

## **Workshop on 'Trophic Interactions in a Changing World'**

Date: April 3-7 2002, the Netherlands  
NIOZ, Texel

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### **1. Scientific content of the event**

#### *Introduction*

Across the biosphere, terrestrial ecosystems are severely affected and dominated by human activities often leading to strong declines in environmental and ecosystem quality and biological diversity. Human-induced changes in the environment have caused losses in natural habitats, but nowadays there are increasing efforts, by policy-makers as well as scientists, to promote recovery and restoration. These activities are directed to restore former species-rich ecosystems, but experiences so far show that 'the way back is often different from the way to'. And in many cases, there may be no way back at all. In order to understand the drivers of, as well as the reversibility (or the irreversibility) of changes, there needs to be an integral consideration of species, interactions at the same or at different trophic levels, community re-assembly, and ecosystem processes in order to identify critical bottle-necks and other constraints and to provide effective, affordable solutions.

#### *The set-up of the workshop*

Ecology is currently facing enormous challenges, such as to link evolutionary and systems approaches, to carry out studies in a multidisciplinary way, and to compare the validity of results across geographic ranges. However, in addressing these challenges it is important to determine the proper courses of action, to identify current successes and future challenges, and how to maintain this progress into the future. In the workshop on Trophic Interactions in a Changing World, research from different disciplines in ecology have been brought together, linking evolutionary and systems ecologists, above- and belowground ecologists, and empiricists and theoretical ecologists. The focus was mainly on terrestrial ecosystems, although there may also be some contributions from aquatic sciences, because that is where most food web modelling has started. The aim of the meeting was to present actual themes on trophic interaction research having a direct link with changes in terrestrial ecosystems and attempts to counteract these changes by ecological restoration. The invited speakers and chairpersons of the sessions were all outstanding scientists with proven expertise in their respective fields of research. There were four sessions which will be summarized.

#### *Session 1: Trophic interactions and landscape processes*

Understanding trophic interactions in a changing world requires understanding the scales at which trophic interactions act and at which the numbers and types of species are determined. Interactions between herbivores and plants, or between predators and preys, are immediate and act on a local scale. However, the type of species present at the local scale depends on the species pool of a landscape and on the ability of species to disperse and establish within, or even between landscapes. The structure of a landscape may affect functional groups of species differently, so that landscape processes determine if special functions in trophic interactions may or may not get lost. In order to understand how a changing world may affect trophic interactions, we determined how changes may affect landscape processes and dynamics, how these work out at interactions between species and trophic groups of species, and how these changed local interactions may feed back to processes at the ecosystem and the landscape scale. It turned out that dispersal is a key mechanism by which changes in one ecosystem may trigger changes thousands of kilometers away. Dispersal is affected by

landscape configuration, so that land use (e.g. intensification, removal of connection zones) may strongly impact on local interactions, such as natural control of herbivorous insects or pollination. Although most of these examples concern aboveground, or visible organisms, there were also demonstrations of large-scale dispersal of soil-inhabiting invertebrates, which were dispersed rapidly through the air across large distances. Visible patterns in, e.g. plant communities, are not random and modelling revealed interesting self-organization patterns and one of the discussion points was that there may be a tension between optimization of patterns and optimization of evolutionary processes.

### *Session 2: Variation and evolution in multitrophic interactions*

The genotypic composition of a population reflects differing selection forces previously acting on that population. This adaptation enables the population to respond to unpredictable conditions because it ensures an instantaneous fit of certain genotypes of the population to a range of environmental conditions and stresses. In nature it is well known that many plant and animal species exhibit considerable spatial variation in phenotypic traits. This workshop examined the role played by a wide range of ecophysiological factors in shaping this variation. Some of the areas to be considered were: the role of bottom up (resource-mediated), top-down (predator-mediated) or idiosyncratic (unpredictable) processes as driving forces for genetic variation across multiple trophic levels. Moreover, to what extent do environmental changes (e.g. human-induced changes in landscape structure) and the rates of change affect the dynamics of trophic interactions which in turn reflect the genetic constitution of organisms within a community? Some directions for presentation included studies of the controlling influence of the biological and physical environment as these influence adaptation, including interactions across different trophic levels, temporal variation in the structure of food webs, and genetic analyses of populations. It became clear that genetic variation has been neglected too often when considering trophic interactions in a changing world. One of the future challenges is to assess the role of evolutionary processes in the maintaining of multitrophic interactions that are exposed to, e.g. land use or climate changes.

