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Biology of *Acalolepta kusamai* HAYASHI (Coleoptera, Cerambycidae) at Yokohama: Boring and Survivorship in Stems of *Sambucus sieboldiana* and Preference for Sunnier Environment[1)]

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Abstract In the Shiki-no-Mori Prefectural Park, Midori-ku, Yokohama, Kanagawa Pref., Central Japan, elder shrubs, *Sambucus sieboldiana* (Caprifoliaceae), were found heavily infested by a cerambycid beetle, *Acalolepta kusamai* HAYASHI. Little or slightly infested host shrubs were found situated in shaded environment, surrounded by many trees/shrubs, whereas heavily infested host shrubs were in sunny environment, surrounded by few trees/shrubs. Host shrubs of greater diameter at the bottom suffered heavier damage. Analysis of holes and larval galleries in infested host stems demonstrated that larvae within the stem wood bore upward so as probably to avoid shading by developing grass stratum around the host, that connection of larval gallery with the hollow pith may result in low larval survivorship probably due to intruding enemies, that small diameter of host may also result in low survivorship, and that larval gallery, if short enough in total, does not accompany fibrous stuffing. It was concluded that *A. kusamai* prefers to oviposit and occur on stems of *S. sieboldiana* that grow at sunnier sites. Around Yokohama City, *S. sieboldiana* shrubs planted under sunnier environment may decline due to heavy infestation of this cerambycid.

The genus *Acalolepta* PASCOE (Coleoptera, Cerambycidae, Lamiinae) includes several species that bore and damage living trees, shrubs and even green crops, such as *A. luxuriosa* (BATES) (AKUTSU, 1985) and *A. vastator* (NEWMAN) (GOODWIN *et al.*, 1994).

1) This paper was presented at the 106th Annual Meeting of the Japanese Forestry Society (Sapporo, 1995).

Acalolepta kusamai HAYASHI, which had been currently called *Cypriola fulvicornis* PASCOE (HAYASHI, 1955), was described by HAYASHI (1969) as a theretofore unnamed species. It forms a species-complex with *A. ginkgovora* MAKIHARA, a possible sibling or closely allied species described by MAKIHARA (1992), but the exact relationship of these two forms is yet to be clarified. They have common characteristics on the distally swollen shape of the first antennal segment.

In Kanagawa Prefecture, particularly in the vicinities of Yokohama City and its surroundings (Kantô District, Central Japan), *A. kusamai* larvae are often found boring and infesting living stems of wild and planted elders ("niwatoko"), *Sambucus sieboldiana* (Caprifoliaceae), a moderately shade-tolerant shrub plant (GO *et al.*, 1976; TSUYUKI *et al.*, 1981; KUSAMA & TAKAKUWA, 1984).

However, the distribution of *A. kusamai* and *A. ginkgovora* is much limited: *A. kusamai* is only rarely and locally found from other regions of Kantô District, including Chiba Pref. (YAMAZAKI, 1980), Saitama Pref. (ISHIKURA, 1998) and Tokyo Pref. (FUJITA, 1988; IWATA *et al.*, 1991; SHIBATA, 1997), and also from the Izu Isls. (FUJITA, 1979; KASHIWAZAKI, 1982; TAKEDA, 1983), Yakushima Is. (TAKAKUWA, 1971; MAKIHARA, 1992) and Taiwan[2)] (KUSAMA & TAKAKUWA, 1984). The populations of the northern part of Kyushu, including Nagasaki, Saga, Fukuoka and Ôita Prefectures, together with that of Yamaguchi Pref., Honshu, now being assigned to *A. ginkgovora*, attack not only elder, *S. sieboldiana*, but also "kusagi", *Clerodendron trichotomum* (Verbenaceae), and surprisingly, a quite unrelated gymnosperm plant, ginkgo ("ichô"), *Ginkgo biloba*, becoming a pest of the last plant species (IMASAKA & IWASAKI, 1974; TANAKA, 1975; ONAGAMITSU & KANEKO, 1983; OGATA *et al.*, 1986; ONAGAMITSU, 1991; TAKAMIYA *et al.*, 1991; TAKAMIYA, 1992; MAKIHARA, 1992). The populations of the other parts of Japan, including the Kii Peninsula (KATO *et al.*, 1995) and the southern part of Kyushu (ARAMAKI *et al.*, 1996; MORI, 1988), need to be studied for exact identification and host plants, while Kôchi Pref. (Shikoku) needs to be tentatively deleted from the distribution range of the *A. kusamai–ginkgovora* complex since the unique relevant report (NAKAYAMA, 1994) is considered to be based on a misidentification of *A. sejuncta* (BATES).

The bionomics of *A. kusamai* is also little known: biological information of this cerambycid species is almost unavailable for the protection of *Sambucus sieboldiana* shrubs in and around Yokohama City. We once had opportunities to study heavy damage on *S. sieboldiana* shrubs caused by an *A. kusamai* population at the Shiki-no-Mori Prefectural Park, Midori-ku, Yokohama, which led to information reported herein on the relationship between the occurrence and environmental factors, as well as on some ecological traits of larval borings.

