Netherlands Annual Ecology Meeting

10 & 11 February 2009
Congrescentrum De Werelt, Lunteren

Handout

Tuesday 10 February				
TIME	**Location / Activity**			
	Main Entrance Hall			
08:30	Registration and coffee in the Lounge and setting up posters			
	Europe Hall			
10:15	**Word of Welcome** (Louise Vet, Chair NERN, Director Netherlands Institute for Ecology)			
10:30	**Plenary 1: "Environments, genes and the information of ecology"** **Speakers** • Robert E. Ricklefs (University of Missouri, St. Louis, USA) • Theunis Piersma (Animal Ecology, University of Groningen / Royal Netherlands Institute for Sea Research)			
12:00	**Lunch in the restaurant**			
	Parallel Session 1			
	America Hall	**Europe Hall**	**Asia Hall**	**Africa Hall**
13:30	**Parallel 1a:** **Foraging Ecology**	**Parallel 1b:** **Biodiversity and community ecology**	**Parallel 1c:** **Aquatic Food webs**	**Parallel 1d:** **Chemical ecology**
	Conveners: 1. Jan van Gils (Royal Netherlands Institute for Sea Research) 2. Bart Nolet (Netherlands Institute of Ecology)	*Conveners:* 1. Liesje Mommer (Wageningen University, Radboud University) *2.* Sander Wijnhoven (Netherlands Institute of Ecology)	*Conveners*: 1. Dr. Lisette N. de Senerpont Domis (Netherlands Institute of Ecology) 2. Dick van Oevelen (Netherlands Institute of Ecology)	*Conveners*: 1. Hans Smid (Wageningen University) 2. Mirka Macel (Netherlands Institute of Ecology)
13:30	All Red Knots are equal, but some are more equal than others: dominance and interference in a 'non-hierarchical' and 'interference-free' shorebird *(Allert Bijleveld, Royal Netherlands Institute for Sea Research)*	Community niche predicts the functioning of denitrifying bacterial assemblages. *(Joana Falcao Salles, University of Groningen / Université Lyon)*	How cod shapes its world *(Anieke van Leeuwen, University of Amsterdam)*	Interspecific bacterial interactions and their impact on suppression of plant pathogenic fungi *(Paolina Garbeva, Netherlands Institute of Ecology)*
13:50	The relationship between social animals and their resource *(Eelke Folmer, University of Groningen)*	Relative abundance of major bacterial groups in soils with different nutrient retention. *(J. Rieckmann, Netherlands Institute of Ecology, Wageningen-UR)*	Decoupling and adaptation of trophic interactions in aquatic food webs under climate change *(Lisette de Senerpont Domis, Netherlands Institute of Ecology)*	Plant – aphid interactions: does soil community composition affect chemical defense? *(Gera Hol, Netherlands Institute of Ecology)*
14:10	Cryptic effects of interference competition on Bewick's swans foraging on cryptic prey *(Abel Gyimesi, Netherlands Institute of Ecology)*	The time scale of phenotypic plasticity, and its impact on competition in fluctuating environments. *(Maayke Stomp, University of Amsterdam)*	Linking species- and ecosystem-level impacts of climate change in lakes with a complex and a minimal model *(Wolf Mooij, Netherlands Institute of Ecology)*	Heavy metals alter interactions in a grass-leaf miner system *(Luc De Bruyn, Research Institute for Nature and Forest, Belgium)*
14:30	**Short break**			

	Parallel Session 1(Continued)			
	America Hall	**Europe Hall**	**Asia Hall**	**Africa Hall**
14:40	**Parallel 1a: Foraging Ecology**	**Parallel 1b: Biodiversity and community ecology**	**Parallel 1c: Aquatic Food webs**	**Parallel 1d: Chemical ecology**
14:40	Evolutionary consequences of a search image *(Edwin van Leeuwen, University of Groningen)*	Comparative breeding ecology of two Australian grass-finches: the Long-tailed Finch (Poephila acuticauda) and the endangered Gouldian Finch (Erythrura gouldiae). *(Erica van Rooij, Macquarie University, Sydney, Australia)*	How will increased PCO2 influence phytoplankton growth and competition? *(Jolanda Verspagen, University of Amsterdam)*	NMR Metabolomics of Thrips Resistance in Chrysanthemum *(Kirsten Leiss, Leiden University)*
15:00	Personality differences explain the use of social foraging information in Barnacle geese *(Ralf Kurvers, Wageningen University)*	From salt to fresh and vice versa; changes in the diversity of macrobenthic communities at the 'Haringvliet experiment'. *(Sander Wijnhoven, Netherlands Institute of Ecology)*	Influence of primary producers on carbon flows in shallow lakes: a stable isotope approach *(Raquel Mendonça, Universidade Federal de Juiz de Fora, Brazil)*	Hitch-hiking parasitic wasp learns to exploit butterfly anti-aphrodisiac *(Ties Huigens, Wageningen University)*
15:20	2 generalists on 2 resources: distinctive feeding patterns in life-stages lead to coexistence *(Tim Schellekens, University of Amsterdam)*	Changes in diversity and functional structure of macrobenthos along a marine gradient in man-shaped water bodies (South West Netherlands): the role of confinement as amplifier of stressors on ecosystems. *(Vincent Escaravage, Netherlands Institute of Ecology)*	The structuring role of microphytobenthos and phytoplankton as food sources for macrobenthic communities in the western Wadden Sea (Balgzand). *(Nienke Klomp, Netherlands Institute of Ecology)*	Odour blends that attract the malaria mosquito Anopheles gambiae s.s. *(Renate Smallegange, Wageningen University)*
15:40	**Time to stretch the legs and have a cup of tea in the Lounge**			
	Parallel Session 2			
	America Hall	**Europe Hall**	**Asia Hall**	**Africa Hall**
16:00	**Parallel 2a: Micro-evolution**	**Parallel 2b: Multitrophic interactions**	**Parallel 2c: Spatial ecology**	**Parallel 2d: Restoration Ecology**
	Conveners: 1. Bregje Wertheim (University of Groningen) 2. Ellen Decaestecker (University of Leuven)	*Conveners*: 1. Roxina Soler (Netherlands Institute of Ecology, Wageningen University) 2. Tibor Bukovinszky (Wageningen University)	*Conveners*: 1. Dr. Daphne vd Wal (Netherlands Institute of Ecology) 2. Sonia Kefi (Utrecht University)	*Conveners*: 1. Merel Soons (Utrecht University) 2. Wilco Verberk (Bargerveen / Radboud University Nijmegen)
16:00	Do movements of locally maladapted individuals speed up adaptation to climate change? *(Christiaan Both, University of Groningen)*	Community consequences of size-selective predation: Emergent Allee effects and emergent facilitation *(André de Roos, University of Amsterdam)*	Experimental evidence for spatial self-organization and its emergent effects in ecosystems *(Johan van de Koppel, Netherlands Institute of Ecology)*	The decline of metallophyte vegetation in floodplain grasslands: implications for conservation and restoration *(Esther Lucassen, B-WARE / Radboud University Nijmegen)*
16:20	Co-existence and co-evolution in lake phytoplankton *(Bas Ibelings, Netherlands Institute of Ecology / EAWAG, Zürich, Switzerland)*	The Differential Impact of a Patchy Environment on Genetic Diversity in a Multi Trophic System *(Sonja Esch, Leiden University)*	Top-down control by herbivores regulates landscape formation on intertidal flats *(Ellen Weerman, Netherlands Institute of Ecology)*	The effect of plant-soil feedback on the restoration of fen meadows *(Pella Brinkman, Netherlands Institute of Ecology)*
16:40	The interface between evolution and ecology in a Climate Change context *(Wendy Van Doorslaer, University of Leuven)*	Are population differences in plant quality reflected in the preference and performance of two endoparasitoid wasps? *(Rieta Gols, Wageningen University)*	Upscaling optimal foraging movements *(Geerten Hengeveld, Netherlands Institute of Ecology)*	Cascading food-web effects of nitrogen deposition on essential micronutrients *(Arnold van de Burg, Bargerveen / Radboud University Nijmegen)*

17:00	**Short break**			
	Parallel Session 2 (Continued)			
	America Hall	**Europe Hall**	**Asia Hall**	**Africa Hall**
17:10	**Parallel 2a: Micro-evolution**	**Parallel 2b: Multitrophic interactions**	**Parallel 2c: Spatial ecology**	**Parallel 2d: Restoration Ecology**
17:10	The variation in survival rates of development in Austrolebias annual killifish *(Tom van Dooren, Leiden University)*	Trophic Control in Soil Microbial Food Webs *(Jennifer Adams Krumins, Netherlands Institute of Ecology)*	Spatial correlation as an early warning signal for transitions in ecosystems *(Vasilis Dakos, Wageningen University)*	Colonisation events in riparian zones in fens, linking dispersal patterns to probabilities for germination and establishment *(Judith Sarneel, Utrecht University)*
17:30	Grazing by amoebae causes a dramatic shift in the genetic structure of a bloom of the cyanobacterium Microcystis *(Pieter Vanormelingen, Ghent University)*	Plants as Green Phone lines. Plant-mediated communication between below- and aboveground insect herbivores and parasitoids *(Roxina Soler, Wageningen University, Netherlands Institute of Ecology)*	Self-organized patterning in seagrasses *(Tjisse van der Heide, Radboud University Nijmegen)*	Short- and long-term responses of aquatic macroinvertebrates to restoration and decreased acidification in moorland pools. A complex of bottlenecks, colonization barriers and habitat suitability. *(Hein van Kleef, Bargerveen Foundation / Radboud University Nijmegen)*
17:50	Micro-evolution of physiological defence traits in a natural population of Daphnia magna *(Kevin Pauwels, University of Leuven)*	The role of plant quality in plant-herbivore interactions in freshwater ecosystems *(Liesbeth Bakker, Netherlands Institute of Ecology)*	Bacterial bioreporter capable of describing heterogeneity in environments and populations *(Mitja Remus-Emsermann, Netherlands Institute of Ecology)*	Restoration measures and species colonisation in nutrient-poor grasslands in Southern Limburg *(Nina Smits, Wageningen-UR / Utrecht University)*
18:10	Drinks in the Lounge and at **18:45** dinner in the restaurant			
19.45	'Jaarvergadering NECOV' (Africa Hall)			
20:00	Poster sessions / Coffee			
	Europe Hall			
21:00	Evening Programme: Community ecology of tropical ecosystems (Han Olff, University of Groningen)			

Wednesday 11 February				
07:30	Breakfast in the restaurant			
08:00	Registration for those coming on Day 2 only			
	Europe Hall			
08:30	**Plenary 2: Searching the Unknown: unveiling novel microbial communities** **Speakers** • Christa Schleper (Dep. of Genetics in Ecology, University of Vienna, Austria) Webpage • Mike Jetten (Dep. Microbiology, Radboud University, Nijmegen, the Netherlands) Webpage			
10:00	Coffee in the lounge			
	Parallel Session 3			
	Note: Session 4a (Biogeochemistry) has replaced session 3a (Global N and C cycles) which has been cancelled			
	America Hall	**Europe Hall**	**Asia Hall**	**Africa Hall**
10:30	**Parallel 3a: Biogeochemistry**	**Parallel 3b: Plant-animal interactions**	**Parallel 3c: Ecogenomics**	**Parallel 3d: Exotic species and genes**
	Conveners: 1. Bart Veuger (Netherlands Institute of Ecology) 2. Leon Lamers (Radboud University Nijmegen)	*Conveners*: 1. Chris Smit (Utrecht University) 2. Jasja Dekker (Zoogdiervereniging VZZ)	*Conveners*: 1. Eric Poelman (Wageningen University) 2. Jan Kammenga (Wageningen University)	*Conveners*: 1. Roy van Grunsven (Wageningen University, Bureau Waardenburg) 2. Wil Tamis (CML-Leiden)
10:30	The effects of herbivores on methane cycling and methane-processing microbes in shallow lakes *(Paul Bodelier, Netherlands Institute of Ecology)*	Dispersal failure contributes to plant losses in NW Europe *(Wim Ozinga, Radboud University Nijmegen / Wageningen UR)*	Competent Endophytes *(Pablo Hardoim, University of Groningen)*	Predicting invasive behavior of exotic plants *(Tanja Speek, Wageningen University)*
10:50	Spatial- and seasonal variability of greenhouse gases in two managed peat meadows in The Netherlands and the comparison of small scale and large scale measurement techniques *(Arina Schrier, Wageningen University)*	White Rhino and Termites as Creators of Environmental Heterogeneity *(Cleo Gosling, University of Groningen)*	Microarray approaches to bacterial mycophagy *(Francesca Mela, Netherlands Institute of Ecology)*	Plant range shifts and reduced enemy impact imply exotic invasion potential due to climate warming *(Tim Engelkes, Netherlands Institute of Ecology)*
11:10	Shifts in macrophyte composition in response to elevated CO_2 in softwater lakes *(Peter Spierenburg, Utrecht University/Radboud University Nijmegen)*	What determines the distribution of herbivores in the Serengeti ecosystem? *(Grant Hopcraft, University of Groningen)*	Ecological genomics of Boechera stricta: Identification of a QTL controlling the allocation of methionine- vs. branched chain amino acid-derived glucosinolates and levels of insect herbivory *(Eric Schranz, University of Amsterdam)*	Climate change, plant invasions and belowground interactions *(Elly Morrien, Netherlands Institute of Ecology)*
11:30	**Short Break**			

	Parallel Session 3 (Continued)			
	America Hall	**Europe Hall**	**Asia Hall**	**Africa Hall**
11:40	**Parallel 3a: Biogeochemistry**	**Parallel 3b: Plant-animal interactions**	**Parallel 3c: Ecogenomics**	**Parallel 3d: Exotic species and genes**
11:40	The importance of bacteria as a source of C, N, amino acids and fatty acids for benthic fauna investigated by stable isotope labeling *(Bart Veuger, Netherlands Institute of Ecology)*	Changing hiding patterns in fennel pondweed tubers (Potamogeton pectinatus) in relation to predation by Bewick's swans *(Bert Hidding, Netherlands Institute of Ecology)*	Assessing hitherto uncultured Acidobacteria and Verrucomicrobia in rhizosphere and bulk soils linking culture-dependent techniques and metagenomics *(Ulisses Nunes da Rocha, Wageningen University)*	Morphological markers distinguishing wild from cultivated carrots *(Cilia Grebenstijn, Leiden University)*
12:00	Alternative strategies to sustain N-fertility in acid and calcareous soil: low microbial N-demand versus high biological activity *(Annemieke Kooijman, University of Amsterdam)*	Interactive effects of large grazers and soil organisms on plant community composition *(Ciska Veen, University of Groningen)*	A non-arbitrary species concept for bacteria based on natural selection *(Michiel Vos, Oxford University)*	Native insects on non-native plants: about biodiversity and effect of specialism *(Kim Meijer, Groningen University)*
12:20	The fundamental science of applied biogeochemistry; cross-fertilization between macro- and microecology *(Leon Lamers, Radboud University Nijmegen)*	Seed and seedling fate of spiny shrubs in grazed woodlands *(Christian Smit, Utrecht University)*	The genetics of source-sink dynamics *(Krijn Trimbos, Leiden University)*	Marine exotic species, a rapid detection method within a changing ecosystem *(Adriaan Gittenberger, Leiden University)*
12.40	Implications of global change for denitrification in shallow freshwater systems *(Annelies Veraart, Wageningen University)*			
12:40	Lunch in the restaurant			
14:00	Poster Session Day 2 / Coffee			

	Parallel Session 4		
	Note: Session 4a (Biogeochemistry) has replaced session 3a (Global N and C cycles) which has been cancelled		
	Europe Hall	**Asia Hall**	**Africa Hall**
15:00	**Parallel 4b: Population dynamics and dispersal**	**Parallel 4c: Plant Physiological Ecology: Scaling up towards understanding emerging properties at plant and ecosystem level**	**Parallel 4d: Tropical Ecology**
	Conveners: 1. Eelke Jongejans (Radboud University Nijmegen) 2. Hans Jacquemyn (University of Leuven)	*Conveners*: 1. Frank Sterck (Wageningen University) 2. Niels Anten (Utreccht University)	*Conveners*: 1. Carina Hoorn (University of Amsterdam) 2. Pieter Zuidema (Utrecht University)
			Paleo
15:00	Demography and dispersal contributions to spatial population dynamics *(Eelke Jongejans, Radboud University Nijmegen)*	The regulation of cell wall extensibility during shade avoidance: a study using two contrasting ecotypes of *Stellaria longipes*. *(Ronal Pierik, Utrecht University)*	Slow processes triggering eco-system reorganization: the role of plate tectonics on tropical reefs *(Willem Renema, Naturalis)*

	Parallel Session 4 (Continued)		
	Europe Hall	**Asia Hall**	**Africa Hall**
	Parallel 4b: Population dynamics and dispersal	**Parallel 4c: Plant Physiological Ecology: Scaling up towards understanding emerging properties at plant and ecosystem level**	**Parallel 4d: Tropical Ecology**
15:20	Fine-scale genetic structure and gene dispersal within Dutch wild carrot (*Daucus carota L. ssp. carota*) populations *(Jun Rong, Leiden University)*	Temperature Effects on the Metabolism of Plants: Does Darwin break the Arrhenius Law? *(Cordula Schmitz, University of Groningen)*	On the origin of Amazonian landscapes and biodiversity *(Frank Wesselingh, Naturalis)*
15:40	Pollen limitation and labile sex expression in a wind-pollinated annual herb (*Mercurialis annua*) *(Elze Hesse, University of Oxford)*	Are there different ways for being successful in drought stressed environments: Scaling-up water relations to whole plant photosynthetic performance in 6 species of a Mediterranean tree community *(José Quero, Wageningen University)*	Climate variability and vegetation change at a submillennial time scales during the Holocene: a multi-proxi approach from Andean sediments *(Zaire Gonzalez, University of Amsterdam)*
16:00	**Short Break**		
			Actuo
16:10	Seed limitation restricts population growth in shaded populations of a perennial woodland orchid *(Hans Jacquemyn, University of Leuven)*	Structure and functioning of young Eucalypt trees under elevated CO_2 and temperature: an assessment with the 3 dimensional YPLANT model. *(Marion Liberloo, University of Antwerpen)*	Tropical tree rings reveal increasing juvenile growth rates over time and preferential survival of fast–growing juveniles *(Danae Rozendaal, Utrecht University)*
16:30	Directed dispersal in wetland plants: Implications for spatial population dynamics and demography *(Merel Soons, Utrecht University)*	From species traits to communities; a promising future for vegetation models *(Bob Bouma, Vrije Universiteit Amsterdam)*	Is canopy disturbance in tropical rain forest spatially contagious? *Patrick Jansen, University of Groningen)*
16:50	The role of odours in parasitoid-host interactions: a modelling study *(Marjolein Lof, Wageningen University)*	Vegetation structure and productivity: the result of cooperation or cheating? *(Niels Anten, Utrecht University)*	Silviculture enhances the recovery of overexploited mahogany Swietenia macrophylla *(Marielos Peña-Claros, Instituto Boliviano de Investigación Forestal,Bolivia, Wageningen University)*
	Europe Hall		
17:20	Closing Session (Hans de Kroon) • Awards ceremony o Best PhD research paper Award (Han Olff) o Best Poster Award (Roland Bobbink) • Synthesis (Louise Vet)		
	Lounge		
18.00	Fare-well drinks and Dinner		

Session 1a: Foraging Ecology

1) All Red Knots are equal, but some are more equal than others: dominance and interference in a 'non-hierarchical' and 'interference-free' shorebird

Allert I. Bijleveld[1, 2], Eelke O. Folmer[2] & Theunis Piersma[1, 2]

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2. *Animal Ecology Group, Centre for Ecological and Evolutionary Studies, University of Groningen, Haren, The Netherlands.*

The red knot *Calidris canutus* is a non-aggressive species with short handling times, for which the impact of interference on intake rate and therefore on aggregation, should be low. Low levels of interference should enable red knots to aggregate where resource densities are highest. However, field observations suggest interference mechanisms cannot be excluded. In a one-patch experiment, where we avoided resource depletion and quantified interference competition as the degree of intake reduction as a function of flock size. Next, we predicted and tested the aggregation in a two-patch experiment. The one-patch experiment showed that intake rate decreased with increased competition and that dominant focal birds had larger intake rates than subordinates. The reduced intake rate was not caused by increased aggression due to increased competitor density. In contrary, aggression levels decreased and the time devoted to searching for food, watching and moving increased with the number of competitors. Furthermore, the density of competitors had a negative effect on time spent on the patch. The two-patch experiment showed that the aggregation between the low and high quality patch was not as predicted. Dominance position had a larger effect than proposed, but focal birds in a dominant position did not occupy the high resource density patch more often, but monopolised the patch where they landed and then chased competitors away. Both experiments showed that red knots avoided aggressive interactions by keeping distance to one another. Thus, knots anticipated aggression and kleptoparasitism by avoiding interactions with conspecifics. As intake rates decrease with increased competitor densities we nevertheless see this as interference, albeit of a cryptic form. We conclude that red knots optimally space themselves through mechanisms of (cryptic) interference to avoid aggressive interactions.

