

Veille d'informations sur mouche de l'oignon (*Delia antiqua*)

Ce document présente une liste d'articles et de rapports de recherches réalisés au Québec ou en dehors du Québec. Dernière mise à jour : 10 janvier 2017.

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Guerra, P. C., Keil, C. B., Stevenson, P. C., Mina, D., Samaniego, S., Peralta, E., ... & Chancellor, T. C. (2016). Larval performance and adult attraction of *Delia platura* (Diptera: Anthomyiidae) in a native and an introduced crop. *Journal of Economic Entomology*, tow237.

Delia platura Meigen is an important pest in crops around the world. Its host range includes almost 50 species, and it can develop in soil organic matter. In Ecuador, *D. platura* is a serious problem for the crop, *Lupinus mutabilis* Sweet (Chocho), and it also attacks broccoli (*Brassica oleracea* L.). After broccoli is harvested, crop residue is mixed with soil or collected and stored close to Chocho fields. The objectives of this study were to determine the adaptive responses of larvae reared on different hosts and whether *D. platura* females are preferentially attracted to germinating *L. mutabilis* seeds or broccoli residue. Accordingly, larval performance and attraction of female *D. platura* reared on broccoli residue and *L. mutabilis* seeds were evaluated. The number of larvae, pupae, and adults were higher when reared on broccoli. Conversely, pupal weight was higher and time from larva to pupa, pupa to adult, and total life cycle were longer in flies reared on *L. mutabilis*. Although *D. platura* developed more quickly on broccoli, *L. mutabilis* was also a good host since pupae were heavier compared with flies reared on broccoli. *Delia platura* females reared on broccoli preferred broccoli residue to *L. mutabilis* in an olfactometer. Volatiles from broccoli residue in soil may attract *D. platura* females and stimulate oviposition on *L. mutabilis* seeds. Environmentally benign production of *L. mutabilis* crops with minimal insecticide applications may require the elimination of fresh broccoli residue as fertilizer in soils where *L. mutabilis* is cultivated.

Miyazaki, Y., Watari, Y., Tanaka, K., & Goto, S. G. (2016). Temperature cycle amplitude alters the adult eclosion time and expression pattern of the circadian clock gene period in the onion fly. *Journal of insect physiology*, 86, 54-59.

Soil temperature cycles are considered to play an important role in the entrainment of circadian clocks of underground insects. However, because of the low conductivity of soil, temperature cycles are gradually dampened and the phase of the temperature cycle is delayed with increasing soil depth. The onion fly, *Delia antiqua*, pupates at various soil depths, and its eclosion is timed by a circadian clock. This fly is able to compensate for the depth-dependent phase delay of temperature change by advancing the eclosion time with decreasing amplitude of the temperature cycle. Therefore, pupae can eclose at the appropriate time irrespective of their location at any depth. However, the mechanism that

regulates eclosion time in response to temperature amplitude is still unknown. To understand whether this mechanism involves the circadian clock or further downstream physiological processes, we examined the expression patterns of period (*per*), a circadian clock gene, of *D. antiqua* under temperature cycles that were square wave cycles of 12-h warm phase (W) and 12-h cool phase (C) with the temperature difference of 8 °C (WC 29:21 °C) and 1 °C (WC 25.5:24.5 °C). The phase of oscillation in *per* expression was found to commence 3.5 h earlier under WC 25.5:24.5 °C as compared to WC 29:21 °C. This difference was in close agreement with the eclosion time difference between the two temperature cycles, suggesting that the mechanism that responds to the temperature amplitude involves the circadian clock.

Sapáková, E., Šefrová, H., Hasíková, L., & Hřivna, L. (2016). Harmfulness of *Delia antiqua* (Diptera: Anthomyiidae) in Garlic in Southeast and Central Moravia. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 64(3), 871-876.

The aim of the three year research was to determine the first occurrence of *Delia antiqua* (Meigen, 1826) (Diptera: Anthomyiidae), specify its bionomics, compare its harmfulness on different garlic varieties, find out the effect of temperature on their life cycle and how their abundance influences garlic yield in regional agriculture areas traditionally growing garlic such as southeast and central Moravia. There was a significantly higher infestation of *Delia antiqua* on the edge (32.3 larvae) of study plot than in the middle (16.3 larvae) from 2010 to 2012. Intensive laying eggs of *D. antiqua* takes place between 9–11 a.m. and 16–18 p.m. hours at the edges of the study plot. The highest number of laid eggs was of 28 per one plant in Nedakonice. The development lasted 15 days at 21 °C under laboratory conditions.

Savage, J., Fortier, A. M., Fournier, F., & Bellavance, V. (2016). Identification of *Delia* pest species (Diptera: Anthomyiidae) in cultivated crucifers and other vegetable crops in Canada. *Canadian Journal of Arthropod Identification*, (29), 1-40.

A number of root maggot fly species from the large genus *Delia* Robineau-Desvoidy (Diptera: Anthomyiidae) are important pests of cultivated crucifers and many other field and vegetable crops. The present work provides identification keys in English and French to the adults, third instar larvae, puparia, and eggs of all pests of cultivated crucifers and other vegetable crops in Canada, namely *Delia antiqua* (Meigen), *D. floralis* (Fallén), *D. florilega* (Zetterstedt), *D. planipalpis* (Stein), *D. platura* (Meigen) and *D. radicum* (Linnaeus). DNA barcodes are provided for all species except *D. planipalpis* and new data on larval host associations in southern Québec are presented.

Tanaka, K., & Watari, Y. (2016). Day-to-day variations in the amplitude of the soil temperature cycle and impact on adult eclosion timing of the onion fly. *International Journal of Biometeorology*, 1-6.

The onion fly *Delia antiqua* advances its eclosion timing with decreasing temperature amplitude to compensate for a depth-dependent phase delay of the zeitgeber. To elucidate whether or not naturally occurring day-to-day variations in the amplitude of soil temperature cycle disturb this compensatory response, we monitored daily variations in the temperature amplitude in natural soils and evaluated the impact on adult eclosion timing. Our results indicated that both median and variance of the soil temperature amplitude become smaller as depth increases. Insertion of a larger temperature fluctuation into the thermoperiod with smaller temperature amplitude induced a stronger phase delay, while insertion of a smaller temperature fluctuation into the thermoperiod with larger temperature amplitude had a weaker phase-advancing effect. It is therefore expected that larger diurnal temperature fluctuations disturb the compensatory response, particularly if they occur at deeper locations, while smaller temperature fluctuations do so only at shallower locations. Under natural conditions, however, the probability of occurrence of smaller or larger temperature fluctuations in shallower or deeper soils, respectively, is relatively small. Thus, naturally occurring day-to-day variations in the temperature amplitude rarely disturb the compensatory response, thereby having a subtle or negligible impact on adult eclosion timing.

Zhang, H., Wu, S., Xing, Z., Wang, X., & Lei, Z. (2016). Bioassay and Scanning Electron Microscopic Observations Reveal High Virulence of Entomopathogenic Fungus, *Beauveria bassiana*, on the Onion Maggot (Diptera: Anthomyiidae) Adults. *Journal of Economic Entomology*, tow235.

When flies were dipped in 1×10^8 conidia/ml conidia suspensions and then kept in the incubator (22 ± 1 °C, $70 \pm 5\%$ RH), scanning electron microscope observations revealed that, at 2 h, the majority of adhering *Beauveria bassiana* conidia were attached to either the wing surface or the interstitial area between the macrochaetae on the thorax and abdomen of the onion maggot adults. Germ tubes were being produced and had oriented toward the cuticle by 18 h. Penetration of the insect cuticle had occurred by 36 h, and by 48 h, germ tubes had completely penetrated the cuticle.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

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Fungal mycelia had emerged from the insect body and were proliferating after 72 h. The superficial area and structure of the wings and macrochaetae may facilitate the attachment of conidia and enable effective penetration. The susceptibility of adults to 12 isolates, at a concentration of 1×10^7 conidia/ml, was tested in laboratory experiments. Eight of the more potent strains caused in excess of 85% adult mortality 8 d post inoculation, while the median lethal time (LT50) of these strains was <6 d. The virulence of the more effective strains was further tested, and the median lethal concentrations (LC50) were calculated by exposing adults to doses ranging from 103–107 conidia/ml. The lowest LC50 value, found in the isolate XJWLMQ-32, for the adults was 3.87×10^3 conidia/ml. These results demonstrate that some *B. bassiana* strains are highly virulent to onion maggot adults and should be considered as potential biocontrol agents against the adult flies.

Zhou, F., Zhu, G., Zhao, H., Wang, Z., Xue, M., Li, X., ... & Liu, Y. (2016). Sterilization Effects of Adult-targeted Baits Containing Insect Growth Regulators on *Delia antiqua*. *Scientific Reports*, 6.

The onion maggot, *Delia antiqua*, is a devastating pest of liliaceous crops and current control measures fail to avert pesticide residues, threats to agroecosystem, and costly expenditures. Insect growth regulators (IGRs) are used as tryptid pest chemosterilants for their suppression on adult fertility and fecundity, but their effects on onion flies are unknown. Here, three IGRs (lufenuron, cyromazine, pyriproxyfen) were incorporated into baits to evaluate their effects on onion fly survival, fecundity, fertility, susceptibility of adults in different ages and offspring development. Lufenuron and cyromazine did not affect survival of new-emerged adults, but lufenuron inhibited adult fertility without affecting fecundity, and cyromazine reduced fertility and fecundity. Differently, pyriproxyfen enhanced fecundity within 10 days after treatment, while it reduced adult survival without affecting fertility. The fertility of younger adults was affected by lufenuron and cyromazine whereas the fecundity was affected with cyromazine and pyriproxyfen. For offspring of onion flies treated with lufenuron or cyromazine, most of larvae died within 5 days after hatch, but surviving larvae pupated and emerged normally. Pyriproxyfen did not affect offspring larval survival or pupation but affected pupal emergence. Thus, lufenuron and cyromazine could be potential chemosterilants for onion flies.

Articles parus en 2015

Guo, Q., Hao, Y. J., Li, Y., Zhang, Y. J., Ren, S., Si, F. L., & Chen, B. (2015). Gene cloning, characterization and expression and enzymatic activities related to trehalose metabolism during diapause of the onion maggot *Delia antiqua* (Diptera: Anthomyiidae). *Gene*, 565(1), 106-115.

Trehalose represents the main hemolymph sugar in many insects, and it functions in energy metabolism and protection in extreme environmental conditions. To gain an insight into trehalose functions in *Delia antiqua* diapausing pupae, genes encoding trehalose-6-phosphate synthase (TPS), trehalose-6-phosphatase (TPP) and trehalase (TRE) were identified and characterized. Analysis of the deduced amino acid sequences indicated that these genes were highly similar to each homolog from Diptera insects. Gene expressions and their enzyme activities were also investigated. The differential expressions of TPS and TPP shared very similar trends for summer and winter diapausing pupae. Their enzyme activities were consistent with the gene expressions. Trehalose concentrations in summer- and winter-diapausing pupae were lower at the initial phase (4.37–5.09 $\mu\text{g}/\text{mg}$) but increased gradually and peaked in the maintenance phase (10.59–14.36 $\mu\text{g}/\text{mg}$); the concentrations then declined in the quiescence phase. We speculated that a higher trehalose content during the maintenance stage may contribute to protein and/or biological membrane stabilization in winter or to desiccation resistance in the summertime. Diapause termination requires a decrease in the trehalose concentration to promote pupal–adult development. The glucose content also varied during the diapausing processes. Our results provide an overview of the differential expression levels of trehalose metabolic enzymes, confirming the important roles of trehalose in diapausing pupae of the onion maggot. Further work remains to explore its actual functions.

Ohta, S., Seto, Y., Tamura, K., Ishikawa, Y., & Matsuo, T. (2015). Comprehensive identification of odorant-binding protein genes in the seed fly, *Delia platura* (Diptera: Anthomyiidae). *Applied Entomology and Zoology*, 50(4), 457-463.

Insect odorant-binding proteins (OBPs) function in the perception of chemical cues such as pheromones and host-plant odors. Comparative genomic analysis has shown that OBP genes underwent the birth-and-death process through the evolution of Hexapoda, resulting in diverged OBP repertoires between distantly related species. On the other hand, comparisons between closely related species, particularly those species with different degrees of host specialization, are limited. In this study, 20 novel OBP genes were identified from *Delia platura* (Meigen) by transcriptome analysis in the antennae and legs. The repertoire of OBP genes was compared with that of a closely related species, *Delia antiqua* (Meigen). Although *D. platura* is a generalist while *D. antiqua* is a specialist in regard to their host utilization, expression profiles of these OBPs were almost identical between the two species. Evolutionary analysis showed that at least 14 OBPs have been under purifying selection, suggesting that they have a similar function in both species. These results suggest that the repertoire of OBPs was relatively independent from host specialization in these species.

Wilson, R. G., Orloff, S. B., & Taylor, A. G. (2015). Evaluation of insecticides and application methods to protect onions from onion maggot, *Delia antiqua*, and seedcorn maggot, *Delia platura*, damage. *Crop Protection*, 67, 102-108.

Onion maggot, *Delia antiqua* (Meigen), and seedcorn maggot, *Delia platura* (Meigen), are important pests of spring-sown onions, *Allium cepa* L. Larvae of both species feed on developing epicotyls and roots of young onion plants often resulting in seedling mortality. Cultural controls used in combination with the insecticide chlorpyrifos are currently the standard practice for maggot control in the western USA. However, cultural controls are only partially effective and reliance on chlorpyrifos has several potential problems including future availability and development of resistance. Insecticides including clothianidin, imidacloprid, spinosad, and thiamethoxam were evaluated in California, USA in 2011–2013 to identify efficacious alternatives to chlorpyrifos. Some insecticides were applied in multiple ways including seed treatment, in-furrow application at planting, and rototiller incorporation prior to planting. Onion plant population, vigor, and yield were measured to assess insecticide efficacy. Maggots reduced onion plant populations by more than 65% of the seeding rate in the untreated controls. Seed treatments with spinosad or clothianidin + imidacloprid were the best alternative to chlorpyrifos for minimizing onion mortality from maggot feeding. Onions treated with both seed treatments had similar or higher plant populations and bulb yields compared to chlorpyrifos. The efficacy of spinosad was greatly improved when applied as a seed treatment compared to an in-furrow application at planting or when incorporated into the soil with a rototiller prior to planting. Spinosad seed treatment increased onion plant populations by 256%, 76%, and 853% compared to untreated controls in 2011, 2012, and 2013, respectively. Conversely, in-furrow and rototill-incorporated applications of spinosad were similar to the untreated control in terms of onion plant population and yield. Seed treatments with newer chemistries could provide an efficacious alternative to chlorpyrifos for protecting onions from maggot damage in western onion production systems.

Zhang, N. X., Yu, G., Li, T. J., He, Q. Y., Zhou, Y., Si, F. L., ... & Chen, B. (2015). The Complete Mitochondrial Genome of *Delia antiqua* and Its Implications in Dipteran Phylogenetics. *PloS one*, 10(10), e0139736.

Delia antiqua is a major underground agricultural pest widely distributed in Asia, Europe and North America. In this study, we sequenced and annotated the complete mitochondrial genome of this species, which is the first report of complete mitochondrial genome in the family Anthomyiidae. This genome is a double-stranded circular molecule with a length of 16,141 bp and an A+T content of 78.5%. It contains 37 genes (13 protein-coding genes, 22 tRNAs and 2 rRNAs) and a non-coding A+T rich region or control region. The mitochondrial genome of *Delia antiqua* presents a clear bias in nucleotide composition with a positive AT-skew and a negative GC-skew. All of the 13 protein-coding genes use ATN as an initiation codon except for the COI gene that starts with ATCA. Most protein-coding genes have complete termination codons but COII and ND5 that have the incomplete termination codon T. This bias is reflected in both codon usage and amino acid composition. The protein-coding genes in the *D. antiqua* mitochondrial genome prefer to use the codon UUA (Leu). All of the tRNAs have the typical clover-leaf structure, except for tRNA^{Ser}(AGN) that does not contain the dihydrouridine (DHU) arm like in many other insects. There are 7 mismatches with U-U in the tRNAs. The location and structure of the two rRNAs are conservative and stable when compared with other insects. The control region between 12S rRNA and tRNA^{Ile} has the highest A+T content of 93.7% in the *D. antiqua* mitochondrial genome. The control region includes three kinds of special regions, two highly conserved poly-T stretches, a (TA)_n stretch and several G(A)_nT structures considered important elements related to replication and transcription. The nucleotide sequences of 13 protein-coding genes are used to construct the phylogenetics of 26 representative Dipteran

species. Both maximum likelihood and Bayesian inference analyses suggest a closer relationship of *D. antiqua* in Anthomyiidae with Calliphoridae, Calliphoridae is a paraphyly, and both Oestroidea and Muscoidea are polyphyletic.

Articles parus en 2014

Ohta, S., Y. Seto, K. Tamura, Y. Ishikawa and T. Matsuo (2014). "Identification of odorant-binding protein genes expressed in the antennae and the legs of the onion fly, *Delia antiqua* (Diptera: Anthomyiidae)." *Applied Entomology and Zoology* 49(1): 89-95.

The onion fly, *Delia antiqua* (Meigen), is a pest specialized to the onion, *Allium cepa* L., and some other *Allium* plants. Host odorants play an important role in the attraction of *D. antiqua* adults and stimulation of oviposition in females. Odorant-binding proteins (OBPs) may serve as a first step in the perception of these chemical cues. In this study, to identify all OBP genes expressed in the chemosensory tissues in *D. antiqua*, RNA-seq analysis was carried out. In addition to the seven OBP genes previously identified, we found eight novel OBPs. Comparisons with *Drosophila melanogaster* Meigen OBP genes revealed that these 15 *D. antiqua* OBPs cover the structural variety observed in *D. melanogaster* OBPs, including Plus C and Minus C OBPs. These results suggest that a relatively large repertoire of chemosensory genes is maintained even in a specialist feeder.

Watari, Y. and K. Tanaka (2014). "Effects of background light conditions on thermoperiodic eclosion rhythm of onion fly *Delia antiqua*." *Entomological Science* 17(2): 191-197.

To elucidate the effects of light on thermoperiodic regulation of adult eclosion rhythm in the onion fly, *Delia antiqua*, the responses to two thermoperiods, 29 degrees C (12h):21 degrees C (12h) and 25.5 degrees C (12h):24.5 degrees C (12h), with different amplitude and same average temperature, were examined in continuous darkness (DD) and continuous light (LL). Irrespective of the temperature step between warm phase (W) and cool phase (C), temperature cycles effectively entrained the adult eclosion rhythm in both DD and LL. Eclosion peaks, however, varied with light conditions and temperature step between W and C. It advanced by approximately 2-3h in DD than in LL and at smaller temperature step. Background light conditions and temperature step also affect the amplitude of eclosion rhythm. It became lower in LL than in DD and at smaller temperature steps. On transfer to constant temperature (25 degrees C), eclosion rhythm was elicited earliest in the pupae at 8 degrees C temperature step in DD and latest in those at 1 degrees C temperature step in LL. Pupae at 1 degrees C temperature step in DD and at 8 degrees C temperature step in LL demonstrated intermediate responses, but the eclosion rhythm was elicited 1day earlier in the former than in the latter. This might be ascribed to the interaction between background light and temperature step under thermoperiodic conditions. The results suggest that continuous light and a smaller temperature step weaken the coupling strength between eclosion rhythm and thermoperiod, but the light effect is stronger than the temperature step effect.

Zhang, Y. J., Y. J. Hao, F. L. Si, S. Ren, G. Y. Hu, L. Shen and B. Chen (2014). "The de novo Transcriptome and Its Analysis in the Worldwide Vegetable Pest, *Delia antiqua* (Diptera: Anthomyiidae)." *G3-Genes Genomes Genetics* 4(5): 851-859.

The onion maggot *Delia antiqua* is a major insect pest of cultivated vegetables, especially the onion, and a good model to investigate the molecular mechanisms of diapause. To better understand the biology and diapause mechanism of the insect pest species, *D. antiqua*, the transcriptome was sequenced using Illumina paired-end sequencing technology. Approximately 54 million reads were obtained, trimmed, and assembled into 29,659 unigenes, with an average length of 607 bp and an N50 of 818 bp. Among these unigenes, 21,605 (72.8%) were annotated in the public databases. All unigenes were then compared against *Drosophila melanogaster* and *Anopheles gambiae*. Codon usage bias was analyzed and 332 simple sequence repeats (SSRs) were detected in this organism. These data represent the most comprehensive transcriptomic resource currently available for *D. antiqua* and will facilitate the study of genetics, genomics, diapause, and further pest control of *D. antiqua*.

Articles parus avant 2014

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

Être informé des activités du PELI : <http://www.lutteintegree.com/fr/Nous-joindre/>

Barette, M. and L. Brodeur (2013). "Utilisation d'une variété d'oignons en cultures pièges dans le but de réduire les dommages dus à la mouche de l'oignon et le nombre de traitements insecticides requis sur l'ensemble de la surface cultivée". Compagnie de recherche Phytodata inc. PRIME-VERT volet 11, 1514: 21.

Lien : http://www.agrireseau.qc.ca/references/6/Volet_11/1514.pdf

Hao, Y. J., W. S. Li, Z. B. He, F. L. Si, Y. Ishikawa and B. Chen (2012). "Differential gene expression between summer and winter diapause pupae of the onion maggot *Delia antiqua*, detected by suppressive subtractive hybridization." *Journal of Insect Physiology* 58(11): 1444-1449.

To gain a better understanding of the molecular mechanisms regulating pupal diapause of the onion maggot *Delia antiqua*, PCR-based suppressive subtractive hybridization was performed to identify genes involved in summer and/or winter diapause. A total of 209 unique sequences were obtained including 89 in forward library for winter diapausing pupae and 120 in the reverse library for summer diapausing pupae. 76.4% (68/89) and 68.3% (82/120) unique sequences had significant hits to non-redundant proteins database. Gene functional annotation showed these non-redundant sequences are involved in stress response and innate immunity, metabolism and energy, information processing and regulation, binding, food storage, morphogenesis and development, cell skeleton and cycle, protein synthesis and folding. Approximately 28.2% (59/209) transcripts showed no significant similarity to any other sequence in the public databases, probably representing unique genes of the onion maggot. Semi-quantitative RTPCR revealed that the relative expression levels of 18 genes were comparable between summer and winter diapause. This study elucidates the temporal expression of diapause-related genes in onion maggot, also provides new insights into the differences in the physiological changes in summer and winter pupae. Functional characterization of some candidate genes will further enhance the understanding of the generating, maintaining, and breaking mechanism of diapause. (C) 2012 Elsevier Ltd. All rights reserved.

Hao, Y.-J., W.-S. Li, Z.-B. He, F.-L. Si, Y. Ishikawa and B. Chen (2012). "Differential gene expression between summer and winter diapause pupae of the onion maggot *Delia antiqua*, detected by suppressive subtractive hybridization." *Journal of Insect Physiology* 58(11): 1444-1449.

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Wang, Z., M. Xue, S. H. Cui, X. D. Ma, Q. C. Zhang and X. X. Li (2012). "Determination of clothianidin residues in garlic by liquid chromatography-tandem mass spectrometry combined with QuEChERS." *Journal of Food Agriculture & Environment* 10(3-4): 232-236.

Clothianidin, a neonicotinoid insecticide, has been applied to broadly control agricultural pests, such as *Delia antiqua*. However, few methods for determination of clothianidin in garlic samples have been published so far. In this study, a rapid, sensitive, and environmental-friendly residue determination method based on QuEChERS for analysis of clothianidin residues in garlic was investigated. The analytes were extracted from the samples using acetonitrile combined with homogenization, purified by dispersion solid phase matrix extraction using ODS-C18, PSA and florisil. Then samples were analyzed by LC/MS/MS with multiple-reaction monitoring (MRM) directly. The content was determined by external standard method. A good linear calibration curve was exhibited over a concentration range of

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1.0 to 100 µg/L for clothianidin with a correlation coefficient of 0.9995. Average recoveries for clothianidin in garlic were 95.7% similar to 100.7% with a relative standard deviations (RSD) of 0.7% similar to 4.3% at spiked levels of 5 similar to 50 µg/kg. For clothianidin, the limit of quantification (LOQ) was 1.55 µg/kg and the limit of detection (LOD) 0.47 µg/kg. Then dissipation of clothianidin was studied by the method above at two dosage of 750 g a.i./ha (the recommended dosage) and 1500 g a.i./ha. In the garlic samples, the concentrations of clothianidin were 0.037 and 0.078 mg/kg, respectively, 7 days after treatment and then decreased rapidly, reached 0.009 and 0.015 mg/kg after 14 days (d). The residues in garlic bulb only 21 days after treatment were 0.003 and 0.011 mg/kg, respectively, less than the MRLs (0.02 mg/kg in garlic) set by Japan's "Positive List System".

