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Secretion of Thrips

VII. Identification of 3-Butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one from *Holothrips japonicus* and *H. hagai* (Thysanoptera: Phlaeothripidae)¹

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When tubuliferous thrips are disturbed they secrete an odoriferous drop of fluid from the anus at the distal end of the abdomen. The rectum of the thrips is filled with this fluid when dissected. The gland secreting this fluid is not yet known. To classify tubuliferous thrips we have tried to use

the components of the secretions chemotaxonomically and have so far examined those from more than thirty species of Phlaeothripidae, Tubulifera and Thysanoptera. The results are various kinds of compounds in specifically various patterns, namely, hydrocarbons, carboxylic acids, terpenes, lactones, acetates and quinones (SUZUKI et al., 1986, 1988, 1989, 1990; HAGA et al., 1989, 1990).

We also obtained a pyranone compound from two species of the genus *Holothrips* and identified it as 3-butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one. Finding this compound from an animal source is a new discovery.

MATERIALS AND METHODS

Thrips. *H. japonicus* were collected from dead wood of an unknown species in Yamanashi Prefecture in June 1990. *H. hagai* were collected from dead foliage at Mt. Yui, Amami Island, Kagoshima Prefecture on February 1991.

Chemical analysis of the extracts. The thrips were immersed in 0.2 ml of re-distilled ether for 5 min, and the extracts were then directly analyzed on GLC, GC-MS and TLC. GLC analyses were carried out using a fused silica CP-Sil 19 CB capillary column and a fused silica FFAP capillary column (both columns, 0.25 mm × 25 m). TLC

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was performed using Kiesel-gel 60F₂₅₄ plates (Merck, 0.2 mm thickness; dev. solv., hexane-ether=7:3, v/v). MS spectra were measured with a Hitachi M-80B GC-mass spectrometer equipped with a fused silica Al-clad methylsilicone (non-polar) capillary column (0.22 mm×25 m) at 70 eV.

The double bond positions of the unsaturated hydrocarbons were determined by GC-MS analysis of dimethyl disulfide (DMS) adducts (FRANCIS and VELAND, 1981; VINCENTI et al., 1987). The configurations of the mono-ene hydrocarbons were decided by comparison of their retention times (t_R) with those of the corresponding synthetic compounds using FFAP column.

Chemicals. 7-Pentadecene and 8-heptadecene were prepared as previously reported (SUZUKI et al., 1989). 3-Butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one was synthesized from dehydroacetic acid via triacetic acid lactone (NAMIKI et al., 1952a).

RESULTS AND DISCUSSION

Components of the extracts

The GLC patterns of the extracts of the two

Fig. 1. Gas chromatograms of the extracts of *Holothrips japonicus* and *H. hagai*. C CB capillary column; 90–200°C, 4°C/min.

Fig. 2. Mass spectra of peak G and the synthetic 3-butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one.

Table 1. GLC and TLC data of peak G substance and the synthetic 3-butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one

Compound	GLC (t_R , min)		TLC
	CP-Sil	FFAP	R_f
Peak G	17.91	18.55	0.16
3-Butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one	17.94	18.55	0.16
Dehydroacetic acid	12.57	11.29	0.10

GLC: CP-Sil 19CB, 90–200°C, 4°C/min; FFAP, 170°C.

TLC: Kiesel-gel 60F₂₅₄, hexane-ether=7:3 (v/v).

Fig. 3. Mass spectra of the DMDS adducts of peak C (above) and peak F (below).

species were similar to each other, however, peak C was not detected and peak D was a main component in *H. hagai* (Fig. 1). The peak observed at t_R 16.40 min in Fig. 1 were separated into two peaks (peaks E and F) on FFAP column. GC-MS analysis revealed that peaks A, B, C, D, E and F were tridecane, tetradecane, pentadecene, pentadecane, heptadecadiene and heptadecene, respectively. The tailing peak G showed the molecular ion (M^+) at m/z 196 and the base peak at m/z 153 (Fig. 2), and agreed with the spot R_f 0.16 which was fluorescent under a UV lamp (254 nm) in TLC. The MS fragmentation pattern and the

small R_f value of peak G substance indicated that this compound was not a hydrocarbon. The MS spectrum of peak G agreed almost completely with that of 3-butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one (I) by a computerized mass spectra library search (Hitachi mass spectra library system). The MS, GLC and TLC data of peak G substance were identical with those of the synthetic (I) (Fig. 2 and Table 1).

