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# A preliminary study on distributions and oviposition sites of *Drosophila suzukii* (Diptera: Drosophilidae) and its parasitoids on wild cherry tree in Tokyo, central Japan

**Akira Matsuura • Hideyuki Mitsui • Masahito T. Kimura**

A. Matsuura

Graduate School of Environmental Science, Hokkaido University, Sapporo, Hokkaido 060-0810, Japan

H. Mitsui

Minami-Tama High School, Hachioji, Tokyo 192-8562, Japan

M. T. Kimura

Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido 060-0810, Japan

Corresponding author: Masahito T. Kimura, e-mail: mtk@ees.hokudai.ac.jp,

Tel and Fax: +81-11-684-6051

**Abstract**

Distributions and oviposition sites of *Drosophila suzukii* (Matsumura) and its parasitoids on wild cherry tree were studied in early summer in the suburbs of Tokyo, central Japan. Adults of *D. suzukii* occurred in the foliage layer as well as in the undergrowth layer. The number of *D. suzukii* that emerged did not significantly differ between wild cherry fruit collected from the foliage layer and those from the undergrowth layer. In addition, the number of *D. suzukii* that emerged per fruit decreased when fruit were left on the ground longer. It is therefore assumed that *D. suzukii* females rarely oviposit eggs in fallen wild cherry fruit. The *suzukii*-associated type of *Ganaspis brasiliensis* (Ihering) was the major parasitoid that emerged from *D. suzukii* in the study area. The rate of parasitism by this parasitoid did not significantly differ between larvae in fresh fruit from the foliage layer and those in fallen fruit from the undergrowth layer. This may also suggest that this wasp rarely attacks *D. suzukii* larvae in fallen fruit. Adults of the *suzukii*-associated type of *G. brasiliensis*, *Asobara* sp. TK1 and *Leptopilina japonica* that attack *D. suzukii* were mainly collected from the foliage layer. From the present results, some proposals for the control of *D. suzukii* were discussed.

**Keywords** *Drosophila suzukii* • Fallen fruit • Foliage layer • Fresh fruit • Parasitoids • Undergrowth layer

## Introduction

*Drosophila suzukii* (Matsumura) is a pest of fresh fruit and causes serious economic loss in temperate regions of Asia, Europe and America (Asplen et al. 2015; Kanzawa 1939). The current major control methods are insecticide application and net covering (Asplen et al. 2015; Beers et al. 2011; Bruck et al. 2011; Kawase et al. 2008; Yamakawa and Watanabe 1991), which incur some environmental loads and/or economic costs. As a method dealing with these shortcomings, biological control and integrated pest management have received much attention. In East Asia where *D. suzukii* has probably originated, the *suzukii*-associated type of *Ganaspis brasiliensis* (Ihering) (assigned as *G. xanthopoda* (Ashmead) in our previous papers) and *Asobara* sp. TK1 are potential candidates as biological control agents, because they are specialized *D. suzukii* parasitoids and their release would lower impact on local biological communities than the release of generalist parasitoids or predators (Daane et al. 2016; Kasuya et al. 2013; Mitsui et al. 2007; Nomano et al. 2015). These two parasitoid species are also potential candidates of classical biological control agents in Europe and North America where no effective predator or parasitoid against *D. suzukii* has been found (Asplen et al. 2015; Chabert et al. 2012; Gabarra et al. 2012; Kacsoh and Schlenke 2012; Rossi Stacconi et al. 2013).

To conduct integrated pest management, in addition, information on spatial distributions or habitats of pests and enemies is very important. It has been reported that *D. suzukii* oviposits in fresh fruit on trees and the *suzukii*-associated type of *G. brasiliensis* attacks *D. suzukii* larvae occurring in fruit on trees (Asplen et al. 2015; Kasuya et al. 2013; Mitsui et al. 2006). However, it is unknown whether *D. suzukii* and

its parasitoids also inhabit the undergrowth layer and oviposit in fallen fruit or attack host larvae in fallen fruit. This is partly because spatial distributions of *D. suzukii* adults and the parasitoids were investigated by collections using traps baited with banana or by monitoring their emergence from fruit collected from field (Asplen et al. 2015; Daane et al. 2016; Kasuya et al. 2013). Here we studied distributions and oviposition sites of *D. suzukii* and its parasitoid on wild cherry trees by net sweeping over the foliage and undergrowth layers of wild cherry trees, monitoring their emergence from fresh and fallen wild cherry fruit, and using oviposition trap baited with cherry fruit in Tokyo, central Japan.