2) The relationship between social animals and their resource

Eelke Folmer

Animal Ecology Group, Centre for Ecological and Evolutionary Studies, University of Groningen, Haren, The Netherlands.

The ideal free distribution represents an equilibrium that emerges when all animals choose a location so that their fitness is maximized. When applied to foraging animals, it is typically assumed that suitability of a patch merely depends on resource density and the level of interference. However, animals may also benefit from the co-occurrence of conspecifics due to for example information sharing and to avoid predation. Thus, spatial aggregations of foraging animals are driven by a combination attractive and repellent forces that are mediated by the environment. Due to the conspecific attraction, non-linear animal-resource relationships emerge. The empirical challenge is to obtain statistical estimates that reflect the true impact of resource and to quantify the effect of social attraction.

I will demonstrate by means of simulation what the consequences of social attraction may be. For this purpose Beddington's functional response model was generalized so that it allows for distance dependent conspecific facilitation. In this context I will also show how a population as a whole may benefit from individuals that are indifferent to conspecifics (i.e. leaders). Besides demonstrating the consequences of social attraction, I will show that spatial autoregressive (SAR) models are able to capture this effect. This provides opportunities for empirical investigations.

Mudflats with foraging shorebirds provide a very good system to estimate the relationships between shorebirds and their food while taking in to account conspecific attraction. We mapped resource and bird densities across the Dutch Wadden Sea and applied SAR models to the relationships from which I will present the outcome.

3) Cryptic effects of interference competition on Bewick's swans foraging on cryptic prey

Abel Gyimesi[1], R.A. Stillman[2], A.M. van den Beld[3], A.M., S. Bergraat[3] and Bart A. Nolet[1]

1. *Department of Plant-Animal Interactions, Netherlands Institute of Ecology (NIOO-KNAW), Nieuwersluis, The Netherlands.*
2. *School of Conservation Sciences, Bournemouth University, Talbot Campus, Poole, Dorset, UK*
3. *Utrecht University, Utrecht, The Netherlands*

It is generally accepted that, due to interference, competitor density has an effect on feeding intake rates. Some argue that intake rates steadily decrease with competitor density. Others, however, claim that the decrease starts only above a certain threshold competitor density. Unfortunately, measuring the clear effects of interference competition is problematic, as it is difficult to disentangle them from the effects of exploitative competition. Here, we use a behavior-based interference model to investigate how the intake rates of free-living Bewick's swans (*Cygnus columbianus bewickii*) foraging on tubers of fennel pondweed (*Potamogeton pectinatus*) change with increasing competitor density. Food is non-depletable in the model; hence any reduction in intake rates experienced at higher forager densities is a result of interference competition. We use the results to highlight the effects of interference at naturally occurring competitor densities. Besides, the results are separated for dominants and subordinates to gain a better insight on the underlying processes. We show that swans regulate their group density in order to minimize the effects of interference. Above a critical competitor density, the intake rate of subordinates decreases dramatically, mainly as a result of spending most of their time with avoiding more dominant individuals. Therefore, at high densities, subordinates likely leave the group and look for another foraging location. These results could also generally help to explain field studies where no relationship was found between competitor densities and intake rates.

4) Evolutionary consequences of a search image

Edwin van Leeuwen

Community & Conservation Ecology Group, Centre for Ecological and Evolutionary Studies, University of Groningen, Haren, The Netherlands.

Many predators are able to become better at spotting prey by recognising specific clues, but by concentrating on one prey type they will become worse at spotting other prey types. This phenomenon is known as the formation of a search image for a certain prey by a predator. In this presentation I will talk about the evolution of a search image in the predator. The predator forages for two prey types and is able to form an independent search image for both prey. The results show that the evolutionary dynamics can be divided into two parts, a fast and a slow part. At first evolutionary pressure will be strong towards an optimal ratio of prey, where the predator is an Ideal Free Forager. Following this the slow dynamics will keep this ratio constant, but the predator will slowly evolve towards a stronger search image and ultimately becoming a specialist predator or slowly evolve towards a weaker search image. In conclusion, the formation of a search image allows the predator to control the prey densities such that the ratio of available prey is ideal for the predator (ideal free forager).

5) Personality differences explain the use of social foraging information in Barnacle geese

Ralf Kurvers
Resource Ecology Group, Wageningen University, Wageningen, The Netherlands

Individuals may use two forms of information to obtain information on food resources. Individuals may either use personal information, usually gathered in a trail and error way by interacting with the physical environment, or they may use information from other individuals: social information. Which information may be more profitable depends on the costs of collecting information, the reliability of information and the ability to use the information. However, which information an individual uses might also depend on the personality traits of an individual. Personality describes the idea that individual differences are repeatable over time and context. How individual differences affect the use of social information is poorly understood. To increase our understanding of the role of personality on social information use we studied social information use in the Barnacle goose, *Branta leucopsis.* Each individual was tested on different personality traits and consequently we studied social information use in an experiment where an observer goose was allowed to observe two pairs of demonstrators. One pair of demonstrators was provided with food, the other pair was food deprived. The observer goose was allowed to observe both pairs and after two minutes released in the arena, where it could choose to join one of both pairs of demonstrators. We found high repeatability scores for activity and exploration scores both over time and over context, suggesting the presence of personality in Barnacle geese. More explorative individuals appeared to make less use of social information, as indicated by a higher number of incorrect decisions. However, after a wrong decision more explorative individuals were faster in exploring the other side for food opportunities.

6) 2 generalists on 2 resources: distinctive feeding patterns in life-stages lead to coexistence

Tim Schellekens
1. *Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, the Netherland*
2. *Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden*

Although many species are generalists, not all individuals of generalist species are generalists themselves. Growing individuals are able to change the relative intake of different resources to accommodate their nutritional needs in a certain life-stage; they can change their feeding pattern over ontogeny. Different species, like daphnids and copepods, differ in this feeding pattern. Some copepods undergo an ontogenetic niche shift, where juveniles feed on different resources than adults do. In contrast, daphnids feed on the same resources during their ontogeny. How do these differences in feeding pattern affect the competition for resources between these generalist species? I analyzed a model describing competition for two resources between two stage structured competitors following the classic competition theory of Tilman. Isolating the effect of different feeding patterns, I show these patterns can affect the competitive ability of species. A difference in what different conspecific life-stages feed on may therefore be an alternative explanation for the coexistence and competitive exclusion of competitors on two resources, besides the causes mentioned by Tilman.

Session *1b: Biodiversity and community ecology*

1) Community niche predicts the functioning of denitrifying bacterial assemblages

Joana Falcao Salles[1,2], Franck Poly[2], Bernard Schmid[3] and Xavier LeRoux[2]

1. *Microbial Ecology, University of Groningen, Kerklaan 30, Haren, The Netherlands, 9751NN*
2. *Ecologie Microbienne, Université Lyon 1 (UMR 5557, USC INRA 1193), 43 bd. du 11 novembre 1918, Villeurbanne, France, 69622*
3. *Institute of Environmental Sciences, University of Zurich, Winterthurerstrasse 190, Zurich, Switzerland, 8057*

A major goal in general ecology is to understand the role of biodiversity on ecosystem functioning. It is now recognized that predicting ecosystem functioning and service provision requires an adequate evaluation of the role of functional diversity among species. Bacterial communities have shown to be valuable model systems to unravel the mechanisms underlying biodiversity–ecosystem functioning relationships. Indeed, the relationship between bacterial diversity and productivity has been successfully addressed by various methods. However, despite the role of functional components in driving biodiversity-ecosystem functioning relationships, the functional diversity of bacterial communities has never been addressed in the context of ecosystem functioning. Thus, the aim of this work was to use assemblages of denitrifying bacterial species as a model to address the functional role of bacterial diversity on the two ecosystem processes: denitrification and anaerobic CO_2-production. For that, we initially measured the activities of 16 bacterial species grown individually on 6 different carbon sources. We then used the same set of species to assemble communities varying in both species richness and composition in microcosms containing all 6 carbon sources, following a broken stick model. The performances of individual species on individual carbon sources were used to calculate, for each process measured, an a-priori measure we called community niche, which accounts for the performances of the species present in a given community across a range of resources. Species richness had a positive but small effect on both community processes whereas community niche explained a much larger proportion of the variation. Path analysis indicated that community niche was the main driver for the corresponding community process and that species richness influenced denitrification and CO_2 production via its influence on community niche. In addition, the positive linear relationships observed between community functioning level and community niche for both processes studied indicated that the performance on carbon sources by individual species and among species was the major effect explaining enhanced collective performance of diverse communities, demonstrating the importance of resource-driven interactions between decomposers. In addition to community niche, the presence of particular bacterial species also influenced community functioning, indicating that other effects than the capacity to use carbon sources played a, albeit minor, role in our experiment. This study demonstrates the importance of community niche in explaining the enhanced performance of diverse bacterial communities and provides evidence of the relevance of resource use capacity in shaping biodiversity-ecosystem functioning relationships for assembled bacterial species.

2) Relative abundance of major bacterial groups in soils with different nutrient retention

J. Rieckmann[1, 2], F.T. de Vries[2, 3], R. van Doorn[1, 4], J.A. van Veen[1], and J. Bloem[2]

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4. *Plant Research International B.V., P.O. Box 16, NL-6700 AA Wageningen, The Netherlands*

Sustainable agriculture requires soils with good nutrient retention and low nutrient losses. We hypothesized that soils with better nutrient retention are characterized by a

different microbial community composition. Different phylogenetic groups of bacteria can be related to different growth strategies. For instance *β-Proteobacteria* and *Bacteroidetes* presumably represent relatively fast growing copiotrophs, whereas *Acidobacteria* represent more slowly growing oligotrophic bacteria. We expected more oligotrophic and less copiotrophic bacteria in soils with low nutrient losses. We sampled two grassland plots from a field experiment at an organic dairy farm in The Netherlands. Earlier, two separate incubation experiments with intact soil columns from these plots demonstrated that the soil with a higher fungal to bacterial biomass ratio showed 50% less nitrogen leaching. We determined biomasses of fungi and bacteria by direct microscopy. The relative fractional abundances of major bacterial groups in the soils were determined using quantitative PCR (qPCR). The fungal/bacterial ratio was 30% higher in soil with low nitrogen leaching. There were clear differences in bacterial community structure between the two soils: in soil with low nitrogen leaching, *Acidobacteria*, *α-Proteobacteria* and *Bacteroidetes* were 10, 40 and 60% higher, respectively. On the other hand *Firmicutes* and *β-Proteobacteria* were 15 and 50% lower, respectively. The increase of *α-Proteobacteria* and *Bacteroidetes* and the decrease of *Firmicutes* and *β-Proteobacteria* in the soil with low nitrogen leaching were significant (T-test, $P < 0.05$). However, the increase in oligotrophic *Acidobacteria* was not significant. Our results support the hypothesis that changes in major bacterial groups may be indicative of sustainable soils with low nutrient losses.

3) The time scale of phenotypic plasticity, and its impact on competition in fluctuating environments

Maayke Stomp, Jef Huisman
Aquatic Microbiology, University of Amsterdam

Although phenotypic plasticity can be advantageous in fluctuating environments, it may come too late if the environment changes fast. Complementary chromatic adaptation is a colorful form of phenotypic plasticity, where cyanobacteria tune their pigment composition to the prevailing light spectrum. Here we investigate the time scale of phenotypic plasticity. We develop a competition model, in which green and red Synechococcus species compete against a third cyanobacterium that can adapt its color to the prevailing light conditions. We'll call the latter species the flexible phenotype. Model predictions are tested in a series of competition experiments in which the prevailing light color fluctuated at different frequencies. They show that the flexible phenotype was much more successful when it had sufficient time to fully adjust its pigmentation. The flexible phenotype benefits from its phenotypic plasticity only when fluctuations in light color were relatively slow, corresponding to slow mixing processes or infrequent storms in their natural habitat. Our findings demonstrate that the time scale of phenotypic plasticity plays a key role in competitive interactions, and affects the biodiversity of plankton communities in fluctuating environments

4) Comparative breeding ecology of two Australian grass-finches: the Long-tailed Finch (Poephila acuticauda) and the endangered Gouldian Finch (Erythrura gouldiae)

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Gouldian Finch (*Erythrura gouldiae*) populations have been declining over several decades and the species is now registered as endangered, occurring in only a small part of its former range. Trapping for the captive bird trade, infestation with air sac mites as well as changes in their habitat caused by fire regimes and grazing and their limited diet are thought to have contributed to the decline. Meanwhile a very similar grass-finch the Long-tailed Finch (*Poephila acuticauda*), inhabiting the same areas and living under the same circumstances, is doing fine. We aim to get more insight in the decline of the Gouldian finch through comparing aspects of the breeding ecology of

both species. Therefore during the 2008 breeding season, the breeding ecology of populations of wild Long-tailed Finches and Gouldian Finches was studied in the savanna woodlands of the Kimberleys, the northernmost region of Western Australia. The length of the breeding seasons differed markedly between the two species, with Gouldian Finches breeding till July and Long-tailed Finches breeding till September. Gouldian Finches therefore could only breed during the period when competition over nest sites and food was high, while Long-tailed Finches, sustained by a broader diet, had another opportunity to breed after that period. Besides that, the species differed in nesting success and preferences for nest sites.

5) From salt to fresh and vice versa; changes in the diversity of macrobenthic communities at the 'Haringvliet experiment'.

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Combining historic and recent monitoring data on macrobenthic communities of the Rhine-Meuse 'estuary' (Biesbosch – Hollandsch Diep – Haringvliet – Pre-delta) resulted in a large long-term dataset for the years 1960-2006. The data give a good view of the developments during and following the Delta-works in this region executed between 1958 and 1970. The Delta-works transformed the estuary into a series of freshwater basins, and had a large impact on the dynamics. Moreover, during the period of this large-scale long-term 'experiment' also large changes in nutrient and pollution status occurred. These changes had a huge impact on the macrofauna species composition of the soft sediment. The developments of the macrobenthic communities in time and space could be used to indicate the state of the environment. From the observed patterns in densities, diversity indices, distributions over feeding-guilds and the abundance of either sensitive and/or exotic species; the potential of the area can be extracted. Analyzing the developments yielded also an indication of what a reference state for this region should look like. This is very relevant as a first step towards the restoration of a natural gradient from fresh to salt water that is planned for 2010 with the installation of the 'Chink' regime at the Haringvliet sluices. The start of a new experiment?

6) Changes in diversity and functional structure of macrobenthos along a marine gradient in man-shaped water bodies (South West Netherlands): the role of confinement as amplifier of stressors on ecosystems

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Major shifts in benthic community diversity and functional structures with decreasing exchange with the open sea have been recently identified in lagoons and marine embayment's worldwide (Tenore et al. 2006). Similar patterns were earlier described by Guelorget and Perthuisot (1989) who originally formalized the concept of confinement (i.e. the lowering of exchange rate, in semi-enclosed basins and lagoons with open coastal waters, coinciding with a decreasing marine influence and longer water residence time) leading among others to decreasing diversity of benthic communities and shifts between water column and interface feeders from the inlet towards the inner reaches of Mediterranean lagoons.
The effect of confinement on the macrobenthic communities and the consequence for the ecosystem functioning is investigated in three Dutch water bodies (the Oosterschelde, Grevelingen and Veerse Meer) characterized by different levels of communication with the open sea. The following conclusions are drawn from the analysis:

- The differences in macrofauna between these three Dutch water bodies are in accordance with the typology of confinement by Guelorget & Perthuisot (1989) for

the Mediterranean lagoons, including lower diversity (i.e. lower species numbers), higher densities, yet lower biomass of zoomacrobenthos, and lower levelsof predators yet higher share of deposit feeders, with an increasing degree of confinement.

