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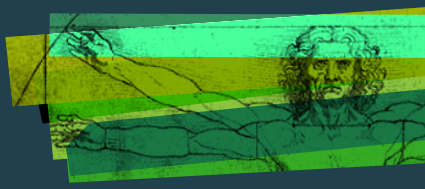
ORLÉANS | 2014

ABSTRACTS



17-19 December 2014

Insect invasions in a changing world

LOCATION

1, rue Dupanloup - Orléans, France
Centre International Universitaire pour la Recherche

CONVENORS

Dr Natalia Kirichenko

LE STUDIUM® RESEARCH FELLOW
On leave from
Sukachev Institute of Forest SB RAS and Siberian Federal University, Krasnoyarsk, RU
In residence at
INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

Dr Alain Roques

INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

Dr Sylvie Augustin

INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

Dr Carlos Lopez-Vaamonde

INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

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Dr Natalia Kirichenko, LE STUDIUM® RESEARCH FELLOW,
From Sukachev Institute of Forest SB RAS, Siberian Federal University, Krasnoyarsk, RU
In residence at INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

Dr Alain Roques, INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

Dr Sylvie Augustin, INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

Dr Carlos Lopez-Vaamonde, INRA, URZF (Unité de Recherche Zoologie Forestière), Orléans, FR

ORGANIZING COMMITTEE

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EDITO

Created in 1996 on the CNRS campus in Orleans La Source by Professor Paul Vigny, LE STUDIUM® has evolved to become a multidisciplinary Loire Valley Institute for Advanced Studies (IAS), operating in the region Centre of France. In December 2013 LE STUDIUM® moved to the city centre of Orleans and into a newly renovated 17th century building. These new facilities, at 1, Rue Dupanloup Orleans, are shared with the University of Orleans. This move into the city centre of Orleans is a major event in the evolution of LE STUDIUM®. During 2014 new and exciting developments are planned to strengthen existing IAS cooperative relationships and to build new programmes with the local and the international community of researchers, developers and innovators.

LE STUDIUM® IAS offers to internationally competitive senior research scientists the opportunity to discover and work in one of the IAS's affiliate laboratories from the University François-Rabelais of Tours, the University of Orleans and National Institute of Applied Science (INSA) Centre Val de Loire, as well as of nationally accredited research institutions located in the region Centre (BRGM, CEA, CNRS, INSERM, INRA). Our goal is to develop and nurture trans-disciplinary approaches as innovative tools for addressing some of the key scientific, socio-economic and cultural questions of the 21st century. We also encourage researcher interactions with industry via the IAS's links with Poles of Competitiveness, Clusters, Technopoles, and Chambers of Commerce etc.

LE STUDIUM® has welcomed over one hundred and thirty LE STUDIUM® RESEARCH FELLOWS, LE STUDIUM® RESEARCH CHAIRS and LE STUDIUM® RESEARCH PROFESSORS for periods of six months and up to two years. In addition to the contribution in their host laboratories, researchers are required to participate in the scientific life of the IAS through attendance at monthly interdisciplinary meetings called LE STUDIUM® THURSDAYS and LE

STUDIUM® CLUB forums that involve participants from industry.

Researchers are also invited and supported by the IAS to organise, during their residency and in collaboration with their host laboratory, a two-day LE STUDIUM® CONFERENCE. It provides them with the opportunity to invite internationally renowned researchers to a cross-disciplinary conference, on a topical issue, to examine progress, discuss future studies and strategies to stimulate advances and practical applications in the chosen field. The invited participants are expected to attend for the duration of the conference and contribute to the intellectual exchange. Past experience has shown that these conditions facilitate the development or extension of existing collaborations and enable the creation of productive new research networks.

The present LE STUDIUM® CONFERENCE devoted to *Insect invasions in a changing world* is the 36th in a series started at the end of 2010 and listed at the end of this booklet.

We thank you for your participation and wish you an interesting and intellectually stimulating conference. Also, we hope that during these two days some of you will see an opportunity to start a productive professional relationship with LE STUDIUM® Loire Valley Institute for Advanced Studies.

Ary Bruand

Chairman
LE STUDIUM®

SUMMARY

Insect invasions in a changing world

CONVENORS

Dr Natalia Kirichenko

LE STUDIUM® RESEARCH FELLOW
Tel.: +7 905 9971294
Email: nkirichenko@yahoo.com

I am a forest entomologist from the V.N. Sukachev Institute of Forest, Siberian branch of the Russian Academy of Sciences, where I have been working since 1997. My interests concern the ecology, molecular genetics, molecular systematics, and risk assessment of invasive forest insect pests. Recently I have participated in research programs to detect potentially harmful herbivorous pests and to study colonization of native and exotic plants by phyllophagous insects in Asian and European botanical gardens in order to test various hypotheses linked to biological invasions. I am particularly interested in colonization and invasion history of leaf mining insects on woody plants.
I have taken part in different national and international projects, including EU-funded projects and carried research on invasive insect pests in different international laboratories: GAU (Germany), LUBIES, ULB (Belgium), CABI-Europe (Switzerland), INRA (France).
I am a deputy of the IUFRO working party 7.03.07 «Population dynamics of forest insects»; division 7 «Forest health». I combine scientific work with teaching, supervising bachelor and master students at the Siberian Federal University.

Dr Carlos Lopez-Vaamonde

INRA, UR0633 Zoologie Forestière, Orléans, France
Tel.: +33 2 38 41 78 61
Email: carlos.lopez-vaamonde@orleans.inra.fr

I am an entomologist interested in the patterns and processes of insect evolution, with a particular focus on leaf-mining microlepidoptera and their associated parasitoids. I obtained a PhD on Evolutionary Biology at Silwood Park, Imperial College (2002) and worked as a postdoctoral associate for three years at the Institute of Zoology in London on molecular and behavioural ecology of social insects. I was then hired as an INRA research scientist in July 2005. My work on invasion biology has been focused on using genetic markers to understand the dynamics of invasion. I am also interested in how communities of phytophagous insects and their parasitoids are assembled in their native range and how they are reassembled in the areas where their host plants have been introduced.

CONVENORS

Dr Alain Roques

INRA, UR0633 Zoologie Forestière, Orléans, France
Tel.: +33 2 38 41 78 58
Email: alain.roques@orleans.inra.fr

Alain Roques (D.Sc., Ph.D.) is a forest entomologist with 31 years of experience on the biology, ecology and behavior of forest insects. He is the leader of the Forest Zoology unit with INRA at Orléans, France. During the last 10 years, his research activity turned towards biological invasions and the effect of global warming on the populations of terrestrial invertebrates. He has participated in most of the recent EU-funded projects dealing with biological invasions. He especially coordinated the inventory of alien terrestrial invertebrates in Europe realized in the DAISIE project. Then, he was the main editor of the book 'Alien terrestrial arthropods of Europe', published in 2010, which provided the first comprehensive review of the fauna of alien terrestrial arthropods having colonized the European continent and its associated islands. The book summarizes the present knowledge of the arthropod invasion process from temporal trends and biogeographic patterns to pathways and vectors, invaded habitats, and ecological and economic impacts. He was also the editor of another recent book devoted to the relationships between climate change and insects: "Processionary moths and Climate Change: An update". He published more than 150 peer-reviewed papers, 25 books and book chapters, and presented 93 communications at international conferences.

