Netherlands Annual Ecology Meeting

9 & 10 February 2010

Congrescentrum De Werelt, Lunteren

Handout

Programme

Tuesday 9 February				
TIME	**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)			
	Plenary 1: "Stability and transitions in ecological systems"			
10:30	1. Structure and robustness of mutualistic networks (Jordi Bascompte, Doñana Biological Station, Spanish Council for Scientific Research (CSIC))			
11.15	2. Early warning Signals for Critical Transitions (Marten Scheffer, Wageningen University)			
12:00	**Lunch in the restaurant**			
	Parallel Session 1			
Location	**America Hall**	**Europe Hall**	**Asia Hall**	**Africa Hall**
13:30	**Parallel 1a: Plant-animal interactions**	**Parallel 1b: Conservation and Restoration Ecology**	**Parallel 1c: Fresh-water and marine Food webs**	**Parallel 1d: Free session**
	Conveners: 1. Merijn Kant (University of Amsterdam) 2. Kirsten Leiss (Leiden University)	*Conveners:* 1. Raf Aerts (K.U.Leuven) Verena Cordlandwehr (University of Groningen)	*Conveners*: 1. Andrea Downing (Wageningen University) 2. Kristina Raab (IMARES) 3. Reinier Hille Ris Lambers (IMARES)	*Conveners*: 1. Rampal Etienne (University of Groningen)
13:30	Variation in flea beetle resistance to plant defense (Kim Vermeer, Wageningen Universty)	The effect of multiple global environmental changes on the performance of forest herbs: a review with *Anemone nemorosa* (Lander Baeten, Ghent University)	Coupled predator-prey oscillations in a chaotic food web. (Elisa Benincà, University of Amsterdam / Wageningen University)	Quantifying Stochastic Introgression Processes (A. Ghosh, Leiden University)
13:50	Whiteflies interfere with indirect plant defense against spider mites in Lima bean (Roland Mumm, Wageningen University)	The response of shoreline vegetation in fens to nutrient enrichment of either the bank soil or the surface water (Judith Sarneel, Utrecht University)	Impacts of omnivorous fishes on submerged macrophytes: prey stoichiometry and food web structure (Martijn Dorenbosch, Netherlands Institute of Ecology)	Migration, who cares? (Rudy Jonker, Wageningen University)
14:10	A herbivore that manipulates plant defence (Arne Janssen, University of Amsterdam)	Abundance and demography of large mammals across conservation boundaries in the Mara region of Kenya (Nina Bhola, University of Groningen)	Collapse and reorganisation of Lake Victoria's food web (Andrea Downing, Wageningen University)	Species in fragmented landscape: How policy scenarios change species distributions (Luc de Bruyn, Reserach Institute for Nature and Forest, Belgium)
14:30	**Short break**			

	Parallel Session 1 Continued			
14:40	Establishing an effective test method for thrips resistance in pepper (Awang Maharijaya, Wageningen UR)	Restoration ecology of lichen-rich inland dunes in the Netherlands (Laurens Sparrius, University of Amsterdam)	Trophic impact of increased anchovy in the North Sea (Kristina Raab, Wageningen-IMARES)	The role of body size in communities: Food web of the Serengeti (Sanne de Visser, University of Groningen)
15:00	Tomato Thrips Resistance: Glycolipids, Methylketones, Phenolics or Sesquiterpenes? (Roman R. Romero-González, Leiden University)	Early indicators of atmospheric nitrogen deposition impact on lichen-rich coastal dune grasslands (Eva Remke, Radboud University Nijmegen)	Getting into hot water? Aquatic food webs under climate climate warming (Lisette de Senerpont Domis, Netherlands Institute of Ecology)	Interactions among mast-eating rodents and ticks (Wesley Tack, Ghent University)
15:20	Metabolomic responses to herbivory in GM potato (Andreas Plischke, Leiden University)	Restoration of soft water lakes: water and sediment quality effects on isoetid vegetation (Christina Pulido, Radboud University Nijmegen / University of Copenhagen)	Habitat segregation and complex life cycles; managing fish populations exhibiting ontogenetic habitat shifts (Karen van de Wolfshaar, Wageningen University)	Spring migration strategy and reproductive success in the Svalbard Barnacle goose *Branta leucopsis*. (Thomas Oudman, University of Amsterdam)
15:40	**Time to stretch the legs and have a cup of tea in the Lounge**			
	Parallel Session 2			
Location	**America Hall**	**Europe Hall**	**Asia Hall**	**Africa Hall**
16:00	**Parallel 2a: Multitrophic interactions**	**Parallel 2b: Spatial Ecology**	**Parallel 2c: Community Ecology**	**Parallel 2d: Evolutionary Ecology**
	Conveners: 1. Marjolein Kruidhof (Netherlands Institute of Ecology) Eduardo de la Pena (University of Ghent)	*Conveners*: 1. Judy Shamoun-Baranes (University of Amsterdam) Frank van Langevelde (Wageningen University)	*Conveners*: 1. Elisa Thebault (Wageningen University) 2. Maarten Schrama (University of Groningen)	*Conveners*: 1. Bas Ibelings (Netherlands Institute of Ecology) 2. Ken Kraaijeveld (Leiden University)
16:00	Both soil organisms and plant intra-specific variation affect aboveground multitrophic interactions. (Patrick Kabouw, Netherlands Institute of Ecology)	The seasonal and circadian rhythms of terrain-use by African elephants (Henjo de Knegt, Wageningen University)	Disentangling drivers of *Jacobaea vulgaris* population dynamics during secondary succession (Tess van de Voorde, Netherlands Institute of Ecology / Wageningen University)	Daphnia-parasite interactions in a dynamic environment (Ellen Decaestecker, Katholieke Universiteit Leuven)
16:20	Tri-trophic effects of inter- and intra-population variation in defence chemistry of wild cabbage (*Brassica oleracea*) (Rieta Gols, Wageningen University)	Visited sites revisited - site fidelity in African elephants (Frank van Langevelde, Wageningen University)	Food web succession on the salt marsh (Maarten Schrama, University of Groningen)	Evolutionary Community Ecology of host-parasite-parasitoid systems: associations between community structure and evolutionary traits (Saleta Perez Vila, University of Groningen)
16:40	Differential covariation of above- and belowground invertebrate species across genotypes of the dune grass *Ammophila arenaria* (Martijn Vandegehuchte, Ghent University)	Can we predict tipping points from spatial patterns? (Ellen Weerman, Netherlands Institute of Ecology)	Different patterns of within-community trait similarity between co-occurring grasses and grasshoppers (Fons van der Plas, University of Groningen)	Lack of lipogenesis: the evolutionary consequence of a parasitoid life style? (Bertanne Visser, VU University, Amsterdam)
17:00	**Short break**			

	Parallel Session 2 Continued			
17:10	Effect of soil conditions on plant-pollinator interactions in natural and restored heathlands (Eduardo de la Peña, Ghent University)	Spatio-temporal dynamics of global H5N1 outbreaks match bird migration patterns (Si Yali, International Institute for Geo-Information Science and Earth Observation)	Structure and stability of interaction webs: what are the differences between mutualistic and trophic networks? (Elisa Thébault, Imperial College / Wageningen University)	Reproductive strategies of Amazonian poison frogs (Erik Poelman, Wageningen University)
17:30	Litter utilization by soil animals and cascading effects on aboveground generalist predators in arthropod food webs (Klaus Birkhofer, Justus Liebig University Giessen)	Using a flexible GPS tracking system to study gull movement at different scales (Judy Shamoun-Baranes, University of Amsterdam)	A simple generalisation of neutral biodiversity theory resolves many of its problems (James Rosindell, University of Groningen)	Local adaptation of bacteriophages to their bacterial hosts in soil (Michiel Vos, Netherlands Institute of Ecology)
17:50	Macro-detritivore identity drives leaf litter diversity effects (Veronique Vos, Wageningen University)	Oystercatchers on Schiermonnikoog: social prisoners forever? (Bruno J. Ens, SOVON)	Linking habitat associations and spatial scales to the spatial patterns in tropical trees (Carol Ximena Garzo, University of Groningen)	Herbivorous insects on introduced plants, a review of the enemy release hypothesis (Kim Meijer, University of Groningen)
18:10	**Drinks in the Lounge**			
18:45	**Dinner in the restaurant**			
20:00	**Poster sessions / Coffee**			
19.45	'Jaarvergadering NECOV' (Africa Hall)			
	Europe Hall			
	<u>Evening Programme</u>			
21:00	- Darwin: Het Onthutsend Ontwerp (Alaska Unlimited) (60 minutes)			
22:00	- Reality Revisited (Marten Scheffer and Jordi Bascompte) 30-45 minutes			

Wednesday 10 February				
07:30	Breakfast in the restaurant			
08:00	Registration for those coming on Day 2 only			
	Europe Hall			
	Plenary 2: "Using functional traits to predict ecosystem functions in a changing world"			
08:30	- Using functional diversity to predict ecosystem services (Sandra Diaz, Universidad Nacional de Córdoba, Argentina)			
09:15	- How plant traits drive soil processes and climate (Hans Cornelissen, VU University, Amsterdam)			
10:00	**Coffee in the lounge**			
Location	**America Hall**	**Europe Hall**	**Asia Hall**	**Africa Hall**
10:30	**Parallel 3a: Global biogeochemical cycles**	**Parallel 3b: Free Session**	**Parallel 3c: Genetics of stress tolerance**	**Parallel 3d: Invasion Ecology**
	Conveners: 1. Claire Evans (Royal Netherlands Institute for Sea Research) 2. Elmar Veenendaal (Wageningen University)	*Conveners*: 1. Claudius van de Vijver (Wageningen University)	*Conveners*: 1. Eric Schranz (University of Amsterdam) 2. Thierry Janssens (VU University, Amsterdam)	*Conveners*: 1. Alejandro Ordonez (University of Groningen) 2. Karin Troost (IMARES)
10:30	Linking Hydrology and Biogeochemistry at Multiple Spatial and Temporal Scales (Karin Rebel, Utrecht University)	Evidence of the 'plant economics spectrum' in a subarctic flora (Grégoire Freschet, VU University, Amsterdam)	Submergence Tolerance in *Arabidopsis* and the Related Genus *Rorippa* (Yellow cress) (Melis Akman, University of Amsterdam)	The arrival, development and impact of exotic species in the brackish and marine waters of Zeeland (Sander Wijnhoven, Netherlands Institute of Ecology)
10:50	The North Sea Carbonate System in Summer (Lesley Salt, Royal Netherlands Institute for Sea Research)	Photoacclimation in marine picophytoplankton: growth and primary production under constant and dynamic irradiance conditions (Gemma Kulk, University of Groningen)	Transcriptional regulation and the microevolution *Orchesella cincta* cadmium tolerance (Thierry Janssens, VU University, Amsterdam)	Causes and effects of a highly successful marine invasion: Case-study of the introduced Pacific oyster Crassostrea gigas in continental NW European estuaries (Karin Troost, IMARES)
11:10	Carbon fluxes in natural plankton communities under elevated CO2 levels: a stable isotope labeling study (Anna de Kluijver, Netherlands Institute of Ecology)	Contemporary pollen dispersal in wild carrot (*Daucus carota L.ssp.carota*) population (Jun Rong, Leiden University)	Developmental plasticity in *Bicyclus* butterflies as a response to alternating seasons of low of high environmental stress (Paul Brakefield, Leiden University)	Ecosystem Engineering By Native and Exotic Shellfish: Feedback Mechanisms On Primary Production (Luca van Duren, Deltares)
11:30	**Short Break**			

	Parallel Session 3 Continued			
11:40	Shrub expansion may reduce summer permafrost thaw in Siberian tundra (Daan Blok, Wageningen University)	Cascading effect of elephants on bird species richness in Southern Africa (Fred de Boer, Wageningen University)	DNA methylation and transgenerational effects of exposure in *Daphnia magna* (Michiel Vandegehuchte, Ghent University)	Bioinvasions in the river Rhine: the battle of species (Rob Leuven, Radboud University, Nijmegen)
12:00	Dissolved organic matter uptake by temperate macrophytes (Tom Van Engeland, Netherlands Institute of Ecology)	The impact of different termites on soil fertility and vegetation in an African savanna (Cleo Graf, University of Groningen)	Epigenetic inheritance in asexual dandelions (Koen Verhoeven, Netherlands Institute of Ecology)	Comparison of exotic range-expanding and related native plants on plant nutrient acquisition and soil nutrient mineralization (Annelein Meisner, Netherlands Institute of Ecology)
12:20	Marine viruses: biogeochemically significant? (Claire Evans, Royal Netherlands Institute for Sea Research)	Early-life drought tolerance codetermines distribution patterns in vascular epiphytes (Maaike Bader, University of Oldenburg)		Invasion success of infectious diseases and the use of elasticity analysis in disease ecology (Nienke Hartemink, Utrecht University)
12:40	**Lunch in the restaurant**			
14:00	**Poster Session Day 2 / Coffee**			
	Parallel Session 4			
Location	**America Hall**	**Europe Hall**	**Asia Hall**	**Africa Hall**
15:00	**Parallel 4a: Microbial Ecology**	**Parallel 4b: Movement Ecology: Migration and dispersal**	**Parallel 4c: Physiological Ecology**	**Parallel 4d: Global change and biodiversity**
	Conveners: 1. Michiel Vos (Netherlands Institute of Ecology) 2. Joana Salles (University of Groningen)	*Conveners*: 1. Merel Soons (Utrecht University) 2. Silke Bauer (Netherlands Institute of Ecology)	*Conveners*: 1. Eric Visser (Radboud University, Nijmegen) 2. Joanna Cardoso (Royal Netherlands Institute for Sea Research)	*Conveners*: 1. Tim Engelkes (Netherlands Institute of Ecology) 2. Gregoire Freschet (VU University, Amsterdam)
15:00	Multi-genome comparative analysis of *Enterococcus faecium*: from harmless commensal to opportunistic pathogen (Willem van Schaik, University Medical Centre Utrecht)	Coral reef fish orientation by use of habitat-specific cues (Chantal Huijbers, Radboud University, Nijmegen)	The regulation of cell wall extensibility during shade avoidance: a study of two ecotypes of *Stellaria longipes* (Rashmi Sasidharan, Utrecht University)	How allometric scaling relates to soil abiotics and land-use changes (Christian Mulder, National Institute for Public Health and the Environment)
15:20	Microbial diversity determines the invasion of soil by a bacterial pathogen (Joana Falcão Salles, University of Groningen)	The importance of personality when individuals are on the move (Ralf Kurvers, Wageningen University)	Spatial and temporal root activity patterns of trees and grasses: two approaches to test the two-layer hypothesis in a subtropical savanna (Richard Verweij, University of Cape Town)	Sub-Arctic Vegetation Composition Resistant to Climate Change? (Frida Keuper, VU University, Amsterdam)
15:40	COLIWAVE a simulation model for survival of E. coli O157:H7 in dairy manure and manure-amended soil Alexander Semenov, University of Groningen)	Speedy ticks as result of *Borrelia* tricks (Fedor Gassner, Wageningen University)	Inorganic carbon uptake by Southern Ocean phytoplankton in response to ambient CO2: from physiology to ecology (Ika Neven, University of Groningen)	Mass-mortality of insular vertebrates during megadrought 4200 years ago: will insular vertebrates cope with future climatic extremes? (Kenneth Rijsdijk, Naturalis)
16:00	**Short Break**			

	Parallel Session 4 Continued			
16:10	The ecology of *Acidobacteria* and *Verrucomicrobia* isolates in the Leek rhizosphere (Ulisses Nunes da Rocha, University of Groningen / Plant Research International)	The dispersal-competition relationship: do the best take the dispersal risk or are the poorest kicked-out? (Dries Bonte, Ghent University)	Differential reproductive strategies of two bivalves in the Dutch Wadden Sea (Joana Cardoso, Royal Netherlands Institute for Sea Research)	Effects of rising CO_2 on stoichiometry and competition in phytoplankton (Jolanda Verspagen, University of Amsterdam)
16:30	Effects of different potato genotypes on soil fungal community structure and function (Emilia Hannula, Netherlands Institute of Ecology)	Migration and dispersal modelling: techniques and applications for river conservation and restoration management (Peter Goethals, Ghent University)	Reproductive investment of *Scrobicularia plana* along a latitudinal gradient (Sílvia Santos, Royal Netherlands Institute for Sea Research)	Beyond climate envelopes: new views on climate change effects from butterfly population dynamics (Michiel WallisdeVries, Wageningen University / Dutch Butterfly Conservation)
16:50	Positive effects of organic farming on belowground mutualists: large scale comparison of mycorrhizal fungal communities in agricultural and natural soils (Erik Verbruggen, VU University, Amsterdam)	Dispersal of tropical megafaunal seeds by rodents (Patrick Jansen, Wagningen University / University of Groningen)	Effects of different time-variable exposure regimes of the insecticide chlorpyrifos on freshwater invertebrate communities in outdoor microcosms (Mazhar Iqbal Zafar, Wageningen University)	Modelling climate impacts on genetic diversity in metapopulations (Marleen Cobben, Wageningen-UR)
	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 1

1a: Plant-animal interactions

Conveners: Merijn Kant (University of Amsterdam),
Kirsten Leiss (Leiden University)

1. Variation in flea beetle resistance to plant defense

Kim MCA Vermeer, Marcel Dicke, Peter W. de Jong
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The flea beetle *Phyllotreta nemorum* is polymorphic with respect to the resistance to the defences of a wintercress (*Barbarea vulgaris*). Some flea beetles are susceptible and some are able to live on B*. vulgaris* G-type. The flea beetle's resistance is caused by a major gene. The distribution of this gene through the flea beetle populations is remarkable. Can this be explained by solely a migration barrier or does selection play a role? A population genomics approach will be useful to examine the role of selection. This way population genomics allows an in-depth study of this ecologically relevant trait under natural field conditions. This might lead to a better understanding of antagonistic plant insect interaction and their (co)evolution.

2. Whiteflies interfere with indirect plant defense against spider mites in Lima bean

Peng-Jun Zhang[a], Si-Jun Zheng[a], Joop J.A. van Loon[a], Wilhelm Boland[c], Anja David[c], Roland Mumm[a,b], Marcel Dicke[a]
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Plants under herbivore attack are able to initiate indirect defense by synthesizing and releasing complex blends of volatiles that attract natural enemies of the herbivore. However, until now little is known about how plants respond to infestation by multiple herbivores, particularly if these belong to different feeding guilds. Here, we report the interference by a phloem-feeding insect, the whitefly *Bemisia tabaci*, with indirect plant defense induced by spider mites (*Tetranychus urticae*) in Lima bean (*Phaseolus lunatus*) plants. Additional whitefly infestation of spider-mite infested plants resulted in a reduced attraction of predatory mites (*Phytoseiulus persimilis*) compared to attraction to plants infested by spider-mites only. This interference is shown to result from the reduction in (E)-b-ocimene emission from plants infested by both spider mites and whiteflies. When using exogenous salicylic acid (SA) application to mimic *B. tabaci* infestation, we observed similar results in behavioral and chemical analyses. Phytohormone and gene-expression analyses revealed that B. tabaci infestation, as well as SA application, inhibited spider mite-induced jasmonic acid (JA) production and reduced the expression of two JA-regulated genes, one of which encodes for the *P. lunatus* enzyme b-ocimene synthase that catalyzes the synthesis of (E)-b-ocimene. Remarkably, *B. tabaci* infestation concurrently inhibited SA production induced by spider mites. We therefore conclude that in dual-infested Lima bean plants the suppression of the JA signaling pathway by whitefly feeding is not due to enhanced SA levels.

3. A herbivore that manipulates plant defence

Renato Almeida Sarmento[1,2,3], Felipe Lemos[2], Petra M. Bleeker[4], Robert C. Schuurink[4], Angelo Pallini[2], Maria Goreti Almeida Oliveira[5], Eraldo R. Lima[2], Merijn Kant[1], Maurice W. Sabelis[1] & Arne Janssen[1]
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Plant defences are induced by attacking pathogens and herbivores. Whereas there are well-described mechanisms by which some pathogens force plants to down-regulate such

defences, evidence for plant defence suppression by herbivores is still scarce. Here we report on a herbivore that not only suppresses induced plant defense but, while doing so, decreases defenses even below the levels that were present prior to the attack turning infested plants into better food than clean control plants. The spider mite *Tetranychus evansi* is an upcoming pest on tomato in Africa and Mediterranean Europe. It suppresses the jasmonic acid and salicylic acid dependent defense pathways. Defensive compounds such as proteinase inhibitors and volatiles involved in indirect plant defence are down-regulated, some to even lower levels than in clean plants resulting in a two-fold increase of mite ovipositionon attacked plants compared to clean plants. Moreover, the mite reaches two-fold higher densities on tomatoes than a closely related mite species that induces plant defences. These insights in the success of a novel invasive pest suggest that the classical plant-herbivore models should be reviewed and that crops should be improved to prevent herbivores from manipulating defences.

