EMPIRICAL CORRELATIONS BETWEEN ELECTROANTENNOMGRAMS AND BIOASSAYS FOR Periplaneta americana

M. L. CONTRERAS, D. PEREZ, and R. ROZAS

Department of Chemistry and Biochemistry
University of Santiago
Casilla 5659, Santiago-2, Chile

(Received August 1, 1988; accepted January 12, 1989)

Abstract—Determination of electroantennograms (EAGs) with an electroantennometer having a positive and a negative peak detection option, and with a stimulus delivery device providing local stimulation of the antenna of P. americana, allowed for the detection of three typical EAG patterns for a wide range of compounds tested. Some of the compounds presented at least one positive EAG peak (0.1-0.3 mV), others showed a single negative EAG peak (-1.0 to -1.1 mV), and a third group had more than one negative EAG peak (-0.2 to -0.8 mV). These EAG results correlate with behavioral assays of P. americana. Thus compounds having a positive EAG response act as repellents, while those having negative EAG responses act as attractants, depending on concentration. EAG patterns thus can permit prediction of behavioral responses of P. americana.

Key Words—Electroantennography, EAG, bioassays, Periplaneta americana, Orthoptera, Blattidae, electroantennogram, attractants, repellents, pheromones, mimics, chemical stimulation, American cockroach.

INTRODUCTION

The electroantennography of insects has normally been done with pheromones, mimic compounds, plant volatiles and, sometimes, repellents (Andersen et al., 1987; Gothilf and Bar-Zeev, 1972; O'Connell et al., 1986; Roelofs, 1984). For P. americana, these studies have been done mostly with pheromones, mimics, and general odors (Manabe and Nishino, 1986; Nishino and Takayanagi, 1979). The electroantennometers used in most of these experiments have been con-
structured to detect just a single depolarization response, i.e., a negative peak if the grounded electrode is connected to the distal part of the antenna. The devices used for obtaining the EAGs normally have considered stimulation of a very wide zone of the antenna as a whole. In these conditions the reported EAG results always have shown a single depolarization, negative in sign, for the active compounds (Gothilf and Bar-Zeev, 1972; O'Connell et al., 1986). On the other hand, bioassays for determining the activity of the compounds as attractant pheromones or mimics have been carried out with compounds presenting a negative peak under the EAG recording conditions. To the best of our knowledge, no clear results have been reported about any positive EAGs.

In this work, we present the results obtained in the electroantennography of \textit{P. americana} with a specially constructed electroantennometer that has a simultaneous positive and negative peak detection option (Perez and Rozas, 1984) and a stimulus delivery system that has been designed to work with local stimulation of the antenna (Rozas and Perez, 1987). We also present the results of the bioassays of \textit{P. americana} with the same compounds tested in the EAGs. It will be shown that compounds with a repellent effect on the insects in the bioassay have a positive EAG; those that behave as attractants in the bioassay have a negative EAG.

\section*{METHODS AND MATERIALS}

\textit{Stimulation Chemicals.} A wide structural array of available compounds was tested in this study, taking in consideration the structure of some repellents (Hagenbuch et al., 1987), some chemicals present in ventral glands of \textit{P. americana} (Fukuchima et al., 1987), common solvents, and known pheromones. All of the chemicals tested were \textit{pro analysi} reagents; before the experiments they were further purified up to 99.0–99.5\% purity as determined by GC. Periplanone B was prepared according to Schreiber and Santini (1984).

\textit{Insects.} The male and female \textit{P. americana} were maintained at 23–27°C, 45 \pm 10\% relative humidity, and a photoperiod of 6:18 light–dark. During the day, darkness was provided by a dark crypt inside a box, which allowed restricted light access to the crypt. Adult males of similar size and weight chosen for the EAG and bioassay experiments were separated into another box five days before the experiments and kept as before in the same environment. After use in the EAG and bioassay, they were discarded.

\textit{Electroantennography.} The electroantennography of \textit{P. americana} was done with an electroantennometer previously described (Perez and Rozas, 1984) and with a specially designed stimulus delivery device (Rozas and Perez, 1987), which basically consists of a glass tube of 3.8 mm internal diameter where the antenna is held perpendicular to it. The antenna at each extreme is attached to