VIDU 18-3&4-24

INSECT PEST CONTROL ; THE SEMIOCHEMICAL APPROACH

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INSECT'S RECOGNITION OF ODORS;

Have you ever seen a female brinjal fruit borer (*Leucinoides orbonalis*) laying eggs on a coconut palm or the reverse, a female red weevil (*Rhynchophorus ferrugineus*) laying eggs on a brinjal plant? The answer is no because insects have a remarkable ability to recognize their respective hosts. They also have ways of communicating with other members of their own species as well as other species.

In 1959 a German scientist A.R. Butenendt isolated and identified an alcohol, 10(E), 12(Z)-hexadecadienol which is emitted by the body of the female silk moth, ***Bombyx mori*** to signal the male ***Bombyx mori*** of her availability for mating. This finding opened up a new chapter on insect communication in the broad area of chemical ecology. More than 1000 such chemicals responsible for interactions between insects and insects/insects and plants have been revealed up to date. The chemicals that carry messages from one organism to another are given the term Semiochemicals meaning, Signal Chemical (Greek semeon=signal). The host finding behaviours of some Coleopterans, mate finding behaviours of Lepidopterans, trail following action of ants, mass attack by ants if you disturb their nest, all organized activities in a beehive are due to the semiochemicals (**Fig 1**).

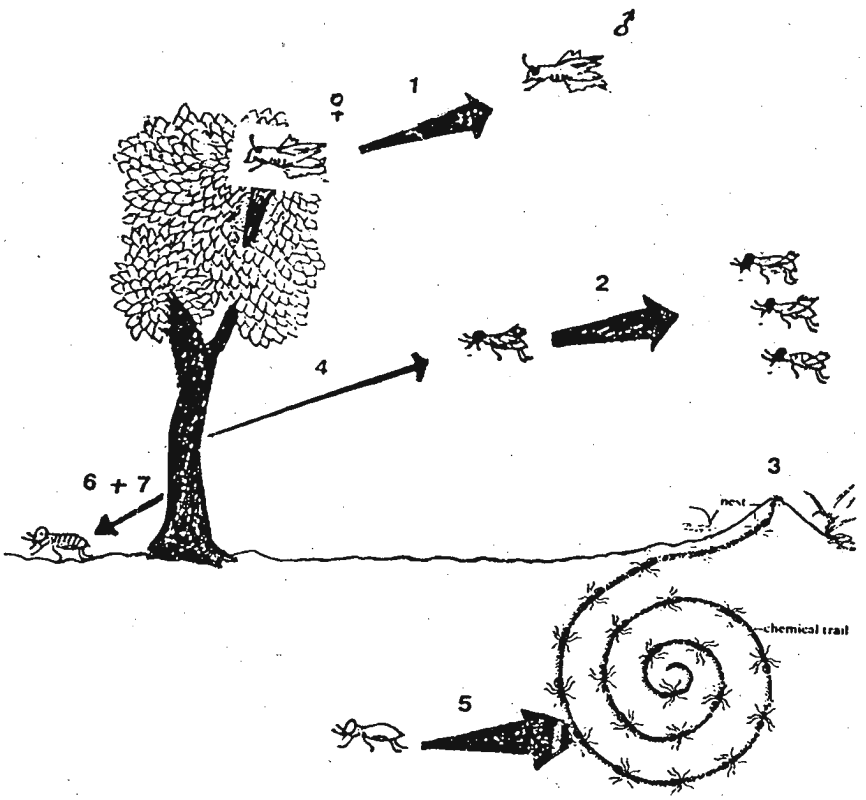
Insects recognize semiochemicals mainly through their antennae. Insect antennae are very powerful detectors which detect compounds at levels even as low as 10^{-10} (picograms) in contrast to some chemical detectors in a modern laboratory, e.g. capillary column Gas Liquid Chromatography, (GLC) which could record chemicals only at 10^{-9} (nano gram) level.

An insect antenna has a large number of olfactory hairs where the receptor cells are located. When semiochemical molecules from the air bind to the receptor cells it creates a flow of ions across the membrane causing a change in the membrane potential. This is called slow receptor potential and is composed by many elementary potentials. The slow receptor potential is transformed to action potentials (nerve impulse) which finally are transposed into the central nervous system resulting in a specific behaviours such as flying towards the host or mate, trail following etc.