- These features show similarities with the changes along gradients of eutrophication whereas primary production does not differ noticeably between the three water bodies. This stresses the role of confinement as a filter modulating the responses of water systems to disturbances.
- These results support the use of confinement as a system-specific attribute in the framework of sustainable water management of coastal zones with respect to its control on the ecosystem structure and functioning

Session 1c: Aquatic Food webs

1) How cod shapes its world (Journal of Sea Research 60 (2008) 89 – 104)

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Cod stocks in the North West Atlantic and the Baltic Sea have shown similar dynamics in recent decades with a rapid decline in abundance and a lack of stock recovery following a period of large biomass. We explore whether the lack of recovery can be ascribed to an emergent Allee effect, which is a mechanism intrinsic to the community in contrast to explanations involving environmental factors. We formulate a stage-structured biomass model for the cod-sprat interaction in the Baltic Sea, paying special attention to the size-dependent prey preference of differently sized cod. The model predicts that alternative community states can occur under the same environmental conditions, in which cod is either present or absent. In a stable equilibrium with its main prey cod has a strong effect on the prey size distribution, resulting in larger densities of preferred prey sizes for cod than in the absence of any predation. Cod thus shapes its food environment to its own benefit. Furthermore, in response to increased exploitation cod biomass and yield tend to increase unless a stock collapse is imminent. After a cod stock collapse and the consequent drop in predation the prey size distribution becomes stunted and offers insufficient food for cod to grow and recover. These results are consequences of the indirect effects of predation and harvesting, whereby increased mortality relaxes competition among surviving individuals, leading to an increase in food intake and hence increased somatic growth and reproduction. We review observed community changes following the collapse of the cod stocks in the North West Atlantic and the Baltic Sea in the light of model predictions. In line with our model predictions growth in body size of cod has slowed down after the collapse, despite high densities of prey biomass. Furthermore, estimates of total prey population fecundity in the Baltic Sea identify the emergent Allee effect as a potentially important mechanism contributing to the lack of cod recovery.

2) Decoupling and adaptation of trophic interactions in aquatic food webs under climate change

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Climate warming has been shown to advance the seasonal timing of life cycle events. Species-specific differences in these changes in phenology may result in a decoupling of trophic relationships in food webs and subsequent cascading effects on community structure. For the timing of life cycle events each species requires specific cues, used as proxies for the suitability of the environment for their reproduction and growth. Climate change may change the validity of the proxies different species use. The fundamental questions underlying our research are threefold: 1) What proxies do different members of the aquatic food web use to estimate the suitability of environmental conditions for successful reproduction and growth? 2) Could projected climate warming invalidate the use of these proxies and lead to a decoupling of trophic interactions? 3) Can adaptation to projected climate warming maintain or restore trophic interactions? We have tested hypotheses generated from these fundamental questions using an integrated approach of both experiments and models. Our observations indicate that the composition of the overwintering community and the trophic state of lakes impact the occurrence of cascading effects.

3) Linking species- and ecosystem-level impacts of climate change in lakes with a complex and a minimal model

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To study the interaction between species- and ecosystem-level impacts of climate change, we focus on how climate-induced shifts in key species affect the positive feedback loops that lock shallow lakes in a transparent, macrophyte-dominated state or, alternatively, in a turbid, phytoplankton-dominated state. We hypothesize that climate warming will weaken the resilience of the macrophyte-dominated clear state. For the turbid state, we hypothesize that climate warming and climate change induced eutrophication will increase the dominance of cyanobacteria. Climate change will also affect shallow lakes through a changing hydrology. We study these phenomena using two models, a minimal dynamic model and a full ecosystem model. Qualitatively, there is a striking resemblance between the patterns shown by both models. We conclude that changes in nutrient loading, hydraulic loading and climate warming can all lead to shifts in ecosystem state. change. The simple model helps in interpreting the non-linear behaviour of the complex model. Analysis with the complex model allows for an interpretation of the results in terms of the seasonal dynamics and shifts in phenology of the dominant groups of phyto- and zooplankton.

4) How will increased PCO_2 influence phytoplankton growth and competition?

Jolanda M. H. Verspagen, Dedmer B. van de Waal, Anthony M. Verschoor and Jef Huisman

University of Amsterdam

Atmospheric CO_2 levels (pCO_2) are increasing at unprecedented rates. When CO_2 dissolves in water, it reacts to form bicarbonate and carbonate. The relative availability of each carbon species depends on pH. Increasing pCO_2 will decrease pH, increase the availability of dissolved CO_2 but will decrease the (relative) availability of bicarbonate. Most phytoplankton species can take up both CO2 and bicarbonate but differ in their affinity for both nutrients. Changes in carbon availability will change phytoplankton carbon:nutrient ratio and may also change the competitive balance between phytoplankton species. Here, we present a chemical-biological model that couples aquatic carbon chemistry to phytoplankton carbon:nutrient stoichiometry and growth. Model predictions are validated against experimental data. We will use the model to explore changes in dominant physiological traits and phytoplankton dynamics along a range of carbon:nutrient concentrations.

5) Influence of primary producers on carbon flows in shallow lakes: a stable isotope approach

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The importance of planktonic carbon to consumers relative to that from macrophytes has been shown by several authors. However, in shallow lakes, especially in those with high water transparency, macrophyte production, especially by C_3 plants, is often important in supporting consumers. Recent stable isotope studies have revealed that C4 plants (such as Ceratophyllum, Myriophyllum and some grasses) play a minor role in aquatic food webs despite their often widespread distribution and production.

We evaluated the food web structures of 19 shallow lakes by determining the isotopic carbon and nitrogen signatures of primary producers and consumers. The studied

lakes were distributed along a latitudinal gradient throughout South America, from the northeast Brazil through Uruguay till southern Argentina. This exploratory study aimed to evaluate the importance of different primary producers to shallow lakes carbon flow.

Overlaps in phytoplankton and C_3 macrophytes (such as Cabomba, Utricularia, Eichornia, etc.) isotopic signatures made it hard to trace their transfer of carbon to consumers. However, our results suggest that in some lakes C_4 macrophytes represented the main carbon source to consumers. This may be explained, both as direct food source for grazers or through carbon subsidy for planktonic food web pathways. This unusual scenario was probably a result of combined high C_4 macrophyte coverage and high carbonate concentration.

6) The structuring role of microphytobenthos and phytoplankton as food sources for macrobenthic communities in the western Wadden Sea (Balgzand).

Nienke Klomp
Netherlands Institute of Ecology

The spatial distribution of food sources, such as microphytobenthos and phytoplankton, in an estuarine ecosystem is reflected by the macrobenthic species composition. In lower, more sandy parts, the species composition is dominated by suspension feeders which are more dependent on phytoplankton, whereas higher more silty parts are dominated by deposit feeders (more dependent on mircophytobenthos) (e.g. Beukema 1976, Herman et al. 2000).

In the western part of the Waddenzee (Balgzand), long-time monitoring series show that 3 types of macrobenthic communities can be distinguished, based on biomass measurements, species composition and position of the community in the tidal zone. We hypothesize that these macrobenthic communities differ in their dependency on microphytobenthos: we expect that species in higher parts of Balgzand are more dependent on microphytobenthos. Besides, we expect that species that occur in a range of tidal hights show a shift in dependency on microphytobenthos.

To test aforementioned hypotheses, we conducted a field study on Balgzand. Sediment samples, macrobenthos samples, and samples of phytoplankton and micropyhtobenthos were taken. Per site, abiotical conditions and species numbers/biomass and composition were described. Stable isotope techniques are used to trace the origin of food sources ($\delta^{13}C$ values) of species, whereas $\delta^{15}N$ values are determined to calculate trophic positions of species in the food web.

Session 1d: Chemical ecology

1) Interspecific bacterial interactions and their impact on suppression of plant pathogenic fungi

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Microbial populations in natural environments such as the soil and rhizosphere are in constant interactions with each other. However, relatively little is known at molecular and biochemical level on the interactions between different bacterial species. The interspecific bacterial interactions can be crucial for the suppression of soil-borne plant pathogens as non-antagonistic soil bacteria may contribute to suppression of fungi during competitive interactions with other bacteria. For examples the combination of two strains, namely *Pseudomonas* sp. and *Pedobacter* sp., completely suppressed the soil-borne pathogen *Rhizoctonia solani* whereas monocultures of these strains exhibited no or modest level of suppression. Relatively strong inhibition of fungal growth was also observed when *Pseudomonas* sp was mixed with a cell-free suspension from *Pedobacter* sp. In the current study we aim to elucidate the mechanism of this interspecific bacterial interaction by description of genes differentially expressed and antimicrobial compounds produced during the interspecific interaction. Moreover, we aim to identify the signaling compound involved in this interaction.

2) Plant–aphid interactions: does soil community composition affect chemical defense?

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The potential of soil communities to enhance the resistance of plants to pests has received little attention. In a greenhouse experiment the effect of different microbial soil communities on plant-aphid interactions (*Brassica oleraceae – Brevicoryne brassicae*) were tested. In addition, half of the plants were exposed to the belowground herbivore *Heterodera schachtii*. Both microbial soil community composition and presence/absence of aphids affected the glucosinolate concentration in the leaves of the plants. Aphid number was not affect by soil community composition, but their effect on glucosinolate concentration depended on the soil community in which the plant was growing. Nematodes did not change overall glucosinolate concentrations, but caused qualitative changes. Population growth of aphids was reduced by nematodes, but this could not be directly correlated with changes in glucosinolates. In conclusion, soil community composition does affect the chemical composition of the plant, but this did not affect the aphids.

3) Heavy metals alter interactions in a grass-leaf miner system

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2. *Evolutionary Ecology, Department of Biology, University of Antwerp, Antwerpen, Belgium*

We studied the effects of heavy metal exposure on host plant (*Holcus lanatus*, Poaceae) growth and survival and subsequent host choice and performance of the grass miner *Chromatomyia milii* (Diptera, Agromyzidae). Cadmium decreased plant growth in a dose-dependent way. *C. milii* preferred the control to the cadmium-exposed plants for feeding and oviposition. Moreover, preference for the control plants increased with increasing cadmium exposure of the alternative choice. Adult and offspring performance decreased with increasing plant cadmium exposure. This suggests that, at least under our laboratory conditions, host choice of *C. milii* is adaptive under pollution stress. Foliar cadmium concentration increased and the soluble sugar concentration decreased with increasing cadmium exposure. Regression analysis showed that both latter components might be responsible for the decrease in

performance of *C. milii* on cadmium-exposed plants. The protein and amino acid concentration of the leaves, the amount of structural defences, and water concentration were not affected by the cadmium treatment.

4) NMR Metabolomics of Thrips Resistance in Chrysanthemum

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Western flower thrips (*Frankliniella occidentalis*) has become a key insect pest of agricultural and horticultural crops worldwide. Little is known about host plant resistance to thrips. In this study, we investigated thrips resistance in chrysanthemum. We identified thrips resistant chrysanthemums applying bioassays. Subsequently, NMR-based metabolomics was applied to compare the metabolome of thrips resistant and susceptible chrysanthemums. The new developments of NMR facilitate wide-range coverage of the metabolome. This makes NMR especially suitable if there is no *a-priori* knowledge of the compounds related to herbivore resistance and allows a holistic approach analysing different chemical compounds simultaneously. We show that the metabolomes of thrips resistant and susceptible chrysanthemums differed considerably. Thrips resistant chrysanthemums contained higher amounts of the phenylpropanoids chlorogenic acid and feruloyl quinic acid. Also, a flavanoid, kaempferol glucoside, accumulated in the resistant plants. Both, phenylpropanoids and kaempferol, are known for their inhibitory effect on herbivores. Not only that they inhibit thrips but they also effectuate a positive effect on human health. Our results prove NMR a promising tool to identify different metabolites involved in herbivore resistance. It constitutes a significant advance in the study of plant –insect relationships, providing key information on the implementation of herbivore resistance breeding strategies in plants.

5) Hitch-hiking parasitic wasp learns to exploit butterfly anti-aphrodisiac

Ties Huigens

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Many insects possess a sexual communication system that is vulnerable to chemical espionage by parasitic wasps. We recently discovered that a hitch-hiking egg parasitoid exploits the anti-aphrodisiac pheromone benzylcyanide (BC) of the Large Cabbage White butterfly Pieris brassicae. This
pheromone is passed from male butterflies to females during mating to render them less attractive to conspecific males. When the tiny parasitic wasp Trichogramma brassicae detects the anti-aphrodisiac, it rides on a mated female butterfly to a host plant and then parasitizes her freshly laid eggs. The present study demonstrates that a closely related generalist wasp, Trichogramma evanescens, exploits BC in a similar way but only after learning. Interestingly, the wasp learns to associate a hitch-hiking response to the odors of a mated female P. brassicae butterfly with reinforcement by parasitizing freshly laid butterfly eggs. Behavioral assays, prior to which we specifically inhibited long-term memory (LTM) formation with a translation inhibitor, reveal that the wasp has formed protein synthesis-dependent LTM at 24 h after learning. The combination of associatively learning to exploit the sexual communication system of a host and the formation of protein synthesis-dependent LTM after a single learning event has not been documented before. We expect it to be widespread in nature as it is highly adaptive in many species of egg parasitoids. Our finding of the exploitation of an anti-aphrodisiac by multiple species of parasitic wasps suggests its use by Pieris butterflies to be under strong selective pressure.

6) Odour blends that attract the malaria mosquito *Anopheles gambiae s.s.*

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The host-seeking behaviour of the females of *Anopheles gambiae* Giles *sensu stricto*, which is the most important malaria vector in Africa, is guided by volatiles of human origin. In this study we aim to establish the components of human odour that are essential in the host-seeking process of this mosquito species.

Ammonia, lactic acid and several carboxylic acids are known to be present in the human odour blend. We investigated the effect of these compounds on the behaviour of female mosquitoes using a dual-port olfactometer.
Our experiments showed that ammonia is an attractant on its own, whereas lactic acid is not. Carboxylic acids, offered as a mixture of 12 compounds, were repellent. However, a synergistic effect was found when ammonia, lactic acid and the carboxylic acids were applied as a blend. In addition, the response to 16 individual carboxylic acids was examined in combination with ammonia and lactic acid. The results showed that seven carboxylic acids augmented the attractiveness of ammonia and lactic acid at certain concentrations. Subsequently, subtraction experiments revealed which of these carboxylic acids play a significant role in the attractiveness of the blend of ammonia, lactic acid and carboxylic acids.

The most attractive blend will be used as the basis on which to further build a highly attractive synthetic mixture that can be applied in mosquito traps in malaria-endemic regions.

Parallel 2a: Micro-evolution

1) Do movements of locally maladapted individuals speed up adaptation to climate change?

Christiaan Both
Animal Ecology Group, University of Groningen

One consequence of climate change is that different trophic levels get out of synchrony, and this insufficient adjustment to climate change could at higher trophic levels lead to severe population declines. I show that this is the case for many migratory passerines in Europe. I address how these species could adapt to climate change, by either a phenotypic plasticity or an evolutionary response. One important adaptation, involving both plasticity and a change in gene frequencies is that individuals could disperse over a latitudinal gradient. This mechanism could introduce new genetic variation in more northern populations, allowing them to adjust their phenology to climate change.

2) Co-existence and co-evolution in lake phytoplankton

Bas Ibelings
Centre for Limnology, Institute of Ecology, The Netherlands / EAWAG, Zürich, Switzerland

The presentation will explore how co-existence and co-evolution interact in phytoplankton. Co-evolution is only possible when species co-exist over long periods, whereas many of the mechanisms that allow co-existence of phytoplankton are the outcome of a co-evolutionary process. Different types of co-evolutionary interactions will be discussed on basis of my studies, e.g. those between host and parasite (diatom hosts and chytrid parasites) and those between resource competitors. Experimental evolution of phytoplankters over 100s of generations is a central tool in all lab-based studies. Finally the presentation will turn its attention to natural lake plankton communities and explore how different ecological (habitat filtering vs.resource competition) and evolutionary (conservatism vs. convergence) processes control phytoplankton community assembly.

3) The interface between evolution and ecology in a Climate Change context

Wendy Van Doorslaer, Joost Vanoverbeke, Robby Stoks & Luc De Meester
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The fate of many organisms confronted with the rapid rate of current Climate Change critically depends on their ability to track the shifting climatic conditions, either by migration or by local adaptation. Both processes are not only important for community assembly but also for population assembly within a species. The process of migration can lead to colonization of new habitats and displacement of local northern populations by immigrants from southern populations that are pre-adapted to higher temperatures. In contrast, the ability of populations to persist locally through rapid genetic adaptation may reduce the population's susceptibility to successful invasion by southern genotypes. Given the increasing number of reports on rapid micro-evolutionary responses, these dynamics are increasingly recognized to potentially have important ecological consequences. However, despite its importance, this feedback from evolution to ecology has been unexplored experimentally in the context of Global Warming.

We conducted an outdoor competition experiment in which we compared the competitive strength between two sets of English resident clones of the water flea Daphnia magna (non-adapted to increased temperature and warm-adapted) and French immigrants. Our results showed a striking difference in competitive strength between non-adapted or warm-adapted residents when confronted with immigrants.

Although French immigrants were the best competitors in all cases, resident warm-adapted clones were much better competitors than non-adapted resident clones. In natural situations where few immigrants have to compete with millions of residents this may make the difference between survival and extinction of the local population.

4) The variation in survival rates of development in *Austrolebias* annual killifish

Tom J.M. Van Dooren
Institute of Biology, Leiden University

Annual killifish inhabit ponds that dry up completely during the summer. An egg or embryo bank in the soil allows populations to persist until ponds refill in autumn. Egg or "germ" banks are presumed to involve adaptations to unpredictable environments. However, we have no idea whether they still protect from extinction or instead hinder adaptation when the environment shows a lasting trend, such as during climate change. To predict the fate of species with germ banks, we need estimates of survival and developmental strategies in different environmental conditions, and whether these are genetically variable, such that they can evolve.

I report results from studies on two species. In *A. bellotti* from Argentina, it is shown that rates of embryonal development in lab conditions are genetically variable, involving genetic variation for entering diapause. Survival is stage-specific, with negligible mortality among embryos that are virtually ready to hatch. Using data from a field experiment on *A. luteoflammulatus* (Uruguay), it is shown that survival of eggs depends on the local microsite where they are buried, such that one can expect that environmental change will affect survival patterns of eggs in the germ bank. There seems to be limited genetic variation for this sensitivity to microsite, which could indicate an evolutionary constraint.

5) Grazing by amoebae causes a dramatic shift in the genetic structure of a bloom of the cyanobacterium *Microcystis*

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Blooms of the cyanobacterium *Microcystis* are a common phenomenon in eutrophic water bodies around the world. Recent molecular studies have shown that blooms generally consist of several genotypes, that blooms often differ in genetic structure and that genetic composition may strongly vary with time. As *Microcystis* genotypes can be functionally strongly divergent, including differences in toxicity, bloom structure has obvious consequences for the aquatic food web and bloom persistence. The factors determining the genetic structure of *Microcystis* blooms are largely unknown, although priority effects, zooplankton grazing and competition for light and nutrients may be important. Here, we report the first results of a high-resolution two-year study of *Microcystis* bloom dynamics in a small urban pond, including an assessment of population structure with light microscopy and Denaturing Gradient Gel Electrophoresis of the ITS rDNA region, limnological and climatic variables, and components of the aquatic food web. Results showed that in 2007, two *Microcystis* morphotypes could be distinguished, which corresponded to the two dominant ITS types present. The "*aeruginosa*" type strongly dominated in June, but was almost completely replaced in a single week by the "*viridis*" type, that dominated the rest of the growth season. This shift coincided with a temporary bloom biomass decrease.

