University of Bayreuth

Complex TERRain and ECOlogical Heterogeneity (TERRECO):

Quantification of herbivory in different management systems – Comparing conventional to organic rice farming using *Pomacea canaliculata* as a biological weed control agent in the Haean-myun catchment, South Korea

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Introduction:

Controlling insect pests and weeds is crucial in managing the world's most important food crop. While conventional rice farming involves applications of herbicides as well as pesticides, organic management systems and low input systems respectively have evolved which depend on little or no application of chemicals. In the Haean-myun catchment, South Korea, the introduction of *Pomacea canaliculata* as a biological weed control agent is being practiced by a number of farmers. Within the scope of this study the effectiveness and efficiency of this practice will be quantified by comparing the scale of herbivory of rice as well as weeds in conventional and organic systems in relation to snail density. As an integral part of the project the population and dispersion characteristics of *Pomacea canaliculata* within a rice field will be studied using mark-recapture methods. By comparing biomass harvest data as well as soil analyses, a comparison of productivity between the two management systems will be made.

Methods:

This study consists of two fundamental parts: The first one is the comparison of magnitudes of herbivory and weed density between agricultural fields depending on their types of management; the next objective is the examination and analysis of the population and distribution characteristics of Pomacea canaliculata as the chosen biological weed agent in an organic rice field.

Objective 1: Quantification of Herbivory

In order to quantify the herbivory, three fields of each management type, organic and non-organic, were sampled once shortly after transplantation in June and will be sampled again in September prior to the harvest. Within all six fields, 16 plots ($0,5\ m^2$ each) were chosen and measurements were taken of five plants in each plot. The plant's amount of leaves, their maximum and minimum leaf height and their scale of herbivory were examined. Additionally, the density of snails and dominance of weeds was recorded as well as the scale of herbivory of the weeds when possible. To avoid sampling of the same rows of rice in different plots and to ensure a realistic representation of the entire rice field, sampling was done along the diagonals of the field excluding the centre.

Fig. 2: Water drains without´protective measures

Side Effects? Organic Farming vs. Biological Invasion

The golden apple snail (GAS) *Pomacea canaliculata* is a freshwater mollusc native to South America. It is listed as one of the World's Worst Invasive Alien Species (ISSG) and known to be a major threat for rice. Using GAS for paddy rice farming was proposed as a management option in rice fields where GAS is already established. However, the introduction and usage of *P. canaliculata* as a biological weed control agent in the Haean Myun Catchment indicates a potential for biological invasion due to rice irrigation systems that are connected to local streams. No protective measures are in place, thus enabling the snails to disperse from rice fields into local streams thereby giving them the opportunity to invade and modify new territory as well as to compete with local species (Fig. 2). Numerous studies have warned that once established, *Pomacea canaliculata* is difficult to control. Although permanent establishment of the snails in Haean Myun Catchment has been avoided by cold winters they are nevertheless reintroduced every year. Thus, potential competition with native species takes place for more than half of the year.

Objective 2: Snail Dispersion – Mark-Recapture

Unlike the first part of the study which observes six rice fields, the second part focuses on the dispersion characteristics of Pomacea spec. within one rice field in particular. In order to be able to estimate the population size as well as study the dispersion patterns a mark-recapture approach was chosen. Snails were collected, dried with a paper towel and individually numbered by using Edding 750 markers. The rice field was divided into 8 x 1m wide stripes starting from the centre point of the fields following both horizontals and both diagonals to the edge (see Fig. 1). Stripes were divided using poles to which strings were attached, so that the normal snail dispersion throughout the field was not affected. The stripes are different in length due to the irregularity of the rice field. However, to be able to define individual diffusion characteristics the stripes were divided into 3-metre long zones which were defined by the radius of different sized circles, all of them originating from the centre point of the field. The centre was defined as the snail release point. Snails were released and then recaptured on three consecutive days and once again a week after their release. Snails were put back into those zones in which they were found rather than putting them back into the centre of the field. A replication of this dispersion experiment was done after a heavy rain event in the same field.

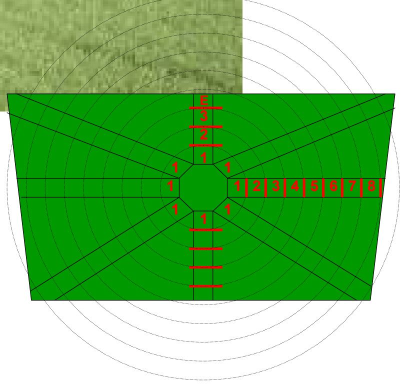

Fig. 1: Snail dispersion experiment

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