Bosquain, F. (2011). "Conditions économiques optimales à l'adoption de lâchers de mouches stériles dans les cultures d'oignons". Compagnie de recherche Phytodata inc. CDAQ, 6424.

Lien : <http://www.cdaq.qc.ca/ShowDoc.asp?Rubrique=2&Document=2&NoProjet=2731>

Mitaka, H., T. Matsuo, N. Miura and Y. Ishikawa (2011). "Identification of odorant-binding protein genes from antennal expressed sequence tags of the onion fly, *Delia antiqua*." Molecular Biology Reports 38(3): 1787-1792.

Insect odorant-binding proteins (OBPs) are thought to play a crucial role in the chemosensation of hydrophobic molecules such as pheromones and host chemicals. The onion fly, *Delia antiqua*, is a specialist feeder of *Allium* plants, and utilizes a host odorant n-dipropyl disulfide as a cue for its oviposition. Because n-dipropyl disulfide is a highly hydrophobic compound, some OBPs might be indispensable for perception of it. However, no OBP gene has been identified in *D. antiqua*. Here, to obtain the DNA sequences of *D. antiqua* OBPs, we performed an analysis of antennal expressed sequence tags (ESTs). Among 288 EST clones, eight *D. antiqua* OBP genes were identified for the first time. Phylogenetic analysis revealed that each *D. antiqua* OBP gene is more closely related to its *Drosophila* orthologs than to the other *D. antiqua* OBP genes, suggesting that these OBP genes had emerged before the divergence of *Delia* and *Drosophila* species. All of the eight *D. antiqua* OBPs are expressed not only in the antennae but also in the legs, suggesting additional roles in the taste perception of non-volatile compounds. These findings serve as an important basis for understanding the molecular mechanisms underlying the host adaptations of *D. antiqua*.

Nault, B. A., B. P. Werling, R. W. Straub and J. P. Nyrop (2011). "Delaying Onion Planting to Control Onion Maggot (Diptera: Anthomyiidae): Efficacy and Underlying Mechanisms." Journal of Economic Entomology 104(5): 1622-1632.

Onion maggot, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), is an important pest of onion, *Allium cepa* L., in northern temperate areas, especially in the Great Lakes region of North America. Management of *D. antiqua* relies on insecticide use at planting, but insecticide resistance can cause control failures that threaten the long-term viability of this strategy. Delaying the time onions are planted was investigated as an alternative management approach for *D. antiqua* and the ecological and behavioral mechanisms underlying host age and insect relationships were examined in laboratory and field experiments. Delaying onion planting by two to four weeks reduced damage to onions by 35 and 90%, respectively. Onions planted later emerged later and this reduced the period overwintered flies had to oviposit on the plants. Moreover, flies tended to lay few to no eggs on these young, late-planted onions. As anticipated, *D. antiqua* laid 4-8 times more eggs on older onions than on young onions, and older onions were more resilient to injury caused by *D. antiqua* neonates compared with younger onions. However, the resiliency to maggot attack lessened as the density of *D. antiqua* increased from 2 to 10 eggs per plant, which probably explains why greater levels of maggot damage are typically observed in early onion plantings compared with later plantings. Delaying onion planting until mid-May reduced *D. antiqua* damage without jeopardizing the period required to produce marketable yield, but this cultural tactic must be combined with other management strategies to prevent economic loss.

Tanaka, K. and Y. Watari (2011). "The onion fly modulates the adult eclosion time in response to amplitude of temperature cycle." Naturwissenschaften 98(8): 711-715.

To confirm whether the amplitude of diel temperature cycles causes a phase shift of adult eclosion rhythm of the onion fly, *Delia antiqua*, the peak time (empty set(E)) of adult eclosion was determined under various thermoperiods with a fixed temperature either in the warm or cool phase and temperature differences ranging from 1 degrees C to 4 degrees C between the two phases. Irrespective of the temperature level during the warm or cool phase, empty set(E) occurred earlier with decreasing amplitude of the temperature cycle. The results strongly support the previous conclusion of

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Tanaka and Watari (Naturwissenschaften 90:76-79, 2003) that *D. antiqua* responds to the amplitude of temperature cycle as a cue for the circadian adult eclosion timing. The phase advance was larger in thermoperiods with a fixed warm-phase temperature than in those with a fixed cool-phase temperature. This might be ascribed to the interaction between the amplitude and level of temperature in the thermoperiodic regimes.

Watari, Y. and K. Tanaka (2010). "Interacting effect of thermoperiod and photoperiod on the eclosion rhythm in the onion fly, *Delia antiqua* supports the two-oscillator model." *Journal of Insect Physiology* 56(9): 1192-1197.

Daily light and temperature cycles entrain adult eclosion rhythms in many insect species, but little is known about their interaction. We studied this problem in the onion fly, *Delia antiqua*. Pupae were subjected to various combinations of a photoperiod of 12L:12D and thermoperiods. The thermoperiods consisted of 12 h warm phase (W) and 12 h cool phase (C), giving a mean temperature of 25 degrees C with different temperature steps of 8, 4 and 1 degrees C. As the phase relation of the two Zeitgebers was varied, the phase of eclosion rhythm was shifted, depending on the phase angle with the light cycle and the amplitude of the temperature cycle. When the temperature step in the thermoperiod was 8 degrees C (WC 29:21 degrees C), the eclosion rhythm was entrained mainly to thermoperiod rather than photoperiod. In the regime with a 4 degrees C temperature step (WC 27:23 degrees C), both thermoperiod and photoperiod affected eclosion rhythm, and a phase jump of the eclosion rhythm occurred when the warm phase of thermoperiod was delayed 15-18 h from light-on. In regimes with a 1 degrees C temperature step (WC 25.5:24.5 degrees C), the eclosion rhythm was completely entrained to photoperiod. The observed interacting effect of light and temperature cycle on the eclosion rhythm in *D. antiqua* can be explained by the two-oscillator model proposed by Pittendrigh and Bruce (1959). (C) 2010 Elsevier Ltd. All rights reserved.

Fournier, F. and L. Brodeur (2009). "Amélioration de la méthode d'élevage et d'entreposage à long terme de la mouche de l'oignon (*Delia antiqua*) et validation de l'efficacité des lâchers inondatifs de mâles stériles au champ". Compagnie de recherche Phytodata inc. PHYD-1-SPP-07-049: 8.

Lien : http://www.agrireseau.qc.ca/references/6/Strat_phyto/RapportFinal049.pdf

Kayukawa, T. and Y. Ishikawa (2009). "Chaperonin Contributes to Cold Hardiness of the Onion Maggot *Delia antiqua* through Repression of Depolymerization of Actin at Low Temperatures." *Plos One* 4(12).

Winter-diapause and cold-acclimated non-diapause pupae of the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae), show strong cold hardiness. To obtain insights into the mechanisms involved in the enhancement of cold hardiness, we investigated the expression patterns of genes encoding subunits of chaperonin (CCT) and the morphology of actin, a substrate of CCT, at low temperatures. Quantitative real-time PCR analyses showed the mRNA levels of CCT subunits in pupal tissues to be highly correlated with the cold hardiness of the pupae. While actin in the Malpighian tubules of non-cold-hardy pupae showed extensive depolymerization after a cold treatment, actin in the same tissue of cold-hardy pupae was not depolymerized. Damage to cell membranes became apparent after the depolymerization of actin. Moreover, administration of Latrunculin B, an inhibitor of actin polymerization, to the larvae markedly decreased the cold hardiness of the pupae obtained. These findings suggest that CCT contributes to the cold hardiness of *D. antiqua* through the repression of depolymerization of actin at low temperatures.

Kayukawa, T., B. Chen, S. Hoshizaki and Y. Ishikawa (2008). "Upregulation of a desaturase is associated with the enhancement of cold hardiness in the onion maggot, *Delia antiqua* (vol 37, pg 1160, 2007)." *Insect Biochemistry and Molecular Biology* 38(3): 374-376.

Cold-acclimated non-diapause pupae, and summer- and winter-diapause pupae of the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae), show marked cold hardiness as compared with intact non-diapause pupae. Homeoviscous adaptation of cellular membranes is crucial to enhance the cold hardiness of organisms, and Delta9-acyl-CoA desaturases have been assumed, albeit without experimental evidence in insects, to play a key role in the adaptation. We cloned the cDNA of a desaturase gene (*Dadesat*) from *D. antiqua*, which is most likely to encode Delta9-acyl-CoA desaturase. Expression of *Dadesat* mRNA in the brain, midgut, and Malpighian tubules of cold-acclimated and diapause pupae was upregulated 2-10 fold, correlating well with the increase in cold hardiness. In the pupae with enhanced cold hardiness, palmitoleic and oleic acids, the presumed products of *Dadesat*, in the phospholipids were significantly

increased. These findings suggest that the increase in the expression of Dadesat contributes to enhanced cold hardiness in *D. antiqua* through the production of these unsaturated fatty acids.

Ellis, S. A. and J. E. Scatcherd (2007). "Bean seed fly (*Delia platura*, *Delia florilega*) and onion fly (*Delia antiqua*) incidence in England and an evaluation of chemical and biological control options." *Annals of Applied Biology* 151(2): 259-267.

Bean seed fly and onion fly are significant pests of allieaceous crops in the UK. Their activity was monitored using yellow water traps at three field sites in England in 2002 and 2003. Bean seed fly were not split between *Delia platura* or *Delia florilega* because from the growers point of view control measures are independent of species. The traps were effective at catching bean seed fly, which was present from April until September. A total of 1729 bean seed fly were trapped in 2002 and 4501 in 2003, with peak activity in May in both years. In 2003, there appeared to be three to four peaks in abundance of the pest. Only 113 onion flies were trapped in 2002 and 23 in 2003. More male onion fly were trapped than females. Pot experiments were carried out to evaluate efficacy of a range of insecticides, garlic and two parasitic nematode species (*Steinernema feltiae* and *Steinernema kraussei*) against bean seed fly and onion fly. Pots of salad onions were exposed to natural oviposition by bean seed fly, but the onion fly experiment was carried out in a glasshouse with eggs of the pest being inoculated into the pots. Tefluthrin seed treatment appeared to be especially effective at preventing bean seed fly damage and produced the most robust seedlings but did not appear to kill the larvae. A drench of chlorpyrifos at the 'crook' stage gave 100% control of bean seed fly larvae. A chlorpyrifos drench was the only treatment to give effective control of onion fly. There was some evidence that the parasitic nematode *S. feltiae* reduced numbers of bean seed fly larvae by about 50%. Guidelines for control of both bean seed fly and onion fly are discussed.

Fournier, F. and L. Brodeur (2007). "Contrôle biologique de la mouche de l'oignon (*Delia antiqua*) dans la production d'oignons à l'aide de lâchers d'insectes stériles produits en insectaire". Compagnie de recherche Phytodata inc. PHYD-1-SPP-04-009: 7.

Lien : http://www.agrireseau.qc.ca/references/6/Strat_phyto/V11_RapportFinal009.pdf

Kayukawa, T., B. Chen, S. Hoshizaki and Y. Ishikawa (2007). "Upregulation of a desaturase is associated with the enhancement of cold hardiness in the onion maggot, *Delia antiqua*." *Insect Biochemistry and Molecular Biology* 37(11): 1160-1167.

Cold-acclimated non-diapause pupae, and summer- and winter-diapause pupae of the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae), show marked cold hardiness as compared with intact non-diapause pupae. Homeoviscous adaptation of cellular membranes is crucial to enhance the cold hardiness of organisms, and Delta 9-acyl-CoA desaturases have been assumed, albeit without experimental evidence in insects, to play a key role in the adaptation. We cloned the cDNA of a desaturase gene (Dadesat) from *D. antiqua*, which is most likely to encode Delta 9-acyl-CoA desaturase. Expression of Dadesat mRNA in the brain, midgut, and Malpighian tubules of cold-acclimated and diapause pupae was upregulated 2-10 fold, correlating well with the increase in cold hardiness. In the pupae with enhanced cold hardiness, palmitoleic and oleic acids, the presumed products of Dadesat, in the phospholipids were significantly increased. These findings suggest that the increase in the expression of Dadesat contributes to enhanced cold hardiness in *D. antiqua* through the production of these unsaturated fatty acids. (C) 2007 Elsevier Ltd. All rights reserved.

Boivin, G. (2006). "Mise au point d'une méthode de lutte biologique contre la mouche de l'oignon et la mouche du chou". Agriculture et Agroalimentaire Canada Saint-Jean-sur-Richelieu. CDAQ 2027.

Lien : <http://www.cdaq.qc.ca/ShowDoc.asp?Rubrique=2&Document=2&NoProjet=617>

Chen, B., T. Kayukawa, A. Monteiro and Y. Ishikawa (2006). "Cloning and characterization of the HSP70 gene, and its expression in response to diapauses and thermal stress in the onion maggot, *Delia antiqua*." *Journal of Biochemistry and Molecular Biology* 39(6): 749-758.

The cytosolic members of the HSP70 family of proteins play key roles in the molecular chaperone machinery of the cell. In the study we cloned and sequenced the fulllength cDNA of *Delia antiqua* HSP70 gene, which is 2461 by long and encodes 643 a.a. with a calculated molecular mass of 70,787 Da. We investigated gene copies of cytosolic HSP70 members of 4 insect species with complete genome available, and found that they are quite variable with species. In order to characterize this protein we carried out an alignment and a phylogenetic analysis with 41 complete protein

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sequences from insects. The analysis divided the cytosolic members of the family into two classes, HSP70 and HSC70, distinguishable on the basis of 15 residues. HSP70 class members were slightly shorter in length and smaller in molecular mass relative to the HSC70 class members, and the conservative and functional regions in these sequences were documented. Mainly, we investigated the expression of *Delia antiqua* HSP70 gene, in response to diapauses and thermal stresses. Both summer and winter diapauses elevated HSP70 transcript levels. Cold-stress led to increased HSP70 expression levels in summer- and winter-diapausing pupae, but heat-stress elevated the levels only in the winter-diapausing pupae. In all cases, the expression levels, after being elevated, gradually decreased with time. HSP70 expression was low in non-diapausing pupae but was up-regulated following cold- and heat-stresses. Heat-stress gradually increased the mRNA level with time whereas cold-stress gradually decreased levels after an initial increase.

Miyazaki, S., T. Kayukawa, B. Chen, M. Nomura and Y. Ishikawa (2006). "Enhancement of cold hardiness by acclimation is stage-specific in the non-diapausing pupae of onion maggot *Delia antiqua* (Diptera : Anthomyiidae)." *European Journal of Entomology* 103(3): 691-694.

When puparia of the onion maggot *Delia antiqua* were preexposed to 5 degrees C for 5 days starting at different time points after pupariation, a large increase in survival after exposure to -20 degrees C for 5 days was observed only when pre-exposure was initiated at 3-6 days after pupariation. The increase in cold hardiness was not associated with a large increase in the trehalose content of the puparia. The supercooling point of the puparia naturally decreased from -18 to -27 degrees C in the first three days after pupariation, and pre-exposure to 5 degrees C did not have an additional effect. Thus, factors responsible for the enhancement of cold hardiness by acclimation other than trehalose and supercooling point should be sought. The period of responsiveness to cold acclimation coincided with the time soon after head evagination, which corresponds to "pupation" in lepidopteran insects. The puparia appear to be physiologically flexible for a short time after head evagination, and able to adapt their physiology to the contemporary cold environment.

Moineddin, Z. M., C. D. Scott-Dupree, C. R. Harris, A. G. Taylor and M. R. McDonald (2006). "Evaluation of reduced-risk insecticide and (or) fungicide seed treatments for control of onion smut *Urocystis cepulae* and onion maggot (*Delia antiqua*)." *Canadian Journal of Plant Pathology-Revue Canadienne De Phytopathologie* 28(2): 339-339.

Nault, B. A., R. W. Straub and A. G. Taylor (2006). "Performance of novel insecticide seed treatments for managing onion maggot (Diptera : Anthomyiidae) in onion fields." *Crop Protection* 25(1): 58-65.

Management of onion maggot, *Delia antiqua* (Meigen), in onion requires the use of an insecticide applied at planting. Insecticide resistance and a dearth of available products have stimulated an effort to identify new insecticides for onion maggot control, especially chemistries that can be delivered as seed treatments. Onion seeds film-coated with fipronil, spinosad, clothianidin or thiamethoxam were evaluated for onion maggot control in muck soils located in two major onion-growing regions in New York, USA in 2001-2003. Fipronil, spinosad and clothianidin at rates of 25, 25 and 50g (a.i.)/kg of seed, respectively, consistently provided excellent control of onion maggot (\leq 5% seedling loss). Moreover, these seed treatments performed well during wet and dry seasons. In contrast, thiamethoxam at a rate of 50g (a.i.)/kg of seed failed to control onion maggot in three of the five experiments. Cyromazine seed treatment, which is currently used by onion growers, provided an equivalent level of onion maggot control to fipronil, spinosad and clothianidin. The other commonly used treatment, chlorpyrifos in-furrow drench, performed poorly in three of the four experiments, resulting in an average seedling loss of 17%. Insecticide resistance was implicated as the reason for the failure in two of the trials where seedling loss averaged 24%. Seed treatments provide growers with a convenient, reliable and environmentally responsible method for managing economically damaging onion maggot infestations, including those that are resistant to chlorpyrifos. Fipronil, spinosad and clothianidin seed treatments should be considered for future registration on onion. Availability of these chemistries would allow rotation with the cyromazine seed treatment, which would likely prolong the longevity of all products. (c) 2005 Elsevier Ltd. All rights reserved.

Nault, B. A., J.-Z. Zhao, R. W. Straub, J. P. Nyrop and M. L. Hessney (2006). "Onion maggot (Diptera : Anthomyiidae) resistance to chlorpyrifos in New York onion fields." *Journal of Economic Entomology* 99(4): 1375-1380.

A larval immersion bioassay was developed to identify susceptibility of onion maggot, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), to chlorpyrifos and to determine whether this assay could be used to predict control in onion fields.

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Laboratory colonies were established from larvae collected in New York onion fields during 2003 and 2004, providing us with test insects to use in bioassays. The larval assay effectively determined susceptibility of *D. antiqua* to chlorpyrifos, and results were congruent with an adult bioassay. However, use of similar-aged larvae (4 d old) in the assays was critical because larvae became more tolerant to chlorpyrifos as they aged. In a field survey, six of the 13 populations had LC50 values above the recommended field rate of 3,600 ppm (range 4,031-6,869). Over two successive seasons in the same field, susceptibility of *D. antiqua* to chlorpyrifos decreased in two of three fields (by 45 and 42%) and remained the same in another field, indicating that resistance is not predictable from year to year. Based on the relationship between damage in the field and LC50 values from 11 of the populations mentioned above, all five populations that had LC50 values above the field rate caused unacceptable levels of damage, whereas five of six populations that had LC50 values below the field rate did not cause serious damage.

Surdek, N., C. Chléla, M. Ruth McDonald and A. Taylor (2006). "Évaluation de l'efficacité des traitements insecticides et fongicides contre le complexe des asticots observés dans la culture de l'oignon". Compagnie de recherche Phytodata inc. PSIH05-2-313: 4.
Lien : http://www.mapaq.gouv.qc.ca/SiteCollectionDocuments/Recherche_Innovation/Legumesdechamp/FichePSIH05-2-313.pdf

Werling, B. P., J. Nyrop and B. Nault (2006). "Spatial and temporal patterns of onion maggot adult activity and oviposition within onion fields that vary in bordering habitat." *Entomologia Experimentalis Et Applicata* 118(1): 49-59.

In New York, onion [*Allium cepa* L. (Alliaceae)] fields often border woods or other vegetable fields. Because onion maggot adults, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), spend a significant portion of their time outside of onion fields, surrounding habitat may affect patterns of fly activity and oviposition within onion fields. To better understand these patterns throughout the onion-growing season, first-, second-, and third-flights maggot adult (male and female) activity was monitored using yellow sticky cards. Half of the monitored fields bordered woods, whereas the other half bordered other onion or vegetable fields. Within all fields, yellow sticky cards were placed at five distances along a transect beginning at the onion field edge extending into the field center. First-flight male and female adult activity was greatest along onion field edges and was especially high along edges bordering woods. This pattern diminished during the second flight and was absent during the third. To determine if spatial patterns of onion maggot oviposition by first-flight onion maggots were similar to first-flight adult activity patterns, potted onion plants were placed in onion fields that bordered or did not border woods in late May and early June 2003. The number of eggs laid in the soil at the base of each plant was recorded. Unlike spatial patterns of first-flight adult activity, oviposition patterns were not affected by bordering habitat or distance from the field edge. Based on the activity of onion maggot adults in onion fields, future and existing control strategies should consider targeting first-flight adults along field edges rather than across entire fields, especially in fields that border woods. In contrast, based on spatial patterns of oviposition within onion fields, controls targeting onion maggot larvae should be applied on a fieldwide basis.

Biron, D. G., D. Coderre, S. Fournet, J. P. Nenon, J. Le Lannic and G. Bolvin (2005). "Larval respiratory systems of two anthomyiid flies, *Delia radicum* and *Delia antiqua* (Diptera : Anthomyiidae)." *Canadian Entomologist* 137(2): 163-168.

The first-instar larvae of *Delia radicum* (L.) and *Delia antiqua* (Meigen) enter host plants to feed in galleries. These galleries can be filled by a liquid resulting from the putrefaction of the host. In this study, we show that *D. radicum* and *D. antiqua* larvae have a metapneustic respiratory system in the first instar and an amphipneustic respiratory system in the second instar, as observed in the majority of cyclorrhaphous Diptera. In addition, we observed four spatulate, ramified structures on the postabdominal spiracles in all three larval instars. We propose that these structures facilitate gas exchange (CO₂ and O₂), especially in the first-instar larvae when they feed in liquid-filled galleries.

Bosquain, F. (2005). "Contrôle de la mouche de l'oignon par des lâchers de mâles stériles - Étude de faisabilité". Compagnie de recherche Phytodata inc. CDAQ 576.

Lien : <http://www.cdaq.qc.ca/ShowDoc.asp?IndLangue=2&Rubrique=0&Document=2&NoProjet=904>

Chen, B., T. Kayukawa, H. B. Jiang, A. Monteiro, S. Hoshizaki and Y. Ishikawa (2005). "DaTrypsin, a novel clip-domain serine proteinase gene up-regulated during winter and summer diapauses of the onion maggot, *Delia antiqua*." *Gene* 347(1): 115-123.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

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Diapause prepares insects and other arthropods to survive in harsh environments. To explore the molecular basis of winter (WD) and summer diapauses (SD), we screened for diapause-specific genes in the onion maggot, *Delia antiqua*, that diapauses as a pupa in both summer and winter. A diapause-induced transcript, DaTrypsin, was identified through differential display, and examined by Northern blot, quantitative real-time PCR and sequence analyses. The full-length cDNA, 1379 bp long, encodes 384 a.a. with a molecular mass of 43,005 Da. The protein contains a 20-a.a. secretion peptide, followed by an amino-terminal clip domain and a carboxyl-terminal serine proteinase domain. With Ser, His and Asp as catalytic residues and Asp, Gly and Ser as specificity determinants, DaTrypsin is anticipated to be a trypsin-like enzyme. DaTrypsin transcription is up-regulated in both SD and WD pupae with higher mRNA levels during WD than SD. Heat shock further elevated gene transcription in both SD and WD pupae, whereas cold shock reduced DaTrypsin expression in SD pupae and had no significant effect on WD pupae. In SD pupae, DaTrypsin transcripts gradually build up during diapause, and after temperature shocks, whereas in WD pupae DaTrypsin mRNA levels are high at the beginning of diapause and immediately after a temperature shock and then gradually decrease with time. DaTrypsin represents the first serine proteinase gene expressed during diapause as well as the first gene upregulated in both SD and WD. It may participate in the host's immune defense and/or maintain the developmental status in the diapausing pupae. (c) 2004 Elsevier B.V. All rights reserved.

