INSTITUT DE FRANCE
Académie des sciences

3 Mazarine
Auditorium André et Liliane Bettencourt
3, rue Mazarine - 75006 Paris - France

Grande Conférence de l'Académie des sciences

Insectes :

amis, ennemis et modèles

Paris, du 12 au 14 mars 2019

Les insectes représentent aujourd'hui 80% des espèces sur Terre et ont un impact significatif sur notre monde. En tant que vecteurs de maladies, ils sont chaque année responsables de plus de morts que tous les conflits armés. Pollinisateurs de nos cultures, ils jouent un rôle essentiel dans notre production de nourriture. Ils tiennent également un rôle clé dans les cycles de la matière ou le maintien des populations de vertébrés.

Apparus il y a au moins 360 millions d'années, ils ont été parmi les premiers animaux à coloniser les écosystèmes terrestres. Leur évolution a connu des expansions considérables, marquées par des innovations majeures telles que le vol ou la vie en société.

Les insectes sont également des modèles biologiques indispensables au laboratoire, avec notamment la fameuse mouche du vinaigre, dont l'étude a permis des découvertes majeures en génétique, immunologie et science du comportement pour ne citer que quelques exemples.

Pour toutes ces raisons, les insectes, fortement affectés par les changements environnementaux, sont plus que jamais un formidable objet d'étude. La recherche dans le domaine est une science d'avenir, qui se développe et se réinvente. L'Académie choisit d'y consacrer sa première Grande conférence pour porter ce message auprès des acteurs scientifiques, mais également aux acteurs de la société civile. Cette rencontre abordera ainsi, à travers les exposés d'experts reconnus, les sujets-clés de la biologie de ces animaux passionnants, depuis leurs relations avec l'environnement jusqu'à leur utilisation dans le domaine biomédical.

Avec le soutien de Institut Pasteur · IRD Institut de Recherche pour le Développement France · Ynsect · ASTANOR VENTURES

The organizers

Pascale COSSART

Secrétaire perpétuel of the *Académie des sciences*

Professor at *Institut Pasteur*, her research focuses on the study of molecular and cellular mechanisms implicated in bacterial infections, using the bacterium *Listeria monocytogenes* as a model. Pascale Cossart was a pioneer in a discipline that she named "Cellular Microbiology". She highlighted numerous strategies used by bacteria during infection. Her work has led to new concepts in infection biology, cellular biology, epigenetics and fundamental microbiology, and has been recognized by several international prizes. Pascale Cossart is a member of the *Deutsche Akademie der Wissenschaften Leopoldina*, the National Academy of Sciences, the National Academy of Medicine and the Royal Society.

Jules HOFFMANN

Member of the *Académie des sciences*

Jules Hoffmann is Professor at the University of Strasbourg and senior researcher at CNRS. He dedicated his work to the study of the genetic and molecular mechanisms responsible for antimicrobial defenses in insects. The work of Jules Hoffmann and his numerous associates has provided new insights into the innate defense mechanisms and the marked conservation of innate defense mechanisms between insects and humans, contributing to a re-evaluation of the role of innate immunity in mammals. With Bruce A. Beutler and Ralph M. Steinman, Jules Hoffmann was awarded the Nobel Prize in Physiology or Medicine 2011.

The co-organizers

Philippe GRANDCOLAS

CNRS, *Muséum National d'Histoire Naturelle,* France

Philippe Grandcolas is Senior scientist at CNRS. He studied deep time evolution in poorly known groups of Insects and then focused on the geography of this process, discovering a new evolutionary paradigm for New Caledonia, the most ancient oceanic island in the world. He developed a strong interest for knowledge integration and big data in biodiversity. He is the director of the *Institut de Systématique, Evolution, Biodiversité*, the largest European laboratory of Systematics. He was elected president of the Willi Hennig Society and is vice-chair of the science comittee of the Global Biodiversity Information Facility.

Jean-Luc IMLER

Strasbourg University, France

Jean-Luc Imler is professor of cell biology at the University of Strasbourg and director of the CNRS research unit Insect Models of Innate Immunity (M3i) at the Institute of Molecular and Cell Biology. A longtime co-worker of Jules Hoffmann, he is working on innate immunity using the fruit fly *Drosophila melanogaster* as a model. Over the past 15 years, his group has focused on antiviral immunity, establishing that it involves both RNA interference and evolutionarily conserved induced responses. He has recently started to investigate antiviral immunity in vector mosquitoes.

Program

Tuesday March 12, 2019

16:00 **Welcome addresses**
Pascale COSSART, *secrétaire perpétuel, Académie des sciences*
Jules HOFFMANN, member of *Académie des sciences*

Session I
Insects as model organisms in biology
Chairpersons : Pascale Cossart and Jules Hoffmann

16:20 **How flies contribute to the discovery of human disease and their pathogenic mechanism**
Hugo BELLEN, Howard Hughes Medical Institute, United States of America

17:00 **Drosophila research: from the genome to the proteome**
Markus AFFOLTER, University of Basel, Switzerland

17:40 **Insects as interactants in artists minds: symbols and anti-symbols**
Yvan RAHBÉ, INRA, France

17:55 **The shining world of beetles**
Michel MITOV, CNRS, France

18:10 **The geopolitics of the mosquito**
Erik ORSENNA, *Académie française*, France

18:25 **Cocktail**

Wednesday March 13, 2019

Session II
Diversity, diversification, extinction
Chairpersons : Jean-Luc Imler and Anna-Bella Failloux

09:00 **The origin of biodiversity in insects: speciation and adaptation and the Earth dynamics**
Philippe GRANDCOLAS, CNRS, *Muséum National d'Histoire Naturelle,* France

09:30 **How insects diversified on earth**
André NEL, CNRS, *Muséum National d'Histoire Naturelle,* France

10:00 **The metamorphosis of insects and their regulation**
Xavier BELLÉS, Institute of Evolutionary Biology, Spain

10:30 **Evolution of aposematism and mimicry in butterflies: causes, consequences and paradoxes**
Marianne ELIAS, CNRS, *Muséum National d'Histoire Naturelle,* France

11:00 **Coffee break**

Session III

Social insects and other

Chairpersons : Jean-Luc Imler and Anna-Bella Failloux

11:15 **Supergene, sex and sociality**
Laurent KELLER, Lausanne University, Switzerland

11:45 **Termites: soil engineers for ecological engineering**
Pascal JOUQUET, IRD, France

12:00 **Using contact networks and next-gen sequencing for wildlife epidemiology**
Vincent DOUBLET, University of Edinburgh, United-Kingdom

12:15 **Microbial nutrient factories in insects on extreme diets**
Angela E. DOUGLAS, Cornell University, United States of America

12:45 **Lunch break and poster session**

Session IV

Interaction with other organisms

Chairpersons : Philippe Grandcolas and Elena Levashina

14:30 **The insect reservoir of diversity for viruses and antiviral mechanisms**
Jean-Luc IMLER, Strasbourg University, France

15:00 **Cassava mealybug biological control delivers multi-faceted societal benefits**
Kris WYCKHUYS, China Academy of agricultural sciences, China

15:15 **Insects and their microbial partners: the Drosophila case study**
François LEULIER, University of Lyon, France

15:45 **Coffee break**

16:15 **What 5 insects told us about how a native plant copes with real-world problems**
Ian Thomas BALDWIN, Max Planck Institute for Chemical Ecology, Germany

16:45 **Evolution and specificity of insect host - endoparasitoid wasp interactions: implications for biological control**
Marylène POIRIÉ, Sophia Agrobiotech Institute, France

17:15 **When a bacterium fights Arboviruses**
Luciano MOREIRA, Fiocruz Institute, Brazil

17:45 **Ecosystem services provided by insects for achieving sustainable developmental goals**
Olivier DANGLES, IRD, France