4. Establishing an effective test method for thrips resistance in pepper

Awang Maharijaya, Greet Steenhuis-Broers, Ben Vosman, R.G.F. Visser and Roeland E. Voorrips

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Thrips are a major pest in pepper cultivation worldwide. They cause damage directly by feeding on leaves, fruits and flowers, and indirectly by transferring viruses, especially Tomato Spotted Wilt Virus. As resistant varieties are not available, thrips have to be controlled using pesticides. However, thrips are developing resistance to pesticides, and the use of pesticides is undesirable because of their harmful effects on growers, consumers and the environment.

Breeding programs for obtaining pepper varieties with sufficient resistance to thrips involve the screening of potential sources of resistance and the selection of resistant genotypes in segregating populations. Therefore effective test methods need to be established, that are easy to conduct, accurate, reproducible, and which require little space, time and energy. Our research is aimed at the development of tools for breeding varieties with a broad resistance to thrips. This encompasses setting up of effective test methods and the identification of sources of resistance.

Thirty-two pepper accessions from four species of pepper (*Capsicum annuum*, *C. baccatum, C. chinense* and *C. frutescens*) originating from different geographic and climatologic regions were tested for resistance using several screening methods. The tests were performed in Indonesia and the Netherlands with *Thrips parvispinus* and *Frankliniella occidentalis*, respectively. Accessions were tested under choice (screenhouse, greenhouse) and non-choice (leaf disc, detached leaf and cuttings) condition. Screening methods were compared and correlations among these methods were assessed.

We observed a large variation for resistance to thrips in pepper. Our results also indicate that the leaf disc test can be used as an efficient and predictive screening method for thrips resistance in pepper. An F2 population from a cross between a highly resistant and a susceptible accession was produced and phenotyped using the leaf disc test.

5. Tomato Thrips Resistance: Glycolipids, Methylketones, Phenolics or Sesquiterpenes?

Roman R. Romero-González[1], Mohammad Mirnezhad[2], Kirsten A. Leiss[2], Robert Verpoorte[1]

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The tomato clade, especially its wild species, has a diverse trichomeborne arsenal proven to be effective against several classes of pests. The main reported resistance mecanisms are: A) Entanglement, conferred by mucilaginous secretions of tomato glandular

trichomes (acylsugars and sesquiterpenes), B) Repellency/toxicity of glandular exudates (methylketones and sesquiterpenes), and C) Immobilization, caused by the solidification of phenolic polymerization products. Independent genetical engineering efforts are currently been made to bring these traits into domesticated tomatoes without having checked first their relative efficiencies. In an attempt to stablish such ranking of the different defenses a set of wild species and cultivars chosen according to their contrasting morphological and chemical features have been tested in this study against one of the most feared herbivores nowadays, the Western Flower Thrips (*Frankliniella occidentalis*). Non-choice leaf bioassays carried out with thrips adults were used to determine insect damage in both older and younger leaves of all tomato plants. Densities of all hair types were determined as well and a comprehensive phytochemical analysis of their exudates was performed. This data was used to estimate in each case the minimal glandular trichome density required to preclude herbivory and the amount of exudate per trichome. The relative efficiency was stablished then in terms of the aproximate effective biomass devoted by each species or cultivar to become thrips immune. The most efficient tomatoes were: as second *S. habrochaites* var. *glabratum* (PI134417), with very high levels of methylketones, and as first a hairy type of domesticated tomato *S. Lycopersicon* var. Moneymaker, with high levels of phenolics. It is rather surprising to discover that the so-long-pursued resistance trait is not in the wild species but already in the domesticated germplasm.

6. Metabolomic responses to herbivory in GM potato

Andreas Plischke[1] , M. Bruinsma[2], P.M. Brakefield[2] and P.G.L. Klinkhamer[1]

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An important question in risk assessment of genetically modified (GM) crop plants is whether unintended genetic or phenotypic side-effects occur in the plant after modification. Side-effects can be caused by gene disruption or altered gene regulation, and one result may be a change in the production of secondary metabolites. Such effects on the metabolome level can have ecological consequences for a plant's interactions with pathogens and herbivores, since many of these interactions are mediated by secondary plant compounds. In this study we present results of a metabolomic approach to study leaf chemistry in response to herbivory and virus infection in a GM potato variety, in comparison to its respective non-modified counterpart. The GM plants are modified in their starch metabolism to increase amylopectin yields in tubers for industrial starch production. The experiment was conducted before the inserted gene was active, i.e. before tuber-onset, in order to test for effects resulting from the process of modification itself as opposed to post-transcriptional effects. Analysis of leaves with H^1-NMR spectroscopy and multivariate statistics revealed no separation in metabolomic profiles, suggesting that metabolite levels were not changed due to genetic modification. Both varieties show similar chemical responses to aphid herbivory and virus infection, i.e. an increase of phenolic compounds and a change in glycoalkaloid patterns. We suggest that metabolomic techniques should be an integral part of ecological risk assessment of genetically modified (GM) crop plants.

1b: Conservation and Restoration Ecology

Conveners: Raf Aerts (K.U.Leuven),
Verena Cordlandwehr (University of Groningen)

1b-1 Conservation in the light of change

1. **The effect of multiple global environmental changes on the performance of forest herbs: a review with *Anemone nemorosa***

Lander Baeten; Pieter de Frenne; Kris Verheyen & Martin Hermy*
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Global environmental changes have become important drivers of plant community shifts and are considered threats to biodiversity. Because several environmental changes often occur simultaneously, effective species conservation hinges upon knowledge of their interactive effects on plant populations. We reviewed the complex responses of the vernal forest herb *Anemone nemorosa* L. to a set of prevailing environmental threats: changes in forest management, land use change, atmospheric deposition and climate change. The synthesis was based upon European literature, with special attention to results from a densely populated region (Belgium) in which multiple changes were expected. An important lesson we learned from this review is that the human alteration of the environment has ambiguous effects on the performance of *Anemone*: some environmental changes were detrimental to the performance of the herb while others were rather beneficial. The ultimate response was therefore very complex. A second conclusion is that we have to measure the effects of global changes at the different levels of biological organisation (traits, individuals, populations). A mechanistic understanding of global change effects on plants mainly requires trait and individual level observations. The consequences of trait-level responses should, however, be evaluated at the population level as this is the scale of interest for biological conservation.

2. **The response of shoreline vegetation in fens to nutrient enrichment of either the bank soil or the surface water**

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Riparian ecosystems harbour great floral and faunal diversity and fulfill several important ecological functions. Although the effect of riparian vegetation on water quality is well-studied, surprisingly, the impact of eutrophication on the riparian ecosystem itself and, in fens, the succession towards floating peat mats remains unclear. We used a large controlled mesocosm experiment to study the complex interactions between eutrophication of bank soil versus surface water and vegetation development and colonisation of the open water. Because litter accumulation in fens strongly controls succession towards floating mats, this process was also studied. The mesocosms consisted of a bank and a water compartment to which different combinations of nutrients to either the bank or the surface water were applied. We found that eutrophication (mainly through phosphorus) of the bank as well as of the open water strongly affected plant growth on the bank and stimulated the growth of pioneers into the open water. However, only the eutrophic species increased shoot density after N and P addition to the bank, hence inducing a species shift. Enrichment of the bank enhanced biomass and litter production, but accelerated decomposition. On a mesocosm scale, net litter accumulation was calculated to be highest on enriched banks. These results imply that eutrophication of fen shoreline ecosystems will strongly accelerate succession but only with eutrophic species. This likely shortens the life-span of this valuable succession stage and reduces its biodiversity. Hence to increase resilient opportunities for the formation of floating peat mats, nutrient availability in both water and the bank soil have to be low.

3. Abundance and demography of large mammals across conservation boundaries in the Mara region of Kenya

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Wildlife habitats in pastoral lands adjoining protected areas in East African savannas are getting progressively degraded, fragmented and lost by expanding human populations, settlements and cultivation, sedentarisation of pastoralists and intensification of land use. To understand these influences, we contrasted the demography of 14 wild ungulate species between the Masai Mara National Reserve and the adjoining pastoral ranches using five ground surveys conducted in the wet and dry seasons. The distribution of herbivore density between landscapes varied with body size, feeding style and seasons. Elephant, buffalo, hartebeest, topi and warthog had higher densities in the reserve than the ranches whereas giraffe, Grant's and Thomson's gazelles had higher densities in the ranches than the reserve in both seasons. The migratory eland, wildebeest and zebra concentrated in the reserve in the dry season but in the ranches in the wet season. Impala was more abundant in the ranches in the dry season but had similar densities in both landscapes in the wet season. Waterbuck and ostrich had similar densities in both landscapes and seasons. Population composition by age was similar between landscapes for all the eight herbivore species that were aged. Adult sex ratio was disparate in favor of females in the dry season but in favor of males in the wet season for giraffe but biased in favor of females for impala in both landscapes but similar between landscapes and seasons for the other four species that were sexed. These findings indicate that human population growth and land use changes are progressively degrading habitats in pastoral lands constituting critical wet season dispersal ranges for ungulates in East African savannas, with important consequences for ungulate population demography and seasonal dispersal movements between the protected areas and adjoining pastoral lands.

1b-2 Restoration

4. Restoration ecology of lichen-rich inland dunes in the Netherlands

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Inland dunes are semi-natural landscapes characterized by drift sand soils originating from glacial cover sands. Over the last 100 years, most inland dunes have been planted with pine trees. Open inland dunes are now rare and protected under the EU Habitats Directive. Inland dunes need management to preserve their open sand and lichen-rich *Corynephorus*-grasslands. Within open inland dunes several vegetation types can be found from open sand with sparse grasses to *Cladonia*-rich grasslands and lichen-rich *Calluna*-heathland. The major threat of inland dunes is nitrogen deposition. The bryophyte *Campylopus introflexus* becomes dominant in high nitrogen deposition areas, wiping out most of the lichen vegetation. These processes will be illustrated with results of experiments and a remote sensing survey.

5. Early indicators of atmospheric nitrogen deposition impact on lichen-rich, coastal dune grasslands

Eva Remke

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Despite reductions in atmospheric nitrogen and sulphur depositions during the last three decades, depositions are still far higher than background deposition and form a permanent threat to oligotrophic and weakly buffered ecosystems. An example are lichen-rich coastal dune grasslands, a priority habitat under the European Habitats Directive. At moderate loads of nitrogen deposition, dry coastal dunes become dominated by a dense sward of only *Carex arenaria*, especially lichen species richness decreases. Thus, critical loads for these acid dunes have to be adjusted to 5-10 kg N ha^{-1} yr^{-1} , half as high as previously thought. Therefore further reductions in deposition in large parts of

Europe, e.g. The Netherlands, are necessary if we want to improve the status of these priority habitats.

Early signs of an impact of atmospheric N-depositions are not easy to detect. Only once a system has experienced longer periods of elevated N-loads and has already swapped to more nutrient-rich conditions, a dense vegetation has established, the impact is obvious. Early indicators of nitrogen deposition impact might therefore be a valuable tool in nature conservation and restoration ecology to be aware of changed environmental impact. An early indicator of the influence of low to medium N-loads on acid to slightly calcareous dune ecosystems may be the total organic matter content (LOI). If the LOI in the upper mineral soil horizon of lichen-rich, short grasslands is above 1-1.5% and the pH is below 4.0-4.5, the system is about to change to nutrient-richer, less extreme soil conditions. Furthermore, at pristine sites the pH slowly decreases during the succession from bare sand over lichen rich short grasslands to tall grasslands, whereas at affected sites the pH stays the same at a lower level. At a low pH (pHsalt<4.0), metals become freely available and e.g. Al/Ca-ratios >1 occur. Furthermore, occurrence of certain lichen and forb species can give a valid indication of site conditions. But one has to bear in mind that not only one singular feature standing alone can give a proper indication of an elevated atmospheric nitrogen deposition influence. Only a certain array and combination of features will give a sound judgment.

6. Restoration of soft water lakes: water and sediment quality effects on isoetid vegetation

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The vegetation of softwater lakes (isoetids) disappeared in Atlantic lakes due to acidification, eutrophication, and lately due to alkalinization. Our objective was to study how the new water and sediment conditions affect the recovery of isoetid vegetation in order to drive future restoration projects. On one hand, we studied how alkaline and rich sulphate water affected three isoetid plant densities. Sulphate decreased photosynthetic efficiency and plant vitality. Plant density increased the redox potential of the sediment, thus, the higher the plant density was, the better the plants performed. On the other hand, we studied how quantity and lability of organic sediment affected isoetids. Moderate concentrations of sediment organic matter stimulated growth of aquatic isoetid plants. Organic matter never affected survival of the plants, however, it led to development of high shoot:root ratios which potentially causes extensive uprooting of, for example, *Littorella uniflora* vegetation. In the absence of rooted plants, the redox potential of the sediment decreases as a result of a lack of sediment oxidation by plants in combination with high oxygen consumption of the sediment. Low redox potential leads to inhibition of germination of seeds, which further hampers the recovery of isoetid vegetation. Our experiments suggest that in order to achieve a successful soft water lake restoration it is necessary to: a) stop input of alkaline sulphate containing surface and ground water, b) improve water quality, c) remove the organic sediment top layer and, d) keep natural water table fluctuations.

1c: Fresh-water and marine Food webs

Conveners: Andrea Downing (Wageningen University)
Kristina Raab (IMARES)
Reinier Hille Ris Lambers (IMARES)

1. Coupled predator-prey oscillations in a chaotic food web.

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Recent theoretical work has shown that coupling of predator–prey oscillations can generate intriguing patterns of synchronization and chaos. Theory predicts that prey species will fluctuate in phase if predator–prey cycles are coupled through generalist predators, whereas they will fluctuate in anti-phase if predator–prey cycles are coupled through competition between prey species. Here, we investigate predator–prey oscillations in a long-term experiment with a marine plankton community. Wavelet analysis of the species fluctuations reveals two predator–prey cycles that oscillate largely in anti-phase. The phase angles point at strong competition between the phytoplankton species, but relatively little prey overlap among the zooplankton species. This food web architecture is consistent with the size structure of the plankton community, and generates highly dynamic food webs.

Continued alternations in species dominance enable coexistence of the prey species through a non-equilibrium 'killing-the-winner' mechanism, as the system shifts back and forth between the two predator–prey cycles in a chaotic fashion.

2. Impacts of omnivorous fishes on submerged macrophytes: prey stoichiometry and food web structure

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In temperate shallow lakes, aquatic omnivores such as fish, may have important structuring effects on the food web. When acting as herbivores, they may significantly reduce submerged macrophyte communities. On the contrary, when acting as carnivores they predominantly influence the zooplankton community. Surprisingly, not much is known about the mechanism that structures these dietary shifts in omnivores. We hypothesize that stoichiometry (with respect to carbon : nitrogen) of prey species (either macrophytes or macrofauna) partly determines prey selection of omnivorous fish. Subsequently, we also hypothesize that fish species with varying degrees of omnivory have different impacts on submerged macrophyte communities.

To further explore these hypotheses, two experiments were conducted. Firstly, the relationship between prey stoichiometry and prey selection was determined for both rudd (a native omnivorous fish) and grass carp (an exotic semi-herbivorous fish) by laboratory choice tests. Secondly, we measured herbivory impacts of both species of fish on macrophyte communities in 15 outdoor mesocosms by exclosure experiments and stabile isotope measurements of the corresponding aquatic food webs.

The choice tests showed that both species of fish are omnivorous, and suggest that prey selection is partly determined by carbon:nitrogen ratio of prey items. Additionally, the mesocosm experiment showed negative impacts of both fish species on submerged macrophytes. However, variation was substantial and could be related to dietary differences between the two omnivores, as revealed by stabile isotope analysis from the food web. Based on this, it can be suggested that both prey stoichiometry and the degree of omnivory influences impact of omnivores on submerged macrophyte communities.

3. Collapse and reorganisation of Lake Victoria's food web

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We create mass-balances of Lake Victoria's food web to understand the interactions and processes that build it. Lake Victoria (in East Africa) is the world's second largest fresh-water system and a rapidly increasing human population is directly dependent on its resources. Over the past century its system has undergone drastic changes. Some 30 years after the introduction of Nile perch and tilapia in the 1950s, the lake's ecosystem shifted and the high diversity of native haplochromines collapsed, leaving a system dominated by only four species. More recently, a remarkable and unexpected resurgence of haplochromines has been reported. To get a better view of the processes driving these changes, we created mass-balances of the food web near Mwanza (Tanzania) before, during and after the Nile perch boom (1977, 1987 and 2005) using the ecosystem model ECOPATH. We compiled survey and literature data to get the models' parameters. We first created *a priori* ranges of parameter values and then calibrated our models to check the internal coherence of our data and narrow-down value ranges. Resulting mass-balances suggest that the Nile perch boom profoundly altered biomass distribution in the food web, but that the overall trophic structure returned to its previous pyramid shape in 2005. No such return appears at the community level, where groups that survived the biodiversity collapse seem to have evolved swiftly to change functions, and resurging haplochromines dominate in a new niche. We suggest processes other than fishing also need investigation to better understand changes in Lake Victoria's system.

4. Trophic impact of increased anchovy in the North Sea.

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Anchovy (*Engraulis encrasicolus*), usually found in the Southern seas of Europe, increased in abundance during the mid-1990s in the North Sea. Since it is a pelagic planktivore, anchovy is a potential competitor of herring (an important commercial species), the recruitment of which has been low for several years. Using empirical information on the diet of anchovy and other small pelagic fish, possible impacts of increased anchovy on the North Sea pelagic food web are explored.

5. Getting into hot water? Aquatic food webs under climate climate warming.

L. N. de Senerpont Domis

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Recent climate warming has been shown to advance the seasonal timing of life cycle events, such as budding of trees and egg laying by birds. 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, such as emergence, moulting and sexual reproduction, each species requires specific cues, which are used as proxies for the suitability of the environment for their reproduction and growth. Climate warming may change the validity of the proxies different species use. The fundamental questions underlying our research are threefold: 1) What proxies do different species 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

used natural plankton communities in large scale mesocosms to test several hypotheses concerning the impact of climate warming on the phenological coupling of key herbivore *Daphnia* and its algal food source. First results of this extensive mesocosm study show effects of climate warming on nutrient recycling, plankton stoichiometry and zooplankton size. Surprisingly, several species of plankton were able to maintain viable population levels beyond their previously assumed lethal temperatures, indicating some potential for adaptation of aquatic food webs to warmer climates.

6. Habitat segregation and complex life cycles; managing fish populations exhibiting ontogenetic habitat shifts.

K.E. van de Wolfshaar[1], R. HilleRisLambers[2] and A. Gårdmark[3]

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Species exhibiting ontogenetic diet shifts between adult and juvenile life stages often also switch habitats. Thus, within-stage processes such as competition or mortality affect other life stages in different habitats only through maturation and reproduction processes. The consequences of this for harvesting and management of exploited populations is yet unstudied. In this paper we use a consumer-resource model incorporating stage specific mortality and survival to study how differences in (stage-specific) habitat productivity regulate a consumer population.

Our results indicate that for intermediate differences in habitat productivity juvenile or adult biomass dominated states can occur as alternative stable states. When adult and juvenile habitats differ greatly in productivity, only a single equilibrium exists. Increased mortality decreases the scope for alternative stable states across all habitat productivities. We find juvenile mortality more detrimental for population persistence than adult mortality, especially in combination with low juvenile habitat productivity. In addition, fisheries yield is highest for low juvenile mortality and low migration mortality. Our results demonstrate that population response to management actions affecting (migration) mortality and habitat productivity depends critically on the mechanism regulating the population. Protection and improvement of (often degraded) juvenile habitat and improved migration survival yield most results in terms of both population persistence and fisheries yield.