MEASUREMENT OF RECOGNITION; ELECTROANTENNOGRAPHY

In 1957 D. Schneider another German scientist found that the sum of slow receptor potentials created in an antenna on receipt of a semiochemical can be measured by inserting two micro electrodes into the two ends of an insect antenna.

FIG 1



INTRA SPECIFIC COMMUNICATION

1. Sex Pheromones
2. Aggregation Pheromone
3. Trail Pheromone

SEMIO CHEMICALS

INTER SPECIFIC COMMUNICATION

4. Host Attractants
5. Defence Secretions
6. Repellents
7. Deterrents

Since the potential differences created are very small being in the range of 0.1 to 1.5 mV in magnitude, an amplification is necessary before recording them. A simple device comprising two microelectrodes, an amplifier and a recorder is called an electroantennogram (EAG) and the response pattern of the insect antenna is shown in **Fig. 2**. The magnitude of the response is a measure of the degree of recognition.

EAG is a powerful technique for screening single candidate compounds for attractivity. Within a short period of time a large number of compounds can be tested. The amount of candidate compounds can be as low as 0.001 micro gram. EAG becomes even more useful when it is combined with a gas liquid chromatography (EAD-GC) where individual compounds in a mixture is separated and exposed to an antenna sequentially.

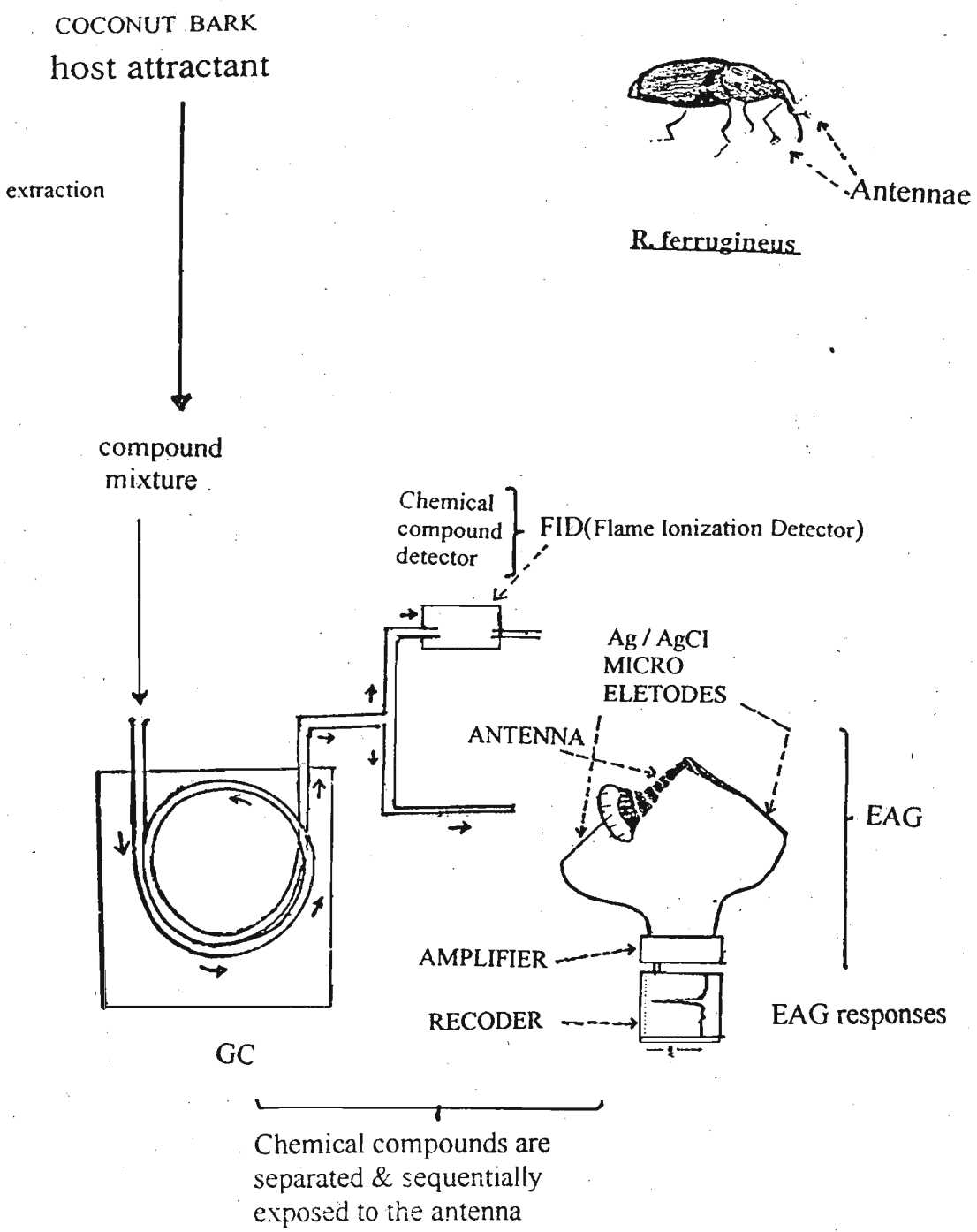
THE SEMIOCHEMICAL APPROACH TO CONTROL INSECT PESTS;