Thursday March 14, 2019

Session V
Vector insects and transmission of diseases
Chairpersons : Markus Affolter and François Leulier

09:00 **Do we have to get rid of mosquitoes to eliminate malaria?**
Elena Levashina, Max Planck Institut for Infection Biology, Germany

09:30 **Human activities and climate change in the emergence of vector-borne diseases**
Anna-Bella Failloux, *Institut Pasteur,* France

10:00 **Benefits and limitations of emerging techniques for mosquito vector control**
Catherine Golstein, *Haut Conseil des biotechnologies,* France

10:15 **Coffee break**

10:45 **A transdisciplinary consideration of sand flies & leishmaniasis**
Rod Dillon, Lancaster University, United Kingdom

11:15 **The trypanosome journey in the tsetse fly**
Philippe Bastin, *Institut Pasteur*, France

Session VI
Insects in the future
Chairpersons : Markus Affolter and François Leulier

11:45 **Insects on the menu**
Marcel Dicke, Wageningen University & Research, Netherlands

12:25 **Industrial insects production as an alternative source of animal protein**
Antoine Hubert, Ÿnsect, France

12:35 **The impact of climate on the winter strategies of insects**
Joan Van Baaren, Rennes University, France

13:15 **Closing remarks**



Programme

Mardi 12 mars 2019

16:00 **Accueil**
Pascale COSSART, secrétaire perpétuel, Académie des sciences, France
Jules HOFFMANN, membre de l'Académie des sciences, France

Session I
Les insectes comme organismes modèles en biologie
Présidents de séance : Pascale Cossart et Jules Hoffmann

16:20 **Comment les mouches contribuent à la découverte de maladies humaines et de leurs mécanismes pathogènes**
Hugo BELLEN, *Howard Hughes Medical Institute*, États-Unis

17:00 **Recherche sur la drosophile : du génome au protéome**
Markus AFFOLTER, université de Bâle, Suisse

17:40 **Les insectes comme «interactants» dans l'esprit des artistes : symboles et anti-symboles**
Yvan RAHBÉ, INRA, France

17:55 **Le monde étincelant des scarabées**
Michel MITOV, CNRS, France

18:10 **Géopolitique du moustique**
Erik ORSENNA, Académie française, France

18:25 **Cocktail**

Mercredi 13 mars 2019

Session II
Diversité, diversification, extinction
Présidents de séance : Jean-Luc Imler et Anna-Bella Failloux

09:00 **Les origines de la biodiversité chez les insectes : spéciation et adaptation et les dynamiques de la Terre**
Philippe GRANDCOLAS, CNRS, Muséum national d'Histoire naturelle, France

09:30 **Comment les insectes se sont diversifiés sur Terre**
André NEL, CNRS, Muséum national d'Histoire naturelle, France

10:00 **Les métamorphoses des insectes et leur régulation**
Xavier BELLÉS, *Institut de Biologia Evolutiva*, Espagne

10:30 **Evolution de l'aposématisme et du mimétisme chez les papillons : causes, conséquences et paradoxes**
Marianne ELIAS, CNRS, Muséum national d'Histoire naturelle, France

11:00 **Pause café**

Session III
Insectes sociaux et autres
Présidents de séance : Jean-Luc Imler and Anna-Bella Failloux

11:15 **Supergène, sexe et sociabilité**
Laurent Keller, université de Lausanne, Suisse

11:45 **Les termites : des ingénieurs du sol pour l'ingénierie écologique**
Pascal Jouquet, IRD, France

12:00 **Utilisation des réseaux de contacts et du séquençage de nouvelle génération pour l'épidémiologie de la vie sauvage**
Vincent Doublet, université d'Edimbourg, Royaume-Uni

12:15 **Usines à nutriment microbien chez les insectes à régime alimentaire extrême**
Angela E. Douglas, université Cornell, États-Unis

12:45 **Pause déjeuner et session de posters**

Session IV
Interaction avec d'autres organismes
Présidents de séance : Philippe Grandcolas et Elena Levashina

14:30 **Le réservoir de diversité des insectes pour les virus et mécanismes antiviraux**
Jean-Luc Imler, université de Strasbourg, France

15:00 **Le contrôle biologique de la cochenille du manioc fournit de multiples avantages pour la société**
Kris Wyckhuys, Académie chinoise des sciences agricoles, Chine

15:15 **Insectes et leurs partenaires microbiens : le cas d'étude de la drosophile**
François Leulier, université de Lyon, France

15:45 **Pause café**

16:15 **Ce que nous ont appris cinq insectes sur la manière dont une plante native fait face à des problèmes du monde réel**
Ian Thomas Baldwin, *Max Planck Institute for Chemical Ecology,* Allemagne

16:45 **Évolution et spécificité des interactions insecte hôte - guêpe endoparasitoïde : implications pour le contrôle biologique**
Marylène Poirié, Institut Sophia Agrobiotech, France

17:15 **Quand une bactérie lutte contre les arbovirus**
Luciano Moreira, *Fiocruz Institute*, Brésil

17:45 **Services écosystémiques fournis par les insectes pour atteindre des objectifs de développement durable**
Olivier Dangles, IRD, France

Jeudi 14 mars 2019

Session V
Insectes vecteurs et transmission de maladies
Présidents de séance : Markus Affolter et François Leulier

09:00 **Doit-on éliminer les moustiques pour éradiquer la malaria ?**
Elena Levashina, *Max Planck Institut for Infection Biology*, Allemagne

09:30 **Activités humaines et changement climatique dans l'émergence de maladies à transmission vectorielle**
Anna-Bella Failloux, Institut Pasteur, France

10:00 **Intérêts et limites des techniques émergentes de lutte antivectorielle contre les moustiques**
Catherine Golstein, Haut Conseil des biotechnologies, France

10:15 **Pause café**

10:45 **Considération transdisciplinaire des mouches de sable et de la leishmaniose**
Rod Dillon, université de Lancaster, Royaume-Uni

11:15 **Le voyage du trypanosome dans la mouche tsé-tsé**
Philippe Bastin, *Institut Pasteur,* France

Session VI
Les insectes dans le futur
Présidents de séance : Markus Affolter et François Leulier

11:45 **Insectes au menu**
Marcel Dicke, *Wageningen University & Research*, Pays-Bas

12:25 **La production industrielle d'insectes comme source alternative de protéines animales**
Antoine Hubert, Ÿnsect, France

12:35 **L'impact du climat dans les stratégies hivernales des insectes**
Joan Van Baaren, université de Rennes, France

13:15 **Remarques de clôture**

Bios and abstracts

Hugo Bellen

Howard Hughes Medical Institute, United States of America

Hugo Bellen is a Howard Hughes Medical Institute Investigator and a Professor at Bayor College of Medicine. His group has made major contributions to our understanding of nervous system development, synaptic transmission and mechanisms of neurodgeneration. His lab has developed numerous tools and generated tens of thousands of reagents that have transformed Drosophila biology. His current research focuses on the discovery of human disease genes and elucidating pathogenic mechanisms of neurodevelopmental and neurodegenerative diseases. He has made major strides in solving key problems related to Friedreich ataxia, Alzheimer disease, Amyotrophic Lateral Sclerosis, and Parkinson disease.