Dr Sylvie Augustin

INRA, UR0633 Zoologie Forestière, Orléans, France
Tel.: +33 2 38 41 78 79
Email: sylvie.augustin@orleans.inra.fr

Sylvie Augustin is a researcher at the Forest Zoology Unit of INRA Orléans. She has devoted her research to invasion ecology. She has studied the mechanisms underlying introduction and spread of invasive insect and she has worked on risk assessment and development of tools for forecasting and managing populations. She initiated research on biological invasion in the framework of a European project on horse chestnut leaf miner *Cameraria ohridella* in 2000. Her research has contributed to the prediction of the insect dispersion, the discovery of the area of origin to find natural enemies, the assessment of the ecological impact of this invasive pest. In addition, she participated in many European projects on management of invasive insect species in Europe.

Dr Tea Ammunét

Department of Ecology, Swedish University of Agricultural Sciences
PO Box 7044, SE-750 07 Uppsala, Sweden

Tel.: +35 840 849 8152
Email: tea.ammunet@slu.se

I have my Doctoral degree from the University of Turku in Finland from 2011 with the thesis titled "Trophic Interactions of Invasive Forest Herbivores and Consequences for the Resident Ecosystem". I have been working as a Postdoctoral researcher (2011-2013) and Researcher at the Swedish University of Agricultural Sciences working under the general theme of invasive insects. Within the field of invasive insect research, and in ecology in general, my more detailed interests are: adaptation, trophic interactions and population dynamics. In my work I aim to combine both theoretical and experimental studies. I have published my work for example in Ecography, Ecological Entomology and Theoretical Population Biology. In addition I have authored and co-authored popular science articles and a book chapter.

Range expansion and establishment in cold climate - case studies on *operophtera brumata* and *cameraria ohridella*

Invasive species encounter many obstacles that need to be overcome before establishing. At northern latitudes, winter conditions act as a strong limiting factor particularly for insect species. Yet new species arrive and spread even to northernmost areas. Case studies on two well-known invading defoliators in Fennoscandia, the winter moth (*Operophtera brumata*) and the horse chestnut leaf-miner (*Cameraria ohridella*), are used explored in order to present what kind of overwintering strategies may have contributed to successful invasions. Results show, that warming winters in the continental northern Fennoscandia may be behind the outbreak range expansion of the winter moth. Winter temperatures have the potential to better limit the range expansion of the leaf-miner that originates from much more southern latitudes. The effects of snow and temperature on the overwintering horse chestnut leaf-miners at the current range edge in Sweden were thus explored. The results indicate that, instead of a simple limiting effect of the overwintering ambient temperatures, the experienced microclimate may play a more important role in the leaf-miner mortality.

Dr Peter Baier

Institute of Forest Entomologie, Forest Pathology and Forest Protection, University of Natural Resources and Life Sciences, Vienna
Hasenauerstraße 38, A-1190 Vienna, Austria

Tel.: +43 1 3686352-26
Email: peter.baier@boku.ac.at

Peter Baier studied Forestry at the University of Natural Resources and Life Sciences in Vienna (Austria) and carried out doctoral studies at the Institute of Forest Entomology, Forest Pathology and Forest Protection (IFFF) in Vienna. Since 1991, he is researcher at the IFFF with the focus on the various aspects of bark beetle-tree-interactions, defense mechanisms, and susceptibility to bark beetle infestation, though more recently, modelling of the phenology and the development of forest insects as a tool for monitoring and risk assessments of insect outbreaks have come to the fore.

Modelling and mapping climate suitability and forest susceptibility to selected potentially invasive insect species under climate change conditions in Europe - mountain pine beetle and Siberian larch moth

We applied GIS-based models for assessments of the climate suitability and forest susceptibility to potentially invasive insect species, the mountain pine beetle and the Siberian moth, under past, present and future climate conditions in Europe. The effects of climate change on climatic suitability were analyzed using regional climate models from ENSEMBLES. Forest susceptibility was assessed by combining the distribution and proportion of potential host (tree species maps from EFI) with the climatic suitability indices. Climate suitability for the mountain pine beetle was mapped using three different models - adaptive seasonality, winter mortality, and Safranik's climate suitability index. Climatic constraints of the Siberian moth were expressed through thermal and moisture conditions, and the frequency of autumn thawing. The resulting maps can be accessed via Web Map Service (http://ifff-server2.boku.ac.at/Services/ISEFOR/). The models revealed different responses of the two species to projected climate change in Europe. For the mountain pine beetle, the rise of temperatures will increase the likelihood of winter survival and will shift suitable habitats for univoltinism northwards and up in elevation. Depending on locally different changes of precipitation, the susceptibility of Scots pine to mountain pine beetle infestations will vary considerably. Larvae of the Siberian moth require continental winters with no autumn thawing for successful hibernation. Current and projected mild pre-winter conditions in Europe will therefore limit the range expansion of the moth.

Dr Yuri Baranchikov

**Department of Forest Zoology, V.N.Sukachev Institute of Forest,
Siberian Branch of the Russian Academy of Sciences
50/28 Akademgorodok, Krasnoyarsk 660036, Russia**

**Tel.: +7 91 30 33 77 62
Email: baranchikov_yuri@yahoo.com**

I was graduated from Urals State University (Ekaterinburg, Russia), Faculty of Biology at 1974 and got my PhD in entomology from Sukachev Institute of Forest in 1986. From 1995 - Head for the Department of Forest Zoology at V.N. Sukachev Institute of Forest, Russian Academy of Sciences, Siberian Branch in Krasnoyarsk, Siberia, Russia. Specialization - forest insect ecology and forest protection with special interest nowadays in gall-forming insects and in wood borers and associated fungi on conifers. Served as a leader, coordinator and an expert in many national and international research projects on forest invasive insects. Author (and co-author) of more than 400 papers and 9 books, editor of 8 books.

Westward rush: Far Eastern invaders in the forests of European Russia

Two originally Far Eastern beetle species: emerald ash borer (EAB) *Agrilus planipennis Fairmaire* (Coleoptera: Buprestidae) and four eyed fir bark beetle (FFBB) *Polygraphus proximus Brandford* (Coleoptera: Curculionidae) at the beginning of millennium became a sudden headache for forest and park protection specialists in European Russia. Till 2014 EAB killed or severely damaged trees of three species of ash (*Fraxinus pennsilvanica, F. excelsior* and *F. ornus*) at streets, parks and arboretums of Moscow and is widely spreading through 11 administrative regions of European Russia. Two of these regions have mutual borders with Byelorussia and Ukraine.

