is more than 60 days at 25°C (KAWAUCHI, 1985) and the period may be prolonged at low temperature in autumn in the field, it is possible that some pupae derived not from second generation adults but from aestivating (first generation) ones. In any case, even in cold winter, the adults of *C. septeimpunctata bruckii* were able to emerge in central Japan on objects such as the wood stake.

OKUDA and HODEK (1983) stated that the life cycle of *C. septeimpunctata bruckii* belongs to type Dc of MASAKI's (1980) classification. However, it is considered from our results that some populations of *C. septeimpunctata bruckii* in warm regions in Japan with abundant sunshine in winter (e.g., the Osaka Plain) may belong to another type in this classification (probably Ec (SAKURATANI et al., 1985)), because of having an active phase in winter.

We wish to thank Dr. T. SUGIMOTO of Kinki University for his encouragement and critical reading of the manuscript.

REFERENCES

- KAWAUCHI, S. (1985) *Jpn. J. Appl. Ent. Zool.* **29**: 203–209 (in Japanese with an English summary).
 MASAKI, S. (1980) *Ann. Rev. Entomol.* **25**: 1–25.
 OKUDA, T. and I. HODEK (1983) *Acta Entomol. Bohemoslov.* **80**: 74–75.
 SAKURAI, H., Y. MORI and S. TAKEDA (1981) *Res. Bull. Fac. Agric. Gifu Univ.* **45**: 9–15 (in Japanese with an English summary).
 SAKURATANI, Y. and T. KUBO (1985) *Appl. Ent. Zool.* **20**: 439–442.
 SAKURATANI, Y., T. FUKUZAWA and T. YAMAMOTO (1985) *Abst. 32nd Conf. Ecol. Soc. Jap.* p. 47 (in Japanese).
 The Japan Meteorological Agency (1984) *Monthly Report of the Japan Meteorological Agency*. December 1983 and January 1984.

Biological Activity of the Chiral Sex Pheromone of the Peach Leafminer Moth, *Lyonetia clerkella* LINNÉ (Lepidoptera: Lyonetiidae)¹

Rikio SATO,² Noriyoshi ABE,² Hajime SUGIE,³ Minoru KATO,⁴ Kenji MORI⁴ and Yoshio TAMAKI³

²Fukushima Fruit Tree Experiment Station, Iizaka, Fukushima 960-02, Japan

³National Institute of Agro-Environmental Sciences, Yatabe, Tsukuba, Ibaraki 305, Japan

⁴Faculty of Agriculture, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan

(Received January 20, 1986)

The sex pheromone of the peach leafminer moth was reported to be 14-methyl-1-octadecene (SUGIE et al., 1984). Subsequently, SATO et al. (1985) reported that the (*S*)-isomer showed strong biological activity and the (*R*)-isomer had weak activity. This suggested that the (*S*)-isomer up to 1% of which may be contained in the (*R*)-isomer contributed to the activity of the (*R*)-isomer. Since 14-methyl-1-octadecene is unique as the sex

pheromone of lepidopterous species, the determination of its absolute configuration is of interest in connection with the correlation of structure-activity. The present paper deals with a further investigation of the activity of the two enantiomers using 100% optically pure synthetic compounds.

MATERIALS AND METHODS

Compounds. The enantiomers of 14-methyl-1-octadecene, the sex pheromone of the peach leafminer moth were synthesized from (*R*)-(+)-citronellol as reported previously (MORI and KATO, 1985).

Field tests. A hexane solution of synthetics was immersed in plastic capsules (8×17.8 mm, Yasumotokasei, YK-1) which contained 0.1 mg to 3 mg of each isomer and 0.1 mg to 1 mg of the mixture of the two isomers at the ratio of 9:1, 5:5, and 1:9. Two entrance types of traps with a sticky plate (25×30 cm) were used and the capsules were placed on the plate. Tests were carried out in a peach orchard in Date-machi, Fukushima Prefecture. Traps were set 1.5 m above the ground and 10 m apart and the locations were exchanged when the number of caught males was checked.