### *Session 3: Linking above- and belowground trophic interactions*

Aboveground and belowground organisms have different rates of response to changed environmental conditions. In general, many aboveground organisms may have better dispersal capacity than many belowground organisms. As a result, there are different time-lags in the response of above- and belowground organisms to changes, especially to ecological restoration following the abandonment of high input-output production land. On the other hand, soil communities may have considerable functional redundancy because of their tremendous microbial diversity. These different responses of the biological diversity both aboveground and belowground to land use changes support the idea that there is a strong need to determine how above- and belowground diversity and complexity may be functionally linked.

Studies have provided evidence of linkages between above- and belowground organisms via their effects on the nutritive quality of plant tissue or via their effects on proportional distribution of above- and belowground plant organs. However, direct and indirect plant defense mechanisms may also provide means of (chemical) communication between above- and belowground organisms. Exploring how these forms of communication work out in different ecosystem compartments (above- and belowground) will provide new and exciting insight in how spatially (and possibly also temporally) separated organisms may influence each other.

#### *Session 4: Stability in trophic interactions*

Food web interactions are known to affect strongly the distribution, abundance and dynamics of populations, since the success of a population is largely a function of benefits derived from the acquisition of energy (and nutrients) and losses derived from predation. Empirical and theoretical studies of trophic interactions and the concomitant transfers of material have enabled the analyses of stability of communities and ecosystem processes. Stability analyses are crucial in our understanding of how ecosystems respond to disturbance and the potentials for ecosystem recovery and restoration. Moreover, trophic networks provide direct relationship between the assemblage of species, or functional groups of species, and processes, as trophic interactions reflect pathways of energy and nutrients. Biological diversity can then be translated into the diversity, and complexity, in the pathways in the ecological cycles. This opens a way to analyse the relation between biological diversity and complexity with the stability of ecosystem processes and hence quality. This session showed that there is a gap between models and data, which requires an urgent need to involve modelling approaches in empirical studies, as well as to make large data sets accessible to modellers.

## **2. Final programme ESF Exploratory Workshop: Trophic Interactions in a Changing World, 3-7 April 2002 Texel, The Netherlands**

### **DAY 1:**

#### **WEDNESDAY 3 APRIL: ARRIVAL**

- 18:00 Dinner  
20:00-20:20 Wim van der Putten (NIOO, The Netherlands)  
*Introduction to the workshop*  
20:20-20:40 Svenje Mehlert (ESF)  
*The European Science Foundation and Exploratory Workshops*

### **DAY 2:**

#### **THURSDAY 4 APRIL**

- 7:30- 8:30 Breakfast  
8:30 Leaving for NIOZ

#### **Session 1: Trophic interactions and landscape processes**

- 9:00- 9:15 Han Olf (Wageningen University, The Netherlands)  
*Introduction to the theme*  
9:15- 9:50 Bob Jefferies (University of Toronto, Canada)  
*Herbivores as opportunists in a world of plenty: The ecological consequences*  
9:50-10:25 Teja Tschardt (University of Goettingen, Germany):  
*Species richness and biotic interactions on a landscape scale*  
10:25-10:50 Max Rietkerk (Utrecht University, The Netherlands):  
*Herbivory and self-organized spatial patterns of plants and their resources in changing arid ecosystems*  
10:50-11:20 Coffee break  
11:20-11:55 Katarina Hedlund (Lund University, Sweden)  
*Colonization patterns of soil organisms, from micro scales to landscape levels*

## **Session 2: Trophic interactions and evolutionary patterns**

- 11:55-12:10 Hefin Jones (Cardiff University, UK)  
*Introduction to the theme*
- 12:10-12:45 Kent Holsinger (University of Connecticut, USA)  
*Evolutionary responses to a changing global environment*
- 12:45-13:45 Lunch break
- 13:45-14:20 Mark Hunter (University of Georgia, USA)  
*Insect population dynamics in a changing world: Some simple models and predictions*
- 14:20-14:45 Arjen Biere (NIOO, The Netherlands)  
*Evolution in trophic interactions in a fragmented landscape*
- 14:45-15:15 Tea break
- 15:15-17:30 Discussion groups day 1
- 18:30-20:00 Dinner
- 20:00-21:30 Reports from discussion groups

