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Program

5 September 2013, Thursday

17:00-20:00	Registration and upload of presentations (Conference building, Technikerstraße 25)
19:00-22:00	**Welcome reception** (Conference building, Technikerstraße 25)

6 September 2013, Friday

9:00-10:00	Keynote (Lecture hall B): **S. Aron: The evolution of unorthodox reproductive systems in *Cataglyphis* desert ants**	
10:00-10:20	**Coffee break**	
	Lecture hall D	**Lecture hall F**
10:20-10:40	R. Boulay: Inhibition of worker-egg laying by brood pheromones in the ant *Aphaenogaster senilis*	X. Cerdá: Seasonal changes in microhabitat preferences in a gypsy ant: colony relocation searching for optimal temperatures promotes intra-specific competition
10:40-11:00	Z. Reznikova: What is it like to be a scouting ant?	S. Kadochova: Ant activity and temperature regime in nests of wood ants *Formica polyctena*
11:00-11:20	A. Bruce: The relationship between tunnel length and digging rate in leaf-cutter ants	V. Jilkova: The role of bacteria and protists in nitrogen turnover in wood ant nests
11:20-11:40	D. Römer: Use of environmental cues during waste management in leaf-cutting ants (*Atta laevigata*)	N. Rastogi: Impact of an ecologically dominant ant species on the brown food web mediated via ecosystem engineering
11:40-12:00	C. Peeters: Sporadic evolution of a soldier caste in ants: comparative morphology and function	M. Khaldi: Importance of the myrmecofauna in the diet of hedgehogs (Mammalia, Erinaceidae) from Algeria
12:00-13:30	**Lunch break** (ICT building, Technikerstraße 21)	
13:30-13:50	R. Schultz: Identification of cryptic Tibetan ant species (Hymenoptera: Formicidae) by means of NC clustering	C. Platner: Foraging behaviour, trophic diversity and importance of trophobiosis for an ant community in a Mediterranean organic citrus grove
13:50-14:10	A. Bagherian Yazdi: Application of geometric morphometrics to analyse allometry in two species of the genus *Myrmica* (Hymenoptera: Formicidae)	E. Gómez: Dynamic disease management and fungal symbiont genetic diversity in *Trachymyrmex* fungus-growing ants (Attini: Formicidae)
14:10-14:30	N. Gratiashvili: Habitat, colony structure of the slave making ant *Myrmoxenus tamarae* (Arnoldi, 1968) and its multidisciplinary comparison with *Myrmoxenus ravouxi* (André, 1896) (Hymenoptera: Formicidae)	A. Tartally: Host ant usage of *Maculinea rebeli* (Hirschke, 1904) around the type locality (Lepidoptera: Lycaenidae)
14:30-14:50	M.C. Kinzner: A routine near-infrared spectroscopy method for species identification in the cryptic *Tetramorium caespitum/impurum* complex	B. Markó: Infestation of *Myrmica scabrinodis* with *Rickia wasmannii* (Ascomycetes: Laboulbeniales) aids the infiltration of socially parasitic *Maculinea* species (Lepidoptera: Lycaenidae) differentially
14:50-15:10	**Coffee break**	
15:10-15:30	D. Grasso: The birth of a society: sociogenesis in incipient colonies of harvester ants	O. Blight: Native and non-native dominant ants do not organize Mediterranean ant communities by competition
15:30-15:50	A. Bernadou: A few days in the life of *Leptothorax gredleri* ant queens: nest choice, adoption and genetic relatedness	Z. Czekes: Density dependent effect of a *Formica exsecta* supercolony on diversity and structure of co-occurring ant community and foraging strategy of rivals
15:50-16:10	D. Moron: Short-lived ants take greater risks during food collection	J. Sorvari: Coexistence of competitors in fragmented landscape: red wood ants *Formica aquilonia* and *F. polyctena*
16:10-16:30	E. Robinson: Exploration, exploitation and polydomy: insights from radio-tagged ants	I. Tausan: Ant assemblages (Hymenoptera: Formicidae) of deciduous forests in Romania: differences at regional scale
16:30-16:50	B. Barth: Paternity skew and colony structure of five highly polyandrous Neotropical army ants (Ecitoninae)	C. Castracani: The ant community structure in urban environments
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19:00	**Dinner** (SoWi-Lounge, Universitätsstraße 15)	

7 September 2013, Saturday

9:00-10:00	Keynote (Lecture hall B): **B. Seifert: Frequency and evolutionary significance of hybridisation in ants**	
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	Lecture hall D	**Lecture hall F**
10:20-10:40	F. Courchamp: Is France too cool for invasive ants?	O. Paknia: Community structure of ants along an overlooked axis
10:40-11:00	A. Bang: Strength in numbers: using a native ant species to control invasive ants	G. Talavera: Discovered just before extinction? The first endemic ant from the Balearic Islands endangered by climate change
11:00-11:20	C. Bertelsmeier: Is there a dominance-discovery trade-off among invasive ants?	G. Berberich: Statistical correlation between red wood ant mounds (*Formica* spp.) and active fault structures in the West Eifel and the Freiburg-Bonndorfer-Grabenzone
11:20-11:40	G. Luque: Allee effects in ants: temporal presentation colony dynamics	A. Freitag: Monitoring red wood ants in Switzerland: goals and methods
11:40-12:00	D. Procter: Massive afforestation has allowed the spread of a woodland specialist	C. Georgiadis: Biogeographical analysis of Cretan (Greece) myrmecofauna
12:00-13:30	**Lunch break** (ICT building, Technikerstraße 21)	
13:30-13:50	J. Trettin: Molecular ecology of reproductive skew in a socially plastic ant	
13:50-14:10	J. Schlaghamersky: Phylogeography of the rare ant *Liometopum microcephalum* (Formicidae: Dolichoderinae): results of a study on populations across the entire species range	
14:10-14:30	P.E. Hanisch: Ants above and below ground at Iguazú National Park, Argentina: using barcodes to improve ant species list	
14:30-14:50	D.M. Sorger: Island-like divergence on Florida's sand ridges (USA): the case of a trap-jaw ant	
14:50-15:10	**Coffee break**	
15:10-15:30	L. Schrader: Japan vs. Brazil: genome-wide comparison of two *Cardiocondyla obscurior* populations	
15:30-15:50	O. Sanllorente: Distribution of the mariner *Azteca* in the ant genomes	
15:50-16:10	H.C. Wagner: The next generation of species delimitation in the *Tetramorium caespitum/impurum* complex (Hymenoptera: Formicidae)	
16:10-16:30	T. Czaczkes: Ant foraging on complex trails: route learning and the role of trail pheromones in *Lasius niger*	
16:30-16:50	E. Schultner: Ant larvae as players in social conflict	
16:50-17:10	S. Ellis: Resource redistribution in polydomous *Formica lugubris* colonies	
17:10-19:00	**Poster session and drinks**	
19:00	**Dinner** (ICT building, Technikerstraße 21)	

8 September 2013, Sunday

8:30-18:30	**Cross-Alpine day trip** (Meeting point: parking area next to conference building)
19:30	**Farewell dinner** (Restaurant Froschkönig, Technikerstraße 84)

Abstracts

6 September 2013, Friday

Oral presentations

Morning session

Keynote
The evolution of unorthodox reproductive systems in *Cataglyphis* desert ants

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With a few rare exceptions, the vast majority of animals reproduce sexually. Some species have, however, evolved alternative modes of reproduction by shifting from classical bisexuality to unorthodox reproductive systems, like parthenogenesis, gynogenesis, or hybridogenesis. Under hybridogenesis, females of hybrid origin discard their paternal genome prior to meiosis and produce gametes carrying no paternally derived genes. Therefore, both the maternal and paternal genomes are expressed in their somatic tissues, while their germ line is purely maternal. I will report a unique case of hybridogenesis at a social scale in desert ants of the genus *Cataglyphis*. Species comprise a pair of distinct genetic lineages, with queens mating with males of the alternate lineage to their own. In the four hybridogenetic *Cataglyphis* species sampled to date, all the workers are inter-lineage hybrids, whereas male and female sexuals are produced by asexual reproduction through parthenogenesis. As a consequence, only maternal genes are perpetuated across generations.

Remarkabky, a survey of colonies structure in the hybridogenetic desert ant *C. hispanica* shows that workers are hybrids of the same two genetic lineages along a 400 km-transect crossing the whole distribution range of the species. This indicates that social hybridogenesis allows the maintenance over time and across a large geographic scale of two highly divergent genetic lineages, despite their constant hybridization. The widespread distribution of social hybridogenesis in *Cataglyphis* ants supports that this reproductive strategy has been evolutionarily conserved over a long period.

Inhibition of worker-egg laying by brood pheromones in the ant *Aphaenogaster senilis*

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In many social hymenopterans, workers have functional ovaries and are able to lay unfertilized (haploid) eggs. However, they generally do not do so until a reproductive queen is present in the colony. The worker-policing theory states that in polyandrous colonies workers refrain from laying eggs because they have a mutual interest in rearing their brothers rather than nephews with which they are less genetically related. In addition, it has been suggested that worker reproduction may have an important cost at the colony level, for example, if laying workers do participate in the realization of other tasks. Here I present a series of experiments showing that in the monogynous and monandrous ant *Aphaenogaster senilis* not only the queen but also the larvae have a negative effect on worker egg-laying. Hence, in queenless condition, worker-derived eggs appear later when the workers are provided with first instar larvae. Traditional mesh experiments suggest a contact pheromone emitted by the larvae is at least partially responsible for this inhibition. Observations suggest the first instar larvae are fed with trophic eggs. Therefore, the larvae may signal themselves in order to maintain the production of trophic eggs by the workers and by so doing inhibit the production of parthenogenetic eggs. From an evolutionary perspective, it may not be in the workers' interest to switch to parthenogenetic egg-laying until larvae are present in the colony since, in queenless condition, one of them may develop into queen.

What is it like to be a scouting ant?

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Long term studies revealed strongly stable professional groups in red wood ants such as shepherds, guards, hunters, transporters, and scouts. What makes an ant scout is still enigmatic. Although sophisticated systems of distant homing are in many respects similar in red wood ants and honey bees, regulation of scouting completely differs in them. Whereas scouting honey bees change their roles from one foraging trip to another, scouting red wood ants perform the same task during several weeks. To revel distinctive features of scouts, we designed the first battery of behavioural tests which included peculiarities of exploratory activity, levels of aggression and spatial cognition. In order to test exploratory activity, we recorded ethograms of individuals placed in a box with artificial models of natural objects (a "tree trunk", "grass stems", a "stone" and a "shelter"). Aggressiveness was estimated from the variety of interactions with ground beetles. The ability to memorize the path was investigated using a binary-tree maze. A significant difference in cognition and behaviour between scouts and foragers was revealed. Both scouts and foragers are more exploratory than "average" out-nest workers, and scouts exceed foragers. In unfamiliar situations scouts more readily switch between different activities. Scouts and foragers displayed nearly equal levels of aggressiveness which are more than in aphid milkers and close to guards. In contrast to guards, both scouts and foragers strongly avoided aggressive actions which may be of danger to themselves, and they never attacked beetles directly. The most distinctive feature of scouts is their high exploratory activity: facing novel items scouts readily advance to explore them. Scouts also form spatial memory faster and keep the information longer and more precisely than foragers.

The relationship between tunnel length and digging rate in leaf-cutter ants

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Ant nests show a linear relationship between nest size and ant number and it has been hypothesised that this is due to nest volume being adjusted to group size: digging rates being high when the nest is too small and lowered when plenty of space is available. This constitutes a negative feedback mechanism, by which nest volume is tuned to group number. In this study we investigated the relationship between tunnel length, which is an important contributor to nest size, and digging rate. Focusing on tunnel length allowed the presentation of different space conditions while controlling the geometry of the emerging space. We allowed sub-colonies of the leaf-cutter ant *Acromyrmex lundi* to excavate tunnel space in a tube and then removed that space by means of a gate. This showed no significant difference in digging rate in comparison to a control. Further experiments, providing tubes with different initial empty tunnel spaces, also showed no significant differences. Our results suggest that leaf-cutter ants do not adjust their digging rates with respect to available tunnel length.

Use of environmental cues during waste management in leaf-cutting ants (*Atta laevigata*)

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A considerable part of a leaf-cutting ant nest consists of underground waste chambers where the colony deposits exhausted and contaminated waste materials. It is unknown what factors motivate the ants to accumulate their waste at a certain place inside their nest. The abiotic environment in the nest's surrounding soil is very heterogeneous with changes in temperature, humidity and CO_2 concentration. We investigated whether leaf-cutting ants spatially organize their waste management based on these factors by performing three different series of binary choice experiments. A subcolony of *Atta laevigata*, consisting of a fungus garden and inhabiting workers, was separated from a large laboratory colony and added with waste material, so as to trigger workers quick waste removal from the fungus chamber. For waste disposal, workers had access through a T-shaped tube to two equally-sized round chambers offering, in independent series, either two different temperatures, two humidities or two distinct CO_2 concentrations. Leaf-cutting ants preferred to accumulate their waste at a temperature of 25°C, a value also preferred for rearing their symbiotic fungus. Humidities of 33% or below were preferred for waste disposal. However, because of the high water content of the waste material, the humidity in the chambers always increased during the experiment. The CO_2 concentration of the offered chambers was not used as an orientation cue for waste disposal, i.e. ants equally distributed the waste between the chambers with either atmospheric CO_2 values or higher concentrations. However, workers preferred to aggregate more in the chamber with the highest CO_2 concentration. Our results demonstrate that leaf-cutting ants use some abiotic cues to spatially guide their waste management, possibly because these conditions support decomposition of the refuse or hinder the growth of pathogenic fungi within.

Sporadic evolution of a soldier caste in ants: comparative morphology and function

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Among social Hymenoptera, only a number of ant genera have more than one morphological kind of non-reproductive adults. This polymorphism is striking in species lacking intermediates between small and big helpers. In many species, bigger helpers function for defence or phragmosis, while in others they are seed-millers. All these functions are associated with specialized heads, including modified mandibles attached to powerful muscles. Bigger helpers also function to store food efficiently, because of a bigger gaster volume and / or more ovarioles (to lay trophic eggs) than ordinary workers. In some species defence and food storage are performed at different ages. Bigger helpers evolved convergently across lineages, which accounts for substantial heterogeneity in morphology.

The evolutionary origin of bigger helpers has been debated for years: are they derived from the worker or from the queen caste? This debate is compromised by the equivocal meaning of the term "soldier" in the literature. In a proportion of species, workers show extensive variations in size although small and big individuals follow the same allometric growth rules. In other species, some traits of bigger helpers follow growth rules distinct from workers. Molet et al. (2012) restricted "soldier" to the latter, and argued they recombine queen-like and worker-like morphological traits (head, ovaries, ...). This is particularly so in taxa with a marked size dimorphism between queen and worker castes, meaning that a morphospace is available for specialized colony-maintenance functions. A mosaic origin for soldiers resolves the conflict between hypotheses of worker versus queen derivation. Detailed molecular phylogenies now make it possible to study the distribution of soldiers in ants, and explore the selective contexts.

Molet M, Wheeler D, Peeters C (2012) Evolution of novel mosaic castes in ants: Modularity, phenotypic plasticity, and colonial buffering. American Naturalist 180: 328-341.

