C_3E NEWSLETTER 2016

CENTRE OF COMPETENCE IN CHEMICAL ECOLOGY

UNIVERSITÉ DE NEUCHÂTEL

FACULTÉ DES SCIENCES

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Cover illustration

A slug *Arion spec.* just about to crawl over a group of first instar *Pieris brassicae* caterpillars. The associated new research project is presented on page 16. Photo credit Neil Villard.

IMPRESSUM

Centre of Competence in Chemical Ecology (C3E)
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CENTRE OF COMPETENCE IN CHEMICAL ECOLOGY

UNIVERSITÉ DE NEUCHÂTEL

A small university with an international presence


Ted Turlings


Felix Kessler


Stephan von Reuss

University rankings are usually dismissed until your own university is ranked high. This is suddenly the case for the University of Neuchâtel. Our tiny university was so far ignored, but recently it was picked up by *Times Higher Education* and we found ourselves at the respectable 11th position among small universities with fewer than 5000 students. More interesting, however, was the ranking in "international outlook", which listed us number 37 among *all* universities, right behind the University of Cambridge.

University rankings remain to be taken with a grain of salt. After all, most of the top-performing chemical ecologists did not necessarily receive their education from one of the so-called top universities. Still, we thankfully take this opportunity to use this high ranking of the University of Neuchâtel in international outlook to devote this newsletter to the global reach of C_3E. The center's international scope is not only evident from the fact that graduate students and postdocs from around the world come to Neuchâtel to take part in our research projects, but it is also reflected in the numerous collaborations, which involve groups throughout Europe, the Americas, Africa and Asia. Here we showcase some of these international players and their important role in our research efforts. The diversity of C_3E research is further evident from the various study organisms and research topics highlighted in this newsletter. The projects include organisms that range from microorganisms, plants, insects, slugs, fish to birds. The common denominator is the need to identify and quantify biologically active chemicals. For this virtually all research groups rely heavily on the Neuchâtel Platform for Analytical Chemistry (NPAC). This common need brings together the various research disciplines and further stimulates national and international collaborations.

Our Faculty of Science harbours junior and senior scientists from over 30 different nationalities. This not only creates an inspiring multicultural and multidisciplinary environment, but we are also coming to realize that these international interactions and collaborations at the scientific and educational level may be our only hope for a sustainable and peaceful future of our planet. Rational science-based approaches that acknowledge and appreciate the diverse and sometimes opposing interests of a global society are urgently needed to solve our common problems. Now more than ever, we as scientists will have to help push the agenda for worldwide peace and prosperity. On that rather dramatic note, we wish you happy holidays and all the best for a healthy, productive and peaceful 2017.

ORGANISATION 4

STEERING COMMITTEE

Ted Turlings (director C_3E) *fundamental and applied research in chemical ecology (FARCE)*
Felix Kessler (director NPAC) *plant physiology*
Reinhard Neier *organic chemistry* **(retired)**
Stephan von Reuss *bioanalytical chemistry* **(new)**

COORDINATION

Thomas Degen *chemical ecology*

NPAC

Gaétan Glauser *mass spectrometry and metabolomics unit*
Armelle Vallat *mass spectrometry and metabolomics unit*
Diego Carnevale *nuclear magnetic resonance unit* **(resigned in 2016)**
Sylvain Sutour *nuclear magnetic resonance unit* **(will start February 2017)**

PARTICIPANTS UNINE

Betty Benrey *evolutionary entomology*
Redouan Bshary *behavioural ecology*
Patrick Guerin *animal physiology*
Fabrice Helfenstein *evolutionary ecophysiology*
Edith Joseph *microbiology*
Pilar Junier *microbiology*
Brigitte Mauch-Mani *molecular and cell biology*
Sergio Rasmann *functional ecology*
Gregory Röder *chemical ecology* **(new)**

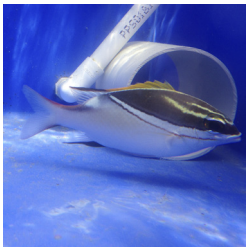
EXTERNAL PARTNERS

Consuelo De Moraes & Mark Mescher *ETH-Zürich*
Matthias Erb *University of Bern*
Ted Farmer *University of Lausanne*
Cris Kuhlemeier *University of Bern*
Jean-Pierre Métraux & Felix Mauch *University of Fribourg*
Heinz Müller-Schärer *University of Fribourg*
Philippe Reymond *University of Lausanne*
Urs Schaffner *CABI, Delemont, Switzerland*
Florian Schiestl *University of Zurich*
Jean-Luc Wolfender *University of Geneva*

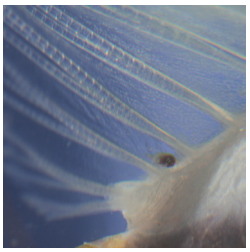
When something feels fishy – higher stress hormone levels with ectoparasitic infection

Zegni Triki

Redouan Bshary



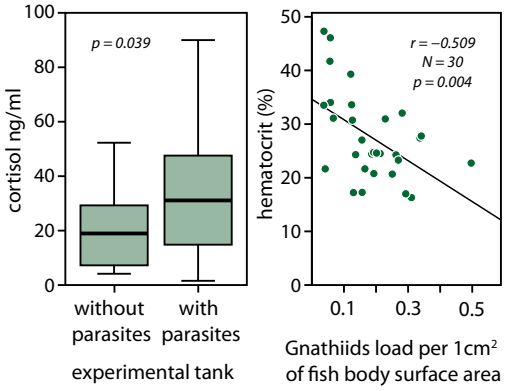
Scolopsis bilineatus



Gnathia aureamaculosa attached to *Scolopsis*

Mutualism, the cooperation between species, is the principal research topic of Redouan Bshary and his team at the laboratory of behavioural ecology. Moreover, they are interested in links between a game theoretic approach, animal cognition and behavioural endocrinology. After having studied veterinary science in Algeria, Zegni Triki joined Redouan Bshary's group in 2013 for her master thesis dealing with the mutualism between cleaner fish and other coral reef fish, which is the main model system of the lab. Concentrating on the part of the 'client' fish served by the cleaners, she conducted experiments in 2013 at Lizard Island Research Station, Australia. The results of this work are now published in *Marine Biology*. Since 2015 Zegni examines further aspects of the same mutualistic system for her doctoral thesis.

On coral reef systems, client fish defend themselves against ectoparasitic infections by engaging in frequent mutualistic interactions with various 'cleaner' organisms. It is known that clients can adjust their visits to cleaners according to their ectoparasite load. This ability raises the question of how clients may sense the presence of parasites. Physiological changes caused by the ectoparasitic infection, prior to engaging in cleaning interactions, might inform clients of their current need to visit cleaners. Hematocrit and cortisol levels appeared to be useful physiological indicators to study hematophagous parasitism. Therefore the authors tested whether these blood parameters vary with ectoparasitic infection. They exposed client fishes (*Scolopsis bilineatus*) in experimental tanks to hematophagous ectoparasite gnathiid isopods (*Gnathia aureamaculosa*) or a control situation without parasites for 30 min.