1d: Free session

Convener: Rampal Etienne (University of Groningen)

1. Quantifying Stochastic Introgression Processes

A. Ghosh and P. Haccou
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Introgression is the permanent incorporation of genes from one population into another through hybridization and backcrossing. This may result in the spread of insecticide or herbicide resistance genes, the escape of transgenes from genetically modified crops, or the incorporation of genes from exotic species into genomes of local species. The potential environmental effects of introgression are severe. For instance, transgene escape might produce robust weeds which can outcompete other species and reduce biodiversity. Introgression involves many random elements, such as rare hybridization events, and demographic variation in offspring numbers and survival. As a consequence, even if foreign genes provide a fitness advantage, it will usually take several invasions before they are established permanently. This causes a large variance in the numbers of individuals carrying foreign alleles during the initial phase of introgression. Until now, introgression studies are usually based on deterministic models, that fail to take such key features of introgression into account, and therefore can be very misleading. To assess introgression risk accurately it is crucial to quantify this initial phase accurately. In this talk, we explain how the instantaneous risk that a successful introgressed lineage is initiated can be derived from a stochastic introgression model.

2. Migration, who cares?

Rudy Jonker
Resource Ecology Group, Wageningen University, Wageningen, the Netherlands

In geese, parental care and migration are widely assumed to be strongly connected. Goslings migrate together with their parents and stay with their parents almost until the next breeding season. Families start breaking up during spring migration, as the parent-offspring conflict intensifies during preparations for the next generation of offspring. Additionally, the extended association of parents and offspring plays a crucial role in culturally transmitting the migration strategy onto the next generation.

Recently, the Russian population of the Barnacle Goose has delayed the onset of spring migration with one month. Our question was if the parental care behaviour changed accordingly to the migratory behaviour. We expected that the delay of migration was followed by a delay of termination of parental care and parent-offspring association. We show that, in contrast to our expectation, parental care was terminated well before the onset of spring migration. Additionally, parent-offspring associations were nearly absent during spring migration. We argue that the mechanism for determining the duration of parental care are different from those determining the onset of spring migration, resulting in a two month gap between the end of parental care and the start of migration. Hence, we conclude that a mismatch has developed between both behaviours. A consequence of this mismatch could be that the cultural transmission of migratory behaviour is disrupted, possibly explaining the recent emerge of new populations of Barnacle geese across the Russian flyway

3. Species in a fragmented landscape. How policy scenario's change species distributions

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In a highly fragmented landscape such as Flanders there is not much space left for nature. Therefore, it is crucial to understand how policy decisions can maintain or improve the environment to support biodiversity. The scope of this study was to get scientifically based insight in possible evolutions of the environment and nature in Flanders under different policy choices within a given socio-economic context. The

modelled time span was 2005-2030. In short, we modelled 6 land use scenario's. A combination of two environmental (business as usual and Europe scenario) and three nature scenario's (business as usual, segregation and intertwine). The business as usual scenario's continue present policy into the future. The Europe scenario puts on more resources to achieve the European environmental targets. Under the segregation scenario, the use of open space is strictly divided between nature (e.g. nature reserves) and other uses (e.g. agriculture). The intertwine scenario strives to realise good nature quality everywhere (multifunctional land use).

To model the effects of changes in land use we used the LARCH model (Landscape ecological Analysis and Rules for the Configuration of Habitat). LARCH is based on meta-population systems. It includes habitat requirement, carrying capacity of the habitat and dispersal capacity of the target species to construct habitat networks. These habitats are tested whether they are viable (extinction risk in 100 years < 5%) or not. To generalise our findings, we used ecoprofiles in stead of existing species. Ecoprofiles are fictive taxa that represent a series of species with comparable ecological requirements (e.g. habitat preference, dispersal capacity).

The main results of our modelling: The potential distribution area for species tied to area's under nature conservation increases under all scenario's (except for wet heathland where there is a status quo). The Europe scenario offers more opportunities for species from farmland with nature targets. The business as usual scenario results in an area increase for species from production grasslands with nature targets, ecological valuable grasslands, open marshes and (deciduous) forests. Under the segregation scenario there is a strong area increase for species from marsh forests and dry heath.

4. The role of body size in communities: Food web of the Serengeti

Sanne de Visser
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One of the most obvious distinguishing and universal features among animals and highly correlated to several life-history traits as well as biological and ecological traits, is body size. How much can body size tell us? In this presentation I will show 1) how body size is related to extinction risk and to vulnerability due to human activities, and 2) how a community is size-structured and how this structure changes under human disturbances. Larger body sized organisms are more prone to become extinct. With empirical data from a savanna food web I show that this species-rich community is hierarchically structured with small predators feeding upon small prey and large predators feeding upon large prey and anything smaller. However, this structure falls apart with the loss of the more vulnerable, larger sized species. These results together indicate an important role for body size to act as a predictor in community processes, especially in the face of increasing human-induced disturbances.

5. Ecological relationships between *Ixodes ricinus* ticks and mast-eating rodents

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Mast seeding has been shown to elevate population densities of small rodents such as wood mouse (*Apodemus sylvaticus*) and bank vole (*Clethrionomys glareolus*). A potential consequence of high rodent density is an increase in human exposure to Lyme disease. This is expected because small rodents are key hosts for *Ixodes ricinus* larvae and are also the principal natural reservoir of the Lyme bacterium, *Borrelia burgdorferi*. The greater the population density of rodents in summer, when larval ticks seek hosts, the greater the opportunities for ticks to acquire the pathogen and the higher the density of infected nymphs the following summer. Nymphs are considered to be the main transmitters of *B. burgdorferi* to humans because they are easily overlooked due to their small size.

Fieldwork was conducted at Averbode Bos & Heide and the Provincial Domain Hertberg (Belgium, Campine district), where we selected 6 common oak (*Quercus robur*) and 6 black pine (*Pinus nigra*) stands. We took advantage of mast crop failure in the autumn of 2008 to add acorns to six experimental grids (3 oak and 3 pine stands) but not to the six control grids. We added 200 kg of acorns to each experimental grid. Questing ticks (larvae, nymphs and adults) were collected by flagging over low vegetation, using a 1 x 1 m white flannel cloth fastened on a wooden dowel. Tick sampling was carried out regularly between May 2008 and October 2009. Small mammal abundance was monitored in September 2008 and 2009 (before and after acorn addition) using capture-mark-recapture techniques. On each plot we established a 7 x 7 point grid of Trip-Trap live traps. Trapping was conducted for four consecutive nights.

In 4.704 trap nights a total of 669 small mammals were caught, which corresponds to a mean trap success of 14.2 individuals per 100 trap nights. The bank vole was the dominant species caught (46.5%), followed by the wood mouse (36.3%). Mast-eating rodents accounted for 83.7% of the total catch. Acorn addition significantly increased rodent density in the experimental plots, while density stayed stable in the control plots. Furthermore, we found a significant positive correlation between larval survival rate and rodent density. Our results confirm previous observations that (1) high availability of acorns leads to increased rodent densities the following summer and (2) high rodent density provides increased opportunities for larval ticks to feed successfully. Since rodents are the principal natural reservoir for the Lyme bacterium, we postulate that the occurrence of a masting event will lead to a higher abundance of infected nymphs two years later, and thus a higher risk of human exposure to Lyme disease.

6. Spring migration strategy and reproductive success in the Svalbard Barnacle goose *Branta leucopsis.*

Thomas Oudman

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Successful reproduction in Arctic breeding birds depends largely on timing of migration. We used light intensity loggers attached to bird rings to assess migratory schedules and the timing of incubation of Barnacle geese breeding on Spitsbergen. Two new patterns of spring staging were revealed. Following an increase in population size, goose numbers at the traditional staging area had stayed relatively constant. A new strategy staging more north became an option due to warmer weather and resulted in earlier incubation. A third strategy with birds staying considerable longer in the wintering areas did result in incubation but with a later start date, suggesting a lower reproductive success.
Interestingly, these developments show great similarity with the Russian breeding population of Barnacle geese, in which a growing part of the population extends its departure from their wintering area by several weeks.

Session 2

2a: Multitrophic interactions

Conveners: Marjolein Kruidhof (Netherlands Institute of Ecology)
Eduardo de la Pena (University of Gent)

1. Both soil organisms and plant intra-specific variation affect aboveground multitrophic interactions.

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Multitrophic Interactions, Netherlands Institute of Ecology, the Netherlands

Recently, there has been an increased interest in how soil communities can affect aboveground communities. These interactions between below- and aboveground communities do not only depend on the belowground communities but may also be determined by the plant species that mediates these interactions. Currently it is unknown how intra-specific variation in plants affects the strength of below-aboveground interactions. To investigate the role of intra-specific variation we selected two distinctly different white cabbage (*Brassica oleracea* var. *capitata*) cultivars, Badger Shipper and Rivera. We inoculated the soils of the cultivars with either nematodes or microorganisms and included a control group grown in sterilized soil. Aboveground, we measured growth-related parameters and the chemical composition (glucosinolates and amino acids) of the plants, population development of the aphid *Brevicoryne brassicae*, and fitness-related parameters of the parasitoid *Diaeretiella rapae*. Soil organisms significantly affected the aphids: Soils inoculated with microorganisms increased and nematodes decreased aphid population sizes on both Badger Shipper and Rivera. Cultivars differed in their root, shoot, and phloem glucosinolate composition and in leaf relative growth rate. This intra-specific variation was reflected in differences in aphid population sizes as well as in the glucosinolate profiles of the aphids from the two cultivars. Badger Shipper had a higher leaf relative growth rate and was able to sustain more aphids. Parasitoid performance was also affected by cultivar, with adult mass and male ratio higher and a shorter developmental time on Badger Shipper. However, there was no interaction in any of the recorded parameter between cultivar and soil inoculum. Therefore, we conclude that in this system intraspecific variation did not influence effects of soil organisms on aboveground multitrophic interactions.

2. Tri-trophic effects of inter- and intra-population variation in defence chemistry of wild cabbage (*Brassica oleracea*)

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The effect of direct chemical defences in plants on the performance of insect herbivores and their natural enemies has received increasing attention over the past ten years. A number of studies have shown that herbivores and their predators or parasitoids develop more poorly on plants producing higher levels of toxins in their shoots. Although some of these studies compare inter-population variation in defence chemistry, few have examined differences in allelochemicals found within populations. This study compares growth and development of the large cabbage butterfly, *Pieris brassicae*, and its gregarious pupal parasitoid, *Pteromalus puparum*, on three wild populations and two cultivars of cabbage, *Brassica oleracea*. Insect performance and glucosinolates chemical profiles were made from every plant used in the experiment. Glucosinolates, secondary plant compounds characteristic for the Brassicaceae, play an important role as defensive chemicals against a range of attackers including insects. Glucosinolate profiles were linked to insect performance.

3. Differential covariation of above- and belowground invertebrate species across genotypes of the dune grass *Ammophila arenaria*

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Although a large body of literature documents on the patterns of covariation of invertebrate responses to genetic variation in plants, the belowground component of the invertebrate community is largely neglected in this context. We have investigated the effect of broad-sense genetic variation in *A. arenaria* on the occurrence of 13 common invertebrate species at both sides of the soil surface after natural colonisation, using geographically separated plant populations. At a species level, most aboveground species clearly preferred local plant genotypes over others, while differentiation by root-feeding nematodes was less pronounced. Multivariate analyses however demonstrated effects of plant genotype on the aboveground, belowground as well as the entire community. Investigation of the correlations between the invertebrate species across plant genotypes revealed strong positive correlation among both above- and belowground invertebrates, while correlations between these two groups were negative. Therefore, location on the plant as well as order level taxonomy explained the clustering of species across genotypes well, while trophic level or degree of specialisation did not correspond with the observed patterns. Our results suggest that plant resistance to above- or belowground invertebrates in *A. arenaria* could be generalised. The trade-off between resistance to root and shoot associated invertebrates could however hamper directional selection on resistance to either suite of invertebrates. Coevolution between *A. arenaria* and its multiple invertebrate species is therefore likely diffuse rather than pairwise. From a conservational point of view, our results stress the necessity to choose *A. arenaria* populations for sand fixation carefully in function of their potential effect on the associated invertebrate community. A more holistic approach of the study of ecological communities, including the belowground component, could thus greatly enhance our understanding of the mechanisms and trade-offs in plant defense and the process of coevolution and provide more effective tools for species conservation.

4. Effect of soil conditions on plant-pollinator interactions in natural and restored heathlands

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Although during the last decade there is been considerable evidence on how belowground biotic interactions affect those aboveground, their importance in restoration issues has been much less investigated. We hypothesized that the contrasting soil conditions resulting from different historical land use in heathlands would mediate the interactions of *Calluna vulgaris* with plant mutualists above- and belowground. We compared the flowering phenology, the interaction with pollinators and the colonization by ericoid mycorrhiza of mature *C. vulgaris* transplanted to three types of soils: (i) natural rhizospheric soil collected in a natural heath, (ii) rhizospheric soil from an arable land recently converted into a heathland and (iii) rhizospheric soil of *C. vulgaris* from an area in which a high degree of heterospecific competition with perennial grasses occurred. The results of the experiments showed a strong effect of soil on flower phenology and synchrony. There was also an interaction with pollinators and in that sense, not only did visitation rates depend on soil type, but also the choice of plants visited by some pollinators. Although the mechanisms of interaction were not fully investigated, differences in ericoid mycorrhizal fungi colonization of experimental plants across the different soil treatments seem to be the causal agent. The results obtained from this study highlight the necessity of incorporating soil biotic interactions and conditions in investigations of aboveground biological processes.

5. Litter utilization by soil animals and cascading effects on aboveground generalist predators in arthropod food webs

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The rate of litter utilization by soil organisms depends on resource availability, quality and distribution. Anthropogenic disturbance may affect trophic links in belowground food-webs via changes in such basal resources. In an agricultural long-term experiment we analyzed stable isotope ratios of naturally occurring C and N isotopes in plant resources, consumers and generalist predators. From this data we estimated the individual contribution of two different carbon sources (wheat, a C_3 plant and maize, a C_4 plants) to decomposer and aboveground herbivore and predator diets in an arthropod food web. We demonstrate how those links and the trophic position of species in the studied food web depend on management practice. The non-random spatial distribution of litter may further determine interaction patterns between belowground prey and aboveground predators. We used spatially explicit sampling and spatial statistics to identify the impact of litter distribution on aboveground predator-belowground prey interactions in a forest ecosystem. Both studies demonstrate the importance of availability, quality and distribution of basal resources in below- and aboveground food webs and highlight the sensitivity of those webs to anthropogenic disturbances.

6. Macro-detritivore identity drives leaf litter diversity effects

Veronique Vos

Nature Conservation and Plant Ecology, Wageningen University, the Netherlands

With the current worldwide decline of biodiversity, it is important to find out how ecosystem processes will be affected. For leaf litter decomposition, an important process in terrestrial and aquatic ecosystems, the importance of litter species diversity has been shown by previous litter-mixing studies with the occurrence of non-additive litter diversity effects. This means that mixtures of leaf litter decomposed faster than was expected on basis of their monocultures. However, it is not clear why they occurred in only half of the studies and which underlying mechanisms can explain these conflicting results. We hypothesized that the effect of higher trophic levels such as macro-detritivores could help to explain the variable result of litter mixture studies. Although often ignored, macro-detritivores are known to strongly influence decomposition. To better understand the importance of macro-detritivores for litter mixing effects during decomposition, four common litter species were added separately and in two and four species combinations to monocultures of three different terrestrial macro-detritivores and a control without fauna. Furthermore the additive partitioning method was used to gain further insight into the underlying mechanisms.

Our results clearly show that litter-mixing effects occurred only in the presence of two macro-detritivores (earthworms and woodlice, see fig. 1 A). Application of the additive partitioning method revealed that, in the specific combination of woodlice and the presence of Fagus, litter mixing effects were strongly driven by a selection effect (fig. 1 C). This was caused by food preference of the isopod: the animals avoided the slow decomposing species when given the choice. However, most litter mixing effects were caused by complementarity effects (fig. 1 B). The potential mechanisms underlying these complementarity effects can be either direct, for instance due to a macro-detritivore preference for a mixed diet, or indirect, via the microbes, by for instance litter mixing and fragmentation, passage through the detritivore digestive system or detritivore feaces. Our results clearly show that higher trophic levels should be taken into account when explaining litter mixture effects and that both litter and animal identity can affect litter decomposition. This may help to explain the conflicting results obtained in previous experiments and thereby clarify the relationship between biodiversity and leaf litter decomposition.

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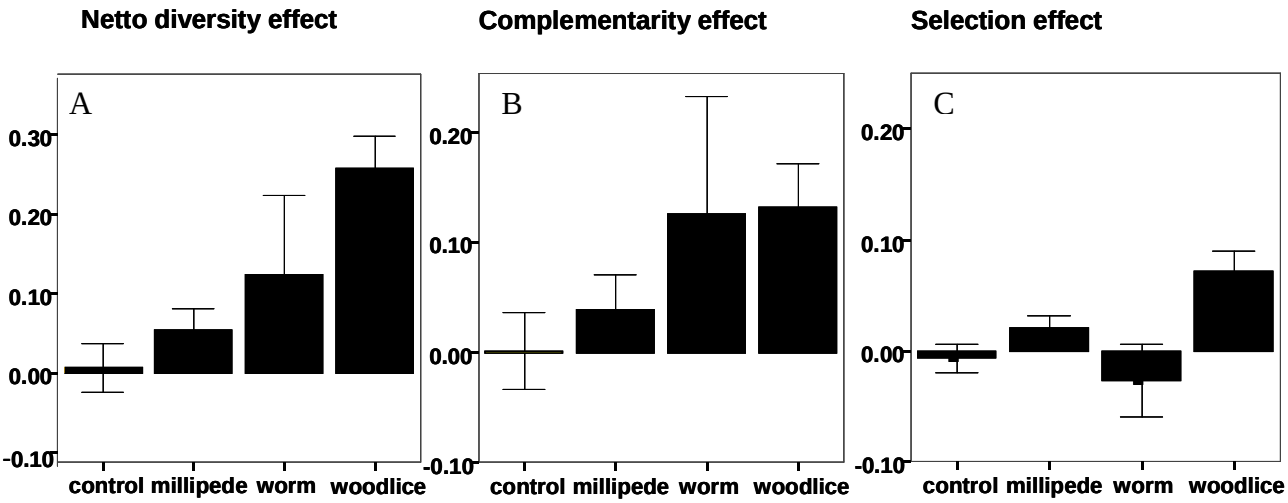

Figure 1. Diversity effects for the different fauna treatments. Shown are the average net diversity effects (A) and its complementarity (B) and selection (C) compartments, of the two and fours litter species mixtures (gram/microcosm). Bars represent mean ± se

2b: Spatial Ecology

Conveners: Judy Shamoun-Baranes (University of Amsterdam)
Frank van Langevelde (Wageningen University)

1. The seasonal and circadian rhythms of terrain-use by African elephants

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Before getting too far into studying the influence of spatial heterogeneity on the movement and distribution of organisms, it is usually necessary to ask: how and why is the landscape heterogeneous? Topography usually has a severe influence on landscape heterogeneity, through influencing broad climatic gradients as well as local gradients in soil moisture and nutrients. In savanna ecosystems with intermediate rainfall, this gives rise to pronounced topo-edaphic vegetation patterns, with relatively open vegetation on sandy soils at the crests of catenas, and more dense vegetation on clay soils containing more nutrients and water in the valleys. Valleys and low-lying parts of the catena therefore have vegetation of higher quality and quantity, remaining green for longer in the dry season, therefore being important for herbivores during the dry season. Furthermore, the more densely vegetated lower parts of the catena may supply shade to heat sensitive animals compared to the more open vegetation on the crest of catenas, so that the vegetation at the lower part of the catena becomes important during times of peak temperature. We therefore set out to test the influence of catenary topography on the spatial distribution of African elephants in a semi-arid savanna ecosystem by testing the hypotheses that elephants (1) move progressively down slope during seasonal dry periods, and (2) move to lower parts of the catena during times of peak temperature (i.e., midday), going back to higher parts of the catena during cooler periods of the day. The results show that elephants organize their use of topographically-mediated environmental gradients around seasonal and circadian rhythms, in ways that are consistent with known eco-physiological processes. In the dry season, and during midday, the elephants preferred to be predominantly at the lower parts of the catena, while being distributed indifferently over the catenary gradient in the wet season and during the night. We conclude that local topography is important in savanna ecosystems, because it interacts with climate to mediate the distribution of nutrients and moisture over the landscape, thereby influencing the patterning and productivity of vegetation, and ultimately affecting the distribution of large herbivores.

