Report on the 27th Annual Meeting of the Working Group 'Beneficial Arthropods and Entomopathogenic Nematodes'

The 27th Annual Meeting of the Working Group 'Beneficial Arthropods and Entomopathogenic Nematodes' of DPG and DGaaE was held in December, 08-09, 2008 at Julius Kühn-Institute Braunschweig. The meeting was well organized by Dr. Martin Hommes and his collegues from the Institute for Plant Protection in Horticulture and Forests Braunschweig.

47 participants from research institutions, universities, extension services and biocontrol companies attended the meeting.

During the two and a half days, 18 contributions (oral presentations and scientific films) were presented which covered the following topics: beneficials in agro-ecosystems, biocontrol in horticulture and fruit growing with entomopathogenic fungi, nematodes, predatory mites and insects. Furthermore, two new scientific video films were presented.

The meeting closed with a general discussion on the prospective activities of the working group and the election of a new head because Prof. Dr. Bernd Freier had to give up this position for an increasing number of tasks in other fields of plant protection. The group elected unanimously Dr. Annette Herz from the Institute for Biological Control Darmstadt (JKI) as new head of the working group.

The next meeting will take place on November 24-25, 2009 in 25373 Ellerhoop, Landwirtschaftskammer Schleswig-Holstein, Gartenbauzentrum. The following abstracts of the contributions were edited by Ute Müller, Prof. Dr. Bernd Freier and Sigrid von Norsinski (JKI Kleinmachnow).

Prof. Dr. Bernd Freier and Prof. Dr. Ralf-Udo Ehlers

The box-tree pyralid *Diaphania perspectalis* in Baden-Württemberg

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The box-tree pyralid *Diaphania perspectalis* (WALKER) (Lepidoptera, Pyralidae), synonym: *Glyphodes perspectalis*, originates from Eastern Asia (Japan, China, Korea), where it is a severe pest of all box-tree species.

The pest has three generations per year in Baden-Württemberg like in the area of its origin. Population density increases considerably from generation to generation. Its well camouflaged green colored larvae with black spots and hairs live at first between leaves span together and feed on the epidermis (upper and lower surface) of the leaves. Later the larvae often stay at daylight in a self woven bag inside the box-tree. It has 6 (to 7) larval stages. The moth's wings are white with a broad black edge. Completely black individuals with only two white points on the wings are also found. Flying moths were still observed at the end of November and the beginning of December of 2008.

Pheromones composed of 5 parts (Z) -11-Hexadecenal, 1.25 parts (E) - 11-Hexadecenal and 1 part (Z) - 11-Hexadecen-1-ol were tested in co-operation with the company Pherobank, Wageningen, the Netherlands, in the year 2008. However, compared to light trap catches of the moth the number of attracted and caught males was relatively small. Further attempts for the monitoring of the pest by means of pheromone traps are planned for the year 2009.

An eradication of this invasive pest is nearly impossible with the many infestation areas in and around Baden-Württemberg (Basel (CH), Kehl, Kornwestheim, Lörrach, Offenburg, Rheinfelden, Weil am Rhein, etc.) and in other regions of Germany (Aachen, Neuss (Rommerskirchen, Mönchengladbach), and towns (Hemmingen-Westerfeld, Hanau, Salzbergen (Emsland). Therefore control should have the aim not to eradicate the pest but to reduce it to lower numbers. That requires a careful, area-wide monitoring of the box-trees for infestations by the moth. Improvements of the trap design and probably of the pheromone composition are necessary. In a nursery it was proven that the moth invaded from China via the Netherlands.

Trichogramma brassicae parasitized the eggs of the moth in laboratory and caused high mortality. Chemical control of the moth seems to be possible using 'Bayer Garten Schädlingsfrei Calypso' (9 g Thiacloprid /1 l Bayer Garten Schädlingsfrei Calypso) and ‚Schädlingsfrei Neem' or ‚NeemAzal-T/S' (Azadirachtin).

New pests - known control methods: First experience with *Trichogramma* releases against the box-tree pyralid *Diaphania perspectalis* and the banana moth *Opogona sacchari* in Germany

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Plant imports regularly result in the introduction of new pest lepidoptera into Germany. The use of *Trichogramma* egg parasitoids is always an important, biological control option which reduces the emergence of pest larvae.

