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Agroecosystem management and spatial organization of arthropod communities

Valentina M. Afonina, Wladimir B. Tshernyshev, Anton V. Sujazov, Rimma R. Seyfulina, Alexander V. Timokhov, Olga V. Solovchenko.....1-4

Abstract: We determined the levels of similarity between the complexes of plants, spiders, all beetles and carabid beetles inhabiting different biotopes of an agroecosystem: forest belts, field margins and the arable field (at 10, 200 and 400m from the edge). Geobotanical analysis, entomological netting and pitfall traps were used. Boundaries between plant communities were clearly expressed whereas arthropod communities were not confined usually to a certain biotope. The catches of all arthropods by pitfall traps in different biotopes were more similar than the catches by entomological net. Differences of all communities within the field were minimal but the influence of adjoining biotopes was obvious. The difference of spider complexes in different biotopes was greater than this difference between beetles complexes. All differences increased according to the distance from one collecting place to another.

Ground beetle dispersal: how to bridge the scales?

Bas Allema, Walter Rossing, Wopke van der Werf, Dine Volker, Juliette Marsan, Eveliene Steingröver, Joop van Lenteren5-8

Abstract: Beneficial arthropods that provide biological control of aphids or weed seeds use a variety of habitats in agricultural landscapes. Information on the movement behaviour of these arthropods between these habitats is needed to develop conservation strategies that sustain pest suppression in agricultural landscapes. Models for movement behaviour may help to understand and explore biocontrol functions. As measurements of behaviour at the landscape scale are technically difficult to make, measurements are often made at smaller scales. It is then necessary to upscale to larger scales, using movement models. Here we present a case study on such upscaling. The first results indicate that upscaling from small scales to large scales, using a correlated random movement model, may result in errors. An alternative approach, to be tested in further work, is to fit the movement model directly to the large scale data.

Wind born pollen effect on arthropod populations in agricultural fields in the northern Negev, Israel

Eitan Amiel, Phyllis G. Weintraub, Yael Lubin.....9-11

Abstract: One of the alternatives for chemical pesticides currently being developed is the improvement and/or conservation of the natural biological control services provided by the agricultural field, a practice known as conservation biological control. In and around agricultural fields there are many predators and parasitoids which provide ecological services as natural enemies of pest species. In this research plants providing wind-borne pollen are used in a habitat management scheme to enhance natural enemy diversity in desert agriculture to achieve pest control. Pollen providing plants will be used in two systems – orchard crops and perennial herb fields – and total pest and predator populations will be monitored.

Farming practices and ecosystem services

Georg Andersson, Henrik G. Smith, Maj Rundlöf..... 12

Abstract: During the last century there has been major intensification in agricultural landscapes and large declines in semi-natural habitats. This affects not only biodiversity but also the ecosystem functions performed by species, such as pollination.

Studies of landscape effects on biodiversity most often focus on the spatial distribution and quality of habitats, but the time-scale is not equally well studied. How historical processes effects the configuration of biodiversity and ecosystem function is of great importance to more efficiently set up management to prevent further losses. In Europe organic farming is one of the environmental schemes argued to benefit biodiversity (Bengtsson *et al.*, 2005), but effects have been shown to depend on landscape context (Rundloef *et al.*, 2008). In this research project I study how organic farming, and the time since transition from conventional farming, affects pollinator diversity and the pollination services they perform. I also study if these differ with landscape intensity use.

We used organic farms, situated in landscape with similar structure but with different time since transition from conventional to organic. A set of conventional farms were used as control. The set up were also contrasted with landscape types with different complexity and farming intensity. To examine the effects on pollination we set up experiments on strawberries in pots situated along transects adjacent to field borders.

Engineering arable landscapes to balance the pros and cons of weeds

Graham Begg, Nick Birch, Pietro Iannetta, Mark Young, Geoff Squire.....13-16

Abstract: Using a metacommunity model of uncultivated plant populations in an arable landscape the positive contribution of source-sink dynamics to species coexistence is demonstrated. The source-sink mechanism, which relies on spatial variation in habitat quality, presents an opportunity to promote arable diversity by managing the spatial component of cropping patterns.

What happens to the predator *Atheta coriaria* when inundatively released in the field for biological control of cabbage root fly?

