Complex Terrain and Ecological Heterogeneity (TERRECO): Evaluating Ecosystem Services in Mountainous Landscapes

Effects of landscape context and management practices on insect diversity and biological pest control

Emily Martin[1], Steve Lindner[2], Bumsuk Seo[2], Chan-Ryul Park[3], Gian-Reto Walther[2], Ingolf Steffan-Dewenter[1]

1 Department of Animal Population Ecology, University of Bayreuth, Germany

2 Department of Plant Ecology, University of Bayreuth, Germany

3 Division of Forest Ecology, Korean Forest Research Institute, Seoul, South Korea

Introduction:

In addition to contributing to the maintenance of biodiversity, insect and bird populations in agricultural areas may provide important ecosystem services, including biological control of agricultural pests by naturally occurring predators. Enhanced biological control could contribute to reducing external effects of conventional agricultural practices, e.g. due to the use of pesticides (Bianchi et al. 2006). However, the mechanisms underlying such control are little known and need to be clarified (Thies et al. 2005).

In order to gain an understanding of these processes and provide guidelines for agricultural management, we hypothesize (i) that both the landscape context and the type of crop management may influence the distribution of pests and predators in fields of the Haean-Myun basin, South Korea; (ii) that pests and pest predators interact with the landscape at different spatial scales; (iii) that the efficiency of biological control is influenced by farmers´ perception and management of crop/landscape interactions.

Main research questions:

1. Under what conditions are populations of insects and birds maintained in the fragmented habitats of this agroecosystem?
2. What factors affect pest and pest predator distribution, and at what scales?
3. How can we define landscape and crop management guidelines that optimize biological control in fields?

Methods:

1. Landscape-based site selection (Figures 1 & 2):
   - 32 fields of major annual crops (potato, bean, radish and rice) differing in management (conventional vs. organic) and in landscape context (% of forest cover in a 500m radius around the field).
   - Sites are distributed across the basin and at least 500m apart to avoid spatial autocorrelation.
2. Diversity sampling in each site on a gradient from field edge to field center (Figures 3 & 4):
   - Use of pan traps (flying insects), funnel traps (ground dwellers), net sweeping and weed surveys;
   - Bird point counts in each site and along gradients of proximity to the forest;
   - Measurement of crop herbivory rates.
3. Structural analyses of field edges and identification of edge management practices through local interviews.

Field sampling design:

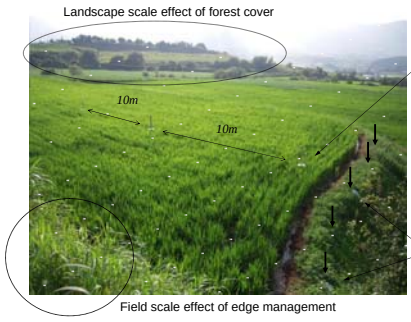


Figure 3. Sampling setup in paddy field, showing edge variability within and between fields.

Argiope bruennichi (Scopoli) in a rice paddy

Syrphid fly on *Sagittaria trifolia* L. in a rice paddy

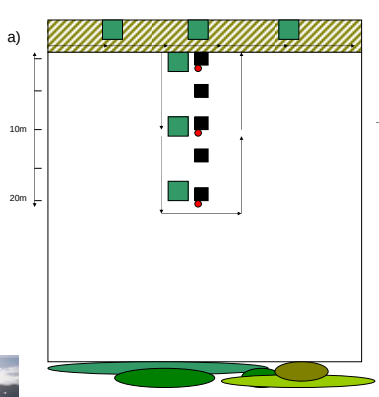
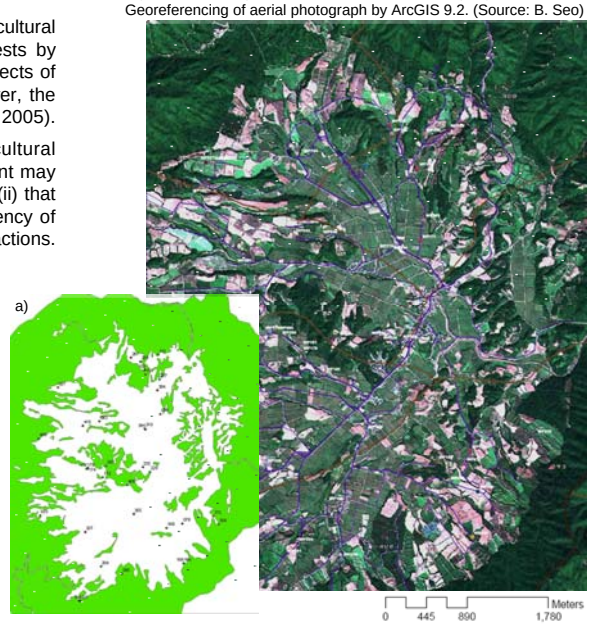


Figure 4. a) Integrated design for dry crops, with gradient from field edge to field center; b) Pan trap cluster before insect collection; c) Protective roof of funnel trap.

Figure 1. Landscape structure and location of sampling sites in Haean basin. Georeferencing of aerial photograph by ArcGIS 9.2. (Source: B. Seo)



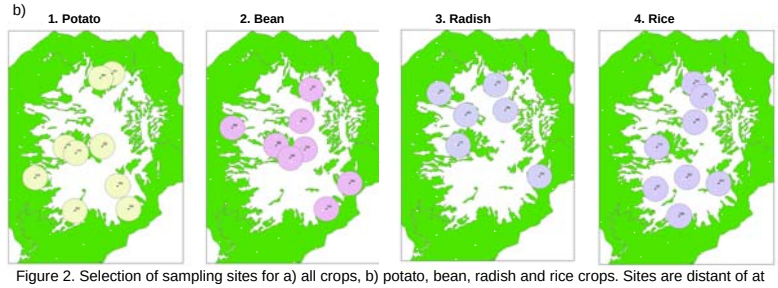


Figure 2. Selection of sampling sites for a) all crops, b) potato, bean, radish and rice crops. Sites are distant of at least 500m (radius of circles) and contain 0% to 85% forest cover within the 500m radius.

Analysis:

An integrated analysis will be based on understanding the effect of landscape and crop management type on measured diversity levels of insects, birds and weeds at several interacting scales: the scale of forest patches and amounts of non-crop habitat within 500m around sites, and the local scale of field edge complexity and proximity.

Functional analyses based on guild distribution and food webs will allow to identify differences of landscape effects on pest and predator species with a focus on pollinators, syrphid flies, carabid beetles and spiders, in view of constructing optimal management schemes that maximize biological control of pests.

Figure 5. Weed survey setup in organic radish field: three 2*2m plots divided into 9 subplots

References:

Bianchi, F., C. Booij, and T. Tscharntke. 2006. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control. Proceedings of the Royal Society B: Biological Sciences 273: 1715.

Thies, C., I. Roschewitz, and T. Tscharntke. 2005. The landscape context of cereal aphid–parasitoid interactions. Proceedings of the Royal Society B: Biological Sciences 272: 203.