Chen, B., T. Kayukawa, A. Monteiro and Y. Ishikawa (2005). "The expression of the HSP90 gene in response to winter and summer diapauses and thermal-stress in the onion maggot, *Delia antiqua*." *Insect Molecular Biology* 14(6): 697-702.

The full-length Hsp90 cDNA in *Delia antiqua* was cloned and sequenced. The deduced polypeptide comprised 717 amino acid residues, with a molecular mass of 82 140 Da. Summer- and winter-diapauses both elevated HSP90 transcript levels in *D. antiqua* pupae. Levels gradually increased with time in summer diapausing pupae whereas levels fluctuated in winter diapausing pupae. Cold- and heat-stressing summer- and winter-diapausing individuals further elevated HSP90 expression. mRNA levels gradually increased with time in summer diapausing pupae whereas levels decreased with time after an initial increase in winter diapausing pupae. HSP90 expression was also up-regulated following cold- and heat-stresses in non-diapausing pupae. Heat-stress gradually increased the mRNA level with time whereas cold-stress gradually decreased levels after an initial increase. These results suggest that the development and physiology of summer- and winter-diapauses, as monitored via variation in HSP90 transcript levels, can be substantial different.

Davidson, G. and D. Chandler (2005). "Laboratory evaluation of entomopathogenic fungi against larvae and adults of onion maggot (Diptera : Anthomyiidae)." *Journal of Economic Entomology* 98(6): 1848-1855.

Laboratory experiments were done to measure the susceptibility of larvae and adults of the onion maggot, *Delia antiqua* (Meigen) (Diptera: Muscidae: Anthomyiidae) to 27 isolates of entomopathogenic fungi from four genera [*Beauveria* Vuillemin, *Lecanicillium* (Petch) Zare & W. Gams, *Metarhizium* Sorokin, and *Paecilomyces* Bainier]. A novel bioassay was developed for *D. antiqua* larvae by using a diet based on mixed vegetable powder. When evaluated in a virulence screen, the fungal isolates caused less mortality of *D. antiqua* larvae than adults. Only three isolates caused > 50% mortality of larvae, whereas 12 isolates caused > 50% mortality of adults. Fungal species was a statistically significant factor affecting the mortality of larvae but not of adults. The fungal isolates causing the most mortality of larvae tended to belong to *Metarhizium anisopliae* (Metschnikoff) Sorokin. Two *M. anisopliae* isolates (389.93 and 392.93) were evaluated in dose-response bioassays. The median lethal concentrations of the isolates against larvae were 6.1×10^7 conidia ml⁻¹ for isolate 389.93 and 7.6×10^7 conidia ml⁻¹ for isolate 392.93. The emergence of adult flies from pupae was reduced at high concentrations of conidia (3.0×10^8 and 1.0×10^8 conidia ml⁻¹). The median lethal concentrations of the isolates against adults were 1.7×10^7 and 4.0×10^7 conidia ml⁻¹, respectively. Some of the fungal isolates examined may have potential as biological control agents of larvae of *D. antiqua* and related species.

Gouinguene, S., H. R. Buser and E. Stadler (2005). "Host-plant leaf surface compounds influencing oviposition in *Delia antiqua*." *Chemoecology* 15(4): 243-249.

Delia antiqua (Diptera: Anthomyiidae) females lay eggs between the leaves of onion plants or in the soil around the base of the plants, then the maggots feed on the onion bulb and roots causing rapid secondary infection by fungi and bacteria. It is well known that the first sensory modality used by the onion fly is vision, therefore the shape (vertical

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narrow cylinders) and colour (yellow) of the plant play a crucial role in the recognition of a potential host plant. In the past it has been shown that n-dipropyl disulfide (Pr2S2), a typical component of onion volatiles, is an important chemical host plant cue. We extracted host leaf surface to verify if Pr2S2 is the major chemical oviposition stimulant and to determine if other as yet unknown substances may play a role in host-plant selection. We confirmed that the females laid more eggs around onion plants with leaves than when only the onion bulb was present and that the odour of chopped onion stimulates oviposition. Extraction of the surface of onion leaves revealed that only the apolar fraction contained substances that stimulate egg-laying in *D. antiqua*. GC-EAD analysis indicated that a minor constituent, Pr2S2, is perceived by the olfactory receptor on the antennae of the onion fly females. This confirmed the importance of Pr2S2 as oviposition stimulant. Contact with the polar fraction did not stimulate egg-laying behaviour in this *Delia* species. We discuss the oviposition strategy of *D. antiqua* in comparison with its closely related species, *D. radicum*, in which the oviposition behaviour is stimulated mainly through contact with the cabbage leaf surface and only partially by the host volatiles.

Gouinguene, S. P. D. and E. Stadler (2005). "Comparison of the sensitivity of four *Delia* species to host and non-host plant compounds." *Physiological Entomology* 30(1): 62-74.

The behavioural facilitation hypothesis, tested in the present study, suggests that evolution of host-plant shifts by phytophagous insects is based on the preadaptation of insects to the chemistry of potentially novel plant hosts. Thus, closely-related insects should have similar sensitivities to compounds that are shared by different host plants. The chemoreception is investigated for four phytophagous flies, *Delia radicum*, *Delia floralis*, *Delia antiqua* and *Delia platura* (Diptera, Calyptratae: Anthomyiidae), belonging to the same genus but developing mainly on different plant families, with particular secondary plant compound profiles. In addition, the carrot fly, *Psila rosae*, an acalyptrate Diptera, is included as an unrelated species that is associated with completely different host plants. For the comparison, the known oviposition stimulants of the cabbage root fly (glucobrassicin, sinalbin, sinigrin and a thia-triaza-fluorene compound; CIF-1) present on the cabbage leaf surface were chosen. Responses from prothoracic tarsal sensilla are recorded to contact stimulation in a dose-dependent manner. Among the different flies tested, only *D. radicum* responds to all the compounds. By contrast, *D. floralis* is only sensitive to CIF-1, and not specifically on the C-5 sensillum, a finding that is in conflict with previously published results. This discrepancy is possibly an indication of the variability among flies originating from different cultures or habitats. With the exception of sinigrin at high concentration, the various compounds tested do not stimulate *D. antiqua* or *D. platura*. However, the carrot fly appears to be completely insensitive to sinigrin even at the highest tested concentration of 10^{-1} M. The responses of the contact-chemoreceptor neurones to the selected compounds therefore provide little evidence of common sensitivities that would explain host shift in *Delia* species and specialization at the physiological level. The wide divergence within closely-related species and rearing cultures appears to indicate that the sensitivity and distribution of sensory receptor neurones is very variable on an evolutionary scale.

Kayukawa, T., B. Chen, S. Miyazaki, K. Itoyama, T. Shinoda and Y. Ishikawa (2005). "Expression of mRNA for the t-complex polypeptide-1, a subunit of chaperonin CCT, is upregulated in association with increased cold hardiness in *Delia antiqua*." *Cell Stress & Chaperones* 10(3): 204-210.

Summer-diapause and winter-diapause pupae of the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae), were significantly more cold hardy than nondiapause, prediapause, and postdiapause pupae. Moreover, cold acclimation of nondiapause pupae conferred strong cold hardiness comparable with that of diapause pupae. Differential display analysis revealed that the expression of a gene encoding TCP-1 (the t-complex polypeptide-1), a subunit of chaperonin CCT, in *D. antiqua* (DaTCP-1) is upregulated in the pupae that express enhanced cold hardiness. Quantitative real-time polymerase chain reaction analyses showed that the levels of DaTCP-1 messenger RNA in pupal tissues, brain, and midgut in particular, are highly correlated with the cold hardiness of the pupae. These findings suggest that the upregulation of DaTCP-1 expression is related to enhanced cold hardiness in *D. antiqua*. The upregulation of CCT in response to low temperature in an organism other than the yeast is newly reported.

Kayukawa, T. and Y. Ishikawa (2005). "Detection of chill injuries in the pupae of the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae)." *Applied Entomology and Zoology* 40(1): 193-198.

To clarify tissues susceptible to chill injuries in the pupae of the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae), 5 d old non-diapausing pupae (ND5) were subjected to a non-freezing temperature of -20 degrees C, with or without prior acclimation at 5 degrees C. Cold acclimation of pupae for 8 d or longer substantially decreased the mortality after exposure to -20 degrees C for 5 d. Analysis of the morphology of dead pupae suggested that they died at two discrete developmental stages: after formation of the adult morphology (type 1), and at a stage indistinguishable from ND5 in appearance (type 2). The two types of death were differentially induced by changing the period of -20 degrees C treatment. A majority of pupae exhibited type 1 death after a 2 d treatment, whereas type 2 death was predominant after a 12 d treatment. Regarding the type 1 death, pharate adults appeared to have died because they failed to emerge from the puparial case. Possibly, the neuromuscular system was impaired by the short term chilling at -20 degrees C. On the other hand, the Malpighian tubules were seriously damaged by long term chilling at -20 degrees C, and this is thought to be the cause of type 2 death.

Watari, Y. (2005). "Comparison of the circadian eclosion rhythm between non-diapause and diapause pupae in the onion fly, *Delia antiqua*: the change of rhythmicity." *Journal of Insect Physiology* 51(1): 11-16.

When pupae of *Delia antiqua* were transferred to constant darkness (DD) from light-dark (LD) cycles or constant light (LL), the sensitivity to light of the circadian clock controlling eclosion increased with age. The daily rhythm of eclosion appeared in both non-diapause and diapause pupae only when this transfer was made during late pharate adult development. When transferred from LL to DD in the early pupal stage, the adult eclosion was weakly rhythmic in non-diapause pupae but arrhythmic in diapause pupae. However, the sensitivity of the circadian clock to temperature cycles or steps was higher in diapause pupae than in non-diapause pupae: in the transfer to a constant 20 degreesC from a thermoperiod of 25 degreesC (12 h)/20 degreesC (12 h) on day 10 after pupation or from chilling (7.5 degreesC) in DD, the adult eclosion from diapause pupae was rhythmic but that from non-diapause pupae arrhythmic. In a transfer to 20 degreesC from the thermoperiod after the initiation of eclosion, rhythmicity was observed in both types of pupae. The larval stage was insensitive to the effect of LD cycle initiating the eclosion rhythm. In *D. antiqua* pupae in the soil under natural conditions, therefore, the thermoperiod in the late pupal stage would be the most important 'Zeitgeber' for the determination of eclosion timing. (C) 2004 Elsevier Ltd. All rights reserved.

Watari, Y. (2004). "Phase-shifting effects of a light pulse interrupting scotophase on locomotor activity rhythm and photoperiodic time measurement for diapause in the onion fly, *Delia antiqua* (vol 6, pg 229, 2004)." *Entomological Science* 7(1): 97-97.

When a light pulse of 1 h duration was given 3 h after lights off in a photoperiod of 11 h light : 13 h dark (LD 11 : 13) at 20°C, the phase of the major peak of locomotor activity rhythm in *Delia antiqua* was delayed for approximately 0.6 h. In contrast, it was advanced by approximately 0.6 h by a light pulse given 9 h after lights off. It is suggested that in the circadian clock, a pulse falling in the early scotophase is taken as a new dusk and a pulse falling in the late scotophase is taken as a new dawn. Although a sharply defined critical photoperiod did not exist in the diapause response to photoperiod in *D. antiqua*, the percentage of pupal diapause decreased by these pulses in LD 11 : 13 at 20°C. The effect of a 15 min light pulse on both locomotor activity rhythm and pupal diapause induction was stronger at 3 h than at 9 h after lights off, while a 1 min light pulse was ineffective at both times. The parallel effects of light pulse on locomotor activity rhythm and diapause response might be based on the same chronobiological functions.

Darvas, B. and A. Szapannos (2003). "Male and female morphology of some central european *Delia* (anthomyiidae) pests." *Acta Zoologica Academiae Scientiarum Hungaricae* 49(2): 87-101.

Based on male and female genitalia and chaetotaxy of legs, the authors give a key for the identification of some important *Delia* (Anthomyiidae) pests of vegetables. The article contains descriptions and drawings of male genitalia (*D. antiqua*, *D. floralis*, *D. florilega*, *D. platura*, *D. radicum*). The drawings and descriptions of female genitalia (*D. antiqua*, *D. platura*, *D. radicum*), are based on specimens from laboratory breeding.

Finch, S., H. Billiard and R. H. Collier (2003). "Companion planting - do aromatic plants disrupt host-plant finding by the cabbage root fly and the onion fly more effectively than non-aromatic plants?" *Entomologia Experimentalis Et Applicata* 109(3): 183-195.

Brassica and *Allium* host-plants were each surrounded by four non-host plants to determine how background plants affected host-plant finding by the cabbage root fly (*Delia radicum* L.) and the onion fly [*Delia antiqua* (Meig.)] (

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Diptera: Anthomyiidae), respectively. The 24 non-host plants tested in field-cage experiments included garden 'bedding' plants, weeds, aromatic plants, companion plants, and one vegetable plant. Of the 20 non-host plants that disrupted host-plant finding by the cabbage root fly, fewest eggs (18% of check total) were laid on host plants surrounded by the weed *Chenopodium album* L., and most (64% of check total) on those surrounded by the weed *Fumaria officinalis* L. Of the 15 plants that disrupted host-plant finding in the preliminary tests involving the onion fly, the most disruptive (8% of check total) was a green-leaved variant of the bedding plant *Pelargonium x hortorum* L. H. Bail and the least disruptive (57% of check total) was the aromatic plant *Mentha piperita x citrata* (Ehrh.) Briq. Plant cultivars of *Dahlia variabilis* (Willd.) Desf. and *Pelargonium x hortorum*, selected for their reddish foliage, were less disruptive than comparable cultivars with green foliage. The only surrounding plants that did not disrupt oviposition by the cabbage root fly were the low-growing scrambling plant *Sallopia convolvulus* L., the grey-foliage plant *Cineraria maritima* L., and two plants, *Lobularia maritima* (L.) Desv. and *Lobelia erinus* L. which, from their profuse covering of small flowers, appeared to be white and blue, respectively. The leaf on which the fly landed had a considerable effect on subsequent behaviour. Flies that landed on a host plant searched the leaf surface in an excited manner, whereas those that landed on a non-host plant remained more or less motionless. Before taking off again, the flies stayed 2 - 5 times as long on the leaf of a non-host plant as on the leaf of a host plant. Host-plant finding was affected by the size (weight, leaf area, height) of the surrounding non-host plants. 'Companion plants' and aromatic plants were no more disruptive to either species of fly than the other plants tested. Disruption by all plants resulted from their green leaves, and not from their odours and/or tastes.

Romeis, J., D. Ebbinghaus and J. Scherckenbeck (2003). "Factors accounting for the variability in the behavioral response of the onion fly (*Delia antiqua*) to n-dipropyl disulfide." *Journal of Chemical Ecology* 29(9): 2131-2142.

The onion fly *Delia antiqua* is a specialist herbivore attacking only onions and closely related *Allium* species. n-Dipropyl disulfide (Pr2S2) has long been known to be attractive to onion flies in the laboratory and in the field. However, the insect's response is highly variable. Using behavioral bioassays we found that Pr2S2 was highly attractive to gravid, mated female onion flies, but did not stimulate oviposition. The response of female onion flies was concentration dependent. The physiological state of the flies (i.e., age, mating status, egg load/oviposition experience) also affected their responsiveness. The response of both sexes of onion flies varied with age, but females were always more strongly attracted than males. Responsiveness of females increased during the first 10 days after emergence. It stayed at a high level until 21 days after which the experiment was terminated. The responsiveness of males reached a maximum at 6-7 days after which it declined. Mated, gravid females responded more strongly to Pr2S2 than unmated, gravid females. Females deprived of the opportunity to oviposit were more attracted compared to females that had oviposited on cut onions prior to the experiment. Electroantennograms (EAG) of females revealed a higher response to stimulation compared to males. The EAG-response of females was not affected by mating status.

Tanaka, K. and Y. Watari (2003). "Adult eclosion timing of the onion fly, *Delia antiqua*, in response to daily cycles of temperature at different soil depths." *Naturwissenschaften* 90(2): 76-79.

For insects pupating in the soil, the day/night temperature cycle may provide a primary time cue (Zeitgeber) for adult eclosion to occur at an appropriate time of the day. In the soil, however, the phase of temperature cycle is delayed with depth because of the low heat conductivity of the soil. Therefore pupae located deeper in the soil may compensate for the depth-dependent phase delay of Zeitgeber to avoid mistimed emergence. We examined the adult eclosion timing of the onion fly, *Delia antiqua*, pupating at different depths in soil and under various thermoperiods in the laboratory to determine if such compensation indeed occurs. We found that *D. antiqua* is able to compensate for the depth-dependent phase delay of the Zeitgeber by advancing the eclosion timing in response to the amplitude of the temperature cycle decreasing with depth.

Yildirim, E. and C. W. Hoy (2003). "Cyromazine seed treatments to control onion maggot, *Delia antiqua*, on green onions." *Journal of Economic Entomology* 96(5): 1494-1499.

Cyromazine seed treatments were evaluated for onion maggot control in green onion crops. The more tolerant to organophosphates of two populations of onion maggots was chosen for further research, based on the results of adult assays in a Potter spray tower. In the laboratory, first-instar mortality was compared between film-coated seed treatment and soil drench treatment. The LC50 for the film-coated seed treatment was approximately one fourth that of

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the soil drench treatment. In choice assays, no significant difference was observed between the number of eggs deposited on seedlings grown from film-coated seeds with cyromazine and film-coated seeds without cyromazine. Field studies demonstrated that all rates of cyromazine seed treatment resulted in protection of onion plants from onion maggot damage. Green onions may not require as high a rate of cyromazine for control of onion maggots as the rate established for use in dry onions for two reasons: the seeding rate is much higher for green onions resulting in more AI/ ha for a given amount of AI/ kg of seed, and a given percentage of stand loss is more difficult to detect in green onions than in dry onions.

Yildirim, E. and C. W. Hoy (2003). "Interaction between cyromazine and the entomopathogenic nematode *Heterorhabditis bacteriophora* Poinar "GPS11" for control of onion maggot, *Delia antiqua* (Meigen)." *Crop Protection* 22(7): 923-927.

Cyromazine seed treatments, which affect insect cuticle formation, and entomopathogenic nematodes, which must pass through openings in the insect cuticle, were applied independently and in combination to test for synergism between the two in their effects on onion maggots. In preliminary assays with *Heterorhabditis bacteriophora*, rates of 10-160 nematodes per larva caused significant mortality in both first and second stadium onion maggots. Cyromazine treatments, applied as a film-coated seed treatment at rates ranging from 0.78 to 50 g ai/kg seed, were tested alone and in combination with 5 and 10 nematodes per larva for first and second instars, respectively, to examine interactions between the insecticide and biological control. No significant interactions between cyromazine and nematode treatments were observed. Differences among rates of cyromazine in plant and larval mortality, however, were statistically significant, and differed for the two larval stadia examined. Although cyromazine and entomopathogenic nematodes could be used independently for onion maggot control without negative interactions, no synergistic effects should be expected from their combined use. (C) 2003 Elsevier Science Ltd. All rights reserved.

Spencer, J. L. and J. R. Miller (2002). "Lifetime ovipositional patterns of mated and virgin onion flies, *Delia antiqua* (Diptera : Anthomyiidae)." *Journal of Insect Physiology* 48(2): 171-180.

Over their 47.2+/-1.9 (mean+/-SEM) day lifespan, mated onion flies, *Delia antiqua*, oviposited more uniformly than did virgins. Mated females began ovipositing at 6.4+/-0.2 days old and regularly deposited 14.2+/-0.6 eggs/day for 3-4 weeks. Thereafter, oviposition slowed and stopped at about 1 week before death. Virgin flies began ovipositing 24.7+/-1.5 days into their 59.0+/-3.8 day lifespan, and deposited eggs at an increasing rate for 3-4 weeks, generating a mean overall ovipositional rate of 5.8+/-0.5 eggs/day. The later onset of virgin oviposition (ovipositional activation) and not a shorter ovipositional period largely accounted for the disparity between virgin and mated female lifespans. Mean lifetime egg production of mated females was 475+/-27 eggs versus 179+/-30 eggs for virgins. Ovipositional and post-ovipositional periods (34.4+/-1.8 and 7.2+/-1.0 days) for mated females were not significantly different from those of virgin females (30.9+/-3.6 and 6.7+/-1.2 days). Over 90% of virgin females laid eggs. The distinction between mated and virgin ovipositional patterns may be specifically attributed to differences in: (1) egg maturation, (2) age at ovipositional activation, and (3) egg-laying rate. (C) 2002 Elsevier Science Ltd. All rights reserved.

Watari, Y. (2002). "Comparison of the circadian eclosion rhythm between non-diapause and diapause pupae in the onion fly, *Delia antiqua*: the effect of thermoperiod." *Journal of Insect Physiology* 48(9): 881-886.

When non-diapause and diapause pupae of *Delia antiqua* were exposed to various thermoperiods where thermophase (T) was 25 degreesC and the cryophase (C) was 15 or 20 degreesC (TC15 or TC20) in constant darkness (DD), the majority of both types of flies emerged before the rise in temperature. Eclosion time was delayed at the lower cryophase temperature. Moreover, there was a significant difference in the time of adult eclosion between non-diapause and diapause pupae; diapause pupae eclosed earlier than non-diapause pupae. When the two types of pupae were transferred to a constant low temperature (15 or 20 degreesC) after having experienced TC15 or TC20 12:12 h, they showed circadian rhythmicity in eclosion. The free-running period (T) of the eclosion rhythm changed after transfer to constant low temperatures in both non-diapause and diapause pupae, suggesting that this change represents a transient cycle until the temperature-sensitive oscillator is coupled again to the temperature-insensitive pacemaker. However, diapause pupae tended to show a shorter tau than non-diapause pupae. This observation suggests that the difference in adult eclosion time under thermoperiodic conditions between non-diapause and diapause pupae is related to their different tau s. (C) 2002 Elsevier Science Ltd. All rights reserved.

Watari, Y. (2002). "Comparison of the circadian eclosion rhythm between non-diapause and diapause pupae in the onion fly, *Delia antiqua*." *Journal of Insect Physiology* 48(1): 83-89.

The influence of pupal diapause on adult eclosion rhythm of *Delia antiqua* was investigated. When non-diapause and diapause pupae were exposed to various photoperiods at 15, 20 and 25 degreesC, both of them emerged as adults close to the light-on time, but the phase of eclosion varied with photoperiod and temperature. Moreover, there was a significant difference in the eclosion time between non-diapause and diapause pupae; the eclosion peak of diapause pupae was earlier than that of non-diapause pupae. When non-diapause and diapause pupae were transferred to constant darkness (DD) after having experienced LD 12:12 at 15, 20 and 25 degreesC, both showed circadian rhythmicity in eclosion. Although the free-running period (τ) decreased slightly as temperature increased in both non-diapause and diapause pupae, the latter tended to show shorter τ than the former. This observation suggests that the observed difference in eclosion time in LD cycles between non-diapause and diapause pupae is due to differences in τ . (C) 2002 Elsevier Science Ltd. All rights reserved.

Ester, A. and H. F. Huiting (2001). Filmcoating the seed of leek with fipronil to control onion thrips, onion fly and leek moth. *Seed Treatment: Challenges & Opportunities, Proceedings*. A. J. Biddle: 159-166.

Research was conducted on the effect of seed filmcoating of winter leek (*Allium porrum* L.) with fipronil and some other insecticides on onion thrips, onion fly and leek moth. Trials were carried out in 1994, 1995 and 1996. Seeds film-coated with fipronil and imidacloprid showed effective control of thrips on the seedbed for twelve weeks and three weeks after transplanting. Diflubenzuron and methiocarb were not effective. Film-coating the seeds with fipronil, diflubenzuron, imidacloprid and teflubenzuron gave acceptable control of the larvae of the onion fly, whereas coating with benfuracarb and methiocarb was only moderately effective. The use of fipronil and imidacloprid film-coated seeds, resulted in sufficient protection against the leek moth, at low populations densities. The most effective insecticide, fipronil, was not phytotoxic.