Outbreaks of FFBB in Southern Siberia were detected in the Siberian fir (*Abies sibirica*) forests on the territory of 49 thousand square km. The beetle recently was found in Moscow where it attacks firs of many species from section Balsamea.

The preliminary results of studies on distribution potential, possible host plants and factors of population dynamics of both invaders will be discussed.

Pr Andrea Battisti

University of Padova
Agripolis 35020 Legnaro, Padova, Italy

Tel.: +39 334 6952488
Email: andrea.battisti@unipd.it

55 year old, Ph.D. 1987, Bologna University, Italy, Entomology. Professor of entomology at Department Dafnae, Università di Padova Italy. Head of the School of Agriculture and Veterinary Medicine at the University of Padova, member of the board of the Scuola Galileiana at the University of Padova, teacher in entomology, zoology, biotechnology, ecology. Associate Editor of Agricultural and Forest Entomology, Journal of Pest Science, Entomologia. The scientific research activity regards the following topics: 1) Insect-plant relationships. Mechanisms of identification and selection of trees by phytophagous insects, plant resistance, modifications related to the climate change. 2) Insect-fungus relationships. Transmission of conifer pathogens by insects feeding on cone and seeds. 3) Biological and integrated control of forest pests. Utilisation of conventional and transgenic Bacillus thuringiensis in the control of insects. 4) Pest monitoring and detection. 5) Insects harmful to humans. Mechanism of action and ecological significance of urticating hairs of arthropods. 6) Biodiversity and conservation of insect populations of natural habitats.

Detection of alien wood boring beetles in high-risk sites: two case studies from Italy

We present an overview of a project conducted in Italy aimed at improving the efficiency of the early detection for alien insects. We focused on wood boring beetles (mainly Cerambycidae, Scolytinae and Buprestidae) which include a high number of invasive species and represent an important threat to the biosecurity of all forested countries.

In 2012, we focused on ports and their surrounding areas, in order to better understand how the port size, in terms of amount of imported commodities, and the characteristics of the landscape surrounding the ports, in terms of forest cover and forest composition, influence the occurrence of alien wood boring beetles. From May to September, 15 Italian international ports were monitored with three traps in each port and three more traps in forest located 3-5 km away from each port. A total of 81 species were trapped, 67 native and 14 alien. Each forest site close to the port was classified into broadleaf or coniferous forest according to tree composition. The number of alien species was positively influenced by the volume of imported commodities, the position of the trap and the composition of the forest close to the ports. In particular, we found that the mean number of exotic species trapped per trap check was higher in forests than in ports when the forests were mainly composed by broadleaf species, while these values were similar for coniferous forest. Forest cover had no effect. The results suggest that surveillance should be concentrated in large ports and in the surrounding broadleaf forests to improve the cost-effectiveness of the programs.

In 2013, the same experimental scheme applied in 2012 was used to explore the role of wood waste landfills in wood boring beetles' invasion process. In the last 30 years, cargo has increasingly shipped in large containers and only a fraction of the latter are opened and inspected within ports. Often commodities and associated wood packaging materials are transported directly to their final destinations, such as industrial or commercial areas. Then wood packaging materials are sent to wood waste landfills where they can act as a source of alien wood boring species before being destroyed or recycled. In order to understand the potential impact of the latter sites, a subset of 11 ports from those used in 2012 was selected, and within each site the port and a wood waste landfill were monitored using the same number of traps. We found that the mean number of alien species trapped in ports was similar to that in wood waste landfills, and that communities did not differ either. This suggests that wood waste landfills have the same importance than ports in wood boring beetles' invasion process, representing an alternative way to detect alien species associated with wood material, even in continental areas far from the coast.

Dr Manuela Branco

Centro de Estudos Florestais, Instituto Superior de Agronomia, Universidade de Lisboa
Tapada da Ajuda, 1349-017 Lisboa, Portugal

Tel.: +35 1 213 653 382
Email: mrbranco@isa.ulisboa.pt

Manuela Branco has a Forestry degree (Technical University of Lisbon), M.Sc. in Applied Statistics, (University of Lisbon) and PhD in Applied Biology (University of Wales, UK). She is Assistant Professor at School of Agronomy (ISA), University of Lisbon, where she teaches several courses at graduation and M.Sc. level such as Ecology and Management of Animal Populations, Forest Pests and Diseases and Forest Protection. She has supervised 4 doctoral students and one post-doctoral researcher; she is currently supervising 5 doctoral students. Her research activity focuses on the ecology of forest insects, especially on the interactions of insect pests and natural enemies and the study of population response to environmental factors, including climate. She participated in 5 European and 6 National projects and was principal researcher of 4 national projects.

Adaptation and phenotypic plasticity in a population of the pine processionary moth with shifted phenology

Phenology determines the stage of development exposed to seasonal variable climate conditions. Our study case concerns a particular population of the pine processionary moth (PPM) with shifted phenology. In typical PPM the adult emergence and oviposition occur in the summer, while the larval stages develop in the winter. In the shifted population (SPPM), the adults mate in the spring and the larvae develop through summer. As reproduction occurs at different seasons, SPPM is allochronically isolated from the sympatric winter population (WP). Molecular markers confirmed genetic differentiation and a founder effect. As in invasive species, temperature plays a key role in limiting the establishment and expansion of a new population with a phenology different from that of the original one. In particular, a shift from winter to summer requires larval adaptation to high summer temperatures. Laboratory experiments confirmed an upper threshold of survival for SPPM about 6ºC above that of the WP. Differences in the expression of heat shock proteins, Hsp90, when exposed to temperatures above 38ºC could partially account for differences on the thermal threshold. Phenotypic traits related with egg stage, such as female realized fecundity, egg size, colour and shape of the cover scales, also diverge between SPPM and WP. Most studies predicting the expansion of invasive species and the effect of climate on populations take into account the species present ecological requirements. Niche conservatism is thus implicitly hypothesized. In our case system, ecological and physiological studies confirm a thermal niche shift. We conclude that plasticity among individuals and the inherent capacity of the species to rapidly evolve and adapt to new conditions may cause a potential expansion of populations into climatic areas beyond limits predicted by its fundamental niche.