The box-tree pyralid *Diaphania perspectalis* was officially reported for the first time in Europe in the Upper Rhine Valley in 2007. It damages *Buxus* species grown in gardens, and parks. The larvae live first between leaves woven together, later in silk sacks and are difficult to reach with pesticides. They overwinter, so feeding can start as early as March. The eggs can be controlled by *T. brassicae* which is used against the related European corn borer. *Trichogramma* releases in 2008 have not yet been evaluated but laboratory tests have shown a high rate of parasitism.

The banana moth *Opogona sacchari* has been found in tropical greenhouses for several years now. It damages a wide range of host plants, e.g. *Yucca*, palm trees and Bromeliaceae. Control with entomophagous nematodes has been successful but only on Bromeliaceae and *Yucca*. Control of the hidden larvae inside the plant tissue is very difficult and the egg laying sites are unknown. The use of *T. evanescens* which is effective against related pests should be possible. A recapture test showed that *Trichogramma* can penetrate even hairy palm tree surfaces. *Trichogramma* was released in green houses in 2007 and 2008, but neither parasitized nor non-parasitized *O. sacchari* eggs were found.

The European Plant Protection Organization (EPPO) has placed *D. perspectalis* on its "alert list" of new pests. *O. sacchari* is already listed as a quarantine pest (EPPO A2/154). Both pests must be reported to the local plant protection services. There are several open questions on their biology and parasitism by *Trichogramma*. Further investigations are urgently needed to develop effective control strategies.

Control of the bark beetle predator *Nemosoma elongatum* L. by kairomones

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Nemosoma elongatum predates bark beetle species in various coniferous and deciduous forests. Possibilities to control this bark beetle predator using the principle of allochtonous kairomones were discussed. Results from aggregation trials in spruce (*Picea abies* [L.] Karst.) forests and spruce-beech (*Picea abies* [L.] Karst. - *Fagus sylvatica* L.) mixed forests are shown. The analysis of theoretical predation rates is hopeful to develop an adapted system of bark beetle regulation and predator breeding in future.

Advancement of beneficial insects on potato fields using biological plant protection products

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Three spray variants ((Neem 25 g a.i./ha + B.t.t. 100 g a.i./ha (+ 4 days), B.t.t. 60 g a.i./ha + B.t.t. 100 g a.i./ha (+ 4 days) and an untreated control to regulate the Colorado beetle in potato fields were arranged in a randomized complete block design with the treatments replicated four times. The trial was carried out on the experimental field of the Julius Kühn-Institute in Dahnsdorf (Brandenburg Land), which is certified according to EC Eco directives. At the beginning, ten plants per variant were randomly chosen and marked. They were checked every week for the number of Colorado beetles, their larvae, the percentage of feeding damage to the potato plants and for the various beneficials (e. g. ladybirds, syrphids, lacewings, spiders). The treated variants showed a significantly reduced loss of leaf surface due to larvae feeding. After 24 days it achieved only 15% as compared to the control averaging 70%.

In the period under investigation all spray variants showed a growing number of beneficial insects compared to the untreated control as a result of the high leaf loss due to beetle feeding and the more and more decreasing habitat for aphids and their antagonists. Most aphid predators were found 23 days after the beginning of the experiment in the Spinosad variant averaging 3 aphid predators/plant compared to the control with only 1 aphid predator/plant. The result is statistically safe (α=0,05; simulate method). The ladybirds (Coccinellidae) are the most frequent beneficials with a total of four species. The Asian ladybird (*Harmonia axyridis*), which was found first in the experimental field in 2007, had a percentage of 33% in 2008. The same is true of *Coccinella septempunctata*. *Adalia variegata* ranked third with 20%. *Adalia bipunctata* and *Propylea 14punctata* had less than 10%.

Effects of elevated temperature on the natural control of aphids on wheat by the ladybirds *Coccinella septempunctata* und *Harmonia axyridis*

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The effect of 3 K elevated temperatures on the natural control of aphids on wheat by the ladybirds *Coccinella septempunctata* und *Harmonia axyridis* was studied in climate chambers and a laboratory climate chamber experiment. Previous experiments showed that *C. septempunctata* realised the highest predatory effects at 25°C. However, usually these values were achieved only for a few hours per day in June when aphid outbreaks occur.