Jude Bennison, Mike Lole, Tom Pope, Heather Maher, Kerry Maulden, Martyn

Watling17-20

Abstract: The predatory staphylinid beetle, *Atheta coriaria*, can be reared easily and cheaply on turkey feed. This creates opportunities for inundative release of the predator at relatively low cost for biological control of pests with ground-dwelling life stages. *A. coriaria* was mass-released into a commercial cauliflower crop, in a field trial to investigate its potential for biological control of cabbage root fly (CRF) (*Delia radicum*). Significantly fewer dead plants due to CRF damage and higher root weights of surviving plants were recorded in plots treated with *A. coriaria* or with chlorpyrifos or spinosad than in untreated control plots. If use of *A. coriaria* for biological control of CRF is developed for commercial uptake, its potential interactions with other immigrant and resident beetles should be investigated. Initial data on beetle activity in the trial field was collected and these preliminary results are discussed.

Predicting the time to colonization of *Diadegma semiclausum* using spatial dispersal kernels

F. J. J. A. Bianchi, N. A. Schellhorn, W. van der Werf21-24

Abstract: The time at which natural enemies colonize crop fields is an important determinant of their ability to suppress pest populations. This time depends on the distance between source and sink habitats in the landscape and on the dispersal behaviour of the natural enemy. Here we estimate the time to colonization of sink habitats from a distant source habitat using a simulation model that was parameterized with mark-capture data of *Diadegma semiclausum*. Dispersal behaviour was modelled with spatial probability distributions of dispersal distance, so-called dispersal kernels. We show that dispersal kernels that receive similar support from the data can produce a wide range of arrival times. We also demonstrate that the time to colonization increases

more than proportionally with the distance between source and sink. This result underscores the importance of proximity of source habitats of natural enemies for early colonization and a large impact of natural enemies in crop fields.

The mainstreaming of biodiversity and conservation stewardship at The Yalumba Wine Company, Australia

Cecil Stephen Camilleri25-28

Abstract: In 1995 *The Yalumba Wine Company* commenced a structured approach to sustainability and environmental management, which in 2003 culminated in a doctoral thesis authored by this writer (Camilleri 2003). Yalumba continued its efforts to mainstream biodiversity as part of its ‘*Commitment to Sustainable Winemaking*’ programme and sought to identify whether the programme was delivering on its commitment by undertaking an ex-post strategic assessment (Camilleri 2008a). The strategic follow-up indicated Yalumba needed to do better in communicating with the principal members of its value chain in order to effectively engage them in its sustainability programme.

Maize weed communities composition in a highly anthropized landscape: which vegetation response variables and landscape descriptors?

Stefano Carlesi, Gionata Bocci, Anna-Camilla Moonen, Paolo Frumento, Paolo Bàrberi.....29-32

Abstract: Few scientific guidelines are available for the definition of parameters to be taken into account in studies aiming at determining the spatial interactions between weeds and their environment. The choice of both landscape descriptors and weed response variables and the scale at which they should be measured is important. The objective of this study was to define a methodology to support the choice of landscape descriptors and weed response variables and the spatial scale at which their interactions occur. We assumed that weed communities respond to landscape parameters based on the various ecological and biological characteristics of the component species. A case study in a highly anthropized landscape along the Tuscan and Ligurian coastline is presented, with the main aim to determine how land abandonment and urbanisation affect in-field weed communities. We selected a variety of landscape descriptors for (a) field margins, (b) landscape structure and (c) landscape composition. Landscape structure and composition were considered in circles of various radii (100, 250, 500, 1000 and 1500m around the centroid of each field). The sensitivity of each weed response variable depended on the scale at which the landscape descriptors were measured and on the characteristics of the field margins. This study shows that the selection of weed response variables, landscape descriptors and the scale at which data are collected are extremely important and may considerably affect results.

Entomophagous insects, dedicated to the study of their diversity, their effectiveness as biocontrol agents and of habitats potentials, a case study in several french areas

Charlotte Dor, Julie Maillet-Mezeray33

Abstract: The project “Les Entomophages en grandes cultures: diversité, service rendu et potentialités des habitats” aims to evaluate the diversity and biocontrol efficiency of the entomophagous insects in cereal crops systems. This project, started in January 2009 and lasting 3 years, gathers 9 partners: *Arvalis Institut du Végétal**, project leader, the *CRAP**, the *ACTA**, the *INRA-SAD Paysage**, the *UMR INRA Agrocampus Rennes Bio3P**, the *UMR INRA Agronomie et Environnement Nancy-Colmar**, the *ITB**, the *CETIOM** and the *ITAB**. This project is partly funded by the Agriculture and Fisheries Ministry.