This paper is dedicated to the memories of the two recently deceased cerambycol-

2) Mentioning Taiwan as a new locality of *A. kusamai* by KUSAMA and TAKAKUWA (1984) was based upon the following specimen: {1 ♀, Nanshanchi, Taiwan, 7–V–1976, K. AKIYAMA leg.; 1 ♂, same loc., 1995}, deposited in Mr. Shigeo TSUYUKI's collection, Zushi.

ogists, the late Dr. Keiichi KUSAMA (1924–1998) and the late Dr. Masao HAYASHI (1920–1998), both of whom had something in relation with the name of the studied species. Mr. Kiichi TACHIKAWA, Kumamoto Prefecture, provided the senior author with information on *A. ginkgovora*, the park office staff of the study site provided us of opportunities and materials for the study, and Dr. M. KON, The University of Shiga Prefecture, critically read the earlier draft. We cordially thank all of them.

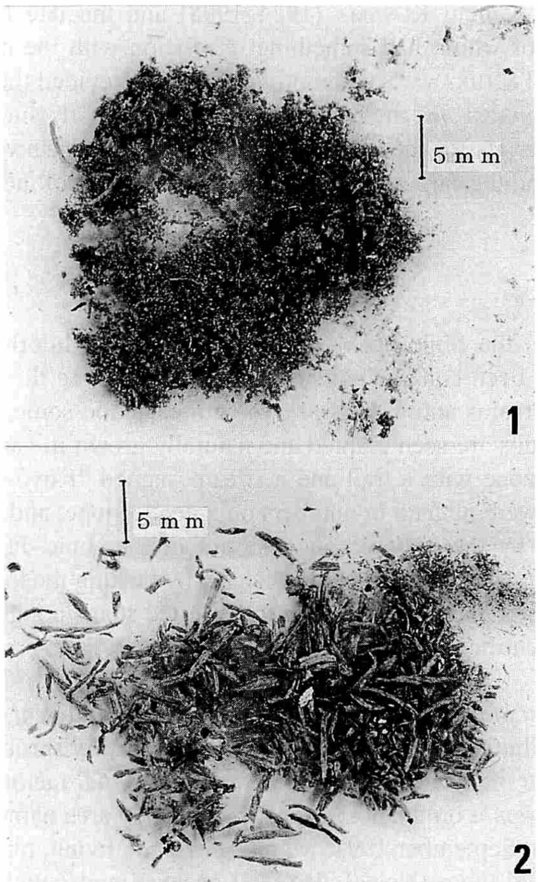
Materials and Method

1. *Study site.*

The study site, the Shiki-no-Mori Prefectural Park, Midori-ku, Yokohama, ca. 35.9 ha of area, has been constructed since 1983, by utilizing the natural topography, including paludal streams and natural groves with oaks and some other trees. *Sambucus sieboldiana* shrubs are seen planted and naturally grown in various places, among which is a strip of zone with a trail and a stream, named "Kôyô-no-Mori", where *S. sieboldiana* shrubs were planted in numbers on a gentle slope, and many of them were recognized infested by insect borers in 1989 autumn. In June–July of 1990–1994, a number of *Acalolepta* adult beetles were collected by kicking the infested host stems to drop them out and by raising the larvae in the infested stems/boughs in the laboratory, and they were all identified with *A. kusamai*.

2. *Infestation of host plants in relation to the ambient environment.*

Since the distribution of heavily infested *S. sieboldiana* shrubs was seen uneven, we tried to detect the influence of the ambient environmental factors to the density and occurrence of *A. kusamai* on the host plants. In the study area named "Kôyô-no-Mori" (about 0.1–0.2 ha) in September 1991, we recognized 36 living, planted *S. sieboldiana* shrubs. We numbered them (Nos. 1–36), and checked and counted the superficially discernible damage patches on the stems. Shrubs were then ranked as to the number of these patches (n), which apparently correlated to the density of cumulative galleries of *A. kusamai* larvae within each shrub, and therefore to the susceptibility of individual *S. sieboldiana* shrub: Rank A, $n<6$; Rank B, $6 \leqq n < 15$; Rank C, $15 \leqq n$. In the case of very heavy infestation (mostly $n \geqq 15$), these patches agglutinated to form an overall damage, the exact number of patches not being given. Also, vegetational conditions around the investigated plants were recorded, including relative density and position of tree crowns and undergrowth. Then, around noon on 12 Sept. 1991, a clear day, we measured the intensity of illumination by each of the 36 infested host plants using a digital illuminometer under almost equal conditions and methods. We also recorded top height above the ground, diameters at the bottom and at the breast height and the number of damage patches (n) of each host plant, as well as aspect (compass directions) and height above the ground of each of the damage patches.



Figs. 1–2. —— 1. Larval frass of *Acalolepta kusamai* HAYASHI removed from a larval gallery in an infested *Sambucus sieboldiana* stem. —— 2. Pre-pupational fibrous stuffing of *A. kusamai* removed from a larval gallery in an infested *Sambucus sieboldiana* stem.

3. *Analysis of larval boring galleries.*

Four heavily and lethally infested host stems (Materials I–IV; 80–124 cm long, 2.2–6.5 cm in diameter) were selected at the study site, harvested, and brought into the laboratory to analyze the larval boring galleries. Materials I and II were harvested on 6 July 1993, both being situated on the sunny periphery of the grove, while Materials III and IV were harvested on 29 June 1994, the former (III) being situated at a position with very sparse trees and shrubs and the highest illumination intensity, and the latter (IV) at the position exposed southward and eastward with a rather high illumination intensity.