In the present experiments, two different temperature regimes were used: 18.7 °C (day: 16 h 22 °C, night: 8 h 12 °C) and 21.7 °C (day: 25 °C, night: 15 °C). The first temperature regime corresponds to current temperatures in Central Germany during June and the second one ran at 3 K temperature increase. Both climate regimes had a short dry stress period (reduced watering during G.S. 73-75). The climate chamber experiment was conducted with four treatments (control, aphids (*Sitobion avenae*), + *C. septempunctata*, + *H. axyridis*) and eight replicates (caged pots with each 18 wheat tillers) in each temperature regime. Population dynamics were weekly monitored.

Surprisingly, the temperature regimes did not differ in infestation development although previous investigations showed that the aphid populations are optimally growing at approx. 22°C. The impact of higher dry stress on plants seemed to compensate the impact of increasing infestation in the warm regime. The infestation-reducing effect of coccinellids was similar in both temperature regimes but remarkable (mean -43%). Furthermore, there were no differences observed between the two ladybird species.

The additional laboratory climate chamber experiment was performed to collect data on development time and mortality of eggs, larvae and pupae, furthermore on feeding rates and weights of emerged adults of the two coccinellids at the same temperature regimes. The experiment began with 30 eggs in each temperature variant. The elevated temperature accelerated the development, but no differences between the species were observed. The higher mortality in *H. axyridis* eggs and larvae at normal temperature was contrary to results in another experiment. The absolute feeding rates of both coccinellids were clearly higher (by 30 and 33% respectively) at elevated temperatures. In both temperature regimes *C. septempunctata* adults fed on significantly more aphids than those of *H. axyridis*. While *H. axyridis* fed on more aphids per mg body weight than *C. septempunctata* at normal temperature, both coccinellids species consumed approx. the same prey amount at elevated temperatures.

Finally, the results have not yet shown a relative benefit from elevated temperatures to one of the two coccinellids and natural control.

Aerial dispersal of spiders in Middle East Germany – Modelling of meteorological and seasonal parameters

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For the last years, there has been a growing awareness of the role of spiders acting as natural enemies of insect pests in agro-ecosystems. But often the spider density in a field is affected by crop management and pesticide use. So the migration from source areas is important for the efficiency of natural pest control by spiders. But little is known on how weather parameters influence the composition and number of long-term flights of spiders. From April to October 2003, airborne spiders were collected at a height of 12.2 meters using a Rothamsted insect survey trap in Aschersleben (Saxonia-Anhalt). In parallel, meteorological conditions were continuously measured at the bottom of the trap. In addition, the year was subdivided into three subsequent periods to account for different life cycles of spider species as well as the cultivation of the agroecosystem. The composition of the aeronautic spider fauna was dominated by four distinct families. First analyses show that Linyphiidae (42%, 2003), Theridiidae (35%, 2003), Tetragnathidae (9%, 2003) and Araneidae (8%, 2003) compose the prevalent spider species. The sexual ratio of aeronautic spiders showed 77.4% juvenile, 9.2% male and 13.4% female animals.

A generalized linear mixed model in SAS is used to calculate which meteorological aspects have a significant impact on long distance flights of spiders depending on family, sex, species, and seasonal changes. First modelling data indicate different preferences of spider families as well as males and females with regard to weather parameters and time of flight during the year.

The model will be used to further elucidate the possible use of airborne spiders as biomarkers for integrated crop management and organic farming to reduce insecticide expenditure. In addition, it will allow predicting recolonisation rates and migration tendencies.

Domestication of nematodes for use in plant protection

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Entomopathogenic nematodes (EPN) are important biocontrol agents used against grubs, weevils, chrysomelids (western corn rootworm), sciarids, tipulids, thrips, lepidopterans and other pest insects. Since they can be produced in liquid culture, the product costs have been significantly reduced. EPN possess many attributes which make them excellent biocontrol agents. They are safe to humans and the environment and providing they are applied at favorable environmental conditions they can easily reach or even surpass control results obtained with chemical insecticides. However, several traits could be improved to even better exploit their potential for pest control. Improvements can be achieved by genetic selection. The reproduction potential in liquid culture of *Heterorhabditis bacteriophora* has already been improved and yields have increased from 100.000 to over 300,000 dauer juveniles per ml. A pre-requisite for success of genetic selection is a high heritability of a trait, which is reasonably high for traits like reproduction potential and tolerance to high temperature and desiccation. Desiccation tolerance is measured as survival at water activity (aw-value) below one. Through genetic selection the mean tolerated aw-value was reduced from 0.95 to 0.81. Several wild type strains have been characterized and the most tolerant strain tolerated an aw-value of 0.77. The best 10% of the population even tolerated 0.61. These will now be crossed into the foundation strain. Domestication using genetic selection and cross breeding to

improve beneficial traits in EPN is a powerful technique to further enhance the tolerance of EPN to environmental extremes and thus increase their control potential and shelf life.