The first part of the project is a census of beneficial insects in crops, especially carabids and syrphids, predators, and parasitoids. Several locations will be monitored in 3 French regions: the Centre region, managed by Arvalis, the Rhone-Alps region, managed by the ACTA and the Picardie region, by the CRAP. A set of trapping (42 crops, 597 pitfall-traps, and 16 Malaise traps) and observation devices have been installed in the plots for a 3 year period: Barber pitfall-traps for carabid beetles, Malaise traps and “observation frame” for syrphids and parasitoids. The target

pests of these beneficials will also be studied: slugs, predated by carabids, censused by INRA-Bayer traps, and aphids, censused by counting within the observation frame.

All the data obtained and data concerning the cultural systems used, the agroecological “facilities” (hedgerows, grass strips) of the crops, the landscape features and the pedo-climatic conditions of the different locations will be compiled in a specific database.

The second part of the project deals with the experimental estimation of the biocontrol efficiency. These trials are to be set up this year, as combined devices of modular beneficial exclusion and pest exposure. The goal of this experiment is to quantify and characterize the impact of the beneficial fauna on pest populations, in light of crop and environment characteristics.

In this project, after a descriptive phase analyzing the spatial distribution of insect populations, it is intended to use the data set to define the factors conducive to beneficials and to assess and “typify” the influence of agroecological structures on their attendance in crops.

Different habitats in arable land and *Fagopyrum esculentum*: their influence on aphid antagonists

Lisa Eggenschwiler, Rémi Dufлот, Katja Jacot.....35-39

Abstract: Wildflower strips, improved field margins, rotational fallows and conservation headlands are part of the Swiss agri-environment scheme. These ecological infrastructures were developed to enhance the diversity of fauna and flora in arable landscapes. However, it would be favourable if attracted beneficial arthropods significantly reduced pest infestations in nearby crops. The aim of our project is to adapt existing ecological infrastructures to create more tailored ones for the promotion of aphid antagonists.

In two field experiments we tested the importance of *Fagopyrum esculentum*, which is part of several seed mixes for ecological infrastructures on arable land, for aphid antagonists (syrphids, coccinellids, chrysopids). In the first experiment *F. esculentum* was placed in pots into different habitats (grassy margin, hedgerow margin, winter wheat) and compared to the existing vegetation. In the second experiment aphid antagonists were counted in a strip sown with *F. esculentum*, an improved field margin, a grassy margin and a hedgerow margin. The first experiment showed that independent of the habitat *F. esculentum* attracted more aphid antagonists than the existing vegetation. As *F. esculentum* is early-flowering it is a promising plant to support the build-up of antagonist populations. Many syrphids, coccinellids and chrysopid eggs were even found when *F. esculentum* was placed within winter wheat fields. In the second experiment most syrphids were counted on *F. esculentum* and in the improved field margin whereas the highest number of coccinellids occurred in the improved field margin. *F. esculentum* offered the best egg-laying sites for chrysopids. Thus open, flower-rich habitats seem to be most attractive for aphid antagonists.

Landscape studies for conservation biological control research: status and future needs. A meta-review from the EU NoE project ENDURE

Andrew W. Ferguson, Oscar Alomar.....41-44

Abstract: A meta-review of 90 review papers published in the period 1989-2009 was used to assess the status of research into landscape management for conservation biological control (CBC) and identify gaps in the science. Landscape scale studies comprised 19% of reports of CBC research and were associated with some of the best evidence for promoting natural enemies. However, 46% of reviews considered more studies were needed on the effect of landscape-scale interactions. A lack of assessment of impacts on pests and crop damage was seen as a barrier to progress. A common approach to sampling methodologies would increase the value of individual studies.

Perennial field margins with combined agronomical and ecological benefits for vegetable rotation schemes

David R. George, Patricia Croft, Phil Northing, Felix L. Wäckers45-48

Abstract: A 5 year project is underway in the UK which is looking to build upon previous research to combine the biodiversity and pest-control benefits of perennial field margins across a horticultural rotation, providing growers with a direct economic benefit in addition to expected subsidies from stewardship schemes. Key to the success of this project is the selection of flowering plant species for inclusion in experimental field margins that will provide multiple benefits in terms of promoting functional agro-biodiversity. For this purpose a combination of margin plant species have been selected that ensure supply of nectar, pollen, bird food and shelter and alternative prey for natural enemies. This paper focuses on the plant selection process used to formulate a suitable margin seed mix. An outline of the project as a whole, including longer-term aims and objectives, is also provided.