Apparently, amoebae were responsible for this dramatic shift as they reached a pronounced peak in abundance at the time of the shift and infected a high percentage of the "*aeruginosa*" colonies. Chytrid fungi (*Chytridium microcystides* Skuja), although they could reach high infection frequencies, and zooplankton, dominated by rotifers, apparently had a minor influence on bloom dynamics. From the first results of 2008, a similar pattern emerges, but without a large increase in "*viridis*" biomass. Effects on bloom toxicity will be discussed. Both amoebae and *Microcystis* have been brought into culture and will in the near future be used in *Microcystis* competition experiments and to test amoeba host specificity and dependence on *Microcystis* colony density.

6) Micro-evolution of physiological defence traits in a natural population of *Daphnia magna*

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Populations often face changes in environmental conditions at a relatively short timescale, which may lead to micro-evolution of traits to cope with these changing selective pressures. Selective forces in natural systems often interact, causing changes in traits that cannot be explained by studying the effects of the different stressors independently. Therefore, we used a natural study system of which we could track the in situ evolution of physiological traits involved in the defence against enemies, using a resurrection ecology approach. We found an increase in levels of the stress protein (Hsp60) and innate immunity (proPO) through time in the studied population. This increase did not match with the historically documented changes in fish predation pressure, but instead paralleling an increase in parasite load through time in this habitat. This might indicate that parasites have been a strong selective force driving micro-evolution In combination with previously described micro-evolutionary responses, we show simultaneous changes of different defence systems in response to multiple enemies.

Session 2b: Multitrophic interactions

1) Community consequences of size-selective predation: Emergent Allee effects and emergent facilitation

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The main body of theory concerning population dynamics and community structure is based on population models that only account for reproductive processes and for mortality, either from predation or from other causes. A major process that is not considered by these classical approaches is the fact that most if not all individual organisms develop during their life history and often grow significantly in body size during this development. In addition, this growth in body size is often food-dependent. If both reproduction as well as development depends on food-density, one of these two processes may turn out to limit population growth more than the other. As a consequence, a population in equilibrium can be regulated in two distinct ways: either through total population reproduction as limiting process or through total population maturation. We will show that in case of reproduction regulation the population is dominated by adult individuals and that any increase in mortality may lead to an increase in juvenile biomass. Similarly, in case of maturation regulation the population is dominated by juvenile individuals and increases in mortality may increase adult biomass. This overcompensation in biomass occurs with increases in both random and stage-specific mortality, even when the latter targets the stage exhibiting overcompensation. Such biomass overcompensation in prey species may have important community consequences, as it may give rise to emergent Allee effects for stage-specific predator species or to facilitation between two stage-specific predator species if these predators exploit different stages of prey.

2) The Differential Impact of a Patchy Environment on Genetic Diversity in a Multi Trophic System

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In fragmented and changing landscapes, many species live in a patchy environment in which their local populations frequently become extinct and "empty" sites are recolonised through dispersal from extant populations. Local extinction is often driven by the interactions between trophic levels (e.g. plant-herbivore or herbivore-parasitoid interactions). Because species from different trophic levels may differ in their dispersal ability, fragmentation may affect trophic levels differentially. In turn this will affect the dynamics of the multi trophic system.

The system we studied consists of the patchy distributed plant species *Senecio jacobaea*, its specialist herbivore, *Tyria jacobaeae*, the specialist parasitoid, *Cotesia popularis*, and the hyperparasitoid, *Mesochorus facialis*. The spatial scale we looked at ranged from meters up to hundreds of kilometres. We examined the effect of the spatial structure of the host populations on the genetic diversity and structure of the herbivore and both parasitoids, using molecular fingerprinting techniques (AFLP, RAF).

All three trophic levels displayed significant genetic differentiation among their sampled subpopulations. *C. popularis* and *M. facialis* unexpectedly showed a similar genetic differentiation among their subpopulations as their hosts do. Significant positive correlations between the genetic and the geographic distances (isolation by distance) of the subpopulations of the herbivore were found for different regional geographic scales. No significant correlation was found for the populations of both parasitoids at any geographic scale. The genetic diversity within the subpopulations of all three species was not correlated with the nearest neighbouring patch. *T. jacobaeae* was the only trophic level that displayed significantly higher genetic diversity within longer existing patches situated in natural areas than within ruderal patches situated

along roadsides or in industrial areas displaying a more ephemeral character. The genetic diversity of *C. popularis* was significantly positively related to its patch size only, whereas for *M. facialis* none of the habitat characteristics was related to its genetic diversity within its sampled patches.

Our findings show that the three species experience different influences and pressures that define their genetic structures, despite the fact that they live in the same patchily distributed environment. We will also discuss these findings in the context of other results that were gathered through field observations and experiments.

3) Are population differences in plant quality reflected in the preference and performance of two endoparasitoid wasps?

Rieta Gols
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In recent years, increasing attention has been paid in exploring the role of direct plant defence, through the production of allelochemicals, on the performance of parasitoid wasps and their hosts. However, few studies have determined if parasitoids can detect differences in plant quality and thus preferentially attack hosts on which their progeny develop most successfully. In this study we examined the development and preference of two endoparasitoids, *Diadegma semiclausum* and *Cotesia glomerata*, developing in larvae of their respective hosts, *Plutella xylostella* and *Pieris brassicae*. In turn, these were reared on different wild populations of black mustard (*Brassica. nigra*) originating in The Netherlands and Sicily (Italy), as well as single cultivated strains of *B. nigra* and brown mustard, *B. juncea*. The four mustard populations differentially affected development time and body mass of the herbivores and parasitoids. Contrasts among the means revealed significant differences mainly between *B. nigra* and *B. juncea*. Both parasitoids, however, preferred to alight on plants in which their progeny developed most successfully. In behavioural bioassays, *D. semiclausum* did not discriminate among the *B. nigra* populations and preferred to alight on *B. juncea*, which was the best plant population for parasitoid development. By contrast, *C. glomerata* females exhibited the lowest preference for Italian *B. nigra* populations, on which adult parasitoid size was the smallest. These results reveal that parasitoids can detect even small differences in plant quality presumably through their volatile blends and that plant preference and offspring performance in the two species are 'optimally synchronized'.

4) Trophic Control in Soil Microbial Food Webs

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We evaluate the relative importance of trophic control in the soil micro-food web of two geographically distinct but structurally similar scrub oak forests, one in Florida (FL) and one in New Jersey (NJ), USA. We experimentally applied allochthonous nitrogen as 0 Kg Ha^{-1} Yr^{-1} (deionized water control), 35 Kg Ha^{-1} Yr^{-1} and 70 Kg Ha^{-1} Yr^{-1} in monthly increments over the course of one year to replicated $1m^2$ plots situated at the base of a reference scrub oak tree (*Quercus myrtifolia in* FL and *Q. ilicifolia* in NJ). We measured bacterial and fungal biomass as well as density of soil animals including collembola, oribatid and predatory mites. Allochthonous nitrogen did not affect the biomass or density of any of the sampled functional groups at either experimental site. However, the FL site supports a greater biomass of bacteria and fungi than NJ, and the NJ site supports a greater density of all soil animal groups than FL. We correlated

microbial biomass and soil animal density with abiotic soil characteristics including, total C, total N, soil moisture, depth of organic horizon, and concentration of soluble nutrients (NO_3, NH_4 and PO_4). We found evidence for top down control by soil animals on microbial biomass. At the same time, we also found evidence for bottom up control because NO_3 and PO_4 positively correlate with microbial biomass. Our results show that top-down and bottom-up control may be working simultaneously in naturally occurring soil food webs. We found differences in soil food web structure between two forests that have similar above ground biotic structure, but which appear to have very different abiotic drivers.

5) Plants as Green Phone lines. Plant-mediated communication between below- and aboveground insect herbivores and parasitoids

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One of the challenges in the study of the interactions between above- and belowground organisms has been to explore whether, and mechanistically how, interactions between organisms directly related to the plant roots and shoot can influence the performance and behaviour of organisms higher in the trophic food chains.
Here I will show a case study where a root-herbivore shares a host-plant with a foliar-feeding herbivore and its parasitoid, influencing the growth and development of both aboveground trophic levels, mediated by chemical changes induced in the shoot of the plant. We found evidence that root-feeding insects can also influence oviposition decisions of their aboveground counterparts, and most remarkably that the parasitoids of the foliar-feeding herbivores can exploit specific volatile signals induced by root herbivores to select the hosts were their off-spring perform more optimal.

6) The role of plant quality in plant-herbivore interactions in freshwater ecosystems

Liesbeth Bakker
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The importance of herbivory as a factor that limits macrophyte abundance and species composition is still debated. My database of measurements of C:N ratio's as a proxy of macrophyte quality shows that median C:N ratio's are higher than those of algae and lower than in terrestrial vascular plants. A review of published vertebrate herbivore exclosure studies shows a similar result for the proportion herbivory, e.g. the proportion consumption of macrophytes is higher than on terrestrial plants and lower than on aquatic algae. I conclude that herbivory should be generally quantitatively more important on macrophytes than on terrestrial plants and this may be explained by plant quality. However, general plant traits as plant stoichiometry don't always hold their predictive value when studied at the species level. Therefore I tested the relationship between plant stoichiometry and palatability for a general consumer in feeding trials. In the field I tested the effect of vertebrate herbivores on macrophyte abundance, species composition and diversity in lakes of contrasting nutrient availability and plant quality.

Session 2c: Spatial ecology

1) Experimental evidence for spatial self-organization and its emergent effects in ecosystems

Johan van de Koppel
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Spatial self-organization is the main theoretical explanation for the global occurrence of regular or otherwise coherent spatial patterns in ecosystems. Using mussel beds as a model ecosystem, we provide an experimental demonstration of spatial self-organization. Under homogeneous laboratory conditions, mussels developed regular patterns, similar to those in the field. An individual-based model derived from our experiments showed that interactions between individuals explained the observed patterns. Furthermore, a field study showed that pattern formation affected ecosystem-level processes in terms of improved growth and resistance to wave action. Our results imply that spatial self-organization is an important determinant of the structure and functioning of ecosystems, and it needs to be considered in their conservation.

2) Top-down control by herbivores regulates landscape formation on intertidal flats

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Studies on the interaction between landscape formation and herbivores have mainly focused on herbivores following landscape structure. However, herbivores can also create landscape structure by interacting with geomorphological processes. Results of this study demonstrate that herbivores on an intertidal flat alter landscape structure. Field observations in two successive years showed a (rapid) disappearance of self-organized spatial patterns when herbivores increase. Field experiments, using defaunated and natural sediment, confirmed the hypothesis that landscape formation on intertidal flats can be driven by herbivores. Herbivores disrupt the interaction between diatoms and sediment dynamics and hence change the intertidal flat into a homogeneous landscape. We suggest that this change in landscape formation is mainly caused by the settlement of *Macoma balthica* larvae. The homogeneous flat has less diatom biomass and will be more erosive compared to the self-organized patterned intertidal flat.

3) Upscaling optimal foraging movements

Geerten Hengeveld
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Levy flights have been enthousiastically used in studies on the foraging movements of animals. They provide an appealing alternative to other random walk models, because theoretical studies have shown two superior qualities: Levy flights are superefficient and scale-free superdiffusive. Where the first property provides a link between movement ecology and optimal foraging theory, the latter can be used in combining small-scale measurements and landscape scale simulations. I will discuss the implications of these assumptions and the applicability of Levy flights in both foraging and landscape ecology.

4) Spatial correlation as an early warning signal for transitions in ecosystems

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Leading indicators of systemic shifts in lakes, fisheries, semi arid ecosystems or even climate have attracted increasing attention lately. Mathematical theory suggests that before such transitions there is a consistently fundamental effect on the dynamical

behavior of the system; the system becomes "slow" as the critical point is approached. Researchers have focused on translating such systemic changes into quantifiable early warning signals. When the state variable of interest is monitored in time, it has been shown that variance, skewness, power spectrum properties and autocorrelation at lag 1 may be used as potential indicators of imminent shifts in systems exhibiting first order transitions. Analogous studies in space have proposed that the spatial organization (patterns and patch size distributions) could be used as a leading indicator of shifts. Here, we use a well-studied model that describes the shift of a clear vegetated shallow lake to a turbid algae dominated state through a fold bifurcation. Our aim is to examine whether correlation in space can qualify for a leading spatial indicator in such model ecosystems which, when spatially explicit, exhibit bistability locally. We find that spatial correlation of neighbouring grid cells increases well before the transition. We compare spatial correlation with temporal autocorrelation and we show that spatial correlation outperforms temporal autocorrelation when connectivity between neighbouring grid cells increases. Our results suggest that spatial correlation may be a reliable and parsimonious measure of proximity to an impending regime shift.

5) Self-organized patterning in seagrasses

Tjisse van der Heide
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The spatial structure of seagrass landscapes is typically ascribed to the direct influence of physical factors such as hydrodynamics, light and sediment transport. We investigated whether spatial structuring in seagrasses may arise from feedback interactions between the vegetation and its abiotic environment. We studied regular banded patterns in a small-scale intertidal seagrass ecosystem. Field measurements and experiments identified scale-dependent feedbacks between hydrodynamics and vegetation as the dominant mechanism behind the patterns in our system, indicating that they were self-organized. Moreover, our field study indicated that two gradients caused by distinct physical stresses (light limitation and desiccation) resulted in a consistent change in patch size and vegetation cover. Model analyses confirmed that the identified scale-dependent feedback processes could explain the observed banded patterns and that changes in abiotic stress affected the patterns in a predictive manner. Our study provides direct empirical evidence for a coherent response of self-organized patterns to changing abiotic conditions, suggesting a potential use for self-organized patterns as stress indicator in ecosystems.

6) Bacterial bioreporter capable of describing heterogeneity in environments and populations

Mitja Remus-Emsermann
NIOO-CTE, Heteren

Bacteria are commonly investigated as populations, thus only averages are being determined. This neglects the large environmental differences that individuals within that population encounter if they are in natural situations like in soil or on plant surfaces. Compared to human scales, an average leaf represents for an average-sized bacteria the dimensions of the Hoge Veluwe. It is fair to assume that an individual leaf-associated bacterium is not able to perceive its entire habitat. Instead, its actions will be determined to a large extent by it local environment. It is unknown what the dimensions of this actual field of perception are, or related to that, at what distance bacteria start to influence each other, for example by competing for resources. We introduce a bioreporter that is capable of describing and measuring microscale environmental impacts on individual bacterial cells.

Session 2d: Restoration Ecology

1) The decline of metallophyte vegetation in floodplain grasslands: implications for conservation and restoration

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Factors and soil processes causing the decline of the endemic metallophyte vegetation and the increase of pseudo-metallophytes in floodplain grasslands of the river Geul were investigated. A soil study was carried out at locations presently and formerly dominated by metallophytes. Additionally, a study was carried out in floodplain grasslands to investigate changes in soil chemistry during the last decades. A plant growth experiment of 2 years was performed in the field, to test the effect of improving the soil conditions by top soil removal in combination with reintroduction of seeds and seedlings.

Metallophytes only occurred on acidic floodplain soils (pH-H_2O 5.0-5.5) with relatively high Zn availability (total Zn > 40 µmol/g; Zn/Ca > 0.8; Zn-H_2O > 59 µmol kg^{-1}) combined with a low phosphate availability (Olsen-P << 1250 µmol/kg). The Olsen-P and total Ca concentrations were relatively high in the top soil (0-20 cm) while total Zn concentration was high throughout the soil profile (0-50 cm). Removal of top soil led to recovery of P and Zn availability. Under these conditions, growth of pseudo-metalliferous grasses was nil and did not significantly increase. In contrast, introduced metallophytes could easily establish, maintain, reproduce and did significantly increase in cover in time.

Our study shows that factors leading to higher soil alkalinity inhibit Zn availability at the cost of the metallophyte vegetation. Factors leading to a higher Olsen-P concentration stimulate the growth of more competitive pseudo-metallophyte grasses. Both eutrophication and alkalinization have contributed to the decline of metallophyte vegetation in floodplains of the Geul. Removal of the alkaline and phosphate enriched soil top-layer restores the original soil chemistry and enables re-colonisation of the metallophyte vegetation. The results can be applied in conservation and restoration strategies

2) The effect of plant-soil feedback on the restoration of fen meadows

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Nutrient-poor fen meadows are of great conservation value because of their endangered flora and fauna, which depend on these areas for their persistence. As a consequence of intensification of agricultural practices, these meadows have become increasingly rare. Restoration measures consist of re-introducing traditional management techniques, in many cases combined with additional measures like rewetting and sod cutting. The success of restoration measures is variable. It has been shown that feedback between plants and the soil community can contribute to secondary succession. Thus, restoration of the soil community may be important to accomplish restoration of the plant community. We investigated the effect of plant-soil feedback on competition between characteristic meadow plant species and more common plants. Most of the tested plant species benefited from growing in soil with a typical fen meadow plant community compared to soil from a degenerated fen meadow.

3) Cascading food-web effects of nitrogen deposition on essential micronutrients

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Many essential micronutrients (minerals, vitamins and amino acids) cannot be synthesized by animals themselves and must be ingested. Nitrogen deposition is believed to change the micronutrient content of plants. Increasing evidence indicate that changes in plant quality cascade up to the top-levels of food chains. For example, populations of Sparrowhawks (*Accipiter nisus*) in forests on mineral-poor sandy soils have declined. Embryos in failed Sparrowhawk eggs incurred symptoms of vitamin B2 deficiency. In the food chain of the Sparrowhawk, insects are the most important accumulators of vitamin B2. In forests on mineral-poor soils, vitamin B2 content in insects is lowered compared to mineral-richer soils. A low vitamin B2 content may result from a lack of essential amino acids that are needed to store vitamin B2 in the caterpillar body (e.g. tryptophan). These micronutrient deficiencies may also cause increased mortality of caterpillars on mineral-poor sandy soils, which was investigated in Wintermoths (*Operophtera brumata*) on Common Oak (*Quercus robur*) and Small Emperor Moth (*Saturnia pavonia*) on Heather (*Calluna vulgaris*). In Heather, increased foliar N correlates with lowered Iron and Nickel, which can both contribute to the lowered survival. This shows that further clarifying the role of Nitrogen and amino acids in causing micronutrient deficiencies is important for understanding the chains of effects of micronutrient limitations in animal communities.

