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Seasonal Changes in the Number and Ovarian Conditions of the Cryptomeria Twig Borer, *Anaglyptus subfasciatus* PIC (Coleoptera: Cerambycidae), Collected with an Odor Attractant¹

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The cryptomeria twig borer, *Anaglyptus subfasciatus* PIC, is a pest of Japanese cedar (*Cryptomeria japonica* D. DON) and cypress (*Chamaecyparis obtusa* ENDL.) and is widely distributed in Japan (KOBAYASHI, 1985). Although it does not kill trees, staining of wood caused by larval activities seriously reduces its commercial value (MAKIHARA, 1987).

Adults of *A. subfasciatus* frequently visit white or whitish flowers of shrubby plants (SAITO et al., 1987) and feed on nectar and/or pollen. Many volatile components of various flowers were examined for attractiveness to the beetle (IKEDA et al., 1993). Although benzyl acetate, a component of jasmine oil, was found to have a remarkable degree of attractiveness, it attracts many anthophilous

insects of various taxonomic groups, as well as the target species (NAKASHIMA et al., 1991). Methyl phenylacetate (MPA), which has a chemical structure similar to benzyl acetate, is more specifically attractive to *A. subfasciatus* and its related species, *Demonax transilis* BATES (NAKASHIMA et al., 1991; IKEDA et al., 1993). The MPA, then, has begun to be used for control of *A. subfasciatus* in Japanese cedar stands (NAKASHIMA et al., 1991).

To be an effective control measure, an attractant should collect as many adults as possible before they begin to reproduce. In other words, if it attracts females after they have laid most of the eggs they could lay during their lifetime, the attractant is not effective. Therefore, we need information not only about seasonal changes in the number of attracted adults, but also about the reproductive status of the individuals attracted. However, such information is still lacking with regard to *A. subfasciatus* and the MPA. We report here on the seasonal changes in the number and sex ratio of *A. subfasciatus* adults collected with the MPA trap and on the ovarian contents of the females, and discuss the effectiveness of the MPA as a control measure against the beetle.

MATERIALS AND METHODS

The attractant MPA in liquid form was absorbed into solid vegetable fat (12-hydroxystearic acid) in a weight ratio of 80% of MPA to 20% of the fat. This made the handling of the chemical easier than in liquid form. We used yellow plastic traps (Sankei Chemicals Co. Ltd.; 42 cm ht. 25 cm dia.) (Fig. 1). Each trap had attached to it a shallow plastic cup containing 50 g of the solidified MPA. Attracted insects were trapped and killed in a pail at the bottom of the trap. The pail contained water with about 0.1% sorbic acid added to prevent

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Fig. 1. A trap used in the study. Solidified attractant (MPA) was contained in a shallow cup (arrow) attached to the trap.

decay of the killed insects.

The study was made at three stations in 1990 and 1991. In 1990, 164 MPA traps were set in three stands (1 ha each) of about 50-year-old cedars at Shizukuishi, Iwate Pref., between May 9 and 11. The stands were about 300 m above sea level, and had understory composed of *Kalopanax pictus* (THUNB.), *Aralia elata* (MIQ.), or *Magnolia obovata* THUNB. At the edges of the stands were shrubs, such as *Stephanandra incisa* (THUNB.) or *Zanthoxylum piperitum* DC., whose flowers are reported to attract *A. subfasciatus* adults (MAKIHARA, 1987). Each trap was hung from a nylon cord which was stretched between two trees at heights of 4.0 to 4.5 m. We collected trapped adults of *A. subfasciatus* 10 times during the following two months, at intervals of about seven days, and counted their numbers. The attractant in all traps was renewed on June 7 and 8. In 1991, 180 traps were set in three other stands (about 300 m above sea level) of Japanese cedar (1 ha each, about 50 years old) at Shizukuishi, and 10 traps in a cedar stand (about 0.4 ha, and about 160 m above sea level), over 80 years old, at Takizawa, Iwate Pref. Understory and vegetation around the stands were similar to those in the stands studied in 1990. The traps were set on May 8 and 9 at Shizukuishi, and May

Fig. 2. Seasonal changes in the number of *A. subfasciatus* adults (solid line: female; broken line: male) collected with MPA traps in the three monitoring stations.

4 at Takizawa in the same way as in 1990. Attracted insects were collected from May 24 to July 4, at intervals of about 14 days in Shizukuishi, and from May 11 to June 27, at intervals of about 7 days in Takizawa. The attractant was not renewed during the study periods in 1991. Adults collected in 1991 were preserved in 70% alcohol, and females were later dissected and examined for ovarian contents under a dissecting microscope. The number of oocytes 1 mm or longer was counted for each female collected. Such oocytes were mature or nearly so, because deposited eggs are 1.5 to 1.7 mm long (MAKIHARA, 1987). At the same time, the length of the right elytron (including the longitudinal projection at the end) was measured as an index of the body size.

RESULTS AND DISCUSSION

The total number of adults collected during the season was 860 in Shizukuishi in 1990 and 180 in 1991, and 104 in Takizawa in 1991, with the mean number of adults collected per trap being 5.2, 1.0, and 10.4, respectively. Why the mean catch differed so widely among the stations of similar conditions was unclear.