## Methods

### Study sites

The study was conducted in Naganuma Park (about 0.4 $km^2$) located at the northern slope of a hillock in a suburb of Tokyo (35.7 ºN, 139.7 ºE). This park is mostly covered with a forest mainly composed of deciduous trees, but a narrow area at the boundary of residential area has been changed to lawn. Two species of wild cherry are found in this park, *Cerasus jamasakura* (Siebold ex Koidzumi) and *C. speciosa* (Koidzumi). The former mainly occurs in the forest area, while the latter mainly occurs in the lawn area. Fruit of these two cherry species are major natural resources of *D. suzukii* from late spring to early summer in central Japan (Mitsui et al. 2006, 2010). In the lawn area, *C. speciosa* trees extend branches downward to the height of 1 m above the ground, and therefore net sweeping in the foliage layer can be easily performed. Such cherry trees

suitable for sweeping survey are not frequently found except avenues or parks that are managed for viewing.

Wild cherry trees bear fruit in mid-April, and fruit changes color from green to yellow, red and dark red with ripening. Green and yellow fruit is unripened and hard, and dark-red ripened fruit sporadically falls on the ground. Females of *D. suzukii* rarely oviposit in green and yellow fruit (Mitsui et al. 2006).

Collection of adult individuals by net sweeping

To investigate distributions of adults of *D. suzukii* and its parasitoids on wild cherry trees, collections were carried out using insect net (360 mm in diameter). In the lawn area, net sweeping was performed over leaves and fruit in the foliage layer (1–3 m in height) and the undergrowth layer of *C. speciosa* trees for 2 h in the morning (from 5:15 to 7:15) and 2 h in the afternoon (from 13:40–15:40) on June 4 in 2015 and for 4 h from 10:00 to 14:00 on June 2 in 2016. The collection was not quantitative; net sweeping was carried out more than 3 hours in the foliage layer and less than 1 hour in the undergrowth layer in both year. In the forest area, net sweeping was carried out only in the undergrowth layer approximately for 1 hour in evening on June 2 in 2016. In the forest area, the foliage layer was out of the reach of insect net (i.e. > 3 m in height).

Emergence of drosophilids and parasitoids from field-collected wild cherry fruit

To investigate the oviposition site selection of *D. suzukii* and its parasitoids, their emergence from fruit occurring in foliage and undergrowth layers was examined. In the

lawn area, fruit was collected from *C. speciosa* trees on June 4, 2015 and June 2, 2016 (10 trees in 2015 and 3 trees in 2016): from each tree, 100 fruit were collected from the foliage layer (1–3 m above the ground), and 100 fallen fruit were collected from the ground. In the forest area, 3 and 4 samples, each with 100 fallen fruit, were collected under *C. jamasakura* trees in 2015 and 2016, respectively. Collected fruit were placed in plastic boxes with paper towel (100 fruit per box), and kept at room temperature (22–25 ºC) in the laboratory. Insects that emerged were identified to species.

In addition, whether *D. suzukii* and some other drosophilid species oviposit in fallen wild cherry fruit was investigated in the forest area. All wild cherry fruit were removed from the undergrowth areas of wild cherry trees on May 27 and June 8 in 2000, and newly fallen fruit in the undergrowth areas were marked with woody toothpicks on May 28 and June 9. Thereafter, 30 fruit were collected daily or once two days for 7 or 8 days. Emergence of drosophilids from these fruit was examined as described above. In this study, emergence of parasitoids was not examined.