4) Colonisation events in riparian zones in fens, linking dispersal patterns to probabilities for germination and establishment.

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The occurrence of new establishment events often determines the success of restoration activities. Lack of establishment events may be caused by factors limiting dispersal or hampering recruitment. Restoration measures taken in riparian zones of fen ponds did not result in the desired vegetation development and lack typical pioneer species. In these systems, dispersal by water (hydrochory) is of major importance for the dispersal of plant propagules. But what are the dispersal mechanisms in such lakes with wind driven current velocities? Can this explain the (lack of) occurrence of typical pioneer species in newly created ponds or are factors hampering germination or establishment of more importance? We studied these questions in fens, and focused on the mechanisms.

First, we tested the hypotheses that hydrochory in fens is driven by wind. Therefore, during November 2007, in 8 turf ponds, artificial-grass mats were placed at banks upwind and downwind to the main wind direction. The seeds and vegetative diaspores trapped in these mats were determined and counted. Significantly more diaspores were found on downwind banks. Afterward, we conducted a sowing experiment at the same banks, to investigate what factors determine germination and establishment for a set of five typical riparian pioneer species that predominantly grow at sheltered sites. We found that the germination of these pioneer species was enhanced by higher light availability, but that their establishment was severely hampered by wave action washing seeds and seedlings away from the shore at unsheltered sites.
So, our results show that hydrochory in water bodies with no or low discharge is directly influenced by wind speed and that deposition patterns seem to be consistent with dominating wind directions. However, as successful establishment was highest in places sheltered from the wind, the recruitment phase might be crucial for successful restoration.

5) Short- and long-term responses of aquatic macroinvertebrates to restoration and decreased acidification in moorland pools. A complex of bottlenecks, colonization barriers and habitat suitability.

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Acidification of moorland pools has led to the decline of characteristic aquatic macroinvertebrates. Although reduced emissions of acidifying substances (NHx and SOx) increased water quality, they did not halt the decline of characteristic species.
The reason for the lack of fauna recovery was that reduced acidification stimulated internal eutrophication, resulting in an ongoing decline of habitat suitability.
My study revealed that characteristic species strongly declined as a result of short term effects of restoration measures. Species were unable to survive the intensity and large scale on which measures were taken and they encountered problems after restoration with acquiring food, ovipositioning and shelter. Evaluation of long term effects revealed that restoration measures where frequently (approx. 40%) taken incorrectly and therefore did not restore habitat suitability. As a result no recovery of flora and fauna diversity occurred. If taken correctly, restoration measures on the long term increased abundance and species richness of characteristic species. However, a number of endangered species did not return or remain rare indicating possible colonization barriers. In conclusion, for the recovery of moorland pool biodiversity, restoration of suitable environmental conditions without introducing new bottlenecks has the highest priority.

6) Restoration measures and species colonization in nutrient-poor grasslands in Southern Limburg

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The plant biodiversity of nutrient-poor grasslands on hillslopes in southern Limburg is still declining. Within the framework of OBN, research was started in 2004, which included experiments on the development of these grasslands from intensively used agricultural grassland. Experimental plots were put up in 2005 on three different fields to investigate the effects of different restoration practices to restore these grasslands. Two aspects are considered: firstly, the removal of nutrients in the soil, secondly, the dispersal possibilities of characteristic species. The presentation handles about the results of these small-scale experiments (3x3m) between 2005 and 2008. The combination of sod cutting and hay transfer (from a well-developed reference site) appears to be the most successful way to restore the valuable matgrass swards. There will be also some attention for the development of calcareous grasslands. The effects of nutrient removal was studied in sod-cut and mown plots, and the results are compared to long-term permanent plot-data in similar calcareous grassland habitats.

Session 3a: Biogeochemistry

1) The effect of herbivores on methane cycling and methane-processing microbes in shallow lakes

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Wetlands are major contributors to atmospheric methane. Herbivorous waterfowl (i.e. swans, geese, ducks) may affect methane cycling and emission from wetlands. Firstly they may bioturbate the sediment while digging for subsurface overwintering organs of aquatic plants. Secondly, they may indirectly affect methane cycling by reducing the below and above ground plant biomass thereby reducing plant oxygen and carbon exudation.

The objective of the present study was to assess whether foraging waterfowl influences functioning and diversity of methane-cycling microbes in shallow lakes thereby affecting methane emission from these systems. In the field, methane emission, diversity and functioning of methane oxidisers were assessed in exclosures where access of waterfowl was seasonally regulated. Flux chamber analyses were carried out in combination with rate measurements, denaturing gradient gel electrophoresis (DGGE), particulate methane monooxygenase (*pmoA)*-based micro array, stable isotope labelling of phospholipids (SIP-PLFA) and *pmoA*-based clone libraries.

Collectively the results show that methane emission is reduced substantially by waterfowl activity mediated through a reduction in plant biomass. Methanotrophic activity, diversity as well as abundance was strongly regulated by season and sediment-physicochemisty (i.e. organic matter, clay content) as confirmed by micro array, DGGE, quantitative PCR and SIP-PLFA analyses. Both type I (*Methylobacter/Methylomonas*) and type II (*Methylocystis*) methanotrophs were active in these sediments demonstrated by mRNA based *pmoA* PCR-DGGE.

It can be concluded that animal-plant-microbe interactions in wetland systems have to be taken into account as a significant factor affecting methane cycling and the ecology of microbes involved.

2) Spatial- and seasonal variability of greenhouse gases in two managed peat meadows in The Netherlands and the comparison of small scale and large scale measurement techniques

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Our research focuses on the production, transport and spatial/seasonal variability and on the driving variables of GHG emission in fen meadow ecosystems. We like to determine the effect of management and ground water level manipulation on the carbon balance and methane (CH_4) and carbon dioxide (CO_2) production. We propose to study what the possibilities are for emission reduction in managed fen meadow areas.

The research sites Stein and Oukoop are located near the town of Reeuwijk. Both areas have peaty soils with clay in the upper 30 cm. About 20% of the area is open water, and the remaining part is grassland. Stein is under less intensive management, as the area is now being partly managed as a bird protection area. Stein has a dynamic ground water regime with high ground water table (-15 cm) in the period October-May and lower groundwater table in the rest of the year (mean of -45 cm). Oukoop is under intensive cultivation with a mean highest GWT of 25 cm below surface and the mean lowest GWT of 50 cm below surface. The third research site Horstermeer is located in the centre of The Netherlands and is taken out of intensive management 14 years ago. This area has developed into a nature area with high GWT throughout the year.

CH_4 flux measurements and CO_2 measurements are performed at both sites by (1) the eddy covariance method (hectare scale), continuously and (2) the closed chamber method (m^2 scale), every month up to every two weeks. The combination of these two methods (landscape scale and plot scale, respectively) is useful for up scaling of emissions to larger scales and for understanding of processes.

Methane fluxes from ditches and ditch edges differ significantly from field fluxes and in the managed areas drainage ditches appear to be emission hotspots. A clear seasonal pattern for CO_2 and CH_4 emissions exist, with very high CH_4 fluxes from the ditches when temperatures are high. Temperature appears to be to the most important driving variable for CO_2 and CH_4. Methane emissions in the nature area are the highest, but when taking into account the farm emissions too, the intensively managed area has the highest methane fluxes. Including methane in the total carbon balance we can conclude that the intensively managed peat area appears to be a source (CO_2 + CH_4) of 4 to 5 tons C per hectare and that extensive management reduces the carbon source with 20-30%, but the effect will be stronger when keeping the water level high over a longer time span. With no management (Horstermeer) the total balance has turned into a C-sink.

3) Shifts in macrophyte composition in response to elevated CO_2 in softwater lakes

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During the past decades macrophyte communities have changed in many softwater lakes. Specialist isoetids like *Isoëtes echinospora* and *Lobelia dortmanna* are replaced by faster growing elodeid species such as *Callitriche hamulata* and *Myriophyllum alterniflorum*. Since many pristine softwater lakes contain very low CO_2 concentrations of <30 µmol L^{-1}, macrophyte production is often carbon limited in these systems. Therefore the observed shift in the macrophyte communities might be related to rising aquatic CO_2 availability.

Three sediment cores from a South Norwegian softwater lake are analyzed for plant macro-, and micro-remains to reconstruct past macrophyte community dynamics. The results show a distinct shift from *Isoetes* spp. to *C. hamulata* dominance during the last decades, while diatom inferred aquatic TP and pH did not change. This rules eutrophication and acidification out as a cause for the invasion of *C. hamulata* . Rising CO_2 availability might, together with nutrient enrichment of the sediment be responsible for the changes in the macrophyte community. To further elucidate the role of CO_2, the growth response of two elodeid species (*M. alterniflorum* and *C. hamulata*) were experimentally determined at CO_2 levels ranging from 20 (ambient) to 230 µmol L^{-1}. *C. hamulata* was also grown on two types of sediment with different nutrient content. Irrespective of sediment type growth of both species was minimal to negative at ambient CO_2 levels and became positive with rising CO_2 availability,

approaching maximal growth at CO_2 levels around 100 µmol L^{-1}. Substantial growth of both species only occurred when the plants were grown on mesotrophic sediments. When *M. alterniflorum* was planted together with the isoetids *Littorella uniflora* growth of *M. alterniflorum* was reduced drastically.

The experiments show that the two tested elodeids will not be able to grow in pristine softwater lakes, but could invade these systems when CO_2 availability rises and the nutrient status of the sediment is sufficiently high.

4) The importance of bacteria as a source of c, n, amino acids and fatty acids for benthic fauna investigated by stable isotope labeling.

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In order to clarify the importance of bacteria as a source of carbon, nitrogen, amino acids and fatty acids for the benthic fauna in intertidal mud flat sediment, we performed a dual stable isotope labeling experiment. ^{13}C-glucose and ^{15}N-ammonium were injected into the upper 10 cm of intertidal mud flat sediment. ^{13}C and ^{15}N were subsequently traced into bacterial biomass (represented by hydrolysable amino acids (HAAs) and phospholipid-derived fatty acids (PLFAs)) and benthic meio- and macro fauna (hand-picked). For three macrofaunal taxa (*Nereis diversicolor, Heteromastus filiformis* and Oligochaeta), ^{13}C and ^{15}N were specifically traced into their HAAs and fatty acids. Results reveal a strong preferential incorporation of bacterial nitrogen over carbon by most meio- and macro faunal taxa and indicate that bacteria can be an important source of nitrogen in the faunal diet. The compound-specific results provide detailed information about the pathways for uptake and synthesis of individual amino acids and fatty acids by the two polychaetes and oligochaetes.

5) Alternative strategies to sustain N-fertility in acid and calcareous soil: low microbial N-demand versus high biological activity

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Soil pH is an important factor regulating C and N dynamics. Acid soils have low rates of decomposition, low gross N-release, and presumably low net N-mineralization, while in calcareous soils net N-mineralization is supposedly high, due to high rates of litter decay.Yet, despite this being the 'conventional wisdom', there are surprisingly few data to support an increase of net N-mineralization with gross N-release and/or pH. In contrast, in coastal dunes, wetlands and beech forests, we measured higher instead of lower net N-mineralization in acid soil than in calcareous soil. This unexpected result may be attributed to lower microbial N-demand. In Luxembourg beech forests, gross N-mineralization was indeed higher at high pH, but microbial N-demand was also high, and efficiency of N-mineralization per unit CO_2 respired or unit microbe was consistently lower than in acid soil. Thin section analysis and fungal:bacterial ratios suggested that the shift from dominance of fungi in acid soil to bacteria in calcareous soil may play a role. Fungi may have lower N-requirements than bacteria, due to differences in life style and osmoregulation, which is supported by higher microbial C:N ratios. Selective inhibition of fungi and bacteria indeed suggests that the two groups are fundamentally different in N-dynamics. In both antibiotic treatments, net N-mineralization increased compared to controls, due to high substrate availability of dead microbes, but fungi and bacteria clearly differed in the way they achieved this. When fungi were excluded, and bacteria remained, increased net N-mineralization was due to high activity and gross N-mineralization. In contrast, when fungi remained, gross N-mineralization did not increase, but high net N-mineralization was due to low microbial N-demand, which suggests that fungi and bacteria really differ in activity and N-requirements. Litter quality did not alter N-mineralization patterns across pH-gradients. Under both low-degradable beech, and

high-degradable hornbeam, microbial N increased with pH, but net N-mineralization and efficiency of N-mineralization per unit microbe clearly decreased with pH. These results further support that acid and calcareous soils have different strategies to maintain N-fertility. In acid soils, net N-mineralization may be higher than expected, despite low biological activity, because microbial N-demand is low as well. In calcareous soils, however, net N-mineralization may be lower than expected, because high biological activity and high gross N-release are counteracted by high microbial N-demand.

6) The fundamental science of applied biogeochemistry; cross-fertilization between macro- and microecology

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Through the integration of the latest insights from different disciplines and their distinct approaches, we may not only be able to solve questions about actual and general biogeochemical mechanisms governing ecological processes, but also improve predictions about future ecosystem functioning in relation to environmental changes. In this paper we will show how applied research on wetland management and rehabilitation, integrating macro- and microecology in the field and in mesocosm designs, may shed new light on these issues.

7) Implications of global change for denitrification in shallow freshwater systems

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One of the major pathways of nitrogen removal in shallow freshwater systems is microbial denitrification. Denitrification is influenced by both temperature and initial nitrate levels, both of which are likely to change substantially over the coming century. In addition to the foreseen rise in global temperature, Western Europe is predicted to see an increase in number of extreme precipitation events, implying more surface run-off and therefore increased nutrient levels in surface waters. So-far, effects of these changes for denitrification in shallow lakes and wetlands have been difficult to predict, as little is known about the interacting effects of temperature and nitrate levels on the complex of processes involved.

Here we present experimental and field data showing the net effect of nitrate concentrations and temperature on denitrification in shallow freshwater systems. Combined and single effects of temperature and nitrate levels on denitrification were studied in a microcosm 15N addition experiment. Microcosms contained natural sediments, macrophytes (Elodea nuttallii) and a macrophyte growth medium. Denitrification rates in the microcosms were measured at 4 different temperatures (10, 15, 20 and 25°C) and 2 different nitrate concentrations (1.5 and 3 mg/l NO3-N). In the field, denitrification was measured by a series of 15N addition surveys in drainage ditches during different times of the year, thus covering a range in water temperatures and nitrate levels as well.

In both microcosms and the field we found exponential relationships between temperature and denitrification rates. Microcosm results also showed a significant interaction between temperature and nitrate levels: the effect of temperature on

denitrification was strongest at high nitrate levels and the effect of nitrate on denitrification rates was strongest at high temperatures.

The exponential increase in denitrification rate with temperature could be described by an Arrhenius model for temperature dependency. The fitted Arrhenius curves suggest that denitrification rates increase by 25 to 35% with each degree of temperature rise. Our results thus indicate that with a foreseen 3-degree temperature rise, denitrification rates might double. This would be favourable for water quality. However, the potent greenhouse gas N2O is one of the end products of denitrification. Therefore, the remarkably strong effect of temperature on the denitrification may also imply a substantial contribution to the positive feedback in global warming caused by the net positive effect of temperature on atmospheric greenhouse gas concentrations.

Parallel 3b: Plant-animal interactions

1) Dispersal failure contributes to plant losses in NW Europe

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The ongoing decline of many plant species in Northwest Europe indicates that traditional conservation measures to improve habitat quality, although useful, are not enough to halt diversity losses. Using recent databases, we show for the first time that differences between species in adaptations to various dispersal vectors, in combination with changes in the availability of these vectors, contribute significantly to explaining losses in plant diversity in Northwest Europe in the 20th century. Species with water- or fur-assisted dispersal are over-represented among declining species, while others (wind- or bird-assisted dispersal) are under-represented. Our analysis indicates that the 'colonization deficit' due to a degraded dispersal infrastructure is no less important in explaining plant diversity losses than the more commonly accepted effect of eutrophication and associated niche-based processes.

2) White Rhino and Termites as Creators of Environmental Heterogeneity

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Heterogeneity or resource patchiness is a global theme in modern ecology. A patchy resource environment often leads to areas of high faunal and floral diversity and therefore high conservation value. On a large scale abiotic factors regularly drive resource patchiness but on a small scale the causes of heterogeneity are more varied and complex. At this scale biotic drivers often interact with abiotic drivers. In this study White rhino (Ceratotherium simum) middens and three genera of termite mounds are examined as key drivers of small-scale resource heterogeneity in savannah grasslands. We investigated how the impact of both biotic drivers interacted with one of the main abiotic drivers in the system, rainfall.

Rhino and termites can both act as ecosystem engineers, creating nutrient 'hotspots' on similar spatial and temporal scales. We compared and contrasted the effects of these agents in creating and maintaining heterogeneity in the savannah grass landscape under low and high rainfall conditions.

We selected ten sites (five wet and five dry) in Hluhluwe iMfolozi Park, South Africa. At each site transects were laid out around rhino middens (dung heaps) and termitaria (termite mounds). On these transects we recorded the species present, ground cover and biomass of all plants within 1x1m quadrats. Additionally, we took paired grass samples adjacent to, and away from, the mounds and middens. These samples were then analysed for various nutrients including C, N and P.

Plant diversity was higher around both middens and termitaria for distances of greater than 5 meters away from these features. Plants adjacent to mounds and middens were of higher quality in terms of C:N ratios than those in the plots further away. Both the impact on plant diversity and plant quality was stronger in areas of relatively high rainfall.

These results indicate that both rhino and termites play a significant and varied role in creating and maintaining heterogeneity and should be considered important in the functioning of savannah ecosystems.

3) What determines the distribution of herbivores in the Serengeti ecosystem?

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Herbivores are caught in a precarious balancing act between accessing sufficient resources of adequate quality while at the same time avoiding predators. I investigate how common drivers may simultaneously influence forage abundance, forage quality and the risk of predation. For example, rainfall increases the abundance of vegetation but reduces its nutritional quality, while at the same time increasing the amount of cover available for stalking predators. Likewise disturbances such as fire change the nutritional composition of grasses while reducing a prey's catchability. I investigate how the interdependencies between resources and risk may shape the distribution of different sized herbivores in the Serengeti Ecosystem.