2. Visited sites revisited - site fidelity in African elephants

Frank van Langevelde[1], Henjo de Knegt[1], Yolanda Pretorius[1], Fred de Boer[1], Gerrit Gort[2], Andrew Skidmore[3], Rob Slotow[4] and Herbert Prins[1]

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Various reasons exist why animals revisit previously visited sites, ranging from natal experience, breeding philopatry, spatial neophobia, to an increase in foraging efficiency due to renewal of plant material following defoliation. In this presentation, we focus on the patterns of site revisitation by African elephants in Kruger National Park, South Africa, looking at the influence of the two main resources for elephants, vegetation and water, on the patterns of site revisitation. Because surface water varies seasonally, and because vegetation growth is dependent on seasonal rainfall patterns, we analyze the patterns of site revisitation in relation to these resources taking into account seasonality in rainfall. Through analyzing the patterns of site fidelity by elephants in relation to environmental and climatic conditions, we show that elephants do not avoid previously utilized areas but seem to exhibit the tendency to return to sites already visited above what can be expected from random movements alone. Furthermore, the patterns of site fidelity were not solely determined by the preference for certain sites independent of past

experience, as some sites were often visited but not much revisited and others not much visited but often revisited. The elephants were more likely to be site-faithful when surface water became scarce (dry season) and in areas close to water. Although we did not find strong overall differences between male and female elephants, the female elephants seemingly timed revisits to specific sites taking into account the environmental (tree cover and distance to nearest water source) and climatic conditions (rainfall). This might be due to the more stringent requirements regarding the quality of and accessibility of forage regarding the female elephants and the young individuals within family herds, which we hypothesize to increase the incentive to consume the regrowth of vegetation previously been utilized. We conclude that familiarity with specific sites influences the movements and habitat selection by African elephants, patterns of which are mediated by seasonally varying abundance of surface water and growth of vegetation.

3. Can we predict tipping points from spatial patterns?

Ellen Weerman[1,2], Johan van de Koppel[1], Stijn Temmerman[3], Jim van Belzen[1] and Peter Herman[1]

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Recent theory proposes that specific frequency distribution of spatial patches could be used as a signature for discontinuous transitions. Vegetation patches in ecosystems with local-faciliation, change from a power law distribution towards a deviation from a power law distribution when the ecosystem approached a tipping point. We put this theory on a test by analyzing changing spatial diatom patterns. On intertidal flats, each spring spatial patterns develop due to a strong diatom-sediment facilitation and longer range negative feedback. This scale-dependent feedback results in a landscape with diatom covered hummocks alternating with almost bare hollows. This striking landscape of hummocks and hollows disappears rapidly early summer due to a gradual increase in herbivores. There is a strong correlation between sediment bed level and diatom biomass when patterns are intact, indicating the dominance of diatom-sediment feedbacks in generating the patterns. At this stage, patch frequency distributions are strongly curved, reflecting the presence of regular spatial patterns. After a sudden collapse of diatom patterns in early summer, most probably due to grazing disturbance by herbivores, the correlation between sediment bed level and diatom biomass is lost. Despite of the apparent loss of sediment-diatom feedbacks and the resulting spatial self-organization, patch size distribution changes towards a clear power law distribution when patterns have tipped to the bare sediment state. These results indicate that the use of power laws in describing of the state of the ecosystem should be used with care as the presence of power-laws does not indicate the presence local-facilitation or self-organization.

4. Spatio-temporal dynamics of global H5N1 outbreaks match bird migration patterns

Yali, Si[1], Andrew K. Skidmore[1], Tiejun Wang[1], Willem F. de Boer[2], Pravesh Debba[3], Albert G. Toxopeus[1], Lin Li[4], Herbert H.T. Prins[2]

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The global spread of highly pathogenic avian influenza H5N1 in poultry, wild birds and humans, poses a significant pandemic threat and a serious public health risk. An efficient surveillance and disease control system relies on the understanding of the dispersion patterns and spreading mechanisms of the virus. A space-time cluster analysis of H5N1 outbreaks was used to identify spatio-temporal patterns at a global scale and over an extended period of time. Potential mechanisms explaining the spread of the H5N1 virus, and the role of wild birds, were analyzed. Between December 2003 and December 2006, three global epidemic phases of H5N1 influenza were identified. These H5N1 outbreaks

showed a clear seasonal pattern, with a high density of outbreaks in winter and early spring (i.e., October to March). In phase I and II only the East Asia Australian flyway was affected. During phase III, the H5N1 viruses started to appear in four other flyways: the Central Asian flyway, the Black Sea Mediterranean flyway, the East Atlantic flyway and the East Africa West Asian flyway, respectively. Six disease cluster patterns along these flyways were found to be associated with the seasonal migration of wild birds. The spread of the H5N1 virus, as demonstrated by the space-time clusters, was associated with the patterns of migration of wild birds. Wild birds may therefore play an important role in the spread of H5N1 over long distances. Disease clusters were also detected at sites where wild birds are known to overwinter and at times when migratory birds were present. This leads to the suggestion that wild birds may also be involved in spreading the H5N1 virus over short distances.

5. Using a flexible GPS tracking system to study gull movement at different scales

Judy Shamoun-Baranes[1], Willem Bouten[1], Edwin Baaij[2], Kees Camphuysen[3] and Emiel van Loon[1]

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Using a flexible GPS tracking system, recently developed at the Universiteit van Amsterdam, we monitored the movements of lesser black backed gulls breeding on Texel, in the Netherlands in 2008 and 2009. The tracking system includes 14-22 gram GPS tags including an accelerometer and a battery recharged with solar energy, a base and relay stations for wireless data download and program transmission and data processing software. The birds were tracked for several weeks to over a year. Locations were collected at different time intervals ranging from once every 15 minutes to once every 3 seconds. We show some examples of what high resolution data can reveal about the spatial ecology of lesser black backed gulls. With hundreds of fixes per day we can answer questions about foraging areas, time budgets, flight strategies, individual preferences and variability in behavior. We also show some striking differences and similarities in foraging movements during the breeding season and migration. High resolution precision tracking provides great opportunities for ecological research, enabling the analysis of movement and spatial patterns at different scales.

6. Oystercatchers on Schiermonnikoog: social prisoners forever?

Bruno J. Ens[1] and Willem Bouten[2]

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Oystercatchers breeding on the saltmarsh of Schiermonnikoog are a prime example of a despotic distribution. So-called "residents" occupy territories of high quality (where they can lead the chicks to the food), whereas "leapfrogs" occupy territories of low quality (where the birds are forced to transport all food from the tidal flats to the chicks). The queue hypothesis explains why so many individuals settle in territories of poor quality. To test the queue hypothesis we continued the population study, which is now entering its 27th year. The original queue hypothesis assumed no differences between individuals, but there is now ample evidence for such differences, which have been incorporated in a modified queue model. The career decisions of the Oystercatcher have even entered a recent debate in Nature on the evolution of animal personalities. In this talk we will highlight the outstanding questions and discuss the potential of GPS-transmitters developed by the UvA to help answer these questions.

2c: Community Ecology

Conveners: Elisa Thebault (Wageningenn University)
Maarten Schrama (University of Groningen)

1. Disentangling drivers of *Jacobaea vulgaris* population dynamics during secondary succession

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*Jacobaea vulgaris (*Jakobskruiskruid*; Senecio jacobaea*)*,* is an early successional plant species that can become very dominant and is considered a problem weed in the Netherlands and many other countries. *J. vulgaris* abundance typically increases during the first years after cessation of agriculture, but this increase is followed by a decline as secondary succession proceeds. We hypothesized that the population dynamics of this plant species during secondary succession is driven by interactions of the plant with soil organisms and the abiotic environment, but that also changes in plant performance are important e.g. germination. Also, we hypothesized that the strength and the importance of these drivers changes during succession.

We studied *J. vulgaris* in a chronosequence of ex-arable fields at the Veluwe at fields that were between 2 and 25 years old. In each field we recorded the *J. vulgaris* abundance, abiotic soil conditions, the composition of the soil nematode and fungal community and conducted vegetation surveys. We also determined plant characteristics as germination potential, establishment rates and presence in the soil seed bank. In addition, we tested the soil-feedback of *J. vulgaris* in soils from the chronosequence fields.

We will show that a combination of these drivers determines *J. vulgaris* population dynamics during secondary succession and we will discuss the importance of these findings for invasion and restoration ecology.

2. Food web succession on the salt marsh

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One of the central issues in ecology is how ecological forces shape communities. Both succession ecology and food web ecology have generated many insights on this topic. On the one hand, succession ecology has approached changes in ecosystems over time as a plant-driven process in which focus was on colonization, facilitation, competition and inhibition as driving forces within this one trophic level. Other trophic levels have long been assumed resultants of plant driven succession. On the other hand, food web ecologists have generally treated ecological communities as static entities in which plants were just one of the trophic levels. It has generated many important findings on how species in different trophic levels can form stable, complex networks.

However, communities in succession are not static by definition. Therefore, how can we understand ecological communities to be regulated by higher tropic levels when all successional changes are driven by plants? To answer this pressing question about which trophic level is driving the different succession stages, a more integrated food web – succession ecology approach is needed.

In this study we present results from a detailed analysis of food web assembly over 100 years of salt marsh succession. We performed a complete analysis of biomass of all trophic groups and diversity in all succession stages, both above and below ground.
We find strong changes from an externally fuelled, decomposer-based food web to a more plant-based, herbivore-driven food web in intermediate succession stages. Towards the late successional stages, the herbivore-based food web gradually changes again towards a decomposer-based food web, which now relies on terrestrially produced detritus towards the climax stage. Furthermore, above ground species diversity reaches

an optimum in intermediate succession, in contrast to below ground diversity, which increases in biomass and diversity towards climax stage.

Our results clearly indicate that different trophic levels can act on succession, which has important consequences for our understanding of how succession is regulated by food webs dynamics.

3. Different patterns of within-community trait similarity between co-occurring grasses and grasshoppers

Fons van der Plas

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Inspired by MacArthur and Levin's notion of 'limiting similarity', several studies have investigated how community assembly acts upon the similarity of functional trait values of co-occurring species. The development of null-models or 'random communities' for studying trait similarity has facilitated this research. Based on such null-models, some studies reported higher and some lower trait similarity in observed communities when compared to 'random' communities. However, the causes of this so-called trait over- and underdispersion are still poorly understood. Current community assembly theory suggests that two main processes act upon the functional diversity of communities: abiotic filtering is expected to decrease trait dispersion, while biotic filters (as resource competition) are expected to increase it. Previous studies showed that the importance of these different classes change over environmental gradients. In addition to this, we hypothesize that their importance may also differ between trophic levels. Abiotic conditions may be important for the community assembly of some trophic levels, but not for others. Furthermore, the strength and direction of trophic interactions and the habitat creating properties of species and communities will determine whether or not trait dispersion patterns of one trophic level are imprinted on an adjacent trophic level.

To test this, we measured the range and spacing of within-community functional trait values of both grasses and grasshoppers over main environmental gradients in a South-African savanna ecosystem. In 51 plots varying in rainfall and fire frequency, we measured three traits of in total 51 grass species and eight traits for in total 61 grasshopper species.

Across the whole study area, both grass- and grasshopper traits were underdispersed. However, within the study area, similarity of grass trait values within communities did not change over environmental gradients and explained little variation in grasshopper traits. In contrast, for grasshoppers, trait similarity decreased from dry to wet areas.
These findings suggest that both for grasses and grasshoppers abiotic filtering are important in structuring communities. However, the lack of imprinting of trait similarity patterns between these guilds suggests that the nature of this filtering differs between trophic levels.

4. Structure and stability of interaction webs : what are the differences between mutualistic and trophic networks?

Elisa Thébault[1,2] and Colin Fontaine[1]

[1]NERC Centre for Population Biology, Imperial College London, Silwood Park, UK. [2]Biometris, Wageningen University, the Netherlands

Understanding which structures and processes contribute to biodiversity persistence in ecological communities is a major issue for both ecological theory and ecosystem conservation. In natural communities, the organization of interactions between species often presents non-random patterns at the origin of complex network architectures. There is growing evidence that some of these non-random patterns can enhance the long-term species coexistence and stability. Moreover, few recent studies have highlighted structural differences between networks depending on the type of ecological interaction involved, i.e. mutualistic or trophic.

These findings raise the following questions: (i) To what extent the structure of ecological networks differs depending on the type of interaction considered? (ii) How are community persistence and stability affected by these different structures? (iii) Does the type of ecological interaction involved affect the relationship between network structure and its persistence and stability? We address these questions by using both a theoretical approach with two dynamical models of mutualistic and trophic networks, and a comparative network approach on 57 empirical datasets describing plant-pollinator and plant-herbivore communities.

Our theoretical analysis shows that in mutualistic networks, both low modularity and high connectance promote stability. The complete opposite pattern is observed in trophic networks where low nestedness and low connectance enhance stability. These theoretical predictions are supported by the results of our comparative approach: pollination networks appear more connected, more nested and less modular than herbivory networks. Each of these two kinds of networks thus exhibits the architectural features that are predicted to favor their stability.

5. A simple generalisation of neutral biodiversity theory resolves many of its problems

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We present a generalisation of Hubbell's Unified Neutral Theory of Biodiversity and Biogeography. The original neutral model has demonstrated its ability to reproduce many widespread ecological patterns such as locally sampled species abundance distributions and species area curves, but it has mostly failed to combine this with convincing timescales for the turnover of species amongst other things. Our new model is simple enough to remain tractable, both analytically and computationally. We show that it resolves several timescale related problems without sacrificing any of the existing achievements of the original model. Neutral theory can thus be defended against many long-standing criticisms and now makes new predictions about species abundance distributions at large scales.

6. Linking habitat associations and spatial scales to the spatial patterns in tropical trees

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A powerful explanation for the coexistence of the high species diversity in the tropical forest is niche theory, which argues that species adaptation to specific conditions allows species to distribute along gradients. There is ample evidence of species-specific variation in niches. However, the strength of the associations as well as the factors are inconsistent. Published studies of habitat association in tropical forest trees show highly variable results. To discriminate between the variables that determine habitat associations of tree species in the tropical forest, it is critical to study the effects of environmental factors at scales relevant to the species-specific distribution. We studied the effect of sampling scale on the detection of habitat associations for a number of tree species in a tropical moist forest (Barro Colorado Island - Panama). We used aerial photographs to measure the spatial distribution of six tree species across the entire 1600-ha island. Then, we determined how well five environmental factors explained the spatial distribution for subsamples of this distribution that ranged in spatial scale from 25 to 1600 ha. We found high variation in the type and strength of the associations with most of the environmental factors among and within the subsamples of different spatial scales

2d: Evolutionary Ecology

Conveners: Bas Ibelings (Netherlands Institute of Ecology)
Ken Kraaijeveld (Leiden University)

1. *Daphnia*-parasite interactions in a dynamic environment

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Fast evolving parasites are a key structuring force in host ecosystems, more in particular in changing the biodiversity of host communities. We are interested in the interaction between parasites and host communities and this in two opposite directions: the effect of these interactions on the host community and the effect of the host community on these host-parasite interactions. It has been shown that parasites reduce populations of the zooplankter *Daphnia* and that this is *Daphnia* species dependent. A crucial factor in this structuring is the density dependent horizontal transmission of most *Daphnia* parasites. As such, strong competitive species, but highly vulnerable to parasites, such as *Daphnia magna*, may lose their competitive strength under high parasite pressure. Our hypothesis is that parasites may influence competition between *Daphnia* species in a zooplankton community resulting in strong dynamic patterns. We further investigate whether the *Daphnia*-parasite interactions are influenced by the larger biotic community in which the interaction takes place. Natural *Daphnia* communities are organized as a connection of locally adapted populations with their own genetic identity. We thus also investigate if regional dynamics influence local *Daphnia*-parasite interactions, and this from a community perspective.

2. Evolutionary Community Ecology of host-parasite-parasitoid systems: associations between community structure and evolutionary traits

Saleta Perez Vila[1], Bregje Wertheim[1], Rampal Etienne[2], Han Olff[2], Leo W. Beukeboom[1]
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Despite biodiversity being considered the outcome of ecological interactions between species and evolutionary processes it has mainly been studied either from an ecological or from an evolutionary point of view. We aim to integrate those two fields at the community level by studying evolutionary and ecological processes that shape host-parasitoid communities in parasitoid wasps that parasitize flies which are the parasites of bird chicks in nests. Insect parasites and parasitoids are involved in an arms race of adaptation and counter-adaptation with their hosts. This results in narrow niches for the parasitoids/parasites and rapid co-evolution. We study traits relevant to the community properties, that are involved in the interactions between species (competition and fitness), and compare them between different equivalent communities with different characteristics (species numbers and relative abundances). Some of the questions addressed are: How much niche differentiation exists between species and what are their host preferences? How much competition occurs between and within parasitoid species of the community? How much does co-evolution restrict niche widths? To what extent have adaptations evolved to prevent species hybridization? How is speciation affected by stochasticity? Is there more speciation in the neartic compared to the paleartic zone, and if so, why? Answering those questions require knowledge on each community network and experiments to understand the interplay between community and species traits. We use empirical observations, natural and laboratory experiments and mathematical modeling. I will present the analysis of one of the communities to understand how species are interacting with each other in this three-trophic community.

3. Lack of lipogenesis: the evolutionary consequence of a parasitoid life style?

Bertanne Visser, Cécile Le Lann, Frank J. den Blanken, Jeffrey A. Harvey, Jacques J. M. van Alphen and Jacintha Ellers

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Nutrition plays an essential role in maintaining sufficient energy levels needed for growth, reproduction and survival. Lipids are one of the most important long-term energy sources and metabolic pathways involved in lipogenesis are highly conserved throughout the animal kingdom. Remarkably, however, several parasitoid species have been found to deviate from this general metabolic model. These parasitoids are unable to synthesize lipids as adults and obtain their lipids during the larval stage, presumably through intense host manipulation, in which nutrients, including lipids, are synthesized by the host to benefit the parasitoid. In this study, we test the hypothesis that the evolution of lack of lipogenesis is concurrent with a parasitic larval lifestyle within the insects. We have tested 24 parasitoid species from different orders for lack of lipogenesis and collected data from existing literature on other insect species. We find that lack of lipogenesis is confined to parasitoids, and has evolved independently several times in hymenopteran, dipteran and coleopteran parasitoids. However, a small number of parasitoid species was found to be able to synthesize lipids. We propose a hypothesis as to why some parasitoid species have retained lipogenesis and discuss the ecological consequences for those who have not.

4. Reproductive strategies of Amazonian poison frogs.

Erik H. Poelman

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Amazonian poison frogs are well known for their divers reproductive strategies with elaborate parental care by one or both parents. These tiny frogs use small resource limited water bodies in leaf axils of plants as offspring rearing sites and some species provision their offspring with nutritive eggs. The diversification of reproductive strategies with different modes of parental care may have evolved by the use of different sizes of water bodies as offspring rearing sites.

The size of water bodies correlates with increased nutrients, but also increased presence of predators. These trade-offs may have directed evolution of reproductive strategies by frogs: those species that use small water bodies have female parental care in which females bring nutritive eggs to their offspring (low nutrients, but no predation). Species using larger water bodies have male parental care, without food provisioning (high nutrients, but also predation risk). Species that use intermediately sized water bodies may provide evidence on a transition from male parental care to female involvement in parental care.

I found that one of those species plastically provisions its offspring when conditions in water bodies become less favourable for offspring and present data on its reproductive strategies.

5. Local adaptation of bacteriophages to their bacterial hosts in soil

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Adaptation to local environmental conditions is crucial to the evolution and distribution of biodiversity. Parasites are thought to be responsible for intense and spatially varying selection pressures on their hosts, and vice-versa. Despite evidence for host and parasite local adaptation in a range of taxa, very little is known to date about this process in natural communities of the most abundant organisms on the planet: bacteria and their parasitic viruses (bacteriophages; phages). We measured local adaptation of *Stenotrophomonas* bacteria and their associated phages in soil, by collecting soil samples from two 25 x 25 cm grids, taking 5 x 5 evenly spaced soil cores (1 cm diam.) from each grid. We isolated 24 bacterial clones as well as a suspension of the total bacteriophage population from every sample. A large proportion of bacteria (33-40%) was found to be

susceptible to phage originating from the same population. Phages were significantly more infective to bacteria from the same sample than to bacteria from other samples. No correlation existed between the degree of local adaptation and distance between samples indicating that local adaptation occurs at a scale of centimetres or less. Our results demonstrate that natural selection, rather than neutral forces, plays a crucial role in shaping the small-scale spatial structuring of phage- and bacterial genetic diversity in this highly structured soil environment. Furthermore, our data are consistent with bacteria and phage undergoing rapid antagonistic coevolution. Such coevolution will have important consequences for population dynamics and life history evolution, and indirectly must affect microbial communities as a whole.