Comment les mouches contribuent à la découverte de maladies humaines et de leurs mécanismes pathogènes

How flies contribute to the discovery of human disease and their pathogenic mechanism

We are interested in the molecular mechanisms required for neural development and neural maintenance by studying genes that play a role in these processes. We use two approaches. First, a forward genetic approach in which we induce lethal mutations on FRT bearing chromosomes and screen in fly head clones for developmental or electrophysiological defects using electroretinograms. This approach has allowed us to identify and sequence ~160 genes whose loss cause neurodevelopmental or neurodegenerative phenotypes. Through genematcher we identified a variety of human loci that cause neurological disorders. This allowed us to discover a new human microcephaly pathway that is affected by the Zika virus. In a second approach we collaborate with human geneticists around the world to solve medical puzzles related to genes that have not yet been associated with disease phenotypes. We typically create a GAL4 insertion in the fly homolog that disrupts gene function but allows us to drive a UAS-human cDNA construct. This has led to the discovery of more than 10 new human diseases in the past two years. By probing the mechanisms in flies we also discovered new mechanisms related to neurodegenerative diseases.

Markus Affolter

University of Basel, Switzerland

Markus Affolter has studied Biology at the ETH in Zurich and at Laval University in Quebec City. After a PhD in Quebec he returned to Switzerland in 1988 and worked for 5 years in the laboratory of Walter J. Gehring at the Biozentrum in Basel. He started his independent research at the Biozentrum in 1993. The major interest of the laboratory focuses on gaining a better understanding of how cells form complex organs *in vivo*, and high resolution live imaging has been extensively used to describe cell behaviour underlying the formation of branched organs such as the tracheal system in drosophila and the vasculature in zebrafish.

Recherche sur la drosophile : du génome au protéome

Drosophila research: from the genome to the proteome

Starting from 1900, *Drosophila melanogaster* has been studied in the laboratory by scientists interested in many different aspects of animal development, physiology and evolution. Over much of this more than hundred year period, genetic analyses have been at the basis of most studies, also those who led to the Nobel prizes attributed to scientists working with Drosophila. More recently, fluorescent proteins and optogenetic tools have been added to the ever-expanding genetic toolbox allowing for a better understanding of basic cellular processes underlying complex developmental processes.

Over the last few years, a novel approach is being added to the toolbox. Small protein binders can be used to directly target and manipulate proteins in their native environment. The development of numerous antibody- and non-antibody-based scaffolds has allowed the rapid identification of such small protein binders, and the many different functionalizations with which such binders can be combined, allows for acute and direct protein manipulation in vivo. Several cases in which such small, functionalized protein binders have been used in Drosophila will be discussed, and a look into the next 100 years of research with drosophila will end the presentation.

Yvan Rahbé
INRA, France

Born in the Lebanon, Yvan Rahbé graduated in Agronomy at INA-PG (AgroParisTech, Biochemistry 1982) and took a PhD in Insect biochemistry (1984). After a move into tropical entomology (leaf-cutting ants, INRA Guadeloupe), he joined INRA Lyon in 1986, to build a group on aphid-plant physiology. INRA Research director in 2000, head of research unit BF2I in 2006 (UMR0203 INRA/INSA-Lyon), he moved to a CNRS Lab in microbiology in 2016 (UMR5240 MAP), to start a project on aphid-bacterial interactions / vector biology, and on the biomimetics of insect cuticle.

Les insectes comme «interactants» dans l'esprit des artistes : symboles et anti-symboles
Insects as interactants in artists minds: symbols and anti-symbols

Insects are among the prominent and most diverse animal groups interacting with humans. How they are perceived by human societies, and how artists mediate this interaction, is a singular object of reflexion. The relationship has been already analysed for the most visible/emblematic of insect taxa, but many others remain seemingly hidden. With the example of aphids, we will show that invisibility itself, and many other traits of "tiny insects", have been a subject of reflexion for a cohort of artists across human history. I will briefly scan a series of case studies on the interaction between nature (aphids, insects), art (artists and scientists) and their observers (humans), from even before antique Greece to the internet era. Aristote, Brueghel the elder, Bonnet, Delacroix, Hugo, Beauvoir, Vian or virtual musical avatars of Guy Debord have all been timidly inspired by such insignificant insects.
But at the microbiome age, is there really a link between size and significance?

Michel Mitov
CNRS, France

Michel Mitov graduated from the University Nice Sophia Antipolis, where he received his PhD in condensed matter physics. He is Director of research at CNRS and Senior Investigator of the Liquid Crystals theme at CEMES in Toulouse. His current interests are the design and the optical properties of twisted liquid crystals and their replicas inspired from insect carapaces. He is the inventor of patents on smart windows. He published an essay of science popularization on soft matter, "Sensitive Matter—Foams, Gels, Liquid Crystals and Other Miracles" (*Le Seuil*, Harvard University Press).

Le monde étincelant des scarabées
The shining world of beetles

Twisted liquid crystals are omnipresent in living matter. Many insects own a tessellated carapace with bumps, pits, indentations, stripes or spots which exhibit iridescent colors as the consequence of complex twist of chitin macromolecules. Little is known on the physical properties of these geometric variations. Many biological functions are still unknown or debated. They are related to conspecific or intra-species communication, thermoregulation, camouflage, survival, navigation. I will summarize a set of recent results on this topic. Potential applications are related to smart windows for solar energy control or wavelength-sensitive light modulators.

Erik Orsenna

Académie française, France

@Bernard Matussière

Erik Orsenna is an economist by profession. He was cultural advisor to french President François Mitterrand and sat on the *Conseil d'État* (the highest legal authority in France). He is also a novelist, having written *colonial exhibiton* (winner of the Goncourt prize in 1988), *indian venture* or *origin of our loves*. Since 1998 he has been a member of the *Académie française*. As a specialist in raw materials, Erik Orsenna has been exploring the planet for the last fifteen years and has published a series of short summaries of globalization. After writing about cotton, water and paper, he authored *The geopolitics of the mosquito*, published by Fayard in March 2017.

Géopolitique du moustique
The geopolitics of the mosquito

Philippe Grandcolas

CNRS, *Muséum National d'Histoire Naturelle,* France

Philippe Grandcolas is Senior scientist CNRS. He studied deep time evolution in poorly known groups of Insects and then focused on the geography of this process, discovering a new evolutionary paradigm for New Caledonia, the most ancient oceanic island in the world. He developed a strong interest for knowledge integration and big data in biodiversity. He is the director of the *Institut de Systématique, Evolution, Biodiversité*, the largest European laboratory of Systematics. He was elected president of the Willi Hennig Society and is vice-chair of the science comittee of the Global Biodiversity Information Facility.

Les origines de la biodiversité chez les insectes : spéciation et adaptation et les dynamiques de la Terre
The origin of biodiversity in insects: speciation and adaptation and the Earth dynamics

The diversity of Insects is often explained as a product of major radiations, trigerred by remarkable adaptations that allowed them to exploit different environments and to accompany the rise of flowering plants. A significant part of Insect diversity results however from allopatric speciation with niche conservatism that exposed species to different conditions and stimulated adaptive divergence. We demonstrated that for several groups of Insects (cockroaches, crickets and grasshoppers) in the oldest oceanic island, New Caledonia. Before our work, New Caledonia was considered as a continental fragment according to its geological basement and local relict species. Molecular phylogenetic trees dated with probabilistic methods showed that most organisms on this island diversified after its emergence, 37 My ago. This result is highly consistent with geological studies implying that the island was submerged during eocene tectonic events. Major adaptive divergence occurred together with land conquest through allopatric speciation and niche conservatism.