## **DAY 3**

### **FRIDAY 5 APRIL**

- 7:30- 8:30 Beakfast  
8:30 Leave for NIOZ

## **Session 3. Linking above- and belowground trophic interactions**

- 9:00- 9:15 Diana Wall (Colorado State University, USA)  
*Introduction to the theme*
- 9:15- 9:50 Valerie Brown (University of Reading, UK)  
Multitrophic interactions above- and belowground: Opening Pandora's box
- 9:50-10:25 David Wardle (University of Sheffield, UK)  
*Plant species effects on the decomposer subsystem: The role of biotic interactions and feedbacks*
- 10:25-10:55 Coffee break
- 10:55-11:20 Nicole van Dam (NIOO, The Netherlands)  
*Above- and belowground induced defenses in a changing world*
- 11:20-11:55 John Moore (University of Northern Colorado, USA)  
*When top-down effects become bottom-up effects*

## **Session 4. Stability in a changing world**

- 11:55-12:10 Janne Bengtsson (Swedish University of Agricultural Sciences) *Introduction to the theme*
- 12:10-12:45 Richard Law (University of York, UK)  
*On permanence, food-web assembly and metacommunities*
- 12:45-13:45 Lunch break

- 13:45-14:20 Neo Martinez (San Francisco State University, USA)  
*Food-web complexity: Mechanisms and predictions of the niche model*
- 14:20-14:45 Andre de Roos (University of Amsterdam, The Netherlands)  
*Towards a food-web theory based on individual life histories*
- 14:45-15:10 Anje-Margriet Neutel (Utrecht University, The Netherlands)  
*Biomass pyramids and the weight of trophic loops: How patterns of interaction strength enhance food-web stability*
- 15:10-15:40 Tea break
- 15:40-17:30 Discussion groups day 2
- 19:30-21:00 Dinner at the beach
- 21:00-21:30 Evening lecture by Theunis Piersma (NIOZ, The Netherlands)  
*Human disturbance of foodweb structure in the Dutch Wadden Sea*

#### **DAY 4**

#### **SATURDAY 6 APRIL**

- 8:00- 9:00 Breakfast
- 9:00-11:00 Fresh walk along the beach, or bike ride on the island
- 11:00-12:30 Discussion groups prepare reports
- 12:30-13:30 Lunch
- 13:30-15:30 Discussion groups present chapters and feed-back from the whole group
- 15:30-16:00 Tea break
- 16:00–17:30 Parallel sessions:  
1) Wim van der Putten (NIOO, The Netherlands)  
*Eurocores: discussing a proposal*  
2) Volkmar Wolters (Justus Liebig University, Germany),  
*Conclusions and perspectives for end users and stake holders: GCTE, Diversitas, SCOPE*
- 18:30–20:30 Dinner
- 20:30–21:15 Roles, procedures, time schedule for the book and final discussion  
21:15–21:40 Louise Vet (NIOO, The Netherlands)  
*Personal impressions and views on the workshop*
- 21:40-late Beer

#### **DAY 5**

#### **SUNDAY 7 APRIL**

*Departure*

### 3. Assessment of the results and contribution to future direction of the field

All contributors and participants were excited about the variety of disciplines that have been brought together for the Exploratory Workshop. The general feeling was, that this shouldn't be a one-time event, but that it should be succeeded by a series of activities. The ESF-representative, in her introduction, concluded that probably the group, or different subsets, would know each other well enough that a network would not make a necessary intermediate step into further developments. During a final discussion on Saturday, we reached the conclusion that a proposal for a programme activity would be the most logic step, enabling to work out each session into a separate workshop en to stimulate exchanges of researchers among research groups. The synthesis should then come from an initial and a final conference. Several participants offered to become local representative and several offered to contribute to the writing. It was concluded that one of the next calls for proposals should be aimed at.

Besides a programme proposal for ESF, it is also aimed at producing a special issue for a journal (instead of a book as initially intended). The articles will be based on the discussion groups, who are now using email for further correspondence. The articles will be about:

- Consequences of changes in landscape structure for evolutionary processes in trophic interactions
- Trophic interactions in soils in changing landscapes
- Scaling trophic interactions in a changing world
- How to model above and belowground interactions in a changing world
- How does global change affect the strength of trophic interactions
- Competition versus trophic interactions for stabilizing interactions in a changing world

### 4. Statistical information on participants

	Country	Number of participants
Europe	Denmark	1
	Finland	1
	Germany	7
	Spain	1
	Sweden	2
	Switzerland	1
	The Netherlands	20
	United Kingdom	9
	Other	United States of America
Canada		1
	Total	48

Age class	Number of participants
20 – 30	3
30 – 40	11
40 – 50	25
50 >	9
Total	48

## 5. Final list of participants

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