Left: Boxplots of median, interquartile, and ranges of **cortisol levels with and without parasite treatment**; **Right:** Scatterplot of the **relationship between parasite load and hematocrit percentage.**

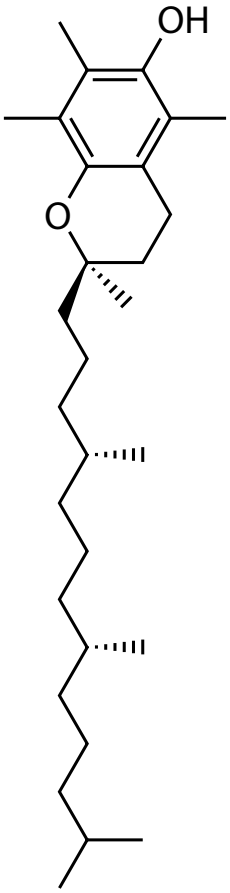
Then they collected fish blood and counted the gnathiids attached to the fish. The concentration of the stress hormone cortisol in the blood plasma was later quantified by HPLC-MS analysis at the Neuchâtel Platform of Analytical Chemistry.

Gnathiid-exposed fish had higher blood cortisol hormone levels compared with control fishes, which suggests that the presence of ectoparasites results in an acute stress hormone response. Hematocrit level, a correlate of blood loss, did not differ significantly between the treatments. However, within gnathiid-exposed fish hematocrit was negatively correlated with the density of attached gnathiids. Therefore, hematocrit could provide information to a fish about the gnathiid load. In conclusion, short-term exposure to an ectoparasite translates into several physiological changes, which provide possible proximate mechanisms underlying the client's decision whether to involve in interactions with cleaners or not.

Triki Z, Grutter AS, **Bshary R**, **Ros AFH** 2016. Effects of short-term exposure to ectoparasites on fish cortisol and hematocrit levels. ***Marine Biology*** 163: 187; DOI 10.1007/s00227-016-2959-y

Prenyllipids in tomato - how to protect the photosynthetic machinery against heat stress

Livia Spicher

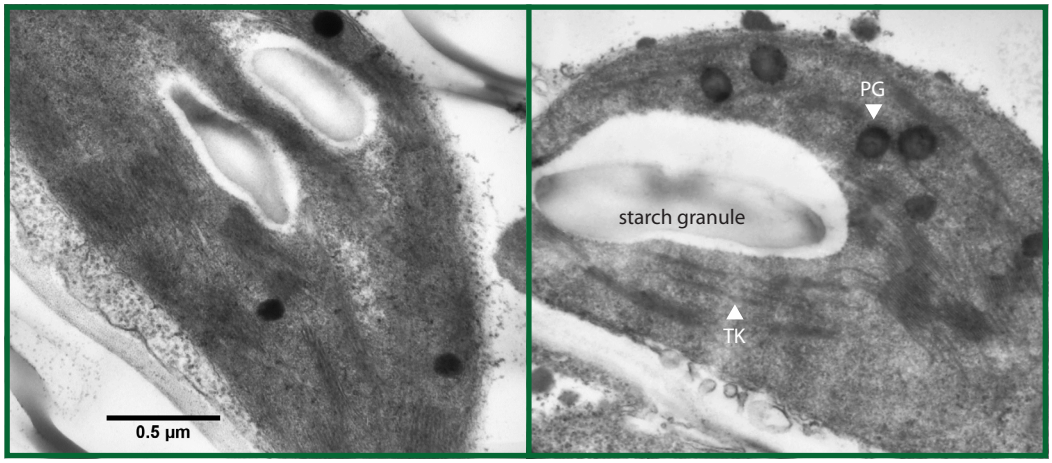


α-Tocopherol

One of the main research interests of the plant physiology laboratory of UniNE concerns the role of plastoglobules (PG) in the metabolism of chloroplasts and other plastids. Plastoglobules are lipoprotein particles, which besides being a storage place for nonpolar lipids are involved in the metabolism and trafficking of diverse lipid species, notably prenylquinones, potent antioxidants protecting membranes. Plastoglobules are often associated with thylakoid (TK) membranes, suggesting an exchange of lipids between both structures. Physiological factors such as senescence and environmental stress like high temperatures lead to an increase in plastoglobule size and number, a "visible" change illustrated by the transmission electron micrograph below on the right compared to the one on the left.

Livia Spicher, a PhD student of Brazilian origin, is finalizing her thesis under the supervision of Felix Kessler. She studied the role of prenylquinones in the protection of photosynthetic membranes against abiotic stresses in tomato. A part of her findings, issued from a close collaboration with Gaétan Glauser from the NPAC, has been published in *Frontiers in Plant Science*.

To function optimally, the photosynthetic apparatus at the thylakoid membrane must continuously adapt to altering conditions. The authors aimed at determining the most important changes arising at the lipid level under high temperature (38°C) in comparison to mild (20°C) and moderately cold temperature (10°C) using a non-targeted lipidomics approach, presumably an unprecedented experiment at the level of the whole membrane system. A total of 791 molecular species were detected by mass spectrometry. They ranged from membrane lipids, prenylquinones (e.g. tocopherols, phylloquinone, plastoquinone), and carotenoids (β-carotene, xanthophylls) to numerous unidentified compounds. At high temperatures, the most striking changes were observed in the degree of saturation of fatty acids in galactolipids and for the contents of the prenylquinones plastoquinone and α-tocopherol, a form of vitamin E. Photosynthetic efficiency at high temperature was not affected. The results indicate that under high temperature stress the thylakoid membrane is remodelled with respect to fatty acid saturation in galactolipids and lipid antioxidant concentrations. Moreover, the data strongly suggest that massively increased concentrations of α-tocopherol and plastoquinone are critical for protection against high temperature stress and proper function of the photosynthetic machinery.



