Geophysical Research Abstracts
Vol. 12, EGU2010-7408-1, 2010
EGU General Assembly 2010

Isotopes and trace elements as geo-location markers for biosecurity: determining the origin of exotic pests.

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Background. The benefits of accurate point of origin discrimination in biosecurity include achieving appropriate operational responses in exotic pest eradication and post-border incursion campaigns, and identifying risk pathways. Reading natural abundance biogeochemical markers via mass spectrometry methods is a powerful tool for tracing ecological pathways and provenance determination of agricultural products and items of forensic interest. However, the application of these methods to trace insects – man's most damaging competitors – has been underutilised to date and our understanding in this field is still in a phase of basic development.

Stable isotope ratio analyses using δ^2H, δ^{13}C have given spatial resolution in the monarch butterfly, single host system in eastern North America. Subsequently, the same method was employed in an attempt to determine the origin of important biosecurity pests in New Zealand. However, the results were contentious as the accuracy and limitations of the method in a biosecurity application were unknown. Further investigation has shown the value of existing invertebrate stable isotope geo-location methodology (i.e., using only two light elements) is tenuous in the biosecurity context, where the sample sizes are usually only one or two insects, and the specimens are generally polyphagous and accidentally introduced, and so from an unknown and unpredictable place, point in time and host: The spatial distribution of ^{2}H in New Zealand may not be reliable over insect life-span time-scales; and fractional variables are un-quantified and potentially overwhelm any New Zealand signal. Further, the geo-location value of ^{13}C is uncertain, especially for polyphagous insects.

Research aims. The internationally distributed *Helicoverpa armigera* [Noctuidae] is being used to examine the processes fundamental to the location-to-plant-to-insect biogeochemical profile imprinting in phytophagous insects, including the turn over of elements in adult insects, the influence of polyphagy and local variation in precipitation ^{2}H. This improved understanding is being applied to assess the validity of using heavy and light element isotope ratio and trace element profiles to differentiate insects of New Zealand natal origin from insects of exotic origin.

Results. An integrated method of TC-IRMS, TI-MS, MC-ICP-MS and ICP-MS analyses of natural abundance ^{2}H, ^{87}Sr/^{86}Sr, ^{207}Pb/^{206}Pb and ^{208}Pb/^{206}Pb isotope ratios and trace element profiles from single insect specimens has been developed. No single geo-location marker has been found in a preliminary comparison of international moths, although the latitudinal cline of δ^2H on a continental scale is confirmed. However, multivariate analysis revealed that successful geo-location discrimination between the study regions is possible.

Conclusion. The promising but imperfect geo-location demonstrated provides solid leads for further investigation. Any geo-location system developed is likely to be applicable to other disciplines, including forensics, ecological studies and pest management.