Seasonal changes in microhabitat preferences in a gypsy ant: colony relocation searching for optimal temperatures promotes intra-specific competition

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Nest relocation is a common strategy to search the best compromise between good resources and enemy avoidance. The risks associated with relocation (i.e. predation of the brood and the queen during and just after relocation) should be highly compensated by the new site conditions. In southern Spain (Doñana), we followed two populations of a monogynous species, *Aphaenogaster senilis* during five years, in order to know whether abiotic and / or biotic factors affected the process of relocation. Under the Mediterranean conditions of our study sites, we predicted that nests would move in search of favorable abiotic conditions (temperatures) but that colony relocation would also be constrained by intra-specific competition. We showed that in spring, when brood biomass increases enormously, spatial arrangement of colonies is overdispersed suggesting colony mutual exclusion. High competition for space in spring is not accompanied by overt aggressive interactions or higher foraging distances. In spring and fall, colonies move to bare soil where they can benefit from heat necessary for brood pupation. However, in summer colonies avoid the elevated ground temperatures by nesting under the scrubs. This was confirmed experimentally: in summer shaded nests remained longer without moving than control ones; and observationally: lower temperatures were recorded at different soil depths of nests under scrubs than those in bare soil (high and risky temperatures). However, moving the nest under scrubs seems to constrain intra-specific competition, as covered nest are closer to neighbors than uncovered nests, especially in spring. We conclude that *A. senilis* has a seasonal pattern for nest relocation motivated mainly by high temperatures of the Mediterranean summer, while intra-specific competition is higher in spring when the colony invests in growth.

Ant activity and temperature regime in nests of wood ants *Formica polyctena*

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Repeated temperature measurement was performed in twelve nests of wood ants *F. polyctena*. Highest inner nest temperatures were reached in June and the lowest in September. Linear models revealed significant difference in thermoregulatory pattern between those periods. From April to August inner the nest temperature was affected both by environmental conditions (air temperature, precipitation, solar income), physical nest properties (moisture, number of nest openings, nest ID) and ant activity counted as number of foragers entering the nest ($p < 0.05$). In September the only significant factors were precipitation and physical nest properties. This is in good agreement with earlier theory, that nest thermoregulation is aimed to assure best conditions for egg laying and brood development in early summer; while in autumn no thermoregulation is needed because of brood absence. Similar daily temperature regime occurred in most nests: The lowest nest temperatures were observed one hour before sunrise, the highest one hour before sunset but not at midday when air temperature and solar income peaked. The delay in nest heating could be caused by excellent isolative properties of nest material or foragers' return into the nest (external heat brought into the nest by ant bodies). Temperature difference between the mound depths 10 - 5 cm was in average positive, which means there is a thermal flow from inside out the nest, suggesting high importance of inner heat sources. Ant activity, counted as number of foragers on the trail, is positively affected by surface temperature, number of nest openings, nest volume and solar income ($p < 0.01$). Ants returning into the nest are negatively affected by previous precipitation as well. Number of nest openings correlates positively with inner nest temperature and nest volume and negatively with surface temperature, solar income, precipitation and nest material moisture ($p < 0.001$). This indicates that ants may trade off temperature for humidity.

The role of bacteria and protists in nitrogen turnover in wood ant nests

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Wood ants are ecosystem engineers influencing especially nutrient flow due to their foraging and building activities. Since nitrogen belongs to limiting nutrients in forest ecosystems, in our study we focused on a process that influences its turnover in wood ant nests – food interaction between bacteria and protists.

We carried out a manipulation experiment to separate contributions of microbial decomposition and bacterial-protozoan interaction to nitrogen flow. Materials from ant nests and surrounding forest floor (control) were X-ray sterilized and then placed into sterile microcosms. One part of the microcosms remained sterile, second part was inoculated with bacteria, and third part was inoculated with bacteria and protists. Microcosms were incubated at laboratory temperature for three weeks. Respiration of microcosms was determined every two days. In addition, the microcosms were watered every week and leachates were analyzed for NH_4^+ and NO_3^- concentrations.

As a result, the highest respiration was determined in microcosms containing ant nest material inoculated with both, bacteria and protists. Higher NH_4^+ and NO_3^- concentrations were assessed in microcosms with ant nest or control materials inoculated only with bacteria. Our study suggests that the ant nest material supports activity of bacteria and protists probably due to high nutrient concentrations. Lower nitrogen leakage from microcosms inoculated with bacteria and protists is most likely caused by food interaction of these groups of organisms and retention of nitrogen in their biomass.

Impact of an ecologically dominant ant species on the brown food web mediated via ecosystem engineering

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Recent emphasis is to conserve and promote farmland diversity. However sustainability in agricultural systems is possible only if agrodiversity leads to a concomitant increase in productivity and protection of environmental services. Hence, there is a need to focus research on taxa or functional groups which play a vital role in ecosystem functioning by contributing to ecosystem services such as soil nutrient enhancement and insect pest suppression. Many ground-nesting ant species are able to tolerate the anthropogenic disturbances prevalent in annual cropping agroecosystems and constitute important components of soil arthropod community. However, not much is known about the impact of ants on soil biota and in driving ecosystem processes in the detrital food web. Impact of *Pheidole* sp., ecologically dominant in managed ecosystems, earlier reported to be important in insect pest suppression was studied on supporting agroecosystem services. Study was carried out of the physico-chemical characteristics and arthropod diversity of the ant nest crater rim debris soil of *Pheidole* sp. The debris soil had significantly higher concentrations of total C, N, P and NO_3-N along with more optimal pH and water-holding capacity. Soil transfer experiments revealed that this ecologically dominant ant species harbours a unique soil arthropod community in the external debris piles by the creation of small, nutrient enriched resource patches with more moderate temperature and moisture conditions at a depth of 2 cm in comparison to the control soil. The results suggest an important role of *Pheidole* sp. in regulating the soil nutrients and soil arthropods as an ecosystem engineer.

Importance of the myrmecofauna in the diet of hedgehogs (Mammalia, Erinaceidae) from Algeria

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Ants are highly appreciated by Algerian hedgehogs. Their large abundances were recorded in the feeding of the two Erinaceidae species in Algeria: the North African Hedgehog *Atelerix algirus* (Lereboullet, 1842) and the Desert Hedgehog *Paraechinus aethiopicus* (Ehrenberg, 1832). The diet of these Erinaceidae was studied by means of faecal analysis during the automnal period, in a humid suburban area in Beni-messous (Algiers, Northern of Algeria) for *A. algirus* and the estival period, in an arid area at the Natural Reserve of Mergueb (M'sila, Eastern of Algeria) for *P. aethiopicus*. Three classes of invertebrate preys were found: Gastropoda, Arachnida and Insecta. Hymenoptera was consistently the main group in the diet represented essentially by Formicidae (94.1% for *A. algirus* vs. 90.18% for *P. aethiopicus*). *Messor barbarus* (52.88%), *Tapinoma simrothi* (18.82%) are the most abundant ants in the feaces of the North African Hedgehog however *Messor medioruber medioruber* (55.56%) and *Cataglyphis bicolor* (24.07%) take an important range in the menu of the Desert Hedgehog. This type of study allows firstly to highlight the close relationship between hedgehogs and ants as prey selected and secondly to learn about myrmecological diversity.

6 September 2013, Friday

Oral presentations

Early afternoon session

Identification of cryptic Tibetan ant species (Hymenoptera: Formicidae) by means of NC clustering

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The Chinese-German project "Monitoring of rangeland health in response to environmental changes on the Tibetan Plateau" (PADEMOS) offered the opportunity to collect ants in the East and South Tibet region. We have investigated ants on 17 different stations in the Chinese provinces Ganzu, Quinghai and the Tibetan Autonomous Region in the years 2011 and 2012.

Here we want to describe the identification of two cryptic species close to *Myrmica tibetana* (Mayr, 1889) based on NC clustering of nine phenotypic characters. This new exploratory data analysis offered a clear separation of three clusters which were confirmed by a linear discriminant analysis in any of the 61 nest samples and each of the 164 worker indivduals.

Application of geometric morphometrics to analyse allometry in two species of the genus *Myrmica* (Hymenoptera: Formicidae)

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Allometric changes in shape were analyzed in two species of genus *Myrmica* using geometric morphometics and the pattern of allometry was visualized by thin plate splines (TPS) analysis. 41 landmarks and 252 semilandmarks were fixed in four anatomical aspects in 299 worker ants – dorsal head, frontodorsal clypeus, dorsal mesosoma and lateral petiole. To explore how shape varies with size, a multivariate regression of four anatomical aspects on centroid size was performed with the scores of all partial warps (PW). The fit of the regression models was evaluated by the explained variance of Goodall's F-test. A comparison of the patterns of allometric shape changes was performed by multivariate analysis of covariance (MANCOVA) using all PWs from pooled coordinates of the two species as varieties, centroid size as covariate and species as grouping factor. The null hypothesis of isometric shape change was rejected (allometry was present) in all aspects of the two species as the multivariate regressions were statistically significant. The amount of shape variation accounted for by the regressions differed considerably among the studied species and anatomical aspects, ranging from 2.62% for the petiole of *M. vandeli* to 13.95% for the mesosoma of *M. scabrinodis*. As a whole, *M. scabrinodis* shows more allometric shape change than *M. vandeli* in all the anatomical aspects. There were no significant differences between allometric patterns of the two species in head, clypeus and mesosoma aspects in MANCOVA test. In a multivariate ordination for all the anatomical aspects there is only a little improvement in patterns of overlap among species after removing allometric effects.

Geometric morphometrics allows to visualize allometries of particular shape components which remain undetected by a conventional morphometric analysis.

Habitat, colony structure of the slave making ant *Myrmoxenus tamarae* (Arnol'di, 1968) and its multidisciplinary comparison with *Myrmoxenus ravouxi* (André, 1896) (Hymenoptera: Formicidae)

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Myrmoxenus tamarae is the only representative of the genus *Myrmoxenus* yet reported from Georgia near to the village Daba. It was recollected after 47 years from the type locality. Main type of the vegetation cover of this slave-making ant is *Pineta xeroherbosa*. Colony structure of *M. tamarae* is investigated. It enslaves *Temnothorax unifasciatus* (Latreille, 1798) and *T.* sp. NYL2, as yet an undescribed species closely related to *T. nylanderi* (Förster, 1850) and *T. crassispinus* (Karavaiew, 1926). Morpholometry, behaviour and mtDNA sequences between two taxa of the slave-making ant genus *Myrmoxenus*, *Myrmoxenus tamarae* (Arnol'di, 1968) from Georgia and the wide-spread *M. ravouxi* (André, 1896) are compared. Workers of the two taxa differed clearly in locomotor activity and slightly also in morphometry, while genetic (COI / COII) investigation did not support a distinct separation. We discuss the taxonomic status of *M. tamarae* as a possible subspecies of *M. ravouxi*.

A routine near-infrared spectroscopy method for species identification in the cryptic *Tetramorium caespitum* / *impurum* complex

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The identification of species is important for many biological disciplines and cryptic species represent a special hurdle for traditional species delimitation. Most approaches are either time-consuming (e.g., morphometrics) or cost-intensive (e.g., molecular genetics). Fibre-optic near-infrared spectroscopy (NIRS) has been shown to be a rapid, cheap and easy-to-use method for the identification of closely related species, but its efficiency has never been tested on a complex of similar species. The cryptic species complex of *Tetramorium caespitum* / *impurum* in the Alpine region is an ideal study system for integrative species delimitation due to the pronounced morphological and ecological similarity of sympatric species. Here, we collected NIR spectra from 540 mounted specimens of the four morphologically highly similar species *Tetramorium alpestre*, *T. caespitum*, *T. impurum* and *T.* sp. B. We evaluated the analysis tools partial least squares (PLS) regression, artificial neural network (ANN) and random forest (RF) in their efficiency in classifying NIR spectral data by using an exhaustive routine of combining three vs. one species. In doing so, we opted for a 100% classification certainty at the cost of excluding specimens from identification. Using this rationale, PLS regression scored best with identifying 57.8% of specimens, while RF was much less effective (8.9%) and ANN failed completely (0%). We discuss the practical use of NIRS and of our combination routine for identifying multiple species, with special attention paid to older specimens such as in museum collections. We emphasize NIRS as a pre-screening method for any down-stream in-depth analyses.

Foraging behaviour, trophic diversity and importance of trophobiosis for an ant community in a Mediterranean organic citrus grove

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Ants as generalist predators and mutualists of herbivores can play an important role in relative stable agroecosystems like plantations. The categorization of the diverse life strategies and traits into ecological groups like trophic levels is essential for a better understanding of food web structures and a better prediction of changes in communities. Stable isotope technology provides simultaneously detection of trophic levels and the ultimate C source of many species.

We studied a highly diverse Mediterranean arthropod community in an organic citrus grove in Tarragona, NE Spain, and analysed stable isotope contents (delta ^{13}C and delta ^{15}N) of 17 species of ants and 22 aphid species together with 18 dominating plant species and spiders and isopods to establish trophic guilds and detect seasonal changes. Combining direct contact observations between ants and aphids with stable isotope analyses we aimed at disentangling the importance of trophobiosis in the food web and possible feedbacks at the functional diversity of ants. In a longterm field experiment we reduced the herb layer beneath the Citrus trees, and thus the number of potential host plants for aphids living in trophobiosis with ants. The results revealed significant differences between species spanning over a huge range in delta ^{15}N-values of at least 10.7‰ which is only comparable to a Peruvian tropical forest with a much higher species diversity. We found highly diverse trophic relationships between host plants, aphids and ants and a significantly increased activity of trophobiotic species like *Lasius grandis* on trees after cutting the herb layer. However, stable isotope contents of most ant species do not exhibit the expected close relationship with their trophobiotic partners. In summary, the climatic seasonality and the high heterogeneity of different plant resources in the organically managed plantation are reflected by a notably high trophic diversity of the ant community.

Dynamic disease management and fungal symbiont genetic diversity in *Trachymyrmex* fungus-growing ants (Attini: Formicidae)

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Multipartner mutualisms have potentially complex dynamics, with compensatory responses when one partner is lost or relegated to a minor role. Fungus-growing ants (Attini) are mutualistic associates of basidiomycete fungi and antibiotic-producing actinomycete bacteria; the former are attacked by specialized fungi (*Escovopsis*) and diverse generalist microbes. Ants deploy biochemical defenses from bacteria and metapleural glands (MGs) and express different behaviors to control contaminants. We studied four *Trachymyrmex* species that differed in relative abundance of actinomycetes to understand interactions among antimicrobial tactics that are contingent on the nature of infection. MG grooming rate and actinomycete abundance were negatively correlated. The two species with high MG grooming rates or abundant actinomycetes made relatively little use of behavioral defenses. Conversely, the two species with relatively modest biochemical defenses relied heavily on behavior. Trade-offs suggest that related species can evolutionarily diverge to rely on different defense mechanisms against the same threat. Neither bacterial symbionts nor MG secretions thus appear to be essential for mounting defenses against the specialized pathogen *Escovopsis*, but reduced investment in one of these defense modes tends to increase investment in the other. In addition we analyzed the fungal symbionts genetic diversity of five *Trachymyrmex* ant species, shedding light on the diversity that can exist in a mutualistic relationship, and in turn, raises new questions about the coevolution of the ant-cultivar conflicts.

Host ant usage of *Maculinea rebeli* (Hirschke, 1904) around the type locality (Lepidoptera: Lycaenidae)

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The taxonomy of the myrmecophylous *Maculinea alcon* (Lepidoptera: Lycaenidae) group is rather problematic and the host plant (where the larvae start the development) and host ant (where the larvae finish the development) usage of these butterflies were thought for a long time to be an important factor in their determination. Nowadays it is the wrong general point of view that *M.* "*rebeli*" is the xerophilous form of *M. alcon*. However, the type locality and the other known sites of *M. rebeli* are above the pine zone and well separated by pine forests from the lower regions where the generally called *M.* "*rebeli*" sites are. Furthermore, no host ant data of the type form of *M. rebeli* have been published yet. Our aim was therefore to find the host ant(s) of *M. rebeli* around the type locality (in Styrian Alps). *Myrmica* (Hymenoptera: Formicidae) nests were opened on two sites around the host plants just before the flying period to find praepupal larvae and pupae. Altogether 38 nests of three *Myrmica* species (*M. lobulicornis*, *M. ruginodis*, *M. sulcinodis*) were found and *M. rebeli* larvae and pupae were found on both sites exclusively in nests of *M. sulcinodis* (22 individuals in 22 nests). The results should call our attention to the differentiation of the "taxonomical *M. rebeli*" from the "generally known *M.* "*rebeli*"" as the latter one was found extremely rarely with *M. sulcinodis*.