Analyses of interactions between the landscape and natural pear psylla antagonists – Results of a study at the German fruit growing region "Lake Constance"

Burhard Golla, Martin Trautmann.....49-53

Abstract: In order to study the influences of the landscape on orchards pests, the areas around pear orchards were investigated. An inventory of landscape elements was made and presence and quantity of natural enemies was assessed. Data were analysed to whether the quantity of small landscape elements and land use were correlated with the quantity of pests or natural enemies. The study was conducted in different European regions within the Network of Excellence ENDURE (European Network for Durable Exploitation of Crop Protection Strategies). Results of the studies are intended to be used to optimise integrated pest management. Results from the Lake Constance region are presented here.

Integrated pest management at the landscape scale: tracing the tale of cotton IPM in the San Joaquin Valley of Central California

P. B. Goodell, K. Patterson-Lynn55-61

Abstract: *Lygus hesperus* (Knight) is a key pest in many crops and is hosted on multiple weed and native vegetation in the San Joaquin Valley (SJV) of Central California. For over 45 years, the cropping landscape has been recognized as a key component in managing this insect pest in cotton. Over the past 20 years, the acreage of cotton has contracted by 80%. As the cotton landscape has become increasingly fragmented, more crops that serve as sources of *L. hesperus* have frequently come into contact with cotton, creating new IPM challenges. We have studied the change using a variety of approaches to estimate the change in landscape structure, the proximity of cotton to sources and sinks and are developing estimates of the “strength” of crops to act as sources for this pest.

Measuring the impact of crop management on crop diseases, weeds and insect pests at the regional scale

Marie Gosme, Maguie de Villemandy, Mathieu Bazot, Damien Marchand, Marie-Helene Jeuffroy63-67

Abstract: Organic farming still represents a small part of agricultural land in France but is developing fast due to government incentives and a growing demand. However, it is unknown whether it would favour or reduce pests and diseases at the landscape scale. Our objective was to measure effects of crop management in a given field and neighbouring fields on pests’ dynamics, through surveys of farmers’ fields in a small region. The cropping practices presented a certain degree of diversity but a hierarchical classification of the fields gave no indication of strong differences between different types of cropping systems, except the obvious separation between organic and conventional farming. Wheat fields were classified according to their management (organic vs. conventional) and management of neighbouring fields (at least one organic vs. all conventional). Leaf blotch was significantly higher in conventional fields, but there was no effect of crop management in the adjacent fields. For powdery mildew, the high variability between

plots led to non-significant effects. The organic plots harboured significantly more weeds with higher diversity than conventional plots. The effect on weeds of having at least one organic plot in the neighbourhood was inconsistent between observation dates. Significantly fewer aphids occurred in the organic plots than in the conventional plots, and having at least one organic plot in the neighbourhood significantly decreased the number of aphids.

Multi-function agricultural biodiversity and agri-environmental schemes in Australian agricultural landscapes

Geoff M. Gurr69-72

Abstract: This paper synthesises recent results from work on enhancing biological control of pests in a range of Australian agricultural systems in which forms of agri-environmental schemes are used. A key aspect of using biodiversity-related effects for pest management is that land managers are concerned with multiple issues and tend to be unwilling to institute changes to land management specifically to achieve sustainable pest suppression. It is therefore important that those involved in developing ecologically-based pest management strategies promote them as part of a suite of benefits that justify the effort involved. For example, work in Australia has demonstrated that biological control can be enhanced by use of ‘shelterbelts’. These rows of trees are traditionally used to protect crops and livestock from extreme weather but have become more popular to manage the hydrology of catchments and avoid soil salinity. Such forms of farm forestry - and agri-environmental schemes in general – are likely to become more lucrative as payments are made for carbon sequestration. Biological control workers can ‘piggy back’ on the ecosystem services provided by farm tree plantings by encouraging use of mixed tree species and the presence of understorey shrubs and groundcover vegetation to enhance parasitoids and predators. This paper also reports on the range of methods being used to elucidate how landscape characteristics can influence the dynamics of pest: natural enemy interactions and how these can be used to better manage pests. These include (i) chemical ecology of induced plant defences to direct natural enemy movement between vegetation types (ii) rare earth and dye marking to track arthropod movement and (ii) geo-spatial analysis to understand the importance of connectivity. Results are presented from a study in which non-crop vegetation harbours an insect-transmitted plant pathogen illustrating that vegetation biodiversity can have negative as well as positive consequences for plant protection.

