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Lepidopteran Sex Pheromones

Tetsu Ando (✉) · Shin-ichi Inomata · Masanobu Yamamoto

Tokyo University of Agriculture and Technology, Graduate School of Bio-Applications and Systems Engineering (BASE), Koganei, 184-8588 Tokyo, Japan
antetsu@cc.tuat.ac.jp

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Abstract As a consequence of the diversity of Lepidoptera, including 150,000 described species, interesting species-specific sex pheromone systems are exhibited in this insect group. The quite varied pheromones, which have been identified from female moths of nearly 530 species from around the world, are classified into groups of Type I (75%), Type II (15%), and miscellaneous (10%), according to their chemical structures. Additionally, many pheromones produced by male moths and butterflies have been known. While new sex pheromones from about 70 lepidopteran species have been reported in the last five years utilizing GC-EAD, GC-MS, LC, and NMR, our information about the pheromones is still rudimentary, and these kinds of semiochemicals remain an exciting research target for natural product chemistry. In addition to the overview of their chemical structures, this chapter deals with current methods for their identification. Furthermore, an actual application of the synthetic pheromones for pest control is briefly introduced.

Keywords Pheromones · Female moth · Male attractants · Chemical ecology · Mating disruption

List of Abbreviations

DMDS	Dimethyl disulfide
EAG	Electroantennogram
EI	Electron impact ionization
FID	Flame ionization detector
GC-EAD	Gas chromatography combined with an EAG detector
GC-MS	Gas chromatography combined with mass spectrometry
HPLC	High performance liquid chromatography
KI	Kovats retention index
LC-MS	Liquid chromatography combined with mass spectrometry
MPLC	Medium pressure liquid chromatography
MTAD	4-Methyl-1,2,4-triazoline-3,5-dione
RID	Refractive index detector
SPME	Solid phase micro-extraction
TIC	Total ion chromatogram

1 Introduction

Lepidoptera is the second largest insect group and includes nearly 150,000 described species, which have evolved over 100 million years since the Mesozoic era. For the birth of a new species, it must be isolated from other species by some factor to prevent inter-species crossing. The sex pheromone, which is secreted by the adult (usually by a female moth and sometimes by a male moth or butterfly) for the benefit of a specific partner, plays an important role in reproductive isolation. Therefore, it is no wonder that the chemical structures of the species-specific pheromones exhibit considerable differences.

As a consequence of the large number of pest species which comprise this order, enormous efforts have been expended, especially since the identification of bombykol from the silkworm female moth (*Bombyx mori*) in the late 1950s [1], on studies of lepidopteran sex pheromones. Namely, in addition to the early studies done with harmful pests such as the cabbage looper (*Trichoplusia ni*) [2] and the gypsy moth (*Lymantria dispar*) [3], the chemical structures of female sex pheromones with a long-range attractive activity have been determined for nearly 530 moth species from across the world to date. Furthermore, field evaluations of the identified sex pheromones and related compounds have revealed attractants of males for another 1250 moth species. Additionally, many male sex pheromones produced by moths and butterflies have been reported. Considering the species diversity within the Lepidoptera, it should be mentioned that our information is still rudimentary. Other natural products, however, have not been investigated on so many different species as the lepidopteran sex pheromone have. In the last 5 years, new pheromones from about 70 lepidopteran species