Infestation of *Myrmica scabrinodis* with *Rickia wasmannii* (Ascomycetes: Laboulbeniales) aids the infiltration of socially parasitic *Maculinea species* (Lepidoptera: Lycaenidae) differentially

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Ants can be attractive targets for parasites due to the concentration of genetically similar host organisms in time and space. There is a wide range of parasitic organisms from fungi to various arthropods that exploit the social system of ants. Caterpillars of the conservation flagship butterfly genus *Maculinea* are social parasites of various *Myrmica* ant species, and one of the common hosts of most *Maculinea* species is *Myrmica scabrinodis* in Romania. Additionally, *Myrmica* ants, e.g. *M. scabrinodis*, are also hosts for the Laboulbeniales fungus *Rickia wasmannii*, which can reach extremely high prevalence in ant nests. However, the presence of a parasite in a system could decisively influence the infiltration success of another parasite either negatively or positively. During our study we investigated in laboratory conditions the effect of *R. wasmannii* infestation in *Myrmica scabrinodis* colonies on the adoption success of caterpillars of four different *Maculinea* forms / species: *M. alcon*, *M. a. xerophila*, *M. nausithous* and *M. teleius*. Based on our results infested ant colonies adopted significantly sooner *Maculinea* caterpillars, while, generally, irrespective of the infestation, caterpillars of all *Maculinea* forms / species were adopted slower, than those of *M. alcon*. The duration of the adoption process was significantly reduced in infested colonies. Behavioural changes could also be observed in ant colonies during the adoption process. Based on our results fungal infestation definitely influences the adoption probability of socially parasitic *Maculinea* caterpillars, although differentially, opening up the colonies mostly for *M. alcon*, the known main social parasite of *Myrmica scabrinodis*.

6 September 2013, Friday

Oral presentations

Late afternoon session

The birth of a society: sociogenesis in incipient colonies of harvester ants

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Ant colonies are complex systems that show emerging properties deriving from simple processes that mediate social interactions among their members. For this reason, they are often defined as "superorganisms". In recent decades, considerable progress has been made in understanding the principles that control the collective activities and division of labor in ants. However, these aspects have been mainly investigated in mature societies and few information is available on starting colonies. The first steps of the development of a society, instead, represent a critical phase for the future success of the superorganism. In the present work, we described and quantified some aspects of the social organization of incipient colonies of the harvester ant *Messor wasmanni*. In particular, we investigated: a) the initial steps of colony founding, b) the social ontogeny of individual workers, c) the development of different activities during colony growth. Results showed the occurrence of a "conditional" polyethism characterized by patterns of activities emerging in accordance with contingent factors. Among these, the colony demography and the availability of food seem to play an important role affecting the amount and sequence of activities carried out by single individuals. Nevertheless, the general colony workforce is allocated to ensure a constant brood care and food processing inside the nest, crucial activities for the success of the society. Hence, incipient colonies, in spite of their reduced size, show a well-structured social life and may represent a useful tool to study sociogenetic processes in ants and the regulatory principles of their collective activities.

A few days in the life of *Leptothorax gredleri* ant queens: nest choice, adoption and genetic relatedness.

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Compared with other insects, surprisingly little is known about the life history traits of social Hymenoptera. In ants, in particular, the behaviour of female sexuals (e.g. dispersal, nest site selection, adoption) has rarely been studied in detail. Because sexual activities of ants are often restricted to only a few days per year and because of the difficulties to obtain freshly mated queens under standardized conditions, data on the life history of female reproductives are lacking.

Unlike species with nuptial flights, most female sexuals of *Leptothorax* exhibit a "female calling syndrome", i.e., they leave their maternal nest, climb up grass stems, extrude their sting, and release sexual pheromones to attract males. Once mated it has been suggested that in *Leptothorax gredleri* (Mayr, 1855) and other functionally monogynous *Leptothorax*, young queens may found solitarily, return into their maternal nest, or possibly seek adoption in another established colony. The ant *Leptothorax gredleri* is a suitable model system to study life-history traits of female sexuals. Sexuals can be raised and mated in the lab, and female sexuals rarely fly but mate on the ground. Therefore, we tested the main characteristics of the reproductive life-history of this species. Behavioural choice tests (unmarked vs. marked substrate and nest selection) as well as adoption experiments on female sexuals were performed. Our results show that female sexuals prefer most often substrates and nests marked by nestmates. When reintroduced in their maternal colony, young queens were readily adopted, however, this situation might be transient because several queens left their nest after 2 - 3 weeks. Finally, we attempted to corroborate our laboratory results by studying the genetic relatedness of queens in the field.

Short-lived ants take greater risks during food collection

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Life-history theory predicts that organisms should alter their behavior if life expectancy declines. Recent theoretical work has focused on worker life expectancy as an ultimate factor in allocating risk-related tasks among the workforce in social insects. A key prediction of this evolutionary model is that workers with shorter life expectancy should perform riskier tasks. We tested this hypothesis, using laboratory colonies of the ant *Myrmica scabrinodis*. We modified foraging so that it differed in level of risk by manipulating distances, temperatures, and the presence of competitors on foraging patches. The life expectancies of foragers were shortened by poisoning with carbon dioxide or by injury through removal of their propodeal spines. Both treatments significantly shortened worker life expectancy in comparison with untreated ants. We show, for the first time, that foragers with a shorter life expectancy foraged under risk more often than foragers in the control group. Thus, a worker's strategy of foraging under risky circumstances appears to be fine-tuned to its life expectancy.

Exploration, exploitation and polydomy: insights from radio-tagged ants

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Foraging animals face an exploration-exploitation trade-off when allocating their time and energy. Ants can benefit from having many individuals in managing this trade-off, because collectively, a colony's foragers can explore many sites simultaneously and can also exploit food sources efficiently by means of rapid recruitment. Some ant species are polydomous, spreading the colony across multiple nests. A recent model (Cook et al. 2013) predicts that polydomy should increase a colony's exploration success, relative to colonies living in a single central nest. However, the model also predicts that this could come at a cost, because dispersing the foragers across multiple nests may make recruitment, and therefore exploitation, less effective. The invasive and polydomous Pharaoh's ant (*Monomorium pharaonis*) was used to test these model predictions, with RFID technology enabling tracking of individual workers. Colonies housed in single or multiple nests were tested to determine how exploration and exploitation behaviour are influenced by the colony's nesting structure and whether colonies can avoid the costs of having a dispersed foraging body by recruiting ants from several nests at once. The results shed light on how the behaviour of these ants contributes to their success as a globally invasive pest.

Cook Z, Franks DW, et al. (2013) Exploration versus exploitation in polydomous ant colonies. Journal of Theoretical Biology 323: 49-56.

Paternity skew and colony structure of five highly polyandrous Neotropical army ants (Ecitoninae)

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Army ants with their unique nomadic life-history patterns (army ant adaptive syndrome) are efficient predators, but also prone to heavily reduced effective population sizes because colonies have only a single queen and can only reproduce through colony fission. Excessive multiple mating of queens (polyandry) with highly mobile males has been suggested to be important to maintain genetic diversity in populations. However, the causal connection between mating strategy and life history, and their combined effects on the population structure in army ants is still not well understood, and genetic data is only available from a few selected species. Here we aim to shed new light on the army ant mating system by comparing mating frequencies, genetic colony structures and paternity skew (distribution of proportional paternity among males) of the five Neotropical army ants *Eciton mexicanum*, *E. vagans*, *Labidus coecus*, *L. praedator* and *Nomamyrmex esenbeckii*. Since a strong paternity skew may result in effective monandry, its strength may indicate the relevance of genetic diversity for the evolution of multiple mating. Queens are expected to equalize paternity of their mates to optimize genetic diversity in the colony, whereas in contrast, males might try to monopolize their reproductive share to enhance their individual fitness. Slight, but significant paternity skew in our study species indicated neither strong equalization, nor monopolization of paternity, suggesting the exact number of matings and some degree of paternity skew to be selectively neutral at the high level of polyandry in army ants. Thus, polyandry may have evolved primarily as an essential and closely associated part of the army ant syndrome, while the benefits of the resulting genetic complexity may have evolved secondarily.

Native and non-native dominant ants do not organize Mediterranean ant communities by competition

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Competition by dominant species is thought to be key to structuring ant communities. In order to determine their effect on ant communities, we document local distribution and effects on ant assemblages of two dominant ants, which are similar in several biological and ecological features, the invasive Argentine ant and a native ant, *Tapinoma nigerrimum*. We compared abundance, composition and patterns of species co-occurrence of eight coastal ant communities in Corsica. We also infer factors responsible for the Argentine ant's success in breaking down ant assemblage equilibrium. While both species numerically dominated ant communities to the same extent and both appeared detrimental to species richness at traps, only the invader reduced species richness at the site scale (up to 78%). Despite their similar habitat requirements, they differed in patterns of space occupation. Unlike the Argentine ant, which was homogenously distributed, *T. nigerrimum* was distributed in dense patches leaving gaps for subordinate species. Using null model analyses, we found random patterns of species co-occurrence at sites invaded by the Argentine ant and dominated *T. nigerrimum*, but aggregate distribution in sites containing neither dominant species. In Corsica, dominant species, both invasive and native seem to not structure coastal ant communities by competition. Moreover, these findings indicate that, in addition to worker numbers, a broad and scattered distribution coupled with inherently aggressive behavior may be decisive in enabling invasive ants to break down ant assemblage equilibrium.

Density dependent effect of a *Formica exsecta* supercolony on diversity and structure of co-occurring ant community and foraging strategy of rivals

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Territorial ant species, situated on the highest level of the competitive hierarchy, act like community organizing centres. They influence the presence of sub-dominant species, regulate their abundance and can alter their foraging behaviour. Those territorial ant species which develop large polydomous systems (so-called supercolonies) are expected to have even greater impact on local ant communities. We studied the spatial distribution of the territorial *Formica exsecta* within a large supercolony (more than 3300 nests), and the nature and strength of its influence on the ant community structure and the foraging behavior of sub-dominant ant species. Two different areas were selected within the supercolony: a high nest density site (HD – 0.05 nests / m^2), and a low nest density site (LD – 0.006 nests / m^2), the HD site being one of the most dense, the LD site one of the most dispersed parts of the supercolony. The daily activity of ants was studied in randomly selected plots in the absence and in the presence of baits during the summer of 2007, 2008 and 2009. We assessed the ant community's structure using pitfall traps in the same plots in 2009. The two parts of the supercolony were different in every aspect. While the presence of *F. exsecta* was more or less even in time and space on the HD site, and subdominant species were almost completely absent, the reverse was valid for the LD site. The structure of the ant community differed significantly between the two sites, while the diversity was significantly higher at the LD site. Differences were observed in the foraging strategies of subdominant ants as well. Patches with low *F. exsecta* abundance within the supercolony let other species survive and even prosper to a certain extent.

Coexistence of competitors in fragmented landscape: red wood ants *Formica aquilonia* and *F. polyctena*

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Species distribution in patchy habitat may be affected by competitive interactions. Among boreal ants, species of red wood ants (*Formica rufa*-group) are known to be dominant and highly competitive. Species pair, *Formica aquilonia* and *Formica polyctena*, needs large territories, because they are multiple-nest breeders. In central Finland, the small-scale habitat requirements (immediate nesting habitat) were similar for the both species, but they never co-existed at the same study plot. This suggests that competitive exclusion occurs. Despite similar habitat requirements at small-scale, at larger landscape scales, however, *F. aquilonia* was more associated with large forest patches, whereas *F. polyctena* had no such habitat associations. We suggest that the species pair can coexist in moderately patchy landscape, but an increase in habitat loss and fragmentation may change the balance between species occurrence favouring *F. polyctena* over *F. aquilonia*.

Ant assemblages (Hymenoptera: Formicidae) of deciduous forests in Romania: differences at regional scale

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Temperate deciduous forests are distributed in North and South America, Asia and Europe. They host a great diversity of invertebrate species. Ants are an important component of these ecosystems. Using pitfall traps, we investigated deciduous forests from different regions of Romania (Dobrogea, Banat and Transylvania), in order to identify differences in terms of ant community structure at regional scale during 2011 and 2012. Altogether 15 ant species were identified. Out of them, nine species are typical species of deciduous forests, namely: *Aphaenogaster subterranea*, *Camponotus truncatus*, *Dolichoderus quadripunctatus*, *Lasius brunneus*, *L. fuliginosus*, *Myrmecina graminicola*, *Stenamma debile*, *Temnothorax crassispinus* and *T. parvulus*. Additionally, *Myrmica ruginodis* and *Lasius platythorax* were sampled, which are general forest species. At smaller spatial scale, within Transylvania, there are significant differences among ant communities, whereas these differences are even more enhancing when comparing different regions, Dobrogea region being the most different. Moreover, our results show a clear species replacement in terms of presence and abundance. *Myrmica ruginodis* and *Temnothorax crassispinus* are replaced in Dobrogea by *Aphaenogaster subterranea* and *T. parvulus* with similar proportions. Regarding species richness, the highest value was recorded in Dobrogea with 10 species.

The ant community structure in urban environments

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Global urbanization is an ongoing and unstoppable process that is leading to a huge transformation of our environments. The risk of biodiversity loss is often connected to this phenomenon. Several approaches to this problem have been proposed and they all share the necessity of an integration of ecologic knowledge into urban planning. To achieve this goal, ecologic patterns and processes in urban ecosystems need to be first understood. Ants represent an interesting model because they are extremely diverse, well represented in urban environments, easy to sample and key stone elements in many ecosystems. In this work we studied the ant community structure inside one of the oldest and biggest park in the city of Parma (Italy): the Ducal Park (208,700 m^2). According to environmental management and human exploitation, the park was divided into three different types of green areas: Bosquettes, Rustic Grasslands and English Grasslands. Pitfall traps associated with food baits were used to achieve information on both numerical and behavioural dominance of ant species. In a two year sampling (2009 / 2010), we collected 24 species divided into 15 genera and 3 subfamilies (Dolichoderinae, Formicinae and Myrmicinae). Data from pitfalls showed that species richness, overall abundances and species abundances are significantly affected by year and green area type. Overall data from baits showed a positive correlation between species discovery ability and their monopolization ability. Species data from baits suggested an effect of green area types on species discovery and monopolization abilities. The results and their interpretation showed the presence of, at least, two different ant communities that can be partially explained considering the tree different green area types. This research suggests that both urban green area management and use have an effect on ant community structure.

7 September 2013, Saturday

Oral presentations

Morning session

Keynote
Frequency and evolutionary significance of hybridization in ants

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Hybridization in ants is a widely spread phenomenon – by December 2012, it has been credibly shown in 18% of the 177 Central European species or 14% of the 37 genera. Outside Central Europe, ant hybridization is known for 0.19% of 10.000 described species and 2.0% out of 296 genera only. This striking difference by a factor of nearly 100 cannot be explained by evolutionary or zoogeographical history – it is simply a consequence of different working philosophies and species delimitation methods of the taxonomists. While being frequent on a per-species level, hybridization is usually rare on the individual level: excluding the extreme scenarios of social cleptogamy, the average figure for the hybridizing species of the Central European fauna is about 1% only. Due to eusocial life history and haplo-diploid sex determination hybridization in ants is much more complex and bizarre then in other groups of organisms. Five types of hybridization scenarios in ants will be discussed in the lecture.