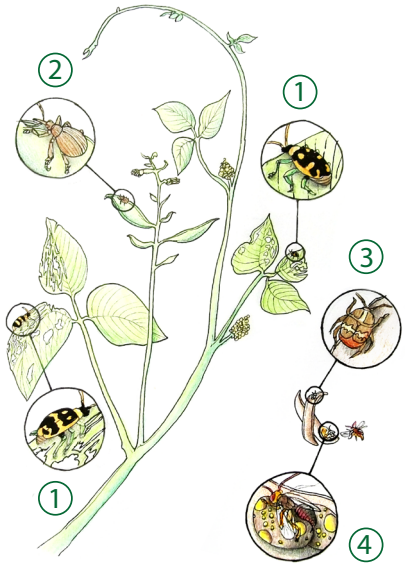
Spicher L, **Glauser G**, **Kessler F** 2016. Lipid antioxidant and galactolipid remodeling under temperature stress in tomato plants. ***Frontiers in Plant Science***: DOI: 10.3389/fpls.2016.00167

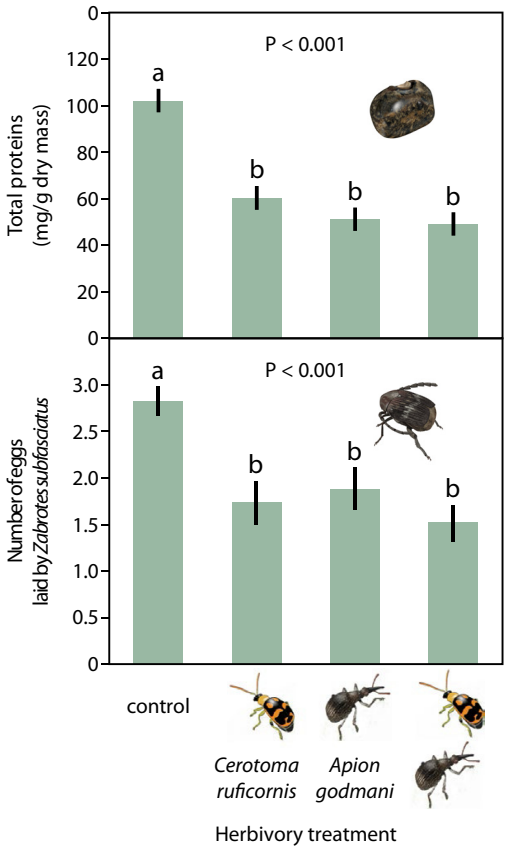
Mexico, bean there, done that!

Johnattan Hernandez

Betty Benrey

In early 2016, Johnattan Hernandez-Cumplido, a Mexican PhD student in Betty Benrey's lab, finished his thesis, which involved field work in Puerto Escondido, Mexico. He examined how early-season herbivory in lima bean *Phaseolus lunatus* by the leaf-chewing herbivore *Cerotoma ruficornis* (1) and the bean pod weevil *Apion godmani* (2) affects the abundance and performance of the seed beetle *Zabrotes subfasciatus* (3) as well as that of its parasitoid *Stenocorse bruchivora* (4), occurring on the plants at the end of the growing season. His findings are now published in *Ecology*.





Effects of early herbivory treatments on total proteins in the seeds of *Phaseolus lunatus* plants in two consecutive years (top) and on number of eggs laid by the seed herbivore *Zabrotes subfasciatus*, a Bruchid beetle, in a laboratory experiment (bottom).

The study found strong support for the hypotheses that plant defences induced by herbivory early in the season would affect plant reproduction and, hence, would alter the suitability of seeds for late-season seed-eating beetles, and that this would in turn alter the vulnerability of these seed beetles to parasitoids. In the field, early-season herbivory negatively influenced plant reproduction. Seeds of these plants were smaller, lighter, and had a lower concentration of cyanogenic glycosides and total protein content (left figure top) than those of control plants. Accordingly they suffered lower levels of infestation by seed-eating beetles, which in turn suffered less parasitism. In laboratory assays, beetles laid fewer eggs on field-collected seeds from plants that had been subjected to early-season herbivory (left figure bottom), and the emergence rate of parasitoids was lower. The reported results provide insight into how direct and indirect interactions between and within different trophic levels affect the dynamics and structure of complex communities.

Hernandez-Cumplido J, **Glauser G**, **Benrey B** 2016. Cascading effects of early-season herbivory on late-season herbivores and their parasitoids. ***Ecology*** 97: 1283–1297.

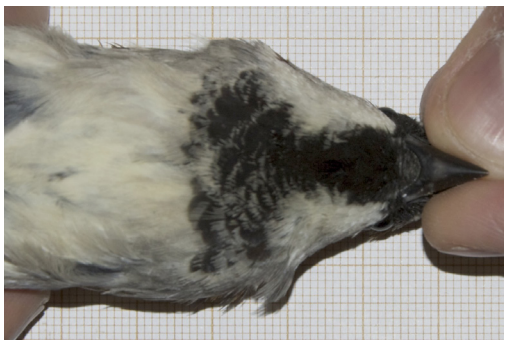
Sparrows who mimic peacocks are likely to break a thigh (Burmese Proverb)

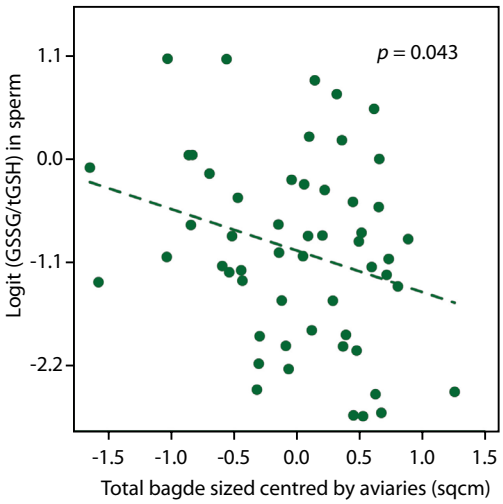
Alfonso Rojas Mora

Fabrice Helfenstein

It is a bit of a stretch from the actual subject of the paper presented here, but one could argue that the male sparrow's black throat badge is the humble equivalent of a peacock's tail. Amongst other questions the laboratory of evolutionary ecophysiology investigates the role of oxidative stress in the evolution of secondary sexual characters, and especially the evolution of colourful ornaments. Alfonso Rojas Mora, a Colombian biologist, joined Fabrice Helfenstein's team in 2012 to carry out a thesis on *Oxidative stress in postcopulatory sexual selection*. They reported a part of the thesis' findings in *Frontiers in Ecology and Evolution*. The team of the NPAC contributed the chemical analytical data.

The phenotype-linked fertility hypothesis proposes that male ornaments reflect male fertility. Male ornaments could honestly signal sperm quality due to the high susceptibility of sperm to free radicals on the one hand and the negative impact of oxidative stress on ornament elaboration on the other hand. Yet, in species where males experience differential access to fertile females, a trade-off emerges between investing into traits favouring mating opportunities (e.g., secondary sexual ornaments, social dominance, mate-guarding behaviours, etc.) or into traits favouring sperm competitive ability (e.g., sperm numbers and quality). When male sexual ornaments promote greater access to fertile females, a negative relationship can then be predicted between ornamentation and sperm quality. The authors tested the latter hypothesis and the phenotype-linked fertility hypothesis in wild House Sparrows *Passer domesticus* by exploring the relationships between sperm quality, melanin-based ornamentation, and redox status in blood and sperm. They found no correlation between badge size and sperm swimming performance. However, within a social group, large-badged males better protected their ejaculates from oxidative stress, and thus produced less oxidized ejaculates. Additionally, badge size did not reflect social dominance, and thus the protection of the ejaculate is independent of males' ability to monopolize resources. The results suggest that badge size might reflect male investment into the antioxidant protection of their sperm relative to a given social environment, and thus females may accrue both direct and indirect benefits by mating with large-badged males producing less oxidized ejaculates.