The harvested materials were cut into bolts, 8–12 cm long, and a standard longitudinal line was drawn on each bolt surface. Six development figures for each bolt were

Table 1. Types of larval gallery of *A. kusamai* with regard to its connection to the pith of *S. sieboldiana* stems. (See also Fig. 3.)

Type	Definition
A	Gallery from entrance hole directly to pith
B	Gallery from entrance hole to exit hole with no connection to pith
C	Gallery from entrance hole to dead end with no connection to pith*
D	Gallery from pith directly to exit hole
E	Gallery of the other type than A–D

* Indicative of larval death.

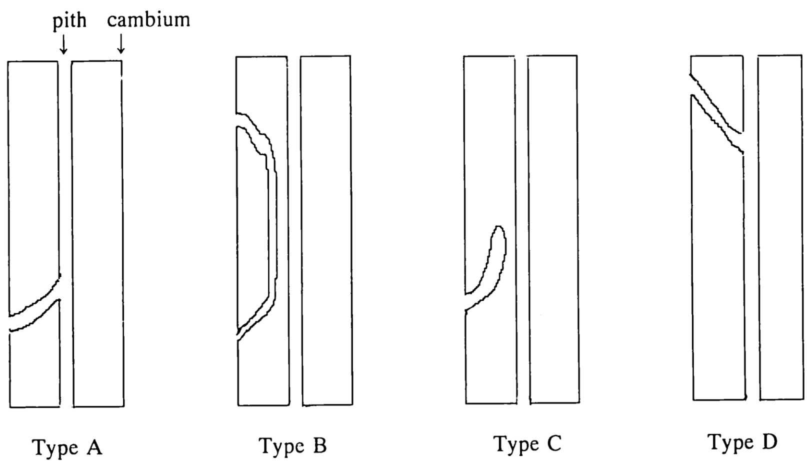


Fig. 3. Types of larval galleries of *A. kusamai* in *S. sieboldiana* stems (see also Table 1).

drawn, four of the six representing four 90° sector surfaces, and the other two representing the top and bottom cross-cut surfaces. All of larval entrance holes beneath the bark, adult emergence holes on the bark, exposed larval galleries, nature of gallery stuffings (whether fine larval frass (Fig. 1) or pre-pupational fibrous stuffing (Fig. 2)) were precisely recorded for each of the bolts. A soft copper wire was put into the gallery to check the connection between the bolt surface items. Results of all the bolts were put together to realize the whole three-dimensional larval gallery system.

In analyzing larval galleries, they were classified into 5 types with regard to the connection to the pith of the host stem (Table 1, Fig. 3). Since each of these types of larval galleries, as well as of the two types of holes, indicates a certain movement or happening in the insect's life, numbers of all the types of galleries and holes within all the materials were utilized to give survivorships during certain steps.

It is important to know if any other boring insect species is responsible for any of the holes and galleries observed. While cutting Material III, one dead dried cerambycid larva, 1.5 cm long, was found, and it was identified with *A. kusamai* larva according to the larval description by GO *et al.* (1973). The traits of the whole larval gallery system containing this dead larva represented all the other galleries reported herein, and also, no other insect species were found boring and/or attacking the materials and the other host shrubs in the study site. These facts suggest that *A. kusamai* is exclusively responsible for all the galleries and holes found in the present investigation (except for some short-cuts and small holes presumably made by unknown predators).

Results

1. *Infestation of host plants in relation to the ambient environment.*

Data of 36 infested *S. sieboldiana* shrubs, including top height above the ground, diameters at the bottom and at the breast height, and aspect and height above the ground of each of the damage patches, are shown in Table 2, while the relationship between the number of superficially discernible damage patches (n) and the intensity of illumination by the stems (I) of the 36 infested *S. sieboldiana* shrubs is shown in Fig. 4. Of these shrubs, 10 were ranked into A (little or slightly infested; $n<6$), 13 into B (moderately infested; $6\leqq n<15$) and 13 into C (heavily infested; $15\leqq n$). As is evident from Fig. 4, a significant influence of the intensity of illumination was detected on the intensity of damage (KENDALL's rank correlation $\tau=0.662$, $p\leqq 0.0001$; KRUSKAL–WALLIS test, $p<0.0005$): in Rank A, shrubs were under a rather shaded condition (I=240–350 lx, with a mean of 306 lx); in Rank B, they were a little more illuminated (I=310–1020 lx, with a mean of 541 lx); in Rank C, they were exposed to heavy sunlight (I=1080–5700 lx, with a mean of 3160 lx). Analyses of the data in Table 2 also demonstrated a weak but significant correlation between the diameter at the bottom and the intensity of damage (KENDALL's rank correlation $\tau=0.30$, $p\leqq 0.0017$; KRUSKAL–WALLIS test, $p<0.017$).