(a) Front line hybridization without a cline: hybridization causes unexpectedly sharp border lines between the ranges of parapatric species with an extremely narrow hybrid zone.

(b) Symmetric social hybridogenesis: bidirectional use of heterospecific genes.

(c) Social cleptogamy: unidirectional strategic hybridization of rare species.

(d) Pulsating hybridogenous evolution: alternating action of disruptive selection and genomic fusion in wood ants.

(e) Supercolonial hybridogenous speciation: evolution of new lines within the "closed societies" of wood ant supercolonies with ten thousands of reproductive females and fierce selection on male hybrid genotypes.

Comparable to the situation in more thoroughly investigated species in other groups of organisms, hybridogenous transfer of selected alleles – i.e., the exchange of some "constructive elements" via fertile backcrossing of F1 hybrids with parental species – is assumed to occur in many ant species in many parts of their range and should have significant adaptive and evolutionary effects.

Is France too cool for invasive ants?

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Ants are among the worst invasive species and can have tremendous negative impacts on native biodiversity, agriculture, estates, property and human health. Because invasive ants are extremely difficult to control, early detection is essential to prevent ant invasions, in particular through surveillance efforts at ports of entry. Here, we assess the potential distribution of 14 of the worst invasive ant species in France, under current and future climatic conditions. We generated consensus species distribution models, using five different modelling techniques, three Global Climate Models and two CO_2 emission scenarios. The projections show that France presented suitable areas for 10 out of 14 species, including four that are among the "100 of the world's worst invasive species". Two of these are already present in the south of France, but both are still far from fully filling the predicted invasive range, which is almost all French departments. Among these 10 species, eight are predicted to increase their potential range with climate change. Areas with the highest concentration of potential invaders are mainly located along the coastline, especially in the South-West of France, but all departments appear climatically suitable for at least two invasive species. We provide a ranking of risk per species for 17 major airports and 14 maritime ports. Overall, the ports of entry with the highest risks are located in Biarritz, Toulon and Nice and the species that are predicted to invade the largest numbers of departments of France are *Lasius neglectus* and *Linepithema humile*, followed by *Solenopsis richteri*, *Pheidole megacephala* and *Wasmannia auropunctata*.

Strength in numbers: using a native ant species to control invasive ants

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Biological invasion is one of the foremost drivers of loss of biodiversity around the globe. The focus in research has largely been on repercussions of successful establishment of invasive species on the native species and ecosystems. Identification and investigation of native species as effective competitors against the invasive species is a relatively underutilised line of inquiry. Argentine ant, *Linepithema humile*, is "one of the 100 of the worst invasive species" on the planet at present as identified by IUCN, and is gradually increasing its range in temperate regions around the world. In this study, we paired the odorous ant *Tapinoma nigerrimum* which is native to the Mediterranean region, with *L. humile*, to investigate the changes in behaviour, survival and productivity of *L. humile*. We found baseline differences between the two species as well as differences in behaviour, survival and productivity arising due to the presence of a competing species. *L. humile* outcompeted *T. nigerrimum* when in equal numbers. For *T. nigerrimum* to pose as an effective competitor, it had to be at least ten times more abundant than *L. humile*. Studies such as these should pave way for field trials and if successful, should be incorporated in broader conservation policy.

Is there a dominance-discovery trade-off among invasive ants?

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Ants are among the most problematic invasive species. They displace numerous native species, alter ecosystem processes and can have negative impacts on agriculture and human health. In part, their success might stem from a departure from the dominance-discovery trade-off, i.e. invasive ants are thought to be at the same time behaviourally dominant and fast discoverers of resources, compared to native species. However, it has not yet been tested whether such a trade-off exists among invasive ants, which may be able to arrive and establish in the same areas in the future. Here, we establish a dominance hierarchy among four of the most problematic invasive ants (*Linepithema humile*, *Lasius neglectus*, *Wasmannia auropunctata*, *Pheidole megacephala*). We used confrontation experiments, testing the aggressiveness in single and group interactions between all species pairs. In addition, we test the species' capacity to explore a maze, where a food resource has been located and the capacity to recruit nestmates to exploit the food resource.

Allee effects in ants: temporal colony dynamics

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Allee effects occur when the aggregation of individuals results in mutually beneficial intraspecific interactions whereby individual fitness, or per capita growth rate, increases with the number of individuals at low population numbers. Allee effects have important implications for many aspects of basic and applied ecology. Over the past decades, the study of Allee effects has influenced population dynamics, community ecology, endangered species management, and invasion biology. We studied Allee effects in the invasive Argentine ant (*Linepithema humile*). In this species, many queens and workers are present in colonies, which allowed us to explore the differential effects of castes on the presence of Allee effects. In the laboratory, we measured brood production and individual survival in experimental colonies that differed in the initial numbers of queens and workers. Our results highlight the differential effect of queens and workers on survival and productivity. We found three positive density-dependent relationships indicative of component Allee effects at the colony level: both workers and queens had a positive effect on the productivity of the other caste, and queens had a positive effect on worker survivorship. Our experimental results suggest a potential positive feedback between worker and queen abundance, which may have contributed to the evolution of large colony sizes. Our study provides the first evidence of Allee effects in eusocial insects, and highlights the need to consider castes separately in population dynamics. Division of labour and differential reproductive rates are factors that should be integrated into the study of Allee effects.

Massive afforestation has allowed the spread of a woodland specialist

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The North York Moors contains one of two substantial populations of the wood ant *Formica lugubris* in England. This area has undergone large change in forest cover over the last 150 years. Most of the change in forest cover is due to afforestation with conifer plantations for commercial forestry. Conifer plantations are generally thought of as negative, containing fewer rare species and lower invertebrate diversity than natural woodland. However no one has assessed the impact on woodland specialists such as wood ants. We ascertained forest cover at five time points between 1854 and 2011 and compared this with the current location of nests across the landscape. We found there was a 285% increase in forest cover between 1854 and 2011 (from 64.4 km^2 to 248 km^2). The majority of this increase occurred between 1952 (125.9 km^2) and 2011 (248 km^2). Only 25% of current nests are in areas that were covered in forest in 1854, meaning there has been large scale spread of *F. lugubris* into new areas. Given that *F. lugubris* reproduces primarily by budding and therefore has limited dispersal, this is a surprising and positive level of population spread. The large afforestation with conifer plantations therefore appears to have been beneficial for this woodland specialist.

Community structure of ants along an overlooked axis

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Ecological communities have been usually linked to spatial variability. Temporal variability is also a factor that influences ecology and evolution of species. Considering "niche" as a range of n-dimensional independent biotic and abiotic requirements for a species to retain a stable or increasing population size it is less known whether physical and biological axes are equally important for determination of temporal ecological niches or pose an ordered structure. Ants possess traits that make them ideal taxon for examining the patterns of temporal niche partitioning. To better understand the effects of biotic and abiotic factors on the partitioning of time as resource (niche) across environmental gradients, I conducted a field survey across ca. 1200 km latitudinal gradient in Iran in along environmentally heterogeneous habitats from temperate deciduous forests to deserts to assess the community structure of ants across the dial cycle. I investigated the role abiotic (habitat complexity, productivity, and climate) and biotic factors (species richness) on patterns of temporal niche partitioning in ant assemblages. Patterns of niche overlap differed significantly from null models in 11 out of 17 assemblages. Two axes of NMDS analysis discriminated observation sessions in two main diurnal and nocturnal groups, reflecting the real dial cycle. A non-significant hump-shaped relationship was evident between temporal range overlap and latitude. Overlapping values, however, were positively and significantly related to elevation. Diurnal range was the most important variable for explaining temporal niche partitioning in ants across the latitudinal gradient. These findings suggest that time significantly mediates ecological interactions and shapes the structure of ant ecological communities.

Discovered just before extinction? The first endemic ant from the Balearic islands endangered by climate change

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Global warming may suppose a major threat to biodiversity, although there is limited empirical evidence on the link between ongoing extinction processes and climate change. Organisms on islands are especially vulnerable because of limited possibilities for spatial shifts following climatic conditions. This effect is even more severe in islands-within-islands, like populations occurring in ecologically unique island mountaintops. Based on morphological, molecular and ecological evidence, we document the unexpected discovery of a non-cryptic ant species in the summits of Mallorca island (Spain), which represents the first endemic ant for the Balearics and displays an extremely restricted and altitudinally constrained distribution. Climate-based distribution modelling and the low intraspecific genetic diversity observed indicate low probability for short-term survival, thus becoming a potential model to study real-time climatic-based biodiversity loss. Notably, only the most optimistic future climatic scenario, based on lower energy requirements and emissions, gives some hope for the persistence of this species after a strong bottleneck in the year 2050.

Statistical correlation between red wood ant mounds (*Formica* spp.) and active fault structures in the West Eifel and the Freiburg-Bonndorfer-Grabenzone

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In a GeoBioScience approach in the West Eifel and in the Freiburg-Bonndorfer-Grabenzone it was demonstrated that there is a relationship between the spatial distribution of red wood ant (RWA) mounds and tectonically active, gas-permeable faults. Such linear patterns have formerly been mostly associated by myrmecologists with edge effects of forest stands and / or roads. Geostatistical techniques were applied to the distribution data of a total of approx. 9500 RWA mounds in the study areas in correlation with known tectonic systems. The study areas underwent a complex tectonic history. The uplift of both the western part of the Rhenish Massif (West Eifel) and the Black Forest, that commenced during the Neogene and still persists during the Quaternary affects the dynamics of the study areas and reactivates and reorganises pre-existing Palaeozoic crustal discontinuities. The currently NW-SE (West Eifel) and the NW-SE / NNW-SSE (Black Forest) main stress direction opens pathways for upwardly migration of geogenic gases. Concurrently, a conjugate wrench fault system exists. The prominent large-scale active tectonic structure that encompasses the Black Forest study area, is the NW-SE to WNW-ESE trending "Freiburg-Bonndorfer-Grabenzone" that consists of several sub-trenches. We tested the hypothesis that the alignment directions of RWA mounds agree with those of tectonically active faults. The Hough transform, a well-established algorithm for the automatic extraction of linear patterns from point clouds, was applied to the spatial distribution of RWA mounds in the Westeifel (3000 RWA mounds) and the Black Forest (3500 RWA mounds). It could be clearly shown that the alignment directions of RWA are consistent with those of tectonically active, gas-permeable faults and that RWA mounds can be used as biological indicators of these faults. This is especially useful when information about the active tectonic regime is incomplete or the resolution by technical means is insufficient.

Monitoring red wood ants in Switzerland: goals and methods

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Red wood ants (Hymenoptera: Formicidae; *Formica rufa* group) have large impacts on forest ecosystems. Because of their ecological importance, they are protected by laws in many countries, including Switzerland. Despite this, some species are listed on the IUCN Red List of Threatened Species and on the Swiss Red List. Wood ants suffer from habitat fragmentation, intensification of forest management and practices such as clear-cuts. Lack of management in woodlands that become more and more shaded can also reduce habitat suitability leading to mounds being abandoned. Hence a good understanding of the effects of forest management on wood ants is needed to ensure their long-term conservation. Unfortunately, little is known about how nest mounds evolve in managed vs. unmanaged forests.

In this context, we've undertaken a long-term monitoring of nest mounds in Switzerland to understand which factors influence their evolution and survival. The study will be conducted in two kinds of areas: a) protected areas without forest exploitation where we can follow the natural dynamic of nest mounds as control and b) exploited forests. Studying the natural dynamic of red wood ants in their natural habitat is an essential condition to understand their evolution in exploited areas.

The monitoring concerns the six wood ant species represented in Switzerland: *Formica rufa*, *F. polyctena*, *F. pratensis*, *F. lugubris*, *F. paralugubris* and *F. aquilonia*. We developed a field protocol to collect standardized data on nest mounds and their neighbourhood that we present here.

Biogeographical analysis of Cretan (Greece) myrmecofauna

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Crete is the largest (8250 km^2) and more habitat-diverse island in Greece holding 96 species of ants. In this study we recorded the presence of all the local ant species from several sources (e.g. collections, bibliography) and by using GIS representation we generated distribution maps on a taxon level. Congruence and spatial analysis of the species presence in Crete were carried out, indicating the existence of an altitudinal and ordinal gradient in species richness, in concurrence with the proposed paleogeography of the area. In addition, geological and habitat data correlations were performed generating information on species diversity components. Finally, we present the first record of Leptanillinae from this southern Aegean island.

Molecular ecology of reproductive skew in a socially plastic ant

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Phylogeographic studies on widely distributed species revealed interesting insights into the dynamics of glacial refugia and postglacial recolonization events in Western Palaearctic.

Here we present data for the Holarctic ant *Leptothorax acervorum*, which usually inhabits rotten sticks, trunks or rock crevices in the boreal coniferous forests of Eurasia and North America. The northern edge of the species area extends into the tundra steppe, whereas its distribution reaches the Mediterranean mountains in the south. Within this vast area *L. acervorum* shows considerable variation in social structure. Whereas reproduction is quite equally shared among nestmate queens in most populations from boreal Eurasia (low skew), colonies from populations at the edge of the species' range are characterized by "functional monogyny" (high skew). By use of a phylogeographic approach, we investigated the evolutionary history of *L. acervorum* from peripheral populations of Iberian peninsula and adjacent regions, and offer insights into ultimate factors that affect plasticity in reproductive skew.

Phylogeography of the rare ant *Liometopum microcephalum* (Formicidae: Dolichoderinae): results of a study on populations across the entire species range

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Liometopum microcephalum is an arboricolous ant ranging from Italy and eastern Czechia and Austria in the west to the Russian Lower Volga, western Iran and northern Israel in the east. Populations are fragmented and, in the north of its range, restricted to the floodplains of large rivers. The aim of our study was to assess the phylogenetic relationships between the more or less spatially isolated populations. We used mitochondrial DNA markers (cytochrome b, cytochrome oxidase I) and 12S ribosomal RNA. We sequenced 87 individuals collected at 25 sites across the entire species range. Bayesian analyses yielded two main clusters of samples: populations from the Middle East (Turkey and Israel) differed distinctly from those from the rest of the distribution area. We suggest that the centre of distribution is situated in south-eastern Europe. From there, the species probably spread northward and southeastward. We also suggest that *L. microcephalum* colonized the Apennine Peninsula from south-eastern Europe, the Alps presenting a barrier that prevented its colonization of western Europe. Six of the studied populations consisted of two or three haplotypes – these populations probably originated from different genetic lineages.

Ants above and below ground at Iguazú National Park, Argentina: using barcodes to improve ant species list

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Ants shape invertebrate and plant communities by acting as predators and competitors of other arthropods, and by engaging in mutualism with a wide variety of plant and insect species. Additionally, ants are involved in some ecological processes such as seed dispersion and organic matter decomposition in soil. In hotspot areas of biodiversity knowing the species identities is the first step for conservation purposes and for future studies. This work focused on the inventory of myrmecofauna above and below ground at Iguazú National Park in Argentina. We used three methods of capture: pitfall traps (30), mini-Winklers (30) and ground probes (120) with two types of baits along six transects throughout the park. Sampling was conducted in January / February 2008 and 2009. We collected 11942 ants belonging to 34 genera and 78 species / morphospecies. The morphospecies were validated also by Neighbor Joining trees constructed from sequences of the mitochondrial COI gene. Based on this sampling we estimate a minimum ant richness of 92.5 ± 1.2 epigeic species and 34.1 ± 0.4 hypogeic species. The most abundant species in our samples were: *Dinoponera australis*, *Pachycondyla striata* and *Linepithema micans*. Five species were new records for Argentina or Misiones. All sampling methods showed a characteristic species composition and included unique species, indicating the importance of using different methodologies to inventory ant communities. Agreeing with other studies, usually a 2 - 3% threshold of divergence of the COI gene was adequate for the delimitation of species. Almost all the species / morphospecies were new for the barcodes database. In genera with polymorphism and lack of accurate keys this technique was particularly useful to link minor workers with majors, making the identification possible. We conclude that barcodes proved to be a useful tool for the building of more reliable inventories and the subsequent identification of minor workers and morphospecies.