Correlation between the level of oxidative stress, i.e. the ratio of oxidized glutathione (GSSG) over total glutathione (tGSH) in sperm and the total badge size relative to the social group means.

Rojas Mora A, **Meniri M**, **Glauser G**, **Vallat A**, **Helfenstein F** 2016. Badge size reflects sperm oxidative status within social groups in the House Sparrow *Passer domesticus*. ***Frontiers in Ecology and Evolution*** 4 (DOI: 10.3389/fevo.2016.00067).

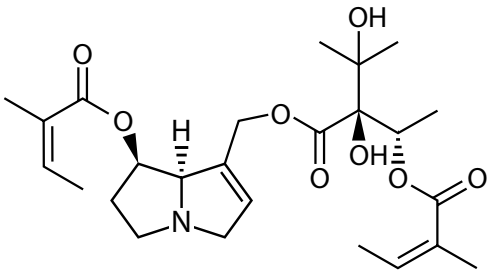
Honey, where did you get your pyrrolizidine alkaloids from?

Matteo Lucchetti

Christophe Praz

Matteo Lucchetti, an Italian food biotechnologist, is an external PhD student of UniNE working at the Swiss Bee Research Centre, Agroscope Liebefeld-Bern. He is currently finalizing his PhD thesis on the *occurrence of plant toxins in honey and pollen* under the supervision of Christophe Praz, a specialist of wild bees associated with the laboratory of evolutionary entomology, and Christina Kast at Agroscope. A chapter of the thesis has been published in an article that we portray here.

Pyrrolizidine alkaloids (PAs) in honey can be a potential human health risk. Viper's bugloss *Echium vulgare* is a plant rich in PAs, and its flowers are readily visited by honeybees. It was unclear whether PAs in honey originate from pollen or floral nectar. The authors quantified PA contents in honey, nectar and pollen obtained from two observation sites where *E. vulgare* was naturally abundant. Researchers of Quality Services International GmbH in Bremen, Germany, determined the amounts of PA in honey by targeted HPLC-MS/MS. Six different PAs and PA-N-oxides present in *E. vulgare* could be detected in concentration of up to 0.153 µg/g. Matteo Lucchetti and Gaétan Glauser of the NPAC analyzed nectar and pollen by nontargeted UHPLC-HR-MS, allowing the detection of 10 alkaloids in small size samples. The concentrations of *Echium*-type PAs ranged between 0.3–95.1 µg/g in nectar and 500–35000 µg/g in pollen. The PA composition in nectar and pollen was compared to the composition in honey. Echimidine (+N-oxide) was the main alkaloid detected in honey and nectar samples, while echivulgarine (+N-oxide) was the main PA found in pollen. These results suggest that nectar contributes more significantly to PA contamination in honey than pollen.



echivulgarine

Honeybee collecting pollen on *Echium vulgare* (© Entomologie/Botanik, ETH Zürich / Fotograf: Albert Krebs)

Lucchetti MA, **Glauser G**, Kilchenmann V, Dübecke A, Gudrun Beckh G, **Praz C**, Kast C 2016. Pyrrolizidine alkaloids from *Echium vulgare* in honey originate primarily from floral nectar. ***Journal of Agricultural and Food Chemistry*** 64: 5267–5273. (DOI: 10.1021/acs.jafc.6b02320)

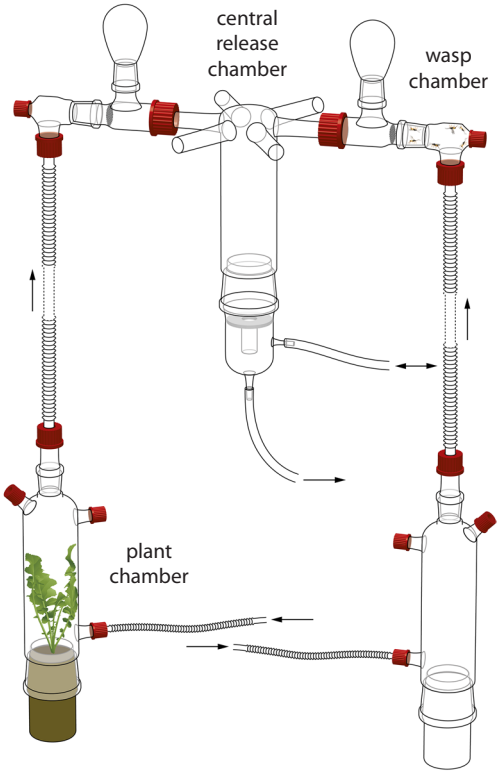
Rendezvous at the host's host plant

Hao Xu

Funded by a grant from the China Scholar Council, Hao Xu joined the research group of Ted Turlings in 2012 to conduct his PhD thesis on sexual pheromones in parasitoids. This year he published his second paper on the topic. He investigated the possibility that herbivore-induced plant volatiles (HIPVs), which are known to be important cues for female parasitic wasps to find hosts, may also serve parasitoids as cues to locate mates. The work was prompted by preliminary observations and the hypothesis that host-infested plants would be timesaving meeting points for these insects.

Hao Xu tested the odour preferences of four braconid wasps, the gregarious parasitoid *Cotesia glomerata* and the solitary parasitoids *Cotesia marginiventris, Microplitis rufiventris* and *Microplitis mediator*. In olfactometer assays, all four species showed attraction to pheromones, but each in a somewhat different way. Males of the two *Cotesia* species were attracted to virgin females, whereas females of *M. rufiventris* were attracted to virgin males. Males and females of *M. mediator* exhibited attraction to both sexes. Importantly, independent of mating status, females and males of all four species were strongly attracted by HIPVs emitted by seedlings of wild cabbage *Brassica rapa* or maize *Zea mays*, corresponding to the respective tritrophic system. In most cases, males were also attracted to intact plants, but not the females. The wasps preferred the combination of HIPVs and pheromones over plant odours alone, except *M. mediator,* which appears to mainly use HIPVs for mate location. The authors postulate that HIPVs due to their high volatility may serve as long-range cues in mate location by braconid wasps, while the pheromones are possibly working at a relatively close range and can be expected to be less volatile. This appears to be the first study to show that braconid parasitoids use HIPVs and pheromones in combination to locate mates.

Male and female *Cotesia glomerata* doing it on Chinese cabbage (Photo by Neil Villard).



Six-arm olfactometer used to test for the attractiveness of plant volatiles (left) and/or sex pheromones (right). Two complete arms are shown only.