Following the trail and the stream along the study site strip, we recognized *S. sieboldiana* shrubs growing in environments with varying illumination intensity, which was associated with the ambient vegetation. Shrub No. 1 (Rank C) was situated off the groves and exposed eastward, whereas Shrubs Nos. 2–7 (Rank A and Rank B) were situated within the grove and covered by other taller shrubs/trees, which reduced the illumination intensity around them to some extent. A grass stratum of about 5–20 cm height above the ground developed as forest floor vegetation there. Shrubs Nos. 8–13 were situated in a similar environment to that of Nos. 2–7, although Nos. 8 (Rank B), 9 (Rank C) and 11 (Rank B) were situated along the trail with slightly sunnier condition than Nos. 10, 12 and 13 (Rank B). Shrubs Nos. 14–20 (Rank C, except for No. 17 of Rank B) were situated in an amply open land off the grove, with almost direct sunlight, although No. 17 was exceptionally situated directly beside a tall oak tree to its north. A grass stratum developed about 5–20 cm high above the ground. In the next section, only Shrub No. 21 (Rank A) was situated in the grove, covered by other taller trees/shrubs, whereas Shrubs Nos. 22–26 (Rank C) were again situated off the grove, with direct and indirect sunlight shining especially on their southwestern and north-

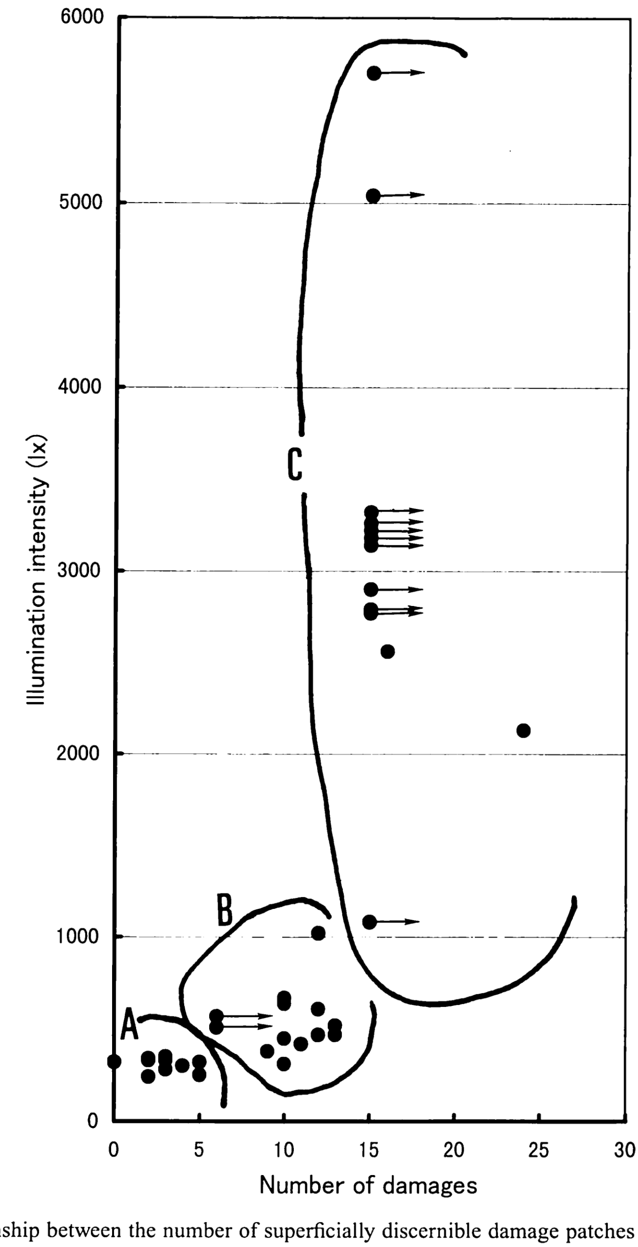


Fig. 4. Relationship between the number of superficially discernible damage patches and the intensity of illumination by the stems of 36 *A. kusamai*-infested *S. sieboldiana* shrubs. Right-pointing arrow means more than this number.

eastern aspects, and a grass stratum developing about 10–20 cm high above the ground. In the last section, Shrubs Nos. 27–36 (Rank A and Rank B) were situated in a similar shaded condition to Nos. 2–7, 10, 12–13 and 21, although No. 33 was exceptionally situated along the stream with slightly open space around it. A grass stratum developed about 50 cm high above the ground.

The above, as well as Table 2 and Fig. 4, collectively indicates that shrubs of Ranks A and B are almost exclusively situated in a shaded environment, with dense vegetation (trees and shrubs) around them, while those of Rank C in open, sunny and airy environment. Table 2 also shows that *A. kusamai* infests uncovered host shrubs or stem aspects (southwestern and northeastern sides in the present case). It was also recognized that the damage patches were, regardless of the infestation rank of host, situated above the grass stratum around the host. Avoidance of host shrubs situated in shaded situation seems quite consistent with avoidance of shaded portion within an uncovered host shrub, namely bottom portion and shaded sides.

In January 1995, not a sound *S. sieboldiana* shrub was found in the sunny area of the study site primarily due to intensive damages by *A. kusamai*, and secondarily due to that most of the infested *S. sieboldiana* shrubs were cut to prevent the beetle occurrence from spreading. In July 1994, only two *A. kusamai* adults were obtained, but no beetles in the 1995 season.

A similar phenomenon was observed also at the Izumi-no-Mori Park, Yamato, Kanagawa Pref., early in 1999.

2. *Analysis of larval boring galleries.*

The four materials (I–IV) were analyzed to realize the entire larval gallery systems inside. As an example, the analysis result of Material III is shown in Fig. 5. While cutting Material III, one dead dried *A. kusamai* larva, 1.5 cm long, was found (Fig. 5) (see above: Materials and Method).