Pr Milka Glavendekić

University of Belgrade – Faculty of Forestry, Department of Landscape Architecture and Horticulture
Str. Kneza Viseslava 1, Belgrade, Serbia

Tel.: +38 1 11 3053899
Email: milka.glavendekic@sfb.bg.ac.rs

Milka is a Professor in the Faculty of Forestry at the University of Belgrade in Belgrade, Serbia. Her research focuses on entomology, invasion biology, population ecology and landscape ecology of forest insects and integrated plant protection on urban green spaces. She obtained her PhD in Forest Entomology from the University of Belgrade-Faculty of Forestry. Milka has also done prior research in Entomology at Julius-Maximilians-Universität Würzburg and Ludwig- Maximilians-Universität München and was Post-Doctoral Researcher at the Technische Universität, München, Freising in Germany. She has authored over 180 papers larger on topic of forest insect ecology, biological control and biological invasions and has been involved in research projects in Serbia and joint projects in Europe.

Invasive insects and their natural enemies in Serbia

The research on invasive alien species in Serbia was conducted for more than 60 years in forest ecosystems, national parks and in urban green spaces. Biological invasions by alien species are dynamic and large-scale phenomena with significant negative impacts on ecosystems. Main focus was on research of following species *Aphis gossypii, Cinara spp., Aproceros leucopoda, Cameraria ohridella, Cinara spp., Corythucha ciliata, Harmonia axyridis, Metcalfa pruinosa, Obolodiplosis robiniae, Phyllonorycter robiniella, P. platani, Stictocephala bisonia, Eopineus strobi, Pseudaulacaspis pentagona* and *Dasineura gleditchiae*. Natural enemies of *C. ohridella* in Serbia are: *Minotetrastichus frontalis, Pnigalio pectinicornis, P. agraules, Pediobius saulius, Cirrospilus talitzkii, Chrysopa spp, Coccinella septempunctata, Adalia bipunctata and Harmonia axyridis*. Native species *Homalotylus flaminius Dalman* (Hymenoptera,Encyrtidae) expanded its host range to *Harmonia axyridis*. American netlike bug is trophicaly realated to predators *Anthocoridae, Miridae,* and *Chrysopidae*. *Metcalfa pruinosa* is in Serbia from 2006 but parasitoid *Neodryinus typhlocybae Ashmead* was observed it in Serbia in 2013 and 2014. *Obolodiplosis robiniae* is well controlled by larval parasitoid *Platygaster robiniae*. In some localities in Serbia more than 60% of larvae were parasitized. Birds are predators of larvae and pupal stages. Invasive species are followed by their natural enemies, native parasitoids and predators adapt to invader and in some cases biological control agents spontaneously arrived to Serbia. There is evidence that birds contribute to decrease of invasive species.

PhD student Julien Haran

INRA, UR0633 Zoologie Forestière,
2163 Avenue de la Pomme de Pin, CS 40001, Ardon, 45075 Orléans Cedex 2, France

Tel.: +33 6 40 90 67 42
Email: julien.haran@gmail.com

I am PhD student at INRA, URZF. My research interest focus on macro and micro evolution of phytophagous beetles in relation with their environment.
My previous projects at Natural History Museum (UK) aimed at reconstructing the deep phylogeny of weevils based on mitogenome sequences, and to relate diversification of lineages to host plants and larval lifestyle.
I am now working at a different evolutionary scale. My PhD deals with dispersal of the beetle Monochamus galloprovincialis, the vector of the pine wood nematode in Europe. I try to identify the landscape features affecting dispersal behavior of this species to uncover potentials pathways to the spread of the nematode. M. galloprovincialis being a native species, we also explore the micro evolutionary processes involved in its intra-specific diversification.

Landscape Genetics of *Monochamus galloprovincialis*, vector of the pine wood nematode in Europe.

Julien HARAN, Alain ROQUES, Christelle ROBINET & Géraldine ROUX-MORABITO

The pine wood nematode (PWN), *Bursaphelenchus xylophilus* (Steiner & Burher) Nickle (Nematoda, Aphelenchoididae) is the causal agent of the pine wilt disease (PWD), a virulent syndrome killing susceptible pines trees within few months. From its native area in North America, it has been introduced in several Asian and European countries causing considerable damages to native pine forests. The PWN was detected for the first time in Europe in Portugal 15 years ago. From its introduction site, it rapidly expanded its range to a large part of the country and entered into Spain. In Europe, the native longhorn beetle *Monochamus galloprovincialis* (Olivier, Coleoptera, Cerambycidae) is the only known vector for this nematode. This beetle performs its larval development in the wood of declining pine trees and spread the PWN when it emerges from infected wood. Thus, the natural dispersion of the PWN is highly depending on dispersal abilities of the beetle. Given the rapid range expansion of this pest and the threat to forests involved, it is crucial to identify potential barriers to dispersal of *M. galloprovincialis* to define suitable pest management strategies.

Based on 1043 individuals from Iberian Peninsula, genotyped at 13 microsatellites loci, we conducted a landscape genetics analysis to uncover the landscape features affecting dispersal of *M. galloprovincialis*. To avoid confounding effect of evolutionary history of this species in the area of study, we used a nested sampling design and assessed population genetic structure in order to select the appropriate populations and the optimal scale for correlation analysis.

Our results show that mountain ranges represent a break to dispersal of *M. galloprovincialis*, and subsequently potential barriers to the spread of the PWN. We also show that the experimental design (scale and populations selected) strongly influence the results of landscape genetics approach.

Dr Marc Kenis

Risk Analysis and Invasion Ecology. CABI, Switzerland
1, Rue des Grillons, 2800 Delémont, Switzerland

Tel.: +41 32 4214884
Email: m.kenis@cabi.org

I obtained my PhD in Agronomy at the University of Brussels and I am currently leading the Risk Analysis and Invasion Ecology Section at CABI in Switzerland. I conduct national and international research projects in applied and environmental entomology, particularly in the field of ecology and management of invasive insects. This includes risk analysis, impact assessment, biological control and integrated pest management. I also have an interest in forest entomology in general, parasitoid community ecology, the effects of climate change on insects and the use of insects as human food and animal feed.

Invasive alien insects: why are we all concerned ?

More than 1500 species of exotic insects are established in Europe. Many of them arrived accidentally through the trade of plants, fruits, vegetables and other goods. Some were introduced intentionally, e.g. in the framework of biological control projects. While most of them have a negligible impact, some have become important pests of agricultural, horticultural and forestry plants. Others are threatening biodiversity and the functioning of natural ecosystems. lastly, some may affect human and animal health. The presentation will discuss recent introductions in France and Europe, such as the box tree moth, the spotted-winged drosophila, the brown marmorated stink bug, the Asian longhorned beetles, the Asian hornet, etc. It will also present new species whose arrival is expected in the next years. Options to manage biological invasions will be discussed. By far the most efficient method is to prevent new introductions, and this concerns us all.

Les insectes exotiques envahissants: pourquoi sommes-nous tous concernés?