6. Herbivorous insects on introduced plants, a review of the enemy release hypothesis.

Kim Meijer

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The ERH (enemy release hypothesis) states that introduced species have a fitness benefit over native species, due to the 'escape' from their natural enemies, like predators, parasites and herbivores. In the past few decades many studies have been publishes testing the ERH in introduced plants in relation to herbivorous insects. Many different approaches have been used, often with conflicting results. Here I will present a review of these studies, compare the different methods, and give an overview of the conclusions.

Session 3

3a: Global biogeochemical cycles

Conveners: Claire Evans (Royal Netherlands Institute for Sea Research)
Elmar Veenendaal (Wageningen University)

1. Linking Hydrology and Biogeochemistry at Multiple Spatial and Temporal Scales

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Until recently, it has been challenging to couple hydrologic and biogeochemical processes at the watershed scale. We have coupled two models, WTB and MEL, to simulate lateral water and nutrient fluxes and their influence on ecosystem functioning. WTB is a spatially explicit water balance model. Vertical flow was simulated using a capacitance model with lateral flow dependent on head development and the local slope of the confining layer. The Multiple Element Limitation (MEL) model is an ecosystem model, developed to examine limitation in vegetation acclimating to changes in the availability of two resources (carbon and nitrogen). MEL also incorporates the recycling of resources through the soil. In our coupled model, nutrients are treated as inert solutes and are transported vertically as well as laterally using a mixing model. Nutrients moving down the slope are repeatedly taken up, cycled through vegetation and soils, and released back into the soil solution.

We evaluated the impact of adding lateral nutrient fluxes to the original MEL model using a virtual experiment. The model (coupled and MEL only) was applied to a small, well-defined catchment. After a simulation period of three years, we detect a redistribution of the stock of inorganic N. A larger amount of N is present near the river than at the top of the slopes of the catchment, largely due to lateral fluxes. Comparing the coupled model to the MEL model, we also find large losses of inorganic N in the coupled model due to large vertical fluxes out of the rootzone. These vertical out-fluxes cause a smaller N uptake by plants. To detect if Carbon (C) uptake by plants is affected due to the changes in N distribution, the simulation period has to be increased due to a lagtime in the optimization of the C:N ratio in plant biomass.

2. The North Sea Carbonate System in Summer

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Coastal regions represent the transition between terrestrial and oceanic environments and are such areas of complex biogeochemical relations. The North Sea is one such coastal region, which has been shown in summer to be a highly effective carbon pump (Bozec et al., 2005). Three late summer cruises and 3 more seasonal cruises took place from 2001-2008 to allow the carbonate system to be investigated throughout the year and on an inter-annual basis. In summer, the deeper northern region of the North Sea expresses oceanic like behaviour, with strong stratification and a large net community production. The southern region however, is much shallower with a net autotrophic community. In the south, the constantly well-mixed water column enables a high rate of remineralization leading to higher pCO_2 values and lower pH. High CO_2 concentrations at this time of year may be partly compensated by anaerobic alkalinity generation. The anaerobic degradation of organic matter in coastal sediments in the southern region irreversibly generates alkalinity, which could potentially increase the buffering capacity of the North Sea by as much as 20-25% (Thomas et al., 2009).

3. Carbon fluxes in natural plankton communities under elevated CO_2 levels: a stable isotope labeling study

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The potential impact of rising carbon dioxide (CO_2) on carbon fluxes in natural plankton communities was investigated during the 2005 PeECEIII mesocosm study in Bergen, Norway. Triplicate mesocosms, in which a phytoplankton bloom was induced by nutrient addition, were incubated with 1x (~350 *µ*atm), 2x (~700 *µ*atm), and 3x present day CO_2 (~1050 *µ*atm) levels for 3 weeks. ^{13}C labeled bicarbonate was added to all mesocosms to follow the transfer of carbon from dissolved inorganic carbon (DIC) into phytoplankton and subsequently heterotrophic bacteria, zooplankton, and settling particles. Isotope ratios of polar lipid fatty acids (PLFA) were used to infer the biomass and production of phytoplankton and bacteria. Phytoplankton PLFA were enriched within one day after label addition, while it took another 3 days before bacteria showed substantial enrichment. Group-specific primary production measurements revealed that coccolithophores grew faster than green algae and diatoms. Elevated CO_2 had a significant positive effect on post-bloom biomass of green algae, diatoms, and bacteria. A simple model based on measured isotope ratios of phytoplankton and bacteria revealed that CO_2 had no significant effect on the carbon transfer efficiency from phytoplankton to bacteria. There was no indication of enhanced settling based on isotope mixing models during the phytoplankton bloom. Our results suggest that CO_2 effects are most pronounced in the post-bloom phase, under nutrient limitation.

4. Shrub expansion may reduce summer permafrost thaw in Siberian tundra

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Climate change is expected to cause extensive vegetation changes in the Arctic: deciduous shrubs are already expanding, in response to climate warming. The results from transect studies suggest that increasing shrub cover will impact significantly on the surface energy balance. However, little is known about the direct effects of shrub cover on permafrost thaw during summer. We experimentally quantified the influence of *Betula nana* cover on permafrost thaw in a moist tundra site in northeast Siberia with continuous permafrost. We measured the thaw depth of the soil, also called the active layer thickness (ALT), ground heat flux and net radiation in 10m-diameter plots with natural *B. nana* cover (control plots) and in plots in which *B. nana* was removed (removal plots). Removal of *B. nana* increased ALT by 9% on average late in the growing season, compared with controls plots. Differences in ALT correlated well with differences in ground heat flux between the control plots and *B. nana* removal plots. In the undisturbed control plots, we found an inverse correlation between *B. nana* cover and late-growing-season ALT. These results suggest that the expected expansion of deciduous shrubs in the Arctic region, triggered by climate warming, may reduce summer permafrost thaw. Increased shrub growth may thus partially offset further permafrost degradation by future temperature increases. Permafrost models need to include a dynamic vegetation component to accurately predict future permafrost thaw.

5. Dissolved organic matter uptake by temperate macrophytes

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Ecosystems dominated by seagrasses often exhibit low inorganic nitrogen concentrations. Given the high productivity in these systems, recycling of nitrogen is expected to be high. We investigated the use of inorganic and organic nitrogen compounds by co-occuring primary producers in a temperate macrophyte-dominated (seagrasses: Zostera noltii, Cymodocea nodosa, and macroalga: Caulerpa prolifera) system. Using dual isotope labeling (^{13}C and ^{15}N) uptake of substrates with different molecular structure and complexity by phytoplankton, planktonic bacteria, epiphytes, seagrasses, and macroalgae were quantified in field incubations. Phytoplankton was by far the largest nitrogen sink, followed by the epiphytic community. In contrast, the seagrasses and Caulerpa prolifera dominated carbon fixation. NH_4^+ was usually preferred over NO_3^- and urea, particularly by the seagrasses. Specific uptake rates of nitrogen from individual amino acids were inversely proportional to their C/N-ratio and structural complexity (glycine > L-leucine > L-phenylalanine). In addition, biomarker-specific measurements (polar lipid-derived fatty acids and D-alanine) indicated an increasing bacterial contribution to nitrogen uptake with increasing amino acids complexity. Algae derived DON was taken up to a larger extent than bacteria derived nitrogen, indicating the importance of the source to DON utilization. All primary producers acquired nitrogen derived from the algae-derived DOM, but the DOC was almost exclusively used by the planktonic biota. Our results illustrate that (1) dissolved organic nitrogen plays an important nutritional role in seagrass meadows, (2) phytoplankton in seagrass meadows is a major sink for dissolved nitrogen at short time scales, and (3) organic nitrogen and carbon dynamics are largely uncoupled and should be investigated as such.

6. Marine viruses: biogeochemically significant?

Claire Evans

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Viruses are the most abundant biological entities in the ocean with literally millions in every teaspoon of seawater. These minute parasites infect and kill both phytoplankton and bacteria and microbial death due to viral lysis can equal or exceed mortality due to grazing. Viral infection causes physiological and biochemical changes within host cells culminating in their lysis and release of their contents, including progeny viruses, to the water column. The precise mode of microbial death has implications for the ecology and biogeochemistry of our oceans and using case studies a number of these will be highlighted. Interactions of the microbial web are known to impact on the production of climate-relevant compounds including the trace gas dimethyl sulphide (DMS). Experiments indicate that viral infection is quantitatively far less significant than microzooplankton grazing on the release of DMS from algae. As DMS is the main form of sulfur fluxing from the oceans to the atmosphere, increased lysis may reduce sulfur transfer. Viral infection may also have consequences for the health of food webs. Phytoplankton are the main source of polyunsaturated fatty acids (PUFAs) to higher trophic levels and these compounds are essential for the health and reproduction of many organisms. Virally infected phytoplankton exhibit significantly altered fatty acid profiles with a decrease in PUFAs. This in combination with the fact that grazers have been shown to preferentially select for virally-infected cells, indicates that viral infection could reduce the amount of PUFAs passed to higher trophic levels, which could impact on ecosystem health. Measurements of viral activity in seawater indicate that significant fractions of microbial biomass may be lysed by viruses on a daily basis. Thus viral activity may be an important factor driving the biogeochemistry of our planet.

3b: Free Session

Convener: Claudius van de Vijver (Wageningen University)

1. Evidence of the 'plant economics spectrum' in a subarctic flora

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1. A fundamental trade-off among vascular plants between traits inferring rapid resource acquisition and those leading to conservation of resources has now been accepted broadly, but is based on empirical data with a strong bias towards leaf traits. Here, we test whether interspecific variation in traits of different plant organs obeys this same trade-off and whether within-plant trade-offs are consistent between organs.
2. Thereto, we measured suites of the same chemical and structural traits from the main vegetative organs for a species set representing aquatic, riparian and terrestrial environments including the main vascular higher taxa and growth forms of a subarctic flora. The traits were chosen to have consistent relevance for plant defence and growth across organs and environments: carbon, nitrogen, phosphorus, lignin, dry matter content, pH.
3. Our analysis shows several new trait correlations across leaves, stems and roots and a striking pattern of whole-plant integrative resource economy, leading to tight correspondence between the local leaf economics spectrum and the root ($r = 0.64$), stem($r = 0.78$) and whole-plant ($r = 0.93$) economics spectra.
4. Synthesis. Our findings strongly suggest that plant resource economics is consistent across species' organs in a subarctic flora. We provide thus the first evidence for a 'plant economics spectrum' closely related to the local subarctic 'leaf economics spectrum'. Extending that concept to other biomes is, however, necessary before any generalization might be made. In a world facing rapid vegetation change, these results nevertheless bear considerable prospects of predicting belowground plant functions from the above-ground components alone.

2. Photoacclimation in marine picophytoplankton: growth and primary production under constant and dynamic irradiance conditions

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Phytoplankton irradiance exposure (intensity and spectral composition) is strongly influenced by physical processes in the ocean. Stratification traps phytoplankton in the upper water layer, thereby enhancing ultraviolet radiation (UVR: 280-400 nm) and excessive photosynthetically active radiation (PAR: 400-700 nm) exposure. In contrast, deep vertical mixing leads to low mean irradiance levels. It is expected that climate change affects the onset and break-up of stratification in temperate and warm-temperate oceanic regions. Because phytoplankton productivity provides the basis of open ocean ecosystems and, moreover, a feedback for anthropogenic carbon emissions it is essential to understand how stratification and mixing affects phytoplankton performance.

In a set of laboratory experiments different picophytoplankton species, including the key oceanic species *Prochlorococcus spp.* and *Synechococcus spp.*, were exposed to several irradiance regimes mimicking stratification and vertical mixing in the water column. Photoacclimation of the species was followed by growth and pigment analysis. Additionally, primary production measurements were performed. Results show differences between eukaryotic and prokaryotic species, as well as difference between stratified and mixed irradiance conditions. This research aims to contribute to the understanding of how mixed layer dynamics structure oceanic phytoplankton productivity and species composition.

3. Contemporary pollen dispersal in wild carrot (*Daucus carota* L. ssp. *carota*) population

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Wild carrot, also known as Queen Anne's lace, is native to temperate regions of Europe and western Asia, and has been introduced into America, New Zealand, Australia and Japan. Wild carrot is the ancestor of cultivated carrot and the most important gene pool for carrot breeding. As they belong to the same species *Daucus carota* they can easily hybridize with apparently no crossing barrier. Spontaneous hybridization between wild carrot and earlier yellow- and white-rooted cultivated carrots is supposed to be involved in the origin of western, orange-rooted carrots. It is well known that pollen dispersal from adjacent wild carrots may lead to the 'contamination' of commercial seeds in cultivated carrot fields. On the other hand, Wijnheijmer et al. (1989) found that wild carrots adjacent to Dutch seed production fields of cultivated carrot were intermediate to typical wild and cultivated carrots suggesting a high frequency of gene flow from cultivated to wild carrots. Genetically modified (GM) carrots have been developed with antifungal activities, herbicide and salt tolerance, increased nutritional benefits and are also used for the production of drugs. Although no GM carrot has the permission for commercialization at the moment, it may be released into the environment in the near future. To assess the risks of transgene introgression, the contemporary gene flow pattern by pollen dispersal is essential for tracing the dynamics of transgenes in wild populations. For establishing an isolation distance to minimize the level of transgene escape into wild populations or possible 'contamination' from wild relatives in cultivar seed production fields, we need to know how far pollen travels. In our study, we used a method developed by Robledo-Arnuncio et al. (2006) to indirectly estimate the contemporary pollen dispersal from mother-offspring data based on a normalized measure of correlated paternity between the offspring of mother plants with different spatial distances. According to the data from 4 microsatellite loci of 437 wild carrot offspring and 20 mother plants from Meijendel, the correlation of paternity among sibships among mother plants decreased significantly (Spearman's rank correlation coefficient $r_s = -0.613$, $n = 190$, $P < 0.001$) with increasing distance between mother plants. Within the sampling scale (< 210 m) the pollen dispersal by insects follows an exponential distribution pattern with a standard deviation of 36 m. It shows that, to reduce the unwanted pollen-mediated gene flow (e.g. transgene flow) to less than 1% between carrot fields and wild carrots, an isolation distance of more than 139 m is required. Compared to the historical gene dispersal estimated by spatial genetic structure analysis in the same population (σ_g = 9 m with 95% confidence interval ranging from 3 to 25 m), our results suggest that seed dispersal may be very restricted in wild carrot populations. The weak spatial genetic structures in wild carrot may be the result of high outcrossing (about 96%), restricted seed dispersal and relatively long distance pollen dispersal within populations.

4. Cascading effect of elephants on bird species richness in Southern Africa

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Elephants (Loxodonta africana) have a large impact on the vegetation structure and tree density by breaking off branches, and felling trees. Several studies have documented the negative effect of elephants on vegetation cover, but few studies have focused on the cascading effect of these ecological engineers. We studied the influence of elephants on different bird species guilds on a large scale, using bird atlas data from Namibia, South Africa and Zimbabwe. We expected different outcomes for different bird guilds: the decrease in tree density by elephants would have a positive effect on savanna bird species, whereas dense woodland dependent bird species and large tree nesting bird species are expected to be negatively affected. For the cavity breeding species a unimodal relationship was expected. In relation to the birds' diet composition we expected no effect of elephants on specialists like frugivores and generalists as insectivores and granivores. We tested for the effects of elephant occurrence and density

on the bird species richness by combining data from the Southern African Bird Atlas Project and the African Elephant Database, correcting for the influence of other environmental variables (e.g., tree cover, or rainfall). We found that elephants at low density have an indirect positive effect on the total number of bird species and on the number of cavity breeding bird species. When elephant densities were above a certain threshold, the total number of bird species and the number of cavity breeding bird species decreased. Increasing elephant densities increased the number of insectivorous bird species. Hence, elephants affect the different savanna birds species differentially, and thereby generate important cascading effects in savanna communities

5. The impact of different termites on soil fertility and vegetation in an African savanna

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Savannas are heterogeneous across a range of spatial and temporal scales. At the landscape scale abiotic and biotic processes interact to structure a heterogeneous template, characteristically producing a patchy nutrient distribution with areas of nutrient enhancement and nutrient depletion. We investigated the implications of these patterns of nutrient patchiness produced by an important biotic engineer. We hypothesised that termites create conditions that facilitate the creation of grazing lawns, but that not all termites are equal. To test this we focused on the indirect effects of termite mound soils, from three termite genera (*Macrotermes, Odontotermes* and *Trinervitermes*), on lawn and bunch grass resources. We conducted a greenhouse experiment to test how the different termite-modified mound soils affected the growth of a dominant lawn grass (*Digitaria longiflora*) and a dominant bunch grass (*Sporobolus pyramidalis*). Secondly, we conducted a field experiment to test whether any effects seen in the greenhouse experiment could be replicated under field conditions by spreading termite modified mound soils over 4x4m cut grass plots. In the greenhouse experiment we found that the highest quality and biomass of grass, of both species, occurred on the termite soils with highest P and K levels. However in the field experiment we found that after application of termite soils the largest change in species composition, dominant grass type and biomass occurred where soil with the highest Na level was applied. We propose that this disparity of results occurs due to the interaction with large herbivores in the field. Herbivores are Na limited in savannahs and are attracted to high Na areas. Here they consume more biomass, promoting the increased coverage of grazing tolerant lawn grass species and stimulating more lawn grass growth. This in turn creates a feedback with increased nutrient availability from dung and urine deposition. We show that termite activities create variation or patchiness nutrient resources and therefore in grass types. Also that the type and scale of effect varies with termite genera, plant species competition and with interaction with herbivores.

6. Early-life drought tolerance codetermines distribution patterns in vascular epiphytes

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Germination and seedling performance may set the limits for plant distributions, particularly in stressful habitats. In the epiphytic habitat, plants are frequently exposed to severe drought, especially in dry regions and at exposed microsites. Larger epiphytes may endure dry periods using stored water or CAM photosynthesis, but during germination and for seedlings other adaptations must prevail. Seedlings may avoid drought stress by germinating only during wet spells, or they may tolerate it. Seeing the predictable shortness of wet spells for epiphytes, especially those from dry or exposed sites, we hypothesise that these plants have a tolerance rather than an avoidance strategy.

Within forests, the strong vertical gradients in light, humidity and temperature fluctuations may explain the typical vertical segregation of species. Between forests, precipitation and temperature probably set species distribution limits. We studied germination requirements and seedling drought tolerance of epiphytic bromeliads as a potential explanation for their distributional patterns along these two gradients: vertical within a forest and horizontal at a broader geographical scale.

Germination responses largely matched moisture conditions in the natural ranges of distribution: species from the outer canopy and from dry regions germinated at lower water availability than species from the moist forest understory. Germination did not respond to light conditions, and there were no consistent species differences in the temperature response. A clear stress-tolerance strategy was found in *Tillandsia flexuosa*, a species from dry forests, where seedling growth was studied as well as germination (Bader et al. 2009). Moderately high water supply increased growth, but after a 3-week drought treatment, the previously well-watered seedlings lost their growth advantage compared to drought-hardened seedlings. Similar drought hardening may be expected in other exposed epiphytic growing sites, where species showed a high drought tolerance at least in germination. In species from moister microsites germination requires more moisture, which may exclude these species from the higher forest strata and dryer regions. This is thus a very early filter determining distributional limits.