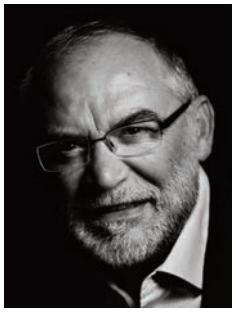
André Nel

CNRS, *Muséum National d'Histoire Naturelle,* France

André Nel has played a major role in the renewal of fossil insects research by discovering several deposits in France and abroad but also as the PhD director of many young researchers. He developed the use of synchrotron x-ray tomography in the study of insects preserved in opaque amber forms.
He is the author of 621 scientific publication and has given more than 40 lectures in conferences. He was awarded, in 2016, the Balachowsky prize from the *Académie des sciences.*

Comment les insectes se sont diversifiés sur Terre
How insects diversified on earth

Insects are the most successful and diversified group of terrestrial metazoans. With estimated 5.5 Millions of extant species (ca. 1 Million described), they represent the great majority extent terrestrial biodiversity, and probably also past one (ca. 26600 described fossil species). By comparison fossil Vertebrates count only ca. 32000 species, while they are much more studied than insects. Yet, many inferences on the major past crises of terrestrial biodiversity are based on the vertebrate fossil record, triggering a biased understanding of crises and precluding a clear and comprehensive knowledge biodiversity evolution.
In addition, the Hexapoda (incl. insects) are very ancient. They have been crucial in terrestrial ecosystems and trophic chains for more than 320 Myrs, as a major source of food for vertebrates among other groups, and yet they are patently understudied. Understanding insect relationships, history, and the specific time intervals for their episodes of radiations and extinctions is critical to any comprehensive perspective on evolutionary events in terrestrial paleoenvironments.



Xavier Bellés

Institute of Evolutionary Biology, Spain

Founder and first director of the Institute of Evolutionary Biology (CSIC-UPF), Xavier Bellés' research focuses on insect metamorphosis, using cockroaches as models and different scales of observation, from morphology to molecular biology. Author or co-author of 19 books and 312 scientific articles, he is member of the Institute of Catalan Studies, the Royal Academy of Sciences and Arts (Barcelona), and of the Royal Academy of Exact, Physical and Natural Sciences (Madrid). He was awarded the *Prix Maurice Pic* of the *Société Entomologique de France*.

Les métamorphoses des insectes et leur régulation
The metamorphosis of insects and their regulation

Insect metamorphosis is a developmental process by which immatures become adults, able to fly and reproduce. Metamorphosis is regulated by two hormones, ecdysone, which promotes molting, including the metamorphic molt, and juvenile hormone (JH), which represses metamorphosis. The study of regulatory mechanisms has undergone spectacular progress in the last 10 years, especially with regard to the molecular action of JH. Functional genomic experiments have shown that JH represses adult morphogenesis in pre-adult stages. However, at the beginning of the last juvenile instar, JH levels dramatically drop, which determines the metamorphic molt. At molecular level, the regulatory axis of the action of JH is based on the Mekre93 pathway, as follows. JH binds to the transcription factor Methoprene-tolerant (Met), which is the JH receptor. The hormone-receptor complex induces the expression of Krüppel-homolog 1 (Kr-h1), the transducer of the anti-metamorphic signal of JH. This anti-metamorphic action is exerted by repressing E93, a transcription factor that triggers metamorphosis. Thus, when JH drops, Kr-h1 expression decreases, E93 becomes de-repressed, and metamorphosis proceeds.

Marianne ELIAS
CNRS, *Muséum National d'Histoire Naturelle,* France

Marianne Elias is an evolutionary biologist with a strong interest in adaptations and diversification of tropical insects. She combines microevolutionary, macroevolutionary, community ecology and behavioral approaches and works in collaboration with physicists and chemists to unravel the ecological drivers of species assemblages and diversification of tropical butterflies.

Évolution de l'aposématisme et du mimétisme ches les papillons : causes, conséquences et paradoxes

Evolution of aposematism and mimicry in butterflies: causes, consequences and paradoxes

Insects have evolved a large panel of anti-predator adaptations. While deceptive adaptations such as camouflage and masquerade rest on avoiding detection by predators, aposematism relies on advertising chemical defenses with conspicuous warning signals. Because the efficiency of a warning signal increases with its own local abundance, multiple aposematic prey exposed to the same predators benefit from converging on the same warning signal, a phenomenon called Müllerian mimicry. Here, I will review recent genetic and ecological results on two well-studied groups of neotropical Müllerian mimetic butterflies that advance our knowledge on the proximal and ultimate drivers of mimicry, and on the evolutionary and ecological consequences of mimicry in terms of speciation, genetic architecture and ecological niche evolution. Finally, I will present recent results that help us understanding two apparent paradoxes: the embarrassing diversity of mimicry patterns despite strong selection from convergence, and the evolution of transparent wing patterns in aposematic butterflies, where conspicuous signals are supposed to be favored.

Laurent KELLER
Lausanne University, Switzerland

Laurent Keller is professor of evolutionary biology at the University of Lausanne. He uses ants as a model organism to study the principles governing the origin and evolution of animal societies. He has also been using experimental evolution with robots to study the evolution of altruism and communication. He has published more than 300 scientific articles, several books and has been awarded several prizes, including the Latsis national prize, the EO Wilson Naturalist award and the Marcel Benoist Prize.

Supergène, sexe and sociabilité

Supergene, sex and sociality

Intraspecific variability in social organization is common, yet the underlying causes are rarely known. I will show that the existence of two divergent forms of social organization in six ant species is under the control of a pair of heteromorphic chromosomes that have many of the key properties of sex chromosomes. In particular, this social chromosome contains a large (13 megabases) region in which recombination is completely suppressed via 3 large inversions. These findings highlight how genomic rearrangements can maintain divergent adaptive social phenotypes involving many genes acting together by locally limiting recombination.

Pascal JOUQUET

IRD, France

Pascal Jouquet is soil ecologist at the Institute of Research for Development (IRD) and head of the team "Ecological Functioning of Tropical and Temperate Soils" at the Institute of Ecology and Environmental Sciences in Paris. His research focuses on the ecosystem services provided by soil biodiversity, and especially on the ecological impacts of termites on soil, water dynamics and plant growth and diversity. His research has mainly been carried out in tropical countries in *Côte d'Ivoire*, Vietnam and India, where he spent about 10 years.

Les termites : des ingénieurs du sol pour l'ingénierie écologique

Termites: soil engineers for ecological engineering

This communication assesses advances in our knowledge of the beneficial influences of termites on ecosystem functioning and services. Termites are amongst the main macroinvertebrate decomposers in arid and semi-arid environments, and exert additional impacts through the creation of biostructures (mounds, galleries, sheetings, etc.) with different soil physical and chemical properties. Termite impacts on soil properties and water dynamics can be differentiated at four different scales: (i) at the landscape scale, where termites act as heterogeneity drivers; (ii) at the soil profile scale, where termites act as soil bioturbators; (iii) at the aggregate scale, where they act as aggregate reorganizers; (iv) and last, at the clay mineral scale, where they can act as weathering agents. Last, recent literature on termite engineering is discussed and new research topics that could contribute to improved knowledge of the impact of termites on soil properties and water dynamics are discussed.

Vincent DOUBLET

University of Edinburgh, United-Kingdom

After completing his PhD at the University of Poitiers, Vincent Doublet studied host-pathogen interactions in honeybees at the University of Halle-Wittenberg, with a focus on the epidemiology of emerging diseases in the context of bee decline. Vincent Doublet then moved to the University of Exeter for a second postdoc, where he combined field surveys and deep sequencing to identify the ecological factors influencing disease transmission in insect pollinators. He has been recently awarded a Marie-Curie fellowship to test new hypotheses for disease transmission using fruit flies, at the University of Edinburgh.

Utilisation des réseaux de contacts et du séquençage de nouvelle génération pour l'épidémiologie de la vie sauvage

Using contact networks and next-gen sequencing for wildlife epidemiology

Horizontal transmission of infectious diseases is determined by the hosts' contact networks, but environmental variables that define the probability of contacts between individuals have been largely neglected in models studying epidemiology of wildlife diseases. Here, we use insect pollinators to study the role of contact networks in a real-life multi-host pathogen community. We constructed high-resolution plant-insect visitor networks from ten farms in Southern England and sampled the most abundant pollinators to characterize their virome by deep transcriptome sequencing. We found that flower density and diversity strongly define pollinator density and foraging behaviour, and influence the structure of contact networks among pollinators. We combined environmental data and sequencing to reveal the impact of plant-pollinator interactions on virus dynamics in insects. Overall, we aim to identify ecological factors that significantly enhance the transmission of plant and pollinator diseases, to improve conservation programs with the ultimate aim of securing pollination as an ecosystem service.