Hoffmann, M. P., T. P. Kuhar, J. M. Baird, J. Gardner, P. Schwartz and A. M. Shelton (2001). "Nonwoven fiber barriers for control of cabbage maggot and onion maggot (Diptera : Anthomyiidae)." *Journal of Economic Entomology* 94(6): 1485-1491.

We investigated the use of nonwoven fiber barriers for control of cabbage maggot, *Delia radicum* (L.), and onion maggot, *D. antiqua* (Meigen). The barriers consist of arrangements of minute fibers loosely intertwined in "web" form. Results from a greenhouse experiment showed that manually applied graphite fibers placed at the base of broccoli plants reduced the number of *D. radicum* eggs by 64-98%, and that efficacy increased with greater fiber density. Using a melt extrusion process, we devised a method for on-site creation of nonwoven fibers of ethylene vinyl acetate (EVA). In field trials with broccoli and onion plants, EVA fibers significantly reduced the number of cabbage and onion maggots infesting plants. Fiber barriers provided comparable control to standard insecticide applications. The addition of blue, yellow, red, or black pigments, as well as optical brighteners that absorb UV light did not enhance fiber efficacy. Incorporation of capsaicin olfactory repellent to EVA also did not enhance fiber efficacy. Nonwoven fiber barriers may offer an alternative to insecticides for control of cabbage maggot and onion maggot mid possibly other insect pests. Additional research is needed to improve the application process and to identify economically feasible and biodegradable compounds for fibers.

Nomura, M. and Y. Ishikawa (2001). "Dynamic changes in cold hardiness, high-temperature tolerance and trehalose content in the onion maggot, *Delia antiqua* (Diptera : Anthomyiidae), associated with the summer and winter diapause." *Applied Entomology and Zoology* 36(4): 443-449.

Changes in cold hardiness, high-temperature tolerance and trehalose content in the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae), associated with the summer and winter diapause were investigated. Survival of summer- and winter-diapausing pupae after a 15 day exposure to - 15 degreesC was greater than 80%, while less than 5% of non-diapausing pupae survived the same treatment. Greater than 80% of winter-diapausing pupae survived -23 degreesC for 15 days, but survival of summer-diapausing pupae at the same procedure was less than 30%. More than 75% of summer- and winter-diapausing pupae, but not non-diapausing pupae, tolerated 35 degreesC for 15 days. Trehalose concentrations in summer- and winter-diapausing pupae were not high at the beginning of diapause (approximate to 5 mug/mg), but increased gradually and reached 10 mug/mg in 40 days, although they were kept at relatively high temperatures of 25 degreesC (summer diapause) or 15 degreesC (winter diapause). Cold hardiness of pupae, however,

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was not proportional to their trehalose content; although trehalose concentrations in winter- and summer-diapausing pupae at day 40 (WD40 and SD40) were similar (- 10 µg/mg), cold hardiness of these pupae differed largely (WD40 > SD40).

Hoepfing, C. A., C. D. Scott-Dupree, C. R. Harris, G. Ritcey, M. R. McDonald and B. Bcpc (2000). Evaluation of insecticide and fungicide combinations for the control of onion maggot (*Delia antiqua*) and onion smut (*Urocystis cepulae*) in Ontario. Bcpc Conference: Pests & Diseases 2000, Vols 1-3, Proceedings. 1-3: 279-284.

A study was conducted to determine the effectiveness of combinations of insecticides (chlorpyrifos, cyromazine, phosetbupirin+cyfluthrin and fipronil) and fungicides (carbathiin+thiram, mancozeb, and carbathiin+thiram+mancozeb) for control of onion maggot (OM) (*Delia antiqua*) and onion smut (OS) (*Urocystis cepulae*) in onions grown in Ontario. Effective OM and OS control was achieved with insecticide treatments in combination with carbathiin+thiram+mancozeb, Cyromazine and fipronil seed treatments provided best OM control. Best OS control was achieved with carbathiin+thiram seed treatment+granular in-furrow applications of mancozeb and chlorpyrifos.

Ishikawa, Y., T. Yamashita and M. Nomura (2000). "Characteristics of summer diapause in the onion maggot, *Delia antiqua* (Diptera : Anthomyiidae)." *Journal of Insect Physiology* 46(2): 161-167.

Characteristics of summer diapause in the onion maggot, *Delia antiqua*, were clarified by laboratory experiments. Temperature was the primary factor for the induction of summer diapause in this species. The critical temperature for diapause induction was approximately 24 degrees C, regardless of the photoperiod. At 23 degrees C, the development of the diapausing pupae was arrested the day after pupariation, when about 7% of the total pupal development had occurred in terms of total effective temperature (degree-days). The most sensitive period for temperature with regard to diapause induction was estimated to be between pupariation and "pupation" (i.e., evagination of the head in cyclorrhaphous flies). Completion of diapause occurred at a wide range of temperatures (4-25 degrees C): The optimal temperature was approximately 16 degrees C, at which temperature only five days were required for diapause completion. The characteristics of summer diapause in *D. antiqua* are discussed in comparison with those of summer dormancy in a congener *D. radicum* and those of winter diapause in *D. antiqua*. (C) 2000 Elsevier Science Ltd. All rights reserved.

Nomura, M. and Y. Ishikawa (2000). "Biphasic effect of low temperature on completion of winter diapause in the onion maggot, *Delia antiqua*." *Journal of Insect Physiology* 46(4): 373-377.

The effect of low temperature on completion of winter diapause was investigated in the onion maggot, *Delia antiqua* (Diptera: Anthomyiidae). Diapause was completed under constant diapause-inducing conditions of 15 degrees C and 12L-12D, without any exposure to lower temperature. The pupal period for 50% adult emergence was 117 days. None of the cold treatments at 5.6 degrees C examined in the present study advanced adult emergence; on the contrary, they delayed it. Detailed analyses of the results revealed that diapause development in *D. antiqua* comprises two phases which differ in sensitivity to low temperature, with the phase shift occurring at around day 60 at 15 degrees C and 12L-12D. In the first phase of diapause development, low temperature (5.6 degrees C) had no effect on diapause development. In the latter phase, by contrast, diapause development was retarded in proportion to the duration of cold treatment. (C) 2000 Elsevier Science Ltd. All rights reserved.

Watari, Y. (2000). "Effects of ambient temperature and temperature cycle on locomotor activity rhythm in the onion fly, *Delia antiqua*." *Zoological Science* 17(9): 1239-1245.

The phase of locomotor activity of the onion fly, *Delia antiqua*, in LD12:12 advanced at a low temperature (20 degreesC) as compared with that at a high temperature (25 degreesC). The free-running period (tau) in constant darkness (DD) at 200 degreesC became shorter than that at 25 degreesC, suggesting that the phase advance of locomotor activity in LD cycles at 20 degreesC was caused by the decrease in tau. In constant light (LL), the locomotor activity was arrhythmic at a constant temperature. In both DD and LL, the locomotor activity was entrained to a 12 hr 25 degreesC:12 hr 20 degreesC temperature cycle; the activity occurred in the thermophase and its peak delayed with age. However, the delay in LL was smaller than that in DD. At a cycle of 12 hr cool (20 degreesC) light and 12 hr warm (25 degreesC) dark, the fly showed a similar activity pattern to that in LD 12:12 at a constant temperature (20 degreesC or 25 degreesC); the

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activity occurred in the light phase. This suggests that LD cycle is a stronger zeitgeber than a temperature cycle to entrain the locomotor activity of *D. antiqua*.

Watari, Y. and T. Arai (1999). "Effect of dim light on locomotor activity rhythm in the onion fly, *Delia antiqua*." *Zoological Science* 16(4): 603-609.

The phase of locomotor activity of the onion fly, *Delia antiqua*, in L (400 lux) L-dim (1.0 lux) cycles delayed as compared with that in LD cycles. The free-running period (τ) in constant dim light (LdimLdim) was longer than that in constant darkness (DD), suggesting that the phase delay of locomotor activity in LL₁ cycle was caused by the increase in τ . At LdimD 12:12 in which the light intensity of the photophase was 1.0 lux, the locomotor activity free-ran with the period shorter than 24 hr until about week 2 after eclosion but thereafter entrained to LdimD in spite of τ might become longer than 24 hr. This suggests that the flies may become more sensitive to light intensity with age.

Eckenrode, C. J. and T. W. Walters (1997). The onion maggot in New York state: Evaluation of host plant resistance. First International Symposium on Edible Alliaceae. J. L. Burba and C. R. Galmarini: 639-645.

Left unchecked, the onion maggot, *Delia antiqua* (Meigen) can cause onion stand losses from 20 to 90 % in many temperate regions. Control of this insect in New York State currently relies upon synthetic insecticides, but the onion maggot has developed resistance to several chemicals, including the products currently used. New chemicals for onion maggot control are scarce. Previous germplasm screens revealed onion maggot resistance in some *Allium* species, but not in the bulbing onion (*A. cepa*). As part of an ongoing project to develop onion maggot control methods, we screened breeding lines derived from crosses with the German cultivar Zittauer Gelb for onion maggot resistance. These lines were previously selected for white rot resistance, and it was suspected that onion maggot resistance may have a similar chemical basis. In order to evaluate the materials under appropriate conditions, screening was carried out with natural onion maggot populations within commercial fields. In three years of evaluation, most of the lines were susceptible, but several exhibited moderate resistance. Resistance was superior to the chemical check in a few cases. The resistance or susceptibility of these lines was combinations with susceptible inbreds. The prospects for development of maggot-resistant onions and the relationship to other methods of onion maggot control are discussed.

Judd, O. J. R. and G. H. Whitfield (1997). "Visual and olfactory behaviour of *Delia antiqua* (Diptera: Anthomyiidae) in relation to time of day and ovarian development." *European Journal of Entomology* 94(2): 199-209.

Visual and olfactory responses of onion maggot flies (OMF), *Delia antiqua* (Meigen), to food and oviposition resources in relation to sex, ovarian development, and time of day, were evaluated in a commercial onion field in Cloverdale, British Columbia, using horizontal coloured sticky traps baited with the oviposition attractant dipropyl-disulphide (DPDS) or feeding attractant, enzymatic yeast hydrolysate (EYH). White and blue were among the most attractive colours to both males and females, but the sex ratio was strongly male-biased (2.7 : 1). Both olfactory baits increased catches of male OMF on all coloured traps to the same extent but neither bait affected the attractiveness ranking of colours. EYH significantly increased female catches on all coloured traps, whereas DPDS only significantly increased response to white traps. The joint action of visual and olfactory stimuli appeared additive in both sexes, not synergistic. DPDS significantly increased catches of mature, gravid females, whereas EYH increased catches of immature females and unbaited traps caught equal proportions of immature and mature flies. The addition of DPDS to white sticky traps could improve monitoring programmes for OMF by attracting more ovipositing females, especially at low populations levels. Census of trap catches every 2 h established a minor flight peak between 10.00 and 12.00 h, primarily in response to food baits, and a major early evening peak (18.00-20.00 h) in response to DPDS. Daily activity patterns of males and females were not significantly different and activity patterns were independent of trap colour. Response to DPDS was low throughout the morning and only started to increase in late afternoon, which is correlated with oviposition patterns observed in laboratory studies. A general crepuscular behaviour and high early evening activity supports the view that where insecticide sprays are still used effectively, these should be applied in early evening.

Matsuo, T., S. Ooe and Y. Ishikawa (1997). "Limitation of dietary copper and zinc decreases superoxide dismutase activity in the onion fly, *Delia antiqua*." *Comparative Biochemistry and Physiology a-Physiology* 117(2): 191-195.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

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Larvae of the onion fly, *Delia antiqua*, have lower superoxide dismutase (SOD) activity when they are fed a defined synthetic diet that contains no copper or zinc. SOD activity was rapidly recovered when these larvae were fed onion bulbs. Addition Bi Copper and zinc to the synthetic diet also led to the recovery of SOD activity. Results of an immunoblotting analysis using anti-D, *antiqua* CuZnSOD mouse monoclonal antibody suggest that this alteration of SOD activity is dependent on the amount of CuZnSOD. (C) 1997 Elsevier Science Inc.

McDonald, R. S. and J. H. Borden (1997). "Host-finding and upwind anemotaxis by *Delia antiqua* (Diptera: Anthomyiidae) in relation to age, ovarian development, and mating status." *Environmental Entomology* 26(3): 624-631.

A dual-port wind tunnel was used to test hypotheses that odor-mediated anemotaxis in the onion maggot, *Delia antiqua* (Meigen), to volatiles of onion, *Allium cepa* L., is affected by differences in age, sex, mated status, and ovarian development. In the absence of odor and air movement, adults of both sexes dispersed randomly in the wind tunnel. They displayed significant, albeit weak (approximate to 15%), anemotactic (upwind) response to air movement at 8.0 cm/s. In 12 h comparisons of virgin females tested at 2, 4, 6, 8, and 10 d of age with gravid, mated females (10-12 d), anemotactic and discriminatory responses to onion odor of females aged 4-10 d were comparable (approximate to 30%), but were consistently lower than the responses of gravid, mated females (approximate to 45%). Male upwind response to host odor increased linearly with age over 10 d. When 10-d-old males were tested together with females in the wind tunnel, however, significantly fewer males were attracted to onion than when females were absent. Ten-day-old protein-deprived virgin and mated females (both previtellogenic) responded to onion odor in a similar manner as did gravid, mated females. The response of mated, 10-d-old previtellogenic females was lower than that of gravid, mated females. We conclude that upwind response by *D. antiqua* to host odor is independent of female ovarian development or mated status. Such a response would serve to draw females to their oviposition sites and may assist males in locating sites where females are likely to arrive.

Watari, Y. and T. Arai (1997). "Effects of photoperiod and aging on locomotor activity rhythms in the onion fly, *Delia antiqua*." *Journal of Insect Physiology* 43(6): 567-576.

At photoperiods longer than 8 h per 24 h, adults of the day-active onion fly *Delia antiqua* showed a major peak of locomotor activity in the late photophase and also bursts of activity induced by lights-on or lights-off. At shorter photoperiods the activity peaks fused. After transfer from long photoperiods to constant darkness (DD), the rhythm free-ran, but only the major peak persisted. This suggests that only the major peak is controlled by the circadian pacemaker. At long photoperiods, the daily phase of the major peak occurred progressively later with age. As a result, the activity at short photoperiods often shifted from photophase to scotophase in old flies. The free-running period (τ) also changed with age; τ was shorter than 24 h until 14-20 days after eclosion and thereafter became longer, but a few individuals repeated changes in τ . The phase delay of locomotor activity with age in *D. antiqua* would be attributable to the increase in τ . (C) 1997 Elsevier Science Ltd.

McDonald, R. S. and J. H. Borden (1996). "Dietary constraints on sexual activity, mating success, and survivorship of male *Delia antiqua*." *Entomologia Experimentalis Et Applicata* 81(3): 243-250.

The effects of protein-deprivation on the sexual activity and reproductive fitness of male onion flies, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), were investigated under laboratory conditions. The percentage of males inseminating gravid females, the magnitude of ovipositional response, and the total numbers of eggs deposited in 1:1 or 1:10 male:female matchings over two days was unaffected by deprivation of dietary protein. The LT(50)'s (median survival time) for solitary males provided proteinaceous, sucrose, or water diets were 38.0, 25.8, and 6.0 days, respectively. Yet independent of diet effects, males lost 50% of their wing tissue by fragmentation after 26 days, suggesting that wing condition is more important in determining male reproductive fitness than longevity. Male mating frequency in single pairings with previtellogenic females deprived of proteinaceous diet for ten days was similar to that of gravid, protein-fed females. In no-choice and choice mating bioassays at a 10: 1 female:male ratio, however, males inseminated significantly fewer previtellogenic than gravid females over 24 h. Despite evidence for male autogeny, removal of exogenous protein resources in the *Allium* agroecosystem may have important effects on the reproductive competency and fecundity of *D. antiqua*.

McDonald, R. S. and J. H. Borden (1996). "Courtship behavior and discrimination between potential mates by male *Delia antiqua* (Diptera: Anthomyiidae)." *Journal of Insect Behavior* 9(6): 871-885.

The repertoire of courtship behaviors of male onion maggots, *Delia antiqua* (Meigen), in a laboratory bioassay chamber, was analyzed by direct observation and by video recordings, in conjunction with a multichannel event recorder. Seven courtship behaviors were categorized: inspection from the substrate, aerial inspection, contact from the substrate, contact from the air, genital alignment, copulation, and male-male interaction. The frequency distribution of copulation bouts was best described by a Poisson distribution; peak mating activity occurred about 1 h into the bioassay. The duration in copulo, however, was extremely variable. On average, males spent approximate to 30 s in copulo ($n = 183$); <30% of bouts were >50 s. The ability of males to discriminate between sexes, sexually immature and mature females, and between females of *D. antiqua* and the cabbage maggot, *Delia radicum* (L.), was most pronounced in the elements of genital alignment and attempted copulation. The courtship and mating behavior in *D. antiqua* is consistent with a sequence that relies initially primarily on indiscriminate visual recognition of a potential mate, followed by species- and sex-specific semiochemical recognition upon contact.

McFerson, J. R., T. W. Walters and C. J. Eckenrode (1996). "Variation in *Allium* spp damage by onion maggot." *Hortscience* 31(7): 1219-1222.

Nearly 350 germplasm accessions representing 25 *Allium* species were evaluated for damage by onion maggot (OM) [*Delia antiqua* (Meigen)] in field experiments in 1989. In 1990, 188 additional accessions and breeding lines were evaluated, and 36 entries from the 1989 evaluation were re-evaluated. In both years, there were no significant differences in OM damage to seedlings among accessions within the species tested. However, differences among species were highly significant. *Allium cepa* L. (bulb onion) seedlings had consistently high OM damage. Species with significantly less seedling damage than *A. cepa* included: *A. altaicum* Pall., *A. angulosum* L., *A. galanthum* Kar. & Kir., *A. pskemense* B. Fedtsch., *A. scorodoprasum* L., *A. ampeloprasum* L. (leek), *A. fistulosum* L. (bunching onion), *A. schoenoprasum* L. (chive), and *A. tuberosum* Rottl. ex Spr. (garlic chive). Some species sustaining minimal damage as seedlings were nonetheless heavily damaged as mature plants by a later generation of OM. *Allium cepa* cultivars that were well-adapted to local conditions were heavily damaged as seedlings, but their bulbs were less damaged than those of poorly adapted *A. cepa* germplasm. *Allium ampeloprasum* seedlings and mature plants sustained low injury throughout both growing seasons.

Ntiamoah, Y. A., J. H. Borden and H. D. Pierce (1996). "Identity and bioactivity of oviposition deterrents in pine oil for the onion maggot, *Delia antiqua*." *Entomologia Experimentalis Et Applicata* 79(2): 219-226.

The oviposition deterrent properties of pine oil (Norpine 65, Northwest Petrochemicals, Anacortes, Washington) for the onion maggot, *Delia antiqua* (Meigen), were verified using a two-choice bioassay with onion oil as an attractive control. The principal deterrent property of this pine oil was found to reside in three monoterpenes, 3-carene, limonene, and p-cymene, which were the primary constituents identified in the most deterrent of two fractions made by preparative gas chromatography of steam-distilled pine oil. At release rates of 220, 320 and 320 $\mu\text{g}/\text{O}$ per 24 h in two-choice bioassays these monoterpenes respectively caused 73.2, 65.4 and 56.3% deterrence of oviposition, while the ternary mixture released at 320 μg per 24 h caused 88.6% deterrence. The ternary mixture also caused 62.5% deterrence in a no-choice bioassay. Of eight other monoterpenes tested, myrcene, alpha-phellandrene, alpha-terpinene, beta-phellandrene, gamma-terpinene, terpinolene, and beta-pinene were significantly deterrent in declining order, while alpha-pinene was inactive. The ternary mixture was released from glass capillary tubes or flexible plastic cylinders in further bioassays that challenged caged females to oviposit around the base of 35 potted onion seedlings with release devices placed on the soil surface. The most effective deterrence (85.3%) was achieved at a release rate of 280 μg per 24 h per pot if plastic cylinder devices were deployed 24 h before the treated pot was exposed to *D. antiqua* females. If female *D. antiqua* were given only a treated pot, deterrence of oviposition on potted onion seedlings was significant, but low (11.7-63.2%). Because of incomplete efficacy, a monoterpene-based deterrent formulation would be best used operationally if combined with other deterrents, or if it were integrated with some other tactic.

Walters, T. W. and C. J. Eckenrode (1996). "Integrated management of the onion maggot (Diptera: Anthomyiidae)." *Journal of Economic Entomology* 89(6): 1582-1586.

In the absence of crop rotation, onion maggot, *Delia antiqua* (Meigen), control was inadequate (<10% plant loss) in field trials within a commercial onion production area when susceptible and potentially resistant onion genotypes were treated with chlorpyrifos at planting. However, when treatments were applied to the same entries in an area that had been rotated completely out of onion production the previous year, exceptional onion maggot damage reduction was noted (<2% plant losses). In the nonrotated area, one genotype (PI 432715) had reduced onion maggot damage compared with that of susceptible onion cultivars when treated with half rates of chlorpyrifos. Rotation of complete production areas can provide effective onion maggot control. When rotation is not possible, integration of plant resistance and judicious application of insecticides may be appropriate.

Hartman, T. P. V. and D. I. Southern (1995). "GENOME REORGANIZATION FROM POLYTENY TO POLYPLIIDY IN THE NURSE CELLS FOUND IN ONION FLY (*DELIA-ANTIQUA*) AND CABBAGE ROOT FLY (*DELIA-RADICUM*) OVARIES (DIPTERA, ANTHOMYIIDAE)." *Chromosome Research* 3(5): 271-280.

The material required to ensure successful embryogenesis in the onion fly (*Delia antiqua*) and the cabbage root fly (*Delia radicum*) (Diptera, Anthomyiidae) is supplied by 15 nurse cells, while the oocyte chromosomes enter a quiescent stage during prophase I of meiosis. This level of transcription is achieved by the polyploidization of the nurse cell DNA. Elongate polytene chromosomes form in both species, but lack the banding and conspicuous puffing commonly seen in other dipteran tissues. The polytene chromosomes contract until they finally appear as small, densely staining spheres. These fragment into large numbers of endochromosomes that are much smaller than their mitotic counterparts, which then despiralize, resulting in the flocculate appearance of the nurse cell nucleus. Photodensitometry revealed a gradient of DNA values between nurse cells near the oocytes and those further away. Final DNA values 1000 times the haploid level were recorded in the nurse cell nearest to the oocyte compared with 336 times the C-value in the most distal cell. At lower temperatures (<10 degrees C), the polytene chromosomes become banded and longer. None of the onion flies kept in these conditions produced viable eggs, though there was some reproductive success among the cabbage root flies.

Ishikawa, Y. (1995). "PURIFICATION AND IMMUNOLOGICAL CHARACTERIZATION OF SUPEROXIDE-DISMUTASE OF THE ONION MAGGOT, *DELIA-ANTIQUA*." *Archives of Insect Biochemistry and Physiology* 28(4): 387-396.

Cytosolic superoxide dismutase (SOD) of the onion maggot, *Delia antiqua*, was purified to apparent homogeneity by ammonium sulfate fractionation followed by anion exchange, hydrophobic interaction, and gel filtration chromatographies. Native molecular mass was estimated as 32,000 daltons. SDS-PAGE revealed only one subunit of 16,000 daltons, indicating that SOD is a homodimer. Isoelectric focusing revealed 3 charge isomers of pI 5.3, 5.5, and 5.7. The specific activity of purified SOD was 4,250 U/mg protein. A monoclonal antibody (MAb, aSOD2B7) raised against *Delia* SOD recognized only SOD of the same genus, but another MAb (aSOD1H11) recognized SOD of *Drosophila melanogaster* as well. (C) 1995 Wiley-Liss, Inc.

