ELECTROANTENNOGRAM RESPONSES OF GRAPE BORER Xylotrechus pyrrhoderus Bates (COLEOPTERA: CERAMBYCIDAE) TO ITS MALE SEX PHEROMONE COMPONENTS

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Abstract—Electroantennograms were recorded from the grape borer Xylotrechus pyrrhoderus in response to serial dilutions of male sex pheromone components, (2S,3S)-octanediol and (2S)-hydroxy-3-octanone, and to 100 µg of their optical isomers and host plant substances. Female antennae always responded more strongly than male antennae. Antennae of both sexes were highly sensitive to (2S)-hydroxy-3-octanone. F/M ratio (female to male EAG value) was greater for male sex pheromone components, especially (2S,3S)-octanediol, and their optical isomers than plant substances. Antennal sensitivity to optical isomers (2R,3R-octanediol and 2S,3R-octanediol) was lower than true pheromone components.

Key Words—Electroantennogram, grape borer, Xylotrechus pyrrhoderus Bates, Coleoptera, Cerambycidae, male sex pheromone, (2S,3S)-octanediol, (2S)-hydroxy-3-octanone, optical isomers.

INTRODUCTION

The grape borer Xylotrechus pyrrhoderus Bates is a major pest of grapevines in Japan. The courtship behavior involves a male sex pheromone attractive to females over a distance of 1–1.5 m (Iwabuchi, 1982).

The male sex pheromone was identified as a two-component mixture of (2S,3S)-octanediol (S,S-diol) and (2S)-hydroxy-3-octanone (S-ketol), although the detail of their biological significance has not been clarified (Sakai et al., 1984).
The electroantennogram (EAG) technique has proved to be useful for identifying the primary pheromone component, particularly in lepidopterous species, and for obtaining valuable information on the coleopterous antennal perception of pheromones for which the behavioral response is known.

The present study was carried out to clarify the antennal responses of the grape borer to synthetic male sex pheromone components and to compare them with responses to their optical isomers and other plant substances.

Nishino et al. (1977) proposed a M/F ratio, the value of male mean response divided by the female mean response. This ratio reflects the patterns of perception of stimuli to the olfactory receptors and represents the discrimination between sexually active compounds and general odorous compounds (Nishino et al., 1977). It has been suggested (Nishino et al., 1980) that a high value would occur if the female antenna has many receptors for an odorant (e.g., sex pheromone) while the male antenna has few or none. Instead of the M/F ratio, we propose the F/M ratio for the grape borer, since the grape borer's pheromone was male-produced and it is the female which responds to the pheromone.

**METHODS AND MATERIALS**

*Animals.* Pupae taken from vine cuttings were sexed and maintained in the laboratory under a photoperiod of 14 hr light–10 hr dark at 25°C. Adults of both sexes were reared separately in glass tubes (1.5 × 3.5 cm) for a period of 15 days, the period required for sexual maturation (Iwabuchi, 1982), before being used for EAG tests. To determine the effect of age on the EAG response, 1-, 7-, 20-, and 25-day-old females were also tested.

*Stimulating Chemicals.* The grape leaf volatile compounds were identified by Wildenradt et al. (1975). Of the major compounds of grape leaf volatile, the following were tested for EAG experiments: hexanol, (E)-2-hexen-1-ol, (Z)-3-hexen-1-ol, citral, linalool, (E)-2-hexenal, and geraniol. In addition, eugenol, which is not reported as a grape leaf volatile compound, was also tested. Chemicals known as major components of vine leaves were obtained commercially.

Pheromone components, S,S-diol and S-ketol, and their isomers were synthesized according to the procedure reported by Sakai et al. (1984). That is, S,S-diol and its optical isomers (R,R-, S,R-, and R,S-diols) were obtained from methyl D- or L-tartrate according to the synthesis of exobrevicomin by Mori et al. (1974), while S-ketol and its optical isomer (R-ketol) were prepared, respectively, from L-lactic acid and from D-alanine treated with amyllithium. Physical data of the compounds are as follows:

- \((2S,3S)\)-Octanediol (S,S-diol). \([\alpha]_{D}^{23} = -19.2^\circ\); \([1^\text{H}]\text{NMR}, \delta 0.90 \text{ (3H, t, } J = 6.7 \text{ Hz)}, 1.19 \text{ (3H, d, } J = 6.3 \text{ Hz)}, 2.01 \text{ (1H, d, } J = 5.9 \text{ Hz)}, 2.07 \text{ (1H, d, } J = 5.9 \text{ Hz)}, 3.33 \text{ (1H, m)}, 3.59 \text{ (1H, m)}; \text{MS, } m/z 101 \text{ (6\%), } \text{M}^+ - \text{CH}_3\text{CHOH), 83(59), 75(4), 57(15), 55(100), 45(22), 43(22), 41(24).}

- \((2R,3R)\)-Octanediol (R,R-diol). \([\alpha]_{D}^{27} = +17.5^\circ\).