Plus de 1500 espèces d'insectes exotiques se sont établies en Europe. La plupart d'entre eux ont été introduits accidentellement par le commerce des plantes, fruits, légumes et autres denrées. Quelques-uns ont été introduits intentionnellement, par exemple dans le cadre de projets de lutte biologique. Si la majorité des insectes exotiques ont un impact négligeable, certains sont devenus d'importants ravageurs agricoles, horticoles ou forestiers. D'autres présentent un danger pour la biodiversité et le fonctionnement des écosystèmes naturels. Enfin, certains peuvent affecter la santé humaine et animale. La conférence fera le point sur les insectes exotiques nouvellement introduits en France et en Europe, tels que la pyrale du buis, la drosophile du cerisier, la punaise diabolique, les longicornes asiatiques, le frelon asiatique, etc. Elle présentera également les espèces dont on peut attendre l'arrivée ces prochaines années. Les solutions pour lutter contre ces invasions biologiques seront discutées. La méthode la plus efficace est d'éviter les nouvelles introductions, et cela nous concerne tous.

Dr Carole Kerdelhué

INRA, UMR CBGP
755 avenue du Campus Agropolis, CS30016
34988 Montferrier-sur-Lez Cedex, France

Tel.: +33 4 30 63 04 35
Email: carole.kerdelhue@supagro.inra.fr

The authors belong to a research consortium dealing with insect evolutionary biology and natural genetic structure at different scales. They were involved in various projects studying rangewide phylogeography of several species of forest pests (mainly seed chalcids, scolytids, processionary moths) in Europe and the Mediterranean Basin, and started to collaborate on host-parasitoid systems. In the recent years, they focused on the question of biological invasions, either involving geographic expansions of native species due to climate and landscape changes, or accidental introductions from different regions.

Reconstructing colonization routes of invasive species from molecular data: case studies in forest entomology

Deciphering the colonization processes by which introduced pests invade new areas is essential to limit the risk of further expansion and/or multiple introductions by increasing vigilance against the identified key source populations. It also helps defining the ecological characteristics of introduced populations and predicting the potential extent of their distribution areas. In some cases, it can help choosing strains of potential auxiliary agents to develop biological control strategies. Yet, historical and observational data often provide incomplete, sparse or even misleading information on invasive populations' history.

In the last decade, population genetics has been used as an indirect tool to reconstruct routes of introduction, highlighting the complexity and the sometimes counterintuitive nature of the true story. The recent development of new model-based methods, such as approximate Bayesian computation (ABC), has allowed quantitative inferences in case of the complex evolutionary scenarios typically encountered during biological invasions. It specifically allows to compare alternative scenarios regarding the number and genetic composition of sources and to explore the number of successive introduction events from each source, the number of introduced individuals and the dynamics of demographic expansion after each introduction.

We describe the principles of the ABC analyses, here applied to microsatellite data and mitochondrial sequences of populations sampled within the native and the invasive range of a species. We will use three main examples in forest entomology, from which we obtained valuable information about the colonization routes and dispersal patterns, namely the cedar seed chalcid *Megastigmus schimitscheki*, the maritime pine bast scale *Matscucoccus feytaudi* and the Western conifer seed bug *Leptoglossus occidentalis*.

Dr Natalia Kirichenko

V.N. Sukachev Institute of Forest SB RAS - Siberian Federal University - Akademgorodok 50/28, Krasnoyarsk, 660036, Russia;
INRA, UR0633 Zoologie Forestière,
2163 Avenue de la Pomme de Pin, CS 40001, Ardon, 45075 Orléans Cedex 2, France

Tel.: +7 905 9971294
Email: nkirichenko@yahoo.com

I am a forest entomologist from the V.N. Sukachev Institute of Forest, Siberian branch of the Russian Academy of Sciences, where I have been working since 1997. My interests concern the ecology, molecular genetics, molecular systematics, and risk assessment of invasive forest insect pests. Recently I have participated in research programs to detect potentially harmful herbivorous pests and to study colonization of native and exotic plants by phyllophagous insects in Asian and European botanical gardens in order to test various hypotheses linked to biological invasions. I am particularly interested in colonization and invasion history of leaf mining insects on woody plants. I have taken part in different national and international projects, including EU-funded projects and carried research on invasive insect pests in different international laboratories: GAU (Germany), LUBIES, ULB (Belgium), CABI-Europe (Switzerland), INRA (France).

From the east to the west: rapid range expansion of the lime leaf miner in Eurasia

Natalia Kirichenko[1,2,3], Paolo Triberti[4], Sylvie Augustin[3], Alain Roques[3], Carlos Lopez-Vaamonde[3]

[1] V.N. Sukachev Institute of Forest SB RAS, Krasnoyarsk, Russia

[2] Siberian Federal University, Krasnoyarsk, Russia

[3] INRA Institut National de la Recherche Agronomique, URZF, Orléans, France

[4] Museo Civico di Storia Naturale, Verona, Italy

In the last decades, the number of insect introductions has increased in Europe dramatically. Remarkably, most of these invasive pests originate from Asia and arrive to Europe either with the trade of ornamental plants, or as stowaways inadvertently transported with imports of goods from Asia or on their own following an expansion of their geographic range. Some of those Asian invasive insects provide extraordinary examples of rapid expansion and represent good models to address interesting questions about the evolutionary changes underlying invasions. Which are the underlying genetic changes associated with successful invasions? Are invasions driven by high performance genotypes?

Here we target those questions by studying the genetic structure of the lime leaf miner *Phyllonorycter issikii* (Lepidoptera: Gracillariidae). This tiny micromoth originating from Eastern Asia in the last few decades has spread westwards at a rate of more than 90 km per year over the whole of Russia and invaded numbers of eastern European countries, becoming a serious ornamental pest of lime trees *Tilia* (Malvaceae). Our analyses of mitochondrial data revealed an unexpectedly high genetic diversity in the invaded regions. We also identified some particular haplotypes that are prevalent in the invaded regions and native area. By combining morphological and genetic data we discovered a putative new species of *Phyllonorycter* feeding on *Tilia*, which co-occurs with its closely related *P. issikii* in some localized areas in the native region. This new species does not show yet any evidence of expansion of its distribution range. These results highlight the importance of studying the phylogeography and systematics of invasive insects to fully understand their evolutionary ecology.

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Dr Mathieu Laparie

INRA, UR0633 Zoologie Forestière,
2163 Avenue de la Pomme de Pin, CS 40001, Ardon, 45075 Orléans Cedex 2, France

Tel.: +33 2 38 41 78 98
Email: mathieu.laparie@orleans.inra.fr

I am a Research Asssociate recently hired at INRA, Forest Zoology Research Unit. My research interests lie in the relationship between the success of invasive and/or expanding species and the way they fit the novel selection regimes they encounter as they expand and disturb newly colonized habitats. I also focus on the effects of climate change as it may facilitate biological invasions or trigger range expansions. The tools I use to study population differentiation as a consequence of the invasion (or range expansion) process range from geometric morphometrics to ecophysiology and metabolomics.