4) Changing hiding patterns in fennel pondweed tubers (*Potamogeton pectinatus*) in relation to predation by Bewick's swans

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Avoidance by escape, a comparatively rare phenomenon in the plant world, was suggested for tubers of fennel pondweed in shallow lakes. The tubers, produced every year anew at the end of the growing season are foraged upon by Bewick's swans. Deep burial in the sediment increases survival to swan foraging but comes at a cost, as the tubers need to be larger to sprout successfully in spring. Due to this trade-off, we expect tubers of fennel pondweed to be buried shallowly in the absence of swans given the notion that tuber burial depth is variable in the field. In a four-year exclosure study in the shallow lake Lauwersmeer we factorially excluded summer and winter herbivores from plots of pondweed vegetation. In autumn and spring we measured the depth of tubers by slicing up sediment cores. Over four years time, we observed a significant decrease of mean tuber depth in autumn in winter exclosed plots confirming our initial hypothesis. The effect was strongest in the year-round treatment. We suggest that deep burial of tubers indeed is an avoidance response to herbivory. We consider the stronger effect observed in the year-round treatment to be an effect of the intense sprout competition taking place under the consistently higher tuber densities in these plots. We propose that changes in tuber burial are achieved both through maternal carry-over effects and genotype sorting.

5) Interactive effects of large grazers and soil organisms on plant community composition

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Soil organisms have been reported as important drivers of plant community structure, composition and dynamics. The soil environment is highly spatially structured, and therefore the specific relationship between some soil organisms and plant species are expected to result in small-scale heterogeneity in plant community composition as well. However, in natural systems small-scale plant community composition is often reported to be homogenized in the presence of large vertebrate grazers. Therefore, we hypothesize that large aboveground herbivores overrule the effect of soil organisms and that the effect of soil biota on plant species composition becomes apparent in the absence of large aboveground grazers only. On the Dutch Wadden Sea Island Schiermonnikoog we set up a field experiment to investigate the interaction between soil organisms and aboveground vertebrate herbivores. We studied the influence of subterranean yellow meadow ants (Lasius flavus) and aboveground herbivores on small scale plant community composition in a salt marsh with and without cattle grazing. We found that plant community composition was strongly affected by cattle grazing. In the presence of cattle plant community composition was not significantly

changed by yellow meadow ants, while in the absence of cattle we found a complete shift in plant community composition on and off ant mounds. We conclude that yellow meadow ants alter plant community composition in the absence of cattle only and thus that large grazers may overrule the effect of soil organisms on plant community composition.

6) Seed and seedling fate of spiny shrubs in grazed woodlands

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Spiny shrubs play a crucial role in the dynamics of grazed woodlands: they protect nearby growing tree saplings from large herbivores and so initiate tree establishment in the landscape. An essential unanswered question at the core of this process is: how do these spiny shrubs themselves establish in grazed woodlands? Shrub establishment is thought to be the main bottleneck for shifts of vegetation mosaics in grazed woodlands. Knowledge of the underlying processes is required for a better understanding of grazed woodland dynamics and for conservation and management purposes.

We studied the fate of seeds and seedlings of the spiny Blackthorn (Prunus spinosa) in ancient cattle-grazed woodlands along floodplains in The Netherlands. We compared micro-environmental conditions of plots with and without recent Blackthorn establishment, quantified post-dispersal seed predation of Blackthorn in short grassland, tall swards and shrubs, and monitored the performance of transplanted Blackthorn and Hawthorn (Crataegus monogyna) seedlings in short grassland and tall swards open to – and excluded from – cattle grazing.

Presence of Blackthorn seedlings was positively correlated with soil pH, soil moisture and vegetation height, and was spatially positively associated with unpalatable sward species. Post-dispersal seed predation by rodents was highest under shrubs (95%), compared to swards (51%) and open grasslands (32%). Performance of Blackthorn and Hawthorn seedling was highest in exclosures, and higher in swards than in open grassland, while seedling mortality was generally low.

Our study shows that soil pH, soil moisture, vegetation type and herbivory interact in creating temporary suitable sites for the establishment of spiny shrubs. Once arrived and established in these suitable sites - the unpalatable swards - seedlings are safe from cattle and may, on their turn, facilitate other palatable trees and shrubs. Hence, unpalatable swards play a crucial role for the initial survival and establishment of spiny shrubs in grazed woodlands, which importantly affects the heterogeneity and dynamics of this system.

Session 3c: Ecogenomics

1) Competent Endophytes

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Bacterial endophytes live inside plants for at least part of their life cycle. Studies of the interaction of endophytes with their host plants and their function within their hosts are important to address the ecological relevance of endophytes. The initial plant-bacterium interactions might depend on stochastic events of recognition (e.g., the presence of particular amounts of specific microorganisms close to emerging roots), however deterministic factors, such the capacity of (mutual) signaling and signal perception, microcolony formation and colonization, very likely represent the driving forces that shape the diversity and composition of endophyte communities. Thus, plants have evolved mechanisms that allow recognition of bacterial cells via signals and they respond physiologically to bacteria that become endophytic. Bacteria, in turn, are capable to modulate the physiology of the plant, for instance by affecting plant ethylene levels. Endophytes can thus, to a certain extent, prevent the activation of the plant stress response and defense system, attenuating plant stress and promoting plant growth. In addition, by degrading plant-produced 1-aminocyclopropane-1-carboxylate (ACC), the precursor of ethylene, endophytes not only affect plant physiology, but they also obtain carbon and nitrogen for growth, without causing severe nutrient disturbance inside the plant. This so-called "double fitness" trait ameliorates the plant response to biotic and abiotic challenges, at the same time allowing bacteria to grow inside the plant. This mechanism leads to the concept of 'competent' endophytes, defined as endophytes that are equipped with genes important for maintenance of plant-endophyte associations.

2) Microarray approaches to bacterial mycophagy

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Mycophagy is a trophic behavior characterized by feeding on living fungal hyphae. Long known to occur in animals, insects and fungi, mycophagy was recently demonstrated for the first time in bacteria from the genus *Collimonas*. In order to understand the mechanisms underlying bacterial mycophagy, *Collimonas fungivorans* strain Ter331 was chosen as a model organism. In order to understand which genes are actually involved in mycophagy and antifungal activity, we confronted *Collimonas fungivorans* Ter331 with the fungus *Aspergillus niger* in vitro, isolated fungal and bacterial mRNA, and used expression arrays of *Collimonas* and *A. niger* to take transcriptional snapshots of the fungus-bacterium antagonistic dialog. This identified several candidate genes for bacterial attack and fungal defense/counterattack. Mycophagous genes and gene functions identified in *Collimonas* will eventually be used as signatures for culture-independent detection of mycophagous lifestyles in other bacteria or in natural environments.

3) Ecological genomics of *Boechera stricta*: Identification of a QTL controlling the allocation of methionine- vs. branched chain amino acid-derived glucosinolates and levels of insect herbivory

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In the Brassicaceae glucosinolates influence feeding, reproduction and development of many insect herbivores. Glucosinolate production and effects on herbivore feeding have been extensively studied in the model species *Arabidopsis thaliana* and *Brassica* crops, both of which constitutively produce leaf glucosinolates mostly derived from the amino acid methionine. Much less is known about the regulation or role in defense of glucosinolates derived from other aliphatic amino acids such as the branched-chain amino acids (BCAA) valine and isoleucine. We have identified a glucosinolate polymorphism in *Boechera stricta* controlling the allocation to BCAA- vs. methionine-derived glucosinolates in both leaves and seeds. *Boechera stricta* is a perennial species that grows in mostly undisturbed habitats of western North America. We have measured glucosinolate profiles and concentrations in 192 F2 lines that have previously been used for genetic map construction. We also performed herbivory assays on six F3 replicates per F2 line using the generalist lepidopteran *Trichoplusia ni*. Quantitative Trait Locus (QTL) analysis identified a single locus controlling both glucosinolate profile and levels of herbivory, the Branched Chain-Methionine Allocation or BCMA QTL. We have delimited this QTL to a small genomic region with a 1.0 LOD confidence interval just 1.9 cM wide, which in *A. thaliana* contains ~100 genes. We also found that methionine-derived glucosinolates provided significantly greater defense than the BCAA-derived glucosinolates against feeding by this generalist insect herbivore. The future positional cloning of this locus will allow for testing various adaptive explanations.

4) Assessing hitherto uncultured Acidobacteria and Verrucomicrobia in rhizosphere and bulk soils linking culture-dependent techniques and metagenomics

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Most often, studies on biogeochemical transformations in bulk or rhizosphere soil have ignored the role of the main part of the cryptobiota, defined as the functionally-unknown microbiota caused by its gross lack of culturability. Among the dominant cryptobiota in soil are the Acidobacteria and Verrucomicrobia. Although few culturable forms have been recovered from the soil environment, no rhizosphere representative has as yet been described for these groups. Also, besides their dominance in bulk and rhizosphere environments, only few glimpses of metabolic function have been assigned to these groups. In this study, we describe experiments to detect and culture Acidobacteria and Verrucomicrobia in rhizosphere and bulk soils, using culture-dependent and -independent techniques, and ascertain if these groups are active in the rhizosphere/bulk soil. The first study was done with potato (*Solanum tuberosum*) and leek (*Allium porrum*) rhizosphere. We developed new media, incubation conditions and detected colonies with less than 250µm diameter (microcolonies) to recover as many species as possible. Thus, cultivation was based on new oligotrophic media supplemented with catalase or rhizosphere extract and long incubations under different CO_2/O_2 ratios. Micro- (80-250 µm) and macrocolonies (>250 µm) were recovered on all plates. R2A was used as the control medium. The new media and incubation conditions resulted in elevated numbers of colonies (between 2.4 and 3.6 times the control). Especially, oligotrophic media amended with calalase or rhizosphere extract incubated or not at high CO_2 showed greatly enhanced colony

numbers (between 23.3% and 27.5% of the microscopic - total - bacterial counts). The enhancement was mainly due to the detection of microcolonies. Besides, 641 colonies were randomly picked and streaked to purity; after, they were identified by sequencing the region V6-V8 of the 16S rDNA (122 micro- and 521 macrocolonies). About 10% of all colonies showed less than 95% similarity with the RDP database, and hence presumptive novel bacterial genera were accessed. Among these, we recovered one representative of the group 8 Acidobacteria group, never isolated from the soil environment, and 8 verrucomicrobial representatives. The second study was performed in a disease-suppressive soil. We developed a methodology based on soil microbial DNA, which allowed the metagenomics-based unlocking of relevant genes. After analysis of approximately 15,000-membered metagenomic library of fosmids in an *Escherichia coli* host, we selected one clone (VM3) with antibiotic activity that showed high similarities with genes of the fully sequenced *Acidobacterium bacterium* Ellin345 (group 1 Acidobacteria). Based on our VM3 clone we developed a specific qPCR to measure the activity of an aminoacid transporter identified from the *A. bacterium* Ellin345 sequence. Furthermore, we demonstrated that this gene was more active in the RNA fraction of bulk soil when compared with the respective rhizosphere of grass and leek. These studies demonstrate that both culture-dependent and independent approaches can access Acidobacteria and Verrucomicrobia in soils and indicate that merging both techniques might minimize the hurdles of both approaches.

5) A non-arbitrary species concept for bacteria based on natural selection

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Bacterial strains are grouped into species on the basis of genetic similarity and the sharing of phenotypes deemed ecologically important. This polyphasic taxonomy has become considered obsolete by many as boundaries between species tend to be arbitrary and because it lacks grounding in evolutionary theory. It has recently been proposed to use multi locus sequence data, taken to represent the clonal frame (that part of the genome shared by related strains and species), to identify distinct clusters of strains that could represent evolutionary distinct units. However, since phylogenetic trees generally consist of many clusters within clusters, it is not straightforward to identify which clusters correspond to true species. Here, it is proposed to use the McDonald Kreitman test to detect whether past selective sweeps have caused distinct sequence clusters to diverge. Statistically significant divergence of sequence clusters due to positive selection offers an objective criterion for species delineation that is founded in evolutionary theory. Clonal frames are interspersed with accessory genes shared between related strains through Lateral Gene Transfer. Although accessory genes are likely to play central roles in defining the ecological niche of a strain, they do not offer an opportunity to consistently delineate species, as clusters of related clonal frames can potentially harbour many different combinations of accessory genes. The criterion of adaptive clonal frame divergence leads to species boundaries that are as broad, or broader, than those recognized using the current polyphasic species concept. The utility of this new species concept is demonstrated using sequence data of a variety of species complexes.

6) The genetics of source-sink dynamics

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Since several years, source-sink dynamics (SSD) have been associated with genetic diversity (Dias 1996, Gagiotti 1996, Manier & Arnold 2005). Only a few studies have used the theoretical relationship between SSD and genetics to investigate SSD in the natural world (e.g. Manier & Arnold 2005, Milot et al., 2008, Schmid-Hempel et al., 2007). Most of these studies have used a combination of genetic diversity (based on heterozygosity) with either genetic differentiation and/or gene flow estimates (based on Fst statistics) to differentiate between source and sink habitat. However, it is not

clear at what spatial scale source and sink dynamics would influence population genetics and therefore larger scales should be considered. Additionally, if the heterogeneity of a landscape increases this could influence the complexity of source and sink dynamics and as a result genetic dynamics within that landscape.
Similar to the population declines in European countries, in The Netherlands several meadowbird species have been demonstrating negative trends over the past decades and as a result are now of high conservation concern. (Birdlife Int. 2004, van Beusekom 2005). Since many of these meadowbird species breed in agricultural landscapes, their decline has been associated with a decrease in quality and an increase in the fragmentation of their habitat due to agricultural intensification (Beintema et al., 1997, Benton et al., 2002, Teunissen & Soldaat 2005). Continued habitat quality deterioration, is supposed to decrease reproductive success which would result in recruitment within a population becoming too low to sustain a viable population (sink). If sinks keep increasing at the expense of sources this might finally result in total population declines. We took the Black tailed Godwit (*Limosa limosa*) as a model species to study the possibilities of using genetic information on different spatial scales (local, regional) to assess SSD of a species in need for science based conservation measures. However, to get enough high quality DNA samples, normally blood, on large spatial scales is often time consuming and sometimes impossible. As such we used egg-shell membranes as it is an easier way of sampling and as such could be implemented on a much larger scale. Our preliminary results show that DNA sampling, by using egg-shell membranes does not result in DNA quality or concentration decrease and thus proves to be a viable method of sampling and investigating SSD on larger spatial scales.

Session 3d: Exotic species and genes

1) Predicting invasive behavior of exotic plants

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Many of the introduced exotic plant species never become a problem, only some of them become invasive. We are investigating whether it is possible to predict by plant traits which exotics are most likely to become invasive in The Netherlands.
In our study we use two measurements for success of the exotics in The Netherlands, at a national and a local level. For the national level we use data from Florbase on the gridcell frequency of plants in The Netherlands. At the local level we use data from the National Vegetation Database about the local coverage of plant species at a plot size. We combine these two scales to make four categories of invasiveness, with the most invasive species in the category with a high national coverage and a high local dominance. A single predictive trait has never been found, but possibly specific combinations of traits may have more predictive power. Therefore we will cluster the plants by their traits to look if there are certain combinations of traits that are typical for any of the categories of invasiveness. To be able to put this into a native perspective, we will also cluster the native plants by their traits and look how they are clustered among the four categories of abundance.

2) Plant range shifts and reduced enemy impact imply exotic invasion potential due to climate warming

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3. *Nationaal Herbarium Nederland, The Netherlands*

Ecosystems worldwide are increasingly being invaded by plants from exotic origin. It has been stressed that these invaders perform better than similar native species in the invaded communities. Although plant invasions have taken place for more than a century, the mechanisms explaining the success of invaders are not well understood yet. Considerable attention has been paid to the role of plant specific traits and natural control by aboveground herbivores, both in the original and new ranges of the invading plants.

Release from belowground or aboveground natural enemies has been widely stressed as the biggest advantage for invaders to become successful. These novel biotic interactions, if favorable, characterize these invasive plants by local dominance in their new community, thereby displacing native species, and strong dispersal reaching high abundances. Currently the consequences of climate warming are being noticed in range shifts of plants and animals to higher elevations and latitudes. Although biotic interactions strongly affect responses to warming, they are not included in climate studies. Hence, when plants spread faster than their natural enemies or than the enemies of their enemies, multi-trophic interactions can become, at least temporarily, disrupted. These changes in relations may create invasion opportunities for species within geographical regions. In order to understand how exotic plant species affect the soil microbial community and their aboveground enemies relative to that of native species we conducted a phylogenetically controlled experiment with cross comparison of plants grown in self conditioned soil and soil conditioned by other species. We investigated how exotic plants from warmer climatic regions within Eurasia respond to soil communities from an invaded ecosystem in North-Western Europe and to aboveground non-coevolved (desert locust (*Schistocerca gregaria*) and cosmopolitan generalist (green peach aphid *Myzus persicae*) shoot herbivores. Effects of range shifts of plant species within the continent were compared to exotic species originating from continents other than Eurasia.

We show that biomass of native plants was significantly negatively affected by their own soil community, whereas exotic plants, irrespective continental origin, experienced a neutral feedback effect. In addition we also found that the suitability of exotic plants towards the naïve locust was much lower than that of native plant species, while the cosmopolitan aphid performance was not affected by host origin. These results suggest that exotic species have been released from their enemies and resist novel enemy pressure both below –and aboveground. Since these effects were not different between Eurasian range expanders and exotics originating from other continents we conclude that climate warming could lead to biological invasions over continuous expanded ranges, influencing new encountered local ecosystem functioning.

3) Climate change, plant invasions and belowground interactions

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In the last decades, in Europe, many plant species expand their ranges northwards and westwards. This spread into former cold regions has been related to climate warming. The aim of our project is to determine how plant species originating from southern latitudes that expand their ranges towards more temperate zones in Europe perform in their new environment. In particular we focus on the soil community and its relation with plant performance. Soil microbes attracted or stimulated in the rhizosphere affect plants either positively or negatively. Exotic plant species might have lost part of their native soil community when dispersing into their new range. If they lost negative plant microbes or pathogens, exotic plants could have an advantage over native plant species in their new environment. To test this we conducted a phylogenetically controlled experiment with cross comparison of plants grown in soil conditioned by their own species and soil conditioned by other species. We measured the above- and belowground biomass, and calculated soil feedback. We expected, in the case of a relaxed pathogen exposure, that exotic plants would perform better on their self conditioned soil than on soil conditioned by other species compared to their native congeners. Within both groups of exotics and natives we observed large amounts of variation in feedback. Nevertheless, on average native plants had a significant negative soil feedback, whereas the exotic plants had a more neutral soil feedback. This implies that beside a relaxation in net pathogen pressure there are also other factors involved in the successful integration of a plant species in its new range. Recently we have profiled the belowground community of fungi using PCR-DGGE. The soil community differences in own soil versus soil conditioned by other plant species are significantly smaller in exotic plant species compared to native plant species. Moreover, if we compare the amount of plant parasitic nematodes per gram root biomass, there are less of these nematodes in exotic plant roots than in native plant roots. With these results we show that the patterns in the belowground soil community reflect the aboveground plant performance.