As usual for most of the wood-boring cerambycids, in *A. kusamai* infesting *S. sieboldiana* shrubs, imaginal exit hole has its opening of an almost complete circle, and larval entrance hole has its opening of an irregular ellipse, subcortical xylem around which was also carved shallowly (Fig. 6). Larval subcortical carving varied considerably in its area, and the direction of larval mining was quite irregular. In some rare cases, as *S. sieboldiana* overcame old damage caused by *A. kusamai* larva, subcortical larval galleries were found much reduced due to cicatrization of the surviving host's tissue. Further, some very irregular holes and short-cut galleries of the other type than *A. kusamai*'s were found, which were considered responsible to possible predators.

Larvae of *A. kusamai* were found boring *S. sieboldiana* stems upward in almost all cases. In cerambycid primary borers, except for root- or stem-base-boring species, larvae mostly mine downward (for example, *Apriona japonica* THOMSON; MURAKAMI, 1960), or mature larvae mine either upward or downward almost equally (for example, *Xylotrechus villioni* (VILLARD); IWATA *et al.*, 1997). This upward-mining habit in the

Table 2. Sizes of 36 *A. kusamai*-infested *S. sieboldiana* shrubs and positions of damage patches.

Shrub No.	Rank of damage*	Top height (m)	Diameter at bottom (cm)	Diameter at breast height** (cm)	Number and positions of damage patches and/or remarks***
1	C	5.0	29.0	6.0/10.0/6.5	Almost wholly infested, especially on SW side 60–230 cm a.g.
2	A	1.8	11.5	3.5	One on N side, two on S side ca. 110 cm a.g.
3	B	4.0	17.0	4.5/6.5/4.0	Two on N side, five on NE side, one on S side and four on SW side 80–180 cm a.g.
4	B	4.5	26.0	4.5/5.8	Four on NE side and five on SW side ca. 150 cm a.g.
5	A	2.2	17.5	3.0	Two on NE side ca. 60 cm a.g.
6	B	5.0	15.5	7.0/7.0	Four on NE side, six on SW side and three on S side 80–200 cm a.g.
7	B	7.0	18.0	8.0/11.5/7.5	Five on NE side and three on SW side 60–200 cm a.g. One on S side 30 cm a.g.
8	B	4.0	19.0	4.5/2.0	Three on NE side and eight on SW side 50–200 cm a.g.
9	C	4.0	27.5	7.9/8.0/4.0	Almost wholly infested, especially on NE and SW sides ca. 200 cm a.g.
10	B	5.5	26.5	7.0/8.3	Ten on NE side.
11	B	3.5	22.0	5.5/4.5	Five on NE side and five on SW side 85–185 cm a.g.
12	B	3.5	24.0	5.5/6.0/5.0	Markedly infested on NE side.
13	B	3.5	22.0	5.0/5.5	Markedly infested on NE side.
14	C	4.5	25.0	8.5	Almost wholly infested, especially on SW side.
15	C	1.8	22.0	2.0/2.0	Nearly solitary. Almost wholly infested.
16	C	4.5	32.0	13.0	Solitary. Almost wholly infested.
17	B	4.0	25.0	5.3/4.2	One on N side, four on NE side, two on S side and five on SW side 120–200 cm a.g.
18	C	5.5	34.0	6.5/13.5	Almost wholly infested.
19	C	3.5	20.0	7.5	Almost wholly infested.
20	C	5.5	25.5	7.5/7.0	Two on N side, five on NE side, two on S side and seven on SW side 120–190 cm a.g.
21	A	5.0	27.5	6.0/6.5	Three on NE side and two on SW side 150–300 cm a.g.
22	C	5.0	23.0	6.3/6.0/5.5/5.8	Heavily infested. Seven on NE side and 17 on SW side 30–350 cm a.g.
23	C	4.5	19.0	5.5/5.0	Almost wholly infested, especially on NE and SW sides.
24	C	5.0	25.0	12.0/5.5	Almost wholly infested, especially on NE and SW sides.
25	C	6.0	21.0	5.4/5.2/7.0	Almost wholly infested, especially on NE and SW sides.
26	C	6.0	24.5	10.5/9.0	Almost wholly infested, especially on NE and SW sides.
27	A	5.0	20.5	5.5/7.7/6.3	One on NE side and two on SW side 120–200 cm a.g.
28	A	4.5	21.0	7.5/7.0	One on NE side and one on SW side 120–200 cm a.g.
29	A	3.5	19.0	4.5/5.0	Two on NE side and one on SW side 80–200 cm a.g.
30	A	3.5	22.5	5.0/4.5/4.5/4.0	Three on NE side and one on SW side 100–180 cm a.g.
31	A	5.0	18.5	9.5	Three on NE side and two on SW side 150–300 cm a.g.
32	A	4.5	22.0	8.5	Two on NE side, each 150 cm and 230 cm a.g.
33	B	5.5	24.0	4.5/5.8/8.5	One on NE side and one on SW side ca. 100 cm a.g. Four on NE side and six on SW side 150–300 cm a.g.
34	A	4.0	16.0	7.0	Seemingly not infested.
35	B	4.5	14.0	4.5/4.5/5.5	One on N side, six on NE side, one on S side and five on SW side 110–250 cm a.g.
36	B	5.0	14.0	7.5	One on S side 110 cm a.g. Four on NE side and five on SW side >180 cm a.g.