3c: Genetics of stress tolerance

Conveners: Eric Schranz (University of Amsterdam)
Thierry Janssens (Vrije Universiteit)

1. Submergence Tolerance in *Arabidopsis* and the Related Genus *Rorippa*(Yellow cress)

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Many crop and wild species are severely stressed by seasonal floods, because decreased light and gas diffusion repress photosynthesis and aerobic respiration. We have studied both the physiological and molecular responses to flooding in *Rorippa amphibia* and *R. sylvestris* (Brassicaceae), two species found along European rivers with different flooding regimes. The two species have a relatively high tolerance for flooding, showing almost no mortality after 40 days of complete submergence, with *R. sylvestris* surviving up to 3 months. The increased tolerance of *R. sylvestris* is due to a "quiescence strategy" in which growth is restricted during submergence. In contrast, *R. amphibian* adopts an "avoidance strategy", defined by prolonged stem elongation in an attempt to reach the water surface to re-establish air contact. This can then supply the rest of the plant with sufficient amounts of oxygen leading to increased survival. Consistent with the avoidance strategy of *R. amphibia*, levels of fermentation products were higher and we found increased gene expression in the anaerobic pathway to fuel its higher growth rate. We are also studying the ethylene-signaling pathway that controls anoxia responses. We are both measuring ethylene production using a trace-gas facility as well as by cloning the ethylene response factor genes (ERFs), known to play a major role in submergence responses in rice. Finally, submergence survival quantitative trait loci (QTL) analysis using Arabidopsis recombinant inbred lines is underway. The close relationship of Arabidiopsis and *Rorippa* will facilitate candidate gene identification for further study in *Rorippa*.

2. Transcriptional regulation and the microevolution *Orchesella cincta* cadmium tolerance

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Strong evidence exists for adaptation to elevated levels of environmental cadmium, in populations of the soil arthropod *O. cincta* from historically contaminated sites. This tolerance correlates with heritable increase in metal excretion efficiency, less pronounced cadmium-induced growth reduction and the elevated expression of the metallothionein gene. Previous research suggested significant additive genetic variation for cadmium-induced transcription of the *mt.* Eight alleles of the promoter, 1.3 kb 5' of the *mt* ORF, have been sequenced, which differ in the number and the arrangement of transcription factor binding sites, such as metal responsive elements (MRE), antioxidant responsive element (ARE) and molting hormone receptor sites. The dose-response relationship by heavy metals, oxidative stress and 20-hydroxyecdysone on the induction of these promoter alleles was analyzed in a luciferase reporter assay in an insect cell line. Striking differences in inducibility by Cd and oxidative stress (paraquat) were detected and allele frequencies in a preliminary field study suggest balancing selection in a metal polluted environment. Subsequently, we applied transcriptomics to determine differential gene expression upon cadmium exposure in a reference and a tolerant population. Many cDNAs responded to Cd exposure in the reference population. Significantly fewer clones were Cd responsive in tolerant animals. Analysis of variance revealed transcripts that interact between Cd exposure and population. Hierarchical cluster analysis of these clones identified two major groups. The first one contained cDNAs that were up regulated by Cd in the reference culture but non-responsive or down-regulated in tolerant animals. This cluster was also characterized by elevated constitutive expression in the tolerant population. Gene ontology analysis revealed that these cDNAs were involved in structural integrity of the cuticle, anti-microbial defence, calcium channelblocking, sulfur assimilation and chromatin remodelling. The second group consisted of cDNAs down-regulated in reference animals but not responding or slightly up regulated in tolerant

animals. Their functions involved carbohydrate metabolic processes, Ca2+-dependent stress signalling, redox state, proteolysis and digestion. The reference population showed a strong signature of stress-induced genome-wide perturbation of gene expression, whereas the tolerant animals maintained normal gene expression upon Cd exposure. We confirmed the micro-evolutionary processes occurring in soil arthropod populations and suggest a major contribution of gene regulation to the evolution of a stress-adapted phenotype.

3. Developmental plasticity in *Bicyclus* butterflies as a response to alternating seasons of low of high environmental stress

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Invertebrates faced with the challenge of persisting through alternating wet and dry seasons in the tropics have frequently evolved developmental plasticity as an adaptive response to the temporal variation in the environment. *Bicyclus* butterflies in Africa exhibit seasonal polyphenism with alternating adult generations of a wet season form and dry season form. These differ in wing pattern but also show numerous other adaptations, either to a favourable (wet) season in terms of resources or to one (dry) that is more stressful. This divergence has led us to examine not only the bases of the developmental plasticity in wing pattern in a model species, *B. anynana*, but also the evolution of key life history traits including adult starvation resistance and longevity. This has been done both in terms of the processes that generate variation and plasticity in the phenotype and in the ecological context of adaptive responses to variation in the occurrence of environmental stress.

4. DNA methylation and transgenerational effects of exposure in *Daphnia magna*

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Exposure to environmental stress can trigger epigenetic changes, e.g. changes in DNA methylation. Through epigenetic inheritance, effects of transient chemical exposure can be transferred to non-exposed generations. For *Daphnia magna*, a key test organism in aquatic toxicology and an important species in many aquatic ecosystems, knowledge on DNA methylation was completely absent. This study was aimed at determining whether CpG methylation is an epigenetic factor in *D. magna*, and if so, whether it can be influenced by exposure to toxic stress.

Daphnids were exposed to Cd, Zn or 5-azacytidine. Exposed and non-exposed offspring were also investigated. CpG methylation was detected with an optimized restriction enzyme-based PCR method (Amplification of Intermethylated Sites or AIMS). To quantify methylation, DNA was enzymatically degraded to nucleosides, which were analyzed with LC-MS-MS.

With the AIMS method, two methylated DNA fragments were found, of which methylation was not altered after Cd exposure. The quantitative analysis demonstrated 0.22% to 0.35% cytosine methylation expressed as [5mdC]/[dG] for daphnids in standard conditions. F_1 offspring of daphnids which were exposed to Zn exhibited a slight but significant decrease in global cytosine methylation. However, this was not reflected in changes in reproduction and it was not passed on to the F_2 generation. A reduction in DNA methylation was also observed in daphnids exposed to 5-azacytidine. This effect was transferred to the two subsequent non-exposed generations, coinciding with a reduced body length at day 7.

For the first time, DNA methylation was discovered and quantified in the *D. magna* genome. Different exposure histories can result in different levels of methylation. The

demonstration of a transgenerational alteration in an epigenetic system in *D. magna* indicates the possibility of transgenerational inheritance of environment-induced epigenetic effects, which may have important implications in aquatic toxicology.

5. Epigenetic inheritance in asexual dandelions

Koen Verhoeven

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Epigenetic mechanisms such as DNA methylation can cause stable but reversible changes in gene activity without changes in the underlying DNA sequence. Recent studies in plants have shown that DNA methylation patterns can be modified by environmental and genomic stresses, they can be transmitted between generations and they can cause heritable trait variation in absence of genetic (sequence) variation. This implies that heritable variation may not be understood from genetic variation alone and that the direction of micro-evolutionary change could be guided by environmental experience. To date, however, the evolutionary relevance of epigenetic inheritance is unknown and much of the underlying mechanisms remains poorly understood. To gain better insight in the factors that generate heritable methylation variation we exosed genetically identical dandelion plants to various ecological stress environments and evaluated genome-wide methylation effects using methylation-sensitive AFLP markers. All stresses triggered methylation changes and most of the changes were faithfully transmitted to unexposed offspring. All stresses also affected offspring phenotypes. These results suggest that heritable methylation variation is readily generated that is independent of genetic variation between individuals, which can have consequences for the adaptive potential of asexual species such as dandelions. I will briefly sketch some perspectives for linking epigenetics and ecological research, which can improve our understanding of the evolutionary relevance of epigenetic inheritance.

3d: Invasion Ecology

Conveners: Alejandro Ordonez (University of Groningen)
Karin Troost (IMARES)

1. The arrival, development and impact of exotic species in the brackish and marine waters of Zeeland.

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Worldwide an increasing number of exotic species is observed. Also in the larger waters of the South-western part of the Netherlands (Zeeland delta), a large number of exotic species is very abundant. The standardized large scale monitoring of the macrobenthic communities of the soft sediment substrates in the Zeeland delta waters during the last 20 years gives insight in the development of populations of exotic species after their arrival. The current study evaluates the proportions occasional arrivals, temporary and permanent successful arrivals and the amount of species showing invasive characteristics. Species distributions, developments in time and differences between the investigated environments, indicate the vectors for dispersal, reasons for success, and the impact of exotic species on indigenous species and macrobenthic communities. As especially mollusks appear to be successful in the Zeeland delta, a substantial to the largest part of the biomass is represented by exotic species. At present 70 % of the biomass in the Grevelingen exists of exotic species, mainly the gastropod *Crepidula fornicata*. In lake Veerse Meer, 80 % of the biomass constitutes of exotics, dominated by the bivalve *Mya areania*. In the Westerschelde and the Oosterschelde, especially the populations of the bivalve *Ensis directus* are increasing, and are respectively 70 and 41 % of the biomass of exotic origin. Besides these species, also *Crassostrea gigas* is very abundant (Grevelingen, Oosterschelde) or populations are increasing (Veerse Meer, Westerschelde). Exotic species among the polychaetes can be very abundant but are less important in terms of biomass. As inventories for exotic species in the Netherlands have largely taken place on hard substrates, two abundant exotic species among the polychaete worms appear to be overlooked for decades. Particularly the water quality plays an important role in the success of exotic species and determines which species can become successful. Where several exotic species have a clear impact on their environment, the role of direct competition with indigenous species, at least on soft sediment substrates, seems to be relatively small. The largest part of the successful exotic species is only very abundant for a short period, and is found to be replaced by other species (indigenous or exotic) after a while. This is especially the case in relatively undisturbed/unstressed environments. Expectations for future developments in the Zeeland delta will be discussed.

2. Causes and effects of a highly successful marine invasion: Case-study of the introduced Pacific oyster *Crassostrea gigas* in continental NW European estuaries

Karin Troost
IMARES, Yerseke, the Netherlands

Since the 1960s, the Pacific oyster *Crassostrea gigas* has been introduced for mariculture at several locations within NW Europe. The oyster established itself everywhere and expanded rapidly throughout receiving ecosystems, forming extensive and dense reef structures. It became clear that the Pacific oyster induced major changes in NW European estuaries. The case of the Pacific oyster in NW European estuaries is only one example in an increasing series of biological invasions mediated by human activities. This case-study will contribute to further elucidate general mechanisms in marine invasions; invasions that sometimes appear a threat, but can also contribute to ecological complexity.

Changes induced by the Pacific oyster are mainly related to its ecosystem engineering activities, its relative lack of natural enemies and high filtration rate. Induced effects differ between ecosystems with different characteristics.

In the Oosterschelde estuary, the rapid increase in stock size of *C. gigas,* combined with the presence of large stocks of cultured bivalves, already lead to a saturation of the carrying capacity of the estuary for bivalve filter-feeders. This apparently resulted in a reduced condition of cultured bivalves and could, in a worst-case scenario, lead to a replacement of the native *M. edulis* locally although it is still not clear whether *C. gigas* is a better competitor for food than *M. edulis*.

In the Wadden Sea, however, the effects appear relatively small and local considering the remarkably rapid expansion of the oyster. Instead of threatening the ecosystem by inducing major changes, the Pacific oysters merely seem to benefit from on-going large-scale changes. Furthermore, development of oyster reefs may compensate for habitat loss and biodiversity loss in estuarine environments that were caused by human activities in previous decades.

3. Ecosystem Engineering By Native and Exotic Shellfish: Feedback Mechanisms On Primary Production

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In shallow ecosystems shellfish can have a significant influence on ecosystem functioning. Dense shellfish beds can filter several cubic metres of water per hour. The Oosterschelde in the south-west of the Netherlands has large stocks of shellfish (native species, such as mussels and cockles and invasive species, such as Pacific oysters and American razor clams). It is estimated that the total volume of the Oosterschelde is processed by shellfish every 4-5 days. The large filtration capacity of shellfish can influence the light regime, nutrient cycling and particle dynamics in the system and thereby have an impact on the carrying capacity.

We are developing a coupled physical-biological ecosystem model to assess the effects of shellfish on carrying capacity of the system for shellfish. This model takes into account the external forcings such as nutrient loads and estuarine circulation, as well as the biological feedback mechanisms of filter-feeder activity on primary production. Flume experiments are used to determine important parameters such as algal uptake rates, remineralisation rates and the fate of faeces and pseudofaeces, related to hydrodynamic conditions.

First model results indicate that the presence of shellfish increases primary production in the system by about 40%. Models such as these can be used to evaluate the effect of water management policies on shellfish production, as well as the effect of invasive species on the carrying capacity of the system for native species.

4. Bioinvasions in the river Rhine: the battle of species

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The river Rhine is heavily influenced by human activities and suffers from a series of environmental constraints, which hamper a complete recovery of biodiversity. These constraints comprise intensive navigation and habitat modification by hydraulic engineering. Improving water quality while these constraints remain in place has led to increased colonization by aquatic invasive species. This tendency has been accelerated by the construction of canals connecting river basins. Over the last two centuries, the

total surface area of river catchments connected to the river Rhine via inland waterways has been increased by a factor 21.6. Six principal invasion corridors for aquatic species to the river Rhine are discerned. The extensive network of inland waterways has allowed macroinvertebrate species from different bio-geographical regions to mix, changing communities, affecting the food webs and forming new constraints on the recovery of the native biodiversity. From the eighteenth century onward, in the freshwater sections of the river Rhine, a total of 45 non-indigenous macroinvertebrate species have been recorded. The average number of invasions per decade shows a sharp increase from\1 to 13 species. Currently, the contribution of non-indigenous species to the total species richness of macroinvertebrates in the river Rhine is 11.3%. The Delta Rhine and Upper Rhine exhibit higher numbers of non-indigenous species than other river sections, because the sea ports in the Delta Rhine and the Main-Danube canal function as invasion gateways. Important donor areas are the Ponto-Caspian area and North America (44.4 and 26.7% of the non-indigenous macroinvertebrate species, respectively). Transport via shipping and dispersal via man made waterways are the most important dispersal vectors. Intentional and unintentional introductions are highest for the period 1950–1992. The cumulative number of non-indigenous species in time is significantly correlated with the increase in total surface area of other river catchments connected to the river Rhine by means of networks of canals. The species richness of non-indigenous macroinvertebrates is strongly dominated by crustaceans and molluscs. Invasive species often tolerate higher salt content, temperature, organic pollution and current flow than native species. Spatiotemporal analyses of distribution patterns reveal that average and maximum dispersal rates of six invasive species vary between 44–112 and 137–461 km year-1, respectively. Species arriving in upstream sections first show a shorter time lag between colonisation of the Delta and Upper Rhine than species initially arriving in downstream areas. Temporal analyses of macroinvertebrate assemblages in the littoral zones show that native species are displaced by nonindigenous species. However, established non-indigenous species are also displaced by more recent mass invaders. These species replacements appeared to be strongly determined by local environmental conditions, physiological tolerances and biological interactions of species.

5. Comparison of exotic range-expanding and related native plants on plant nutrient acquisition and soil nutrient mineralization

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Due to climate warming, plants can expand their range to higher latitudes. Some of these exotic range-expanding plants may become invasive in the new range. When exotic-range expanding plant establish in the new range, new interactions between soil microbes and range-expanding plants can alter rhizosphere-driven nutrient mineralization and litter decomposition.

Two experiments were performed: one in a greenhouse and one in a climate chamber. In the greenhouse, we studied if exotic range-expanding plants might alter rhizosphere nutrient mineralization and plant nutrient acquisition compared with congeneric natives. In the climate chamber, we studied if litter of range-expanding plants might alter soil nutrient availability and litter-feedback to plant biomass production compared with confamilial natives.

In the greenhouse experiment, species-specific differences in rhizosphere nutrient mineralization and plant nutrient acquisition were observed, but no consistent differences between range-expanding plants and congeneric natives were observed. In the climate chamber experiment, species-specific differences in soil nutrient availability and litter-feedback to plant biomass production were observed, but soil N availability was more often increased by litter of range-expanding plants than by litter of confamilial native plants. This increase in soil N availability resulted in increased biomass production for both range-expanding and confamilial native plants.

These results suggest that exotic range-expanding plants do not have a superior rhizosphere nutrient mineralization and plant nutrient acquisition compared with congeneric natives. Litter of exotic range-expanders, however, can create a positive feedback on plant biomass production for both exotic range-expanding and native plants.

6. Invasion success of infectious diseases and the use of elasticity analysis in disease ecology

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In the field of infectious disease epidemiology, a concept has been developed to study the risk of establishing of infectious diseases: the basic reproduction number. This quantity, also known as R_0, is defined as the average number of secondary cases caused by one typical infectious individual placed in a naive population. It is a measure of the success of invasion into a population; if R_0 is higher than 1, an outbreak is possible if the pathogen is introduced, whereas if R_0 is smaller than 1, introduction will fail.
For complex disease systems, R_0 is often derived using the next-generation method. This method has numerous advantages; one of the most intriguing is the fact that this matrix in many ways resembles the projection matrices as used in population ecology.
We draw a parallel between the application of matrices and elasticity analysis in plant and animal ecology and in infectious disease ecology. The interpretation of composite elasticities as contributions to the growth rate has generated insight into plant and animal populations. We show that similar insight can be gained for infectious diseases; contributions of different transmission routes or of different host types can be quantified using elasticity analysis. To illustrate this, we compare seven tick-borne diseases by parameterising a next-generation matrix for each and interpreting composite elasticities as contributions to R_0 from different transmission routes (systemic transmission, transovarial transmission, and non-systemic transmission). We estimate R_0 for each pathogen. Despite the uncertainty in R_0 arising from variation and uncertainty in epidemiological and ecological parameters, clear differences emerge among the seven pathogens in terms of the contributions to R_0 from the three types of transmission.

Session 4

4a: Microbial Ecology

Conveners: Michiel Vos (Netherlands Institute of Ecology)
Joana Salles (University of Groningen)

1. Multi-genome comparative analysis of *Enterococcus faecium*: from harmless commensal to opportunistic pathogen

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Enterococci are Gram-positive bacteria that are common commensal bacteria of humans and animals. The two most studied enterococcal species are *Enterococcus faecium* and *E. faecalis*. Historically, *E. faecalis* has caused 90% of all enterococcal infections, but since the late 1980s a rapid increase in nosocomial *E. faecium* infections has occurred. This coincided with the swift acquisition of multiple antibiotic resistances by *E. faecium*, which is severely limiting treatment options against this organism. To obtain an overview of the intra-species diversity of the species *E. faecium* and to identify previously unrecognized aspects of *E. faecium* biology, we sequenced the genomes of seven *E. faecium* strains from different ecological backgrounds.

In the genomes of clinical isolates several antibiotic resistance genes were identified, including the *vanA* transposon that confers resistance to vancomycin in two strains. A functional comparison between *E. faecium* and *E. faecalis* based on differences in the presence of protein families, revealed divergence in plant carbohydrate metabolic pathways and oxidative stress defense mechanisms. The *E. faecium* pan-genome was estimated to be essentially unlimited in size, indicating that *E. faecium* can efficiently acquire and incorporate exogenous DNA in its gene pool. One of the most prominent sources of genomic diversity consists of bacteriophages that have integrated in the genome. Three sequenced isolates carry the *esp* gene, which is involved in urinary tract infections and biofilm formation. The *esp* gene is located on a large pathogenicity island (PAI). Conjugation experiments showed that the entire *esp* PAI can be transferred horizontally and inserts in a site-specific manner.

This study shows that multi-genome comparisons can greatly contribute to understanding the diversity among strains within a microbial species and can be applied to robustly determine the evolutionary trajectories of individual isolates. Our study also indicates that genes involved in environmental persistence, colonization and virulence can easily be acquired by *E. faecium*, making the development of successful treatment strategies against this organism a challenge for years to come.

2. Microbial diversity determines the invasion of soil by a bacterial pathogen

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Natural ecosystems show variable resistance to invasion by alien species and this resistance can relate to the species diversity in the system. In soil, microorganisms are key components that determine life support functions, including resistance to invasion. Theoretical and experimental studies have indicated that biologically-diverse (plant) communities are often less prone to being invaded than simpler ones, but effects of microbial diversity on invading organisms have remained underexplored. In order to determine the effect of microbial diversity on the survival of invading pathogens, we have used two approaches in which microbial diversity was manipulated, to address fate the pathogen *E. coli* O157:H7 in soil. More specifically, the invader's fate in soil was assessed in the presence of (1) differentially-constructed culturable bacterial communities, and (2) microbial communities established using a dilution-to-extinction approach. The results from both approaches suggest that the survival of bacterial pathogens was strongly limited in microbiologically-diverse soil, but higher in biologically-compromised soil. Our

results suggest that the major mechanism controlling the inverse relationship between soil microbial diversity and the survival of the invading species was resource competition, as addition of carbon resources to the microcosms restored *E. coli* populations. The inverse relationship between survival and microbial diversity extends a central hypothesis concerning soil biodiversity-invasibility to microorganisms, i.e. that at progressively-lowered soil microbial diversity increasing establishment of invading species is possible.