Use of entomopathogenic nematodes against the western corn rootworm (*Diabrotica virgifera virgifera*)

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Since the introduction of the western corn rootworm (WCR) into Germany in July 2007, effective control measures must be used to reduce the further establishment of the invasive pest. These rules are laid down in EU Directive 2006/565/EC. In 2008 maize seeds had been treated with Clothianidin. Translocation of this active ingredient to flowers in the vicinity of the corn fields caused a severe mortality among bees. As a consequence the authorisation of Clothianidin has been suspended since May 2008. Transgenic corn with resistance to WCR larvae has not yet been authorized in the EU. An alternative control measure is the use of entomopathogenic nematodes (EPN). Among all EPN tested, *Heterorhabditis bacteriophora* came out best in laboratory and field evaluations. During the last three years more than 20 field trials in Hungary and Austria have produced excellent control results for *H. bacteriophora*. EPN can be applied at 1.5 billion per hectare (10^9 EPN/ha) during sowing or when the WCR larvae occur in May/June. Plants were infested with 150 WCR eggs per plant. Adult reduction ranged from 50 to 80% and root damage was reduced below the economic damage level. Finally, *H. bacteriophora* is an appropriate and safe agent to control the WCR and can substitute the use of Clothianidin in German maize production.

Influence of chitosan on selection behavior, mortality and development of *Frankliniella occidentalis*. Primarily study of project: efficiency increase of control of *Frankliniella occidentalis* by entomopathogenic nematodes

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(No abstract)

Parasitoids as natural enemies of pests on oilseed rape: Key species and adaptation of cultural practices for enhancing biological control

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Populations of economically important pests of winter oilseed rape (OSR) are regulated to some extent by specialist solitary larval endoparasitoids (Hymenoptera: Ichneumonidae).

Levels of parasitism commonly range between 20 to 50%, occasionally exceeding 80%. Husbandry techniques such as insecticide application and tillage may have adverse impact on the abundance of parasitoids. As parasitoids overwinter in the soil of OSR fields post-harvest, they may be affected by tillage before sowing the following crop.

In field experiments comparing different tillage treatments after harvest of OSR, the abundance of adult pollen beetle parasitoids (*Tersilochus obscurator* and *Phradis interstitialis*) emerging in the following spring was significantly reduced by ploughing or rotary harrowing as compared to tillage by grubber or direct drilling. Damage to parasitoids may result mainly from shifting the parasitoid cocoons deeper into the soil by ploughing or from direct damage by rotating tines of the rotary harrow.

Parasitoids are mainly active in crops of winter OSR during flowering. Consequently, they are particularly vulnerable to insecticides applied during this period. Field experiments were conducted to study the effect of lambda-cyhalothrin and thiacloprid on the abundance and effectiveness of parasitoids on winter OSR. In insecticide treated plots, the level of parasitism of pollen beetle larvae was significantly reduced compared to untreated plots. Parasitism of cabbage stem weevil and rape stem weevil by *Tersilochus obscurator* and *T. fulvipes*, respectively, did not differ significantly between treated and untreated plots. While parasitoids of *M. aeneus* are mainly foraging for their hosts on top of crop canopy, parasitoids of stem weevils are active close to ground level, where they are less exposed to insecticide sprays due to the filtering effect of flowers and leaves.