Collection by oviposition trap

To examine occurrence and oviposition of *D. suzukii* at different heights, collections were conducted using wire-mesh traps baited with *C. speciosa* fruit (flesh + seed = 0.68 g on average) and ‘bing’ cherry fruit (*Cerasus avium* (L.): 8.15 g on average) in 2015. Dark red ripened *C. speciosa* fruit was collected from trees in the lawn area and checked for oviposition by *D. suzukii*; if *D. suzukii* females oviposited, one or more small hole(s) with egg filaments were present on fruit skin. Fruit without *D. suzukii* egg were used as bait. ‘Bing’ cherry fruit were bought from a shop. Six traps, each containing 20 *C.*

*speciosa* fruit and 2 ‘bing’ cherry fruit, were prepared; fruit in 4 traps were intact, whereas those in 2 traps were injured by knife. The reason why injured fruit were used in addition intact fruit is to examine oviposition of non-*D. suzukii* drosophilids which prefer fermenting or decayed fruit (see Results); injury would enhance fermentation of decay.

Four trees were chosen to set traps, 2 in the lawn area and 2 in the forest area. Traps were set at 3 heights, low (i.e. 50–100 mm above the ground), mid (2 m) and high (5.6–14.0 m). Traps with intact fruit were set on all trees, and traps with injured fruit were set on a tree in each of the lawn and forest areas. Traps were set on May 31 or June 1, 2015. After a week, fruit in the traps were collected, placed in vials with tissue paper and kept at room temperature in the laboratory. When insects emerged, they were collected and identified to species.

Species identification

Drosophilids and parasitoids were usually identified to species by morphology. However, *G. brasiliensis* in this area consists of 3 types, the *suzukii*-associated, *lutescens*-associated and widely-distributed types, which are hardly discriminated by morphology (Kasuya et al. 2013; Nomano et al. 2017). These types were discriminated by the nucleotide sequence of the *CO1* gene (Kasuya et al. 2013; Nomano et al. 2017).

DNA was extracted from each specimen using DNeasy Blood & Tissue Kit (Qiagen, Hilden, Germany). Amplification was preformed with a pair of primers, 5’-GGTCAACAAATCATAAAGATATTGG-3’ (LCO) and 5’-TAAACTTCAGGGTGACCAAAAAATCA-3’ (HCO) (about 600 bp) (Folmer et al.

1994). All amplifications were performed in 23μl reaction volumes containing 1.3 mM $MgCl_2$, 0.042 mM dNTP, 2.6 μM primers, 0.042 U Ampli *Taq* DNA polymerase, and 2.4 μL 10× PCR buffer. PCR profile consisted of one cycle of denaturation (94°C for 10 min), 35 cycles of denaturation (94°C for 1 min), annealing (50°C for 1 min) and extension (72°C for 1.5 min), followed by one cycle of final extension at 72°C for 12 min. Amplified products were diluted to 1ng/μL, and used as sequencing templates.

For all sequence reactions, Big Dye Terminator Cycle Sequencing Kit (ABI) was used. Sequencing was carried out with a 3100 Genetic Analyzer (ABI), utilizing the same primers used for PCR amplification.

In this study, *Ganaspis* individuals collected by net sweeping in 2016 and a part of *Ganaspis* individuals that emerged from fruit in 2016 were determined for the nucleotide sequence of the *CO1* gene. *Ganaspis* samples collected in 2015 were not determined for the *CO1* sequence. For the obtained sequences, genetic distances from the sequences of individuals of the *suzukii*-associated, *lutescens*-associated and widely-distributed types obtained in our previous study (Nomano et al. 2017) were calculated with Kimura's two-parameter model and pairwise deletion using Mega7 software (Kumar et al. 2016).

Statistical analysis

In this study, statistical analyses were performed on the number of *D. suzukii* that emerged from fruit and the rate of parasitism by *G. brasiliensis* in the lawn area. Data from the forest area were not analysed because sample size was small. The number of *D. suzukii* that emerged from fruit was compared between the undergrowth and foliage

layers and between 2015 and 2016 by a generalized linear model (GLM) with a log link function and a Poisson error distribution (the number of *D. suzukii* was a response variable, and layer and year were explanatory variables). The rate of parasitism by *G. brasiliensis* was calculated based on the assumption that the wasp emerged from only *D. suzukii* or both of *D. suzukii* and *D. lutescens* and compared between the undergrowth and foliage layers and between 2015 and 2016 by a GLM with a logit link function and a binomial error distribution (the rate of parasitism was a response variable, and layer and year were explanatory variables). The analysis was performed with R 3.3.2 (R Development Core Team, 2016).