McDonald, R. S. and J. H. Borden (1995). "PROTANDRY IN *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE)." *Annals of the Entomological Society of America* 88(6): 756-763.

Sex differences in the duration of egg-larval and pupal stages, and in eclosion curves were examined under 3 different temperature regimes in the laboratory to assess the likelihood of protandry as an adaptive strategy for the onion maggot, *Delia antiqua* (Meigen). Significant sex differences in development time of larval and pupal stages were evident when eggs were reared at constant (22 degrees C) or alternating (12-22 degrees C) temperature. When male egg development was delayed 24 h by storage at 4 degrees C, followed by 22 degrees C, mean larval development time was significantly greater, but pupal biomass and development time were significantly lower suggesting variation in relative larval growth rates between the sexes. Under nondiapauses conditions, male pupae weighed significantly less than females, but pupal weight was only weakly correlated with larval development. Eclosion of diapause male pupae occurred over a shorter interval (4 d) than from nondiapauses pupae (9-12 d), but protandry resulted from disparate pupal development times between the sexes alone, because sexual dimorphism of pupal weight was not apparent. The hypothesis that protandry is an adaptive strategy providing reproductive benefits to either sex is equivocal for *D. antiqua* because eclosion curves of pupae were normally distributed and mean time lags in eclosion peaks between the sexes were too short (4 d) to optimize any reproductive benefits from early sexual maturation or mating. The alternative

hypothesis is presented that protandry is a nonadaptive outcome of selection for other life history traits that is unbiased by female size dimorphism.

McDonald, R. S. and J. H. Borden (1995). "THE RELATIONSHIP OF AGE AND OVARIAN DEVELOPMENT TO MATING OF DELIA ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Physiological Entomology* 20(2): 155-163.

The relationship between age and sexual receptivity for male and female onion flies, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), and factors affecting ovarian development were examined under various conditions. Confinement in small arenas had a significant negative effect on the rate of oogenesis over the first 10 days of adult life and, in some cases, on the percentage of females inseminated. The rate of oogenesis was not affected by male population density, but high density of females in large arenas appeared to have a priming effect. Few males in single-pair mating bioassays conducted over 24 h were sexually mature at 3-4 days post-eclosion, but > 50% mated when aged 6-7 days. Although females first mated at 3-4 days post-eclosion when confined for 24 h with sexually mature males, most females mated at 6-7 days of age when oocytes in the terminal ovariole position comprised 50% of total egg volume (stage 7 or greater on a 10-stage scale). No females aged 3 days were mated in no-choice and two-choice bioassays with sexually mature males over 24 h. Previtellogenic females (stage 3) were not inseminated, and ovarian development was only correlated weakly ($r = 0.48$) with mating. Frequency of mating in mixed-sex groups of twenty flies was comparable with that in single pairs. However, more females were inseminated at 3-4 days, probably as a result of multiple matings by a few precocious males. These results do not support the hypothesis that females mate only when ovarioles are mature.

Spencer, J. L., M. P. Candolfi, J. E. Keller and J. R. Miller (1995). "ONION FLY, DELIA-ANTIQUA, OVIPOSITION AND MATING AS INFLUENCED BY INSECT AGE AND DOSAGE OF MALE REPRODUCTIVE-TRACT EXTRACT (DIPTERA, ANTHOMYIIDAE)." *Journal of Insect Behavior* 8(5): 617-635.

One hundred percent of virgin female onion flies, *Delia antiqua*, receiving greater than or equal to 1/20 of a male equivalent of an aqueous extract of mature male reproductive tract remained unmated in the presence of males and began laying unfertilized eggs at a normally mated rate of about 20 eggs/female/day. The 50% behavioral response (BR(50)) fell between 1/40 and 1/20 of a male equivalent. Sex peptide responses are not always all-or-none. Some females receiving extract at less than or equal to 1/40 male equivalent oviposited at an intermediate rate. Moreover, at low sex peptide dosages, some females were fully activated ovipositionally but were receptive to mating. A low level of sex peptide was present in 1-day-old males. Sex peptide titer rose with age until plateauing by 6 days posteclosion. Males began mating at 3 days, when they first had ample mature sperm; 50% of 6-day-old males mated. The mean number of females inseminated per male exposed to an excess of virgin females over 24 h was 4.3 ± 0.6 (\pm SE). Presence of mature eggs was not always a prerequisite for mating, although probability, of insemination was correlated with egg maturation. One-day-old preovipositional females receiving 1/20 of a male equivalent of extract began ovipositing when they had mature eggs at 5-6 days old. Therefore, sex peptide may act early and permanently or have a long half-life and affect behaviors once females reach sexual maturity. Male flies provide females with an excess of sex peptide in many cases. *D. antiqua* males transferred ca. 5-10 times more sex peptide than necessary to activate females fully. We suggest this excess is related to the speed of female response. It is yet unclear whether sex peptide potency or titer in Diptera has become exaggerated by intra- or intersexual selection.

Ester, A. and R. Devogel (1994). FILM-COATING OF LEEK SEEDS WITH INSECTICIDES - EFFECTS ON GERMINATION AND ON THE CONTROL OF ONION FLY (*DELIA-ANTIQUA* (MEIGEN)). *Seed Treatment: Progress and Prospects*. T. Martin: 195-199.

Hartman, T. P. V. and D. I. Southern (1994). "FEMALE MEIOSIS IN THE ONION FLY AND CABBAGE ROOT FLY (DIPTERA, ANTHOMYIIDAE)." *Genome* 37(5): 848-857.

The sequence of female meiosis was investigated in two populations of the cabbage root fly (*Delia radicum*) and three populations of the onion fly (*D. antiqua*). In contrast with the completely achiasmate males, both species showed high levels of recombination in females. However, significant differences in chiasma frequency occurred between individuals within populations and between the populations. It was not uncommon to find aneuploidy of the X chromosomes. The autosomes occasionally showed asynapsis or desynapsis, but normal disjunction of univalents was facilitated by distance pairing.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

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Narkiewiczjodko, J. and G. Univ (1994). "EFFECT OF SEED TREATMENT WITH CARBOSULFAN AND IMIDACLOPRID FOR THE CONTROL OF ONION FLY DELIA-ANTIQUA." 46th International Symposium on Crop Protection, Proceedings, Vols 1-4 59(2A): 599-604.

Mowry, T. M. (1993). "OVIPOSITIONAL PATTERNS AND LARVAL MOVEMENT OF DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE) ON SPROUTED BULB AND SEEDLING ONIONS." *Journal of Economic Entomology* 86(5): 1440-1445.

Delia antiqua (Meigen) exhibited pronounced differential oviposition on seedling versus sprouted bulb onions. In a dual treatment experiment, flies laid significantly more eggs per plant per day on sprouted bulbs (97.4 +/- 14.4 [mean +/- SEM]) than on seedlings (0.4 +/- 0.3). In a single-treatment experiment, sprouted bulbs received 103.2 +/- 11.4 eggs per plant/d and seedlings only 3.5 +/- 1.8. Switching treatments in the single-treatment experiment caused an immediate reversal in oviposition. Flies first given sprouted bulbs ceased oviposition when presented with seedlings and flies switched from seedlings to sprouted bulbs commenced oviposition. Therefore, once activated, the fixed action pattern governing *D. antiqua* egg deposition is not free-running. In glasshouse experiments, sprouted bulbs did not influence the pattern of egg deposition by female flies on surrounding seedlings, indicating that ovipositional patterns cannot fully explain aggregated damage observed in the field. Onion maggot movement away from sprouted bulbs previously inoculated with high numbers of eggs resulted in aggregated damage to surrounding seedlings, at least partially explaining field observations. Differential oviposition supports the use of sprouted bulbs as an ovipositional trap crop for onion maggot control, but larval movement away from potentially impenetrable, undamaged bulbs requires consideration of trap crop placement relative to seedlings, timing of planting so that the seedling stage coincides with peak *D. antiqua* oviposition, and timing of trap crop removal.

Cowles, R. S. and J. R. Miller (1992). "DIVERTING DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE) OVIPOSITION WITH CULL ONIONS - FIELD STUDIES ON PLANTING DEPTH AND A GREENHOUSE TEST OF THE STIMULO-DETERRENT CONCEPT." *Environmental Entomology* 21(3): 453-460.

Microplots (2.5 m long) of sprouting onion bulbs planted 5 cm deep received an average of 2,300 *Delia antiqua* (Meigen) eggs during 3 wk in a field trial. Plots with bulbs resting on the soil surface, planted with their neck at the soil surface, or at 12-cm depth, received 280, 1,530, and 980 eggs, respectively. In the laboratory, damage to sprouting bulbs caused by slicing, maggot infestation, or both did not enhance or diminish *D. antiqua* oviposition compared with intact bulbs. Egg laying was equivalent for all treatments as long as green, moist foliage was present. The simultaneous use of an ovipositional deterrent (cinnamaldehyde) and diversionary cull onions to protect seedling onions from *D. antiqua* was tested using a factorial experiment in the greenhouse. The interaction between deterrent and culls was consistent with a multiplicative model where the probability of an onion maggot fly accepting seedlings was reduced independently by the presence of deterrent or culls. Collectively, these experiments suggest that insect control by stimulo-deterrent diversion is a valid concept, albeit not yet practical for *D. antiqua*.

Havukkala, I., M. O. Harris and J. R. Miller (1992). "ONION FLY EGG DISTRIBUTION IN SOIL - A NEW SAMPLING METHOD AND THE EFFECT OF 2 GRANULAR INSECTICIDES." *Entomologia Experimentalis Et Applicata* 63(3): 283-289.

A method for rapidly determining the vertical and horizontal distribution of insect eggs in fragile soil is described. Liquefied agar is allowed to permeate intact soil samples from below; after cooling, the resulting solid is cut into thin sections, from which eggs can be recovered by washes with hot water. This technique revealed that in organic (muck) soil in the laboratory, undisturbed onion flies, *Delia antiqua* (Meigen) (Diptera: Anthomyiidae), laid 95% of their eggs within a 10 mm diameter zone around the base of a surrogate onion 'stem' arising vertically from the soil. Ninety % of all eggs were found in the top 12 mm of soil, with an apparent maximum at depth of 2-4 mm. Increasing fly density from 30 to 200 flies per 30 x 30 x 42 cm cage flattened the horizontal distribution of eggs and extended the ovipositional range from c. 15 mm to beyond 60 mm, suggesting there was competition for the preferred ovipositional sites. Surface treatment of muck soil in the field by granular formulations of the insecticides Lorsban(TM) 15 G (active ingredient chlorpyrifos) and Dyfonate(TM) 15 G (fonofos) three weeks prior to bioassaying reduced egg-laying at depths greater than 8 mm. The relation between the measured egg distribution and mortality factors in soil (low moisture and high temperature) is discussed.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

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Judd, G. J. R. and J. H. Borden (1992). "INFLUENCE OF DIFFERENT HABITATS AND MATING ON OLFACTORY BEHAVIOR OF ONION FLIES SEEKING OVIPOSITIONAL HOSTS." *Journal of Chemical Ecology* 18(4): 605-620.

Using traps baited with natural and synthetic onion volatiles, we examined the effects of different habitats and mating on the olfactory behavior of laboratory-reared and wild onion flies. Rankings of olfactory treatments as host-finding stimuli for females were dependent on their mating status and the habitat in which they were foraging. In habitats devoid of hosts, traps baited with individual alkyl sulfides were as effective as 4-day-old chopped onions and more effective than 1-day-old onions in eliciting host-finding behavior in laboratory-reared unmated females (LUF) and laboratory-reared mated females (LMF). However, upwind dispersal and percent recapture were always significantly greater in LUF. In one experiment, Pr2S2 was 19 times more attractive to LMF in a fallow field, as than it was in an onion field. Reduced effectiveness of alkyl sulfides as host-finding stimuli in onion fields probably results in part because they are less findable, but more importantly because of a change in searching behavior after females have mated. Evidence to support the latter contention is that traps baited with alkyl sulfides and onions were equally findable by unmated females in both habitats. The behavior of LMF was identical to that of wild females, whereas the behavior of LUF was identical to wild males. The hypothesis that olfactory host-finding behavior in onion flies is modified by the resource level was upheld. Alkyl sulfides appear to be the primary, and possibly the only, chemical effectors of host-finding at the patch level of resource distribution, whereas the complex blend emitted by aged, chopped, or damaged onions appears to be acting at the final level of host-finding, while egg-laying females are moving between adjacent hosts in search of an optimal oviposition site.

Judd, G. J. R. and J. H. Borden (1992). "AGGREGATED OVIPOSITION IN DELIA-ANTIQUA (MEIGEN) - A CASE FOR MEDIATION BY SEMIOCHEMICALS." *Journal of Chemical Ecology* 18(4): 621-635.

Experiments conducted in the laboratory tested the hypotheses that aggregated oviposition by onion maggot flies, *Delia antiqua* (Meigen), is caused by stimuli associated with ovipositing females, newly laid eggs, or both. Using a paired oviposition station bioassay that eliminated visual stimuli associated with the treatment under study, 67% of the eggs laid by caged females were in response to the odor of females already ovipositing on an onion slice, as opposed to 33% of the eggs laid in response to an onion slice alone. When newly laid eggs were transferred to onion slices and held for either 24 or 48 hr before being bioassayed against similarly aged untreated onions, 74% and 97% of the eggs were laid at the egg-treated onion stations, respectively. Similar results were achieved when an aqueous wash of newly laid eggs was applied to the onion slice. When the egg wash was processed through a bacterial filter or when eggs were present but not in contact with onions, all response was eliminated. These results implicate microorganisms transmitted on the egg surface in creating an attraction for ovipositing females. Heptane extracts of ovipositor tips from mated, ovipositing females induced 72% of the test females to oviposit near points at which extracts were applied to the oviposition station floor. A behavioral sequence for an optimal host-selection strategy is hypothesized, whereby host-seeking female onion flies respond to host-derived alkyl sulfides at long range and metabolic by-products of microbially infested hosts and visual cues at short range (ca. 1 m), with final selection of oviposition sites potentially reinforced by contact with an aggregation pheromone released or left on the substrate by ovipositing females.

Ross, K. T. A. (1992). "COMPARATIVE-STUDY OF THE ANTENNAL SENSILLA OF 5 SPECIES OF ROOT MAGGOTS - DELIA-RADICUM L, D-FLORALIS F, D-ANTIQUA MG, D-PLATURA MG (DIPTERA, ANTHOMYIIDAE) AND PSILA-ROSAE F (DIPTERA, PSILIDAE)." *International Journal of Insect Morphology & Embryology* 21(2): 175-197.

A comparative study of the antennal sensilla of *Delia radicum* L., *D. floralis* F., *D. antiqua* Mg., *D. platura* Mg. (Diptera : Anthomyiidae) and *Psila rosae* F. (Diptera : Psilidae) is undertaken. For both sexes of each species, the type, distribution, and density of sensilla are determined. All 5 species have trichoid (olfactory) and grooved (olfactory) sensilla. Basiconica I (blunt) sensilla (olfactory) are found on each of the species examined, except *D. platura*. Basiconica II (tapered) (olfactory) and clavate (olfactory) sensilla are found only on *Delia* species. Also, only *Delia* species have single-chambered, dorsal pits, and these contain basiconic II pit sensilla (olfactory). Common to all 5 species is a multi-chambered ventral pit (olfactory). In the ventral pit, all 5 species have grooved pit sensilla (olfactory). In addition to this type of sensillum the *Delia* species have smooth-walled conical pit sensilla (hygro-/thermosensitive) and *P. rosae* has granular pit sensilla (hygro-/thermosensitive). Smooth-walled tapered pit sensilla (hygro-/thermosensitive) are found in *D. radicum*. Similarities and differences in the density of surface sensilla between dorsal and ventral funicular surfaces, male and female flies, and oligophagous (*D. antiqua*, *D. radicum*, *D. floralis* and *P. rosae*) and polyphagous (*D. platura*)

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species are compared. Several differences in sensillum density between the dorsal and ventral funicular surfaces are observed, but these do not fit into a consistent trend. Except for *D. radicum*, there are differences in sensillum density between male and female flies. For the oligophagous species, females have a greater sensillum density, whilst for the polyphagous *D. platura* males have a greater sensillum density. Comparisons between species show the greatest differences between the *Delia* species and *P. rosae*, and within the 4 *Delia* species, differences in sensillum density do not correlate with host range or body size.

Spencer, J. L., G. L. Bush, J. E. Keller and J. R. Miller (1992). "MODIFICATION OF FEMALE ONION FLY, *DELIA-ANTIQUA* (MEIGEN), REPRODUCTIVE-BEHAVIOR BY MALE PARAGONIAL GLAND EXTRACTS (DIPTERA, ANTHOMYIIDAE)." *Journal of Insect Behavior* 5(6): 689-697.

Egg depositional rates of onion flies, *Delia antiqua* (Meigen), injected thoracically with extracts of male paragonial glands were identical (14.5 eggs/female/day) to those of normally mated females. Moreover, when continuously exposed to males, extract-injected females refused to mate and produced unfertilized eggs for the duration of the > 15-day experiment. For this normally monocoitic dipteran, < 1 male equiv of paragonial secretion completely reproduced the ovipositional responses characteristic of normal mating, and this effect required no involvement of the genitalia or genital chamber. We suggest that the receptor for the active chemical(s) (sex peptide ?) would be an excellent target for biorational insect control by sterilization. Moreover, these primer sex pheromones might play an important role in insect reproductive isolation and evolution.

Weston, P. A., J. E. Keller and J. R. Miller (1992). "OVIPOSITIONAL STIMULUS DEPRIVATION AND ITS EFFECT ON LIFETIME FECUNDITY OF *DELIA-ANTIQUA* (MEIGEN) (DIPTERA, ANTHOMYIIDAE)." *Environmental Entomology* 21(3): 560-565.

Life time oviposition was measured for female *Delia antiqua* (Meigen) caged individually with cups of moist sand or surrogate onions possessing combinations of host-plant color and chemical stimuli. Females laid more eggs on surrogates than on sand and laid more eggs on surrogates coated with synthetic onion volatiles (n-dipropyl disulfide, Pr2S2) than on untreated surrogates. Surrogate color had no effect on fecundity. Flies deprived of exposure to Pr2S2 took longer to initiate oviposition and took longer to complete ovipositional cycles. The presence of untreated surrogates increased the percentage of eggs laid in ovipositional cups from 14 to 74%, whereas the presence of Pr2S2 or host-plant color resulted in nearly all eggs being laid in cups. The number of eggs retained at death did not differ among treatments. The results suggest that differential oviposition may have resulted from reduced rates of egg maturation as a consequence of accumulation of unladen eggs. Host specialization by the onion fly is probably due to ecological factors as well as an ovipositional preference for onion.

Harris, M. O. and J. R. Miller (1991). "QUANTITATIVE-ANALYSIS OF OVIPOSITIONAL BEHAVIOR - EFFECTS OF A HOST-PLANT CHEMICAL ON THE ONION FLY (DIPTERA, ANTHOMYIIDAE)." *Journal of Insect Behavior* 4(6): 773-792.

Behavioral responses of female onion flies, *Delia antiqua* (Meigen), to host-plant cues were quantified during encounters of individual flies with onion plants and onion foliar surrogates. The behavioral repertoire of such females included sitting, grooming, running up and down foliar surfaces, extension of the proboscis such that the labellum contacted foliar and soil surfaces, movements of the tip of the abdomen over surfaces (surface probing), subsurface probing of soil crevices with the ovipositor, and oviposition. Sequences of behaviors preceding oviposition were probabilistic rather than highly stereotyped but generally followed the order given above. Foliar surrogates were used to determine the effects of n-dipropyl disulfide (Pr2S2) on the sequence of behaviors leading up to oviposition. The addition of a Pr2S2-treated surrogate to a cage increased the frequency of alighting on that surrogate but also increased alighting on a nearby foliar surrogate without Pr2S2. After alighting, females encountering surrogates treated with Pr2S2 had shorter latencies to proboscis extension and surface probing, spent less time sitting and grooming, and had runs of shorter duration. These females were also more likely to make the transition from probing of surfaces of foliage and soil to subsurface probing of soil crevices and oviposition. Thus, rather than mediating a particular step in the behavioral sequence, Pr2S2 played a role throughout the sequence leading up to oviposition. Collectively, these data and past studies on the onion fly support the hypothesis that egg-laying is triggered by a temporal summation of inputs to the central nervous system from various sensory modalities rather than strict behavioral chaining, with each transition effected by some unique cue.

Ishikawa, Y. and T. Kubota (1991). "EFFECT OF HOST PLANTS AND DIETARY QUERCETIN ON ANTIOXIDANT ENZYMES IN ONION AND SEEDCORN MAGGOTS, *DELIA-ANTIQUA* AND *D-PLATURA* (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 26(2): 245-253.

Effect of host plants and dietary quercetin on antioxidant enzymes, superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPOX), was studied in the onion and seedcorn maggots, *Delia antiqua* and *D. platura*. SOD activity of the latter species was 1.7 times that of the former when the two species were grown on a synthetic diet devoid of plant secondary compounds. SOD activities of the two species feeding on respective host plants were 100-230% greater than those of larvae feeding on the synthetic diet. Synthetic diet containing up to 0.1% of quercetin, a prooxidant chemical present in onion bulbs, elicited no increase in SOD activity, though SOD grew ca. 2.5 times in both species when the concentration was raised to 1.0%. CAT levels were very high, being unaffected by the diet or the addition of quercetin in both species. Strong inhibition of GPOX was observed in onion maggots reared on onion and the synthetic diet containing 0.1% quercetin.

Judd, G. J. R. and J. H. Borden (1991). "SENSORY INTERACTION DURING TRAP-FINDING BY FEMALE ONION FLIES - IMPLICATIONS FOR OVIPOSITIONAL HOST-PLANT FINDING." *Entomologia Experimentalis Et Applicata* 58(3): 239-249.

Using various three-dimensional traps alone and in combination with the onion volatile, dipropylidysulphide (Pr2S2), we found that visual behaviour of female onion flies, *Delia antiqua* (Meigen), varied with the 'visual context' (background composition and trap spacing) in which traps were presented and the females' reproductive state (mated vs. unmated). Against a background of real onions, females alighted more frequently on spherical than cylindrical traps, and white than green spheres, but females responded equally to white and green cylinders. In an onion field, baiting traps with Pr2S2 significantly increased female response to white over green traps, but had no influence on their response to trap shape. When traps were spaced 10 m apart and against a background of bare soil, females orienting to Pr2S2 baits alighted more frequently on vertical than horizontal traps, but shape and spectral reflectance were insignificant. However, when traps were spaced 0.25 m apart, females orienting to Pr2S2 baits alighted more frequently on cylinders than spheres. Mated females alighted more frequently on green than white cylinders, but unmated females responded to cylinders independent of spectral reflectance. When located 20 m downwind from Pr2S2 baits, mated females alighted on green cylinders significantly more often than unmated females. Response to traps mimicking onion plants suggests that ovipositional host-finding in female onion flies is dominated by olfactory responses at long range (several metres) and by visual cues at short-range (ca. 1 m). The view that host location by female onion flies is a hierarchical response pattern mediated by multiple sensory modalities and modified by resource level (habitat) and reproductive status, is discussed.

Ritcey, G., F. L. McEwen, H. E. Braun and R. Frank (1991). "PERSISTENCE AND BIOLOGICAL-ACTIVITY OF RESIDUES OF GRANULAR INSECTICIDES IN ORGANIC SOIL AND ONIONS WITH FURROW TREATMENT FOR CONTROL OF THE ONION MAGGOT (DIPTERA, ANTHOMYIIDAE)." *Journal of Economic Entomology* 84(4): 1339-1343.

Studies with the granular insecticides chlorfenvinphos, chlorpyrifos, isofenphos, and terbufos showed that when these are applied properly as in-furrow treatments for the control of the onion maggot in organic soil, good control is obtained of the first-generation maggot and that damage caused by infestation by second- and third-generation larvae is significantly reduced. Survival of onion maggots from eggs to larvae was independent of whether the eggs were placed beside the plant or in the leaf axils of the plant. Fonofos, chlorpyrifos, and isofenphos were more persistent than isofenphos in organic soil and, with the exception of chlorpyrifos, all had declined to less than half the original level by the beginning of September. Significant residues of each of the four insecticides were detected in immature bulbs (64-76 d after seeding) with the level of residue being much higher in the roots and outer skin. Ninety-six days after seeding (2 mo before harvest), insecticide residues in bulbs were below the level of detection.