Angela E. DOUGLAS
Cornell University, United States of America

Angela E Douglas is the Daljit S. and Elaine Sarkaria Professor of Insect Physiology and Toxicology at Cornell University, USA. She was previously a faculty member at the University of York, UK, where she held a personal Chair, and has held research positions as a Royal Society University Research Fellow and BBSRC Research development Fellow. She has BA (Oxon) in zoology and PhD (Aberdeen) in microbiology. She is the author of more than 250 refereed publications, including 40 review articles and 5 scholarly books.

Usines à nutriment microbien chez les insectes à régime alimentaire extrême
Microbial nutrient factories in insects on extreme diets

Insects are renowned for their capacity to specialize on a wide diversity of diets, many of which are nutrient-poor or nutritionally unbalanced. For example, various insects feed through the life cycle on wood, vertebrate blood, plant sap and other extreme diets that are variously deficient in vitamins, sterols and essential amino acids. These insects circumvent the fundamental "rules" of animal nutrition because they possess symbiotic microorganisms that overproduce the limiting dietary nutrients. Many associations between insects and microorganisms are evolutionarily ancient and involve the exquisite coevolution of metabolic function in the insect and microbial partners, including the restructuring of microbial metabolism as nutrient factories for the host. These insects include major pests and vectors of animal, human and crop disease agents. Their dependence on specific microorganisms offers novel routes for the control of these globally important insect pests.

Jean-Luc IMLER
Strasbourg University, France

Jean-Luc Imler is professor of cell biology at the University of Strasbourg and director of the CNRS research unit Insect Models of Innate Immunity (M3i) at the Institute of Molecular and Cell Biology. A longtime co-worker of Jules Hoffmann, he is working on innate immunity using the fruit fly *Drosophila melanogaster* as a model. Over the past 15 years, his group has focused on antiviral immunity, establishing that it involves both RNA interference and evolutionarily conserved induced responses. He has recently started to investigate antiviral immunity in vector mosquitoes.

Le réservoir de diversité des insectes pour les virus et mécanismes antiviraux
The insect reservoir of diversity for viruses and antiviral mechanisms

Innate immunity is the first line of host defense, which operates in all animals to control infections. It involves receptors that sense infection and regulates the expression of hundreds of genes encoding antimicrobial effectors and cytokines, which concur to control the proliferation and dissemination of infectious agents. Like all living organisms, insects are continually exposed to viruses and have developed efficient antiviral defense mechanisms. RNA interference, in particular the small interfering (si) RNA pathway, represents a major antiviral defense in insects. In addition, complex inducible responses and restriction factors contribute to the control of infections. Some of the genes involved in these pathways have been conserved through evolution, highlighting loci that may account for susceptibility to viral infections in humans. Other genes are not conserved and represent evolutionary novelties. The characterization of the latter genes may provide hints for the design of original, insect-based, antiviral strategies.

Kris WYCKHUYS

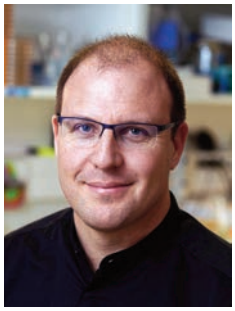
China Academy of agricultural sciences, China

Kris A.G. Wyckhuys is a Belgian bio-science engineer and insect ecologist (PhD, 2005, Purdue), and currently is Honorary Associate Professor at University of Queensland (Australia), Guest Professor at China Academy of Agricultural Sciences CAAS, and Jinshan Scholar at Fujian Agricultural and Forestry University (China). He has worked on arthropod biological control in a wide range of cropping systems in Europe, the Americas, and tropical Asia. Kris Wyckhuys has 75 peer-reviewed international publications on agro-ecology and biological control, and also runs a private consulting firm Chrysalis.

Le contrôle biologique de la cochenille du manioc fournit de multiples avantages pour la société

Cassava mealybug biological control delivers multi-faceted societal benefits

As core component of sustainable intensification, biological control constitutes a tailor-made solution for the long-term management of both endemic and invasive pests. Here, drawing upon the example of the cassava mealybug (Phenacoccus manihoti; Hemiptera), we illuminate the myriad benefits of insect biological control. In 2008, the above mealybug invaded Asia, where it inflicted a 27% drop in aggregate cassava production and triggered a 260% surge in starch prices. Mealybug-induced shocks in Thailand's cassava output were offset by a 300,000 ha expansion of the agricultural frontier - accompanied with major loss of intact tropical forest. Mealybug outbreaks were permanently resolved through the release of the neotropical wasp *Anagyrus lopezi* (Hymenoptera). This minute parasitoid effectively suppressed *P. manihoti* at a continent-wide scale, restored food security, and delivered pest control services worth US$200-700/ha. This same parasitic wasp had previously averted famine for ~ 20 million people in Africa. Our work emphasizes how beneficial (pest-controlling) insects help meet food production needs while benefiting farmers' pockets, global commodity trade and the environment.



François LEULIER

University of Lyon, France

François Leulier is a geneticist by training. He obtains in 2003 his Ph D under the supervision of Pr. Bruno Lemaitre at the CNRS *Centre de Génétique Moléculaire* in Gif-sur-Yvette where he studies the genetic basis of host resistance mechanisms to bacterial infections using Drosophila as a model host. In 2011, he showed that intestinal *Lactobacilli* promote juvenile systemic growth in Drosophila and he is appointed by the FINOVI foundation in summer 2012 to set up a research group at the *Institut de Génomique Fonctionnelle de Lyon* (IGFL) at the ENS-Lyon to develop his research on deciphering the mechanisms underlying the beneficial properties of intestinal *Lactobacilli* on their host biology using drosophila and mice as host models. Since then the Leulier lab at IGFL is developing research programs in bacteriology and animal physiology and nutrition to decipher the functional interplays between the intestinal microbiota, lactobacillus strains and chronic undernutrition and their influence on juvenile growth dynamics.

Insectes et leurs partenaires microbiens : le cas d'étude de la drosophile

Insects and their microbial partners: the Drosophila case study

Metazoans establish reciprocal interactions with their commensal bacterial communities. Despite recent progress, a clear view of the physiological benefits associated with host/microbiota relationship remains elusive. Hence the molecular mechanisms through which the microbiota exerts its beneficial influences are still largely undefined. In this line, we aim at deciphering the molecular dialogue governing the mutualistic interaction between intestinal bacteria and their host. To this end, we are using a genetically tractable gnotobiotic animal model: *Drosophila melanogaster,* which is mono-associated to one of its natural dominant commensal, *Lactobacillus plantarum*. We are developing multiscale functional approaches to identify the mechanisms that underlie their mutualistic relationship, which results in the promotion of host juvenile growth upon chronic undernutrition. Our approaches aim at identifying both the bacterial and host genetic networks required to sustain their mutualistic relationship.

Ian Thomas BALDWIN
Max Planck Institute for Chemical Ecology, Germany

Ian T. Baldwin received a Bachelor of Arts from Dartmouth College (1981), his PhD from Cornell University (1989), rose through the academic ranks at the SUNY at Buffalo and in1996 became the founding director of the Max Planck Institute for Chemical Ecology in Jena Germany, where he heads the Department of Molecular Ecology. He is a member of the National Academy of Sciences, European Molecular Biology Organization EMBO, *Nationale Akademie der Wissenschaften Leopoldina*, amongst others. He has published more than 500 peer-reviewed papers and one book on the induced defenses of plants, and has been a leader in the OA publication movement.