The Farm4Bio project: investigating the relationship between uncropped land and beneficial invertebrates

John M. Holland, Tom Birkett, John Simper, Helen Martin, Jonathan Storkey73-76

Abstract: The overall project’s aim is to determine whether management of uncropped land for biodiversity on conventional arable farms can achieve significant and measurable increases in biodiversity, that are at least equivalent to those attained on organic farms. The proportion and type of land usage within and surrounding the 1km² study areas is also being investigated for a range of organisms that include natural enemies of pests for which results are presented. The numbers of pests and their natural enemies within grass margins were positively related to the proportion of arable land in the 3 x 3km surrounding the study area. Numbers of hoverflies were similar in a range of sown non-crop habitats, but lower in grass margins and natural regeneration. The findings indicate that sown wildlife habitats can support natural enemies but landscape usage is also a key driver.

Response of weed flora to large-scale landscape factors

Maria John, Bärbel Gerowitt77-80

Abstract: Weed communities were investigated in a large-scale agricultural region in northern Germany. Multivariate analysis was used to determine how species richness and weed composition respond to landscape structure at different spatial scales (namely 100m–2500m). Records of species numbers were accompanied by high variance. There was a significant correlation between landscape structure and species richness. However, the impact of landscape complexity on species richness was relative low and mostly scale independent. Landscape

characteristics within a 100m circle provided significantly the best explanation of species richness on conventional plots. The percentage of explained variation in species composition through landscape variables ranged from 3% to 5%. Local site effects explained a considerably higher percentage of variation in species composition. Ellenberg indicator values and soil type explained 14% of variation. These results indicate that it is difficult to relate weed species communities to landscape characteristics if the landscape is relatively homogenous and large-scaled. Nevertheless there seems to be a stronger effect of landscape characteristics on species if diversity exists at a small spatial scale.

The effect of landscape composition on host-parasitoid interactions in brassica crops

Mattias Jonsson, Hannah L. Buckley, Bradley S. Case, Roddy J. Hale, Steve D. Wratten, Raphael K. Didham.....81

Abstract: Crop fields located in diverse landscapes with a lot of non-crop vegetation tend to have higher densities of natural enemies and lower pest numbers than fields in simplified landscapes dominated by agriculture. However, since many factors are correlated in most agricultural landscapes it is often difficult to tease apart the mechanisms driving such landscape effects. We took advantage of a landscape modification gradient in New Zealand in which landscape diversity and cover of annual crops were uncorrelated, and studied the effect of these variables on interactions between two pests and their parasitoids and hyperparasitoids in forage brassica crops. We then used structural equation models to try to tease apart the potential mechanisms behind observed relationships between landscape composition and parasitism rates. We hypothesized that landscape effects might be mediated by availability of floral resources, availability of crucifer host plants, the frequency of mechanical disturbance and the frequency of insecticide application. Results from this study will be presented at the conference.

Parameter harmonisation for calculating landscape configuration effects on weed communities

Anna-Camilla Moonen, David Bohan, Sandrine Petit, Bruno Chauvel, Lisa Eggenschwiler, Stefan Otto, Burkhard Golla.....83-86

Abstract: Within the Network of Excellence ENDURE (European Network for Durable Exploitation of Crop Protection Strategies) a group of weed scientists have explored the possibility of re-analysing existing weed community databases for possible surrounding landscape configuration effects. Existing databases were characterised and the weed measurement and landscape metrics important for such analyses were selected. In the next phase all partners tested relevant hypotheses on their database, following agreed guidelines. Results from these case studies confirmed the importance of incorporating ecological and biological characteristics of the weed flora. They also confirmed the need to define landscape metrics which express landscape mosaic structure and land-use diversity at relatively small scales, ranging from directly-adjacent to the field (i.e. margin types) up to landscape metrics about 200m from the field. This work is intended to stimulate other weed scientists to repeat this exercise on their own databases in order to continue the discussion on parameter definition for testing of landscape effects on weed communities.