3. COLIWAVE a simulation model for survival of *E. coli* O157:H7 in dairy manure and manure-amended soil

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A simulation model was developed to investigate the relative effects of temperature, oxygen concentration, substrate content and competition by autochthonous microbial community on the oscillatory behaviour and survival of *Escherichia coli* O157:H7 in manure and manure amended soil. The overall decline in *E. coli* O157:H7 was primarily determined by competition with autochthonous copiotrophic bacteria simulated by an inter-specific competition term according to Lotka-Volterra. Oscillations of bacterial populations were attained by the relationships between relative growth and death rates with readily available substrate content. The model contains a logistic and exponential relation of relative growth and death rates, respectively, of *E. coli* O157:H7 and copiotrophic bacteria with temperature, resulting in optimum curves for net growth rates similar to the curves reported in the literature. The model has been both calibrated and validated on experimental data. The model was used to perform sensitivity analysis and to evaluate different manure and soil management scenarios in terms of survival of *E. coli* O157:H7. The relative effects of changes in temperature on simulated survival time of *E. coli* O157:H7 were more pronounced than changes in oxygen condition. Testing manure storage scenarios with realistic data revealed that manure stored in a heap that was turned every week resulted in almost 70% reduction of *E. coli* O157:H7 survival compared to unturned manure. At the surface of a heap with unturned manure, simulated survival time was the longest (2.4 times longer than inside the same heap). The simulation model provides a new approach to investigating dynamic changes of invasive microorganisms in natural substrates such as manure or manure-amended soil.

4. The ecology of *Acidobacteria* and *Verrucomicrobia* isolates in the Leek rhizosphere

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The ecology of bacterial groups that are known for their recalcitrance to growth in culture media, such as the *Acidobacteria* and *Verrucomicrobia,* was studied. Information about the distribution of these groups in the rhizosphere and bulk soil is scarcely available and occasionally even conflicting reports were made about their distribution over the different plant-soil compartments. Culturable representatives of both groups obtained from leek and potato rhizospheres were used to study their ecological behaviour in different plant-soil compartments.

Two isolates from the *Acidobacteria* group 8 and nine from the *Verrucomicrobia* subdivision 1 were recovered from oligotrophic agar media either or not amended with catalase or root exudates and incubated at 4 % CO_2 after plating of rhizophere extracts. Their potential to interact with plants was studied in vitro. Three approaches were followed to determine possible interactions: (1) growth on different carbon sources common in plant root exudates (i.e., organic acids, aminoacids and sugars); (2) in vitro studies on growth effects in sterilized plants (3) differences in distribution over plant-soil compartments using real-time PCR with primer systems specific for the isolates.
Both *Acidobacteria* (CHC25 and ORAC) were able to utilize malate, succinate and glutamine. The *Verrucomicrobia* isolates were able to utilize two or more of the following compounds: oxalate, malate, succinate, citrate, glutamine and/or alanine. Isolate CHC8,

belonging to the *Verrucomicrobia* subdivision 1, was the only isolate that was able to degrade cellulose. In the *in vitro* assays with sterilized plants, it was demonstrated that the isolates influenced plant growth differently. Isolate CHC12 (*Verrucomicrobia*) inhibited the growth of 20% of the inoculated leek plants, and the sizes of these plants were reduced by approximately 50%, in comparison with the uninoculated leek plants. *Verucomicrobial* isolate ONA9 colonized the root surface of leek plants, but did not influence shoot or root growth. Both *Acidobacteria* isolates increased the root size of leek plants by about 40% in comparison with uninoculated plants. Quantification of *Verrucomicrobia* isolates introduced into the plant-soil system revealed a higher abundance in the rhizosphere (about 10^6 cell per gram of soil) than in the bulk soil (10^4-10^5 cell per gram of soil). Numbers of introduced *Acidobacteria* group 8 isolates (determined by real time PCR) were grossly the same in rhizosphere and bulk soils.

This study provided clear indications that some of the *Acidobacteria* and *Verrucomicrobia* isolates interact with plants. The role of these isolates in plant growth promotion and rhizosphere functioning will be further explored in plant-soil microcosm and field studies.

5. **Effects of different potato genotypes on soil fungal community structure and function**

S.E. Hannula

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The soil microbial community structure and functioning is strongly influenced by plants and the plant community is known to have a strong impact on the belowground fungal communities. Yet, it is not clear how much the genotype of a plant influence the soil microbial community. This study investigates the effects of different potato genotypes on soil fungal communities and the role of fungi in the rhizosphere. Fungi form a group of key microorganisms in soil ecosystem functioning for which is the possibility of negative side-effects of genetically modified (GM) crops less intensively studied than for bacteria. Approach of combining both community structure data of different fungal phyla (*Ascomycota*, *Basidiomycota* and *Glomeromycota*), fungal biomass estimates and enzymatic measurements of soil was adopted to gain better understanding of plant genotype mediated effects on soil fungal communities. The effects of field site, year, soil compartment (bulk soil vs. rhizosphere), plant growth stage and plant cultivar (genotype) were analyzed with fungal phylum specific primers using terminal restriction fragment length polymorphism (T-RFLP) combined with multivariate statistical methods. Additionally, arbuscular mycorrhizal colonization, fungal biomass (via quantifying ergosterol) and activities of extracellular fungal enzymes (laccases, Mn-peroxidases and cellulases) involved in degradation of organic matter in the soils were determined. Both the functional and structural data on the fungal communities suggested that the communities of higher fungi were significantly different between the rhizosphere and the bulk soil. The most important factors determining fungal community composition and functioning were plant growth stage for the rhizosphere communities and location and soil properties for the bulk soil communities. In addition, different fungal groups differed in their responses to the growth stage. The diversity estimates showed that the basidiomycete community was dominating in the fields before the season and in the rhizosphere of young plants while in the rhizosphere of the flowering plants the members of ascomycetes were dominant. The GM cultivar did not affect the fungal community structure or functioning differently than the parental line. Fungal community structure and functioning of both GM- and parental cultivars fell within the range of other cultivars at most of the time points.

6. Positive effects of organic farming on belowground mutualists: large scale comparison of mycorrhizal fungal communities in agricultural and natural soils

Erik Verbruggen

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Organic agricultural practices have been advocated for the maintenance and restoration of farmland biodiversity. The impact of organic farming on soil biodiversity, and in particular on arbuscular mycorrhizal fungi (AMF), is however still poorly understood, even though AMF diversity has been suggested to promote plant productivity and ecosystem functioning. These fungi engage in symbiosis with the majority of land plants and are a key link between aboveground and belowground ecology.

Diversity of AMF is thought to improve nutrient use efficiency, and through functional complementarity of species many soil-ecological processes are maintained, potentially negating negative effects of agriculture on the surrounding ecosystem. To assess this potential, the AMF community composition was assessed in 26 agricultural fields (13 pairs of organically and conventionally managed fields) and five semi-natural grasslands, all on sandy soil. AMF identities were assessed by molecular markers targeting the Large Subunit of the rDNA gene.

The average number of AMF taxa recovered was highest in grasslands (8.8), intermediate in organically managed fields (6.4), and lowest in conventionally managed fields (3.9). AMF communities of organically managed fields were also more similar to those of natural grasslands as compared to those under conventional management, and were less uniform, as expressed by higher β-diversity. A probable explanation is that conventional agriculture selects for a specific set of generalist AM fungi by outcompeting fungi with other strategies. Potentially, this uniformity will reduce AMF contribution to ecosystem sustainability. In an additional greenhouse experiment plants were inoculated with soils derived from multiple organic and conventional fields, and AMF density and phosphorus leaching after a mimicked heavy raining event were measured. It was found that soils from organic fields reached significantly higher densities, and that higher AMF density reduced nutrient leaching.

These results suggest that organic management in agro-ecosystems contributes to the restoration and maintenance of these important belowground mutualists.

4b: Movement Ecology: migration and dispersal

Conveners: Merel Soons (Utrecht University)
Silke Bauer (Netherlands Institute of Ecology

1. Coral reef fish orientation by use of habitat-specific cues

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The ability of animals to acquire information from their environment is an essential determinant in ecological processes. Both biotic and abiotic cues guide animals through a mosaic of habitats. Among coral reef fish, some species have developed a 3-phase life history strategy in which they display ontogenetic habitat shifts between a variety of shallow-water habitats in order to optimize their fitness. In our research, we have studied three possible sensory cues that can be used for habitat selection by these fish. We have conducted several /in/ and /ex situ/ experiments in which the response towards four different habitats (seagrass beds, mangroves, rubble and coral reef) was tested. Our results show that multiple cues can be used during the same life phase for habitat recognition. However, each tested cue (sound, vision, smell) induced a different reaction towards the same habitat. Based on our results we propose a hypothetical model of stepwise use of cues for navigation from the open ocean towards temporary non-reef habitats in the early life of a reef fish.

2. The importance of personality when individuals are on the move

Ralf Kurvers
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Individuals need to move to find food, find partners, suitable breeding grounds, escape from danger etc. An interesting question is why individuals vary in their decision making that leads to differences in movement patterns. For instance, in individuals moving in groups it has been shown that certain individuals are more often found in the leading edge of a moving group than other individuals. This may be due to differences in age, knowledge, status or needs between individuals, illustrating that differences between individuals in movement behaviour may be explained by individual characteristics. Additionally, individual variation in spatial positions in moving groups, or speaking more broadly in movement patterns could also be a more stable individual feature. Personality describes the idea that a range of individual differences in behaviour and/or physiology are consistent over time and situation. These differences are independent of sex, knowledge, status etc. In recent years there has been an increased interest in the field of animal personality. In this talk I would like to give an overview of the current knowledge on how the personality concept can explain individual differences in movement patterns, including some of our work on the importance of boldness in affecting movement patterns in small groups of Barnacle geese. I try to highlight that personality differences affect individual movement patterns and sketch some possible directions for future research.

3. Speedy ticks as result of *Borrelia* tricks?

Fedor Gassner
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The ability to move from one host to the next is a major factor that determines pathogen virulence. Some pathogens use animal vectors for their dispersal. It is beneficial for these pathogens to manipulate the behaviour or physiology of the vector to increase their transmission to the next host. Here, we question whether the bacterium that causes Lyme borreliosis, *Borrelia burgdorferi* s.l. can alter the host searching behaviour of its tick vector *Ixodes ricinus.* Behaviour of *I. ricinus* was monitored using video capture in a laboratory setup. Digital tracking of tick movement revealed significantly higher activity in infected ticks, as expressed by greater walking speeds and distances, and activity at different microclimatic zones in the setup. The observed changes could lead to increased contact with natural reservoirs of *Borrelia* and increased contact between infected ticks and humans.

4. The dispersal-competition relationship: do the best take the dispersal risk or are the poorest kicked-out?

Dries Bonte
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Trade-offs between dispersal and competitive abilities can be shaped by phenotypic plasticity due to the allocation of energy for reproduction or growth towards flight structures or due to the fact that individuals in worst body condition (with eventually lowest fecundity) are forced to leave populations. As opposed to this constraints-hypothesis, adaptive strategies for body condition-dispersal reaction norms can be expected when body condition provides direct and reliable information on the prevalent local population density conditions. This may be especially true for species that are immobile and/or lack sufficiently developed sensory organs to sample the local density (e.g., plants, sessile animals).

I show that spiders inhabiting arable landscapes are kind of 'superdispersers', with individuals in best condition taking the risk of ballooning (i.e., a risky aerial dispersal behaviour). Information related to population density and body condition determine as such context and phenotype-dependent dispersal strategies. According to developed theoretical models, both positive and negative body condition-dependent dispersal strategies can evolve in metapopulations, depending on the system's connectivity and environmental stochasticity.

5. Migration and dispersal modelling: techniques and applications for river conservation and restoration management

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The distribution of species in rivers is to a high extend determined by the local river conditions. However, migration and dispersal processes play also a crucial role both in natural as well as deteriorated streams. Models can help to integrate knowledge and insights to systematically analyse spatial and dynamical patterns in species abundances. Major constraints for this type of modelling and in particular its application are both relevant field data and ecological knowledge, but moreover the selection of a convenient modelling technique in function of the available data, information and research/management questions. This presentation will illustrate three different migration modelling techniques (electricity network method, cost-function model and cellular automata) that can be combined with habitat suitability models to describe shifts in populations in relation to altered river conditions, and how these can be applied to predict the effect of restoration plans in rivers.

6. Dispersal of tropical megafaunal seeds by rodents

Patrick A. Jansen
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The End-Pleistocene mass extinction of mammals severed numerous large-seeded plant species in tropical forests from their primary seed dispersers, leaving many of them with no other seed dispersers than rodents. Long-distance seed dispersal is essential for long-term persistence, but documented seed dispersal distances provided by rodents are generally short and cache survival is low, hence it remains a conundrum how these plant species have survived. Here, we show that scatter-hoarding rodents can in fact provide long-distance dispersal to large seeds but do so in multiple steps. We affixed radio-transmitters to the large nuts of a megafaunal palm in Central Panama to follow their fate as they were processed by agoutis and other rodents. Initial seed dispersal distances were short and cache survival rates were low, as in previous studies. Seeds removed from caches, however, were usually not eaten but re-cached, up to 13 times, yielding net dispersal distances as far as 300 m from the source plant. Seeds crossed multiple agouti home ranges, indicating that this was due to rodents stealing each others caches. Our study suggests that secondary seed dispersal by rodents can be sufficient to replace primary seed dispersal by megafauna.

4c: Physiological Ecology

Conveners: Eric Visser (Radboud University)
Joanna Cardoso (Royal Netherlands Institute for Sea Research)

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

Rashmi Sasidharan
Dept. Plant Ecophysiology , Utrecht University, the Netherlands

The shade avoidance syndrome is an escape strategy employed by plants upon encountering shade. Crowding in natural plant communities, as well as dense agricultural settings result in characteristic light quality changes that trigger a rapid elongation response in some plants. This allows growth out of the crowded canopy, access to sunlight and an increased chance of survival. Rapid elongation responses during shade avoidance require fast cellular expansion. This in turn requires modifications to the cell wall of expanding cells. The regulation of cell wall modifying proteins is therefore crucial to shade avoidance. This is very well demonstrated in two ecotypes of the polymorphic plant species *Stellaria longipes* that show contrasting responses to shade. The non-responsiveness of the alpine ecotype to shade and the sensitivity of the prairie ecotype to even mild shade conditions could be attributed to their respective habitats. Shade avoidance in these ecotypes was measured in terms of internodal elongation and found to correspond to the properties of the cell wall. The regulation of the wall loosening protein expansin corresponded with the ability of an ecotype to respond to a characteristic light quality conditions implying shade. Regulation of specific expansin genes indicates the specificity of gene family members. Multigene families like expansins can thus equip a plant species with the versatility it needs to survive in a challenging and dynamic environment as well as to colonize diverse habitats.

2. **Spatial and temporal root activity patterns of trees and grasses: two approaches to test the two-layer hypothesis in a subtropical savanna**

R.J.T. Verweij[1,2], A. Kulmatiski[3], K.H. Beard[4], S.I. Higgins[5], W.J. Bond[1], E.C. February[1]
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The proposed mechanisms facilitating the co-dominance of trees and grasses in savannas include root niche partitioning. Woody plants are often assumed to use deep soils to avoid competition with grasses, yet direct measurements of root activity are rare. We examined the "two-layer hypothesis" through a field experiment in which we severed deep and shallow roots of *Terminalia sericea* saplings. During the course of a growing season, responses to the root severing were measured and compared to a control group. Furthermore we injected deuterated water into four soil depths four times during the year to measure the vertical and horizontal location of water uptake by trees and grasses in a mesic savanna, Kruger National Park, South Africa.

Contrary to the prediction of the two-layer hypothesis, severing shallow roots resulted in rapid leaf abscission, small leaves and low xylem pressure potentials (i.e. high water stress levels), whereas effects of deep root severing were small compared to the control group. Our results suggest that trees coexist with grasses without avoiding competition through spatial root separation. The results of our study therefore do not support the two-layer hypothesis as the explaining model of tree-grass coexistence in this mesic savanna.

In the isotope tracer experiment, trees absorbed 24%, 59%, 14% and 4% of tracer from the 5, 20, 50, and 120 cm depths, respectively, while grasses absorbed 61%, 29%, 9%, and 0.3% of tracer from the same depths. Trees absorbed tracer under and beyond their crowns, while 98% of tracer absorbed by grasses came from immediately under the stem. Trees absorbed tracer only when shallow (0-20 cm) water was available while grasses absorbed tracer throughout the growing season.

Even though trees primarily used deeper (20 cm vs. 5 cm) soil water than grasses, trees did not avoid competition with grasses by accessing a unique resource because grasses used as much deep (50–120 cm) soil water as trees. The tracer injection technique provided direct measurements of root activity needed to parameterize both conceptual and quantitative models of resource partitioning and water movement.

3. Inorganic carbon uptake by Southern Ocean phytoplankton in response to ambient CO_2: from physiology to ecology

Ika Neven[1], Jacqueline Stefels[1], Hein de Baar[2,3], Theo Elzenga[1]

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Marine primary productivity contributes up to 40% to global photosynthesis. As a consequence fixation of CO_2 by marine photosynthetic organisms is an important factor when quantifying the global carbon cycle and predicting future atmospheric CO_2 levels. Dissolved inorganic carbon (DIC) acquisition of natural phytoplankton assemblages was quantified at different stations in the Atlantic sector of the Southern Ocean. The contribution of different carbon species (CO_2 and bicarbonate (HCO_3^-)) to the overall DIC uptake and the extent to which external carbonic anhydrase (eCA) plays a role in facilitating DIC uptake was estimated using the isotopic disequilibrium technique. Simultaneous uptake of CO_2 and HCO_3^- was observed in all cases, but the proportions in which different DIC species contributed to carbon assimilation varied considerably between stations. HCO_3^- as well as CO_2 could be the major DIC source for local phytoplankton assemblages. The contribution of CO_2 to total DIC uptake was positively correlated to ambient concentration of CO_2 in seawater. Consequently, it can be anticipated that Southern Ocean microalgae will increase the proportion of direct CO_2 uptake under future high atmospheric CO_2 levels. Consequences for the energy balance of iron and light stressed Antarctic phytoplankton and possible effects on the Southern Ocean ecosystem will be discussed.

4. Differential reproductive strategies of two bivalves in the Dutch Wadden Sea

Joana F.M.F. Cardoso, Johannes IJ. Witte, Henk W. van der Veer

Marine Ecology, Royal Netherlands Institute for Sea Research, Den Burg Texel, the Netherlands

Cerastoderma edule and *Mya arenaria* are two common bivalve species in European waters. Longevity and maximum size are much greater in the latter species. Because comparison of species life-history strategies states that a long life span (i.e. high annual survival) generally goes with lower fecundity, we hypothesise that reproductive output would be lower in *M. arenaria* than in *C. edule*. In the present paper, we studied the reproductive strategies of these two species in an intertidal and a subtidal area of the western Dutch Wadden Sea, by following seasonal changes in absolute and relative weights of somatic and gonadal tissues in these bivalves. Starting of spawning was similar in the two species, around May, except for intertidal *M. arenaria*, which initiated spawning in August. Individual energy investment in reproduction was similar for the two species but, unlike *M. arenaria*, *C. edule* spawned completely, releasing all energy of gonadal mass in the form of gametes. *M. arenaria* used the gonad not only for reproduction but also for storage. In the intertidal area, we found a trade-off between longevity and reproduction, i.e. maximum reproductive output (expressed as a proportion of body mass) was higher in *C. edule* than in *M. arenaria*. However, since body size is larger and life span longer in *M. arenaria* than in *C. edule*, mean lifetime reproductive output per individual must be higher in the first than in the latter. Based on the differences in reproductive strategies of these two species, we hypothesise that the negative effects of warming climate on bivalve population dynamics in the Wadden Sea will be stronger in *C. edule* than in *M. arenaria*.