Side-effects of pesticides used in the integrated production of apples in Brazil on the predator *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae)

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The green lacewing *Chrysoperla carnea* (Neuroptera, Chrysopidae) is a cosmopolitan foliage-dwelling predator found in a wide range of agricultural habitats. Our study aimed at providing information on the effects of pesticides commonly used or in test in Brazil in apple orchards on all developmental stages of *C. carnea*. We examined direct mortality and sublethal effects, and persistence for harmful products. The experiments were carried out using standard methods developed by the IOBC/WPRS Working Group “Pesticides and Beneficial Organisms“. We tested the maximum field recommended rate of three insecticides: DELEGATE® WG (a.i. Spinetoram), ENTRUST® 80 W (a.i. Spinosad), ACTARA® 250 WG (a.i. Thiamethoxan); five fungicides: UNIX® 750 WG (a.i. Cyprodinil), SHIRLAN® 500 SC (a.i. Fluazinam), SYSTHANE® E.C. (a.i. Miclobutanil), MYTHOS® SC 300 (a.i. Pirimetanil), NATIVO® SC 300 (a.i. Tifloxystrobin + a.i. Tebuconazol); one acaricide/insecticide: VERTIMEC® 18 EC (a.i. Abamectin) and one fungizide/acaricide: KUMULUS® DF (a.i. sulphur). Four of the pesticides affected survival of *C. carnea* on treated glass plates: ACTARA® caused 100% mortality in larvae and adults (IOBC class 4). DELEGATE® was moderately harmful to adults (class 3), even if applied at one-third rate, whereas to larvae, it was slightly harmful (class 2) at full rate and harmless (class 1) at one-third rate. ENTRUST® was harmless (class 1) to larvae, but moderately harmful (class 3) to adults. NATIVO® was slightly harmful (class 2) to larvae, and harmless (class 1) to adults. In all larval exposure tests

with high adult emergence rate, reproduction was consistent with the control. Regarding persistence of the three insecticides, ACTARA® was highly persistent, causing 100% mortality for >30 days. DELEGATE® and ENTRUST® caused only low mortalities to larvae on 3-day old residues (12.5 % and 6.3 %, respectively). Eggs and pupae in their cocoons were not affected by these insecticides.

Who's who of beneficials and the potential use of diagnostic molecular markers to improve their characterization

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The 2008 update of the "List of biological control agents widely used in the EPPO region", published by EPPO, and of the catalogue of beneficials ("Nützlinge in Deutschland"), published by the JKI, list 91 and 89 species (including nematodes), respectively, which are commercially produced for use in biological control. Correct identification of these species is an essential prerequisite for their efficient mass rearing and use. It is also a requirement in countries where a regulation of invertebrate biological control agents has already been implemented. Species determination based on morphological traits requires to consult an official expert for the particular taxon. Molecular diagnostic tools can help to facilitate species identification also for non-experts, to allow differentiation among strains and to check species identity on mass production and for quality control. A search in the GenBank database revealed that for most of the 89 species currently sold in Germany, one or several relevant nucleotide sequences (mtDNA: Cytochrom oxidase I & II, 16S & 12S rRNA coding regions; nuclear rDNA: 18S & 28S rRNA coding regions, internally transcribed spacers ITS1 & ITS2) are published. The level of intra- and interspecific divergence of these markers needs to be explored before their usefulness for species differentiation is proven. Whereas ITS2 sequences of about one third of the 160 species in the genus *Trichogramma* are known, only a few species of the genus *Amblyseius* are recorded in GenBank and information on most of the other taxa is incomplete. "DNA-barcoding" of species by exploration of a 658-bp fragment of the mitochondrial COI gene as molecular marker as suggested by the "Barcode of Life Initiative" may be a useful concept to accumulate the needed information for important beneficials rather quickly. At this stage, 9 species of *Trichogramma* and 4 species of *Amblyseius* are registered in this archive.

Control of a new spider mite in indoor areas

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In a city like Berlin the cultivation of indoor plants is a new service and an important contribution to the income of horticulture. The arrangement of indoor plants is varying very much and combines tropical and subtropical plants or trees.

Danger arises from the introduction of unknown animal inhabitants of plants as a result of the world-wide import of big-plants from other continents for modern indoor greening. Despite intensive control by the plant quarantine service it is not always possible to detect potential pests on import, when they hide in leaf-axes and partially under the bark at very low population density. After planting, monitoring is inalienable over a longer period to discover the inhabitants early. Often intensive diagnosis is required.

Control of these new pests is especially complicated with indoor plants. Chemical methods often must not be applied, and biological control methods are not practicable or known.

In a building with indoor plants in Berlin we had found a spider mite on *Cinnamomum camphora.* As the spider mites' population increases, it will move to the upper surface of the leaves. The leaves will be damaged and fall. Identification of the spider mite species has not yet been finished.