Xu H, Desurmont G, Degen T, Zhou G, Laplanche D, Henryk L, **Turlings TCJ** 2016. Combined use of herbivore-induced plant volatiles and sex pheromones for mate location in braconid parasitoids. ***Plant, Cell and Environment***: DOI: 10.1111/pce.12818

Longtime underestimated, BABA now given due honour

Damien Thévenet

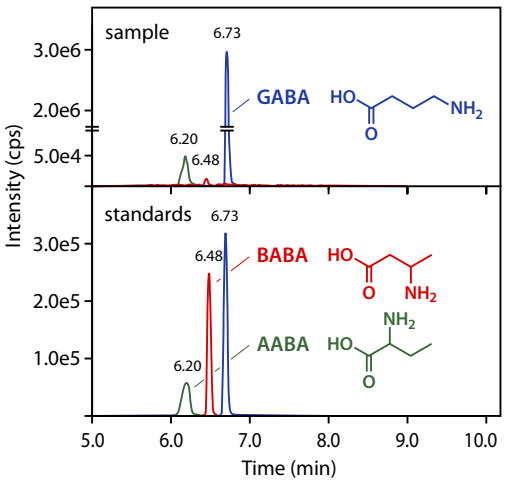
Brigitte Mauch-Mani

Gaétan Glauser

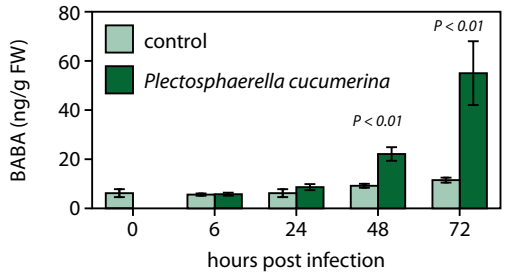
Brigitte Mauch-Mani and her team at the laboratory of molecular and cell biology have conducted pioneering research on priming, the phenomenon that plants, after having been exposed to stressful situations, can "remember" these events and consequently defend themselves faster and better upon renewed exposure to any stress. Priming can be triggered by biotic and abiotic stimuli, as well as by chemicals such as β-aminobutyric acid (BABA), a nonprotein amino acid. The compound had been known as an inducer of disease resistance since 1963, but for the following 30 years no more research was published on BABA. Until recently it was considered a xenobiotic substance. As the perception mechanism of BABA had been identified in *Arabidopsis thaliana*, the research group of Brigitte Mauch-Mani teamed up with that of Reinhard Neier and the NPAC staff at the institute of chemistry to explore the possibility that plants do synthesize BABA. The results of these joint efforts have been published in *New Phytologist*.

First the authors had to develop a reliable method to detect and quantify BABA in plant tissues, and unequivocally separate it from its two isomers α- and γ-aminobutyric acid (AABA and GABA), a challenging task also due to the fact that BABA occurred in the plants in comparatively very low concentrations. The analysis of BABA levels in stressed and non-stressed *A. thaliana* plants showed that BABA is a natural plant product and that its endogenous levels increase rapidly after infection with necrotrophic, biotrophic and hemibiotrophic pathogens, as well as after salt stress and submergence. Moreover, not only *A. thaliana*, but all the plant species tested so far in this way appear to be endowed with the capacity to produce BABA, e.g. maize, wheat, chinese cabbage and even a species of moss.

These exciting findings imply a re-thinking of the biological roles attributed so far to BABA



LC-MS chromatograms for standards and for a plant sample, a representative *Arabidopsis thaliana* leaf extract.

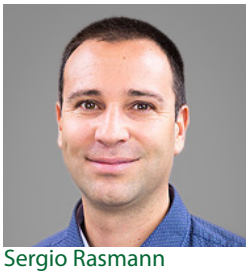


Quantification of BABA in *Arabidopsis thaliana* plants after infection with the necrotrophic fungus *Plectosphaerella cucumerina*.

and opens numerous novel opportunities of research. BABA is well known to speed up and boost the defensive reaction of the plant. It is even an agent with transgenerational efficacy, as seeds derived from treated plants may produce primed progeny. Therefore it may deserve to be upgraded to the status of a novel stress hormone helping plants to better cope with stress, but its place and role in the complex interplay of phytohormones leading to stress resistance remain to be established.

Thevenet D, **Pastor V**, **Baccelli I**, **Balmer A**, **Vallat A**, **Neier R**, **Glauser G**, **Mauch-Mani B** 2016. The priming molecule β-aminobutyric acid is naturally present in plants and is induced by stress. ***New Phytologist***: DOI: 10.1111/nph.14298

Mountain high, valley deep – constitutive and inducible plant defences along an altitudinal gradient



Sergio Rasmann

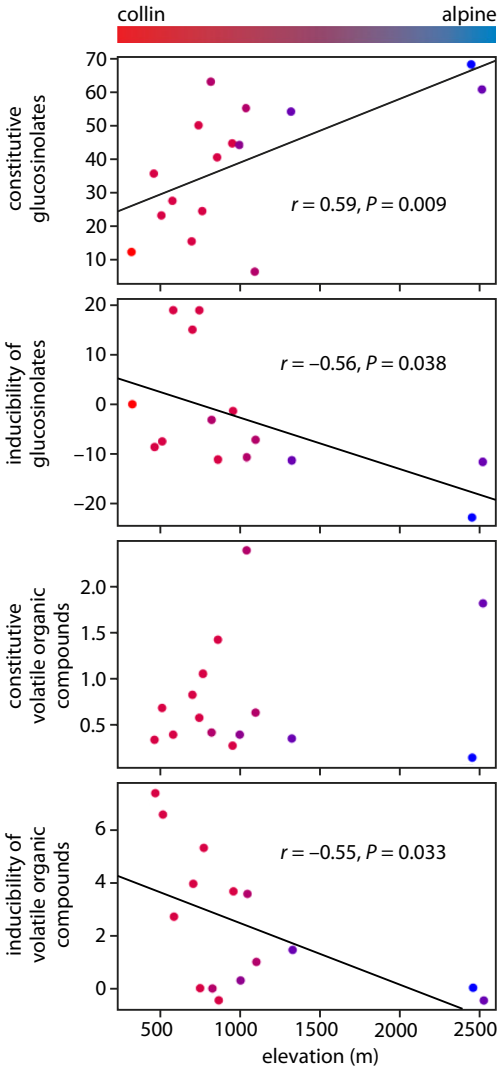
Xoaquin Moreira

Sergio Rasmann and Xoaquín Moreira, a former postdoc of Betty Benrey's group, have co-authored a paper that reports the results of a phylogenetic study on altitudinal gradients of plant defenses against herbivores. The project was a collaborative effort involving researchers at eight different labs in four countries.

Ecological theory indicates that warmer and more stable climates should result in stronger biotic interactions. Therefore, plant species growing at lower elevations and experiencing greater herbivore pressure should invest in higher levels of defences than those at higher elevations. However, for several potential reasons previous studies did not consistently find such an altitude–defence relationship.