Ross, K. T. A. and M. Anderson (1991). "SENSILLA OF THE LARVAE OF *DELIA-RADICUM* L, *D-FLORALIS* F AND *D-ANTIQUA* MG (DIPTERA, ANTHOMYIIDAE)." *International Journal of Insect Morphology & Embryology* 20(6): 275-282.

A comparative SEM study of the sensilla of larval *Delia radicum*, *D. floralis* and *D. antiqua* (Diptera : Anthomyiidae) was undertaken. All had a dorsal organ and an anterior organ. These may contain olfactory receptors, contact chemo- and mechanoreceptors. *Delia radicum* and *D. floralis* also possessed a ventral organ, which is a possible chemo- and

mechanoreceptor. Campaniform (mechanoreceptor) and hair sensilla, which may be humidity receptors, were present on the body segments.

Cowles, R. S., J. R. Miller, R. M. Hollingworth, M. T. Abdelaal, F. Szurdoki, K. Bauer and G. Matolcsy (1990). "CINNAMYL DERIVATIVES AND MONOTERPENOIDS AS NONSPECIFIC OVIPOSITIONAL DETERRENENTS OF THE ONION FLY." *Journal of Chemical Ecology* 16(8): 2401-2428.

Hayden, J. and E. Grafius (1990). "ACTIVITY OF CYROMAZINE ON ONION MAGGOT LARVAE (DIPTERA, ANTHOMYIIDAE) IN THE SOIL." *Journal of Economic Entomology* 83(6): 2398-2400.

Keller, J. E. and J. R. Miller (1990). "ONION FLY OVIPOSITION AS INFLUENCED BY SOIL-TEMPERATURE." *Entomologia Experimentalis Et Applicata* 54(1): 37-42.

Kubota, T. and Y. Ishikawa (1990). "BIOCHEMICAL-PROPERTIES OF A GLUTATHIONE-S-TRANSFERASE FROM THE ONION FLY, HYLEMYA-ANTIQUA MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 25(3): 375-382.

Majchrowicz, I., T. J. Poprawski, P. H. Robert and N. K. Maniania (1990). "EFFECTS OF ENTOMOPATHOGENIC AND OPPORTUNISTIC FUNGI ON DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE) AT LOW RELATIVE-HUMIDITY." *Environmental Entomology* 19(4): 1163-1167.

The pathogenicity of *Beauveria bassiana* (Balsamo) Vuillemin and *Paecilomyces fumosoroseus* (Wize) Brown & Smith to the onion maggot, *Delia antiqua* (Meigen), was studied at 50% RH in the laboratory. Conidiospores of *P. fumosoroseus* sprayed on puparia of the onion maggot at the concentration $1 \times 10^8 \text{ ml}^{-1}$ ($=4 \times 10^5 \text{ cm}^{-2}$) increased pupal mortality to 47.5% as compared with 6.6% in the controls. There was no latent effect on adults that emerged from treated puparia. Spores of *B. bassiana* sprayed at the same concentration had no effect on pupal and adult mortality. Sixteen additional species of fungi were recovered from test puparia during reisolation of *B. bassiana* and *P. fumosoroseus*. Species from the genera *Aspergillus*, *Fusarium*, *Geotrichum*, *Penicillium*, *Mucor*, and *Scopulariopsis* were isolated, *A. clavatus* Desmazières being the most common among them. This fungus grew faster than the entomopathogens in vitro and might have inhibited their action in vivo.

Miller, J. R. and R. S. Cowles (1990). "STIMULO-DETERRENT DIVERSION - A CONCEPT AND ITS POSSIBLE APPLICATION TO ONION MAGGOT CONTROL." *Journal of Chemical Ecology* 16(11): 3197-3212.

Considerable basic information has been gathered on the interaction between the onion fly (*Delia antiqua*) and its host plant, the onion (*Allium cepa*). An attempt is underway to manipulate ovipositional behavior of this pest by treating onion seedlings with chemical deterrents while simultaneously providing deeply planted onion culls on which onion flies prefer to lay. This bipolar strategy of behavioral manipulation, termed "stimulo-deterrent diversion" (SDD), has the advantages of: (1) avoiding severe pest deprivation and concomitant overriding of deterrents, (2) combining the effects of "push" and "pull" multiplicatively, and (3) providing opportunities for enhanced biological control in sites where the pest becomes concentrated. The suggestion is made that using SDD along with soil insecticide might relax or even reverse selection for physiological resistance of *D. antiqua* to insecticides. As tools of molecular biology open new possibilities for manipulating plants and their allelochemicals, applied chemical ecologists should consider arranging situations where the allelochemicals have clear and adaptive messages for the pest. By combining toxins and deterrents at sites where feeding should be prevented, while simultaneously expediting use of alter-native plants or plant parts, it might be possible to guide pest evolution toward paths of less conflict and with human interest.

Missonnier, J. and N. Boulle (1990). DEVELOPMENTAL LENGTHS AND INDUCTION OF NYMPHAL DIAPAUSE IN THE DIPTERAN MUSCIDAE (DELIA-RADICUM L, HYLEMYIA-ANTIQUA MEIG) - CONJUGATE EFFECTS OF TEMPERATURE AND INDIVIDUAL VARIABILITY.

Cowles, R. S., J. E. Keller and J. R. Miller (1989). "PUNGENT SPICES, GROUND RED PEPPER, AND SYNTHETIC CAPSAICIN AS ONION FLY OVIPOSITIONAL DETERRENENTS." *Journal of Chemical Ecology* 15(2): 719-730.

In laboratory choice experiments, the spices dill, paprika, black pepper, chili powder, ginger, and red pepper deterred *Delia antiqua* oviposition by 88–100%. Dose-response choice tests demonstrated that 1 mg of ground cayenne pepper (GCP) placed within 1 cm of artificial onion foliage reduced oviposition by 78%. A synthetic analog of capsaicin, the principal flavor ingredient of red peppers, deterred oviposition by 95% when present at 320 ppm in the top centimeter of sand (the ovipositional substrate). However, in no-choice conditions 10 mg GCP was not an effective deterrent. Sevana Bird Repellent and Agrigard Insect Repellent both use red pepper as a principal ingredient; at recommended field rates, neither of these materials was an effective ovipositional deterrent either in laboratory or field. Capsaicin-based materials do not appear to be candidates for onion maggot control via behavioral modification.

Grafius, E. and F. W. Warner (1989). "PREDATION BY BEMBIDION-QUADRIMACULATUM (COLEOPTERA, CARABIDAE) ON DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Environmental Entomology* 18(6): 1056-1059.

Bembidion quadrimaculatum L. is one of the most common carabids in Michigan onion fields and feeds on onion maggot, *Delia antiqua* (Meigen), eggs and first instars as well as a number of other prey. Laboratory and field experiments were conducted to determine the effectiveness of *B. quadrimaculatum* as a predator of the onion maggot. Up to 25 onion maggot eggs per day were consumed per *B. quadrimaculatum* adult. Consumption of eggs and first instars increased with temperature. Predation was higher when eggs were placed on the soil surface than for eggs placed 1 cm deep (70% versus 17.5%). In field cage studies, *B. quadrimaculatum* reduced onion maggot numbers by up to 57%. *B. quadrimaculatum* may therefore be an important biological control agent for the onion maggot.

Hausmann, S. M. and J. R. Miller (1989). "OVIPOSITIONAL PREFERENCE AND LARVAL SURVIVAL OF THE ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) AS INFLUENCED BY PREVIOUS MAGGOT FEEDING." *Journal of Economic Entomology* 82(2): 426-429.

Onion maggot, *Delia antiqua* (Meigen), ovipositional preference and subsequent larval survival on maturing onion bulbs with different levels of larval feeding and microbial damage were determined. Females preferentially oviposited on onion plants with low to moderate damage compared with healthy or severely damaged plants. Newly hatched onion maggots successfully colonized 90-100% of slightly to moderately damaged bulbs, which were preferred for oviposition, but colonized only 15-20% of the severely damaged and healthy plants. Weight gains for larvae reared on healthy or slightly damaged bulbs did not differ; both gains were greater than for larvae reared on more severely damaged bulbs. Overall larval survival was highest on slightly damaged bulbs. High densities of onion maggots are found on recently damaged fall onions, because they are preferred by *D. antiqua* for oviposition and are highly suitable larval food.

Hausmann, S. M. and J. R. Miller (1989). "PRODUCTION OF ONION FLY ATTRACTANTS AND OVIPOSITIONAL STIMULANTS BY BACTERIAL ISOLATES CULTURED ON ONION." *Journal of Chemical Ecology* 15(3): 905-916.

Decomposing onions at certain microbial successional stages produce potent volatile attractants and ovipositional stimulants of the onion fly, *Delia antiqua* (Diptera: Anthomyiidae). A reproducible source of these compounds was obtained by culturing *Erwinia carotovora* var. *carotovora* (EC) on sterile onion tissue. In laboratory choice tests, EC-inoculated onion was more attractive than *Klebsiella pneumoniae* (KP) cultured on onion, EC cultured on potato (a nonhost of onion fly), or the chemical synthetic baits dipropyl disulfide and an aqueous solution of 2-phenylethanol and pentanoic acid. Onion flies were mildly attracted to potato after inoculation with EC, but females did not accept EC-inoculated potato for oviposition. This work emphasizes that sources of semiochemicals may need to be defined microbiologically as well as physically and chemically.

Judd, G. J. R. and J. H. Borden (1989). "DISTANT OLFATORY RESPONSE OF THE ONION FLY, DELIA-ANTIQUA, TO HOST-PLANT ODOR IN THE FIELD." *Physiological Entomology* 14(4): 429-441.

Martinson, T. E., J. P. Nyrop and C. J. Eckenrode (1989). "LONG-RANGE HOST-FINDING BEHAVIOR AND COLONIZATION OF ONION FIELDS BY DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Journal of Economic Entomology* 82(4): 1111-1120.

The importance of directed movement by adults of the onion maggot, *Delia antiqua* (Meigen), in the colonization of new onion fields was assessed. In two mark-recapture experiments where flies were released in the center of circular bands of onions or nonhost vegetation, recaptures of mated females in the host and nonhost circle were distributed randomly. Recaptures of males were distributed randomly in the nonhost circle and directionally in the host circle,

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either downwind (release 1) or upwind (release 2) of the release point. In six similar releases in two nonhost environments, recaptures of females were randomly distributed regardless of mating status. Recaptures of males were often significantly directional but not correlated with wind direction. Mating status and ovarian development of feral *D. antiqua* trapped at three sites with different cropping histories were measured. Ovarian development and mating status of flies recaptured in nonhost vegetation 1.2 km from the nearest onion field or overwintering site were similar to those trapped in an onion field. Flies trapped at an overwintering site with no host plants were, on average, younger and less likely to be mated. These results suggest that long-range directed movement has little influence on the probability or extent of colonization of new onion fields by *D. antiqua*.

- Mochizuki, A., Y. Ishikawa and Y. Matsumoto (1989). "OLFACTORY RESPONSE OF THE LARVAE OF THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE) TO VOLATILE COMPOUNDS." *Applied Entomology and Zoology* 24(1): 29-35.
- Mochizuki, A., Y. Ishikawa and Y. Matsumoto (1989). "FACTORS ON INTRA-HOST PREFERENCE OF THE LARVAE OF THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 24(1): 36-41.
- Mowry, T. M., J. E. Keller and J. R. Miller (1989). "OVIPOSITION OF *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE) AS INFLUENCED BY SUBSTRATE HOLES AND PARTICLE-SIZE." *Annals of the Entomological Society of America* 82(1): 126-131.
- Mowry, T. M., J. L. Spencer, J. E. Keller and J. R. Miller (1989). "ONION FLY (*DELIA-ANTIQUA*) EGG DEPOSITIONAL BEHAVIOR - PINPOINTING HOST ACCEPTANCE BY AN INSECT HERBIVORE." *Journal of Insect Physiology* 35(4): 331-339.
- Vernon, R. S., J. W. Hall, G. J. R. Judd and D. L. Bartel (1989). "IMPROVED MONITORING PROGRAM FOR *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE)." *Journal of Economic Entomology* 82(1): 251-258.
- A vertical, two-sided sticky trap consisting of non-ultraviolet reflective, white-painted cardboard was developed for monitoring activity of adult *Delia antiqua* (Meigen) in commercial onion fields. A total trap surface area of 308 cm² was efficacious and economically desirable for trapping. Traps painted white were four times more attractive to *D. antiqua* flies than traps painted yellow, and were similar in attractiveness to horizontally oriented yellow sticky traps baited with onions. Traps placed 10-30 cm above a bare soil field captured more *D. antiqua* flies than traps at higher elevations. Within a mature onion stand, male fly captures increased linearly with trap height, whereas females appeared to prefer areas within the canopy. The most appropriate location for capturing males and females in a mature stand was just below the top of the crop canopy. Captures of the flies as influenced by trap direction followed a sinusoidal regression model, but combined trap catch on the complementary sticky trap faces was not significantly influenced by direction. Trap catch would be optimized by placing traps just inside the perimeter of an onion field with a spacing of 100 m between traps. A monitoring program using white sticky traps was as effective and considerably more cost efficient than a previous monitoring program that used yellow sticky traps baited with onions.
- Whistlecraft, J. W. and I. J. M. Lepard (1989). "EFFECT OF FLOODING ON SURVIVAL OF THE ONION FLY *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE) AND 2 PARASITOIDS, *APHAERETA-PALLIPES* (HYMENOPTERA, BRACONIDAE) AND *ALEOCHARA-BILINEATA* (COLEOPTERA, STAPHYLINIDAE)." *Proceedings of the Entomological Society of Ontario* 120: 43-47.
- Harris, M. O. and J. R. Miller (1988). "HOST-ACCEPTANCE BEHAVIOR IN AN HERBIVOROUS FLY, *DELIA-ANTIQUA*." *Journal of Insect Physiology* 34(3): 179-190.
- Ishikawa, Y. (1988). "ELECTROANTENNOGRAM RESPONSES OF THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE) TO OVIPOSITION STIMULANTS." *Applied Entomology and Zoology* 23(4): 388-395.
- Ishikawa, Y., K. Saito and Y. Matsumoto (1988). "CARBON-DIOXIDE EXPIRATION RATE OF THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE) WITH REFERENCE TO DIAPAUSE." *Applied Entomology and Zoology* 23(2): 194-196.
- Judd, G. J. R. and J. H. Borden (1988). "LONG-RANGE HOST-FINDING BEHAVIOR OF THE ONION FLY *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE) - ECOLOGICAL AND PHYSIOLOGICAL CONSTRAINTS." *Journal of Applied Ecology* 25(3): 829-845.

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Judd, G. J. R., J. H. Borden and A. D. Wynne (1988). "VISUAL BEHAVIOR OF THE ONION FLY, DELIA-ANTIQUA - ANTAGONISTIC INTERACTION OF ULTRAVIOLET AND VISIBLE WAVELENGTH REFLECTANCE." *Entomologia Experimentalis Et Applicata* 49(3): 221-234.

Martinson, T. E., J. P. Nyrop and C. J. Eckenrode (1988). "DISPERSAL OF THE ONION FLY (DIPTERA, ANTHOMYIIDAE) AND LARVAL DAMAGE IN ROTATED ONION FIELDS." *Journal of Economic Entomology* 81(2): 508-514.

Onion flies, *Delia antiqua* (Meigen), trapped in water pan traps in nonhost vegetation throughout a 740-ha muck, were captured in large numbers up to 1.5 km from overwintering sites in May and June during the first flight. Few flies were captured in nonhost areas during the second flight in July. Similar, high levels of onion maggot (OM) damage were observed in 10 small onion plots planted in organic soils in the 740-ha muck at locations varying from 0.4 to 1.5 km distant from OM overwintering sites. Damage in untreated plots in commercial fields not planted to onions the previous year was related to distance from overwintering sites (fields planted to onions the previous year), and declined with increasing distance. Lowest damage levels, comparable to damage measured in chlorpyrifos-treated research plots, were observed in fields located in small, isolated mucks that had been planted to another crop the previous growing season.

Tu, C. M. and C. R. Harris (1988). "A DESCRIPTION OF THE DEVELOPMENT AND PATHOGENICITY OF ENTOMOPHTHORA-MUSCAE (COHN) IN THE ONION MAGGOT, DELIA-ANTIQUA (MEIGEN)." *Agriculture Ecosystems & Environment* 20(2): 143-146.

The development and pathogenicity of *Entomophthora muscae* from infected onion maggot adults originally collected from Keswick Marsh, Ontario, are described. Morphological examination of the fungal growth, fruiting bodies and development of the disease is reported.

Boivin, G. and D. L. Benoit (1987). "PREDICTING ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) FLIGHTS IN SOUTHWESTERN QUEBEC USING DEGREE-DAYS AND COMMON WEEDS." *Phytoprotection* 68(1): 65-70.

Harris, M. O., J. E. Keller and J. R. Miller (1987). "RESPONSES TO NORMAL-DIPROPYL DISULFIDE BY OVIPOSITING ONION FLIES - EFFECTS OF CONCENTRATION AND SITE OF RELEASE." *Journal of Chemical Ecology* 13(5): 1261-1277.

Harris, M. O., J. R. Miller and O. M. B. Deponti (1987). "MECHANISMS OF RESISTANCE TO ONION FLY EGG-LAYING." *Entomologia Experimentalis Et Applicata* 43(3): 279-286.

Havukkala, I. J. and J. R. Miller (1987). "DAILY PERIODICITY IN THE OVIPOSITIONAL BEHAVIOR OF THE ONION FLY, DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Environmental Entomology* 16(1): 41-44.

Honda, I. and Y. Ishikawa (1987). "ELECTROPHYSIOLOGICAL STUDIES ON THE DORSAL AND ANTERIOR ORGANS OF THE ONION FLY LARVA, HYLEMYA-ANTIQUA MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 22(4): 410-416.

Honda, I. and Y. Ishikawa (1987). "ULTRASTRUCTURES OF THE LARVAL CEPHALIC SENSORY ORGANS OF THE ONION AND SEED-CORN FLIES, HYLEMYA-ANTIQUA MEIGEN AND HYLEMYA-PLATURA MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 22(3): 325-334.

Honda, I., Y. Ishikawa and Y. Matsumoto (1987). "ELECTROPHYSIOLOGICAL STUDIES ON THE ANTENNAL OLFACTORY CELLS OF THE ONION FLY, HYLEMYA-ANTIQUA MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 22(4): 417-423.

Ishikawa, Y., Y. Matsumoto, M. Tsutsumi, Y. Mitsui, K. Yamashita, M. Yoshida and E. Shirai (1987). "CONTROLLED RELEASE FORMULATION OF ATTRACTANT FOR THE ONION AND SEED-CORN FLIES, HYLEMYA-ANTIQUA AND HYLEMYA-PLATURA (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 22(3): 303-309.

Ishikawa, Y., S. Tsukada and Y. Matsumoto (1987). "EFFECT OF TEMPERATURE AND PHOTOPERIOD ON THE LARVAL DEVELOPMENT AND DIAPAUSE INDUCTION IN THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 22(4): 610-616.

Javer, A., A. D. Wynne, J. H. Borden and G. J. R. Judd (1987). "PINE OIL - AN OVIPOSITION DETERRENT FOR THE ONION MAGGOT, *DELIA-ANTIQUA* (MEIGEN) (DIPTERA, ANTHOMYIIDAE)." *Canadian Entomologist* 119(7-8): 605-609.

Pine oil (Norpine-65, Northwest Petrochemicals) was assessed as an oviposition deterrent for gravid female onion maggots, *Delia antiqua* (Meigen), in two types of laboratory experiments. When given a choice for 24 h between a control onion half treated with hexane and an onion half treated with pine oil in hexane, the females oviposited preferentially on or around the control onion half. In a no-choice experiment the females laid over three times as many eggs on or around solvent control onions as on or around onions treated with 1.0% pine oil. The DC50 (deterrent concentration 50) was calculated to be 0.09%. The results suggest that pine oil (or its constituents) may have potential as an oviposition deterrent under field conditions.

Résumé : L'huile de pin (Norpine-65, Northwest Petrochemicals) a été testée comme inhibiteur de la ponte chez des femelles gravides de la mouche de l'oignon, *Delia antiqua* (Meigen), par deux types d'expériences. En présence pendant 24 h d'un choix entre une moitié d'oignon témoin traitée à l'hexane et une moitié traitée avec l'huile de pin, les femelles ont pondu préférentiellement sur ou autour de la moitié témoin. Dans une situation n'offrant pas de choix, les femelles ont pondu plus de trois fois plus d'oeufs sur ou autour des moitiés d'oignon traitées à l'hexane, que sur ou autour de celles traitées avec l'huile de pin à 1,0%. La DC50 (concentration répulsive médiane) a été estimée à 0,09%. Les résultats indiquent que l'huile de pin (ou certains de ses constituants) est peut-être utilisable pour inhiber la ponte dans certaines conditions sur le terrain.

Vernon, R. S., G. J. R. Judd and J. H. Borden (1987). "COMMERCIAL MONITORING PROGRAM FOR THE ONION FLY, *DELIA-ANTIQUA* (MEIGEN) (DIPTERA, ANTHOMYIIDAE) IN SOUTHWESTERN BRITISH-COLUMBIA." *Crop Protection* 6(5): 304-312.

Onion flies were monitored from 1979 to 1982 using onion-baited yellow sticky traps in 88 commercial onion fields in the lower Fraser Valley of British Columbia. Capture rates of onion flies varied widely both between and within farms, and within fields both spatially and temporally. An action threshold of 0.1 females/trap/day was used to determine the need for first-generation adult sprays, beginning 30 days after seeding with a granular insecticide. Over the 4 years, growers applied an average of 1.6 sprays per field per season using the monitoring programme, compared with averages of 4.4 or 9.3 sprays had they followed a production guide schedule, or a 10-day fixed routine schedule, respectively. Growers adhering to the established monitoring programme achieved excellent control of maggot damage.

Eckenrode, C. J. and J. P. Nyrop (1986). "IMPACT OF PHYSICAL INJURY AND COMMERCIAL LIFTING ON DAMAGE TO ONION BULBS BY LARVAE OF ONION MAGGOT (*DIPTERA, ANTHOMYIIDAE*)." *Journal of Economic Entomology* 79(6): 1606-1608.

Finch, S., M. E. Cadoux, C. J. Eckenrode and T. D. Spittler (1986). "APPRAISAL OF CURRENT STRATEGIES FOR CONTROLLING ONION MAGGOT (*DIPTERA, ANTHOMYIIDAE*) IN NEW-YORK-STATE." *Journal of Economic Entomology* 79(3): 736-740.

Finch, S., C. J. Eckenrode and M. E. Cadoux (1986). "BEHAVIOR OF ONION MAGGOT (*DIPTERA, ANTHOMYIIDAE*) IN COMMERCIAL ONION FIELDS TREATED REGULARLY WITH PARATHION SPRAYS." *Journal of Economic Entomology* 79(1): 107-113.

Numbers of *Delia antiqua* (Meigen) adults captured in yellow water-traps in New York State indicated that fly activity remained crepuscular throughout each of three annual fly generations. Flies avoided onion crops during most of the day; they preferred to rest in the shade of surrounding foliage. Once active, flies were distributed more or less evenly through crops; most females were caught in the evening. Parathion sprays had to contact flies directly for mortality to occur. Data indicated that a single parathion spray applied at peak fly emergence in the spring is unlikely to contact >10-20% of the fly population. Sprays applied later in the year either to the entire crop or to just the surrounding hedgerows were unlikely to contact >4 or 0.2% of the fly population, respectively. These data suggest that application of parathion as an adulticide is unwarranted.

Soni, S. K., R. E. Baldwin and P. R. Ellis (1986). "EVALUATION OF ONION CULTIVARS FOR REARING ONION FLY IN THE LABORATORY." *Annals of Applied Biology* 108: 172-173.

