Research on chemical ecology at the Plant Protection Institute (ATK HAS, Hungary)

Inaugural lecture, Hungarian Academy of Sciences
Oct. 18, 2011.
Miklós Tóth

Foto: Tóth M.
Research and application of pheromones and other semiochemicals

- identification of first pheromone structure (silk moth - *B. mori*) (Butenandt et al., 1959)

- definition of the term “pheromone” (Karlson and Lüsch, 1959)

- elucidation of pheromone structures of the first few agricultural pest moths (end of sixties - beginning of seventies)

Foto: Tóth M.
General characteristics of pheromones:

– pheromone composition is unique per insect

– pheromones can be extracted in extremely low quantities from insects

– insects require extreme purity in synthetic pheromones
The challenge was:
to elucidate pheromone composition of agricultural pest insects

Preconditions:

– as background, behavioral observations on target insects

– adaptation or development of special instruments and methods used in the research on pheromones
Background studies:
emission of pheromone -
calling posture

cabbage armyworm
(*M. brassicae*)
**Background studies:** daily rhythmicity and age dependence of pheromone emission (females) and responsiveness (males) to the pheromone.

Intensity of calling behaviour

Gamma moth (*A. gamma*)

Catches (males) in traps baited with respective pheromone.
Adaptation / development of special instruments and methods: electroantennograph (EAG)

gamma bagolylepke (A. gamma)

Adaptation / development of special instruments and methods: wind tunnel olfactometry

Cabbage armyworm (M. brassicae)

1 = Z11-16Al
2 = Z9-16Al
3 = S16Al

Tóth et al., Ent. exp. appl., 42:291, 1986
Adaptation / development of special instruments and methods: volatile collection of pheromone in glass capillaries

Tóth et al., J. Chromat., 598:303, 1992

Cotton bollworm (H. armigera)
Adaptation / development of special instruments and methods: gas chromatography with parallel insect antennal and flame ionisation detection (GC-EAD/FID)

1 = Z11-16Al
2 = Z9-16Al
3 = S16Al

Tóth et al., Ent. exp. appl., 122:125, 2007

Sugarbeet weevil *B. punctiventris*
Adaptation / development of special instruments and methods: collection of volatiles in a closed-loop system (CLSA)

**Agriotes sordidus** click beetle

<table>
<thead>
<tr>
<th>gland extract</th>
<th>geranyl hex.</th>
<th>farnesyl hex.</th>
</tr>
</thead>
<tbody>
<tr>
<td>int. std.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**geranil / farnezil arány**

| mirigy: | 1 : 1 |
| CLSA    | 1 : <0.1 |

Chemical research support:

MTA Központi Kémiai Kutatóintézete - Szántay Cs.
BME Szerveskémiai Intézet - Novák L.
Hamburg Universität (Németo.) - W. Francke
Eidgenössische Forschungsga.t Wädenswil (Svájc) - H. Arn
Lund University (Svédo.) - C. Löfstedt

USDA ARS NCUR, Peoria (USA) - R.E. Bartelt
USDA ARS CMAYE, Gainesville (USA) - J.H. Tumlinson
Rothamsted Research, Harpenden, Herts. (UK) - J.A. Pickett

...and several other labs...
New discoveries in moths (Lepidoptera)

Elucidation of chemical structures of pheromones in 47 pest moths

Distribution by plant culture:
- orchard and horticult.
- field and vegetable crops
- forestry
- other
New discoveries in moths (Lepidoptera)

5,9-dimethyl-heptadecane

Leucoptera scitella

Érd
Duna-haraszti

New discoveries in moths (Lepidoptera)

(3Z,6Z)-1,3,6-9S,10R-epoxy heneicosatriene

fall webworm

(H. cunea)

Foto: Nagy Z. L.

Tóth et al., Tetrahedron Lett. 30:3405, 1989
New discoveries in moths (Lepidoptera)

Nepticula malella

Foto: Nagy Z. L.