The consortium conducted a comprehensive test of the effects of elevation and its associated biotic and abiotic factors on the individual and simultaneous expression of constitutive direct and indirect defences and their inducibility, i.e. the expression of defences after herbivore attack. Specifically, they estimated climatic and soil variables and measured herbivore damage and constitutive as well as jasmonic acid-induced glucosinolate levels in the leaves as a proxy for direct defences, and volatile emission as a proxy for indirect defences. The chosen study system comprised 16 brassicaceous species in the genus *Cardamine* (bittercress), naturally growing along the steep elevational gradients of the Alps and with known phylogeny.

Within this phylogenetic comparative framework, they found that species growing at lower elevations invested more in the simultaneous inducibility of both direct (toxic glucosinolates) and indirect (volatile organic compounds) defences, whereas species growing at higher elevations invested more in constitutive direct defences. Although they provide evidence for strong elevational gradients in herbivory, glucosinolate production was mainly associated with soil fertility, while volatile production with air moisture. The results highlight the importance of accounting for the simultaneous expression of several defensive strategies, as well as the relative influence of abiotic and biotic factors.



Correlations between elevation and constitutive glucosinolates (GSLs), inducibility of GSLs by jasmonic acid (JA), constitutive volatiles (VOCs) and JA inducibility of VOCs. Colours correspond to the optimal elevational distribution of each species, as indicated by the gradient above.

Pellissier L, **Moreira X**, Danner H, Serrano M, Salamin N, van Dam NM, **Rasmann S** 2016. The simultaneous inducibility of phytochemicals related to plant direct and indirect defences against herbivores is stronger at low elevation. ***Journal of Ecology*** 104: 1116–1125. DOI: 10.1111/1365-2745.12580

The NPAC in numbers

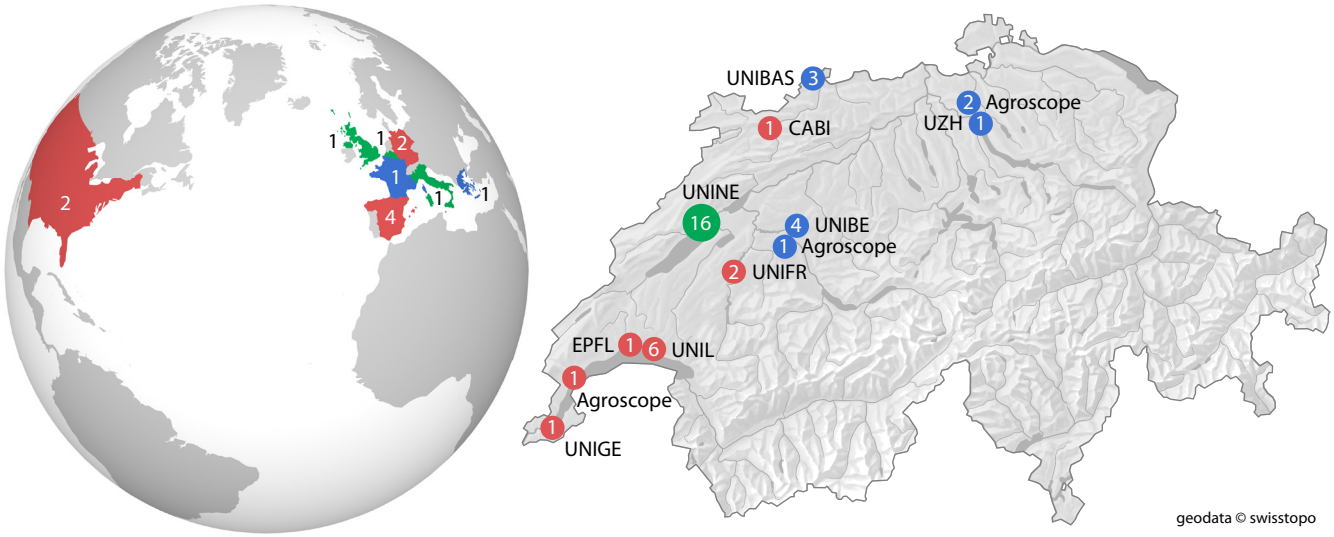
Laurence Lachat

Claudia Fillonneau

There is the saying *figures don't lie*, and with due reservation we would like to adopt this notion to illustrate the substantial contributions made by the Neuchâtel Platform of Analytical Chemistry (NPAC) to a diversity of research projects. More than 48'000 analyses were made over the two last years (2014 and 2015). Of these, 32'530 were carried out by the Mass Spectrometry and Metabolomics Unit and 15'470 by the Nuclear Magnetic Resonance Unit. These efforts resulted in the co-authorship of NPAC members in a total of 38 scientific publications.

Collaborations were established with a total of 52 research groups at universities and public research institutions, from a local to an international level. At UniNE, 16 research groups, belonging to the institutes of biology, chemistry and hydrogeology, were involved in joint projects, representing 31% of all collaborations. Other Swiss partners made up for 44%, with an approximately equal share of institutions in the French and the German speaking parts of the country. The remaining 25% of collaborations concerned partners from abroad, 11 from European Union countries and 2 from the USA. In addition to these academic institutions, NPAC offered its services also to a number of customers from industry, including Baxalta, Philip Morris, Bayer Crop Science, Febex SA, Analytecon, Asulab (Swatch Group), Montavon, Metalor Technologies SA and MicroChemical Systems.

In order to cope with the increasing workload, two new technicians were appointed. Laurence Lachat joined the team coming from Philip Morris and has a permanent contract with UniNE since June 2015. Claudia Fillonneau was hired in October 2015 within the framework of the SNF-funded Sinergia project *Sugar wars* for a duration of three years. The new chair for bioanalytical chemistry, filled by Stephan von Reuss in August 2016 (see page 18), will further strengthen the position of NPAC. Hence, the prospects for the future are excellent, and the NPAC can be expected to continue to thrive, as it has done since its inception in 2013.



Number of collaborations at the local, national and international level.

Spot on Cotton: direct and indirect defence in wild and cultivated plants

Victor Parra-Tabla

Luis Abdala-Roberts

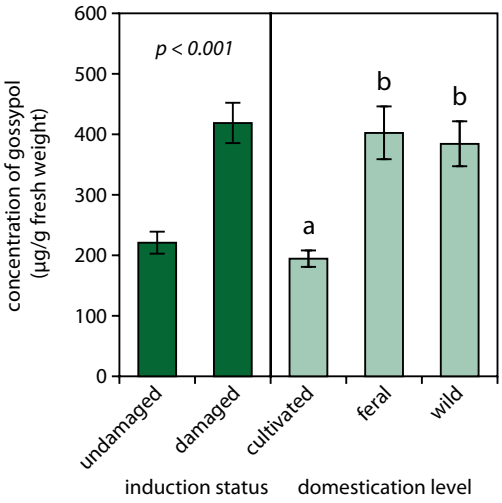
Laura and Alicia

Luca Grandi

The Cooperation and Development Center of the Swiss Federal Institute of Technology Lausanne (EPFL) offers grants for seed money projects aiming at encouraging scientific partnerships with focus countries. In 2015, the FARCE lab of Ted Turlings received a grant for a one-year project to study chemical defence traits in wild cotton in collaboration with Victor Parra-Tabla and Luis Abdala-Roberts from the Autonomous University of Yucatán (Mexico). *Gossypium hirsutum*, originating from the Yucatán peninsula in Mexico, is the most commonly cultivated species of cotton.