**Results**

Collection of adult individuals by net sweeping

In the lawn area, *Drosophila suzukii* was collected from both foliage and undergrowth layers, whereas other drosophilids were almost exclusively collected from the undergrowth layer (Table 1). *Drosophila suzukii* was also collected from the undergrowth layer in the forest area as well as other drosophilids.

Five species of *Drosophila* parasitoids were collected, mostly in the lawn area (Table 1). In these parasitoid samples, 14 individuals assigned as *Ganaspis brasiliensis* by morphology were determined for the nucleotide sequence of the *CO1* gene. As a result, 4 were assigned as the *suzukii*-associated type, 5 were the *lutescens*–associated type, and 5 were the widely-distributed type. All of these three types were collected from both layers. On the other hand, *Leptopilina japonica* and *Asobara* sp. TK1 were

collected only from the foliage layer.

Emergence of drosophilids and parasitoids from field-collected fruit

Among drosophilids that emerged from wild cherry fruit, *D. suzukii* was the most abundant (Table 2). The GLM analysis on the number of *D. suzukii* that emerged per fruit showed that the effects of year and layer and the interaction of year and layer were significant (year; likelihood ratio $\chi^2$ = 1540.59, df = 1, $p < 0.001$: layer; likelihood ratio $\chi^2$ = 81.74, df = 1, $p < 0.001$: interaction; likelihood ratio $\chi^2$ = 180.9, df = 1, $p < 0.001$ ); i.e., the number of emergence was much larger in fruit from the foliage layer than in those from the undergrowth layer in 2015, but the difference was quite small in 2016. Other drosophilids such as *D. lutescens* Okada, *D. rufa* Kikkawa & Peng and *D. triauraria* Bock & Wheeler mostly emerged from fruit collected from the undergrowth layer.

*Drosophila suzukii* emerged most abundantly from fruit collected on the day of fall and its emergence decreased when fruit were left on the ground longer (Fig. 1). In contrast, *D. lutescens*, *D. rufa* and *D. immigrans* Sturtevant did not emerge from newly fallen fruit but emerged from fruit that were left on the ground for a day or longer after fall (Fig. 1).

A total of 513 parasitoids emerged from samples of wild cherry fruit (50 individuals in 2015 and 463 individuals in 2016). Among them, *G. brasiliensis* was most abundant, followed by *Asobara japonica* Belokobylskij and *Leptopilina japonica* Novković & Kimura (Table 2). According to the nucleotide sequences of the CO1 gene for 19 *G. brasiliensis* individuals that emerged in 2016, 18 were the *suzukii*-associated

type, and one from the undergrowth layer was the *lutescens*-associated type. The rate of parasitism by *G. brasiliensis* was 0.077 (0.076) in pooled samples for the foliage layer and 0.073 (0.054) in those for the undergrowth layer in 2015, and 0.197 (0.189) in those for the foliage layer and 0.274 (0.199) in those for the undergrowth layer in 2016 (the rates given out of parentheses were based on the assumption that the wasp emerged only from *D. suzukii*, and those in parentheses were based on the assumption that the wasp emerged from both of *D. suzukii* and *D. lutescens*). According to the GLM analysis, the effect of year was significant (likelihood ratio $\chi^2 = 30.0$, df = 1, $p < 0.001$), but the effect of layer and the interaction of layer and site were not significant (layer; likelihood ratio $\chi^2 = 0.012$, df = 1, $p = 0912$: interaction; likelihood ratio $\chi^2 = 0.818$, df = 1, $p = 0.366$), irrespective of either assumption.

Collection by oviposition trap

No drosophilid individual emerged from intact fruits placed at the low height in the lawn area (Table 3). Except this case, *D. suzukii* emerged from both intact and injured fruit placed at all heights. In contrast, *D. lutescens* emerged mostly from fruit placed at low height. Only 2 individuals of *A. japonica* emerged from fruit placed at low height in the forest area (data not shown).