Does wing morphology of the active flyer *Calliphora vicina* change as it invades islands ruled by flightless insects?

The cosmopolitan blowfly *Calliphora vicina* established in the sub-Antarctic Kerguelen Islands in the late 1970s, following a warming period that allowed its full development. Although temperature and wind may limit its flight activity, it invaded the archipelago towards sites remote from the introduction point. While most native competitors have converged to flightlessness as a response to local stringent environmental conditions, the flight strategy of *C. vicina* might be either a handicap or a competitive advantage under ongoing climate change. Using geometric morphometrics, we questioned whether the wing changed over time within the archipelago (1998 vs. 2009), and compared its morphology with a continental population from a temperate area (1983 vs. 2009). Wing shape plasticity to temperature was also experimentally investigated. We found no cues of relaxed selection on flight morphology in the invaded range. However, comparatively rapid changes of wing shape occurred over time in females from the Kerguelen Islands, despite a shorter time-lag between the samples compared to the continental population. We also reported different reaction norms to temperature for wing shape between the populations. These findings are consistent with a fingerprint of local adaptation to the peculiar environmental conditions encountered in the invaded range, but additional studies are necessary to test this hypothesis. From an evolutionary standpoint, sustained flight capability under the novel sub-Antarctic conditions may be critical in the invasive success of *C. vicina*, given the flightlessness rule observed in native competitors. To address the adaptive significance of the changes recorded, further studies should tackle their aerodynamic consequences and future evolution.

Pr Stig Larsson

Dept. of Ecology, Swedish University of Agricultural Sciences
PO Box 7044 - 75007 Uppsala, Sweden

Tel.: +46 708 772 333
Email: stig.larsson@slu.se

Professor in Forest Entomology, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden, during 1993-2014, presently Professor emeritus at SLU. Vice Dean at the Faculty of Natural Resources and Agricultural Sciences, SLU 2007-2012. Member of the Royal Swedish Academy of Agriculture and Forestry. Research interests include Tree-herbivore interactions, Population Ecology, Management of Biodiversity, Climate-Change effects on Biota. Published 80+ peer-reviewed papers . For a complete CV, see http://www.slu.se/ecology_stiglarsson

Range expansion in insect pests: how important is climate change?

Stig Larsson, Andrea Battisti

The distribution range of insects is generally determined by niche availability, demographic processes and dispersal capacity (active or passive). The true range is difficult to describe because the occurrence of individuals forming stable populations in a given area is often not known in enough detail. For forest pests, surveillance networks provide useful information about the geographic area where they occur. Climate change has been invoked to explain recent range expansion in a few insect pest species from the temperate region; presumably higher temperatures have resulted in higher winter survival and prompted dispersal over longer distances. This applies, in different ways, to both native and alien species. We have analysed literature data on range expansion for a number of pests in forestry, and compared with similar data for agriculture. Appropriate data were available for 10 alien and 19 native forest pests. Most species show expansion as a result of higher temperature whereas very few show retraction at the rear edge of their distribution. The expansion rates vary greatly among species, and seem to be generally higher for alien species, in both forestry and agriculture. Ecological phenomena behind differences in expansion among insect species are discussed and potential mitigation measures suggested.

Dr Carlos Lopez-Vaamonde

INRA, UR0633 Zoologie Forestière,
2163 Avenue de la Pomme de Pin, CS 40001, Ardon, 45075 Orléans Cedex 2, France

Tel.: +33 2 38 41 78 61
Email: carlos.lopez-vaamonde@orleans.inra.fr

I am an entomologist interested in the patterns and processes of insect evolution, with a particular focus on leaf-mining microlepidoptera and their associated parasitoids. I obtained a PhD on Evolutionary Biology at Silwood Park, Imperial College (2002) and worked as a postdoctoral associate for three years at the Institute of Zoology in London on molecular and behavioural ecology of social insects. I was then hired as an INRA research scientist in July 2005. My work on invasion biology has been focused on using genetic markers to understand the dynamics of invasion. I am also interested in how communities of phytophagous insects and their parasitoids are assembled in their native range and how they are reassembled in the areas where their host plants have been introduced.

Patterns of invasion of Lepidoptera in Europe

Here I provide an overview of Lepidopteran invasions to Europe that result from increasing globalisation and also review expansion of species within Europe. A total of 97 non-native Lepidoptera species (about 1% of the known fauna), in 20 families and 11 superfamilies have established so far in Europe, of which 30 alone are Pyraloidea. In addition, 88 European species in 25 families have expanded their range within Europe and around 23% of these are of Mediterranean or Balkan origin, invading the north and west. Although a number of these alien species have been in Europe for hundreds of years, 74% have established during the 20th century and arrivals are accelerating, with an average of 1.9 alien Lepidoptera newly established per year between 2000–2007. For 78 aliens with a known area of origin, Asia has contributed 28.9%, Africa (including Macaronesian islands, Canaries, Madeira and Azores) 21.6%, North America 16.5%, Australasia 7.2% and the neotropics just 5.2%. The route for almost all aliens to Europe is via importation of plants or plant products. Most alien Lepidoptera established in Europe are also confined to man-made habitats, with 52.5% occurring in parks and gardens.

Dr Deepa Pureswaran

Canadian Forest Service, Laurentian Forestry Centre
1055, rue du PEPS, Quebec City, QC G1V 4C7, Canada

Tel.: +1 418 648 7532
Email: deepa.pureswaran@nrcan.gc.ca

Deepa Pureswaran is a research scientist in forest insect ecology with the Canadian Forest Service in Quebec City, Canada. She has a PhD from Simon Fraser University in British Columbia. During her graduate and post-doctoral work, she travelled to various parts of North America to study the outbreak ecology of forest insects. Her research explores the ecology and management of native and exotic forest insect pests, including semiochemistry, host and mate finding behaviour, community and population ecology. She uses empirical and theoretical approaches to understand the factors involved in pushing forest insect populations over the edge, causing them to transition from endemic to epidemic states.