Conservation biological control at the landscape level: measuring and modelling

Sandrine Petit, Claire Lavigne, Andrew Ferguson, Philippe Tixier, David Bohan, Ian Denholm, Stefan Otto, Oscar Alomar, Andrea Veres, Lisa Eggenschwiler, Gionata Bocci, Camilla Moonen, Burkhard Golla.....87-93

Abstract: The incorporation of landscape management into Conservation Biological Control (CBC) strategies is a priority area of research but is hindered by a lack of harmonisation of the means to describe and measure the effectiveness of CBC, the organisms under focus and the landscape. This paper provides a set of recommendations that represents the consensus amongst experts of the ENDURE network. The most important data values that were identified were: pest population level; natural enemy population or % parasitism/predation; crop damage; estimate of mobility of study organisms (dispersal function) and non-explicit spatial measurements such as

the proportion of the landscape offering resources and the connectivity between resource patches. For all these measurements, careful consideration should be given to the appropriate spatial and temporal scale of assessment. For analysis, we advocate an iterative use of modeling tools, particularly individual-based models, and statistical approaches: the former to understand mechanisms underlying the population dynamics of pests and their natural enemies in landscapes and the latter to characterize the observed patterns of these populations in a given landscape.

Identification of resource bottlenecks in agro-ecosystems and quantifying their impact on biological pest control

Mark Ramsdena, Rosa Menendez, Simon Leatherb, Felix Wäckers.....95-98

Abstract: Insect predators and parasitoids can provide valuable ecosystem services by acting as biological pest control agents in agro-ecosystems. The natural enemies of pest species often require a greater diversity of resources than the crops themselves provide, and in conventional farm management these beneficial species may be compromised by lack of floral resources, alternative prey, or suitable overwintering sites. While previous studies have shown that field margin management can influence the population dynamics of beneficial insects, the particular mechanisms involved remain unclear. The study aims to disentangle the mechanisms contributing to the supporting of beneficial species population, and provide quantitative data to assist in the design of optimum integrated management prescriptions.

Influence of crop management and landscape diversity on *Meligethes aeneus* and its biological control

Adrien Rusch, Muriel Valantin-Morison, Jean-Pierre Sarthou, Jean Roger-Estrade99-103

Abstract: Pest management strategies have traditionally focused on the field scale and often rely on the use of broad-spectrum pesticides. Recent studies have pointed out the importance of taking into account larger scales to understand pest and natural enemy population dynamics. Enhancing the natural regulation function in agroecosystems therefore appears to be a promising way to increase crop production sustainability.

In this study, we examined the relative influence of crop management and landscape context on a serious winter oilseed rape (OSR) pest (*Meligethes aeneus*) and its parasitoids. Landscape variables were assessed in 8 different buffers ranging from 250m to 2000m radius in order to identify the most relevant spatial scale. We used multimodel inference methods to identify and rank the relative importance of the explanatory variables. The most relevant spatial scale and predictors were determined examining their relative importance based on the sum of Akaike weights.

We found that large buffers (from 1500m to 2000m) were the most adapted scales to explain pest abundance and subsequent crop damage. Proportion of forest is positively correlated with pollen beetle abundance and injuries and is the most significant explanatory variable. Nitrogen nutrition index appears to have an important influence on crop damage, with high nitrogen content plants supporting the lowest proportions of destroyed buds. Non-crop areas and the proximity to previous year oilseed rape crop in the 250m buffer around the fields appear to be the most important variables for explaining parasitism rates of pollen beetle larvae. These results are discussed in relation to the design of innovative crop protection strategies.

The role of 'low-input' agri-environmental schemes in the enhancement of functional biodiversity of Hungarian arable fields

Ferenc Samu, Dóra Neidert, Éva Szita, Kinga Fetykó, Zoltán Botta-Dukát, András Horváth105-108

Abstract: The Mezőföld region in Hungary typically consists of intensive arable land which dominates large areas on the loess plateaus of the region, and low-input meadows in mosaic with wooded areas which are typical for the incised loess valleys. We carried out a landscape experiment in seven 5x5 km quadrates in the region. The quadrates contained different proportions of arable land and low-input meadow areas, thus represented a land-use intensity gradient. We studied the exchange of functional biodiversity between these habitat types at a

series of spatial scales. We regarded spider assemblages of the sampled plots as a model group that represents broader functional biodiversity. Samples were taken for three years in two cereal field plots and in one meadow plot per landscape quadrat. We studied the effect of the presence of different habitat types in the landscape neighbourhood of the plots on spider species richness, abundance and community composition. For spiders in the meadow plots the presence of arable habitats had in general a negative effect, while for spiders in the cereal plots the presence of meadows had a positive effect after controlling for local environmental variables and taking into account spatial effect. This analysis had been performed five times for each plot to take into account habitat types within five different radii between 50-1000m. The strongest effects were observed for habitats within the 100m and 600m circles both for meadow and cereal plot spider assemblages. These and further studies into the effective distances of interacting habitat types may help to optimize the spatial distribution of agri-environmental schemes.