Ce que nous ont appris 5 insectes sur la manière dont une plante native fait face à des problèmes du monde réel

What 5 insects told us about how a native plant copes with real-world problems

Five native insects have taught us about traits that are essential for the survival of a native tobacco plant, *Nicotiana attenuata*, that lives in the Great Basin Desert of the USA. The 5 insects come from different feeding guilds, attack different tissues at different developmental stages and have revealed different traits that are essential for plant survival. For example, this plant recognizes attack from a specialized Lepidopteran herbivore (*Manduca sexta*) by the particular chemistry of the herbivore's saliva, and uses this recognition to tailor a complicated 6-layered defense response that requires a remodeling of the plant's transcriptome, metabolome and proteome, as well as some of its life history traits. The plant traits revealed by the remaining 4 insects will be described in the talk, and how these insects are being used as high-through-put screening tools for large plantations of transformed and recombinant inbred lines of this native plant, to reveal the function of genes required for survival in nature. Insects are some of the best plant biologists on our planet and it behooves plant biologists to rediscover the lost art of natural history discovery.

Marylène POIRIÉ
Sophia Agrobiotech Institute, France

Professor of Genetics and Evolutionary Genetics, Marylène Poirié is the former co-Head of the Sophia Agrobiotech Institute (2012-2017), and currently Principal Investigator of the team "Evolution and Specificity of Multitrophic Interactions". Her research focuses on the molecular bases and evolution of insect host - parasitoid wasp interactions, in particular the immune defenses of insects (Drosophila, aphids) against parasitoids and the evolution of the composition of the venom of parasitoids in link with their success and specificity. The context is biological control improvement and biocontrol.

Évolution et spécificité des interactions insecte hôte-guêpe endoparasitoïde : implications pour le contrôle biologique

Evolution and specify of insect host - endoparasitoid wasp interactions: implications for biological control

Endoparasitoid wasps oviposit in the body of their host and develop by consuming their tissues, resulting in death. This makes them regulators of insect populations, especially crop pests. Oviposition triggers the immune response of the host which can lead to the formation of a melanized capsule around the egg and the failure of parasitism. In turn, parasitoids have evolved strategies to circumvent these defences including the "domestication" of viruses allowing them to directly produce or transfer virulence factors into the parasitized host. However, most wasps succeed thanks to the injection of venom components, mainly proteins but also, in Leptopilina species, vesicles with very original biogenesis. I will discuss the variability of the immune response of Drosophila species to parasitism and that of virulence factors of parasitoids, as well as their role. Data evidencing the potential for rapid evolution of venom composition depending on the host species or the temperature and those concerning the bases of host specificity of parasitoids - especially the role of the venom vesicles - will be discussed in a context of biological control and climate change.

Luciano MOREIRA

Fiocruz Institute, Brazil

Luciano Moreira focuses his research on vector mosquitoes. In 2002, he got a permanent position at *Fundação Oswaldo Cruz* (Fiocruz), in Brazil, and started working with transgenic mosquitoes, bird malaria and some aspects of neotropical Anopheline mosquitoes. In 2008, he joined Scott O'Neil's laboratory, for a sabbatical, at the University of Queensland, Australia. There, they discovered the ability of *Wolbachia* to block dengue virus in *Aedes* mosquitoes, promoting the creation the «Eliminate Dengue: our Challenge» and now «World Mosquito Program». In Brazil, he is the Leading Scientist for the WMP Program, working today in several localities in the state of Rio de Janeiro. His group discovered the ability of *Wolbachia* to block Zika virus and, more recently, to Mayaro virus.

Quand une bactérie lutte contre les arbovirus

When a bacterium fights Arboviruses

Arboviruses such as dengue, chikungunya and Zika impose serious burden towards public health in tropical regions of the world and more recently have widely spread in the Americas. A new control strategy is being tested in several countries and involves an arthropod endosymbiont called *Wolbachia* (www.worldmosquito.org). When stably introduced into *A. aegypti*, *Wolbachia* is able to block several arboviruses in these mosquitoes. Here we will discuss the expansion of the WMP activities in Brazil in order to check the impact towards these diseases. Details on the several steps (community engagement, communication, mosquito production, releases and epidemiological analysis) will be discussed. This strategy has the potential to significantly reduce the burden of arboviruses, such as dengue, chikungunya and Zika in Brazil and in other endemic countries and is perfectly complementary to current control methods, including vaccines.

Olivier DANGLES

IRD, France

Olivier Dangles is a director of investigations in ecology, agriculture and development at the French research institute for sustainable Development (IRD, UMR CEFE, Montpellier). He is co-director of a Joint International Laboratory on Biodiversity and Agriculture shared between France, Colombia and Ecuador. His research focuses on the effect of global changes on biodiversity, in particular insects, both in agricultural and natural ecosystems. He has been working for more than 12 years in the tropical Andes and has published more than 125 peer-reviewed articles and five books.

Les services écosystémiques fournis par les insectes pour atteindre des objectifs de développement durable

Ecosystem services provided by insects for achieving sustainable developmental goals

Ecosystem services underpin all dimensions of human wellbeing. As a consequence it is crucial to integrate ecosystem services into strategies for achieving Sustainable Development Goals (SDGs). Because insects and other invertebrates have profound and well-identified influences on many ecosystems services (e.g. pollination and biological control) and SDGs (e.g. crop pest and disease vectors), insect research and development have a great potential to address current global challenges. We argue that time is ripe to put more efforts in developing integrated research on the ecosystem services provided by insects, as they may result in solutions to achieve many SDGs. We provide evidence of insects' utility to address global challenges and propose a framework of the needed shift in the perception of insects from enemies and allies, providers of ecosystem services, to solutions to achieve SDGs. We further advocate that making a place for SDG-relevant research on insects' ecosystem services requires transforming existing academic knowledge into applications-driven science, a potential up-scaling of local solutions and socio-economic relevance.

Elena LEVASHINA
Max Planck Institut for Infection Biology, Germany

Elena Levashina received her Ph.D. in Plant Genetics from the University of Saint-Petersburg, Russia. Her research background includes studies on Drosophila immunity at the IBMC, Strasbourg, France, and on Anopheles immunity at the EMBL, Heidelberg, Germany. She is currently leading the Vector Biology Unit at the Max Planck Institute for Infection Biology in Berlin, Germany. Her work has contributed greatly to the understanding of vector immune responses to malaria parasites.

Doit-on éliminer les moustiques pour éradiquer la malaria ?
Do we have to get rid of mosquitoes to eliminate malaria?

Malaria is a local disease with global impact. The fitness of vector-borne Plasmodium parasites, the causative agents of malaria, is closely linked to the ecology and evolution of its mosquito vector. Ongoing adaptive radiation and introgression diversify mosquito populations in Africa. However, whether the genetic structure of vector populations impacts malaria transmission remains unknown. In my talk, I will discuss new approaches that gauge the contribution of mosquito species to Plasmodium abundance in nature with a particular focus on time-series analyses in the context of population genetics and epidemiology. I will present the data that highlight the importance of focusing vector control strategies on mosquito species that drive malaria dynamics. Extending such studies to other key components of vectorial capacity and epidemiological and parasitological surveys should ultimately identify patterns, tipping points and general laws that describe dynamics, emergence, and resurgence of mosquito-borne diseases.

Anna-Bella FAILLOUX
Institut Pasteur, France

Anna-Bella Failloux, PhD, is a medical entomologist and chief of the unit "Arboviruses and Insect Vectors" at the *Institut Pasteur* in Paris. Her work mainly focuses on investigations of arbovirus–mosquito interactions in order to decipher the factors leading to the viral emergence.
Anna-Bella Failloux earned her Ph.D. in Ecology/Entomology from Orsay University (Paris XI). She performed Postdoctoral Research training at the Institut Pasteur where she obtained a full position as research assistant. She has an extended expertise on vectors of alphaviruses, flaviviruses and phleboviruses. She participates actively in teaching medical entomology as co-director of a course and a MOOC.