¹ Appl. Ent. Zool. **21** (3): 478–480 (1986)

Table 1. Field attraction of the peach leafminer moth by the enantiomers of the sex pheromone of this species

Lure		No. of males caught/trap/night
<i>S</i> ^a	3 mg	618.0 a ^c
	1 mg	164.3 cde
	0.3 mg	163.0 cde
	0.1 mg	42.0 fghi
<i>R</i> ^b	3 mg	0.0 k
	1 mg	0.0 k
	0.3 mg	0.0 k
	0.1 mg	0.3 k
<i>S</i> : <i>R</i> =9: 1	1 mg	286.0 b
	0.3 mg	225.0 bc
	0.1 mg	61.0 fg
<i>S</i> : <i>R</i> =5: 5	1 mg	197.3 bcd
	0.3 mg	74.3 f
	0.1 mg	17.3 hij
<i>S</i> : <i>R</i> =1: 9	1 mg	59.3 fgh
	0.3 mg	23.3 ghij
	0.1 mg	0.7 k
Control		0.0 k

^a *S*: (*S*)-14-methyl-1-octadecene, ^b *R*: (*R*)-14-methyl-1-octadecene.

^c Values were transformed by $\sqrt{x+0.5}$ and tested by DUNCAN's new multiple test. Values followed by the same letter are not significantly different from each other at the 5% level.

RESULTS AND DISCUSSION

The activity of the two isomers is shown in Table 1. A mixture of 9: 1 was more active than the (*S*)-isomer itself at 1 mg dose level but at 0.3 mg and 0.1 mg dose levels the activity was not significantly different. It is then difficult to conclude that the addition of the (*R*)-isomer to the (*S*)-isomer has a synergistic effect. A racemic mixture showed strong activity and the (*R*)-isomer was not active.

SATO et al. (1985) reported that 100 μ g of the (*R*)-isomer showed almost the same activity as 1 μ g of the (*S*)-isomer. As the optical purity of synthetics used by SATO was estimated to be more than 99%, about 1 μ g of the (*S*)-isomer may be contained in 100 μ g of the (*R*)-isomer. Thus the weak activity of the (*R*)-isomer (SATO et al., 1985) can be explained by our results that only the (*S*)-isomer is active and 1% enantiomeric contamination causes the (*R*)-isomer to be active.

Three cases of the activity of the enantiomers of sex pheromones produced by female moths have been reported as follows. 1) Only one of the

enantiomers shows activity and the others are inhibitory (the gypsy moth, MILLER and ROELOFS, 1977; the western skeletonizer moth, SONDERSTROM et al., 1985). 2) Only one of the enantiomers shows activity and the others do not (the bugworm moth, LEONHARDT et al., 1983). 3) All enantiomers show activity (the smaller tea tortrix moth, TAMAKI et al., 1980; TAMAKI et al., 1983). The enantiomers of the sex pheromone of the peach leafminer moth show activity like that in the second case.

REFERENCES

- LEONHARDT, B. A., J. W. NEAL, Jr., J. A. KLUN, M. SCHWARZ and J. R. PIMMER (1983) *Science* **219**: 314-316.
- MILLER, J. R. and W. L. ROELOFS (1977) *Ann. Entomol. Soc. Am.* **70**: 136-139.
- MORI, K. and M. KATO (1985) *Liebigs Ann. Chem.* **1985**: 2083-2087.
- SATO, R., N. ABE, P. SONNET, H. SUGIE and Y. TAMAKI (1985) *Appl. Ent. Zool.* **20**: 411-415.
- SONDERSTROM, E. D., D. G. BRANDL, J. MYERSON, R. G. BUTTERY and B. E. MACKEY (1985) *J.*

- Econ. Entomol.* **78**: 799–801.
 SUGIE, H., Y. TAMAKI, R. SATO and M. KUMAKURA
 (1984) *Appl. Ent. Zool.* **19**: 323–326.
 TAMAKI, Y., H. SUGIE, M. OSAKABE and P. SONNET
 (1983) *Appl. Ent. Zool.* **18**: 292–294.
 TAMAKI, Y., H. NOGUCHI, H. SUGIE, A. KARIYA,
 S. ARAI, M. OHBA, T. TERADA, T. SUGURO and
 K. MORI (1980) *Jap. J. appl. Ent. Zool.* **24**:
 221–228 (in Japanese with an English summary).