Phylogenetic community structure and invasiveness of brown spruce longhorn beetle

As a consequence of increasing global trade, invasive alien forest insects are causing large scale ecological and economic disturbance to North American and European forests and plantations. Only a small proportion of exotic insects that establish in a new range become highly invasive; others that establish spread slowly, or cause little damage. We are seeking to explain the relatively slow invasion of the brown spruce longhorn beetle (*Tetropium fuscum*), native to Europe that established in Halifax, NS, Canada circa 1990. It has since spread < 140 km, in contrast to more catastrophic invaders such as emerald ash borer. In its new habitat, *T. fuscum* occupies a niche similar to a native congener, *T. cinnamopterum*. It is also parasitized by at least two Nearctic koinobiont parasitoids that have previously been recorded only from Nearctic congeners. Using metrics of phylogenetic community structure, we propose a conceptual framework to test the hypotheses that exotic insects are less invasive if 1) they encounter close relatives in their new range that share the same ecological niche and 2) they encounter competitors and natural enemies that are closely related to those in their native range. Understanding the ecological and evolutionary mechanisms that mediate differences in invasion impact between species such as emerald ash borer and brown spruce longhorn beetle will help us predict the invasiveness of introduced species in the future.

Dr David Renault

University of Rennes 1, UMR CNRS 6553 EcoBio
263 Avenue du Gal Leclerc, CS 74205, 35042 Rennes Cedex, France

Tel.: + 33 2 23 23 66 27
Email: david.renault@univ-rennes1.fr

I am casting my research in the sub-discipline of stress physiology, which intersects with ecology in attempts to characterize and explain the distributional limits of species and the variation of abundance within their geographic ranges. As the climate warms, one might expect both the spread and population growth of previously introduced species and the survival of propagules of other species that would previously have been eliminated by the climate. In this context, I am studying the behavioral, metabolic and physiological responses settled by arthropods to survive in fluctuating environmental conditions (thermal and trophic fluctuations, desiccation, salinity), and the importance of phenotypic plasticity in the invasive success of alien insects. I am using the state-of-the-art metabolomics techniques to delineate insect-environment interactions.

Climate change and phenotypic plasticity as important parameters setting insect invasion potential at the subantarctic islands

The Southern Ocean contains a number of dots of land, almost all of which are volcanic in origin. These subantarctic islands are characterised by impoverished terrestrial ecosystems with highly reduced or absent functional redundancy. Subantarctic biodiversity is currently threatened by the significant increase in the number of introduced species. The permanent establishment and spread of alien insects is facilitated by the ongoing climate changes, as observed for the blowfly *Calliphora vicina* at the Kerguelen Islands. Indeed, we calculated the amount of heat required by this alien fly to successfully complete its development (Physiological time, expressed in degree-days). We found that the permanent establishment of the blowfly at the Kerguelen Islands occurred just after climate warming resulted in an amount of heating days that matches with the physiological time required for this fly species. Using another species, the ground beetle *Merizodus soledadinus* that is invasive at the Kerguelen Islands, we examined the role of phenotypic plasticity in the invasive success. The plastic response of this species to a range of environmental conditions including salinity (0 ppt to 70 ppt), temperature (0 to 20 °C), desiccation food deprivation and diet was evaluated. All of these experiments ended to the conclusion that the high phenotypic plasticity of this alien ground beetle plays a significant role in its invasive success at the Kerguelen Islands.

Dr Christelle Robinet

INRA, UR0633 Zoologie Forestière,
2163 Avenue de la Pomme de Pin, CS 40001, Ardon, 45075 Orléans Cedex 2, France

Tel.: +33 2 38 41 80 38
Email: christelle.robinet@orleans.inra.fr

Christelle Robinet is a researcher at INRA since 2008. She develops simulation models to determine the potential range expansion of forest pests, either invasive or native species. She assessed the potential range expansion of the pine processionary moth in France in relation with climate warming and anthropogenic activities. She also studied the potential range expansion of the invasive pine wood nematode in China and Europe considering both short and long distance dispersal. She is now focusing also on social insects currently invading France: an invasive North American termite and the invasive yellow-legged hornet. In addition, she participated to the development of generic tools: a generic spread model to support pest risk analysis and a generic pathway model to assess the probability of entry of invasive pests with imported wood. She works in collaboration with several research labs, notably at IRBI (Tours, France) and Wageningen University (The Netherlands).

Assessing the invasion probability of the pine wood nematode with imported wood

Robinet C[1], Douma JC[2], Magnusson C[3], Hemerik L[4], Mourits MM[5], Roques A[1], van der Werf W[2].

[1] INRA, UR633 Zoologie Forestière, F-45075 Orléans, France

[2] Centre for Crop Systems Analysis, Plant Sciences, Wageningen University, the Netherlands

[3] Bioforsk, Norwegian Institute for Agricultural and Environmental Research, Ås, Norway

[4] Biometris, Wageningen University, the Netherlands

[5] Business economics group, Social Sciences, Wageningen University, the Netherlands

The pine wood nematode, Bursaphelenchus xylophilus, is the causal agent of the pine wilt disease. Native to North America, it was introduced in Asia (Japan, China, Taiwan and Korea) and in Europe (Portugal). In invaded areas, the pine wood nematode can kill a tree within a few weeks. It is carried by insects of the genus Monochamus over relatively short distances, and can disperse from one tree to another during the beetle maturation feeding and beetle oviposition. The nematode can also disperse over long distances when it is accidentally transported with infested wood. Preventing introductions is very important as containing its range is very difficult once it arrived. Here, we present a probabilistic pathway model that keeps track of infested wood products coming from China and entering into Europe until the possible dissemination of the nematode on a suitable host in Europe. The model accounts for the structure of the trade pathway and the wood transformation chain, the applied inspection procedures and wood treatments, and the dissemination capability on a suitable host tree at each node. The performed study highlights the most important parameters that should be known to quantify the probability of introduction. We also search for the nodes and the European countries that contribute the most to this introduction. With these results, we can then determine the best strategies to reduce this probability of introduction. Our probabilistic pathway model was designed to be generic. Thus, it can be used by pest risk analysts for any forestry pest. To estimate the overall invasion probability, this model should be combined with other approaches which assess establishment and potential spread of the pest.

Dr Rodolphe Rougerie

UMR7205, Muséum National d'Histoire Naturelle
Laboratoire d'Entomologie, CP50, 45 rue Buffon
75005 Paris, France

Tel.: +33 1 40 79 53 83
Email: rodolphe.rougerie@mnhn.fr

Rodolphe Rougerie is Assistant Professor and Curator of Lepidoptera at the Muséum national d'Histoire Naturelle (MNHN) in Paris where he conducts research on the systematics and evolutionary history of Lepidoptera (moths & butterflies), with a special focus on the patterns of diversity and the processes of diversification in Wild Silkmoths and Hawkmoths.
He contributes to the assembly of DNA barcode libraries for several groups of invertebrates in Europe and in the tropics, and is also involved in DNA metabarcoding studies to develop new protocols and address ecological questions using NGS technologies.

Fast and curious: DNA metabarcoding, a next-generation sentinel tool for early detection of invasive species?

New DNA sequencing technologies (often referred to as Next Generation Sequencing or NGS) have considerably increased the capacities and the throughput for producing genomic data. Beyond the advances in genome sequencing per se, NGS have led to the emergence of environmental genomics, a field exploiting the wealth of information contained in the «metagenome» of organisms within complex communities.

