カシノナガキクイムシ、摩擦音、音

* 森林総合研究所北海道支所　〒 062-8516　北海道札幌市豊平区羊ヶ丘 7　e-mail: akira@ffpri.affrc.go.jp
1) 森林総合研究所北海道支所
2) 京都府林業試験場