The Plant Protection Service Berlin has developed a method for mass rearing of the new spider mite, using another host plant - *Aesculus hippocastanum*. It is used to test biological control methods. *Amblyseius cucumeris, Amblyseius degenerans, Amblyseius californicus, Amblyseius swirskii, Typhlodromus pyri, Phytoseiulus persimilis* were tested under laboratory conditions. *Amblyseius californicus* reduced the spider mite on plants sufficiently.

Field test of the impact of four insecticides on European earwig, *Forficula auricularia,* in an apple orchard

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The European earwig *Forficula auricularia* (Dermaptera: Forficulidae) is an important predator of psyllids and aphids, including the woolly apple aphid. Resurgence of the latter pests is often connected to the use of pesticides which harm earwigs. A field test was carried out in 2008 with four new-generation insecticides used in apple production (CALYPSO – a.i. 480g/l thiacloprid, SPINTOR – a.i. 480g/l spinosad, STEWARD – a.i. 300 g/kg indoxacarb and TEPPEKI- 500g/kg flonicamid) to study their effects on earwig populations. Earwigs are nocturnal and hide in shelters during the day. We installed bamboo tubes as artificial shelters.

Each shelter was made from three tubes glued together. The tubes were open at one end and closed at the other by the internodium. The shelters were fixed to the tree trunk in vertical position with their closed end to the top to protect them against rain. Once the shelters were well occupied by earwigs, and earwigs were in the 4th instar, the insecticides were applied (4 replicates of 7 trees per plot); control plots were left untreated. The numbers of earwigs in the shelters of 5 trees per plot were assessed for up to 10 weeks post-application by knocking the earwigs out of the tubes, collecting them in a plastic bag and photographing them for later counts from the digital images. Immediately afterwards, the earwigs were released back to the appropriate tree. All insecticides caused significant reductions (Henderson & Tilton) in the earwig numbers as compared with control populations. Within two weeks post-application, reductions were most pronounced for indoxacarb with a maximum of 76%, followed by thiacloprid with 60%, spinosad with 59% and flonicamid with 48%. Six weeks post-

application, the population effects were still about –50% for indoxacarb and thiacloprid, and were reduced to about –30% for flonicamid and spinosad.

Pathogenicity of three entomopathogenic fungi against different stages of the Mediterranean fruit fly *Ceratitis capitata*

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The objective of this study is to determine the pathogenicity of three entomopathogenic fungi *Beauveria bassiana*, *Lecanicillium muscarium* and *Paecilomyces fumosoroseus* to eggs, old larvae and adults of *C. capitata* under laboratory conditions.

The fungi were pathogenic to the emerged flies (3×10^6 conidia/cm²; 25°C and 70% R.H). After 14 days, 66% of flies were dead through *L. muscarium* and 74% *through B. bassiana.* The lowest mortality of 49% caused *P. fumosoroseus* in comparison to the control with 13%. In case of *L. muscarium* about 63% of dead flies were moulded. Mouldiness was high (85%) by *B. bassiana* and low (20%) by *P. fumosoroseus*.

The old larvae were average sensitive to the entomopathogenic fungi. After treatment with *L. muscarium* and *B. bassiana* ($2x10^6$ sp/cm²) the emergence of adults was reduced to 46% and 44% respectively in comparison to the control with 74%.

The eggs were not susceptible and the emerged larvae form the treated eggs were not infected and could develop to pupae. *P. fumosoroseus* caused the highest mortality (32%) among the fungi.

These results indicate that *B. bassiana* and *L. muscarium* were highly pathogenic to the adult stage and have mid pathogenicity to the larval stage of *C. capitata*.

Key words: Pathogenicity, entomopathogenic fungi, Mediterranean fruit fly, *Ceratitis capitata, Beauveria bassiana*, *Lecanicillium muscarium* and *Paecilomyces fumosoroseus*

Persistence of the entomopathogenic fungus *Lecanicillium muscarium* ZARE & GAMS under outdoor conditions

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Positive results from laboratory trials to prove the effectiveness of the entomopathogenic fungus *L. muscarium* against endophytic damaging larvae of the horse chestnut leafminer moth *Cameraria ohridella* DESCHKA & DIMIC led to following outdoor trials. One aspect of the test was to determine the persistence of the fungus, which was used as commercial product Mycotal® (Koppert, NL) and as strain V24 from the Phytomedicine Department. Different variants tested several spore concentrations and the influence of an oil-containing addit (Koppert, NL). The trial took place on 3 years old horse chestnut seedlings. Persistence was determed 1, 7, 14 days past application of the suspension (dpa) through the numbers of colony forming units (cfu) after impressing the leaves on agar plates.