Management of habitat diversity on arable farmland to maximise control of crop pests by communities of beneficial organisms

Martin T. Torrance, Jason Baverstock, Helen Martin, Judith K. Pell109-112

Abstract: The effect of habitat diversity on beneficial insects is being assessed in order to optimise the management of the arable landscape to improve pest suppression. The abundance of aphids and their natural enemies was assessed by Vortis sampling on uncropped and cropped land within 100 ha study areas on twelve farms in the east of England. Eight of these farms had additional sown covers established on them, either as strips or blocks and in two quantities, 1.5 and 6ha. All samples were taken in July 2008. The new covers comprised natural regeneration (NR), floristically enhanced grass (FEG), insect rich cover (IRC) and winter bird cover (WBC). Within the newly sown covers the total number of natural enemies was greatest in the FEG, although parasitoid numbers were greatest in the WBC in which flowering fodder radish provided a supply of nectar at that time. Although parasitoids were equally abundant in strips and blocks, the total number of natural enemies was greatest in strips, perhaps reflecting variability in mobility of different taxa. We hypothesised that the total number of natural enemies would be greater in the new sown habitats than in other uncropped land areas, but this was not the case in 2008 and may have been because the covers were newly established that spring. Further data from 2009 and 2010 will aid interpretation. There were fewer aphids in crops on farms with the additional sown covers compared to farms without additional covers. While we hypothesise that this could have been as a result of enhanced enemy activity prior to the date we sampled, and associated with the presence of the experimental sown covers, we will only be able to understand this more fully by evaluating additional through-season samples that were made on a sub-set of the farms and data from subsequent years. Here we have presented preliminary interpretations based on available data for 2008 only. Far more robust analysis and interpretation will be possible when we are able to include data from 2009 and 2010.

May ecosystem sustainability be influenced by carnivorous carabid beetles – inhabitants of ground surface?

Wladimir B. Tshernyshev, Valentina M. Afonina, Andrey N. Semenov, Yaroslav

A. Terehov.....113-116

Abstract: Carabid beetles of many species are very active and abundant predators. Analysis of their intestinal content shows that they can eat arthropods inhabiting the grass layer (hortobionts). There are many important pests among hortobionts. However the carnivorous carabid beetles usually hunt at the soil surface and it is not clear how these beetles can reach inhabitants at grass level. Analysis of special literature has shown that hortobiont pests only seldomly go down. Likewise the inhabitants of ground level (herpetobionts) are not usually able to climb the grass. With the help of plastic open containers put on the soil surface between grass stems we have found that about 200-300 specimens of hortobiont arthropods fall down onto 1m² of the soil surface per day. Such arthropods may serve as a food for carnivorous beetles – herpetobionts. Influence of these predators on ecosystem sustainability is questionable.

Arthropod biodiversity monitoring using RBA techniques in viticulture

Maarten van Helden, Josépha Guenser, Emma Fulchin.....117-120

Abstract: Wine producing areas often contain a rather high percentage of ‘non-productive’ interstitial space that could be managed in favour of biodiversity. Wine growers are often interested in biodiversity since they presume that conservation biological control can contribute to pest management. When farmscaping measures are taken the expected increase in biodiversity over time should be monitored. There are few clear practical indications available for farmers on how to manage the landscape of a farm in favour of biodiversity.

We tested the Rapid Biodiversity Assessment method (RBA) which consists of trapping arthropods (using a pitfall and an aerial interception trap) followed by the identification up to order level and then of ‘morphospecies’ (visually different individuals are presumed to be different species). The method is not 100% sound for a taxonomist but it allows quick and easy measurement of general biodiversity, which can be done by non-experienced volunteers, reducing costs and increasing efficiency. Morphospecies richness and overall abundance can easily be measured and compared among sites, habitats and years.

Modeling and valuating the effects of landscape management on the ecosystem service of biological pest control – a spatial dynamic perspective

Wopke van der Werf.....121-124

Abstract: Biological control of crop pests is affected by a broad range of organisms which need a variety of resources in the crop and non-crop elements in the landscape to complete their life cycles. The effect of enemies on the population dynamics of pests depends on enemy density and diversity, and is critically affected by spatial and temporal scales. Recent studies illustrate how models can help to bridge those scales and quantify: (1) the relationship between sink-source distance in the landscape and time of colonization; (2) the relationship between time of colonization and enemy impact on pest population dynamics; (3) the relationship between enemy impacts, crop damage, and economic loss. Such models help to predict the effect of landscape and crop management on the effectiveness of ecosystem services. They are indispensable tools for integrating information across spatial and temporal scales, and translate ecological thinking into economic valuation.