* Rank A, $n<6$; Rank B, $6 \leqq n < 15$; Rank C, $15 \leqq n$, where n is the number of damage patches. See text (Materials and Method).

** Multiple figures mean forking of the stem.

*** N, north; NE, northeast; S, south; SW, southwest; W, west; a.g., above the ground.

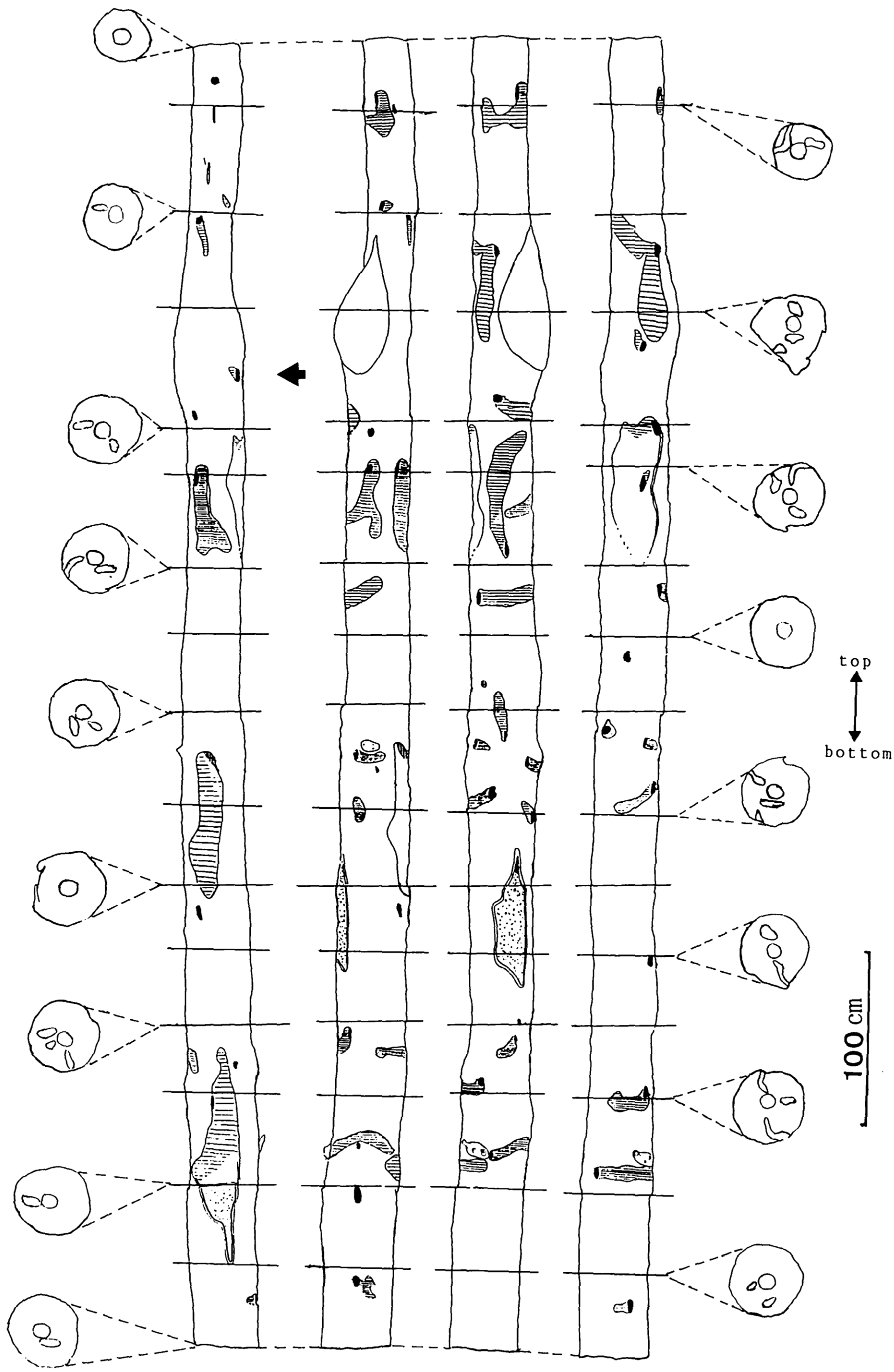
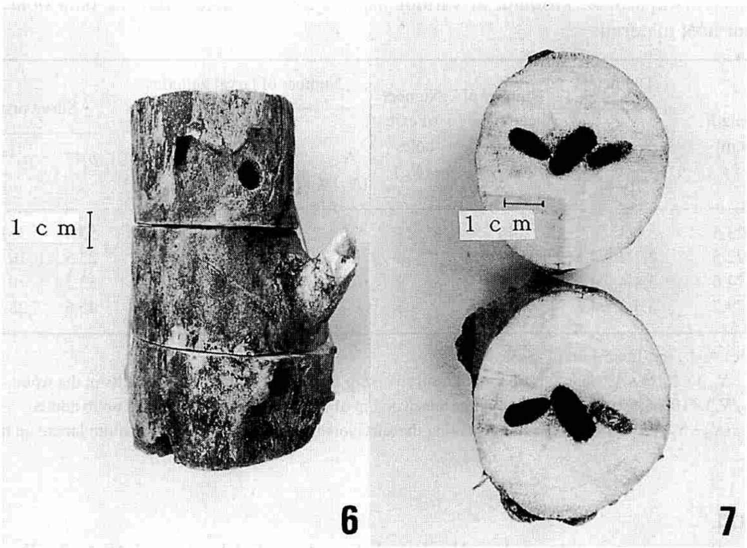


Fig. 5. Analysis of *A. kusamai* galleries and holes in *S. sieboldiana* Material III. Arrow indicates the position from which dead *A. kusamai* larva was found.