Cotton is the world's "dirtiest" crop in terms of pesticide use. It is envisioned that certain traits from wild plants can be (re)introduced into cultivated cotton to increase its natural defence abilities, thereby reducing the need for insecticides to control pests. Cottonseed has also great nutritional potential, but currently cannot be consumed because it contains the defence compound gossypol. Future cotton breeding efforts should aim at eliminating this compound in the seed, without affecting the defences in the rest of the plant. In addition to containing toxic substances, the plant can also defend itself indirectly by attracting parasitic wasps and predators with the use of herbivore-induced volatiles. There is evidence that both these direct and indirect defences are considerably reduced in cultivated cotton as compared to wild cotton.

In the pilot study, two master students, Laura Chappuis and Alicia Egger, conducted a series of experiments to determine the constitutive and inducible defences in cotton and their effects on the feeding behaviour, growth and survival of common caterpillar pests. Concentrations of gossypol and other terpenoid aldehydes, measured with assistance by the NPAC staff, were found higher in wild than in cultivated cotton. These concentrations increased in response to simulated caterpillar feeding, rendering the plants more resistant to these herbivores. Cultivated and wild cotton plants differed less in their release of herbivore-induced plant volatiles, which are implicated in plant-plant communication and in the attraction of the natural enemies of herbivores.



Gossypol concentration depending on induction status (left) and domestication levels (right). Damaged plants induced by mechanical damage and application of caterpillar regurgitant. Mean value of 6 genotypes per category (cultivated, feral, wild).

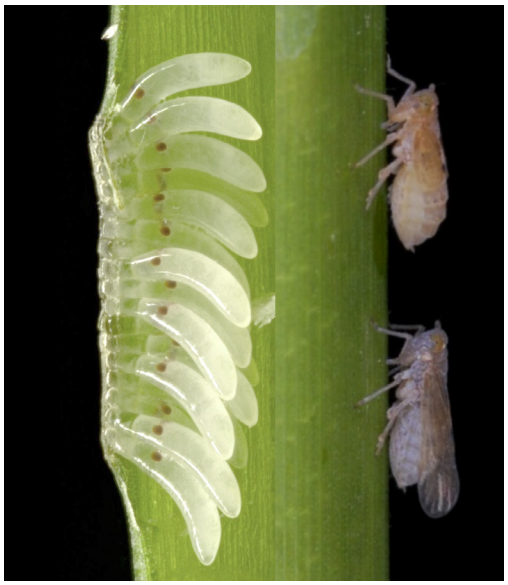
The collaborations established during the seed money project, not only with the Mexican partners, but also with researchers from the CIRAD at Montpellier, France, are to be continued. As a first follow-up step, the FARCE lab hired a UniNE-funded PhD student, Luca Grandi, to examine whether communication between cotton plants may enhance resistance to insect pests.

Title	
Funding Organization	Cooperation & Development Center, École Polytechnique Fédérale de Lausanne (EPFL)
Funding scheme	***EPFL Seed Money Program***
Budget	CHF 21'100
Start/End	1.10.2015 - 30.9.2016

The Chinese Connection

Yonggen Lou

Professor Yonggen Lou of Zhejiang University in Hangzhou visited the laboratory of Ted Turlings at the University of Neuchâtel as a post-doctoral researcher for about five months in 1998. They have collaborated ever since and have so far five joint publications. Most of these previous research projects dealt with the role of herbivore-induced plant volatiles in a tritrophic system that comprises rice, the rice brown planthopper *Nilaparvata lugens*, a sap-sucking insect, and its natural enemies, predators and parasitoids. At the beginning of 2016, Yonggen Lou launched a major international joint research project, which follows up on the previous findings and involves the research groups of Ted Turlings at the University of Neuchâtel and Matthias Erb at the University of Bern. They continue investigating the interactions between rice and the rice brown planthopper. It was already shown that feeding, but also egg-laying by the insect can induce defence responses in rice. Interestingly, the planthoppers can overcome the resistance of rice when they feed on it for several generations. By combining genetics, genomics, molecular biology, chemistry and insect performance assays, the project intends to further explore the mechanisms responsible for herbivore-induced defence responses in rice, both above and belowground. The generated knowledge is expected to help developing new control strategies against the rice brown planthopper, which remains one of the most important insect pests on this staple crop.



Eggs and adult females of the rice brown planthopper *Nilaparvata lugens*, truncate-winged 'brachypterous' (above) and fully winged 'macropterous' form (below).

Planthopper damage in a rice field.

Title	**Chemical cues derived from *Nilaparvata lugens* and their mediated interactions between rice and herbivores**
Funding Organization	National Natural Science Foundation of China
Funding scheme	***Major International (Regional) Joint Research Project***
Budget	Chinese RMB 3'500'000 (CHF 515'000)
Start/End	1.1.2016 - 31.12.2020

Slow slimy slugs – a neglected group of herbivores in the spotlight of a new SNSF-funded research project

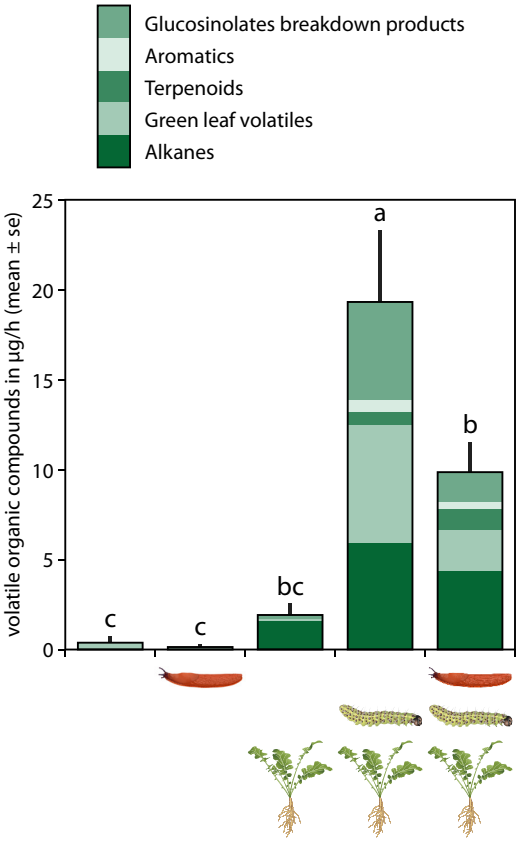
Gaylord Desurmont

Geoffrey Jaffuel

Diane Laplanche

Gaylord Desurmont and co-workers recently reported that plants infested with slugs and plants co-infested with slugs and caterpillars were far less attractive to parasitoids than plants damaged by caterpillars only, and that volatile emissions, which provide foraging cues for parasitoids, were strongly reduced in co-infested plants (Journal of Chemical Ecology, 2016, 42: 183–192; see also figure). These findings of the InvaVOL project, which ended in 2015, inspired a new proposal, which was conceived jointly by Ted Turlings and Gaylord Desurmont who has left UniNE in the meantime to work for the European Biological Control Laboratory of USDA in Montpellier, France. The project was approved by the Swiss National Science Foundation and is expected to provide novel insight into the interactions between gastropods and plants, and the consequences of these interactions for insect herbivores and natural enemies. A postdoctoral fellow, Geoffrey Jaffuel, and a doctoral student, Diane Laplanche, will carry out the research.