**Discussion**

In the study area, *D. suzukii* is the only drosophilid species that inhabits and oviposits in the foliage layer (Tables 1 & 2). Keesey et al. (2015) observed that *D. suzukii* females

are more attracted to leaf odors than *D. melanogaster* Meigen females that prefer fermenting fruit, and they considered that this is the key characteristic that leads *D. suzukii* to forage not only the undergrowth layer but also the foliage and canopy layers. In this study, however, the number of *D. suzukii* adults collected from the foliage layer was not large, although net sweeping was performed for more than 3 hours (i.e., net was swung some hundred times); i.e., only 28 in 2015 and 11 in 2016 (Table 1). It is not certain whether the rate of fruit attacked by *D. suzukii* observed in this study, i.e., 0.36 (2015) – 1.79 (2016) eggs per fruit (Table 2), can be explained by this adult density. It is possible that net sweeping in the foliage layer is not effective to collect *D. suzukii* adults or other insects.

The number of *D. suzukii* that emerged from wild cherry fruit was significantly larger in those collected from the foliage layer than in those from the undergrowth layer at least in 2015 (Table 2). In addition, the number of *D. suzukii* that emerged from fallen fruit decreased when they were left on the ground longer (Fig. 1). If *D. suzukii* females oviposit eggs in fallen fruit in addition to fresh fruit on trees, the number of *D. suzukii* that emerged from fruit would be larger in those collected from the undergrowth layer than in those from the foliage layer and increase if fruit were left on the ground longer. In fact, *D. lutescens*, *D. rufa* and *D. immigrans* that oviposit in fallen fruit increased in fruit that were left on the ground longer. Therefore, it is assumed that *D. suzukii* females rarely oviposit eggs in fallen fruit, although they frequently occur in the undergrowth layer. However, *D. suzukii* oviposited in fresh and injured cherry fruit that were placed close to the ground (Table 3). In addition, *D. suzukii* oviposits in fresh fruit placed in vials or bottles (Kasuya et al. 2013; Mitsui et al. 2006). These results suggest that *D. suzukii* females oviposit in fruit placed on or near the ground. They may avoid

oviposition in fallen fruit that have started fermentation or decay. Further study is needed on this issue.

In the study area, the major parasitoid that attacked *D. suzukii* larvae in wild cherry fruit is the *suzukii*-associated type of *G. brasiliensis*, a specialist of *D. suzukii* (also see Kasuya et al. 2013). The rate of parasitism by this parasitoid did not significantly differ between larvae in fresh fruit collected from the foliage layer and those in fallen fruit collected from the undergrowth layer (Table 2). If *D. suzukii* does not oviposit in fallen fruit as mentioned above, this result suggests that this parasitoid also rarely attacks *D. suzukii* larvae in fallen fruit. Although the sample size was small, this species was more frequently collected in the foliage layer (3 individuals in 2016) than in the undergrowth layer (1). On the other hand, a somewhat larger number of *Asobara* sp. TK1 was collected from the foliage layer (16 individuals in 2016) (Table 1), but only few individuals of this wasp emerged in this study (Table 2). Further survey on the distribution of adult wasps is needed to understand their ecology.

Although sample size was small, adult wasps of the *suzukii*-associated type of *G. brasiliensis*, *Asobara* sp. TK1 and also *Leptopilina japonica* were collected almost from the foliage layer. From the present results on the distributions of these parasitoids and *D. suzukii*, some implications for the control of *D. suzukii* are obtained. First, in the practice of integrated management, pesticide application to the foliage layer should be avoided, because specialist parasitoids mainly forage there. Second, fallen fruit should be removed from fruit farms, because *D. suzukii* larvae occur in them but they were rarely attacked by specialist parasitoids. However, this is a preliminary study based on field collection at a locality. Further study is needed to deepen our knowledge on ecology of *D. suzukii* and its parasitoids.

In the collection by oviposition trap in the lawn area, no drosophilid emerged from intact cherry fruit placed at the low height, although many drosophilids emerged from injured fruit placed at the low height. This difference may be attributable to the difference in the occurrence of ant (*Formica japonica* (Mochoulsky)): many ants were observed in the traps with intact fruit but only few ants were observed in the traps with injured fruit. It has been reported that ant is one of the important mortality factors of drosophilid larvae (Lewis and Worthen 1992; Worthen et al. 1993). Ant predation may be an important factor to reduce *D. suzukii* populations.