Island-like divergence on Florida's sand ridges (USA) – the case of a trap-jaw ant

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Florida's inland ridges (USA) originated as sand islands at a time when sea levels were significantly higher than they are now. These ridges (some up to 100 miles long) are home to orange trees, but also endemic animals like the charismatic trap-jaw ant *Odontomachus relictus*. This ant occurs on only two of these sand ridges and lives in sand hill scrub habitat. Here, I present preliminarily data from sampling populations on each ridge to test the hypothesis of species divergence between ridges using behavioral, morphological, and genetic data. Behavioral assays indicate a striking pattern of non-aggression within and aggression between clusters on each ridge. Phylogenetic analysis shows a significant divergence between ridges (but not within). Morphology shows no consistent inter-ridge differentiation. Collectively, these data suggest differentiation of ridge populations. Given that many of the species found on the ridges are even less vagile than *O. relictus*, cryptic species, many of them likely in need of conservation, may be common on each of the ridges.

Japan vs. Brazil: Genome-wide comparison of two *Cardiocondyla obscurior* populations

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Propagules of terrestrial and aquatic species are continuously transported to novel habitats. Separated populations may then follow distinct evolutionary routes, either due to differences of founding individuals or as a result of local adaptation to different environmental conditions. We have sequenced the genomes of two introduced populations of the highly inbred tramp ant *Cardiocondyla obscurior*. Inbreeding is considered a pre-adaptation for establishing stable populations from introduction events. In addition to data on genetic divergence, we present major differences in endosymbiont content and expression that might account for hybrid breakdown between the populations. In addition, we discuss transposable element content in the genome, suggesting that TEs might act as a powerful driver of genome evolution in this species.

Distribution of the mariner *Azteca* in the ant genomes

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Mariner elements are the most abundant and extended DNA transposons in the eukaryote genomes. Usually they codify a single protein called transposase which is responsible for cutting the mariner element and integrating it into another place of the genome.

Ants are not an exception and to date three different types of mariner have been described in ants, all of them in species from the Myrmicinae subfamily. Recently the three mariners have been found in the same ant genome, specifically in *Tapinoma nigerrimum* (Dolichoderinae) as well as a new defective mariner (*Azteca*) inserted into one of the three previously known. According to this, ant genomes have been invaded by at least four different mariner elements and the existence of a mariner within another mariner element may suggest that a significant proportion of ant DNA is made up of transposable elements in spite of the haplodiploid genetic system.

We investigate whether the mariner *Azteca* is present in its complete form in *T. nigerrimum* as well as in other ant species whose genomes have been sequenced and that include also species from Formicinae and Ponerinae subfamilies. These subfamilies seem to have diverged millions of years ago and therefore one would expect similar rates of divergence for the mariners present in these ants. We perform a phylogenetic study to analyze the possible existence of horizontal transmission mechanisms in the mariner invasion of the ant genomes.

The next generation of species delimitation in the *Tetramorium caespitum / impurum* complex (Hymenoptera: Formicidae)

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Following disputes of more than a century about the number of species similar to *Tetramorium caespitum* (Linnaeus, 1758) it had become generally accepted, that these ants represent just two species: *T. caespitum* and *T. impurum* (Förster, 1850). Then, around the millennium's turn, the detection of variation in cuticular hydrocarbons, nestqueen numbers, mitochondrial (mt) DNA and male genitalia led to the discovery of a cryptic species complex tentatively consisting of seven Central European species. Still, species status is unclear in some cases, in that additional species may exist from which too little material was at hand previously, and in that mtDNA based evidence may suffer from problems such as introgression due to hybridisation – potentially involving even species outside the complex – and incomplete lineage sorting.

In this situation, nuclear DNA markers resolving at the species level are dearly needed. In meeting this demand, we have adapted a next generation sequencing based reduced representation library (RRL) protocol, targeting variable fragments of 1 - 2% of the genome. While 454 sequencing is a cost-effective way to retrieve large amounts of 400 - 500 bp reads from genomic libraries, RRLs severely suffer from short fragment overrepresentation. Our novel, denaturing gel-based approach is a simple and effective solution to this problem.

The nuclear DNA data will also allow the reconstruction of the complex' species tree and will thus elucidate the evolution of the recent cryptic diversity. Of equal relevance is the revised and enlarged set of morphometric characters we have developed – according to "leave-one-out cross-validation" some of our new characters seem to be more useful than former ones – which are core to the necessary nomenclatural changes based on the analysis of type material. A profound morphometric characterisation of the species will also aid in determining existing dry-mounted specimens and thus in resolving the zoogeography of the species complex.

Ant foraging on complex trails: route learning and the role of trail pheromones in *Lasius niger*

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Ants are central place foragers and use multiple information sources to navigate between the nest and feeding sites. Individual ants rapidly learn a route, and often prioritize memory over pheromone trails when tested on a simple trail with a single bifurcation. However, in nature ants often forage at locations which are reached via more complex routes with multiple trail bifurcations. Such routes may be more difficult to learn so that ants benefit from additional information. We hypothesized that trail pheromones play a more significant role in ant foraging on complex routes, either by assisting in navigation or route learning or both. We studied *Lasius niger* workers foraging on a doubly-bifurcating trail with four endpoints. Route learning was slower and errors greater on alternating (e.g. left-right) versus repeating routes (e.g. left-left) – error rates 32% and 3%, respectively. However, errors on alternating routes decreased by 30% when trail pheromone was present. Trail pheromones also aid route learning, leading to reduced errors in subsequent journeys without pheromone. If an experienced forager makes an error when returning to a food source, it reacts by increasing pheromone deposition on the return journey. In addition, high levels of trail pheromone suppress further pheromone deposition. This negative feedback mechanism may act to conserve pheromone or to regulate recruitment. Taken together, these results demonstrate further complexity and sophistication in the foraging system of ant colonies, especially in the role of trail pheromones and their relationship with learning and private information in relation to the challenges of foraging in a complex environment.

Ant larvae as players in social conflict

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In social organisms, cooperation is widespread. However, social groups also provide excellent opportunities for individuals to exploit the cooperative efforts of others, thus creating conflict. Ants provide some of the most intriguing examples of social conflict in nature but whilst much is known about conflicts between adults, the selfish interests of developing offspring has been largely neglected. One taxonomically widespread way for offspring to engage in competition is through egg cannibalism. We show that larvae of the ant *Formica aquilonia* compete by eating eggs, which increases their survival. Cannibalism behavior differs strongly between sexes, and males cannibalize three times as often as females. This points to sex-dependent benefits from cannibalism, for males possibly through removal of future competitors for mating opportunities. Larvae also preferentially eat eggs of distinct origin and odor profile, suggesting that they can detect and react to chemical cues. Thus, similarly to adult ants, larvae possess the power to adjust their behavior to available information. We conclude that exploring the behavior of developing individuals can give new insight into social conflict in ants, and social animals in general.

Resource redistribution in polydomous *Formica lugubris* colonies

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Polydomy (a single colony spread between multiple nests) is a life-history strategy that has convergently evolved multiple times in ants, but its adaptive benefit and organisation remain poorly understood. A polydomous colony is typically made up of several nests connected by trails of ants travelling between them. These colonies are analogous to networks, with nests as nodes, and internest trails as edges. We investigated how the properties of individual nests relate to their position in the network, and how local interactions between nests relates to resource exchange through the network. This was investigated using nest-networks of the facultatively polydomous wood ant *Formica lugubris*. The nest-networks were mapped in the Peak District, England in July and August 2012. We found that *F. lugubris* polydomous networks are structured around exchange of foraged resources. This exchange is mediated by local, pair-wise, interactions between nests rather than colony-level redistribution of resources. Local interactions which build up to more complex, global behaviours is a recurring theme in the study of social insects, and collective behaviour generally.

Poster presentations

(in alphabetical order according to the presenting author's last name)

Split colonies in male production in the ant *Cataglyphis tartessica* with two different morphs of queens

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Cataglyphis tartessica Amor & Ortega (sp. nov., submitted) is an ant species endemic to southern Spain that reproduces by colony fission. Colonies are headed by a single queen that can be either brachypterous (short-winged queen) or ergatoid (wingless queen) with different ovariole numbers (20 to 12, respectively). The aim of this study was to test differences in the production of workers and males in function of the queen morph.

During the springs and summers 2008 to 2010 we excavated a total of 144 colonies, of which 69 were involved in a fission event. Colony demography revealed that:

(1) The number of workers per colony was independent of the queen morph (brachypterous vs. ergatoid: 179.9 ± 34.6 and 214.0 ± 39.9, mean ± SE; ANOVA, Queen effect: $F_{1,54} = 7.99$, $P = 0.37$)

(2) Males were produced only in non fissioning colonies.

(3) Although the number of colonies producing males did not differ significantly depending of the queen morph, males were more abundant in colonies headed by an ergatoid queen ($t = -2.43$, $P = 0.02$).

(4) 65% of the non fissioning colonies produced only worker cocoons; 19% of non fissioning colonies produced only male cocoons; only a 3% of the colonies produce both male and worker cocoons.

Conclusion: Colonies either invest resources in producing workers and can undergo fission or in males and do not fission. The decision of rearing a male or a female brood may come from the queen who controls the production of haploid or diploid eggs. Alternatively, the queen may lay both types of eggs and adult workers decide to eliminate one or the other sex depending on the resources.

Expression of aquaporins in the Malpighian tubules of the tropical ant *Pachycondyla villosa* (Ponerinae)

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The physiological mechanisms that increase or decrease water absorption from the insect haemolymph by the Malpighian tubules (MT) influence the total loss of water via excretion. Aquaporins are membrane proteins that form specific channel for water transport, and cell membranes with abundant aquaporins have higher rates of water flux. Many of the ecological processes that allow insects to have successes in environments with different humidity conditions may be under the influence of aquaporins. Ants of the genus *Pachycondyla* (Ponerinae) are generalist predators found in Brazil's Atlantic Forest occupying a niche with plentiful access to water most of the year, being good models for studies of the physiological mechanisms of resistance to dehydration in insects involving aquaporins. Previous analyzes of immunofluorescence showed the presence of the aquaporin AQPAn.G-like (NCBI: XP_624531) from *Apis mellifera* in the MT of *Pachycondyla villosa*. This study evaluated whether there is variation in the expression of these aquaporins in the MT of ants kept in a humid environment and under water stress. Workers of *P. villosa* were kept in moist (30% RH) and dried (1% RH) soil for 16 h followed by dissection of the MT for RNA extraction and evaluation of the aquaporins mRNA levels by qPCR with primers designed from the *A. mellifera* aquaporin gene AQPAn.G-like (NCBI: XM_624528.3). The *A. mellifera* rp49 gene (NCBI: AF441189) was used as reference gene. The C_t values ± SE obtained for AQPAn.G-like and rp49 genes were respectively 8.26 ± 0.38 and 8.24 ± 0.31 for ants kept in a humid environment and 10.26 ± 0.16 and 10.35 ± 0.12 for ants under water stress. These data indicate that there were no differences in the levels of expression of aquaporins between treatments ($p = 0.85$), suggesting that increased expression of these aquaporin in the MT is not one of the mechanisms responsible for the control of water loss of these ants under water stress. Supported: FAPEMIG, CAPES, CNPq

First data of the Myrmecofauna near the salt lake of Hodna (Chott El-Hodna) in Algeria

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Chott el Hodna (M'sila) is a representative type of wetland in the Mediterranean by the extent of its size and its watershed. Its location in the arid zone is another advantage to justify the rarity of this type of natural environment. Paradoxically however, no studies have investigated the myrmecofauna in this area. The diversity and abundance of ant species were determined across two sites (Medbah and Bir Kraa) in spring (March - April) of 2011 just next the Chott El-Hodna, using a pitfall trapping and hand collecting. We report 24 species of ants comprising four sub-families (Dolichoderinae, Formicinae, Myrmicinae and Dorylinae) and fourteen genera. Pitfall trapping was responsible for recording more species than hand sampling (respectively 21 vs. 15). The two most abundant species in both site are *Monomorium salomonis* (95.3%) and *Tetramorium biskrense* (56.6%). We report that *Aphaenogaster* sp. as new species for the Algerian myrmecofauna that deserves particular attention (probably a new species to science).

Male-biased dispersal promotes large scale gene flow in a subterranean army ant, *Dorylus* (*Typhlopone*) *fulvus*

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Sex-biased dispersal is widespread in the animal kingdom and may strongly influence gene flow and population structure. Particularly army ants, important key-stone predators in tropical ecosystems, are prone to population fragmentation and isolation due to their extraordinary mating system: Queens are permanently wingless and propagate via colony fission and only the males disperse in mating flights. Here we report on sex-biased dispersal and the genetic population structure of an African subterranean army ant, *Dorylus* (*Typhlopone*) *fulvus*. Using maternally inherited mtDNA and bi-parentally inherited microsatellites we found strong geographical structuring of mtDNA haplotypes, whereas the microsatellite genetic population structure was less pronounced. Strong mtDNA, but significantly lower microsatellite genetic differentiation translated to a more than an order of magnitude larger male migration rate compared to that of queens. This reflects the low motility of queens and strong, promiscuous dispersal by males. Thus, the well flying *D. fulvus* males appear to be the sex to promote large scale gene flow. With this study we aim to achieve a better understanding of how the evolution of sex specific dispersal patterns and mating systems affect the population structure and phylogeography of species.

Behavioural effect of *Rickia wassmannii* (Ascomycetes: Laboulbeniales) on *Myrmica scabrinodis* (Hymenoptera: Formicidae)

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The interactions of Laboulbeniales (Ascomycetes) fungi and ants (Hymenoptera: Formicidae) are understudied. These fungi can develop to strong surface on the ant body and we supposed that this structural cuticular change can influence the behaviour of the infected ants. The most frequently found Laboulbeniales in Europe is *Rickia wasmannii*, which often infects *Myrmica* ants and is therefore an easily available model species. The behaviour of infected and uninfected *Myrmica scabrinodis* workers were studied on individual level under lab conditions by hundreds of infected and uninfected specimens in three different experiments. Based on our preliminary results, uninfected individuals were braver and showed higher aggression in one-to-one aggression tests than the infected ones.

Can Bergmann's rule be applied to the relationship between altitude and ant colony size?

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Bergmann's rule describes an increase of body size from tropical to polar latitude; the rule also applies from low to high altitude. According to the superorganism concept, the colony is the unit of selection for ants. Combining these two ideas, this project uses wood ants (*Formica lugubris* and *F. paralugubris*) to investigate changes in colony size with altitude. We developed an accurate and non-destructive method to estimate wood ant nest size. We subsequently tested the hypothesis that nest size will increase with increasing altitude in Swiss Jura mountains during the summer 2012. We found no relationship between altitude and nest size. Another possible factor for nest size variation was canopy cover as we tend to find larger nests in areas with higher canopy cover. We conducted a further study on canopy cover and polydomy of *F. lugubris* in Peak District, UK. We also plan to investigate the canopy cover and polydomy of *F. lugubris* and *F. paralugubris* along altitudinal gradients in the Swiss Alps. The results of this study will not only shed light on the ecology of organisational strategies in ants, but has implications for the study of the effects of climate change on social groups.