6,8-nonadiene-2-ol

New discoveries in moths (Lepidoptera)

Turnip moth (A. segetum): pheromonal “strains”

New discoveries in beetles (Coleoptera)

Identification of pheromones, allomones and kairomones in 25 pest beetles

Distribution by plant culture:
- field and vegetable crops
- orchard and horticult
- other

Horticult.
New discoveries in beetles (Coleoptera)

Click beetles (Elateridae)

Gas chromatography of pheromone gland extracts

- first identification
- improving known composition
- confirming known composition

A. ustulatus
A. obscurus
A. sordidus
A. litigiosus
A. lineatus
A. brevis
A. sputator
A. rufipalpis
A. proximus
New discoveries in beetles (Coleoptera)

Scarab beetles (Scarabaeidae)

- first identification
- improving known composition
- confirming known composition

- A. dubia
- A. solida
- A. solstitialis
- A. vitis
- C. aurata
- E. hirta
- O. funesta
- O. cinctella
- P. cuprea
- R. vernus
- T. squalida
New discoveries in beetles (Coleoptera)

Flea beetles (Halticidae)

- Ph. cruciferae
- Ph. nemorum
- Ph. nigripes
- Ph. undulata
- Ph. vittula

First identification

Improving known composition

Confirming known composition

- Ph. cruciferae (európai populáció)
- Ph. nemorum
- Ph. nigripes
- Ph. undulata
- Ph. vittula

Ph. vittula

Összes fogás: 577 bogár

Ph. cruciferae

Összes fogás: 3696 bogár

Átlag + SE

ALLYL feromon

Foto Csonka É
Extension activities

Application of our scientific results:

- non-profit advisory extension service for detection, monitoring and forecast
- pest-specific pheromone trap

The “founding fathers”:

- Tóth Miklós
- Szőcs Gábor
- Ujváry István

MTA NKI
Csalmón®

trap family

Extensive field tests before traps for a given pest are put on our product list available to farmers
Among traps developed by us one of the most successful ones is the **CSALOMON® PAL** pheromone trap, which is the supported trap type for detection and monitoring of *Diabrotica v. virgifera* in EU countries [EU framework 5 (QLK5-CT-1999-01110)].
Occurrence of *Diabrotica v. virgifera* in Europe in 2010

From 1995 on detected by CSALOMON® PAL pheromone traps
Contribution of basic scientific research to the CSALOMON® trap family:

From all species on our list of products:

- we identified the pheromone
- we adapted known pheromone
- we improved activity of known pheromone
Acknowledgements: my coauthors (and their “geographical occurrence”)
Acknowledgements: my coauthors (and their “geographical occurrence”)
Acknowledgements: my coauthors (and their “geographical occurrence”)

Spain:
- T. Cabello
- A. Pena

Portugália:
- A. Xavier

U.K.:
- S.Y. Dewhirst
- W.E. Parker
- J.A. Pickett
- L.E. Smart
- L. Wadhams

The Netherlands:
- E.J. Nieuwerken
- M. Van de Veire

Sweden:
- M. Bengtsson
- B.S. Hansson
- C. Löfstedt
- J. Löfquist
- N. Ryrholm
- M. Svensson
- R.C. Unelius
- P. Witzgall
- J. Zhu

South-Africa:
- I. Pajor

Switzerland:
- H. Arn
- H.R. Buser
- P. Charmillot
- P.M. Guerin
- E. Mani
- H. Müller
- S. Rauscher
- W. Sauter
- A. Schmidt

Croatia:
- B. Baric
- M. Brmez
- R. Dobrincic
- K. Franin
- J. Igrc-Barcic
- M. Ivezic
- S. Pancic
- J. Razov

Greece:
- K. Karabatsas
- V. Tsakiris
- J. Tsitsipis
- K. Zarpas

Egypt:
- A.I. Farag

Bulgaria:
- Р. Андреев
- Д.И. Атанасова
- Х. Кутинкова
- А. Мирчева
- Е. Младенов
- И. Средков
- М. Събчев
- И. Станимирова
- И.Л. Стоилов
- Т. Тошова
- Е. Цолова
- Д.И. Велчев
Acknowledgements: my coauthors (and their “geographical occurrence”)