4) Morphological markers distinguishing wild from cultivated carrots

Cilia Grebenstijn
Leiden University

Genetically Modified as well as traditional crops can be considered as exotic species introduced by humans. One of the main concerns about GM Crops is the escape of transgenes into wild relatives through introgression, which could lead to the creation of detrimental species such as "super weeds", or the impoverishment of the germplasm stock represented by the wild relatives.

Carrots (*Daucus carota*) are cultivated in The Netherlands since hundreds of years, and several GM carrots have already been field tested, comprising varieties with

improved pest resistance and herbicide tolerance. Cultivar distribution as well as flowering phenology overlaps with those of the wild form, the so called Queen Anne's Lace. The cultivar characteristics are adapted to agricultural habitats and are supposed to be under negative selection in natural environments, but several authors showed morphological as well as molecular evidences of hybridization between the two forms. Survival and fitness of the hybrids seems close to those of the wild form, but no clear proofs of introgression haven been found yet. This can be due to recombination and natural selection, some of the most evident morphological and molecular markers being quickly lost in the generations following the hybridization event.
In order to quantify the amount of introgression of cultivated carrots into their wild relatives in The Netherlands, we developed morphological markers to distinguish wild and cultivated carrots. Carrots are described as showing a wide range of variation in leaf shape, umbel and flower morphology, but also in life span, both at the intra and inter variety/population level. This high variability demanded careful experimental set up in order to define the reliable markers presented here. The distribution of the developed marker was then checked in F1 hybrid plants.

5) Native insects on non-native plants: about biodiversity and effect of specialism

Kim Meijer
Groningen University

Nowadays approximately 10% of all plant species is introduced (Heywood 1989). These introduced plants lack most of their natural phytophagous insect fauna opening a niche for insects living in the introduced habitat. But since many of these insect species are highly specialized to their host plants host-shifts might be rear and evolutionary adaptation might be needed. Many authors state that the number of species living on introduced plants is much lower compared to native species. Unfortunately in most studies the sample is very low, often comparing two or only a few species. Here I will show an overview of several studies and combining their data for an analysis of the differences in insect biodiversity between native and introduced plants.

In the second part I will focus on the effect of specialism on the chance insects shift towards a novel (introduced) host. Many phytophagous species are specialists – monophagous –, living on one or only a few species of host plants within the same genus. Others are less specialized living on several plant genera within the same family – oligophagous – and only a small proportion of the species are real generalists living on different plant families – polyphagous – (Thompson 1994; Menken 1996). Here I will present the results of a study on the effect of specialism on the type of host shift. Was the shift within or between plant genus/family.

6) Marine exotic species, a rapid detection method within a changing ecosystem

Adriaan Gittenberger
Leiden University

Biological Invasions (the establishment of species beyond their historical range, triggered by humans) are a major force of ecological and evolutionary change. Invasions are fundamentally changing the structure and function of most ecosystems around the world and are impacting many dimensions of human society. Moreover, the observed rates and impacts of new invasions have increased dramatically in recent times. Also in the marine environment, substantial ecological and economical damage has been caused by the introduction of diseases, parasites, predators, invaders outcompeting native species, and species that are a nuisance for public health, tourism, aquaculture or in any other way. Comparatively little research is done on marine invasive species in The Netherlands, even though several marine invaders that have destroyed complete ecosystems in other areas, have recently arrived in Dutch

waters. Most of these new invaders are not dealt with in a way as is done in e.g. New Zealand, the USA and Canada where such species are on a high-risk species list, and funds and infrastructure are available for immediate action and research. To study the impact of invasive species on the more native marine ecosystems in The Netherlands, a continuous fouling community study was started in 2006. In the SETL-project, 14x14 cm PVC-plates are hung 1 meter below the water surface, and refreshed and checked for species at least every three months. 140 plates are being deployed along the Dutch coast at the moment. Since 2006, the SETL- methodology and materials have been copied and applied along temperate coasts from New Zealand, NW America, and NE America to Europe, to ease making comparisons and combining fouling community study results in future time. Tissue samples of all plants and animals that live in association with these plates (about 130 species), are taken for population genetic analysis and DNA-barcoding to ease and check their identifications, and to get an idea of their origin and invasion pathway. In addition, the impact of introductions on the population genetics of both non-native species and native species with The Netherlands ecosystems as a whole, is studied. Some preliminary results are presented here.

Parallel 4b: Population dynamics and dispersal

1) Demography and dispersal contributions to spatial population dynamics

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The spatial population dynamics of species is determined by both dispersal and local demography. Spatial population models form useful tools for studying the relative importance of demographic and dispersal processes in different systems. For instance, dispersal can be a key component of both the life history of invasive species and restoration management of species that have declined in abundance. Examples of such studies focusing on invasion or persistence will be given:
The invasive thistle *Carduus nutans* shows different spatial population dynamics in its native and invaded ranges. Spatial integrodifference models that combine structured, local population models with mechanistic (WALD) models of seed dispersal by wind across a homogeneous landscape were used to analyze the contributions of the changes in demographic rates and dispersal parameters to the increases in the invasion wave speed (c*) estimates for the different invaded ranges (Australia, New Zealand, USA) compared to that for the native range (Eurasia). This c*- LTRE analysis showed that the net contribution of the dispersal parameters to c* increases varied among the populations (50%-85%). This approach can thus be used to analyze which aspects of an invader's life history have changed most importantly from the native range.

Plant survival: Many floodplain plant species in The Netherlands have declined in abundance over the past century due to habitat loss and reductions in dispersal via waterways. Furthermore, climate change, through higher temperatures in the Alps and increased precipitation in winter, will continue to significantly affect the survival of populations with altered flood timing, duration and frequency. On a positive note, many plant species show signs of resilience, delaying local extinction for long but finite periods. Plastic expression of e.g. flood tolerance and seed dispersal related plant traits is an important mechanism of such resilience, but the direct and indirect consequences of phenotypic plasticity for population dynamics are poorly understood. It is therefore necessary to study population dynamics under past, present and a range of future climate regimes and landscape use scenarios with spatial population models that hierarchically incorporate environment-trait, trait-trait and trait-life history relationships.

2) Fine-scale genetic structure and gene dispersal within Dutch wild carrot (*Daucus carota* L. ssp. *carota*) populations

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Wild carrot (*Daucus carota* L. ssp. *carota*) is the ancestor of cultivated carrot (*D. carota* L. ssp. *sativus*) and the most important gene pool for carrot breeding. Today's orange-colored carrot is thought to be first produced by Dutch breeders in the 17th or the beginning of the 18th century. In spite of the long history of carrot breeding and the fact that wild carrot is widely distributed in The Netherlands, the genetic structure of wild carrot populations is still unknown. In this study, we sampled leaves of wild carrots from two populations in The Netherlands (Meijendel and Alkmaar) and recorded relative spatial positions of each samples. Then, 32 microsatellite markers of carrots were tested, which were either developed by Drs. Ono and Eguchi, or taken from the literature. Nineteen microsatellite markers worked well. One microsatellite marker was found to have specific alleles for the 6 widely different cultivars tested (Nantes, Parijse Market, Flakkese, Berlikummer, Amsterdammer Bak, and Chantenay) and these specific alleles were missing in all wild carrot samples. We used the 19 microsatellite markers to genotype the two wild carrot populations. Spatial

autocorrelation analysis was performed to detect the genetic structure in these populations and gene dispersal distance (σ) was estimated based on the model of Isolation by Distance. Weak spatial genetic structures were found within the two wild carrot populations. Significantly positive correlations between genetic and spatial distances were detected within 19 m in Meijendel and 32 m in Alkmaar. Mean gene dispersal distance was 23 m (95% CI = 9, +∞) and neighborhood size was 163 (95% CI = 36, +∞). In addition, the values of '*Sp*' statistics were 0.017 in Meijendel and 0.011 in Alkmaar indicating much weaker spatial genetic structure than selfing species. The low *Sp* values suggest that wild carrot is a predominant outcrossing species. Our findings are helpful for sampling strategies of wild carrots for carrot germplasm collection and breeding purposes. The confirmed microsatellite markers can be a useful tool for tracing introgression between cultivars and wild carrots and marker assisted breeding. These results will be used to develop models for assessing hazard rates of transgene introgressions from crops to wild relatives.

3) Pollen limitation and labile sex expression in a wind-pollinated annual herb (*Mercurialis annua*)

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Because most plants mate and disperse locally, plant fitness is influenced by the local mating environment. Seed set should therefore critically depend on the proximity and density of males within local patches. Consequently, females can be pollen limited at low densities, whilst hermaphrodites may enjoy the benefits of reproductive assurance through their ability to self-fertilise their ovules. Pollen limitation in dioecious populations may be alleviated when females are sexually labile and able to produce pollen, thereby ensuring fertilization. Lability in sex expression is resource-dependent in natural populations, indicating that costs of pollen production are high. Here, we experimentally test the effects of resource availability and the local mating environment on pollen limitation and sex lability. The wind-pollinated annual herb *Mercurialis annua* is remarkable for the wide variation in sexual systems it displays, including dioecy and monoecy (functional hermaphrodites having separate male and female flowers). Our results demonstrate that pollen dispersal in *M. annua* decreases rapidly with increasing distance from the male pollen source. Consistently, seed set of females is pollen limited at low densities in natural populations, whilst that of self-fertile hermaphrodites is not. In agreement with our predictions, females only produce pollen under resource-rich or pollen-limited conditions. Reproductive assurance through plasticity in sex expression could be of vital importance for colonization success and persistence of dioecious populations. Pollen limitation may be a major selective force governing plasticity in sex expression in dioecious plant species.

4) Seed limitation restricts population growth in shaded populations of a perennial woodland orchid

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It is generally acknowledged that in long-lived perennial plants, seed production and seedling recruitment are thought to be of minor importance in determining population dynamics and long-term viability. A low level of reproduction suffices to balance low adult mortality rate of long-lived species and the population growth rate is much more sensitive to changes in survival than in reproduction rates. However, recent meta-analyses of seed addition experiments have shown that most plant populations are seed limited, and that supplemental addition of seeds to populations almost always, irrespective of longevity, results in increased seedling recruitment. However, the extent to which increased fruit and seed production affect overall population dynamics remains relatively unknown.

Here we show that in the long-lived woodland orchid *Orchis purpurea* flower and seed production have important effects on its population dynamics. We present demographic data of six populations that were monitored for seven consecutive years (2002-2008) occurring in two contrasting light environments. We use a nested Life Table Response Experiment (LTRE) at the vital rate level to disentangle the relative contributions of each of 6 annual transitions, 6 sites and light environment on the population dynamics of this species and to determine vital rate variations that contributed most to variation in λ. Population growth rates were significantly higher in the light environment than in the shaded environment (average λ = 0.9930 and 1.0492 in the shaded and light environment, respectively). LTRE analysis showed that variation in fecundity, and to a lesser extent variation in growth, made the largest total contributions to variation in λ, whereas the contributions of variation in survival were almost negligible. Fruit production was two times larger and the net reproductive rate (R0) was about six times higher in the light environment than in shaded areas, suggesting that variables related to reproduction are the key drivers of population dynamics of this long-lived orchid species in different light environments. Life expectancy and survival on the other hand were less affected by light.

5) Directed dispersal in wetland plants: Implications for spatial population dynamics and demography

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In sessile organisms such as plants, the dispersal of propagules away from the parent is essential for generating spatial population structure, maintaining spatial (meta-) population dynamics and colonizing new areas – for example, in migration following climatic changes. In higher plants, the seed or fruit (from here on grouped under the term 'seed') is typically the propagule that disperses. Plant species around the world produce seeds in varying, often (very) large, numbers and in varying seed sizes, in many cases with morphological adaptations for their dispersal. These investments in dispersal of seeds indicate that some fitness benefit is expected from seed dispersal. Not all dispersed seeds will reach sites suitable for germination and establishment, however, and plants can increase their fitness by increasing the proportion of seeds that are dispersed to sites where they have a predictably high probability of germination and growth. Such disproportionate dispersal to suitable sites is known as 'directed dispersal' and has previously been shown to occur in some animal-dispersed plant species. It may, however, be a more widely spread phenomenon in the plant world, including also seed dispersal by other dispersal vectors such as water or wind.

Water and wind are very common and widely available dispersal vectors. If they disperse seeds specifically to suitable sites then directed dispersal may play a far more important role in ecology than previously thought, with implications for plant species dynamics and demography. We investigated whether seed dispersal by water and wind disperses seeds predominantly to suitable sites in wetlands. Many wetlands are dynamic, spatially heterogeneous ecosystems where wind and water are among the most widely available dispersal agents. Our study shows that wetland plants may have evolutionary adaptations that facilitate dispersal to suitable wetland sites by water and wind, thereby significantly enhancing the success of seed dispersal. Such adaptations indicate that the seed stage and the seed dispersal process may contribute much more significantly to the fitness of wetland plants than previously thought. In other dynamic and spatially heterogeneous ecosystems, common seed dispersal vectors may perform the same function and their potential ecological importance should not be overlooked.

6) The role of odours in parasitoid-host interactions: a modelling study

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Parasitoids are efficient natural enemies. Once they found a patch parasitism rates can be very high. Moreover, some parasitoids are able to distinguish odors that are associated with their hosts' presence. To study how the ability to use odors affects the interaction between a parasitoid and its host, we developed a spatially explicit model that incorporates odor dispersion and population responses. As a study system we chose the fruit fly Drosophila melanogaster and its parasitoid Leptopilina heterotoma. D. melanogaster feeds and breeds on ephemeral resources like fermenting fruits. In their natural environment these resources are unevenly distributed. Chemical attraction towards fermentation products and an aggregation pheromone, emitted by recently mated females of D. melanogaster, play a directive role in the localization of and aggregation on these resources. It is known that its larval parasitoid L. heterotoma uses the same odors to find its host. We investigate the relative costs and benefits of the ability to use infochemicals by studying fruit fly population numbers and larval mortality due to Allee effect, competition and parasitism.

Session 4c: Plant Physiological Ecology: Scaling up towards understanding emerging properties at plant and ecosystem level

1) The regulation of cell wall extensibility during shade avoidance: a study using two contrasting ecotypes of *Stellaria longipes*.

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Shade avoidance in plants involves rapid shoot elongation to grow toward the light. Cell wall-modifying mechanisms are vital regulatory points for control of these elongation responses. Two protein families involved in cell wall modification are expansins and xyloglucan endotransglucosylase/hydrolases. We used an alpine and a prairie ecotype of Stellaria longipes differing in their response to shade to study the regulation of cell wall extensibility in response to low red to far-red ratio (R/FR), an early neighbor detection signal, and dense canopy shade (green shade: low R/FR, blue, and total light intensity). Alpine plants were nonresponsive to low R/FR, while prairie plants elongated rapidly. These responses reflect adaptation to the dense vegetation of the prairie habitat, unlike the alpine plants, which almost never encounter shade. Under green shade, both ecotypes rapidly elongate, showing that alpine plants can react only to a deep shade treatment. Xyloglucan endotransglucosylase/hydrolase activity was strongly regulated by green shade and low blue light conditions but not by low R/FR. Expansin activity, expressed as acid-induced extension, correlated with growth responses to all light changes. Expansin genes cloned from the internodes of the two ecotypes showed differential regulation in response to the light manipulations. This regulation was ecotype and light signal specific and correlated with the growth responses. Our results imply that elongation responses to shade require the regulation of cell wall extensibility via the control of expansin gene expression. Ecotypic differences demonstrate how responses to environmental stimuli are differently regulated to survive a particular habitat.

2) Temperature Effects on the Metabolism of Plants: Does Darwin break the Arrhenius Law?

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The metabolism of plants is dependent on temperature, which has a physical impact on the enzyme kinetics that causes changes in the metabolism. The respiratory temperature dependency, which reflects the metabolic change at different temperatures, is considered to be universal. The respiratory temperature dependency may be described by the Arrhenius relation $A*^{e-kE/T}$. The universality of the temperature dependency is based on the assumption that both the activation energy (E) of the limiting key-enzymes and the baseline respiration (A), which is given by the enzyme and substrate availability of the limiting key-enzymes, are similar for all organisms. Those assumptions exclude that various organisms may have developed differences in the enzymatic network, which exclude furthermore thermal acclimation and adaptation within extended temperature exposure duration. Variations in the enzymatic network might result in differences of the respiratory temperature dependency.

Our results showed that the Arrhenius relation predicted the short term respiratory temperature response, which appeared to be highly variable. For different plant species and plants acclimated to different temperatures, the slope of the respiratory

temperature response differed, showing that the temperature dependence cannot be considered to be universal. Furthermore, the acclimation and adaptation temperature had a high impact on the baseline respiration. Upon acclimation and adaptation of plants to high temperatures the baseline respiration decreases. This decrease resulted from compensatory modifications of the enzymatic network, which counteracted the increased respiration predicted by the Arrhenius relation. It was evident that the acclimated and adapted respiratory temperature response, by comparing the basal metabolism of plants grown in different temperatures, was relatively independent of temperature.

3) Are there different ways for being successful in drought stressed environments: Scaling-up water relations to whole plant photosynthetic performance in 6 species of a Mediterranean tree community

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Plant photosynthesis in drought stressed environments is largely driven by the way plants control water relationships. We studied responses in water relationships and photosynthesis related traits for six dominant woody species in South Spain during the summer of 2008. Based on physiological mechanisms, we expected a trade-off between high capacity plant traits for water relationships (high water flow conductance in branch and leaves) and photosynthesis (high nitrogen concentrations, assimilation rates) and low tolerance to drought due to cavitation risks in water flow and stomatal closure at lower leaf water potential. We periodically monitored six individuals of 6 coexisting tree species from April till September in Spain. This period "contains" a natural drought experiment since the rains fully stop after May. We found strong correlations across functional traits and, in the light of the hypothesis, explain how completely different plant strategies might coexist in these drought stressed conditions. We try to understand these responses from basic theoretical plant models, as to use the gathered information also for understanding and predicting plant and vegetation responses to the warming and more extreme drought predicted for Mediterreanean areas.

4) Structure and functioning of young Eucalypt trees under elevated CO_2 and temperature: an assessment with the 3 dimensional YPLANT model.

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Global CO_2 concentrations are quickly rising (1.5 – 2ppm over the last decades), causing temperatures to increase and rainfall patterns to change. This could affect forest productivity and vegetation water balance, with feedbacks on climate. Overall, growth and productivity of elevated CO_2 grown trees are reported to increase over current growth rates, although positive effects vary strongly between different species and soil conditions. However, there is still a large uncertainty around the control of the partitioning of this extra C taken up in elevated CO_2.