Termination Pattern of Diapause in
 the Two-Spotted Spider Mite,
Tetranychus urticae KOCH (Acarina:
 Tetranychidae) in Sapporo¹

Tetsuo GOTOH²

*Institute of Applied Zoology, Faculty of Agriculture,
 Hokkaido University, Sapporo 060, Japan*

(Received February 13, 1986)

The reproductive diapause of the two-spotted spider mite, *Tetranychus urticae* KOCH, terminates after the mite has been kept in a cold rest for 10 to 100 days (LEES, 1953; BONDARENKO, 1958; VON NUBER, 1961; HUSSEY, 1972; VEERMAN, 1980), but in some populations they terminate diapause without a cold rest (VON NUBER, 1961; PARR and HUSSEY, 1966; VEERMAN, 1977). These suggest that the duration of the diapause period which provides a measure of the intensity of diapause varies widely among local populations. In Sapporo, northern Japan, there is no report on the intensity of diapause in *T. urticae*. The present study shows the termination pattern of diapause of a *T. urticae* population from red currant, *Ribes rubrum* L., in a pear-apple experimental orchard of Hokkaido University, Sapporo.

Samples of about 40 diapausing females were collected from litters beneath red currant plants every 10 days during the period from mid-October, 1981 to late April, 1982, and their capacity for terminating diapause was tested by placing them individually on fresh bean leaves (*Phaseolus vulgaris* L.) at $25 \pm 1^\circ\text{C}$ and 15L–9D (see GOTOH, 1986 for details). These females were checked daily and they were considered to have reactivated if their colour had changed from the bright orange-

red of the overwintering form to the yellowish-green of the summer form, and in addition feeding and oviposition had started (VEERMAN, 1977).

Twenty-eight (72%) out of 39 diapausing females tested had reactivated in mid-October when the investigation was started (Fig. 1), and the remainder died within 20 days after incubation. In and after November, the percentage of females that laid eggs increased gradually. After mid-February, almost all the females laid eggs. These results differ from the results of the Sapporo population of *Tetranychus viennensis* ZACHER, in which no diapausing females reactivated until November, and the proportion of ovipositing females reached a maximum of 93% in early February under the same conditions (GOTOH, 1984). This shows that diapause of *T. urticae* is weaker than that of *T. viennensis*, and that diapause of *T. urticae* can be terminated without a cold rest under long photoperiods and high temperatures, as shown in some tetranychids and insects (VEERMAN, 1977; BECK, 1980).

The number of days to oviposition after incubation was 12 on the average with a large variation in October, and thereafter both the average and range declined continuously with a small fluctuation until April (Fig. 1). In late April, all the females laid eggs within 5 days (2.5 days on the average). This period is much shorter than that observed in *T. viennensis*, which required 8.5 days on the average in the same season (GOTOH, 1984). This is in accordance with previous reports showing that the occurrence of *T. urticae* in Sapporo was earlier than that of *T. viennensis* (IMABAYASHI, 1961; GOTOH, 1984, 1986). Since the number of days to oviposition after incubation decreased continuously with the advance in season, the time of diapause termination could not be determined.

¹ *Appl. Ent. Zool.* **21** (3): 480–481 (1986)

² Present address: *Laboratory of Applied Entomology, Faculty of Agriculture, Ibaraki University, Ami, Ibaraki 300-03, Japan*