Activités humaines et changement climatique dans l'émergence de maladies à transmission vectorielle
Human activities and climate change in the emergence of vector-borne diseases

Because of human population expansion and activities, arthropod-borne viruses (arboviruses) have increased in importance during these last decades. Zoonotic in nature, arboviruses escaped from an enzootic cycle to affect the health of millions of people via spillover transmission from animals to humans. Dengue, chikungunya, zika, and yellow fever mainly use humans as amplification hosts. Extensive urbanization combined with increased commerce and travel give rise to the mosquitoes *Aedes aegypti* and *Aedes albopictus*, both highly adapted to the human environment. The high densities of these human-biting mosquitoes which proliferate in highly populated cities made the bed to explosive outbreaks of arboviral diseases. As insects are ectothermic organisms, climate change may affect the geographical distribution of vectors with consequences on the transmission of arboviruses. All these aspects will be discussed through several examples.

Catherine GOLSTEIN

Haut Conseil des biotechnologies, France

Catherine Golstein was trained as an agricultural engineer (ENSAR, Rennes) and obtained a Ph.D. in biology (University East Anglia, Norwich, UK). As a research scientist at The Sainsbury Laboratory (Norwich, UK), then at Indiana University (Bloomington, USA), she explored the molecular mechanisms of plant disease resistance. She then engaged in scientific management of a non-profit international platform and in the INRA Foresight Unit on the Technologies of the Future project. She currently works at the High Council for Biotechnology (HCB, Paris) as senior scientific and European affairs officer.

Intérêts et limites des techniques émergentes de lutte antivectorielle contre les moustiques
Benefits and limitations of emerging techniques for mosquito vector control

In response to a broad governmental referral, the French High Council for Biotechnology has published an opinion on the use of genetically modified (GM) mosquitoes for vector control. To date, only one GM mosquito-based technique has been developed to an operational level, Oxitec's RIDL technique, which seeks to reduce a mosquito population by repeated mass releases of sterilising transgenic males. Two other techniques under development rely on CRISPR-based gene drive, seeking to spread a genetic trait in a wild population, either to eliminate the population by spreading sterility or to make the target mosquitoes incapable of transmitting pathogens.

To identify the specific benefits and limitations of the different GM mosquito-based techniques, a cross-analysis of different vector control techniques was conducted with respect to possible objectives, efficacy and sustainability, technical constraints and risks to health and the environment. Consideration was given to both existing techniques (chemical, biological, physical and environmental) and emerging techniques based on release of mosquitoes, whether GM (RIDL and the different gene drive techniques) or non-GM – irradiated (standard sterile insect technique (SIT)) or carrying Wolbachia (incompatible insect technique (IIT) and spread of pathogen interference (PI) technique). Key results will be highlighted.

Rod DILLON

Lancaster University, United Kingdom

Rod Dillon has spent over 30 years researching the intersection between insects and microbes. His early work with germ free locusts uncovered evidence of the benefits of the gut microbiota towards the insect host. This focus on multitrophic interactions continued with investigations on sandfly-Leishmania interactions. Rod has wide ranging creative practice on biomedically focused projects with partners within and outside universities, in UK, W. Africa and S. America. Rod Dillon has also worked at University of Bath, London School of Tropical Medicine, Natural History Museum London and Liverpool School of Tropical Medicine.

Considération transdisciplinaire des mouches de sable et de la leishmaniose
A transdisciplinary consideration of sand flies & leishmaniasis

It has been a hundred years since sand flies were first identified as the transmitters of the medically important parasites called *Leishmania*. During the first sixty years the key players investigated in this transmission process were confined to the insect-parasite-host (human or animal). Forty years ago, plants were included as potentially influential players in the transmission process. During the past 10 years we have seen an expansion to include bacteria and viruses influencing transmission and the realisation of a fascinating network of interactions with surprising consequences for the control of the leishmaniases.

This talk will focus on the recent inclusion of the bacterial players in the sand fly- *Leishmania* drama. It will also be a personal reflection on the urgent need for entomologists to continue their creative endeavours and to harness some of their creativity to engage with policy makers and the public about what insects can teach us and the importance of insects in a human centred world.

Philippe BASTIN
Institut Pasteur, France

Philippe Bastin is currently an Inserm (Biomedical research institute) Director of Research heading a research group at the *Institut Pasteur* in Paris. He devoted most of his career to the study of African trypanosomes. He did a doctoral thesis on an invariant cell surface antigen as vaccine candidate at the UCL (Brussels) under the supervision of Pierre Courtoy and Fred Opperdoes. He next moved to the lab of Keith Gull at the University of Manchester where he investigated assembly of a unique cytoskeletal structure called the paraflagellar rod. He also came across (accidentally) the first RNAi mutant in trypanosomes. He set up his own research group at the *Muséum National d'Histoire Naturelle* (Paris) and discovered the role of the flagellum in trypanosome morphogenesis. In 2005, he moved to the *Institut Pasteur* to lead the Trypanosome Cell Biology Unit. His work deals with flagellum function and assembly in trypanosomes, using advanced imaging and functional genomics.

Le voyage du trypanosome dans la mouche tsé-tsé
The trypanosome journey in the tsetse fly

Trypanosoma brucei is a flagellated parasite responsible for sleeping sickness in central Africa. It is transmitted from one host to another via the bite of the tsetse fly (*Glossina* genus), which is the major mode of contamination. The tsetse fly (males and females) feeds exclusively on blood and exhibits unique features such as viviparous reproduction and lactation. It should be considered as a real host for trypanosomes since the parasites differentiate and proliferate in several fly tissues such as the gut, the proventriculus and the salivary glands. Trypanosomes adapt to these various environments by modifications in their cell surface composition, metabolism and morphogenesis. One of the most prominent characteristics of trypanosomes is the presence of a flagellum that is attached to the cell body and drives parasite movement, but also dictates cell morphology. Its length varies according to the life cycle stage, ranging from 3 to 30 µm. This organelle is essential for parasite survival. This talk will discuss the different aspects of trypanosome development in the tsetse fly, with special focus on flagellum assembly and function.

Marcel DICKE
Wageningen University & Research, Netherlands

Marcel Dicke's research focusses on the ecology of insect-plant interactions and ecosystem services of insects, including their opportunities for food and feed. He received the Rank Prize for Nutrition (2006, London) and the Spinoza award (also known as Dutch Nobel Prize, 2007). His team organised the festival Wageningen, City of Insects that attracted more than 20,000 visitors. He is one of the authors of The Insect Cookbook (2014), and organised the international conference Insects to Feed the World (2014). His TED talk "Why not eat insects?" can be accessed at www.ted.com.

Insectes au menu
Insects for nutrition

Insects are nutritious food for a wide variety of animals ranging from insects to chimpanzees. They are high in protein, contain polyunsaturated fatty acids and high levels of minerals such as iron and zinc. Moreover, insects have been on the menu of humans throughout our evolutionary history and to date ca 2 billion people eat insects on a regular basis. To feed the world in 2050 is a major challenge that cannot be solved by simply enhancing food production. We need innovative solutions that are compatible with solving other challenges such as climate change and mitigating biodiversity loss. The majority of our agricultural land is currently used for livestock production. Per unit output insects require much less land than livestock. The production of insects as mini-livestock for food has a much lower ecological footprint than the production of common livestock. Thus, insects can provide a valuable contribution to sustainably feed the world. In 2029 we may wonder why we did not yet eat insects in Europe in 2019.