Turnbull, S. A. and C. R. Harris (1986). "INFLUENCE OF POSTTREATMENT TEMPERATURE ON THE CONTACT TOXICITY OF 10 ORGANOPHOSPORUS AND PYRETHROID INSECTICIDES TO ONION MAGGOT ADULTS (DIPTERA, ANTHOMYIIDAE)." *Proceedings of the Entomological Society of Ontario* 117: 41-44.

Vernon, R. S. (1986). "A SPECTRAL ZONE OF COLOR PREFERENCE FOR THE ONION FLY, *DELIA ANTIQUA* (DIPTERA, ANTHOMYIIDAE), WITH REFERENCE TO THE REFLECTIVE INTENSITY OF TRAPS." *Canadian Entomologist* 118(9): 849-856.

Whitfield, G. H., F. A. Drummond and D. L. Haynes (1986). "OVERWINTERING SURVIVAL OF THE ONION MAGGOT, *DELIA ANTIQUA* (MEIGEN), (DIPTERA, ANTHOMYIIDAE) IN MICHIGAN." *Journal of the Kansas Entomological Society* 59(1): 197-199.

Carruthers, R. I. and D. L. Haynes (1985). "LABORATORY TRANSMISSION AND INVIVO INCUBATION OF ENTOMOPHTHORA-MUSCAE (ENTOMOPHTHORALES, ENTOMOPHTHORACAE) IN THE ONION FLY, *DELIA ANTIQUA* (DIPTERA, ANTHOMYIIDAE)." *Journal of Invertebrate Pathology* 45(3): 282-287.

A high-moisture infection chamber was used for the in vivo transmission of *Entomophthora muscae* within laboratory populations of the onion fly, *Delia antiqua*. This cadaver-to-fly transmission procedure provided an average experimental infection rate well above 95%. Laboratory infection and temperature-dependent incubation rates of *E. muscae* were further examined in adult populations of *D. antiqua*. The time from initial exposure until host death and pathogen sporulation was accurately predicted using a second-order function of the incubation temperature. A developmental base temperature of approximately 5°C was estimated, with 105 degree-days being the average number of heat units required between host infection and death. *E. muscae* transmission between *D. antiqua* and *D. platura*, two insect pests typically associated with Michigan onion production, was verified under laboratory conditions.

Carruthers, R. I., D. L. Haynes and D. M. Macleod (1985). "ENTOMOPHTHORA-MUSCAE (ENTOMOPHTHORALES, ENTOMOPHTHORACAE) MYCOSIS IN THE ONION FLY, *DELIA ANTIQUA* (DIPTERA, ANTHOMYIIDAE)." *Journal of Invertebrate Pathology* 45(1): 81-93.

Entomophthora muscae was identified as a common fungal pathogen of the onion fly, *Delia antiqua*, and the adult seed corn maggot, *D. platura*. Low infection levels also were found in populations of the cluster fly, *Pollenia rudis* (Diptera: Muscidae), and the tiger fly, *Coenosia tigrina* (Diptera: Muscidae). The disease cycle, as it affects *D. antiqua* in the onion agroecosystem, is described, including the etiology, symptomatology, and phenology. Natural infection levels approaching 100% were noted early in the spring and in late fall, impacting the 1st and 3rd generations of the *D. antiqua* population significantly. A lagged density-dependent disease response was noted at the gross population level, although more specific biological interactions may be involved in regulating the disease intensity.

Carruthers, R. I., G. H. Whitfield and D. L. Haynes (1985). "PESTICIDE-INDUCED MORTALITY OF NATURAL ENEMIES OF THE ONION MAGGOT, *DELIA ANTIQUA* (DIPTERA, ANTHOMYIIDAE)." *Entomophaga* 30(2): 151-161.

Pesticide-induced differential mortality between *Delia antiqua* (MEIGEN) and several other organisms associated with its natural control [*D. platura* (MEIGEN), *Coenosia tigrina* (F.), *Entomophthora muscae* (COHN), and *Aphaereta pallipes* (SAY)] were evaluated under simulated field conditions. Direct and residual differential mortalities were described for 3 herbicides (Chloro-IPC, nitrofen, and CDAA), 3 fungicides (maneb, chlorothalonil, and copper sulfate), and 1 insecticide (malathion). The recommended field application rates of these chemicals produced high positive differential mortality levels between *D. antiqua* and some of the natural mortality agents. Chloro-IPC, a preplant and midseason herbicide, induced 100% mortality of *A. pallipes* over the 3-day residual test period. Modifications in behavioral orientation and death patterns of *D. antiqua* adults infected with *E. muscae* were also noted in malathion-treated flies such that subsequent conidial dispersal was highly restricted.

Résumé : Les différences de mortalité induites par les produits phytosanitaires entre *Delia antiqua* et plusieurs organismes antagonistes associés à sa limitation naturelle *D. platura* (MEIGEN), *Coenosia tigrina* (F.), *Entomophthora muscae* (COHN) et *Aphaereta pallipes* (SAY) ont été évaluées dans des conditions simulant celles des cultures. Les mortalités différentes dues à l'action directe ou résiduelle des produits sont décrites pour trois herbicides (Chloro-IPC,

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Nitrofen et CDAA), trois fongicides (Maneb, Chlorothalonil et Sulfate de Cuivre) et un insecticide (Malathion). Les taux d'application pratique recommandés de ces produits entraînent des différences hautement positives dans les niveaux de mortalité entre *D. antiqua* et quelques-uns de ses agents de mortalité naturelle. Le Chloro-IPC, herbicide de préplantation et de demi-saison, provoque la mortalité totale d'*A. pallipes* au-delà des trois jours qui constituent la période test pour les résidus. Des modifications d'orientation comportementale et des modalités de la mort des adultes de *D. antiqua* infestés par *E. muscae* ont été aussi notées chez les mouches traitées au Malathion de sorte que la dispersion des conidies était hautement réduite.

Everts, K. L., H. F. Schwartz, N. D. Epsky and J. L. Capinera (1985). "EFFECTS OF MAGGOTS AND WOUNDING ON OCCURRENCE OF FUSARIUM BASAL ROT OF ONIONS IN COLORADO." *Plant Disease* 69(10): 878-882.

Eymann, M. and W. G. Friend (1985). "DEVELOPMENT OF ONION MAGGOTS (DIPTERA, ANTHOMYIIDAE) ON BACTERIA-FREE ONION AGAR SUPPLEMENTED WITH VITAMINS AND AMINO-ACIDS." *Annals of the Entomological Society of America* 78(2): 182-185.

Eymann, M. and W. G. Friend (1985). "EFFECTS OF VITAMIN SUPPLEMENTS ON THE DEVELOPMENT OF ONION MAGGOTS (DIPTERA, ANTHOMYIIDAE) ON AXENIC ONION AGAR." *Canadian Entomologist* 117(4): 475-479.

Finch, S. and C. J. Eckenrode (1985). "INFLUENCE OF UNHARVESTED, CULL-PILE, AND VOLUNTEER ONIONS ON POPULATIONS OF ONION MAGGOT (DIPTERA, ANTHOMYIIDAE)." *Journal of Economic Entomology* 78(3): 542-546.

Havukkala, I. (1985). "SOIL PARTICLE-SIZE PREFERENCE ON EGG-LAYING ONION FLIES, *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE), ENHANCED BY HOST PLANT-CHEMICALS." *Annales Entomologici Fennici* 51(2): 62-63.

Ishikawa, Y., S. Tanaka, Y. Matsumoto, K. Yamashita, M. Yoshida and E. Shirai (1985). "COLOR PREFERENCE OF THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE) WITH REFERENCE TO ULTRAVIOLET REFLECTION." *Applied Entomology and Zoology* 20(1): 20-26.

Mochizuki, A., Y. Ishikawa and Y. Matsumoto (1985). "SUGARS AS PHAGOSTIMULANTS FOR LARVAE OF THE ONION FLY, *HYLEMYA-ANTIQUA* MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 20(4): 465-469.

Poprawski, T. J., P. H. Robert, I. Majchrowicz and G. Boivin (1985). "SUSCEPTIBILITY OF *DELIA-ANTIQUA* (DIPTERA, ANTHOMYIIDAE) TO 11 ISOLATES OF ENTOMOPATHOGENIC HYPHOMYCETES." *Environmental Entomology* 14(5): 557-561.

Susceptibility of *Delia antiqua* (Meigen) to 11 isolates of entomopathogenic hyphomycetous fungi was studied in the laboratory. Newly formed pupae were sprayed directly with four concentrations of aqueous spore suspensions of *Beauveria bassiana* (Balsamo) Vuillemin (three isolates), *Metarhizium anisopliae* (Metschnikoff) Sorokin (three isolates), and one isolate each of *Metarhizium flavoviride* Gams & Rozsypal, *Nomuraea rileyi* (Farlow) Samson, *Paecilomyces farinosus* (Dickson ex Fries) Brown & Smith, *Paecilomyces fumosoroseus* (Wize) Brown & Smith, and *Tolyposcladium cylindrosporum* Gams. Pupae were generally not susceptible to mycoses but deferred mortality was observed in adults that emerged from puparia treated with nine of the fungal isolates. *N. rileyi* 5 and *M. anisopliae* 120 did not induce mycosis in adult flies. Mortality due to the other isolates ranged from <5% (*T. cylindrosporum* at 4×10^5 blastospores ml⁻¹) to 75% for *P. farinosus* and *P. fumosoroseus* (4×10^5 conidia ml⁻¹). The three *Beauveria* were moderately pathogenic at all four concentrations tested. Sporulation occurred on 56% of adults infected with *M. anisopliae* 71 and on 17% of those infected with *M. flavoviride* (4×10^5 conidia ml⁻¹). Significant differences were thus found between isolates with regard to their ability to infect emerging adults, but dose-level differences for a given isolate were generally not significant. Overall, toxicity appeared to have been more evident than pathogenicity and resulted in reduction in numbers of viable and fertile adults that emerged from puparia treated with nine of the isolates. *P. farinosus* 46 and *P. fumosoroseus* 45 (LD50's in the range of 103 conidia cm⁻²) are promising candidates for the control of *D. antiqua*.

Poprawski, T. J., P. H. Robert and N. K. Maniania (1985). "SUSCEPTIBILITY OF THE ONION MAGGOT, DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE), TO THE MYCOTOXIN DESTRUXIN-E." *Canadian Entomologist* 117(6): 801-802.

The onion maggot, *Delia antiqua* (Meigen), is the most important pest of *Allium* spp. in temperate regions of the northern hemisphere (Loosjes 1976; Ellis and Eckenrode 1977). If left uncontrolled, the onion maggot can cause from 20 to 100% crop losses, especially in light organic soils. In the early 1950's, with the development of organochlorine insecticides, onion growers obtained good control of onion maggot populations (Finlayson et al. 1959), but the pest rapidly developed resistance to these toxicants (Harris 1977). The chlorinated hydrocarbons were replaced by the less persistent organophosphorus and carbamate insecticides (Hanis et al. 1981), but the onion maggot was reported to become resistant to these compounds (Harris et al. 1981; Carroll et al. 1983). Among alternatives to the use of insecticides to control the onion maggot are the entomopathogenic fungi and their metabolites. The potential of mycotoxins as microbially derived insecticides has been investigated by several researchers and reviewed recently by Roberts (1981).

Schneider, W. D., M. O. Harris and J. R. Miller (1985). "ONION MAGGOT FEEDING AND DEVELOPMENT ON HETEROGENEOUS SECTIONS OF THE ONION BULB." *Entomologia Experimentalis Et Applicata* 38(2): 151-155.

Tomlin, A. D., J. J. Miller, C. R. Harris and J. H. Tolman (1985). "ARTHROPOD PARASITOIDS AND PREDATORS OF THE ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) IN SOUTHWESTERN ONTARIO." *Journal of Economic Entomology* 78(4): 975-981.

Miniature (1 m²) mass-rearing beds containing onion maggot, *Delia antiqua* (Meigen), were established during 1980 and 1981 at three commercial onion-growing fields and an experimental farm in southwestern Ontario to attract local parasites and predators. Onion maggot (OM) pupae from each of the three generations were collected from the beds before eclosion and allowed to complete development in the laboratory, enabling collection and identification of emerging parasitoids. Seven insect species (three staphylinid, four hymenopteran) were confirmed as parasitoids of OM, of which only *Aphaereta pallipes* (Say) and *Aleochara bilineata* (Gyllenhal) were significant mortality agents (parasitism rates up to 17 and 20.7%, respectively). Twenty carabid, 42 staphylinid, and 17 other (total 79) arthropod species of predatory habit were associated with OM in or near the miniature rearing beds. Twenty-one of the 79 species of mooted predators accepted OM eggs, larvae, or pupae as food under laboratory conditions. Diversity of arthropod predators and parasitoids was highest at the experimental farm at London (53 + 7 spp., respectively) > the three commercial onion-growing fields at Thedford (39 + 6) > Keswick (36 + 5) > Bradford (36 + 4).

Vernon, R. S. and D. L. Bartel (1985). "EFFECT OF HUE, SATURATION, AND INTENSITY ON COLOR SELECTION BY THE ONION FLY, DELIA-ANTIQUA (MEIGEN) (DIPTERA, ANTHOMYIIDAE) IN THE FIELD." *Environmental Entomology* 14(3): 210-216.

Weston, P. A. and J. R. Miller (1985). "INFLUENCE OF CAGE DESIGN ON PRECISION OF TUBE-TRAP BIOASSAY FOR ATTRACTANTS OF THE ONION FLY, DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Journal of Chemical Ecology* 11(4): 435-440.

Whitfield, G. H., R. I. Carruthers and D. L. Haynes (1985). "PHENOLOGY AND CONTROL OF THE ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) IN MICHIGAN ONION PRODUCTION." *Agriculture Ecosystems & Environment* 12(3): 189-200.

Andaloro, J. T., K. B. Rose and C. J. Eckenrode (1984). "SUPPRESSING ONION MAGGOT IN COMMERCIAL FIELDS AND RESEARCH PLOTS, AND MONITORING WITH AIR THERMAL UNIT ACCUMULATIONS." *New York State Agricultural Experiment Station Search Agriculture*(29): 1-5.

Blaine, W. D. and F. L. McEwen (1984). "NUTRITION OF THE ONION MAGGOT, DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Canadian Entomologist* 116(3): 473-477.

Carruthers, R. I., G. H. Whitfield and D. L. Haynes (1984). "SAMPLING PROGRAM FOR ESTIMATING PLANT-DAMAGE CAUSED BY THE ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) ON THE REGIONAL AND FIELD LEVELS." *Journal of Economic Entomology* 77(6): 1355-1363.

Chapman, R. A., C. R. Harris, H. J. Svec and J. R. Robinson (1984). "PERSISTENCE AND MOBILITY OF GRANULAR INSECTICIDES IN AN ORGANIC SOIL FOLLOWING FURROW APPLICATION FOR ONION MAGGOT CONTROL." *Journal of Environmental Science and Health Part B-Pesticides Food Contaminants and Agricultural Wastes* 19(3): 259-270.

Harris, C. R., J. W. Whittlecraft, H. J. Svec, J. H. Tolman and A. D. Tomlin (1984). "OUTDOOR REARING TECHNIQUE FOR MASS-PRODUCTION OF ONION MAGGOTS (DIPTERA, ANTHOMYIIDAE)." *Journal of Economic Entomology* 77(3): 824-827.

Harris, M. O. and J. R. Miller (1984). "FOLIAR FORM INFLUENCES OVIPOSITIONAL BEHAVIOR OF THE ONION FLY." *Physiological Entomology* 9(2): 145-155.

Ikeshoji, T. (1984). "S-PROPENYL-CYSTEINE SULFOXIDE IN EXUDATES OF ONION ROOTS AND ITS POSSIBLE DECOMPARTMENTALIZATION IN ROOT-CELLS BY BACTERIA INTO ATTRACTANT OF THE ONION MAGGOT, HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 19(2): 159-169.

Ishikawa, Y., Y. Matsumoto, M. Tsutsumi and Y. Mitsui (1984). "EXPERIMENTAL FIELD TRAPPING OF THE ONION AND SEED-CORN FLIES, HYLEMYA-ANTIQUA AND HYLEMYA-PLATURA (DIPTERA, ANTHOMYIIDAE), USING 2-PHENYLETHANOL FOR POPULATION ESTIMATION." *Applied Entomology and Zoology* 19(1): 75-81.

Ishikawa, Y., Y. Matsumoto, M. Tsutsumi and Y. Mitsui (1984). "MIXTURE OF 2-PHENYLETHANOL AND N-VALERIC ACID, A NEW ATTRACTANT FOR THE ONION AND SEED-CORN FLIES, HYLEMYA-ANTIQUA AND HYLEMYA-PLATURA (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 19(4): 448-455.

Lanterman, W. S., D. T. Warholc and R. D. Sweet (1984). "EFFECT OF WINTER COVER CROPS AND TILLAGE ON ONIONS, WEEDS, ONION MAGGOTS AND NEMATODES." *Hortscience* 19(3): 576-576.

McEwen, F. L., G. Ritcey and H. J. Liu (1984). "LABORATORY STUDIES OF RADIATION-INDUCED STERILITY ON THE ONION MAGGOT, DELIA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Canadian Entomologist* 116(2): 119-122.

Miller, J. R., M. O. Harris and J. A. Breznak (1984). "SEARCH FOR POTENT ATTRACTANTS OF ONION FLIES (DIPTERA, ANTHOMYIIDAE)." *Journal of Chemical Ecology* 10(10): 1477-1488.

Ritcey, G. and F. L. McEwen (1984). "CONTROL OF THE ONION MAGGOT, DELIA-ANTIQUA (MEIGEN) (DIPTERA, ANTHOMYIIDAE), WITH FURROW TREATMENTS." *Journal of Economic Entomology* 77(6): 1580-1584.

Soni, S. K., G. H. Freeman and P. R. Ellis (1984). "A GLASSHOUSE SCREENING METHOD TO ASSESS RESISTANCE IN ONIONS TO DAMAGE BY ONION FLY (DELIA-ANTIQUA) LARVAE." *Annals of Applied Biology* 105(3): 565-573.

Carroll, K. A., C. R. Harris and P. E. Morrison (1983). "RESISTANCE SHOWN BY A PARATHION-RESISTANT ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) STRAIN TO SOME OTHER INSECTICIDES." *Canadian Entomologist* 115(11): 1519-1522.

Eymann, M. and W. G. Friend (1983). "ONION MAGGOT DEVELOPMENT IN A BACTERIA-RICH ENVIRONMENT WITHOUT ONION TISSUE." *Proceedings of the Entomological Society of Ontario* 114: 99-100.

Goth, G. J., W. G. Wellington and H. Y. Contant (1983). "VARIATION DUE TO MATERNAL AGE IN THE ONION ROOT MAGGOT, HYLEMYA-ANTIQUA (MEIGEN)." *Researches on Population Ecology* 25(2): 366-386.

Harris, M. O. and J. R. Miller (1983). "COLOR STIMULI AND OVIPOSITION BEHAVIOR OF THE ONION FLY, DELIA-ANTIQUA (MEIGEN) (DIPTERA, ANTHOMYIIDAE)." *Annals of the Entomological Society of America* 76(4): 766-771.

Honda, I., Y. Ishikawa and Y. Matsumoto (1983). "MORPHOLOGICAL-STUDIES ON THE ANTENNAL SENSILLA OF THE ONION FLY, HYLEMYA-ANTIQUA MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 18(2): 170-181.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

Être informé des activités du PELI : <http://www.lutteintegree.com/fr/Nous-joindre/>

Ishikawa, Y., T. Ikeshoji, Y. Matsumoto, M. Tsutsumi and Y. Mitsui (1983). "2-PHENYLETHANOL - AN ATTRACTANT FOR THE ONION AND SEED-CORN FLIES, HYLEMYA-ANTIQUA AND HYLEMYA-PLATURA (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 18(2): 270-277.

Ishikawa, Y., A. Mochizuki, T. Ikeshoji and Y. Matsumoto (1983). "MASS-REARING OF THE ONION AND SEED-CORN FLIES, HYLEMYA-ANTIQUA AND HYLEMYA-PLATURA (DIPTERA, ANTHOMYIIDAE), ON AN ARTIFICIAL DIET WITH ANTIBIOTICS." *Applied Entomology and Zoology* 18(1): 62-69.

Mochizuki, A., Y. Ishikawa and Y. Matsumoto (1983). "SEX IDENTIFICATION OF PUPAE OF THE ONION FLY, HYLEMYA-ANTIQUA MEIGEN (DIPTERA, ANTHOMYIIDAE)." *Applied Entomology and Zoology* 18(2): 286-287.

Schneider, W. D., J. R. Miller, J. A. Breznak and J. F. Fobes (1983). "ONION MAGGOT, DELIA-ANTIQUA, SURVIVAL AND DEVELOPMENT ON ONIONS IN THE PRESENCE AND ABSENCE OF MICROORGANISMS." *Entomologia Experimentalis Et Applicata* 33(1): 50-56.

Belanger, A., S. P. Mathur and P. Martel (1982). "THE EFFECT OF FONOFOS AND CARBOFURAN ON MICROBIOLOGICAL POPULATION, AND PERSISTENCE OF FONOFOS IN 4 ORGANIC SOILS INFESTED WITH ONION MAGGOT." *Journal of Environmental Science and Health Part B-Pesticides Food Contaminants and Agricultural Wastes* 17(2): 171-182.

Harris, C. R., J. H. Tolman and H. J. Svec (1982). "ONION MAGGOT (DIPTERA, ANTHOMYIIDAE) RESISTANCE TO SOME INSECTICIDES FOLLOWING SELECTION WITH PARATHION OR CARBOFURAN." *Canadian Entomologist* 114(8): 681-685.

Hough, J. A., C. J. Eckenrode and G. E. Harman (1982). "NON-PATHOGENIC BACTERIA AFFECTING OVIPOSITION BEHAVIOR IN THE ONION FLY (DIPTERA, ANTHOMYIIDAE)." *Environmental Entomology* 11(3): 585-589.

Ikeshoji, T., Y. Matsumoto, M. Nagai, S. Komochi, M. Tsutsumi and Y. Mitsui (1982). "CORRELATION BETWEEN THE SUSCEPTIBILITY OF ONION CULTIVARS TO THE ONION MAGGOT, HYLEMYA-ANTIQUA MEIGEN (DIPTERA, ANTHOMYIIDAE), AND THE BIOCHEMICAL CHARACTERISTICS OF ONION PLANT." *Applied Entomology and Zoology* 17(4): 507-518.

Liu, H. J., F. L. McEwen and G. Ritcey (1982). "FORECASTING EVENTS IN THE LIFE-CYCLE OF THE ONION MAGGOT, HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE) - APPLICATION TO CONTROL SCHEMES." *Environmental Entomology* 11(3): 751-755.

Martin, J. S. and F. L. McEwen (1982). "FREQUENCY OF MATING IN THE ONION MAGGOT, HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Canadian Entomologist* 114(7): 647-648.

Dindonis, L. L. and J. R. Miller (1981). "ONION FLY TRAP CATCH AS AFFECTED BY RELEASE RATES OF NORMAL-DIPROPYL DISULFIDE FROM POLYETHYLENE ENCLOSURES." *Journal of Chemical Ecology* 7(2): 411-418.

Dindonis, L. L. and J. R. Miller (1981). "ONION FLY AND LITTLE HOUSEFLY HOST FINDING SELECTIVELY MEDIATED BY DECOMPOSING ONION AND MICROBIAL VOLATILES." *Journal of Chemical Ecology* 7(2): 419-426.

Hough, J. A., G. E. Harman and C. J. Eckenrode (1981). "MICROBIAL STIMULATION OF ONION MAGGOT OVIPOSITION." *Environmental Entomology* 10(2): 206-210.

Ishikawa, Y., T. Ikeshoji, Y. Matsumoto, M. Tsutsumi and Y. Mitsui (1981). "FIELD TRAPPING OF THE ONION AND SEED-CORN FLIES WITH BAITS OF FRESH AND AGED ONION PULP." *Applied Entomology and Zoology* 16(4): 490-493.

Marshall, S. A. and M. Eymann (1981). "MICROORGANISMS AS FOOD FOR THE ONION MAGGOT, DELIA (=HYLEMYA) ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Proceedings of the Entomological Society of Ontario* 112: 1-5.