To illustrate the semiochemical approach, the case of the coconut pest, Rhynchophorus ferrugineus commonly known as the red weevils can be considered. The red weevil is one of the major pests of coconut palm. The female red weevil lay about 200 eggs on an open tissues (a wound) of the coconut bark and the larvae feed on the soft tissues of the palm until they complete their growth which take 4-6 months. This cause damage to the palm and finally it dies. Since the larvae are inside the palm it is difficult to detect this pest before the damage become serious.

In the semiochemical approach one looks for possible clue of the target insect's communication modes. In this case it was known that the red weevil is attracted to damaged coconut palms. Most plausible explanation is that a chemical signal may be released as a clue to the red weevil to find its host. When the chemical compound mixtures extracted from the coconut bark was tested against the red weevils in a laboratory for attractivity, it was found positive confirming the presence of an attractant. The response profile of the coconut bark to a chemical detector called flame ionization detector (FID) (**Fig 3,** chromatogram) showed a large number of compounds. How does one recognizes the semiochemicals in this mixture? In order to pin point only the semiochemicals in the coconut bark extract, EAD=GC was carried out using the red weevils antenna (**Fig 2**). The bark extract was separated into its components by the GC and they were sequentially & simultaneously exposed to an FID and a red weevil antenna. The red weevil antennal response profiled (EAD-GCs) showed the recognition of compounds exposed to the antenna at 39.00 min. Chemical identification of the two compounds fell into this active region showed r-nonanoic acid lactone (1) and 4-hydroxy-3-methozystyrene (2) as attractants.

The next step was to produce these chemicals in sufficient quantities synthetically because from coconut several

FIG 2.


COCONUT BARK
host attractant
extraction
compound mixture
Antennae
R. ferrugineus
Chemical compound detector
FID(Flame Ionization Detector)
Ag / AgCl MICRO ELETODES
ANTENNA
EAG
AMPLIFIER
RECODER
EAG responses
GC
Chemical compounds are separated & sequentially exposed to the antenna

EAD-GC

kilos of the coconut bark one can isolate only micro gram quantities of above attractants. Artificially produced attractants can be used in a trap as a bait to attract the red weevil. The red weevils which lure into the attractants will get trapped & die.

THE ADVANTAGES

Semiochemical baited traps can be deployed to reduce adult pest population thus reducing the pest attacks on palms.

An attractant baited trap can be used to monitor pest levels too. The trap catch will be indicative of the level of pest population and preventive measures such as sealing the wounds of the bark can be attended to if necessary.

The conventional method of control of this pest is drilling holes in the bark of a infested palm and introducing several kilos of insecticides to kill the larvae inside.

The attractant baited trap is completely free of insecticides and therefore this method is environmentally safe.

Insecticides are not selective for a particular pest species thus killing beneficial insects species as well as pest species. Semiochemical approach only destroys a target species because the attractants are species specific.