Figs. 6–7. —— 6. Exit hole (circle), entrance hole (irregular ellipse) and subcortical carving made by *A. kusamai* on *S. sieboldiana* stem. —— 7. Galleries (Type B) made by *A. kusamai* larvae within *S. sieboldiana* stem xylem as seen in consecutive cross sections. The top and bottom sections represent distal and basal ones, respectively. The right gallery contains fibrous stuffing at the bottom but not at the top. The center hole is the pith.

host stem of the present species seems adaptive to the situation where grasses around the host shrub is growing to eventually cover and shade the most bottom portion of the host, and also at this locality it serves as indicative of the species when *S. sieboldiana* is found infested by any insect borers.

The numbers of all types of galleries (Table 1, Fig. 3) and holes (entrance and exit), as well as the survivorships at certain steps of the insect's life, as calculated from gallery and hole numbers, are presented in Table 3.

Material I had the greatest number of entrance holes, as is simply expected from the size of the material, while Material III (a shrub planted at the sunniest situation of the four) had a greater number and density of entrance holes than Material IV, as is also expected from the above-stated correlation between illumination intensity and host's susceptibility. However, the three survivorship ratio values are higher in Material IV than in III, possibly suggesting a density effect among crowded larvae. Table 3 also indicates a higher survivorship (lower mortality) of non-pith-entering larvae than pith-entering larvae, suggesting that the presence of hollow pith in the host wood affects the larval survivorship, probably through letting predators enter into and freely move within the host wood. Low survivorship values in Material II might be due to its smaller diameter: larvae boring thinner wood might be subjected to a greater hazard of entering into the pith, whose area ratio in cross section is larger in thinner wood than in

Table 3. Survivorships of *A. kusamai* at various aspects as calculated from the data obtained from the four host materials.

Material	Length [cm]	Diameters (Distal/Middle/Basal) [cm]	Number of entrance holes (N_{ent})	Number of exit holes (N_{ex})	Number of larval galleries: A (N_A)	Types*: B (N_B)	C (N_C)	D (N_D)	E (N_E)	Survivorships [%]: p_1**	p_2***	p_3****
I	123.5	3.0/4.9/6.5	46	27	20	17	4	7	7	53.3	35.0	85.0
II	122.5	2.2/2.8/4.5	19	4	10	3	4	1	5	23.3	10.0	42.9
III	74.0	3.4/4.0/4.3	27	9	13	9	5	0	2	33.3	0.0	64.0
IV	79.7	3.4/3.7/4.2	11	5	7	3	1	2	1	45.6	28.6	75.0

* For Types A–E, see Table 1 and Fig. 3.

** $p_1=(N_{ex}/N_{ent})\times100\%$: A value representing the survivorship from mid-instar larvae to adults in the wood.

*** $p_2=(N_D/N_A)\times100\%$: A value representing the survivorship of pith-entering mature larvae up to adults.

**** $p_3=\{N_B/(N_B+N_C)\}\times100\%$: A value representing the survivorship of non-pith-entering mature larvae up to adults.

thicker wood.

Of the four types of larval galleries defined in Table 1 and Fig. 3, Type B (those from the entrance hole arriving at the exit hole with no connection to the hollow pith) is the most important to know the boring manner of mature larvae because of its completeness. Data of the lengths of all the galleries of this type are summarized in Table 4. Some of the galleries of this type contain fibrous stuffing, while the others do not (Fig. 7). Of all the 31 Type B galleries of the four materials, 13 (42%) counted among the former cases, with the whole gallery length averaging 9.8 cm, whereas 7.6 cm in the latter cases (Table 4). These two differed significantly (MANN-WHITNEY's *U*-test, $p=0.0053$): it can be said that *A. kusamai* mature larva builds fibrous stuffing near its own pupal chamber only when the gallery is long enough.

Taking into account the length between fibrous stuffing end and exit hole (44 mm; Table 4), as well as the adult size (17–29 mm; KUSAMA & TAKAKUWA, 1984), pupal chamber is considered to be built at a very short distance under the bark.

Discussion

The present result indicates that the illumination intensity at the situation of host *S. sieboldiana* is positively correlated with the density of and damage by *A. kusamai*. In a rather natural environment, where the forest stand is dense, this cerambycid species occurs at a normally low density, while in an artificially disturbed environment, such as gardens and parks, where the hosts can be exposed to the sunlight and wind to a greater degree, it occurs in an abnormally high density, eventually resulting in decline of the host plants as was observed in the present study.

Similar inclinations have been reported in other cerambycids attacking living trees: *Megacyllene robiniae* (FORSTER) (Cerambycinae, Clytini) damages locust trees, *Robinia pseudoacacia*, under sparser and sunnier conditions (CRAIGHEAD, 1919),

Table 4. Lengths (cm) of larval galleries of *A. kusamai*, Type B*, in *S. sieboldiana* stems.