On the other hand, the MS spectrum of the DMDS adduct of pentadecene (peak C) gave M^+ at m/z 304 with two characteristic fragments at m/z 145 and 159 ($304=145+159$). Thus, peak C was

Table 2. Components of the extracts of *Holothrips japonicus* and *H. hagai*

GLC peak No.	Compound	MS M ⁺ (base)	Content (%)	
			<i>H. japonicus</i>	<i>H. hagai</i>
A	tridecane	184 (57)	2.4	7.0
B	tetradecane	198 (57)	1.7	2.3
C	(Z)-7-pentadecene	210 (55)	1.6	—
D	pentadecane	212 (57)	24.2	59.3
E	heptadecadiene	236 (67)	30.0	12.3
F	(Z)-8-heptadecene	238 (55)	22.2	7.0
G	3-butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one	196 (153)	17.8	11.9

Fig. 4. Structures of 3-butanoyl-4-hydroxy-6-methyl-2H-pyran-2-one (I) and dehydroacetic acid (II).

determined as 7-pentadecene (7-C_{15:1}). Similarly, peak F was identified as 8-heptadecene (8-C_{17:1}) (Fig. 3). The two double bond positions of heptadecadiene (peak E) were not determined. Both configurations of double bonds of these two monoene hydrocarbons were decided as (Z) by comparing their retention times with those of the corresponding synthetic compounds using FFAP column (col. temp. 100°C, Peak F, *t_R*=27.03, (Z)-8-C_{17:1}, *t_R*=27.03, (E)-8-C_{17:1}, *t_R*=27.67; col. temp. 90°C, Peak C, *t_R*=15.74, (Z)-7-C_{15:1}, *t_R*=15.76, (E)-7-C_{15:1}, *t_R*=16.00).

All the components found in Fig. 1 were identified (Table 2). Pentadecane was a main component (59.3%) in *H. hagai* whereas heptadecadiene was a major component (30.0%) in *H. japonicus*. In addition, (Z)-7-pentadecene was not found in *H. hagai*. Therefore, both species were distinguishable from each other by GLC patterns of the extracts, although their components were almost identical.

The compound (I) (Fig. 4) was first synthesized by NAMIKI et al. (1952a) as a homolog of dehydroacetic acid (Fig. 4, II) (the well-known food

preservative) and has been identified from the essential oil (Patchouli oil) of *Pogostemon cablin* (Tabiatae) (DE RIJKE et al., 1978). (I) has anti-fungal activity like (II) (NAMIKI et al., 1952b), however, the significance of (I) for insects is still unknown.

(I) was identified for the first time from an animal source in this study.

Biology.

The *Holothrips* live in narrow crevices of dead wood or dead foliage, similar to the *Hoplothrips* we previously reported (HAGA et al., 1989). *Hoplothrips japonicus* of the latter genus has a secretion with only two carboxylic acids ((E)-3- and (Z)-5-dodecenoic acids).

On the other hand, there is a taxonomic problem with the subfamilial status of the genus *Holothrips*. The family Phlaeothripidae is divided into two subfamilies: the small-sized, juice-sucking Phlaeothripinae and the large-sized, spore-feeding Idolothripinae. *Holothrips* has been classified as the former with hesitation because the insects of this genus are medium-sized, fungus spore-feeders or hyphaefeeders. The broadness of maxillary stylets is intermediate between the two subfamilies (MOUND and PALMER, 1983; OKAJIMA, 1987). All of the idolothripine thrips we examined (14 species) have juglone (quinone) and carboxylic acids. Therefore, the results of this study support the hypothesis of MOUND and PALMER or OKAJIMA, namely that the *Holothrips* belong to a member of the Phlaeothripinae.

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Wing Reduction in the Autumn
Generation of the Oriental Chinch
Bug, *Cavelerius saccharivorus* OKAJIMA
(Heteroptera: Lygaeidae)¹

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The oriental chinch bug, *Cavelerius saccharivorus* OKAJIMA, is an important pest of sugar cane from Taiwan to the southwestern islands of Japan. This bug shows wing polymorphism of brachypters and macropters in both sexes, and only the macropters can fly (MURAI, 1975; FUJISAKI, 1985). Various environmental factors such as crowding of conspecifics, high temperature and long photoperiod accelerate the production of macropters (ÔSHIRO, 1981; FUJISAKI, 1989b).

This bug is trivoltine, with the first generation

in spring, the second in summer and the third in autumn. The production of macropters in spring and summer generations in response to these environmental factors would be highly adaptive because they can escape from crowded populations and colonize more favourable habitats such as newly planted sugar cane fields (FUJISAKI, 1985, 1986, 1989b). Conversely it is expected that both lower temperatures and shorter daylength in the autumn season should lead to the wing reduction in this bug.

In this paper, I describe the results of field surveys on the wing reduction of *C. saccharivorus* adults in the autumn season and discuss the adaptive significance of the wing reduction in this season.

MATERIALS AND METHODS

The visual counting of the numbers of each sex of adults and each stage of nymphs of *C. saccharivorus* was conducted for 20 stalks in a sugar cane field in the Okinawa Prefectural Agricultural Experiment Station in Naha, Japan, once a week from mid-October to late December in 1989. At the same time, more than 100 adults were collected from the sugar cane field to check their sex and wing form.

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