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Research Kernels

Our Latest Research Results - December 2011

The Heat-Shock Protein Gene Mds-1 Encodes a Major Susceptibility Gene in Wheat to the Hessian Fly Gall Midge

Authors: X. Liu, C. Khajuria, J. Li, H.N. Trick, G.R. Reek, F.F. White, M.S. Chen
Submitted to: Proceedings of the National Academy of Sciences

Plant parasites, including many insects, manipulate plants in order to utilize the host resources. Here, we show that the *Mayetiola destructor* susceptibility gene-1 (Mds-1) of wheat encodes a small heat-shock protein and is a major susceptibility gene for infestation of wheat by the gall midge *M. destructor*, commonly known as the Hessian fly. Transcription of Mds-1 increased upon insect infestation. Knockdown of Mds-1 transcript levels by RNA interference conferred immunity to all Hessian fly biotypes on normally susceptible wheat genotypes. Ectopic expression or induction by heat shock of Mds-1 suppressed resistance mediated by the resistance gene H13. Mds-1-silenced plants were also found to be resistant to the powdery mildew fungus *Blumeria graminis f. sp. tritici*, and Mds-1 expression was upregulated during the fungal infection of normal wheat plants, suggesting that Hessian fly and *B. graminis f. sp. tritici* exploit a common stress response pathway for parasitism. Modification of susceptibility genes may provide a potentially broad and durable source of resistance to Hessian fly and *B. graminis f. sp. tritici* pests.

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A Novel Aminopeptidase P-Like Gene (OnAPP) and its Possible Involvement in Bt Toxicity and Resistance in European Corn Borer, *Ostrinia nubilalis*

Authors: C. Khajuria, L.L. Buschman, M.S. Chen, B.D. Siegfried, K.Y. Zhu
Submitted to: PLoS One

The use of *Bacillus thuringiensis* (Bt) toxins in transgenic plants has revolutionized insect pest management in crops including corn, cotton, and other crops. However, there is a potential danger for the Bt strategy since insects can develop resistance to Bt toxins. To maximize and prolong the effectiveness of Bt toxins, we need to understand the mechanisms for insects to develop resistance to these toxins. This research characterized 10 aminopeptidase-like genes in the insect pest European corn borer (ECB), and analyzed their potential involvement in insect resistance to the Bt Cry1Ab toxin. We found that the two amino acids of an aminopeptidase-P like protein, Glu305 and Arg307, were changed to Lys305 and Leu307 in two Cry1Ab-resistant ECB strains compared with three Cry1Ab-susceptible strains. Suppression of the aminopeptidase-P-like transcript level by RNA-interference resulted in ECB larvae that were more resistant to the Bt toxin Cry1Ab. These results suggest that the aminopeptidase-like gene may be involved in conferring Bt toxicity and resistance in ECB resistance strains.

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A Machine Vision System for High Speed Sorting of Small Spots on Grains

Authors: T.C. Pearson, D. Moore, J. Pearson
Submitted to: Sensing and Instrumentation for Food Quality and Safety

A new type of automatic electro-optical sorting system was developed to identify and remove grains with small spots, or blemishes, on them. There currently is no commercially available system that can separate grains having small blemishes on their surface. However, several food processors have requested development in this area as it would improve food quality and safety. The newly developed system was tested for removing popcorn with a defect called blue-eye, which is caused by a fungus and appears as a small blue blemish on the germ of the kernel. This system was able to remove 89% of the blue-eye damaged popcorn kernels while only rejecting approximately 6% of the un-damaged kernels. Blue-eye infected popcorn results in off tastes so the system will find use with popcorn processors across the country. The system can also be used to separate grains with other types fungal damage or insect damage, resulting in higher quality and safer food products.