The traps attracted *A. subfasciatus* for a period of about two months after they were set, and the total

Table 1. Numbers of oocytes (1 mm or longer) of *A. subfasciatus* females collected with the MPA traps at the two monitoring stations during different periods in 1991

Station	Collection date ¹	Sample size	Number of oocytes ² (Mean±SEM)
Shizukuishi	May 24	29	10.9±0.8 ^a
	June 6	31	9.2±0.8 ^{a,b}
	June 21	40	5.7±0.7 ^{b,c}
	July 5	10	1.9±0.5 ^c
Takizawa	May 11 (1), May 16 (7)	8	10.9±1.6 ^a
	May 23 (18), May 28 (2)	20	8.6±0.9 ^{a,b}
	June 4 (11), June 12 (14)	25	5.4±0.7 ^b
	June 18 (4), June 27 (2)	6	2.8±1.2 ^b

The eight samples of Takizawa were grouped into four. These new samples each contained females attracted during about two weeks, as in the Shizukuishi samples.

¹ For Takizawa, sample size of each collection date is given in parentheses.

² Within each station, the number of oocytes significantly differs ($p<0.01$) between two groups unless followed by any common letter [tested by a nonparametric multiple comparison method by DUNN (1964)].

catch of both sexes peaked in mid to late June (Fig. 2). The length of attraction was similar to that of the period when adults were collected on various flowers (MAKIHARA, 1987).

The catch temporarily dropped in Shizukuishi in early June 1990 and in Takizawa, in late May 1991. In Shizukuishi, the drop occurred at the collection just before renewal of the attractant, and the catch increased again at the next collection (Fig. 2). However, the likelihood that the attractant had become less effective in some four weeks was small, because in Takizawa, where the attractant was not renewed, the catch recovered at the next collection. Thus, the reason for the drop was unknown.

More females were attracted than males, except in a few collections in Takizawa, 1991 (Fig. 2). The sex ratio (male:female) of individuals collected during the monitoring periods was female-biased in all stations: 0.26:1 in Shizukuishi 1990 ($n=860$ adults), 0.25:1 in Shizukuishi 1991 ($n=180$), and 0.76:1 in Takizawa 1991 ($n=104$). The values were significantly different from 1:1 ($p<0.0001$; χ^2 test), except in Takizawa ($p>0.05$).

The number of oocytes 1 mm or longer was greatest in the earliest collection, and decreased gradually both in Shizukuishi and Takizawa (Table 1). It differed significantly among females

of the four samples at Shizukuishi in 1991 ($p<0.001$; KRUSKAL-WALLIS test). The same was true of the four samples made up of eight collections at Takizawa ($p<0.001$; Table 1). The males collected in early July in Shizukuishi and those collected in mid to late June in Takizawa had only a few mature eggs. It has been reported that the number of oocytes correlates positively with the adult size in this species (ENDA et al., 1984; IGARASHI and IGARASHI, 1988). However, body size can not account for such temporal differences in ovarian contents of our females, because their elytral lengths were not significantly different among the four samples at both stations ($p>0.05$; ANOVA; $F=1.061$ for Shizukuishi, 0.941 for Takizawa).

The most probable reason for the consistent decrease in the number of oocytes during the monitoring periods is the senescence of the adults. In laboratory conditions, newly emerged females fed with honey lay their eggs most actively at the age of 15 to 30 days after emergence, and daily oviposition rates decline thereafter (IGARASHI and IGARASHI, 1988). If this oviposition schedule is also the case in the field, the oviposition rate may be expected to peak around mid June or earlier, because the adults emerge in early to mid May in Iwate Pref. (IGARASHI, 1984). Our results are

compatible with this expectation: the number of oocytes began to decrease in mid June (Table 1). Older females may be more prone to be attracted to flowers or MPA than younger ones.

This study shows that the MPA traps collected more females than males throughout the season and that many of the females had eggs. However, the catch of the females was relatively small in May when they had more eggs or had higher reproductive values than they would later in the season. Then, the chemical seems to attract mainly females that have already laid various quantities of eggs. IGARASHI and IGARASHI (1988) also found that female adults collected on flowers had lower longevities and laid fewer eggs than newly emerged females under the same rearing conditions. Thus, the female may visit flowers (or get attracted by their odors) after having laid a certain number of eggs. To control the beetle more effectively with attractant, we need another chemical that attracts virgin or young females that have laid no or few eggs.

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Pteridine Accumulation for Age Determination in the Melon Fly, *Bactrocera (Zeugodacus) cucurbitae* (COQUILLET) (Diptera: Tephritidae)^{1,2}

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The melon fly *Bactrocera cucurbitae* is a serious pest of various beneficial fruits, vegetables and trees South-East Asia and Hawaii. Since 1972, an eradication program of the melon fly with the sterile insect technique has been successfully conducted in subtropical region (the Nansei Islands) of Japan (NAKAMORI, 1991; SHIGA, 1991 a, b). Knowledge of age distribution of released flies as well as the wild fly population in the field is necessary for evaluating the effect of sterile insect release, quality of mass-produced flies, etc.

However, age determination of adult insects is difficult. MAIL et al. (1983) proposed a method for determining the age of *Stomoxys calcitrans* that depends on the accumulation of fluorescent materials in the head capsule with time. This method proved to be much more precise and simple than other methods such as changes in the reproductive

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