5. Reproductive investment of *Scrobicularia plana* along a latitudinal gradient

Sílvia Santos, Joana F.M.F. Cardoso, Célia Carvalho, Pieternella Luttikhuizen and Henk W. van der Veer

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The bivalve *Scrobicularia plana,* an important species in shallow water benthic communities, shows differences in reproductive cycle along its distributional range. While shorter spawning periods are usually observed at higher latitudes, in more southern areas the spawning period tends to be lengthened and in some cases, more than one period has been detected. These differences in reproductive cycle between spatially separated populations make *S. plana* a suitable species for the study of the factors regulating the reproductive cycle, by means of comparison of different populations. This study describes the monthly investment in soma and gonads of populations from three locations along its distributional range: Minho estuary, Portugal; Westerschelde estuary, The Netherlands and Buvika estuary near Trondheim, Norway. A clear seasonal cycle in body mass (BMI), somatic mass (SMI) and gonaldal mass (GMI) indices was observed for all populations. In Portugal, BMI and SMI reached maximum values in November 2007 with a minimum in April 2007. For The Netherlands, both indices were at their lowest in March 2009, with a peak in May for BMI and at the end of April for SMI. In Norway, BMI and SMI showed lowest values in June 2008, followed by a peak in November 2008 although another peak in spring was suggested. GMI reached maximum values in July in Portugal and Netherlands and in June in Norway. The spawning period was clearly longer in Portugal, lasting the whole summer, while in The Netherlands and Norway it only lasted two months, August-September and July-August, respectively. The reproductive investment (GSR) in Norway was very low with only about 6% of the body mass of the population consisting of gonadal mass at its peak in June 2008. In Portugal, the investment in gonadal mass at its peak in May 2007 was much higher (13.3%) while in The Netherlands GSR reached intermediate values (6.4% in 2008 and 12.3% in 2009). Monthly mean temperature of the sediment surface layer, in Portugal, varied between 19.89°C in July and 12.23°C in December. In The Netherlands and in Norway, the highest mean temperatures were observed in July 2008, 19.48 and 18.01°C respectively; while the lowest were recorded in February 2009, 2.91°C in The Netherlands and 1.92°C in Norway. Overall, mean BMI and SMI were lower in Portugal than in the other two locations, while mean GMI was lower in Norway and similar between the other locations.

6. Effects of different time-variable exposure regimes of the insecticide chlorpyrifos on freshwater invertebrate communities in outdoor microcosms.

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Contamination of surface water from pesticides typically occurs in single or repeated pulses due to for instance agricultural runoff, spray drift. Risks of pesticides to aquatic ecosystems are often assessed by performing cosm experiments evaluating a particular exposure regime (e.g.1 pulse application), not necessarily corresponding with the exposure part of risk assessment (e.g. multiple applications). The aim of the present study is to compare the effects of different time-variable exposure regimes of chlorpyrifos (CPF) towards freshwater invertebrate communities. The experiment was performed in 16 outdoor microcosms by introducing three different regimes; (1) A single application of 0.9 µg a.s./L, (2) three applications of 0.3 µg a.s./L , with a time interval of 7 days and (3) a continuous exposure of 0.1 µg a.s./L for 21 days, based on same 21d-Time Weighted Average (TWA).The Principal Response Curve (PRC) resulting from analysis of macroinvertebrate and zooplankton data set depict small variation in the pre-treatment period and large concentration-dependent differences with the control after start of treatment. The application of CPF resulted in a decrease in densities of the arthpode community, with the largest adverse effects reported for mayflies (*C. dipterum*) and cladocerans (*D. longispina, Alona* sp.*)*, followed by other insects (e.g. Phryganaidae and crustaceans (e.g. adult *Cyclopoids*, *Nauplii* and *Gammarus pulex*). The decline of grazer arthropods might explain the increased abundance of non arthropod grazers

(rotifers and snails).By the end of the experimental period, both PRCs show the same effects magnitude for all treatment regimes, indicating that generally for long-term effects the area under the curve (AUC) is more important than the peak concentration.
Keywords: pesticides, microcosm, macroinvertebrates, chlorpyrifos

4d: Global change and biodiversity

Conveners: Tim Engelkes (Netherlands Institute of Ecology)
Gregoire Freschet (Vrije Universiteit)

1. How allometric scaling relates to soil abiotics and land-use changes

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For most species, the logarithm of their average body mass is negatively related to the logarithm of the relative population density, i.e. the numerical abundance. In this way, allometric scaling (mass–abundance regressions and body size spectra) becomes useful in ecological theory to build and explain food webs. Using empirical evidence derived from Dutch field studies, an hypothesis is formulated to explain how soil microbivores, detritivores and predators react to increasing resource availability and this model is further discussed defining critical conditions for sustainability in soils. Under low soil fertility, in fact, the aggregate contribution of small invertebrates to the entire faunal community is high and shifts in allometric scaling cause changes in food web structure. We show that the averages of the (log-transformed) faunal prey : predator ratios are reliable predictors for assessing faunal responses to nutrient availability and predict environmental shifts. We view this work as a first attempt toward an extensive comparison of ecological processes.

2. Sub-Arctic Vegetation Composition Resistant to Climate Change?

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Arctic ecosystems are considered fragile and sensitive to climatic changes. Species diversity in these regions is expected to decrease as a result of a warming climate. Currently, increases in both summer and spring temperatures and winter snowfall have been recorded at northern high-latitudes over the past decades and are predicted to continue for this century. The commonly observed response of Arctic vascular plants to (imposed) warming is a decrease in species diversity and evenness, and enhanced cover and canopy height of deciduous shrubs as well as an increase in graminoid cover. However, previous studies mainly concentrated on summer warming effects and did not differentiate between the seasonal components of climate change. Moreover, most of these studies did not look at the effect of warming on systems dominated by the peat moss *Sphagnum fuscum*. Here we present the results of a 9-year study in which we imposed six different experimental climate scenarios on sub-arctic bog vegetation. Contrary to previous findings, our results show how the vascular plant community of a sub-Arctic peatbog is surprisingly insensitive to nine years of climatic manipulations, including summer as well as spring warming and an enhanced winter snow cover. We hypothesize that this unexpected stability of species composition may be explained by the equal challenge to all species to stay on top of their elevating ground: the faster growing *Sphagnum fuscum.* In a warmer world, vascular species of sub-Arctic peat bogs appear to just keep pace with growing *Sphagnum* in their race for space.

3. M**ass-mortality of insular vertebrates during mega drought 4200 years ago: will insular vertebrates cope with future climatic extremes?**

Kenneth F. Rijsdijk[1,2], Jens Zinke[3] , Perry G.B. de Louw[4], Julian P. Hume[5], Hans (J) van der Plicht[6,7], Henry Hooghiemstra[2], Hanneke J.M. Meijer[1], Hubert Vonhof[3], Nicolas Porch[8], Vincent Florens[9], Claudia Baider[10], Bas van Geel[2], Joost Brinkkemper[2], Anwar Janoo[9].

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We present a ground-breaking case of a mass mortality of est. 100.000s of insular vertebrates (23 species), including the iconic dodo, on a volcanic island (Mauritius), coinciding with a natural Mid-Holocene climatic extreme event 4200 yr ago. This period coincides with a global megadrought that affected ecosystems globally with reduced discharges of major rivers in Africa and Eurasia and led to the collapse of several societies, including the Egyptian first kingdom. Multidisciplinary evidence (palaeoclimatical, palaeo-ecological, hydrological and geological) demonstrates strong consilience, indicating that insular biota on Mauritius were affected by megadrought conditions causing a depletion of fresh water sources, leading to the mass mortality event. The data evidences that megadrought conditions not only affected ecosystems on the continental realm, but also affected insular ecosystems, which are generally considered climatologically buffered through the oceanic water mass. In spite of high death rates the fauna survived the megadrought event with extinctions taking place only since the 17th century human colonization of Mauritius. We argue that one reason for survival of the insular fauna populations was the abiotic heterogeneity offered by the volcanic island Mauritius providing alternative refugia elsewhere on the island. Without such abiotic diversity (geodiversity), the insular fauna would be more prone to natural extinction. A natural mass mortality on this scale invokes the question: how vulnerable are insular biota to climate extremes? Given the anticipated future extreme drought conditions predicted for the SW Indian Ocean coinciding with the currently exponential exploitation of island ecosystems, there will be no safe haven options left for the remaining insular vertebrates.

4. Effects of rising CO_2 on stoichiometry and competition in phytoplankton

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Atmospheric CO_2 concentrations are expected to double during this century. About half of the global carbon fixation is accounted for by phytoplankton. Increased dissolution of atmospheric CO_2 results in acidification of water. Conversely, uptake of CO_2 by phytoplankton results in an increased pH. Changes in pH cause a shift in the dissolved carbon species. Major species-specific differences exist both in the relative uptake rates of different carbon species and in the optimum pH for growth. Therefore, changes in aquatic carbon chemistry can have a large impact on competitive interactions among phytoplankton species. Furthermore, changes in carbon availability may change the elemental ratio, or stoichiometry of phytoplankton, which may decrease the food quality of phytoplankton for zooplankton. Here, we present a chemical-biological competition model that couples aquatic carbon chemistry to the carbon:nutrient stoichiometry and species composition of phytoplankton. The model predictions are validated against data from chemostat experiments. Our research shows that rising CO_2 concentrations affect phytoplankton stoichiometry, and can cause shifts in species composition.

5. Beyond climate envelopes: new views on climate change effects from butterfly population dynamics

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Although the effects of climate change on biodiversity are increasingly evident by shifting ranges across taxonomical groups, the underlying mechanisms affecting individual species are still poorly understood. The power of climate envelopes to predict future ranges has been seriously questioned in recent studies. Amongst others, improved understanding of the effects of current weather on population trends is required. Here, we present data suggesting that local weather, weather extremes and microclimatic cooling should be taken into account in predicting climatic impact on butterflies.

We analysed the relation between butterfly abundance and the weather experienced during the life cycle between successive years. We used data from the Dutch Butterfly Monitoring Scheme for 40 species over 15 years and corresponding climate data. Significant weather effects were obtained for 38 species, with the most frequent effects of temperature. Positive density-dependence suggested climatic independent trends in 12 species, however. Data from the warm and dry year 2003 indicate that negative effects of climatic extremes are underestimated for butterflies in drought-susceptible habitats. Furthermore, with the advancing plant growing season, microclimatic cooling is suspected to hasten the decline of species with spring-developing larvae. Overall, our analyses predict a continuing decline of 23 butterfly species. This greatly exceeds the expectations from climate envelope models.

6. Modelling climate impacts on genetic diversity in metapopulations

MMP. Cobben[1], J Verboom[2], P Opdam[3], R Hoekstra[1], MJM Smulders[4]

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One consequence of global climate change is that for many species the optimal habitat range will shift poleward or uphill. Important questions are if species can move fast enough to follow their habitat optimum, whether our landscapes will permit them to do so, and what will happen to their genetic diversity when they move. Using a simulation model we investigated the effects of range shifts on species' population size and neutral genetic diversity in a spatially explicit metapopulation. The model was parameterised for a forest bird and used the predictions of the Hadley Centre for the global mean temperature rise over the 21st century, as well as increased weather variability. We showed that:

- even when the yearly dispersal capacity of an animal is four times as large as the average movement of the habitat optimum, the metapopulation is not capable of long-term tracking and survival,
- part of the genetic diversity does not move along during range shifts and is being lost once the original habitat becomes unsuitable,
- increased weather variability leads to a somewhat lower population size and level of genetic diversity but does not significantly influence the range or range shift.

Poster Titles

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 have been submitted on registration. Please note this list may not be complete and that posters may not be listed but will be exhibited.

Parallel 1a: Plant-animal interactions

Name Main Author	University/Institute	Title Poster
Cindy ten Broeke	Wageningen University	Unraveling the mechanism of resistance to *Nasonovia ribisnigri* in lettuce
Floor van den Elsen	Wageningen University	Resistance mechanisms against Whitefly in tomato
Patrick Kabouw	Netherlands Institute of Ecology	Intraspecific variation in root glucosinolate profiles in *Brassica oleracea* is consistent across environments and has implications for resistance against plant parasitic nematodes.
Ana Pineda	Wageningen University	Aphids manipulating plant defenses: effects on feeding behavior
Tjeerd Snoeren	Wageningen University	Molecular ecological approach to role of herbivore-induced plant volatiles in parasitoid attraction.

Parallel 1b: Conservation and Restoration Ecology

Name Main Author	University/Institute	Title Poster
Gerlinde de Deyn	Netherlands Institute of Ecology	How to restore hay meadow diversity & soil carbon sequistration?
Bikila Warkineh Dullo	University of Groningen	Restoration of dune slacks in the Netherlands: Opportunities and Challenges
Ine Pauwels	Ghent University	Coupling water quality and datadriven ecological models to assess and optimize river restoration plans in Flanders (Belgium)
Rohani Shahrudin	University of Groningen	Population structure of Schoenus nigricans in Dutch wet dune slacks

Parallel 1c: Fresh-water and marine Food webs

Name Main Author	University/Institute	Title Poster
Anna de Kluijver	Netherlands Institute of Ecology	Carbon flows from Microcystis to zooplankton in Lake Taihu, China

Parallel 2a: Multitrophic interactions

Name Main Author	University/Institute	Title Poster
Esther Chang	University of Groningen	Ecological stoichiometry of plant-soil feedbacks
Gert Everaert	Ghent University	The added value of multi-community cascade models to analyze the relation between water quality conditions and ecological status of rivers
Martine Kos	Wageningen University	Host-mediated effects of glucosinolates on natural enemies of cabbage pests.
Marjolein Kruidhof	Netherlands Institute of Ecology	Host-specific reward determines differential memory consolidation in parasitic wasps
Marjolein de Rijk	Netherlands Institute of Ecology	The effect of herbivory on the roots of Brassica nigra on the performance of an aboveground herbivore and its solitary parasitoid

Parallel 2b: Spatial Ecology

Name Main Author	University/Institute	Title Poster
Kelly Elschot	University of Groningen	Two interacting feedback loops controlling non-linear salt-marsh dynamics.
Nika Galic	Wageningen University	Influence of landscape structure, disturbance frequency and correlation on recovery time of 2 arthropod species
Peter Goethals	Ghent University	Optimization of a fuzzy physical habitat model for spawning European grayling (Thymallus thymallus L.)
Fernando Monroy	Netherlands Institute of Ecology	Similarity decay in soil bacteria and nematode communities in relation to geographic distance
Peter Mwangi	University of Twente	The Influence of landscape heterogeneity to amphibian species richness in Malaga province, Spain
Shirin Taheri	University of Twente	Hyper temporal NDVI images for modelling the habitat distribution of Green lizard

Parallel 2c: Community Ecology

Name Main Author	University/Institute	Title Poster
Herman Hummel	Netherlands Institute of Ecology	The effects of locking-up a sea-arm: Long-term developments in the macrobenthic communities of the saltwater lake Grevelingen
Jasper Ruifrok	University of Groningen	Heterogeneity in vegetation structure in grazed ecosystems, a modeling approach
Ciska Veen	University of Groningen	Effects of above-belowground interactions on vegetation patterns depend on aboveground herbivore size.
Kim Meijer	University of Groningen	The Enemy Release Hypothesis - a review
Andreas Demey	Ghent University	Direct and indirect impacts of the hemiparasites Rhinanthus angustifolius and Pedicularis sylvatica on species richness and community structure in managed grassland in Flanders

Parallel 3a: Global biogeochemical cycles

Name Main Author	University/Institute	Title Poster
Arina Schrier	Wageningen University	Release of CH4 and CO2 from lakes and ditches in temperate wetlands
Elmar Veenendaal	Wageningen University	Vegetation structure dynamics in the forest-savanna boundaries in tropical regions of Africa, Australia and South America; an analysis across continents
Lesley Salt	Royal Netherlands Institute of Sea Research	The North Sea Carbonate System

Parallel 3d: Invasion Ecology

Name Main Author	University/Institute	Title Poster
Pieter Boets	Ghent University	What caused changes in the gammarid fauna in brackish polder waters?
Sabrina Carvalho	Netherlands Institute of Ecology / University of Twente	Study the biochemical properties of Senecio inaequidensand Jacobaea vulgarisusing visible and infra-red spectroscopy
Thomas van Hengstum	University of Amsterdam	Potential effects on the pollination of native plants in the presence of feral populations
Sandra Hudina	University of Zagreb	Interactions between two invasive crayfish species, the signal crayfish (Pacifastacus leniusculus) and the spiny cheek crayfish (Orconectes limosus) : outdoor experiment and laboratory study
Andreja Lucic	University of Zagreb	Ecological characteristics of invasive signal crayfish (Pacifastacus leniusculus) in Croatia
Lidwien Raak-van den Berg	Wageningen University	Establishment of Harmonia axyridis in the Netherlands: successful aphid control and/or ecological disaster?
Tanja Speek	Wageningen University	Predicting invasive behaviour of exotic plants with plant traits on a regional and a local scale.
Maria Viketoft	Netherlands Institute of Ecology	Plant parasitic nematodes on native and exotic plants: differences in top-down control?

Parallel 4a: Microbial Ecology

Name Main Author	University/Institute	Title Poster
Emilia Hannula	Netherlands Institute of Ecology	Effects of different potato genotypes on soil fungal community structure and function
Eelco Hoogwout	University of Groningen	effect of potatocropping on the soil microbial community - assessing ammonia oxidizing bacteria and archaea
Özgül Inceoglu	University of Groningen	Effect of plant genotype and growth stage on the ß-proteobacterial community associated with different potato cultivars in two fields.
Omid Jazayeri	Mazandaran University (IRAN)	Role of riboflavin on population of Pyricularia grisae (a common pathogen in rice)
Michele de Cassia Perreira e Silva	University of Groningen	Establishing the baseline of soil functioning in relation to key steps of the N_2 cycle
Tess van de Voorde	Netherlands Institute of Ecology / Wageningen University	Linking plant community heterogeneity to arbuscular mycorrhizae colonizing individual plants: A molecular field study

Parallel 4b: Movement Ecology: migration and dispersal

Name Main Author	University/Institute	Title Poster
Vena Adamczyk	Wageningen University	Barnacle geese (Branta leucopsis) prefer to associate with will known group members
Monique de Jager	Netherlands Institute of Ecology	Mussels on the move
Gustavo Pazos	CENPAT-CONICET (Argentina)	Measuring and modelling seed abscission in wind-dipersed Patagonian grasses
Tiejun Wang	Wageningen University	Migration patterns of two endangered sympatric species from a remote sensing perspective

Parallel 4c: Physiological Ecology

Name Main Author	University/Institute	Title Poster
Melis Akman	University of Amsterdam	Submergence Tolerance in Arabidopsis and the related genus Rorippa (Yellow cress)
Sebastiaan De Smedt	University of Antwerp	Effects of human pressure and climatic factors on leaf traits of baobab (*Adansonia digitata* L.) in Mali, Western Africa
Aghajanzadehdivaei Taherehalsadat	Mazandaran University (IRAN)	Effects of four allelopathic phenolics on physiological factors in rize (*Oryza sativa*) cultivars

Parallel 4d: Global change and biodiversity

Name Main Author	University/Institute	Title Poster
Aida Cuni Sanchez	Southampton University	Baobabs and climate change
Alma de Groot	Wageningen University	Modelling the effect of sand nourishments, sea-level rise and climate change on young dune formation and associated vegetation development
Henk van der Jeugd	Netherlands Institute of Ecology	Studying Avian Population Processes using Standardised Ringing
Christian Kampichler	Netherlands Institute of Ecology	Studying avian population processes using standardised ringing
Koen Lock	Ghent University	Are surfzone hyperbenthic communities affected by exotic species and global warming ?
Elly Morriën	Netherlands Institute of Ecology	Climate change induced range expanders promote release of soil-borne enemies
Hester Soomers	Utrecht University	Hydrochorous plant seed dispersal in fragmented habitats

Parallel 1d & 3b: Free Session

Name Main Author	University/Institute	Title Poster
Pascaline Le Gouar	Netherlands Institute of Ecology	Is spatial heterogenity in capture rate matter? Analyses of Dutch bird ringing data at Constant Effort Sites.
Cilia Grebenstein	Leiden University	Metabolic fingerprinting of carrot shoots enables distinction between wild and cultivated carrots (Daucus carota L.)
Nienke Hartemink	Utrecht University	Elasticity Analysis in Epidemiology: An Application to Tick-Borne Infections
Marlotte Jonker	Wageningen University	Foraging and public information use in common pipistrelle bats (Pipistrellus pipistrellus): A field experiment
Katrien Töpke	Ghent University	Application of data mining tools to relate macroinvertebrate traits to river conditions