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Evaluating RNAlater® as a Preservative for Using Near-Infrared Spectroscopy to Predict Anopheles Gambiae Age and Species

Authors: M. Sikulu, K.M. Dowell, L.E. Hugo, R.A. Wirtz, K. Michel, K.H.S. Peiris, S. Moore, G.F. Killeen, F.E. Dowell
Submitted to: Malaria Journal

Determining mosquito age and species is important to determine the effectiveness of vector control programs. Near-infrared spectroscopy (NIRS) has previously been

applied to determine the age and species of freshly anesthetized mosquitoes that transmit malaria. However, this has only been achieved on freshly-collected specimens, and future applications will require samples to be preserved between field collections and scanning by NIRS. In this study, a sample preservation method (storage in RNAlater®) was evaluated for mosquito age and species identification by NIRS. The average accuracy obtained for predicting the age of young (<7 days) or old (≥ 7 days) of all fresh and all preserved mosquito samples was 83% and 90%, respectively. For species identification, accuracies were 82% for fresh against 80% for preserved. Thus, RNAlater® can be used to preserve mosquitoes for subsequent scanning and analysis by NIRS to determine their age and species with minimal costs and with accuracy similar to that achieved from fresh insects.
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Performance of Diapausing Parasitoid Wasps, *Habrobracon hebetor*, after Cold Storage

Authors: H. Chen, H. Zhang, K.Y. Zhu, J.E. Throne
Submitted to: Biological Control
The Indianmeal moth is a major pest of stored grain and processed commodities. There is a small wasp that does not sting humans but naturally parasitizes the Indianmeal moth, and releasing these parasitic wasps would be an environmentally friendly way to control the Indianmeal moth. But, there is currently no way to store these wasps for when they are needed for controlling the Indianmeal moth. We found that the adult wasps entered reproductive diapause (a resting stage where they don't produce offspring) when they are reared at a cool temperature and short daylength (68°F and 10 hours of light), and these diapausing wasps could be stored for up to two months in a refrigerator and still perform well. Being able to store these parasitic wasps in a refrigerator will enable mass production of the wasps for release for pest management.
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Coming Apart at the Seams: Morphological Evidence for Pregnathal Head Capsule Borders in Adult *Tribolium castaneum*

Authors: M.S. Haas, R.W. Beeman
Submitted to: Development, Genes and Evolution
The insect head is a complex structure that encompasses functions of sight, smell, taste, mate-detection, feeding, defense, and central nervous integration. This structure evolved from the fusion of a tandem series of body segments in a wormlike ancestor, but the details of this evolutionary fusion are obscure. We have attempted to recreate the evolutionary steps that gave rise to the modern insect head by detailed analysis of a series of mutations that cause partial reversions of head morphology to earlier evolutionary states. Our analysis suggests that the six anteriormost body segments in a wormlike ancestor fused to form the head of a modern-day insect. Understanding the evolutionary derivation and genetic regulation of vital insect structures will facilitate efforts to design improved, gene-based control strategies.
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Proteomic and Transcriptomic Analyses of Rigid and Membranous Cuticles from the Elytra and Hindwings of the Red Flour Beetle, *Tribolium castaneum*

Authors: N.T. Dittmer, Y. Hiromasa, J.M. Tomich, N. Lu, R.W. Beeman, K.J. Kramer, M.R. Kanost
Submitted to: Journal of Proteome Research
The insect exoskeleton has many functions vital for insect survival, and is therefore an attractive target for new biopesticide design. Among the most important functions of beetle exoskeleton are to confer lightweight flexibility to the flight wings, or strength and rigidity to the nonflight wing covers, to either enable flight or confer protection. We identified more than 100 proteins in beetle wings and wing covers, including many that appear to affect the physical properties of exoskeleton. Some of these were predominantly found in wings, and others in wing covers. Each of these two groups had distinct biochemical fingerprints, which probably reflect their different functions in flexible vs rigid tissues. Understanding the biochemical basis of the properties and functions of insect exoskeleton will aid our continuing efforts to reveal new weaknesses that may lead to new methods of insect control.
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