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**Table 1** Number of adult drosophilids and parasitoids collected by net sweeping in the foliage (F) and undergrowth (U) layers in lawn and forest.

| | Lawn | | | | Forest |
|---|---|---|---|---|---|
| | F | | U | | U |
| | 2015 | 2016 | 2015 | 2016 | 2016 |
| Drosophilids | | | | | |
| *D. suzukii* | 28 | 11 | 95 | 41 | 41 |
| *D. subpurchrella* | 0 | 1 | 0 | 0 | 1 |
| *D. lutescens* | 0 | 0 | 17 | 25 | 121 |
| *D. rufa* | 0 | 0 | 3 | 8 | 103 |
| *D. biauraria* | 0 | 0 | 3 | 6 | 6 |
| *D. triauraria* | 0 | 0 | 5 | 25 | 0 |
| *D. sternopleuralis* | 0 | 0 | 2 | 1 | 68 |
| *D. immigrans* | 0 | 0 | 1 | 7 | 16 |
| others | 0 | 4 | 4 | 19 | 39 |
| Parasitoids | | | | | |
| *Ganaspis brasiliensis* | 3* | | 1* | | |
| *suzukii*-associated type | | 3 | | 1 | 0 |
| *lutescens*-associated type | | 2 | | 2 | 1 |
| widely-distributed type | | 2 | | 3 | |
| *Leptopilina japonica* | 1 | 2 | 0 | 0 | 0 |
| *Asobara* sp. TK1 | 4 | 16 | 0 | 0 | 0 |
| *A. rufescens* | 0 | 1 | 0 | 1 | 0 |
| *Trichopria* sp. | 0 | 2 | 0 | 0 | 0 |

* The type was not determined.

**Table 2** Number (mean ± SD) of drosophilids and parasitoids that emerged per 100 fruits.

| | Lawn | | | | Forest | |
|---|---|---|---|---|---|---|
| | Foliage layer | | Undergrowth layer | | Undergrowth layer | |
| | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| Drosophilids | | | | | | |
| *D. suzukii* | 36.0 ± 37.8 | 179.3.0 ± 45.2 | 5.1 ± 3.4 | 168.0 ± 64.1 | 30.0 ± 33.8 | 40.5 ± 20.6 |
| *D. lutescens* | 0.3 ± 0.7 | 9.0 ± 12.3 | 1.9 ± 3.0 | 86.3 ± 104.0 | 17.7 ± 6.7 | 34.3 ± 20.9 |
| *D. rufa* | 0 | 0 | 0 | 1.7 ± 1.5 | 0.7 ± 1.2 | 10.8 ± 7.4 |
| *D. biauraria* | 0 | 0 | 0 | 1.7 ± 1.5 | 0 | 0.3 ± 0.5 |
| *D. triauraria* | 0 | 0 | 0.6 ± 0.7 | 10.3 ± 11.2 | 0 | 0.3 ± 0.5 |
| Others | 0.3 ± 0.7 | 0 | 0.3 ± 0.9 | 1.0 ± 1.0 | 0 | 0.5 ± 0.6 |
| Parasitoids | | | | | | |
| *G. brasiliensis* | 3.0 ± 2.9 | 44.0 ± 53.6* | 0.4 ± 0.7 | 63.3 ± 29.7** | 1.0 ± 1.7 | 0.8 ± 1.0 |
| *L. japonica* | 0.1 ± 0.3 | 1.0 ± 1.0 | 0 | 9.0 ± 5.3 | 0 | 2.0 ± 2.7 |
| *Asobara* sp. TK1 | 0.5 ± 0.8 | 0.3 ± 0.6 | 0 | 0.3 ± 0.6 | 0 | 0 |
| *Asobara* sp. TK2 | 0 | 0 | 0 | 0.3 ± 0.6 | 0 | 0 |
| *Asobara japonica* | 0 | 0 | 0 | 28.0 ± 40.7 | 0.3 ± 0.6 | 2.8 ± 2.5 |
| *A. rufescens* | 0 | 0 | 0 | 0.3 ± 0.6 | 0 | 0 |
| *A. rossica* | 0 | 0 | 0 | 0.3 ± 0.6 | 0 | 0 |

In the lawn area, 100 *C. speciosus* fruits were collected from both foliage and undergrowth layers of 10 cherry trees in 2015, and 3 trees in 2016. In the forest area, 3 and 4 samples, each with 100 *C. jamasakura* fruits, were collected in 2015 and 2016, respectively.