Antoine HUBERT

Ÿnsects, France

Antoine Hubert is Ÿnsect's Chairman and CEO. He also leads the cooperative insect industry association, the International Platform of Insects for Food and Feed (IPIFF) and is Board Member of Agrocampus Ouest, Agriloops and LFD. Prior to co-founding Ÿnsect, a leading global provider of sustainable, premium nutrition for all by tapping the natural goodness of insects at large scale, Antoine Hubert worked on scientific projects in environmental risk assessment, biomass and plastics recycling. He is an agronomy engineer graduate from *AgroCampus-Ouest* and *AgroParisTech*. He co-founded NPO WORGAMIC and the company ORGANEO.

La production industrielle d'insectes comme source alternative de protéines animales
Industrial insects production as an alternative source of animal protein

By 2050, the World Resources Institute projects a 70% human food calorie gap. The race for sustainable protein alternatives is heating up; livestock consume 20% of global proteins – in direct competition with human consumption for dwindling fish stock, water, land, and soil resources. To avoid global issues, the world needs massive productivity increases in protein production. The FAO expects insect protein could help close the gap. The European insect sector is an emerging industry which concentrates most research and innovation efforts that are invested into the sector worldwide. Legislative decisions taken by EU policy makers constituted decisive factors which contributed to boost the advancement of the sector.

This presentation will be about the state of art of insect production in EU and beyond, and will focus on major issues of the insect industry.

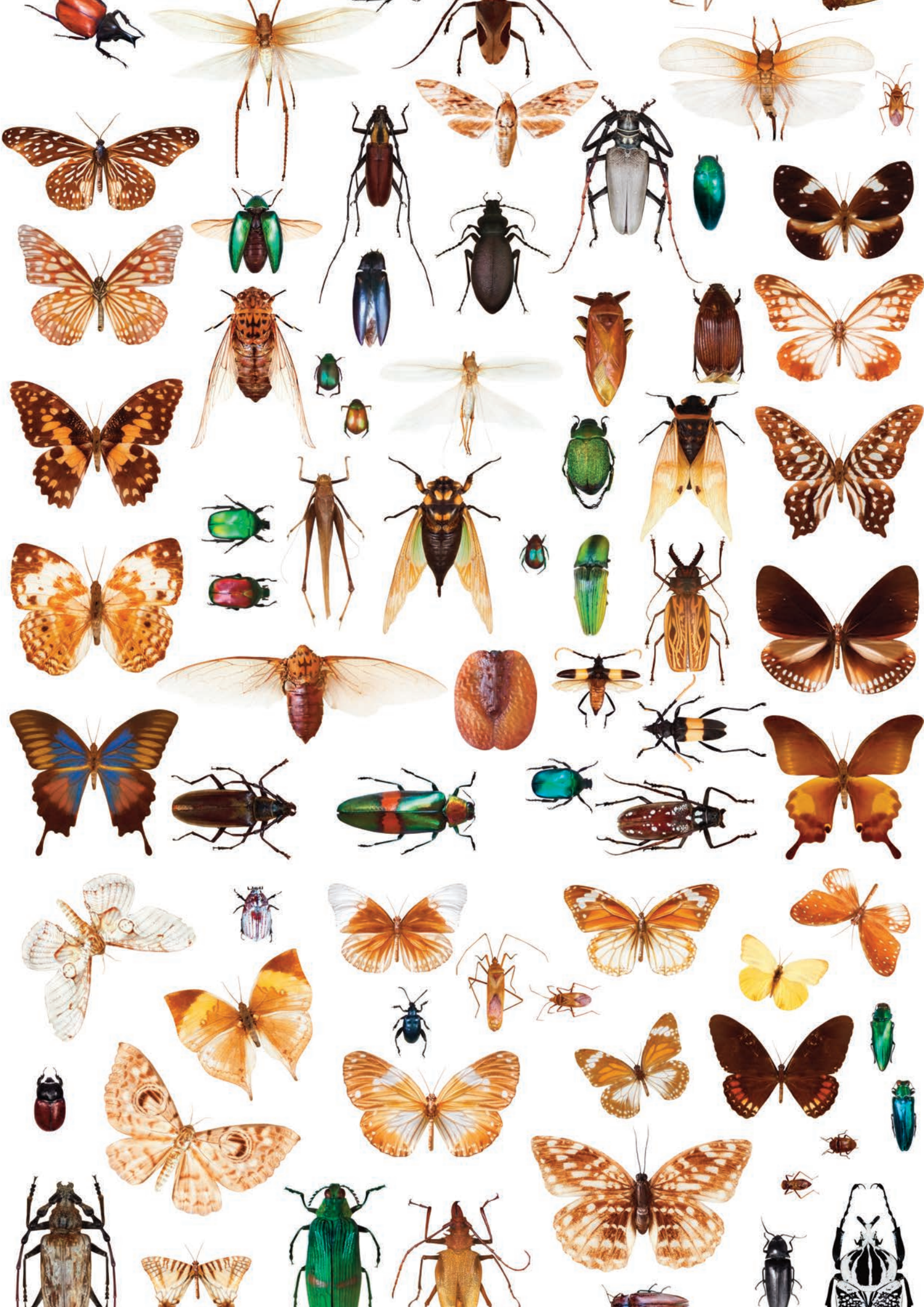
Joan VAN BAAREN

Rennes University, France

Joan van Baaren is professor at the University of Rennes since 2012. She is currently heading up the UMR-CNRS ECOBIO, Ecosystems, Biodiversity, Evolution, a multi-disciplinary unit in ecology, with around 100 permanent members, whose unifying focus is the biodiversity of continental and island ecosystems, from the molecule to the eco-system level. Her research concerns insect behaviour such as decision-making and learning, insect life-history traits evolution and insect communities, all in the context of both Global Changes (climate and landscape use) and Conservation Biological Control.

L'impact du climat dans les stratégies hivernales des insectes
The impact of climate on the winter strategies of insects

Life-history traits within ecological communities can be influenced by two opposite pressures, the first being community-wide density dependent processes like competition, and the second regional environmental conditions. While niche theory predicts that species of the same guild may present contrasting traits as a means of niche differentiation allowing species coexistence, convergent winter strategies could conversely be expected in insects of the same area, because ectotherm organisms depend strongly on temperatures. In temperate areas, insects can escape the stressful winter conditions either by (1) migration, (2) diapause (i.e. arrest of development) or (3) remaining in activity by producing cryoprotectant molecules. In the last 30 years, we observed a change in overwintering strategies of insects in cereal fields in western France, with fewer and fewer species entering diapause. This increase of winter activity has cascading consequences on community structure and ecosystem functioning. These consequences include an increasing competition between species, an increasing complexity of trophic web structures and modifications of the biocontrol ecosystem service.



INSTITUT DE FRANCE
Académie des sciences

Insects today make up to 80% of animal species on earth and have a significant impact on our world. As vectors of disease they are responsible for more deaths each year than those caused by armed conflict. As pollinators of our crops they play an essential role in the production of food. Insects also have key roles in the organic matter cycle and the maintenance of vertebrate populations. They have existed for at least 360 million years and were among the first animals to colonise terrestrial ecosystems. During the course of their evolution they have undergone significant expansion and diversification, marked by the development of specialised traits, e.g. flight and the ability to form complex societies. Insects such as Drosophila are now essential tools in laboratories and serve as key biological models which have led to major discoveries in genetics, behavior and immunology to name but a few. For all these reasons and the ongoing impact of environmental changes on their populations, insects are more than ever an important topic of research for our future. The *Académie des sciences* has decided to spread this message amongst the scientific community and the civil society by dedicating its first Grand Conference to this expanding subject.

Through presentations from internationally recognised experts, this conference will address the key topics of insect biology, from their interaction with the environment to their use in the biomedical and ecological research.

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