Aggregation and grooming behaviour of *Myrmica scabrinodis* infested by the fungus *Rickia wasmannii* (Ascomycetes: Laboulbeniales)

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Ant colonies are highly rewarding target for parasites. Ants employ a number of hygienic behaviours to reduce virulence and transmission of entomopathogenic agents within the colony, as increased grooming and nest cleaning, pathogen avoidance, removal of infected individuals. *Rickia wasmannii* is an ectoparasitic fungus living on different species of the ant genus *Myrmica* in Europe. In Romania, the most frequent host species is *Myrmica scabrinodis*. The fungi penetrate the outer layer of the cuticle of ants. In a previous study we showed that the lifespan of infested individuals was significantly reduced. Parasites, in addition to physiological effects, might also induce behavioural changes in the host that could serve their transmission. We investigated the differences between infested and non-infested host ants regarding corpse handling, aggregation and grooming behaviour. The analysis showed that aggregation pattern of corpses did not differ significantly between infested and non-infested colonies. In addition, individuals did not aggregate in significantly different manner in infested and non-infested colonies. On the other hand, the frequency of allo-grooming was significantly higher in infested colonies. Although allo-grooming aids the removal of thalli from the body of the groomed individual, but at the same time it could increase the transmission of fungi. Infestation with *R. wasmannii* seems to modify, although to lesser extent, the behaviour of infested individuals. E.Cs. was funded by a scholarship of Collegium Talentum and by AntLab Marie Curie Career Integration Grant.

Division of labour in the Mediterranean harvester ant *Messor wasmanni*: is worker size polymorphism involved?

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Division of labour and workerforce allocation are important components of ant social organization that largely contribute to their ecological success. In polymorphic species, a phenotype-task matching may result in an increased worker performance and colony efficiency. However, some tasks may be more strictly linked to the size of the workers than others may. A task like "foraging" seems to be complex to explain concerning worker size: factors such as "temperature tolerance" and "food size range" may affect the size distribution representative of the task. We investigated these topics in *Messor wasmanni*, a seed-harvester ant common in Mediterranean grassland ecosystems, whose colonies exploit food sources by trunk-trail systems.

The first step was to characterize (by field observations and laboratory analysis) the morphometric parameters eventually linked to specific tasks. We selected the following activities that were easier to observe and define: 1) foraging, 2) trail clearing, 3) out-trail occurring workers 4) chaff pile sorting. Further investigation was conducted focusing our attention on the foraging task. In this case, we used artificial seed baits of small and large size categories. This allowed us to evaluate if, within a generalist task as foraging, the temperature and seed-size may determine a sub-allocation of worker size to optimize foraging success.

Workers involved in the tasks differed significantly concerning the considered morphometric parameters, suggesting that in *M. wasmanni* division of labour is linked to the polymorphism of this caste. Tukey's test showed a similarity between chaff pile sorting and foraging, as well as between chaff pile sorting and trail clearing, suggesting the possibility that workers switch from one task to the other over their lifespan. Concerning the foraging task preliminary results didn't show an overall effect of the considered factors on worker size. These results are discussed in respect of bibliographic data.

The ant fauna (Hymenoptera: Formicidae) of a short rotation coppice agroforestry system

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Agroforestry systems are currently discussed with respect to their potential as integrative biodiversity conservation measure in agriculture. An open question is whether agroforestry should be eligible as ecological focus area within the greening of the EU common agricultural policy. One type of agroforestry in Europe is alley cropping with strips of short rotation coppice (SRC; mainly of fast growing poplar) for the combined production of food and energy. So far little is known about the importance of those systems for the effective support of biodiversity in agricultural landscapes.

To increase our understanding of the habitat quality of SRC-alley cropping for ground dwelling arthropods, we compared their assemblages in SRC-strips with different composition of trees and different rotation periods in autumn and spring (2012 / 2013) using pitfall-traps. In addition, we compared the arthropod communities overwintering in soils of the alley cropping system to those of seminatural habitats (e.g. hedgerows, grassy fieldbanks) and conventional agricultural fields by taking soil samples in winter 2012. Here we present the results obtained for ants.

In the SRC-strips predominantly common ant species such as *Lasius niger*, *Myrmica rubra* and *M. scabrinodis* were found. Also in the soil samples only *L. niger* was present in the SRC-strips. In contrast, in the seminatural landscape elements species of more specific habitat requirements occurred in the soil samples such as *Myrmecina graminicola* (grassy fieldbank), *Stenamma debile* (hedgerow) and *Temnothorax nylanderi* (forest edge). In conclusion, SRC-poplar strips, even four years after planting, do not provide habitat for a species rich ant community. Their importance for biodiversity conservation in agricultural landscapes, in comparison to seminatural landscape elements, therefore is questionable and has to be tested for further taxonomic groups as well.

Regional diversity and resource use in the ant genus *Pachycondyla* in southeastern Bahia, Brazil (Hymenoptera: Formicidae: Ponerinae)

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The ant genus *Pachycondyla* is here referred to in the sense of MacKay & MacKay (2010), although many nomenclatural changes are to be expected since the Schmidt's work (2009). These ants are generally characteristic of well conserved forest or perennial crops in tropical regions. In general, they form colonies with small to medium (500+ individuals) populations. Thirty-four species are currently known in southeastern Bahia, Brazil, with only two species probably being endemic to the Atlantic rain forest, namely *Pachycondyla* sp. A and *P. schultzi*. Multi Dimensional Scaling (MDS) analysis shows the strong dependence of these ants on the structure of the forest vegetation. Most of them are inhabitants of litter layer in wet habitats; some of them are facultative arboreal (*P. apicalis*, *P. constricta*, *P. unidentata*); others live obligatory on the trees where they nest in hollow branches or in epiphytes (*P. curvinodis*, *P. inversa*, *P. villosa*); and a few are cryptobiotic and nest more or less superficially in the soil of forest or cocoa plantations (e.g. *P. bucki*, *P. ferruginea* or *P. holmgreni*). The way these ants divide the resources when they are in sympatry is poorly understood. Most of them are confirmed or supposed to be generalist predators and scavengers; arboreal species also opportunistically visit extrafloral nectaries or Hemiptera-produced honeydew; while few species are specialized termite predators (*P. holmgreni*, *P. laevigata*, *P. marginata*).

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The mechanism of resource redistribution in polydomous *Formica lugubris* colonies

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Polydomy (a single colony spread between multiple nests) is a life-history strategy that has convergently evolved multiple times in ants, but its adaptive benefit and organisation remain poorly understood. A polydomous colony is typically made up of several nests connected by trails of ants travelling between them. How a colony exchanges resources between nests of a polydomous colony is unknown. Here we investigate the mechanism of resource redistribution in polydomous *Formica lugubris* colonies. Red wood ant foraging behaviour has been shown to be based on individual foragers showing a high degree of site allegiance and route fidelity. We use RFID tags to investigate if a similar mechanism can be used to explain resource redistribution through a polydomous colony.

Simple defense mechanisms against a parasitic fungus in *Formica polyctena*

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The social system of ants is an attractive target for parasites, as the high abundance of potential host organisms is combined with the spatial and temporal stability of colonies. Ants developed various physiological and behavioural defence adaptations in order to fight parasites: e.g. development of metapleural gland, nest cleaning, mutual grooming, disposal of refuse material from the nests. Our target species, *Formica polyctena*, is parasitized by the lethal endoparasitic fungus *Pandora myrmecophaga*. The fungus manipulates workers to climb and die on grass-blades near the nest, which ensures the efficient distribution of the parasite by covering the nest surface with the spores produced afterwards. This technique predicts high prevalence of the fungus. We tested a hypothesis regarding the existence of simple defence mechanism: workers would dispose of every corpse, as potential source of infestation, appearing on grass-blades, thus lowering the chances of infestation. We imitated the appearance of infected ants by fixing fresh and one-day old corpses on grass-blades near the nest. The effect of distance was tested by fixing one-day old corpses 0.5 m away from the nest; dummies placed near the nest served as controls. The discovery and removal success of the corpses by target ants, as well as the behaviour of ants was observed. The results confirmed our hypothesis: ants quickly discovered close corpses within two hours, and then they removed them efficiently within one day. Following the discovery of close corpses ants were present constantly. On the other hand, dummies did not elicit intensive reactions. This defence mechanism can be very efficient against those parasites that rely primarily not on within-nest, but external factors during their dispersal, because in such way their dispersal rate can be significantly decreased. During data analysis K.E. was subsidized by Collegium Talentum (Bethlen Gábor Fund, Budapest, HU).

The effect of wood ants *Formica polyctena* on nutrient turnover and tree growth

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The effect of *Formica polyctena* ant nests on distribution of nutrients and growth of young seedlings and adult trees was studied in laboratory experiment and field survey.

Nest material and soil in close vicinity of the nest (< 1 m) showed significantly higher content of nutrients P, N, K, Ca, and higher pH, than samples in the larger distances from the ant nests. Some depletion in nutrients and increase in organic matter and increase in pH was observed in distances 1 - 8 m from the tree. Ants support high nutrient content in the nest by food and ant nest accumulation and by fasted decomposition in the nest. Growth of young seedlings and nutrient content were compared between nest material and surrounding soil. Analysis of the tree rings indicated the fastest growth for trees that were located more than 200 m from the ant nest. The second highest growth was observed in the trees that were in close vicinity of the nest. The weakest growth was found for trees growing in intermediate distances from the nests. We expect that depletion for nutrients by honeydew collection from the trees in vicinity of the nest may slow the tree growth. The tree, that grow in close vicinity of the nests may compensate for this nutrient depletion by surplus of available nutrients in immediate surrounding of the nest.

The results are discussed in the context of nutrient cycling in forest ecosystem and cost and benefits for tree growth.

Current aspects of ant biogeography in Greece

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Greece at present holds the richest myrmecofauna in Europe. Recent publications and research regarding ants from mainland and insular Greece have raised the need for a reassessment of the status of ant species, which have been recorded and described from this Mediterranean area. Under this scope, we have prepared a current catalogue of 283 species belonging to eight subfamilies indicating their biogeographical distribution and endemism, according to chorotypes proposed by Taglianti et al., 1999. We present alpha, beta and gamma diversity matrices on a geographical scale with annotations on several species regarding their taxonomic status. GIS spatial analysis is used to portray local taxa distribution. In addition, we have developed an identification software tool (Linnaeus II, ETI BioInformatics), based on published descriptions and morphological characteristics of specimens from the Formicidae collection of the Zoological Museum of the University of Athens. Finally, we propose several rare and endemic species to be included in the National and IUCN Red Data Books, as species of important conservation concern.

Actualisation of the Swiss Red List of ants

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The Swiss Red List of Ants needs an update at many levels: systematic (new species description after 1994), threat degree and faunistic (new records after 1994). In this purpose, different sampling methods have been tested in southern Swiss Alps: Canton Ticino and Moesano (Canton Grigioni). This region has been chosen because in the last 30 years, many studies on ants have permitted to create a complete dataset, which can now be very useful for comparing different sampling methods. This project is supported by the Cantonal Museum of Natural Histoy of Lugano (MCSN), by the Swiss Cartographic Centre for Fauna (CSCF) and by the regional Forest Services.

In 2012 and 2013 ants have been collected by direct hunt, attractive traps, litter techniques and beating branches. Afterwards, a standard sampling method representative for ant fauna in Switzerland, will be created.

As for some species the genetic approach is the only certain method for correct species identification (*Tetramorium* spp.), a survey of genetic material of sampled species is also realized within the SwissBOL project (Swiss Barcode of Life).

Besides the ant sampling in 2012-2013, other ants collected in regional vineyards by pitfall traps during a separate study in 2011, have also been identified. This meadows are indeed very interesting habitats and allowed to gather some rare species (*Aphaenogaster italica*, *Chalepoxenus muellerianus*, *Hypoponera punctatissima*, *Messor structor*, *Plagiolepis xene*, *P. pygmaea*, *P. vindobonensis*, *Polyergus rufescens*, *Pyramica argiola*, *Stenamma striatula*, *S. zanoni*, *Strongylognathus testaceus*) and to find new species for the southern Swiss Alps (*P. baudueri*, *Strongylognathus alpinus*).

Zn tolerance in the ant *Lasius niger*: does common mean tolerant?

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Common garden ant (*Lasius niger*) is the most frequent ant species detected in the metal-polluted area in vicinity of Olkusz, southern Poland. The study area is highly polluted due to intensive emission of dust containing metals, mainly Zn, Cd and Pb, resulting in one of the heaviest polluted area in Poland. The study presents the results of field survey and laboratory feeding experiment performed on 57 independent ant colonies in order to assess Zn-tolerance of *L. niger* workers.

Although *L. niger* was found in each of 20 study plots, its abundance was negatively correlated with the metal soil pollution of these plots. Furthermore, contrary to expectations ants originating from the most polluted sites were more sensitive to relatively high and high dietary Zn doses than the ones from less polluted sites. Our data suggest that high abundance of *L. niger* in the study area is supported by other biological features than adaptation to Zn by itself.

Anemotactic orientation in leaf-cutting ants during digging

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The grass-cutting ant *Atta vollenweideri* inhabits giant underground nests and builds large conical-shaped mounds uncovered of vegetation. A mature nest may contain up to 200 nest openings, most of them very large, through which air moves to allow a continuous gas exchange between the nest and the environment. The direction of the air-flow depends on the location of the nest openings, i.e. the central ones serve as outflow conduits, whereas the peripheral ones serve as inflow conduits. To enhance nest ventilation, workers build conspicuous turrets on top of the nest mound. Since workers build ventilation turrets mostly on outflow conduits, we hypothesized that ants are able to perceive the direction of air movements.

In the laboratory, workers of *Atta vollenweideri* that experienced either inflow or outflow of air while digging were subsequently given a choice between two alternative digging sites in a T-maze, one providing inflow and the second one outflow of air. Ants that previously experienced an inflow of air significantly chose the inflow site to continue digging, whereas workers that experienced an outflow of air preferred the outflow site. These results indicate that ants are able to perceive the direction of air currents inside the nest and can use them as orientation cues during nest digging.

Male "territoriality" in *Cardiocondyla venustula*: insights from behavioural and genetic analysis

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The evolutionary biology of social insects and their fascinating complex social structures including sterile worker castes have been important research topics in the field of social evolution. However, inter- and intrasexual selection were seldom taken into account neither as cause nor as consequence of the evolution of eusociality, partly because in many ant species matings occur only in a short period of the year and are hardly observable.

In contrast, many species of the genus *Cardiocondyla* have wingless males with lifelong spermatogenesis and easily observable intranidal matings. They furthermore show a large variety of mating systems including wingless fighter males with or without sporadically produced peaceful winged males or mutually tolerant wingless males. A formerly unknown behaviour in social insects was discovered in a Hawai'ian colony of *Cardiocondyla venustula*: wingless males fight for "territories" in their nest and only occasionally engage in lethal combat. In our study, behavioural observations of several colonies from different geographical origins provide deeper insights into this "intermediate" male strategy. Molecular genetic analysis shows effects of this mating strategy on population genetic structure and diversity and further enlightens the phylogeny.

Effects of temperature and altitude on CO_2 production of ants and nest materials – preliminary results

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Wood ants maintain stable high temperatures in their nests, even in different mean annual temperatures, i.e. on latitudinal and altitudinal gradients. One of the possible mechanisms of heat production is metabolical activity of ants and microbes living in ant nests. In our study we tested CO_2 production (metabolical activity) of ants and microbes on altitudinal and temperature gradients.

In a manipulation experiment, we incubated ants and nest materials (microbes) from two different altitudes – 700 and 1000 m, in three temperatures – 10, 20, 28°C, for two days. Consecutively, respiration was determined. Respiration of both, ants and nest materials, significantly increased with temperature. Effect of altitude was not significant in nest materials, however, respiration of ants from the higher altitude was significantly higher in comparison to the respiration of ants from the lower altitude.

Our results suggest that ants from higher altitudes have higher metabolical activity and thus may contribute to maintaining of high temperatures in ant nests in colder conditions, whereas nest material does not seem to play a substantial role.