The primary factors determining plant productivity are photosynthetic efficiency and light interception, the latter depending on leaf area and tree architecture. Trees growing under elevated CO_2 may produce more leaves faster, increasing light interception for photosynthesis. However, a denser tree crown increases water loss through transpiration, decreasing at the same time the amount of rainfall reaching the soil. In addition, investment in more leaves is costly and may result in a smaller investment in the production of wood. This could negatively affect the water balance of trees; the effect gains importance when high CO_2 levels are accompanied by elevated temperatures and drought. The interactions between the different crown

functions (light capture, hydraulics and biomechanical support) have not been studied into great detail, and especially not their combined response to future elevated CO_2 levels and temperature.

We studied the detailed 3-dimensional architecture of young Eucalyptus trees growing in a controlled environment under 3 different CO_2 concentrations (280 ppm, 400 ppm and 640 ppm) combined with ambient and elevated (ambient + 6 °C) temperatures, at the Hawkesbury Forest Experiment of the University of Western Sydney, Australia. We studied the effects of elevated CO_2, temperature and their possible interactions on the three dimensional (3-D) structure (stem + branches + leaves) of the fast-growing Eucalyptus saligna. With the Fastrak magnetic digitizer (Fastrak 3 space, Vermont, USA), we measured the exact 3-D positioning of each node, leaf and branch of different E. saligna trees. From the digitized trees, we measured leaf photosynthetic light and CO_2 response curves and determined C-allocation to wood vs. leaves from a final destructive harvest. This detailed information on tree architecture and leaf photosynthesis is used as an input for the 3 Dimensional YPLANT model. The YPLANT model can simulate the light capture efficiency and daily C-assimilation of the trees. In this way, important trade-offs between structure (amount and positioning of the leaves and C-allocation to wood vs. leaves) and function (plant carbon gain and water loss) can be studied. We will use the YPLANT model to answer following questions: 1) How does elevated CO_2 and temperature affect tree architecture? 2) What is the effect of canopy architecture on light interception, ruling out effects of elevated CO_2 and temperature on leaf physiology? And 3) how should canopy architecture change to optimize light interception? Preliminary results will be presented.

5) From species traits to communities; a promising future for vegetation models

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Specific environmental conditions require specific eco-physiological adaptations to survive and out-compete others. These adaptations are expressed in functional traits. If this adaptation to environmental conditions is dominant across habitats than we expect that traits within communities to be non-randomly selected from the species pool. We investigated this by using 12 different traits and 8,988 plant communities in The Netherlands. It was found that indeed species within communities are non-randomly assembled and are functionally more similar than species between communities. Furthermore we tested which combination of three functional traits optimally explains the functional variation between plant communities across a wide range of habitats and how this combinations of traits is related to combination of traits that are used in generally accepted species strategy schemes (for example Grime, Westoby etc.). We show that these schemes also can be used at community level. The ability to link the community trait averages to environmental drivers opens up the way to a new generation vegetation models. Examples of these links will be given.

6) Vegetation structure and productivity: the result of cooperation or cheating?

Niels P.R. Anten and Peter J. Vermeulen
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Understanding how vegetation structure and productivity arise from plant photosynthetic traits entails scaling up from leaf to canopy. Simple optimization has commonly been used to this end, with traits being assumed optimal when productivity of a vegetation stand is maximized. While this has led to good qualitative predictions, there have been consistent and systematic differences between predictions and reality. Simple optimization ignores that plants interact with each other; their leaves and roots influence each other's light and nutrient availability. In such cases game theory (competitive optimization) is more appropriate. Focusing on leaf area, I will

show that stands with an optimal structure for maximum productivity are not evolutionarily stable and can be invaded by a 'cheating' mutant that overinvests in leaf area. As a result natural plant communities are less than maximally productive. The weakness of most game theoretical models for plant communities however is that they tend to predict a single winner of the game. This is essentially a stand of identical plants, and obviously contradicts with the large genetic variation that exists even in single species stands. I will address our first work in using game theory to analyze experimental stands consisting of ten known genotypes of a clonal species.

Session 4d: Tropical Ecology

1) Slow processes triggering eco-system reorganization: the role of plate tectonics on tropical reefs

Willem Renema,
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Modern, highly diverse reef ecosystems occur in the Indo-Australian Archipelago. These ecosystems are under threat of both local (terrestrial run-off, overfishing) and global (global warming, ocean acidification) long-term stressors, often attenuated by disturbance events (bleaching, earthquakes or storms). Most of these processes act over longer timescales than available time-series. The fossil record can be very informative about how reefs respond to both long-term trends and brief events. In this talk I will discuss two examples of how long term processes effect the geometry and ecological structure of modern day reefs by using modern analogues from the Indo-Pacific.

Recent fossil and molecular evidence reveal an origin of modern type coral reef ecosystems around 20-25 My ago. Prior to this period diversity distribution as well as community composition differed markedly from the present day. The timing and locations of aggregations of biodiversity coincided with major tectonic events. At this time the first collision of island arcs with the Eurasian continent as a result of the northward movement of Australia occurred. While in Europe and the Middle East tropical diversity decreased, Indo-Pacific diversity started to bloom.
Coral reefs have a high structural and biotic complexity in which the reef building corals are the main structuring elements, but with increased terrestrial run-off and overfishing corals are replaced by macro-algae. This has major impacts on the assemblage structure of associated biota. In a comparison between a more and a less severely affected reef system, it is demonstrated that one group of large benthic foraminifera dominates the assemblages in algae dominated environments. This is the only family that evolved during the last 10 My, and become dominant in the fossil record during the past 4-5 My. This is the time of a major reorganization of plate boundaries, resulting, for example, in a change of platform to fringing reefs dominated geometry.

These examples demonstrate that local and regional processes are important moderators of global environmental change. They also demonstrtate the necessity of observing at the appropriate scales when assessing ecosystem conditions.

2) On the origin of Amazonian landscapes and biodiversity

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The Amazon rainforest and rivers are highly diverse ecosystems. The origin of these has long been subject of scientific controversy. Until very recently a geological young (Quaternary) origin of Amazonian biodiversity as a result of allopatric speciation has been the predominant paradigm. In this paper we review new evidence from the geological record, the fossil record and DNA studies that shed light on the origin of Amazonian ecosystems and biodiversity. The various studies all show that rainforests have been around in Amazonia during the entire Cenozoic, and that the modern rainforests had developed by the Late Miocene. The fossil record also shows that different groups underwent different episodes of diversity increase (through speciation and immigration) and extinction. The development of Amazonian biodiversity is intimately linked with its Cenozoic landscape evolution.

3) Climate variability and vegetation change at a submillennial time scales during the Holocene: a multi-proxi approach from Andean sediments

Zaire González Carranza, María Isabel Vélez and Henry Hooghiemstra
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The scarce data from the Southern Hemisphere suggest that in past millennia temperature changes differed markedly from those in the Northern Hemisphere and therefore it is believed that Holocene climate variability was relatively stable. We show the preliminary results of a new pollen record (ca. 550 data points) and a diatom record (ca. 120 data points) from Lake La Cocha (01º 08' N, 077º 09' W ; 2800 m alt.) in southern Colombia. The reconstruction of regional vegetation change was based on c. 230 taxa, most of them with distinctive ecological information. The taxa have been sorted according to their main ecological and climatological/altitudinal preferences. Local vegetation and environments were reconstructed based on aquatic plants and algae: shore, shallow water and deep water vegetation. Local conditions at the lake site also follow from a diatom record: planktonic, planktonic/littoral, littoral and aerophil diatoms are used to identify different lake conditions.

We reconstructed altitudinal shifts of the forest-to-páramo ecotone (upper forest line = UFL), which is temperature dependant, by using the arboreal pollen (AP) proportions. Main frequencies of the AP record are compared with the drift ice stack of the North Atlantic and proxies of solar activity. We include comparisons with the Cariaco Basin records offshore Venezuela: (a) the Titanium (%) concentration record of ODP Site 1002 (a proxy for the input of land-derived material variations of these concentrations are a direct measure of rainfall and runoff from regional watersheds); (Haug et al., 2001a) and (b) the colour reflectance record (550 nm) of ODP Hole 1002C (indicative of the mean position of the ITCZ; Peterson et al., 2000). We explore (interrelated) relationships between changes in precipitation (water availability) and changes in the mean position of the ITCZ. We show how these factors have impact on the altitudinal extension and vegetation composition of Andean forest.

The combination of the regional and local vegetation records showed that during the last 14000 cal yr BP there have been strong climatic shifts. Relatively cold and warm periods alternated throughout time. The AP-Clean signal 95% shows periods of c. 2000 yr, which are within the variance of the millennial band (Bond et al., 1991), while the corresponding 99% signal follows strongly the precession forcing. These findings show the high sensibility of the Andean ecosystems to climate change.

4) Tropical tree rings reveal increasing juvenile growth rates over time and preferential survival of fast–growing juveniles

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Growth patterns of juvenile tropical trees were evaluated to test two hypotheses: (1) fast-growing juvenile trees have a higher chance to attain the canopy ('juvenile selection effect'), and (2) juvenile tree growth has increased over the last century. Tree ring analysis was applied to test these hypotheses for five tree species from three moist forest sites in Bolivia, using samples from 443 individuals with widely ranging diameter. Basal area increment was calculated for juvenile tree rings (<10 cm diameter). For three out of five species, a juvenile selection effect was found in rings formed by small juveniles. Thus, extant adult trees of these species have had higher juvenile growth rates than extant juvenile trees. Rings formed by somewhat larger juveniles showed the opposite pattern in three species, with juvenile growth rates

increasing over time. This finding is consistent with a CO_2-fertilization effect, in particular for two species for which the increase was limited to the 20th century. A cautious interpretation of the observed growth patterns is required. Sample size before the 20th century was low, and the observed increase in juvenile growth over time may be a consequence of sampling bias.

5) Is canopy disturbance in tropical rain forest spatially contagious?

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Spatial contagiousness of canopy dynamics – the tendency of canopy disturbances to occur nearby existing canopy openings due to an elevated risk of tree fall around gaps – has been demonstrated in many temperate-zone forests, but only inferentially for tropical forest. We tested whether disturbance levels are indeed elevated around natural canopy gaps in a Neotropical rainforest in French Guiana, and more so as gaps are larger. We followed the fate of 5660 trees >10 cm stem diameter over five years across 12 ha of old-growth forest and analyzed the risk and magnitude of canopy disturbance events in relation to tree diameter and the proximity and size of natural canopy gaps. We found that neither the risk nor the magnitude of canopy disturbances increased significantly with the proximity of gaps. Moreover, canopy disturbance risk around gaps was independent of gap size, while the magnitude of disturbance events around gaps was weakly related to gap size. Tree size was the major driver of disturbance risk as well as magnitude. We did find an elevated incidence of disturbance inside pre-existing gaps, but this "repeat disturbance" was due to an elevated disturbance risk inside gaps, not around gaps. Overall, we found no strong evidence for canopy dynamics in this rain forest being spatially contagiousness. Our findings are consistent with the traditional view of tropical rainforests as mosaics of patches with predictable regeneration cycles

6) Silviculture enhances the recovery of overexploited mahogany *Swietenia macrophylla*

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Big leaf mahogany *Swietenia macrophylla* is the most valuable timber species in the tropics but its future as a commercial timber species is at risk. This study evaluates whether recovery of overexploited mahogany populations is enhanced by actively managing the species and its surrounding forest. We assessed the effect of four different management interventions that varied in their intensities of harvesting and silvicultural treatments. Data were gathered over a four-year period in the plots (326 ha) of the Long Term Silvicultural Research Program in Bolivia. Plants >1.3 m tall were identified and monitored in the plots, while seedlings and saplings (<1.3m tall) were recorded and measured around 58 adult mahogany trees. Population growth rate was simulated using population matrices based on observed vital rates. The application of silvicultural treatments had a negative effect on seedling and sapling survival. Growth of larger trees tended to increase with management intensity, and was dependent on crown position and liana infestation. Model simulations suggested that the recovery of overexploited mahogany population is enhanced by the application of intermediate levels of silvicultural treatments. Harvesting simulations indicate that mahogany populations can only be sustainably harvested by increasing the cutting cycle length, reducing harvesting intensity and by maintaining optimal growing conditions.

Posters Netherlands Annual Ecology Meeting

The Poster exhibition is arranged according to the parallel sessions and can be found in the main hall and on the way to the various locations where sessions will be held. Below you can find a list of posters titles that save been submitted on registration. Please note this list may not be complete and that posters may not be listed but will be exhibited.

Name	Title Poster
Parallel Session 1b: Biodiversity and community ecology	
Gera Hol	Soil biodiversity and ecosystem functions
Ellen van Velzen	Evolutionary Community Ecology: modelling the interplay between evolution and community structure
Veronique Vos	Biodiversity and Macro-detritivore effects on litter decomposition
Fredrick Ayuke	Termite and Earthworm biodiversity across the sub-humid to semi-arid ecological zones of East and West Africa
Xiaoguang Du	Density dependence can compromise the effect of species competitive asymmetry: a mechanism for neutral model to apply
Vincent Escaravage	Effects of cockle fisheries on the macrobenthos biodiversity and sediment characteristics of a mud flat in the Eastern Scheldt estuary, Netherlands
Rampal Etienne	The allometry of diversification
Herman Hummel	The effect of mussel, Mytilus sp., shipments from Ireland to the Netherlands on the intra- and interspecific biodiversity of the Oosterschelde – the risk of introducing exotic species
Parallel Session 1c: Aquatic Food webs	
Mark van Dijk	Flow cytometry meets spectrophotometry. Specific absorption signatures in phytoplankton communities
Susanne Wilken	Do microcystins act as an inducible defense against flagellate grazing in Microcystis aeruginosa
Parallel Session 1d: Chemical ecology	
Sabrina Carvalho	Tracking plant biophysical and biochemical properties through hyperspectral remote sensing
Niels Verhulst	Attractiveness of human skin bacteria to the malaria mosquito Anopheles gambiae in a laboratory, semi-field and field setup
Mirka Macel	Novel weapons of invasive plants
Lotte Joosten	Soil-Born Microorganisms and Abiotic Soil Factors affect Plant Defense Above and Below Ground: Pyrrolizidine alkaloids in *Jacobaea vulgaris* (syn *Senecio jacobaea*) as an example

Name	Title Poster
Parallel Session 2a: Micro-evolution	
Marlies Coopman	Host-symbiont co-evolution between *Microcystis* and its cyanophages in a dynamic environment
Ellen Decaestecker	Host-parasite Red Queen dynamics archived in pond sediment
Alena Gsell	Genotype by environment interactions in the diatom *Asterionella formosa*
Bas Ibelings	Co-existence and co-evolution in lake phytoplankton
Michaël van den Berg	Bidirectional selection on learning rate in the parasitic wasp *Cotesia glomerata*.
Bregje Wertheim	Genomics of adaptation: Drosophila and parasitoid resistance
Parallel Session 2b: Multitrophic interactions	
Sanne de Visser	Trophic interactions among invertebrates in termitaria in the African savanna: a stable isotope approach
Nina Fatouros	Male-derived butterfly anti-aphrodisiac mediates induced indirect plant defence
Taiadjana Fortuna	The effect of invasive plants on herbivore and parasitoid development
Fernando Monroy	Local variation in belowground multitrophic interactions
Asghar Shirvanisaadatabadi	Interactions among the Entomopathogenic Fungus, *Beauveria bassiana (Ascomycota: Hypocreales)*, the Parasitoid, *Aphidius matricariae (Hymenoptera: Braconidae*), and its Host, *Myzus persicae (Homoptera: Aphididae)*
Ineke van Gremberghe	Zooplankton grazing mediates intraspecific interactions in microcystis populations
Parallel Session 2c: Spatial ecology	
Nina Bhola	Herbivore hotspots in relation to landuse and vegetation change in the Mara Ecosystem.
Monique de Jager	With or Without You: Cooperation and Competition in Self-Organized Spatially Patterned Mussel Beds
Aaike de Wever	Microphytobenthos production and biomass monitoring on intertidal mudflats using remote sensing
Mitja Remus-Emsermann	Bacterial Bioreporter to Quantify Individuality
Marjolein Sterk	Spatial planning for Dutch Ecological Networks
Johan van de Koppel	Experimental evidence for spatial self-organization and its emergent effects in ecosystems
Daphne van der Wal	Distribution and dynamics of intertidal macrobenthos predicted from remote sensing

Name	Title Poster
Parallel Session 3a: Biogeochemistry	
Jeroen Geurts	Pore water Fe:PO_4 ratio as a diagnostic and prognostic tool for the restoration of aquatic biodiversity in fens
Lara Pozzato	Prokaryotic, protozoan and metazoan processing of organic matter in sediments
Jan Willen van Groenigen	Trade-offs between N_2O emission and C-sequestration in the soil: the role of earthworms
Elmar Veenendaal	The carbon balance of Dutch fen meadows ecosystems with contrasting land management
Parallel Session 3b: Plant-animal interactions	
Marjolijn Christianen	Seagrass under Turtle grazing
Francisco Encinas-Viso	"A plant-pollinator model with complex life cycles
Parallel Session 3c: Ecogenomics	
Martine Kos	Ecological effects of transgenic plants on aboveground non-target insects.
Kim Vermeer	Genetics of overcoming host plant defence by a flea beetle: One gene at work?'
Parallel Session 3d: Exotic species and genes	
Antje Ehrenburg	Opmars en aanpak van *Prunus serotina* in de Amsterdamse Waterleidingduinen
Suzanne Kos	Quantifying introgression risks of transgenes with hazard rates, using carrot as a model species
Elly Morrien	Climate change induced range shifts promotes release from soil-borne enemies
Leonie Doorduin	Genetic variation among native and invasive populations of *Jacobaea vulgaris* suggests multiple introductions from the same European populations.

Name	Title Poster
Parallel Session 4b: Population dynamics and dispersal	
Fedor Gassner	Interactions between ticks, rodents and *Borrelia burgdorferi* s.l.
Atiyo Ghosh	Quantifying stochastic introgression processes with hazard rates
Marleen Pierik	Travelling to a former sea floor: colonization of forests by understory plant species
Casper van Leeuwen	Long-distance dispersal: aquatic snails surviving gut passage of waterfowl
Parallel Session 4c: Plant Physiological Ecology	
Ute Sass-Klassen	Drift-sand dynamics reflected in wood anatomy of European oak
Yuki Fujita	Phosphatase activity regulated by N:P stoichiometry
Cristina Pulido	Effects of soil organic matter quantity and quality soil on development of two isoetid plant species
Parallel Session 4d: Tropical Ecology	
Raul Bogota	Centennial climate variability during the last two glacial cycles from new tropical Andean pollen record Fq-9C, Colombia
Kenneth Rijsdijk	Past and future dynamics of an oceanic island ecosystem (Mauritius): From prehuman fossil baseline towards future scenario testing