The suitability of field margin flowers as food source for zoophagous hoverflies

Paul C. J. van Rijn, Felix L. Wäckers125-128

Abstract: Hoverflies with zoophagous larvae are among the most common natural enemies of pests in Dutch arable fields. Their effectiveness is partly limited by the availability of nectar and pollen for the adults. In this study we examined the suitability of flowers of *ca.* 30 plant species as food source for the common *Episyrphus balteatus*, both with choice tests and with non-choice survival tests. Many common field margin flowers appear to be unsuitable, as they do not allow the hoverflies to survive up to their reproductive age. The results can well be explained by flower morphology: only flowers with nectar available at a depth of less than 2mm are suitable. Choice tests indicate that the hoverflies mainly select flowers with accessible nectar. Moreover, field studies showed that field margins with a higher proportion of flowers with accessible nectar attract higher numbers of zoophagous hoverflies. These results stress the importance of laboratory bioassays for selecting the right plants for functional field margins.

A literature review on impacts of landscapes characteristics on densities of pests and on their regulation by natural enemies

Andrea Veres, Sandrine Petit, Cyrille Conord, Claire Lavigne129-133

Abstract: We performed a literature review on the impact of large-scale landscape composition on the abundance of pests or conservation biological control (CBC) effectiveness, measured in terms of parasitism or predation rates. We located 28 studies and 77 independent cases published between the years 1993-2008. Pests considered in these cases were mostly Lepidoptera, Hemiptera and Coleoptera. A large number of cases reported significant landscape effects but the

only significant tendency was that of increased CBC or lesser pest abundance with increasing non cultivated landscape area around sampling points.

Innovative methods for measuring *Orius* spp. (Anthocoridae) abundance at a landscape scale

Andrea Veres, Attila Kotan, Kinga Fetyko, Szilvia Orosz, Ferenc Toth.....135-138

Abstract: This study aimed at finding an appropriate method to measure abundance in the landscape of *Orius*, a biocontrol agent against thrips. Such measure would indeed provide an assessment for the potential of the conservation biological control of thrips species for greenhouse sweet pepper producers. Greenhouse sweet pepper was sampled 3 times during the season in 2005, while *Orius* larva, nymph and adult abundances in the landscape was measured once on poison hemlock (June), on maize silk (July), and finally in spider web pockets in the same maize fields (August). *Orius* abundance could be estimated in the landscape with these methods, which were easy to standardize and independent from local variability (like local vegetation). If we assume that, for a given date, the younger populations are situated at larger distances from the overwintering sites, we may conclude from the observed pattern of the individuals that the landscape may provide highly suitable overwintering sites in the south-east part of the study area. *Orius* spp. are highly mobile and generalist predators that use both flowering cultivated and non cultivated habitats. The second generation may therefore be highly abundant in the whole landscape by the end of August in such an extensively managed region.

Spatial ecology of *Cosmopolites sordidus* in banana field landscapes

Fabrice Vinatier, Pierre-François Duyck, Grégory Mollot, Philippe Tixier.....139-142

Abstract: We applied a comprehensive approach to understanding the spatial epidemiology of *Cosmopolites sordidus* in banana fields and to design of landscape strategies in order to minimize population levels and spread. We integrated different levels of complexity, from individual traits to the whole population, from the field to the landscape scale. To tackle this complexity, we linked experimental measures, statistical analysis and modelling tools. The originality of the approach lies in the iterative use of these different methods, usually applied separately.

Managing weed seed predation in arable fields

P. R. Westerman, B. Baraibar, D. Deadlow, M. Liebman.....143-146

Abstract: Weed seed mortality due to predation can have a strong regulatory effect on weed population dynamics and is therefore potentially important as a bio-control option for weeds. Weed seed predation is maximal when there is full spatiotemporal overlap in the occurrence of seeds and the activity patterns of seed predators. Crop management influences seed shed and seed burial, and could be used to increase seed availability on the soil surface. Weeds, and thus weed seeds, occur in patches that differ in density and quality. Two examples illustrate that seed predators responded slowly to seed patches, resulting in inversely density dependence, which favours the persistence of weeds in patches.