Use of thermal imaging for studying ant nest thermoregulation – a novel methodic approach

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Wood ants are well known for their huge nests, which may contain more than million workers. The nest does not serve only as a shelter for adult workers; it is an effective incubator for brood with very precise thermoregulation as well. There are several proposed mechanisms how the ants keep their nest warm. The nest structure works as a solar collector, moreover there is a significant contribution of microbial activity to nest heating and presumably the ant workers are capable of active nest thermoregulation too. The most striking thermoregulatory behavior of ants could be observed early in the spring, when the ants create thick clusters on the nest surface and bask in the sun. Heated enough the ants move into the nest interior where the accumulated heat is released. This way the workers can speed up the establishment of nest thermal homeostasis after winter.

Until today this behavior was observed by many authors, but its importance for nest thermoregulation was not scientifically evaluated. As a novel method we are testing the use of FLIR infrared cameras for investigation of ant clustering and basking behavior. The thermo camera makes accurate non-contact temperature measurements which enable us to assess the surface temperature of nest and more importantly the body temperature to which basking ants heat themselves without disturbing the process. Later on we will be able to calculate the total amount of heat which is transferred into the nest by ant bodies. In this contribution we would like to discuss the most problematic issues concerning the use of thermal imaging for field research of wood ants and present first results of our study.

First record of the south European rare parasitic ant species *Camponotus universitatis* Forel (Hymenoptera, Formicidae) in Asia

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Camponotus universitatis was the only known inquiline parasitic species of the genus *Camponotus* until *C. ruseni*, a putative parasitic species, recently described by Karaman in 2012. *C. universitatis* has only been recorded from southern Europe (Spain, France, Italy, Switzerland, Albania and Bulgaria) by a few studies. Although the Bulgarian record of *C. universitatis* was from Strandzha Mountains which is located very close to Turkish boundary, no record for the species has been given from Turkey so far. In this study, we recorded *C. universitatis* from Konya-Akşehir-Engili Village (Central Anatolia) representing the first record in Asia.

This study was supported by TUBITAK (The Scientific and Technological Research Council of Turkey) (Project No: 109T088).

Ant fauna (Hymenoptera, Formicidae) of hazelnut and tea orchards in eastern Black Sea region in Turkey

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This study was performed to determine the ant fauna of hazelnut and tea orchards located in eastern Black Sea region of Turkey.

526 samples from hazelnut and 136 samples from tea orchards in 35 localities between 0 - 1463 m a.s.l. were collected during 21 days excursion in 2012. With this study four subfamily (Dolichoderinae, Formicinae, Myrmicinae, Ponerinae) and 42 species were determined (26 species in tea orchards, 38 species in hazelnut orchards).

Nests of 34 species were found (33 in hazelnut, 19 in tea orchards) in several microhabitats (under stone, in soil, in and under tree trunk, in branch, under bark, in stone crevice and under moss), and eight species nest were not found (five in hazelnut, seven in tea orchards). *Aphaenogaster subterranea* is the most abundant species in both hazelnut and tea orchards (79 observations – 15.2% hazelnut, 34 observations – 25% tea orchards). Four species occur only in tea orchard, 16 species only in hazelnut orchard, 22 species in both, and 20 species are observed in only one orchard.

As a result hazelnut orchards have higher species richness and abundance than tea orchards by occupying larger areas, having various vegetation ranging from grass type plants to high trees thus providing more suitable nest and foraging grounds.

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Three Genomes Shape Diverging Populations of the Opportunistic Ant Cardiocondyla obscurior

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The Myrmicinae ant species *Cardiocondyla obscurior* is a model system for studying eusocial traits. In the framework of the *C. obscurior* genome project, two diverging populations of Brazil (BR) and Japan (JP) are compared with regard to genomic and phenotypic features. Meanwhile, procaryotic scaffolds in the genome revealed that *C. obscurior* harbours two endosymbiotic bacteria: *Wolbachia* and *Sodalis*.

In this study, we analyzed endosymbiont content by using real-time qPCR of bacterial genes. The population comparison confirms the coverage data of the genome: *Sodalis* is exclusively found in the BR population, while the level of *Wolbachia* in individual ants is higher in JP than in BR. Moreover we investigated the influence of morph, age and temperature on the endosymbiont titer. *Wolbachia* abundance was only significantly influenced by temperature, while *Sodalis* titer was also dependent on morph and age of the individual ant. Hence *Wolbachia* seems to be a stable symbiont, only reacting to environmental conditions, whereas *Sodalis* interacts more intensively with the host.

44 years of settlement behavior and population dynamics of hill-building wood ants (1966 - 2010) in Freiburg area (SW-Germany)

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The occurrence of hill-building wood ants of the *Formica rufa*-group was comprehensively surveyed repeatedly (1966, 1969, 1972, 1976, 1978, 1991, 1992, 1997, 2008, 2009, 2010) in 1640 ha area (300 - 800 m above MSL) east of Freiburg / Br. (SW-Germany) and their settlement behavior and population dynamics analysed. Between 208 and 314 (mean 265) occupied nests were found each year, mostly *F. rufa* (L.) and *F .polyctena* (Foerst.). *F. pratensis* (Retz.) and *F. lugubris* (Zett.). represented only 10 and 5%, respectively, and *F. truncorum* (Fabr.) even less. The ant community exhibited a clear shift in species composition and a shift into the higher altitudes of the study area. A decline of *F. rufa* and an increase in *F. polyctena* corresponded to changes in the percentage of nests belonging to colonies and colony size. At first 75% of both species belonged to colonies, but this proportion declined for *F. rufa*, while *F. polyctena* developed more and larger colonies.

The average density was 16.2 nests per 100 ha, but the majority of the study area remained largely free of ants. In contrast, several large settlements were regularly encountered in a small space. Out of 82 (500 × 500 m) cells laid over the study area, approximately 30 were regularly occupied by *F. rufa* with densities of about four nests per cell, while *F. polyctena*, at densities of about eight nests per cell, was limited to far fewer squares. The correlation of the species' densities (*F. polyctena* with *F. lugubris*, *F. rufa* with *F. pratensis*) within the cells was weak. Occurrence of some of the species appears mutually exclusive; *F. rufa* and *F. polyctena* occurred mostly in different cells.

The continued occurrence of small areas of high population density suggests that the study area is suitable for settlement only at a few places. The ants tended to settle close to conspecific nests; the distance to the nearest neighbor was usually less than 50 m. The resulting small size of the territory of a given species seems to be offset by the favorable local conditions and benefits from neighboring conspecific nests.

Winter activity of the false honeypot ant, *Prenolepis nitens* (Mayr, 1853) in Hungary

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Prenolepis nitens, the single European species of its genus, is an uncommon formicine ant, which has an area of distribution from the west of Italy across Central Europe and the Balkan Peninsula to the Caucasus and Asia Minor in the east, inhabiting mostly Mediterranean and Sub-Mediterranean habitats. In the studied area, it is one of the most abundant ant species, which, contrary to its distribution, has a less thermophilous character, showing highest activity in spring and autumn, and lowest in summer, at higher temperatures.

The aim of the present study was to determine if this species keeps its foraging activity during winter. Field work was conducted in the oak forest on the south-facing slope of Péter Hill, located in the middle of the Balaton uplands, in mid-western Hungary. To assess winter activity of *P. nitens*, baiting and quadrate sampling were carried out during seven 5 h periods, from 10 am to 3 pm, between December 2012 and March 2013. Air temperature on the soil surface and soil temperature in 30 cm depth was measured each hour.

Similarly to its North-American sister species, *P. imparis*, the so-called "winter ant", *P. nitens* was also active during the winter period examined. There was a significant positive correlation between its activity on baits and soil temperature. The lowest temperature at which foragers could have been observed was 2.6°C (with soil surface temperature 1.3°C), though they began to forage actively in higher numbers only when soil temperature raised above 4°C. Based on the carried prey items that were taken from workers observed in the quadrats, the collected winter food of *P. nitens* seems to consist mainly of springtails, presumably benumbed with cold.

Contribution of cytogenetics to the integrative taxonomy and biogeography of neotropical Ponerinae (Hymenoptera, Formicidae)

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Studies on Ponerinae are especially important for the Neotropics since the diversity of these ants is increasingly considered to be a trusted biological indicator of the health of native environments, as many of these ants are very sensitive to the degradation of their habitat. Recent studies on several genera of Neotropical Ponerinae have shown that these ants are more diverse than generally thought, with examples of cryptic sympatric species, or taxa constituted by allopatric (sometimes, sympatric too) populations being cytogenetically different, with or without morphological characters allowing us to distinguish them. That is the case, for example, in *Pachycondyla* spp. (sensu MacKay & MacKay, 2010) of the species groups Harpax, Villosa or Apicalis, and in *Dinoponera* spp. or *Thaumatomyrmex* spp. of the Mutilatus species group. On the other hand, the same kind of studies showed that populations of some other Ponerinae and with a large distribution seem rather homogeneous from the cytogenetic point of view, even in apparently isolated populations, such as in *Odontomachus* spp., *Pachycondyla constricta* or *Thaumatomyrmex atrox*, suggesting the recent geographical expansion of these species. Our results are put in parallel with those of Imai, Crozier, Crosland and Taylor when they studied the cytogenetic structure of populations of the Australian genus *Myrmecia* (Myrmeciinae) in the 1980's and 1990's.

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Hydrocarbons and sterols from intramandibular glands of the ant *Pachycondyla villosa* (Fabricius, 1804) (Hymenoptera: Ponerinae)

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Various exocrine gland secretions modulate the behavior of social insects. Among the exocrine glands, the function of intramandibular glands has not been well characterized. In order to study the effects of exocrine gland secretions on the behavior of the ant *Pachycondyla villosa*, identification of body surface and intramandibular gland compounds was performed and was followed by behavioral analyses. These analyses revealed a significant increase in walking time for ants exposed to nestmate mandible extract. Seven different compounds were identified in workers and queens. Linear alkanes C28 and C30, as well as the methylated alkane 18, 17, 13-MeC38, were found on the body and mandible surface of both workers and queens. Methylated alkanes 4-MeC28 and 13, 11-MeC32 were only found on the body surfaces of workers and queens. The sterols, cholesterol and sitosterol, were found only in the mandibles, with cholesterol present in both workers and queens, and sitosterol present only in queens. The results suggest that intramandibular gland compounds of *P. villosa* may play a role as indicators of nestmate recognition or worker activity. The presence of hydrocarbons and cholesterol in workers and sitosterol in the mandible of queens may be associated with caste profile.

The cavity-nest ant *Temnothorax crassispinus* prefers larger nest sites

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Colonies of the ant *Temnothorax crassispinus* inhabite mostly cavities in wood and hollow acorns. It is difficult to measure real volume of most nest sites. Typically in the field nest sites, which can be used by the ant, are limited. I analysed whether the ant prefers specific size of nest, when different ones are available. In July 2010, total of 160 artificial nests were placed in a beech-pine forest. Four artificial nests (pieces of wood with a longitudinal cavity 4 mm in diameter, volume ca. 415, 605, 730, and 980 mm^3, respectively) were located on each square meter of the experimental plot. One year later, shortly before the emergence of new sexuals, the nests were collected and transferred to the laboratory. The nests were carefully opened, the ants captured with an aspirator and counted. Then the ants were reared in artificial conditions. In July 2012 colonies with queens inhabited more frequently bigger nest sites, and colonies which inhabited bigger nests had more workers. However, there was no relationship between volume of nest site and number of workers for queenless colonies. Colonies from bigger nest sites produced more sexual individuals, but there were neither correlation between number of workers and sex allocation ratio, nor correlation between volume of nest and sex allocation ratio.

The call of duty: light, temperature and humidity cycles as zeitgebers for circadian activity rhythms in *Camponotus* ants

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Ant colonies show complex division of labor, with various tasks performed by distinct worker castes. Here, the temporal coordination among workers and their environment is essential for adaptive collective behavior and colony success. Endogenous clocks are known to enable the determination of daytime or season, and the corresponding timing of activities. Reliable zeitgebers are required to synchronize the endogenous clocks and the generated rhythms with the environment, even inside the nest. To what extent the locomotory activity of ants is under the control of an endogenous clock and what the potential zeitgebers are was investigated in *Camponotus* ants. As all these factors vary through the day under natural conditions, daily cycles of light, temperature and humidity were tested as zeitgebers for circadian activity rhythms in *C. mus* workers. A subcolony composed of workers and brood was first exposed to one of the zeitgebers to be tested. After four weeks of entrainment, individual activity profiles of isolated ants were recorded via customized locomotor activity monitors. Under a 24 hour light-dark-cycle (12 h light / 12 h dark), all ants showed a marked activity-rest cycle, with the activity occurring in the light phase. Light acted as a strong zeitgeber, because the period of activity rhythms correlated with the period of the zeitgeber cycle and additionally a fast resynchronisation occurred after a 6-hour phase delay. Locomotor activity under either temperature or humidity cycles also showed rhythmicity, but period values deviated from 24 h. Since the resynchronisation after a phase delay took several cycles and occured only in some of the individuals, humidity and temperature were considered as weak zeitgebers. Nevertheless, these non-photic cues were able to entrain the circadian system of *C. mus* in constant darkness and are therefore expected to enable timing of worker activity within the nest.

Short-term changes in ant community structure along a successional gradient on abandoned old fields in Romania

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Significant proportion of agricultural lands are abandoned nowadays in Central-Eastern Europe. The study of insect versus plant community succession could help us understand how these lands transform and, eventually, return to a semi-natural state. Ants are present in high densities in almost every type of terrestrial habitats, therefore they can be used efficiently for biomonitoring studies. We studied epigaeic ant communities of abandoned Transylvanian old-fields along a successional gradient, in order to elucidate how these communities change structurally, and whether short-term changes occur and to what extent. Pitfall traps were applied in four different aged old-field (1, 8, 16, 30 years old) as well as on two control sites (reference grassland and a shrub-land) near Suatu, Central Transylvania, Romania. Collections were carried in autumn 2006, 2008 and 2010. We identified a total of 18 ant species. The most abundant ant species were the disturbance requiring *Lasius paralienus*, *Formica cunicularia*, and *Tetramorium* cf. *caespitum*. A noticeable short-term increase in the diversity of the ant community was registered only at the one year old field, whereas the overall highest ant community diversity was recorded at the shrub-land stage. Disturbance-requiring species dominated almost every community based on the species abundance data, however, the number of grassland species was higher, generally, than the species number of any other ecological category. The old-fields of different ages are clearly distinguishable based on vegetation structure, and they also differ based on their ant communities. Significant short term changes occurred only in the case the ant community of the one year old-field. Our results suggest that ant communities of old-field do not return to a so-called natural state, where grassland species would dominate in every respect.

Early task division in *Cardiocondyla obscurior*

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We study foraging in *Cardiocondyla obscurior*, an ant that forages individually. We describe basic properties of foraging such as daily activity rhythms, onset of foraging, interactions of returning workers with recruits, etc. We also study the division of labor of very young workers. To this end we set up colonies comprising a standardized number of worker pupae, eclosing within the same day. Approximately 10% of these young workers begin foraging while the remaining workers stay in the nest. We describe the expression of foraging, a gene that has been associated with this task.