*Ten individuals were determined for the nucleotide sequence of the CO1 gene, and all were identified as

the *suzukii*-assocaited type.

**Among 9 individuals that were determined for the nucleotide sequence of the CO1 gene, 8 were identified as the s*uzukii*-assocaited type, and one was the *lutescens-rufa-biauraria*-associated type.

**Table 3** Number of drosophilids that emerged from fruit bait in oviposition traps at high, middle and low heights of wild cherry trees in lawn and forest areas.

| | Lawn | | | Forest | | |
|---|---|---|---|---|---|---|
| | High | Middle | Low | High | Middle | Low |
| Intact fruit (two sites in each of lawn and forest areas) | | | | | | |
| *D. suzukii* | 20 | 14 | 0 | 3 | 5 | 6 |
| *D. lutescens* | 0 | 0 | 0 | 0 | 0 | 26 |
| *D. immigrans* | 0 | 4 | 0 | 0 | 0 | 0 |
| Injured fruit (one site in each of lawn and forest areas) | | | | | | |
| *D. suzukii* | 3 | 4 | 6 | 1 | 1 | 3 |
| *D. lutescens* | 0 | 0 | 92 | 1 | 1 | 10 |
| *D. rufa* | 0 | 0 | 3 | 0 | 0 | 1 |

Intact and injured *C. speciosa* fruit and 'bing' cherry fruit were used as bait.

Figure legend

**Fig. 1** Numbers of *D. suzukii* (●), *D. lutescens* (▲), *D. rufa* (▼) and *D. immigrans* (■) that emerged per wild cherry fruit. Fruit that fell on the ground on May 28 (A) and June 9 (B) in 2000 were marked by toothpicks, and 30 fruit were collected daily or once two days for 7 or 8 days after fall. Collected fruit were placed in plastic boxes and the number of drosophilids that emerged from these fruit was examined in the laboratory.

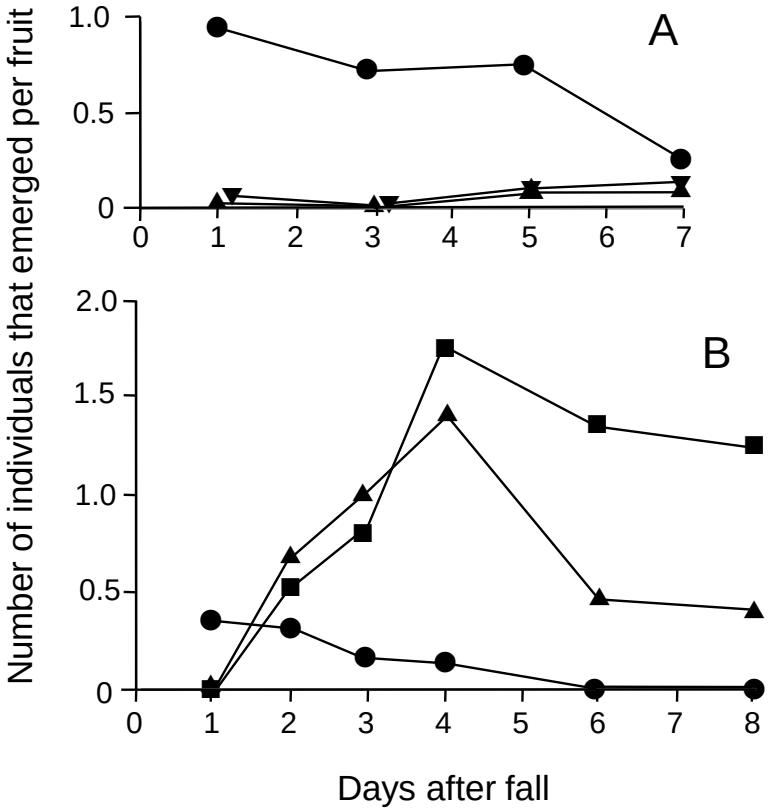

A
B
1.0
0.5
0
2.0
1.5
1.0
0.5
0
0 1 2 3 4 5 6 7
0 1 2 3 4 5 6 7 8
Number of individuals that emerged per fruit
Days after fall

Fig. 1