DNA metabarcoding is an emerging approach at the crossroad between metagenomics and molecular characterization of species. Through the sequencing of species-diagnostic DNA snippets from bulk (multiple individuals and species) or environmental (e.g. water, soil) samples, DNA metabarcoding can considerably facilitate and accelerate the documentation of species diversity (richness, composition) in complex assemblages.

In this presentation, I will present original results as well as examples from the literature to illustrate the use of DNA metabarcoding to document complex communities, with emphasis on its potential for detection and identification of invasive species.

Pr Axel Schopf

Institute of Forest Entomologie, Forest Pathology and Forest Protection, University of Natural Resources and Life Sciences, Vienna
Hasenauerstraße 38, A-1190 Vienna, Austria

Tel.: +43 1 3686352 29
Email: axel.schopf@boku.ac.at

Axel Schopf is forest entomologist and head of the institute of Forest Entomology, Forest Pathology and Forest Protection. His main field of studies are ecology and physiology of forest insects, tritrophic systems of host plant-herbivore-parasitoid interactions, and risk assessment against forest pests. He was work package leader of several EU projects and is member of several Societies of Entomology; Wilderness Area Administration (advisory board member); Advisory Board Member J Appl Entomol.; Reviewer for several scientific journals in Entomology and Forest Protection.

Voltinism and life history traits of the two potential invasive pests in Europe

Climate warming is expected to have a large impact on the population dynamics of ectothermic organisms, like insects. They may be affected by the changes in environmental conditions directly in dispersal, reproduction, development and mortality, and indirectly through altered interactions with their hosts and natural enemies. Depending on their actual physiological adaptations to their environment, climate warming should be of advantage for more thermophilic organisms. Presently well adapted organisms to higher latitudes, however, may suffer in their viability under increasing temperatures and thus may become a member in the group of „losers" in their ecological importance. The two potential invasive species, *Dendrolimus sibiricus* and *Dendroctonus ponderosae*, are known for their heavy outbreaks in forests of more northern latitudes. Compared to close related endemic species the influence of climate change on the life cycle of the two exotic insects will be discussed.

Dr Viktória Tóth

University of West-Hungary, Faculty of Forestry, Institute of Silviculture and Forest
H-9400 Sopron, Bajcsy-Zsilinszky u. 4, Hungary

Tel.: +36 3 04 77 47 69
Email: montia21@gmail.com / toth.viktoria@emk.nyme.hu

The author has been studying biology at the University of Pécs and graduated there in 2006. At the beginnings her research interest focused mainly on botany and floristics. During her PhD work her research interest turned to the interaction between host plant and herbivorous insects and to the population genetics of invasive species. She earned the PhD degree at the University of West-Hungary in 2014. Her most recent work concentrates to invasive insect species, for example the plane leaf miner moth (Phyllonorycter platani Stgr. 1870), and the sycamore lace bug (Corythucha ciliata Say, 1873) and their population genetics.

The invasion genetics of the plane leaf miner (*Phyllonorycter platani* STGR. 1870)

In this study we analysed the phylogenetical pattern of 227 individuals from 26 populations of the plane leafminer (*Phyllonorycter platani*). 20 haplotypes were detected on the 1243bp long fragment of the mitochondrial DNA (COI gene). On the 530bp long fragment of the 28S rDNA 2 allels were identified. The influence of recent and past gene flow were detected on the phylogeographical pattern of the plane leaf miner. The genetic patterns revealed at least two refugia during the last ice-age, one of them is located in the Southern part of the Balkan Peninsula, the other in the Caucasus. Population from Asia Minor shown up founder effect. The diversity pattern of the asian clade suggests a recent colonization of Central Asia from the Caucasus. The rapid expansion from a small effective population is the most important demographycal effect on the european population. For the North American population our analyses suggest a recent rapid demographic expansion. The European origin of this population has been confirmed.

Dr Erik J. van Nieukerken

Naturalis Biodiversity Center
PO Box 9517, 2300 RA Leiden, Netherlands

Tel.: +31 71 5687682
Email: Nieukerken@naturalis.nl

Erik van Nieukerken graduated in 1978 at the University of Leiden and. From 1978 to 1983 he was PhD student at the Free University of Amsterdam; thesis: Taxonomy of the leafmining moth family Nepticulidae (Lepidoptera). In 1986 he was appointed at the Rijksmuseum van Natuurlijke Historie (now Naturalis Biodiversity Center) as coordinator of the Netherlands Office of the European Invertebrate Survey. He initiated and edited a book series on the Fauna of the Netherlands. From 2000 he was curator for Lepidoptera and Arachnida and since 2005 researcher. Leafmining Lepidoptera are his main research interest, but he has also a broad interest in biodiversity studies. He was co-author and editor of two important books on the Biodiversity of the Netherlands and authored ca 150 scientific publications. He is editor for several journals and General Secretary of the Societas Europaea Lepidopterologica. In 2013 he received the Uyttenboogaart-Eliasen Prize for his work as Entomologist.

The role of taxonomy and DNA barcoding in recognising invasive and native lepidopterous leafminer infestations

The last decades several leafmining Lepidoptera have invaded other continents or extended their ranges from their natural distribution. Well known examples are in the family Gracillariidae, but recently it has become clear that also species of Heliozelidae, Bucculatricidae and Nepticulidae may have this ability. Common denominations are the small size and the hibernating stage in cocoons or leafmines that allow for easy spreading, assisted by human transport and for air transport of adults. In some recent invasions, identification was only possible after extensive taxonomic research, including DNA barcodes of the invasives and related specimens from their native areas. Examples discussed include three invasions from North America: *Antispila oinophylla* on grapevine in Italy had to be described as new species, and it was revealed that this group contained several unknown species in North America also feeding on grapevines. *Coptodisca lucifluella* invaded walnut orchards in Italy, a simultaneous geographic and host shift, from its North American host *Carya* (hickory, pecan) to *Juglans* (walnut) in Italy. The third, *Bucculatrix ainsliella*, discovered on, equally non-native, northern Red oak (*Quercus rubra*) in the Netherlands was the only species for which recent taxonomic work was available, but still it took some time before the species was identified. A fourth case, in South Africa, involves an undescribed species of Heliozelidae that probably shifted host in its native region from indigenous Vitaceae (*Rhoicissus*) to cultivated (non-native) grapevine. Here taxonomic knowledge was virtually non-existing and in depth taxonomic research, coupled with DNA barcoding was needed to establish an identity. Although DNA barcoding is a powerful tool to recognize many pests and invasions, this only holds true when taxonomic studies have provided reliable references. The effects of measures for early detection and avoiding of invasive pests therefore depend heavily on taxonomic attention that has been paid to potential future invasives.

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