Identification of the chemical compounds in the venom of the tropical ant *Pachycondyla striata* F. Smith (Formicidae: Ponerini)

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Ant venoms are a complex mixture of alkaloids, hydrocarbons, carboxylic acids, proteins, peptides and other bioactive compounds, used in individual or in the colony defense. This study identified the main compounds in the venom of *Pachycondyla striata*. For the study four colonies were collected in Viçosa, MG, Brazil (20° 48' S 42° 51' W). About 60 workers from each colony were cryo-anesthetized, dissected and the venom reservoir transferred to 1% protease inhibitor cocktail solution. Samples containing venom proteins were submitted to 2D gel electrophoresis. For each spot detected were calculated isoelectric point (IP) and molecular weight (MW), followed by analyses on MALDI-TOF-TOF. PMF and MS / MS analyzes were performed, and then identified from the protein sequences deposited in NCBInr and Swissprot, assuming $p < 0.05$ and $p < 0.01$. For analysis by GC-MS, 1µL of the venom were injected into gas chromatograph QP-2010 plus, equipped with silica capillary column RTX-5MS. For each compound detected by GC-MS were calculated Kovats indices, followed by comparison to the mass spectra available in electronic libraries Wiley 7.0 and Nist 8.0. A two-dimensional separation of proteins from the venom showed the presence of 29 spots with MW between 8.7 to 296.6 kDa and IP from 3.4 to 9.9. The identified proteins are ctenitoxina-U10-Pn1a; protein Wnt-7a; aminopeptidase N and hialuronoglucosaminidase. The GC-MS analysis identified the presence of 29 compounds in the venom of *P. striata*, including hexadecanoic and oleic acids and hydrocarbons C_{20}-C_{30}. These findings suggest a complex mixture of compounds in the venon of *P. striata*, which may play roles in both defense and chemical communication.

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Parallel evolution of wing venation in different subfamilies of Formicidae

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Homoplasy in morphological evolution has been known for a long time, including Formicidae. The most difficult problem for investigation is parallel evolution of closely-related taxa. In this situation for differentiation the morphological similarity (homoplasy or homology) we solve a complex problem. We investigate ways of transformation of wing venation types in forewings of Formicinae, Dolichoderinae, Myrmecinae and Poneromorpha.

Recent Formicidae have wide range of forewing venation types (16 by our typology). Nevertheless most of them we observe simultaneously in several subfamilies and some of the types are more frequent. In that way a similar wing venation (homoplasy) in different subfamilies arise as a result of parallel evolution. We show stages of formation of new venation types on the basis of intraspecific variability. The reduction series of venation transformations for each subfamily was produced. Different subfamilies are distinguished by details of venation because of different evolutionary ways of its reduction. For example, reduction of the second and third sections of the RS vein takes place after the reduction of the fourth section in myrmicine wings. While the fourth section of the RS vein in poneromorphs form the transversal radial vein named usually as the second 2r-rs. Therefore, the second 2r-rs vein is long and sloping in poneromorphs but short and erect in myrmicine wings. The features of venation of different subfamilies are defined by different ways of reduction of respective wing area.

Starvation-induced gene expression and inbreeding in the ant *Formica exsecta*

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Inbreeding has profound consequences on a genomic, individual, population and even species level. However, the effects of inbreeding on natural populations, especially on insects, remain largely unstudied. Ants are an ideal model system to study the consequences of inbreeding, as they are ecologically important and form socially complex groups. Social groups provide another level possibly affected by inbreeding, as the large amount of interactions between numerous individuals could give rise to socially mediated inbreeding depression. Inbreeding has been shown to have negative consequences both at the individual and colony level in a natural population of the narrow-headed ant (*Formica exsecta*). Here, we compare the resistance of inbred and outbred worker ants against starvation. We analysed changes in gene-expression upon starvation, and investigate the effect of inbreeding on the found expression profiles.

The invasion strategy of Yellow Crazy Ants

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All highly invasive ant species are polydomous, spreading their colony across multiple nests. These species can have huge negative impacts on the native ant fauna and the ecosystem they invade. Relatively little is known about how invasive species use polydomy to move into new environments. We studied the devastating invasive species *Anoplolepis gracilipes*, (Yellow Crazy Ant) in the Northern Territory of Australia to determine their nesting strategy. We tested two strategy hypotheses: territorial saturation versus food-driven spread. The territorial saturation hypothesis predicts that colonies of an invasive species occupy as many potential nest sites as possible, dominating the area. The food-driven spread hypothesis predicts that colonies of an invasive species selectively spread into nest sites near food sources. We compared these to the null hypothesis that colonies spread through a random diffusive process. Our results strongly support the food-driven spread hypothesis and suggest that Yellow Crazy Ants do not use a territorial saturation nesting strategy. We discuss the implications of these findings for the spread and success of damaging invasive ant species.

Taking out the trash: the role of olfactory cues in leaf-cutting ant waste management

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Waste management plays an important role in leaf-cutting ant colonies because of the susceptibility of their symbiotic fungus to contaminants and pathogenic fungi. Workers continuously remove pieces of exhausted and infected mycelium from their fungus chambers. But where to dispose of the colony waste? We investigated whether leaf-cutting ants try to avoid the disposal of refuse near their symbiotic fungus, and whether volatiles arising from both the refuse and the fungus are used as orientation cues for waste disposal. A subcolony of *Atta laevigata*, consisting of a fungus garden and inhabiting workers, had access to a circular arena with a fine-meshed bottom, so that workers could perceive volatiles coming from below. In the middle of the mesh, a small amount of waste was placed. A round container located below the arena was divided into two half-rounds filled with fungus or waste as odour sources. We performed three series offering the following odour sources: fungus vs. empty, waste vs. empty, and waste vs. fungus. After 3 h we measured how much of the waste initially placed in the circular arena was relocated towards one of the sides exposed to the volatiles. To our surprise ants did not remove the waste material when exposed to fungus volatiles coming from below as far as the alternative side contained no odour source. However, when waste was presented as odour source, significantly more waste was relocated towards that side. Our results indicate that workers use the waste odor as an orientation cue to decide where to dispose of the refuse, which would lead to massive waste accumulation at an already established place within the nest.

The construction of underground foraging tunnels by leaf-cutting ants (*Atta laevigata*)

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Leaf-cutting ants of the species *Atta laevigata* build giant subterranean nests with conspicuous tunnels that connect to foraging sites at distances of up to 70 meters. It can be assumed that the width of those tunnels should be appropriate for the size of the colony and the thereby arising foraging traffic. We hypothesized that bottleneck passages in an underground tunnel may cause traffic congestions and crowding, resulting in a lower speed of leaf transport that should be avoided.

We investigated the development and maintenance of underground foraging tunnels in the leaf-cutting ant *Atta laevigata* under varying conditions of traffic intensity and crowding. Under laboratory conditions, we connected a colony to a foraging arena located 5 meters apart. To reach the arena, workers needed to pass a clay-filled box with a prepared tunnel of a given width. A section of the tunnel was narrowed to still allow workers to walk through, but to cause crowding. In control series, no tunnel constriction was offered. Workers were expected to widen the narrowed tunnel by digging, so as to facilitate the traffic flow. Results showed that ants mainly excavated at the narrowed tunnel section and widened the tunnel, which resulted in an increase in the speed of leaf-transport as compared to the conditions without tunnel constrictions. The results are discussed in the context of traffic dynamics and foraging efficiency.

Ants at the upper limit – ecological inverstigations of Tibetan ants (Hymenoptera: Formicidae)

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Within the project PADEMOS: "Monitoring of rangeland health in response to environmental changes on the Tibetan Plateau", we have investigated ants on 17 different stations in the Chinese provinces Ganzu, Quinghai and the Tibetan Autonomous Region during the years 2011 and 2012. We aimed on finding differences in ant species composition between intensively and less intensively grazed test plots. Except when otherwise indicated by the missing investigation of type material of taxa currently considered as junior synonyms, we could find 14 still undescribed ant species within a total of 32.

Ants could be found on our 100 m^2 plots up to 4387 m a.s.l. (at 33.827°N). The species number was decreasing from 3.3 between 2700 and 3500 m a.s.l. (max. 6 at 3296 m) to 1.0 above 4000 m a.s.l. (*Formica candida* Smith, 1878). The nest density was decreasing from 50 nests / 100 m^2 below 3500 m a.s.l. to 18 nests / 100 m^2 above 4000 m a.s.l. We compare these results to our findings in the European Alps.

Transport of vitellogenin in the ovary of the Neotropical ant *Pachycondyla striata* (Formicidae: Ponerini)

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Vitellogenesis involves the synthesis of lipoglycoproteins named vitellogenins in the fat body, which are the main yolk compound in the oocytes. The vitellogenin is synthesized on a large scale in the fat body, released into the hemolymph and captured by the developing oocytes where vitellogenin is converted to vitellin to be consumed during embryogenesis. However, vitellogenin need to cross the follicular epithelium that surrounds the oocyte, but the mechanisms by which vitellogenin crosses the layer of follicle cells on ant remain unknown. This study identified the route of transport of vitellogenin from the hemolymph to the oocyte in the ant *Pachycondyla striata*. The immunolocalization of vitellogenin associated with the actin filaments pattern in the follicular cells showed that vitellogenin was found in the cytoplasm of follicular cells suggesting a trans-cellular route. Moreover ultrastructural analysis of follicular cells showed enlarged intercellular spaces in 2 / 3 of basal cell region, but at 1 / 3 apical follicle cells were juxtaposed with the presence of extensive septate junctions, suggesting both trans and paracellular routes. Our findings suggest that in *P. striata* vitellogenin is initially transported via paracellular route from hemolymph to the apical region of the follicular cells from where it is transported via transcellular route. Thus in *P. striata* vitellogenin is transported to the oocyte across the follicular epithelium for both para- and transcellular routes.

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Impact of an ecologically dominant, predatory ant species on arthropod diversity and nutrient accumulation in the nest rim debris soil

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1. Soil arthropods and physico-chemical characteristics of the debris soil of the ecologically dominant, predatory ant, *Pheidole* sp. was examined from nests located by the road side and within two managed ecosystems in a tropical region.

2. Total 32 morphospecies belonging to 14 arthropod orders (Thysanura, Collembola, Orthoptera, Dermaptera, Blattodea, Isoptera, Hemiptera, Neuroptera, Lepidoptera, Diptera, Coleoptera, Araneae, Isopoda, Diplopoda) were recorded in the ant nest crater rim debris soil, transferred debris soil and control loose soil in the ¾ habitats under study.

3. The entrance rim debris soil supported 9 - 16 arthropod morphospecies belonging to 6-8 different orders, though Hemiptera was the dominant myrmecophilic order.

4. The debris soil was characterised by significantly higher concentrations of total carbon, nitrogen, phosphorus and nitrate nitrogen in comparison to the control soil from the surrounding non-ant nest areas. It had significantly higher water-holding capacity, moisture content and moderate-sized soil particles in comparison to the control.

5. The debris soil pH was lower than that of the control while the temperature at 2 cm depth was significantly lower (4.28 ± 0.51°C less) during peak summer and higher (5.63 ± 0.37°C more) than the freshly loosened control soil during the peak winter season.

6. The 15 - 45 day old loose soil from non-ant nest areas exhibited significantly reduced temperature (2.63 ± 0.33°C lower) in comparison to freshly loosened control soil, during the peak summer season. Of the eight arthropod morphospecies inhabiting it only two were similar to those found in the debris soil.

Successional changes of ant communities in planted poplar forests

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Planted forests may ensure a corridor between natural forest patches and can provide a shelter for wild species, which cannot survive on agricultural landscapes. Our study was performed in four poplar (*Populus alba*) forests of different ages (10, 26, 36 and 46 years) in the summer of 2012, near Bugacpusztaháza (Hungary). The *Asclepias syriaca* (an invasive plant species) was spread in large amounts in these forests. In each forest we examined two squares of 5 × 5 meters, in which we searched the litter and the upper layer of soil to determinate the position and the type of the nest belonging to different species. Afterwards, 2 - 3 workers were collected from each colony to identify them under laboratory conditions. The most common species were *Temnothorax unifasciatus*, *Myrmica sabuleti* and *Formica fusca*. On the basis of the Rényi diversity profiles we have found a different pattern than for the plant diversity, because instead of linear growth, the two younger forests were more diverse, but in the two older forests the species abundances were higher. Analyzing the nest distances it seemed that in the younger patches the interspecific and in the older patches the intraspecific competition may have an important effect in shaping the nest spacing patterns. Generally, the nests pattern was segregated. In the older patches more colonies were found in soil and in trunks than in the younger ones, where the colonies in died milkweed stems dominated. Our results suggest that the younger forests are colonized by several species, but the lack of available nesting places and the growing competition eliminates many of them, leading to a well shaped and less diverse community in the older forests. On the other hand, the presence of the invasive milkweed may have a strong influence in altering the ant community in poplar forests.

Genus *Messor* (Forel, 1890) (Hymenoptera, Formicidae): species biodiversity and variability in the Bosnia and Herzegovina's Mediterranean region

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Faunistic analysis of ants in the Mediterranean region of Bosnia and Herzegovina showed presence of three species from genus *Messor* (Forel, 1890): *M. capitatus* (Latreille, 1798), *M. structor* (Latreille, 1798) and *M. wasmanni* (Krausse, 1910). Morphometric analysis of the *Messor*'s worker caste variability was undertaken using 15 morphometric characters, and based on the analysis descriptions of local populations of *Messor capitatus* (Latreille, 1798), *M. wasmanni* (Krausse, 1910) and *M. structor* (Latreille, 1798) is presented here. Using discriminant analysis it was established that the postpetiole width contributes the most to the interespecies variability, and that the accuracy in clasifying species using this method is 97.3%.

Exploring variation in longevity: transcriptomic studies in long-lived ant queens

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Senescence occurs in all multicellular and unicellular organisms. It is generally assumed that lifespan is genetically determined. Several candidate genes are suspected to be responsible for a gradual deterioration of physical function. These findings mainly arise from experiments with rather short-lived organisms (flies, worms, mice). However, the enormous intraspecific variation in longevity is often disregarded.

Social insects with their different castes (queens, workers, males) have plastic life history traits which also include different aging rates. Ant queens are famous due to their exceptional long life spans compared to workers and males, making them a good model for the study of aging.

The myrmecine tramp ant *Cardiocondyla obscurior* lacks the "reproductive senescence" which is normally present in other organisms. In addition, female-male co-evolution determines the lifespan of the queen. However, even queens mated with a sterilized male live considerably longer and start to lay eggs earlier than virgin females.

In order to gain insights into lifespan-mediating mechanisms of mating, we conducted RNAseq of gene expression of old queens that were subjected to different mating. By comparing old queens mated to a fertile or a sterile male with virgin queens, we aim to find genes involved in the regulation of queen longevity.

Where diversity and discovery meet: ants in the Philippine islands

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The Philippine islands are among the most diverse islands in the world. Though recognized internationally as a biodiversity hotspot, the Philippines represent one of the least studied places worldwide with likely less than half of the predicted biodiversity described. A new checklist contains 474 valid Philippine ant species and subspecies in 92 genera (General & Alpert 2012). However, true species numbers may range between 1000 and 2000 based on the estimates of undescribed species in museum collections and undiscovered species.

The major part of the Philippine islands is of oceanic origin. Only in the south, Pleistocene land connections to Borneo facilitated a moderate exchange with other faunas. Consequently, the number of endemic species is very high. Examples are given from some recently revised genera: endemic species are, e.g., 77% in *Aenictus* (16 species total), 73% in *Anochetus* (11 species total), 67% in *Odontomachus* (9 species total), and 56% in *Pristomyrmex* (18 species total). In some species-poor genera (1 - 4 species each), e.g., *Acanthomyrmex*, *Forelophilus*, *Myrmoteras*, all Philippine species are endemic.

Preliminary results for species-rich genera like *Polyrhachis*, *Camponotus*, *Tetramorium*, or *Pheidole* indicate that focused taxonomic studies will lead to significantly higher species numbers and even more endemics since many old records from the Philippines are based on misidentifications.

Another interesting observation shows high regional endemism within the Philippines. These endemism patterns largely agree with the distribution of Pleistocene islands; such patterns are also frequently observed in plants and other terrestrial animals in the Philippines. The observed level of endemism can be explained by relatively recent diversification by genetic isolation.

General DM, Alpert GD (2012) A synoptic review of the ant genera (Hymenoptera, Formicidae) of the Philippines. ZooKeys 200: 1-111.

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