- Miller, J. R. and B. K. Haarer (1981). "YEAST AND CORN HYDROLYSATES AND OTHER NUTRITIOUS MATERIALS AS ATTRACTANTS FOR ONION AND SEED FLIES (DIPTERA, ANTHOMYIIDAE)." *Journal of Chemical Ecology* 7(3): 555-562.
- Robinson, A. S. (1981). "GENETIC-CONTROL OF DELIA (HYLEMYA) ANTIQUA .6. X-IRRADIATION OF FERTILIZED FEMALES TO PRODUCE TRANSLOCATIONS." *International Journal of Applied Radiation and Isotopes* 32(3): 143-146.
- Robinson, A. S. and K. Vanheemert (1981). "COMPLEX Y-LINKED TRANSLOCATIONS IN DELIA-ANTIQUA PRODUCED BY IRRADIATION OF A FERTILE Y-LINKED TRANSLOCATION." *Heredity* 46(FEB): 41-&.
- Robinson, A. S. and K. Vanheemert (1981). "TRANSLOCATIONS INDUCED BY FAST-NEUTRONS AND X-RAYS IN DELIA-ANTIQUA." *Theoretical and Applied Genetics* 59(5): 307-312.
- Robinson, A. S. and G. Zurlini (1981). "MATING SUCCESS OF DIFFERENTLY SIZED ONION FLIES, DELIA-ANTIQUA." *Entomologia Experimentalis Et Applicata* 30(2): 101-105.
- Vosselman, L. (1981). "MEIOTIC SEGREGATION OF 5 DIFFERENT RECIPROCAL TRANSLOCATIONS IN THE ONION FLY, HYLEMYA-ANTIQUA (MEIGEN)." *Chromosoma* 81(5): 727-738.
- Chiang, M. S. and J. P. Perron (1980). "EFFECTS OF SEEDLING DENSITY AND SOIL-MOISTURE ON ATTRACTIVENESS OF EGG-LAYING BY THE ONION MAGGOT." *Phytoprotection* 61(1): 9-12.
- Dindonis, L. L. and J. R. Miller (1980). "HOST-FINDING RESPONSES OF ONION AND SEEDCORN FLIES TO HEALTHY AND DECOMPOSING ONIONS AND SEVERAL SYNTHETIC CONSTITUENTS OF ONION." *Environmental Entomology* 9(4): 467-472.
- Dindonis, L. L. and J. R. Miller (1980). "HOST-FINDING BEHAVIOR OF ONION FLIES, HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Environmental Entomology* 9(6): 769-772.
- Emmett, B. J. and M. J. Savage (1980). "CHEMICAL CONTROL OF ONION FLY, DELIA-ANTIQUA (MEIG)." *Plant Pathology* 29(4): 159-167.
- Harris, C. R. and S. A. Turnbull (1980). "TOXICITY OF SOME INSECTICIDES TO INSECTICIDE-SUSCEPTIBLE STRAINS OF THE ONION, CABBAGE, AND SEEDCORN MAGGOTS (DIPTERA, ANTHOMYIIDAE) AND THE DARKSIDED CUTWORM (LEPIDOPTERA, NOCTUIDAE)." *Canadian Entomologist* 112(10): 1029-1032.
- Ikeshoji, T., Y. Ishikawa and Y. Matsumoto (1980). "ATTRACTANTS AGAINST THE ONION MAGGOTS AND FLIES, HYLEMYA-ANTIQUA, IN ONIONS INOCULATED WITH BACTERIA." *Journal of Pesticide Science* 5(3): 343-350.
- Robinson, A. S. (1980). "EFFECT OF SEX-RATIO AT 3 DENSITIES ON REPRODUCTION IN LABORATORY COLONIES OF DELIA (= HYLEMYA) ANTIQUA MEIG." *Zeitschrift Fur Angewandte Entomologie-Journal of Applied Entomology* 90(1): 82-89.
- Robinson, A. S., M. Herfst and L. Vosselman (1980). "GENETIC-CONTROL OF DELIA-ANTIQUA (MEIGEN) (DIPTERA, ANTHOMYIIDAE) - SENSITIVITY TO DIAPAUSE INTERFERING WITH A FIELD-CAGE EXPERIMENT USING A HOMOZYGOUS CHROMOSOMAL TRANSLOCATION." *Bulletin of Entomological Research* 70(1): 103-&.
- Vanheemert, C. and L. Vosselman (1980). "A MALE-LINKED TRANSLOCATION WITH HIGH FERTILITY IN THE ONION FLY HYLEMYA-ANTIQUA (MEIGEN)." *Genetica* 51(2): 111-114.
- Vanheemert, C. and I. Witteveenpillen (1980). "LOCATION OF THE ADH GENE IN THE ONION FLY USING A TRANSLOCATION TESTER SET." *Journal of Heredity* 71(5): 364-365.

- Vosselman, L. (1980). "FITNESS OF A TRANSLOCATION HOMOZYGOTE IN CAGE EXPERIMENTS WITH THE ONION FLY, HYLEMYA-ANTIQUA (MEIGEN)." *Theoretical and Applied Genetics* 58(2): 79-85.
- Vosselman, L. and C. V. Heemert (1980). "MEIOTIC DISJUNCTION AND EMBRYONIC LETHALITY IN SEX-LINKED DOUBLE-TRANSLOCATION HETEROZYGOUS MALES OF THE ONION FLY, HYLEMYA-ANTIQUA (MEIGEN)." *Theoretical and Applied Genetics* 58(3-4): 161-167.
- Whitfield, G. H., F. A. Drummond and D. L. Haynes (1980). "A SIMULATION-MODEL FOR THE SURVIVAL AND DEVELOPMENT OF THE ONION MAGGOT HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE)." *Proceedings of the Entomological Society of Ontario* 111: 39-55.
- Zurlini, G. and A. S. Robinson (1980). "THE EFFECT OF CROWDING ON ADULT-POPULATIONS OF DELIA (=HYLEMYA) ANTIQUA (MEIGEN)." *Researches on Population Ecology* 22(2): 228-241.
- Ellis, P. R. and C. J. Eckenrode (1979). "ONION MAGGOT AND ITS CONTROL IN NEW-YORK." *New Yorks Food and Life Sciences Bulletin*(79): 1-3.
- Ellis, P. R., C. J. Eckenrode and G. E. Harman (1979). "INFLUENCE OF ONION CULTIVARS AND THEIR MICROBIAL COLONIZERS ON RESISTANCE TO ONION MAGGOT (DIPTERA, ANTHOMYIIDAE)." *Journal of Economic Entomology* 72(4): 512-515.
- Ketel, D. H. and C. Vanheemert (1979). "MATING ASSESSMENT OF THE ONION FLY HYLEMYA-ANTIQUA MEIGEN AND THE HOUSE-FLY MUSCA-DOMESTICA L USING P-32." *International Journal of Applied Radiation and Isotopes* 30(10): 651-651.
- McLean, J. A., I. G. Stump, J. M. Dauria and J. Holman (1979). "MONITORING TRACE-ELEMENTS IN DIETS AND LIFE STAGES OF THE ONION MAGGOT, HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE), WITH X-RAY-ENERGY SPECTROMETRY." *Canadian Entomologist* 111(11): 1293-1298.
- Reid, J. A. K. and F. L. McEwen (1979). "SEMI-STERILE MUTANTS IN THE ONION MAGGOT, HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE), POPULATION EFFECTS IN FIELD CAGES." *Canadian Entomologist* 111(6): 749-750.
- Soni, S. K. and S. Finch (1979). "LABORATORY EVALUATION OF SULFUR-BEARING CHEMICALS AS ATTRACTANTS FOR LARVAE OF THE ONION FLY, DELIA-ANTIQUA (MEIGEN) (DIPTERA, ANTHOMYIIDAE)." *Bulletin of Entomological Research* 69(2): 291-298.
- Vanheemert, C., D. H. Ketel, J. J. F. Mulders and W. J. Vandenbrink (1979). "RELATIONSHIP BETWEEN SEX AND DEVELOPMENTAL TIME IN THE ONION FLY HYLEMYA-ANTIQUA (MEIGEN)." *Netherlands Journal of Zoology* 29(2): 233-241.
- Vosselman, L. (1979). "SEX DETERMINATION OF THE ONION FLY, HYLEMYA-ANTIQUA (MEIGEN) .2. SEX-RATIO DISTORTION BY UNSTABLE SOMATIC BEHAVIOR OF CHROMOSOME-Y2, AND INHERITANCE OF A NONFUNCTIONAL Y2(YM)." *Chromosoma* 75(3): 353-367.
- Zurlini, G. and A. Robinson (1979). "LARVAL DISPERSAL AS RELATED TO DENSITY IN WILD AND LABORATORY STRAINS OF DELIA (= HYLEMYA) ANTIQUA MEIGEN." *Netherlands Journal of Zoology* 29(3): 402-417.
- Ishikawa, Y., T. Ikeshoji and Y. Matsumoto (1978). "STUDIES ON OVIPOSITION ATTRACTANTS AND STIMULANTS OF ONION FLY, HYLEMYA-ANTIQUA (DIPTERA-ANTHOMYIIDAE) .1. PROPYLTHIO MOIETY ESSENTIAL TO OVIPOSITION ATTRACTANT AND STIMULANT OF ONION FLY, HYLEMYA-ANTIQUA-MEIGEN." *Applied Entomology and Zoology* 13(2): 115-122.
- Straub, R. W. and A. C. Davis (1978). "ONION MAGGOT DIPTERA-ANTHOMYIIDAE - EVALUATION OF INSECTICIDES FOR PROTECTION OF ONIONS IN MUCK SOILS." *Journal of Economic Entomology* 71(4): 684-686.

- Vosselman, L. (1978). "SEX DETERMINATION OF ONION FLY, HYLEMYA-ANTIQUA (MEIGEN) .1. SEX-CHROMOSOME POLYMORPHISM, GYNANDROMORPHISM AND X-POLYSOMY." *Chromosoma* 67(3): 201-218.
- Zurlini, G. and A. S. Robinson (1978). "ONION CONDITIONING PERTAINING TO LARVAL PREFERENCE, SURVIVAL AND RATE OF DEVELOPMENT IN DELIA (=HYLEMYA) ANTIQUA." *Entomologia Experimentalis Et Applicata* 23(3): 279-286.
- Reid, J. A. K. and F. L. McEwen (1977). "GENETIC INSECT CONTROL - CHROMOSOME REARRANGEMENTS ISOLATED USING A SIMPLE SYSTEM IN ONION MAGGOT, HYLEMYA-ANTIQUA (DIPTERA-ANTHOMYIIDAE)." *Canadian Entomologist* 109(9): 1287-1291.
- Saynor, M. and D. S. Hill (1977). "CHEMICAL CONTROL OF ONION FLY, DELIA-ANTIQUA." *Annals of Applied Biology* 85(1): 113-120.
- Vanheemert, C. (1977). "SYNTHESIS OF COMPOUND CHROMOSOMES FROM A PERICENTRIC INVERSION IN ONION FLY HYLEMYA-ANTIQUA." *Nature* 266(5601): 445-447.
- Vanheemert, K. (1977). "ISOLATION OF A HOMOZYGOUS X-LINKED TRANSLOCATION STOCK WITH 2 ADDITIONAL SEX-CHROMOSOMES IN ONION FLY HYLEMYA-ANTIQUA MEIGEN." *Theoretical and Applied Genetics* 49(3): 123-132.
- Harris, C. R. and H. J. Svec (1976). "ONION MAGGOT RESISTANCE TO INSECTICIDES (DIPTERA-ANTHOMYIIDAE)." *Journal of Economic Entomology* 69(5): 617-620.
- Theunissen, J. and J. P. W. Noordink (1976). "INCORPORATION OF TRITIATED-THYMIDINE IN GERMINAL AND SOMATIC-CELLS OF ONION FLY, HYLEMYA-ANTIQUA(DIPTERA-ANTHOMYIIDAE), AS DETERMINED BY AUTORADIOGRAPHY." *Entomologia Experimentalis Et Applicata* 20(1): 56-66.
- Vanheemert, C. and W. J. Vandenbrink (1976). "LOCATION OF AN EYE MUTANT IN ONION FLY HYLEMYA-ANTIQUA MEIGEN USING A PERICENTRIC CHROMOSOME INVERSION." *Experientia* 32(9): 1142-1144.
- Chawla, R. P., B. S. Joia and R. L. Kalra (1975). "LINDANE RESIDUES IN ONION, FOLLOWING ITS GRANULAR APPLICATION FOR CONTROL OF ONION MAGGOT." *Indian Journal of Agricultural Sciences* 45(11-1): 503-505.
- Eckenrode, C. J., E. V. Vea and K. W. Stone (1975). "POPULATION TRENDS OF ONION MAGGOTS CORRELATED WITH AIR THERMAL UNITS ACCUMULATIONS." *Environmental Entomology* 4(5): 785-789.
- Reid, J. A. K. and F. L. McEwen (1975). "HERITABILITY OF SEMI-STERILITY IN SEVERAL STRAINS OF ONION MAGGOT HYLEMYA-ANTIQUA (DIPTERA, ANTHOMYIIDAE), ISOLATED FOR GENETIC POPULATION-CONTROL PURPOSES." *Canadian Journal of Genetics and Cytology* 17(3): 464-465.
- Vanheemert, C. and K. J. A. Wijnandsstab (1975). "RADIATION-INDUCED SEMI-STERILITY FOR GENETIC-CONTROL PURPOSES IN ONION FLY HYLEMYA-ANTIQUA (MEIGEN) .2. INDUCTION, ISOLATION AND CYTOGENETIC ANALYSIS OF NEW CHROMOSOMAL REARRANGEMENTS." *Theoretical and Applied Genetics* 45(8): 349-354.
- Theuniss.J (1974). "EFFECTS OF TEMPERATURE ON EGG-CHAMBER DEVELOPMENT IN ONION FLY, HYLEMYA-ANTIQUA (DIPTERA-ANTHOMYIIDAE)." *Entomologia Experimentalis Et Applicata* 17(3): 355-366.
- Vanheeme.C (1974). "MEIOTIC DISJUNCTION, SEX-DETERMINATION AND EMBRYONIC LETHALITY IN AN X-LINKED SIMPLE TRANSLOCATION OF ONION FLY, HYLEMYA-ANTIQUA (MEIGEN)." *Chromosoma* 47(1): 45-60.
- Vanheeme.C (1974). "MEIOTIC DISJUNCTION AND EMBRYONIC LETHALITY IN TRISOMICS DERIVED FROM AN X-LINKED TRANSLOCATION IN ONION FLY, HYLEMYA-ANTIQUA (MEIGEN)." *Chromosoma* 47(3): 237-251.

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Être informé des activités du PELI : <http://www.lutteintegree.com/fr/Nous-joindre/>

- Wijnands.Kj and Vanheeme.C (1974). "RADIATION-INDUCED SEMI-STERILITY FOR GENETIC-CONTROL PURPOSES IN ONION FLY HYLEMYA-ANTIQUA (MEIGEN) .1. ISOLATION OF SEMI-STERILE STOCKS AND THEIR CYTOGENETICAL PROPERTIES." *Theoretical and Applied Genetics* 44(3): 111-119.
- Harris, C. R. (1972). "CROSS-RESISTANCE SHOWN BY SUSCEPTIBLE AND ALDRIN RESISTANT STRAINS OF SEEDCORN MAGGOTS, DIPTERA-ANTHOMYIIDAE ONION MAGGOTS, DIPTERA-ANTHOMYIIDAE AND CABBAGE MAGGOTS DIPTERA-ANTHOMYIIDAE TO CHLORDANE." *Journal of Economic Entomology* 65(2): 347-&.
- Kageyama, M. E., L. W. Getzin and W. A. Rawlins (1972). "LOSS OF ACTIVITY OF DIAZINON FOR ONION MAGGOT DIPTERA-ANTHOMYIIDAE CONTROL IN MARL-CONTAINING MUCK SOIL." *Journal of Economic Entomology* 65(3): 873-&.
- Gostick, K. G., D. F. Powell and C. Slough (1971). "DIELDRIN-RESISTANT ONION FLY (DELIA-ANTIQUA(MEIG)) IN ENGLAND." *Plant Pathology* 20(2): 63-&.
- Allen, W. R. and W. L. Askew (1970). "SIMPLE TECHNIQUE FOR MASS-REARING ONION MAGGOT (DIPTERA-ANTHOMYIIDAE) ON AN ARTIFICIAL DIET." *Canadian Entomologist* 102(12): 1554-&.
- McEwen, F. L., H. W. Goble, C. C. Filman and Edgingto.Lv (1969). "FURROW APPLICATIONS OF VARIOUS INSECTICIDE-FUNGICIDE COMBINATIONS FOR CONTROL OF ONION MAGGOT AND ONION SMUT IN ONIONS GROWN FROM SEED IN ONTARIO." *Proceedings of the Entomological Society of Ontario* 100: 150-&.
- Stoffola.Jg (1969). "NEMATODE PARASITES OF FACE FLY AND ONION MAGGOT IN FRANCE AND DENMARK." *Journal of Economic Entomology* 62(4): 792-&.
- Broersma, D. B. and W. H. Luckmann (1968). "FREQUENCY OF MATING BY FEMALE ONION MAGGOT ADULT." *Journal of Economic Entomology* 61(2): 568-&.
- Allen, W. R. (1967). "AN ASSAY FOR DETERMINING INSECTICIDE TOLERANCE OF ONION MAGGOT LARVAE." *Canadian Entomologist* 99(4): 402-&.
- Luckmann, W. H., G. Gangrade and D. B. Broersma (1967). "INDUCING STERILITY IN ONION MAGGOT." *Journal of Economic Entomology* 60(3): 737-&.
- Rawlins, W. A. (1967). "OVIPOSITION BY ONION MAGGOT ADULTS FED ON A CHEMICALLY DEFINED DIET." *Journal of Economic Entomology* 60(6): 1747-&.
- McClanah.Rj (1966). "A SYNTHETIC DIET FOR ONION MAGGOT HYLEMYA ANTIQUA (MEIGEN) (DIPTERA-ANTHOMYIIDAE)." *Canadian Journal of Zoology* 44(6): 1089-&.
- McClanah.Rj and H. S. Simmons (1966). "STERILIZATION OF ONION MAGGOTS BY IRRADIATION WITH CESIUM-137." *Canadian Entomologist* 98(9): 931-&.
- Rawlins, W. A. and D. Gonzalez (1966). "EVALUATION OF SEVERAL INSECTICIDES TO CONTROL ONION MAGGOT." *Journal of Economic Entomology* 59(2): 288-&.
- Rawlins, W. A. and M. Lodge (1966). "INSECTARY EVALUATION OF NEW INSECTICIDES FOR ONION MAGGOT CONTROL." *Journal of Economic Entomology* 59(2): 299-&.
- Carden, P. W. (1965). "CONTROL OF ONION FLY IN BEDFORDSHIRE 1964." *Plant Pathology* 14(15): 18-&.

Cette veille bibliographique est réalisée par Nathalie Roullé et Nicolas Chatel-Launay, Pôle d'excellence en lutte intégrée (PELI).

Être informé des activités du PELI : <http://www.lutteintegree.com/fr/Nous-joindre/>

- Niemczyk, H. D. and G. Prins (1965). "CONTACT TOXICITY OF 13 INSECTICIDES TO CYCLODIENE-SUSCEPTIBLE AND CYCLODIENE-RESISTANT STRAINS OF ONION MAGGOT." *Journal of Economic Entomology* 58(6): 1074-&.
- Barlow, C. A. and H. D. Niemczyk (1964). "INHERITANCE OF WHITE-EYE MUTATION IN ONION MAGGOT FLY HYLEMYA ANTIQUA (MEIG)." *Nature* 202(493): 827-&.
- Elmosa, H. M. and H. L. King (1964). "SOME EFFECTS OF TEMPERATURE HUMIDITY AGE + SEX ON TOXICITY OF DIELDRIN + ETHION TO RESISTANT ONION MAGGOTS HYLEMYA ANTIQUA." *Journal of Economic Entomology* 57(5): 649-&.
- McLeod, D. G. R. (1964). "NUTRITION + FEEDING BEHAVIOR OF ADULT ONION MAGGOT HYLEMYA ANTIQUA." *Journal of Economic Entomology* 57(6): 845-&.
- Niemczyk, H. D. (1964). "MASS REARING OF ONION MAGGOT HYLEMYA ANTIQUA UNDER LABORATORY CONDITIONS." *Journal of Economic Entomology* 57(1): 57-&.
- Peterson, A. G., A. B. Meade and Silberma.Ms (1963). "DEVELOPMENT OF RESISTANCE TO INSECTICIDES BY ONION MAGGOT, HYLEMYA ANTIQUA, IN MINNESOTA." *Journal of Economic Entomology* 56(5): 580-&.
- Towgood, J. G. and A. W. A. Brown (1962). "INHERITANCE OF DIELDRIN-RESISTANCE IN ONION MAGGOT." *Canadian Journal of Genetics and Cytology* 4(2): 160-&.
- Elmosa, H. M., H. L. King and G. E. Guyer (1959). "A MODIFIED MICROBURET FOR TOPICAL APPLICATION OF INSECTICIDES TO THE ONION MAGGOT, HYLEMYA-ANTIQUA (MEIG)." *Journal of Economic Entomology* 52(4): 683-684.
- Finlayson, D. G., H. H. Crowell, A. J. Howitt, D. R. Scott and A. J. Walz (1959). "CHEMICAL CONTROL OF THE ONION MAGGOT IN ONIONS GROWN FROM SEED IN VARIOUS TYPES OF SOIL IN NORTHWESTERN NORTH-AMERICA IN 1955 AND 1956." *Journal of Economic Entomology* 52(5): 851-856.
- Friend, W. G., E. H. Salkeld and I. L. Stevenson (1959). "NUTRITION OF ONION MAGGOTS, LARVAE OF HYLEMYA-ANTIQUA (MEIG), WITH REFERENCE TO OTHER MEMBERS OF THE GENUS HYLEMY." *Annals of the New York Academy of Sciences* 77(2): 384-393.
- Shirck, F. H. (1957). "EXPERIMENTS FOR THE CONTROL OF THE ONION MAGGOT." *Journal of Economic Entomology* 50(5): 577-580.
- Finlayson, D. G. (1956). "MAGGOTS AND PUPARIA IN STEMS AND SEED BALLS OF ONIONS AT HARVEST." *Journal of Economic Entomology* 49(4): 460-462.
- Peterson, A. G. and D. M. Noetzel (1954). "SEED TREATMENTS COMPARED WITH OTHER METHODS FOR CONTROLLING THE ONION MAGGOT." *Journal of Economic Entomology* 47(5): 852-859.
- Tozloski, A. H. (1954). "CONTROL OF ONION MAGGOT ON SEED SETS IN THE CONNECTICUT VALLEY." *Journal of Economic Entomology* 47(3): 494-497.
- Merrill, L. G. and R. Hutson (1953). "MAGGOTS ATTACKING MICHIGAN ONIONS." *Journal of Economic Entomology* 46(4): 678-680.
- Newhall, A. G., W. A. Rawlins, J. L. Brann and W. W. Gunkel (1953). "LIQUID CONCENTRATES VERSUS DUSTS FOR IN-THE-ROW TREATMENTS AGAINST SEEDLING DISEASES AND INSECT PESTS, WITH SPECIAL REFERENCE TO ONION SMUT AND MAGGOT." *Phytopathology* 43(9): 480-481.

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Être informé des activités du PELI : <http://www.lutteintegree.com/fr/Nous-joindre/>

Rawlins, W. A. (1953). "A METHOD FOR REARING THE ONION MAGGOT IN INSECTARY CULTURES." *Journal of Economic Entomology* 46(6): 1101-1101.

Rawlins, W. A. and A. G. Newhall (1950). "AN IMPROVED METHOD OF APPLYING INSECTICIDES FOR ONION MAGGOT CONTROL." *Journal of Economic Entomology* 43(6): 950-951.

McLeod, W. S. (1946). "HEXACHLOROCYCLOHEXANE IN THE CONTROL OF ONION MAGGOT." *Journal of Economic Entomology* 39(5): 631-637.