Despite most unfavourable weather conditions, the fungus could be detected until 14 dpa, with differences between the variants. The application of the fungus led to moulding of larvae within the mines.

The sporulation results prove the ability of the fungus to germinate, infect and kill the larvae followed by growth and sporulation on the cadaver under outdoor conditions. Furthermore, the results show the persistence of *L. muscarium* on the plant leaves during trial. Further investigations follow.

Behaviour and Development of Clitostethus arcuatus (Coccinellidae, Scymninae)
(Video documentation)

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The behaviour and development of *Clitostethus arcuatus* (Rossi), a small indigenous ladybird beetle, known to predate on whitefly species, was recorded on tobacco leaves that were heavily infested by the greenhouse whitefly *Trialeurodes vaporariorum*. The video documentation (duration 14 minutes) first shows adult beetles searching for prey. Preferred stages of attack are young and old puparia, the brim of which is cut open by the strong and sharp mandibles of the beetle. Food removal from the injured puparia is assisted by pronounced extra-oral digestion. Body contents are gradually dissolved by repeated regurgitations until the puparia are sucked dry within about 20 minutes. Subsequent sequences show the mating behaviour of the beetles and the hatching processes of 1st instar larvae (L_1 larvae). When deposited eggs are surrounded by numerous eggs and crawlers, the hatched larvae start feeding on them even before the cuticle has completely hardened. Older 1st instar larvae (as well as all other larval instars) have orange gut contents that shrink to small spots after defaecation. All instars (L_1-L_4) show a characteristic locomotion pattern when in search for prey. They attach the end of their abdomen (pygopodium) by a rubbing action onto the leaf surface, then stretch their body and search by moving their head sideway in different directions. In the absence of prey, the pygopodium is detached, pulled forward half way and attached again. In this way locomotion resembles that of caterpillars of geometrid moths. The moulting process is shown for all larval instars. L_1 and L_2 larvae usually feed on crawlers and occasionally also on eggs, the contents of which are sucked dry within a few minutes. L_3 and L_4 larvae prefer older nymphal whitefly instars as prey. In every case food removal by the larvae is accompanied by extensive extra-oral digestion. The film ends with sequences that show the pupation process and the emergence of young beetles from the pupa.

The film was presented by J. Rademacher (Katz Biotech AG, Baruth).

Remarks on the biology of *Encarsia tricolor* a parasitoid of the cabbage whitefly (*Aleyrodes proletella)*
(video documentation)

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The cabbage whitefly (*Aleyrodes proletella)* (Hom., Aleyrodidae) is one of the most important cabbage pests in Germany. Its control is very difficult because insecticide spraying cannot cover the cabbage plant completely. The development of the pest mainly takes place on the undersurface of the leaves. After spraying, the pest recovers in a relatively short time due to its high reproduction rate. Host plants are all kinds of cabbage (*Brassica* sp.), but also damage to ornamental plants (*Pointsettia*) has been reported. Biological antagonists of *A. proletella* are predators such as *Clitostethus arcuatus* (Col., Coccinellidae) and several parasitoids of the genus *Encarsia* (Hym., Aphelinidae) with the indigenous species *E. tricolor*, *E. inaron* and at a lower abundance *E. formosa*.

The video documentation (13 ½ minutes) shows the biology of the cabbage whitefly. The sexual dimorphism of the adults, egg clusters, the crawling first-stage nymphs and older nymphal stages are documented as well as an emerging adult from a pupa. The parasitization of the nymphal stages 3-4 and puparia of the cabbage whitefly by *E. tricolor* is shown as well as the host-feeding behaviour that represents another mortality factor for the pest apart from parasitism. The pupae of *E. triclor* and *E. formosa* are remarkably different. The male development *of E. tricolor* clearly shows ectoparasitic characteristics, which needs further investigation.

Currently there are several ongoing studies on the biological control of the cabbage whitefly by *E. tricolor*. In Northern Hesse, cage and field studies, including netting as a mechanical control method, showed a low efficacy. However, in the Upper Rhine Valley released parasitoids could establish and control the pest.

The DVD video documentary of a host-parasitoid-system is intended as an educational tool to present the basic biology of a new biological control method.