The study of plant-herbivore interactions has been a cornerstone of modern ecology for decades, whereby the focus has mainly been on insect and mammalian herbivores. Little attention has so far been paid to another significant group of plant consumers: terrestrial mollusks belonging to the Gastropoda class, better known as snails and slugs. These have been found to elicit general defensive pathways in plants. The project intends to provide answers to the questions of how gastropod herbivory through elicitors in the mucus – a unique trait among herbivores - affects the secondary metabolism and volatile emissions in plants and how this in turn influences insect-plant interactions at the second and third trophic level.



Volatile compounds emitted by undamaged *Brassica rapa* plants, plants infested by *Pieris brassicae,* plants infested by *P. brassicae* and *Arion vulgaris* simultaneously, *A. vulgaris* alone and empty odor sources.

Slugs also constitute important pests for a variety of cultivated crops and vegetables, and an important secondary aim of the project is therefore to explore new environmentally save strategies to control them, namely alginate beads containing mollusk-killing nematodes. Furthermore, it is envisioned to identify potent gastropod attractants to be incorporated in the beads as a lure.

Title	**Exploring the Chemical Ecology of Gastropod-Insect-Plant Interactions**
Funding Organization	Swiss National Science Foundation
Funding scheme	***Regular grant, Project funding (Div. I-III)***
Budget	CHF 618'159
Start/End	1.4.2016 - 31.3.2019

The kickoff meeting of the Sinergia project *Sugar wars*

Matthias Erb

Pierre Mateo

Angela Köhler

A bright rainbow shone over the kickoff meeting of the Sinergia project *Sugar wars* that was held together with the midterm meeting of the ERA-CAPS project BENZEX on 18/19 June 2016 at the Kursaal in Bern. It stood emblematically for the full spectrum covered of current research topics on benzoxazinoids, the main chemical defence compounds of maize plants. The event was jointly organized by C_3E and our external partner Matthias Erb, head of the Biotic Interactions Lab at the Institute of Plant Sciences of the University of Bern and the driving force behind both collaborative projects. The 23 participants came from eight research institutes in five different countries (Switzerland, Denmark, Germany, UK and USA). The ten presentations on the first day dealt with a whole range of disciplines and topics: from chemistry (purification, analytics, organic synthesis) over biochemistry and genetics to ecology (microbial and belowground tritrophic interactions). They included contributions of the two Sinergia subprojects linked to C_3E/UniNE by Pierre Mateo and Angela Köhler and showcased the very productive interdisciplinary interactions among the research groups. The second day was reserved for one-on-one discussions among the individual groups to organize the forthcoming collaborations.

After 25 years of hire, Reinhard Neier does retire

Reinhard Neier

Reinhard Neier studied chemistry at the University of Basel and obtained his PhD at the ETH Zurich. He conducted post-doctoral research for 1 ½ years at Cambridge University. In Geneva and Fribourg he took up his first academic positions as a lecturer. Having obtained his habilitation at the University Fribourg, he was appointed associate professor, just before he moved to the University of Neuchâtel in 1991 to take up a full professorship in organic chemistry. He kept interest in porphyrins, especially studying the biosynthesis of porphobilinogen and the modification of calix[4]pyrroles. Reinhard Neier was involved in the founding of the SAF, the precursor of NPAC, and of C_3E. In 2016 he has reached the age of retirement. On this occasion and to honor his achievements, a course of the doctoral program *Molecular Sciences in the Context of Life and Material Sciences* was organized on 24 June 2016. It had the title *Chemistry in and Chemists from Neuchâtel* and offered plenary lectures by four invited speakers from abroad and short talks by four former students of Reinhard Neier.

Stephan von Reuss appointed professor in bioanalytical chemistry

Stephan von Reuss

The vacant chair of organic chemistry held by Reinhard Neier was replaced by a new chair in bioanalytical chemistry, for which Stephan von Reuss was appointed. Stephan von Reuss studied chemistry at the University of Hamburg, Germany, where he also obtained his doctoral degree in organic chemistry. Before joining UniNE in August 2016, he carried out post-doctoral research at the Boyce Thompson Institute at Cornell University, USA, and established his own research group at the Department of Bioorganic Chemistry at the Max Planck Institute for Chemical Ecology in Jena, Germany. His major research interests are the ecology and evolution of secondary metabolism in nematodes with a focus on nematode-derived small molecule signals and their importance in inter- and intraspecies communication, as well as cross kingdom interactions. Stephan von Reuss has already acquired funding from the SNF to keep on pursuing this research direction with a project entitled *Comparative analysis of secondary metabolism in Caenorhabditis nematodes.* The new chair of bioanalytical chemistry will assure the continued strong link between biology and chemistry, notably by means of the NPAC. Stephan von Reuss is designated future director of the NPAC and replaces Reinhard Neier in the steering committee of C_3E.

Edith Joseph granted an SNFS professorship

Edith Joseph

Edith Joseph has studied chemistry at the University of Nantes, France, and received her PhD degree in environmental & heritage chemistry from the University of Bologna, Italy. She was awarded a Marie Curie fellowship followed by an Ambizione fellowship for her postdoctoral research carried out at the Swiss National Museum and as member of the microbiology lab at UniNE, respectively. In addition, she is project leader at the RA&D department of the Haute Ecole ARC Conservation-restauration (HES-SO) in Neuchâtel. She studies heterogeneous matrixes (artistic and archaeological objects) through spectroscopic techniques. Edith Joseph is specialist of biopatinas, investigating how microorganisms can be exploited for heritage preservation, such as for corrosion stabilization of ancient iron artefacts and for protecting architectural metals in an ecologically friendly way. In 2016 she was granted an SNSF professorship with the project *MICrobes for the Archaeological wood Conservation (MICMAC)*. This allowed her to establish her independent laboratory *Technologies pour les matériaux du patrimoine* as an assistant professor at the institute of chemistry.