Material	Bolt No.	From the entrance hole to the stuffing end	Between fibrous stuffing ends	From the stuffing end to the exit hole	Total
I	1	5.5	0.8	5.0	11.3
		5.2	0.2	4.5	9.9
	2	5.0	3.0	3.8	11.8
		7.4	0.7	7.4	15.5
	3	—	—	—	7.8
		—	—	—	9.2
		6.7	0.9	3.5	11.1
		—	—	—	10.1
	4	1.8	0.7	4.8	7.3
		—	—	—	6.2
		3.1	0.5	6.2	9.8
	6	—	—	—	7.1
		4.5	1.3	3.7	9.5
	8	4.3	0.6	4.1	9.0
		3.6	0.5	3.1	7.2
	9	—	—	—	6.3
	10	—	—	—	5.5
II	2	—	—	—	7.2
	4	—	—	—	5.6
	5	—	—	—	6.4
III	1	—	—	—	8.5
	2	—	—	—	10.5
		—	—	—	7.8
	4	—	—	—	8.5
		—	—	—	8.5
		—	—	—	6.2
	5	3.8	0.5	3.8	8.1
	7	—	—	—	8.1
IV	3	—	—	—	7.8
	4	2.9	0.4	4.2	7.5
	7	4.6	2.0	3.5	10.1
Averages of the galleries with fibrous stuffing		4.5	0.9	4.4	9.8
Average of total lengths of the galleries without fibrous stuffing**					7.6
Average of total lengths of all galleries					8.6

* See Table 1 and Fig. 3.
** For gallery without fibrous stuffing, only the total value is given.

Anaglyptus subfasciatus PIC (Cerambycinae, Anaglyptini) occurs and damages a conifer species, *Cryptomeria japonica*, more heavily with lower density of plantation (NITTO & SAITO, 1962), sparser groves of oaks, *Quercus* spp., are more susceptible to attack by *Batocera lineolata* CHEVROLAT (Lamiinae, Batocerini) (HIDAKA, 1941), and *Anoplophora malasiaca* (THOMSON) (Lamiinae, Lamiini) causes damage on the sunnier sides of *Alnus hirsuta microphylla* plantations than the more shaded sides (ENDA & KOBAYASHI, 1968).

Whether these inclinations imply the direct preference of ovipositing cerambycid females for sunny and/or airy spots remains to be studied further: a seeming preference for sunnier condition may be resulted from that of ovipositing females and/or boring larvae for higher temperature and/or lower moisture content of the host wood, or from susceptibility of the hosts to beetle attack due to stress through droughty condition. In fact, not many, but a few wood-boring beetle species are heat-resistant (GRAHAM, 1925). Thus the causality among the factors must be considered.

Since the significant correlation between the increased diameter at the bottom and the increased intensity of damage was detected, the following two alternative scenarios are drawn: 1) if sunnier environment favors *S. sieboldiana* growth, increased illumination intensity leads to increased growth of *S. sieboldiana*, which leads to increased diameter at the bottom, which further leads to increased susceptibility to attack by *A. kusamai*; and 2) if sunnier environment affects *S. sieboldiana* health, increased illumination intensity leads to increased stress of *S. sieboldiana*, which further leads to increased susceptibility to attack by *A. kusamai*. Further study is needed to know which is the fact.

A decline of *S. sieboldiana* at the Shiki-no-Mori Prefectural Park is no doubt due to the infestation of and the damage by the present cerambycid species. Since this is not a highlighted plant species in this park, little attention has been paid to what it suffered. The present study, however, might contribute to the control of *A. ginkgovora*, a species very closely related to (or possibly a race of) *A. kusamai*, in the northern part of Kyushu, where ginkgo trees, *Ginkgo biloba*, suffer its damage (ONAGAMITSU & KANEKO, 1983; ONAGAMITSU, 1991; TAKAMIYA *et al.*, 1991; TAKAMIYA, 1992; etc.). Studying the susceptibility of ginkgo trees to *A. ginkgovora* in relation to the illumination under which trees are situated would contribute to its control.

要　　約

岩田隆太郎・高桑正敏・近藤雅浩・丸山祐治：横浜市におけるチャイロヒゲビロウドカミキリの生態，とくにニワトコ幹内での穿孔と生存率，日向の選好性について．—— 神奈川県横浜市緑区神奈川県立四季の森公園に植栽のニワトコにおいて，チャイロヒゲビロウドカミキリの激しい食害が認められた．低被害のニワトコは周囲に樹木が多く暗い環境に見られ，被害の激しいニワトコは周囲に樹木が少なく明るい環境に見られた．また被害は地際直径の大きい株に多く見られた．本種により加害されたニワトコの食坑道や孔を解析し，次の結果を得た．材内部の幼虫は，おそらくは宿主の周囲の草本層の成長による日陰を避けるために，上方へ向か

って穿孔していた．食坑道がいったん中空の髄に連絡すると，おそらくは侵入天敵が原因で，幼虫の生存率の低下が見られた．食入材が細いと生存率は低下した．食坑道が全体的に短いと，繊維状の詰物は見られなかった．以上より，本種は明るい場所に生えているニワトコの幹を好んで産卵し発生することが判明した．横浜市近辺では，明るい環境下に植栽されたニワトコは，本種の発生により衰退するものと考えられる．

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