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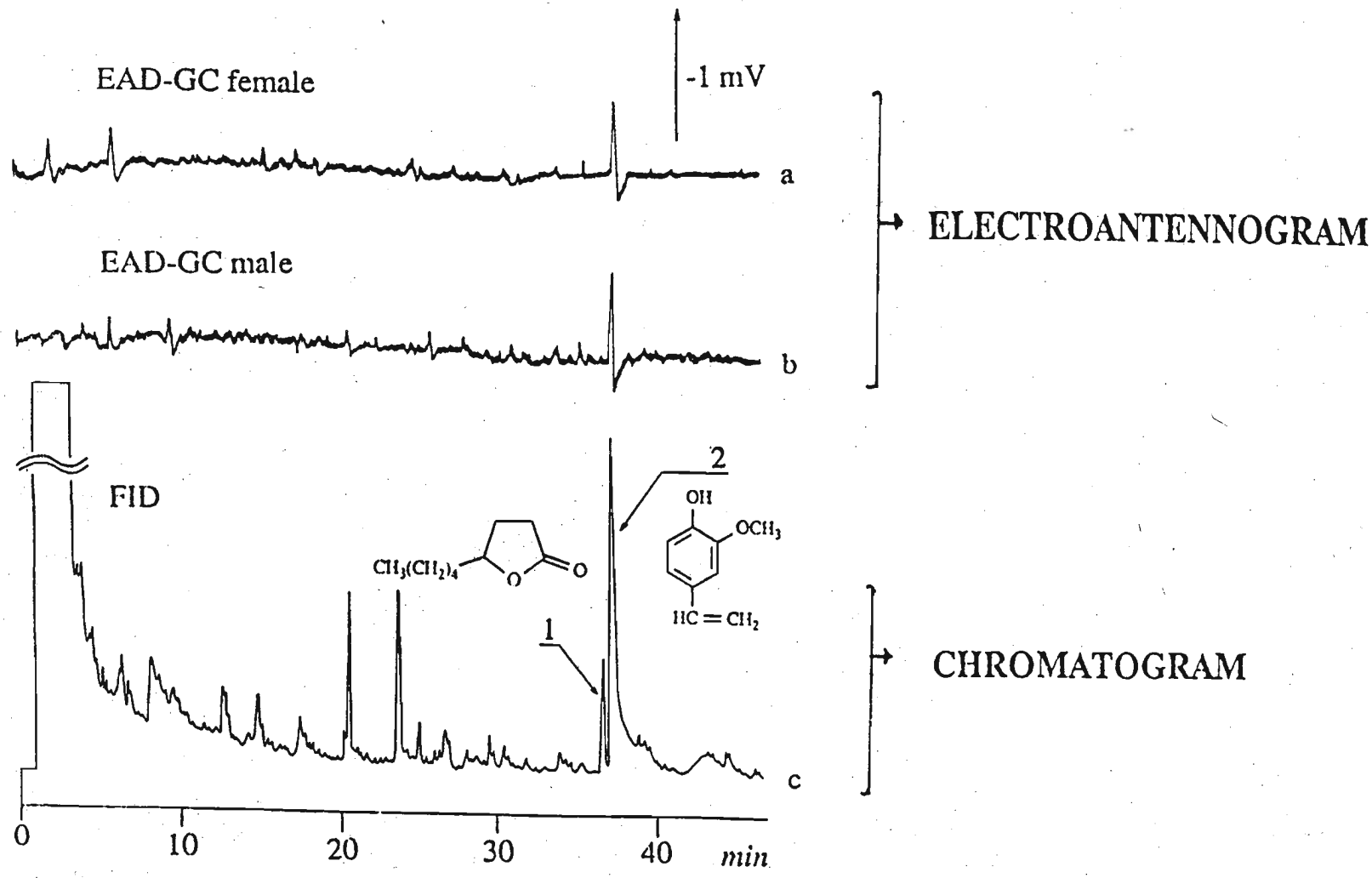
EAD-GC female
-1 mV
a
EAD-GC male
b
ELECTROANTENNOGRAM
FID
2
OH
OCH3
CH3(CH2)4
O
O
HC = CH2
1
CHROMATOGRAM
c
0
10
20
30
40
min

FIG 3