Comparison of Associated Agrobiodiversity in Terms of Insects and Soil Mites in Two Farming Systems and Forest Edge in Thong Pha Phum District, Kanchanaburi Province

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Abstract: The guild composition and the diversity index of some arthropods in a non-cropped area are compared between an organically certified farm, a chemically intensive farm, and the adjacent forest edge. Insects were sampled from non-cropped vegetation by using sweep net and soil arthropods were separated from soil samples using Berlese's funnels. The aboveground insects from non-cropped vegetation in August 2006 were mainly sucking-mouthpart herbivores at 24-47% while the soil mites and insects were majorly scavengers at about 60% similarly in all three areas. The Shannon-Weiner's diversity index in soil samples from the forest edge (2.68±0.17) was significantly higher than the organic farm (2.06±0.23) and the chemical farm (1.79±0.22). These preliminary data showed an interesting pattern of higher diversity of soil mites and insects in soil from the minimally managed area. Further sampling is currently underway to compare the seasonal effects.

Key words: Shannon-Weiner's diversity index, agrobiodiversity, associated biodiversity, guild composition, non-cropped area, soil mites

Introduction

Biodiversity in agricultural systems provides important information for the whole picture of biodiversity as well as for management of agricultural production. The type of biodiversity found in agricultural systems can be classified as planned biodiversity and unplanned or associated biodiversity (Clough et al., 2005). Unplanned or associated biodiversity is the major source of biodiversity in agricultural systems (Clough et al., 2005). Weeds, insects, and fungi can be found both in cropped areas and non-cropped areas, but they are usually more abundant in non-cropped areas (Shannon et al., 2002).

Besides genetic diversity, taxonomic diversity, and ecological diversity, the diversity of management systems is also important in agriculture. Decision making and actions of farmers have impacted on the biodiversity in the ecosystem (Schmidt et al., 2005). Chemical and energy inputs in agriculture collectively affect the composition and diversity of organisms from microbes to insects and weeds (Shannon et al., 2002; Holzschuh et al., 2006).

Farming systems in Thong Pha Phum, Kanchanaburi consist of subsistence farming by small farmers, conventional commercial farming, and organic commercial farming. Subsistence farming includes growing grains and vegetables as well as harvesting from the nearby forest. Commercial farming includes teak and rubber plantation, fruit orchards, and cut flowers. Organic farms grow varieties of plants including Sato, mangosteen, bamboo, cut flowers *Heliconia*. However, these farms also shared similar plant (or weed depending on farmers's copes) compositions in the non-cropped area between plots or trees.

This study focused on the associated biodiversity in the non-cropping area of two orchards (a chemically intensive durian orchard and an organically certified orchard) and the forest edge nearby.

Methodology

We collected insects from ground cover plants and soil from: 1. an organically certified farm (organic), 2. a chemically intensive farm (conventional), and 3. the forest edge (forest) adjacent to the two farms in Huai Khayeng, Thong Pha Phum, Kanchanaburi approximately 1 km surrounding the coordinate UTM 47P 0456628E 1621399N. Each sampling area was divided into 6 sampling sites (Fig. 1), O1-O6 for the organic farm, C1-C6 for the conventional farm and F1-F6 for the forest edge. Each sampling site was approximately 20x20 m^2, and an area of 1x1 m^2 covered with non-cropped plants in each site was randomly selected for vegetation and soil sampling.

For insects on vegetation, a sweepnet

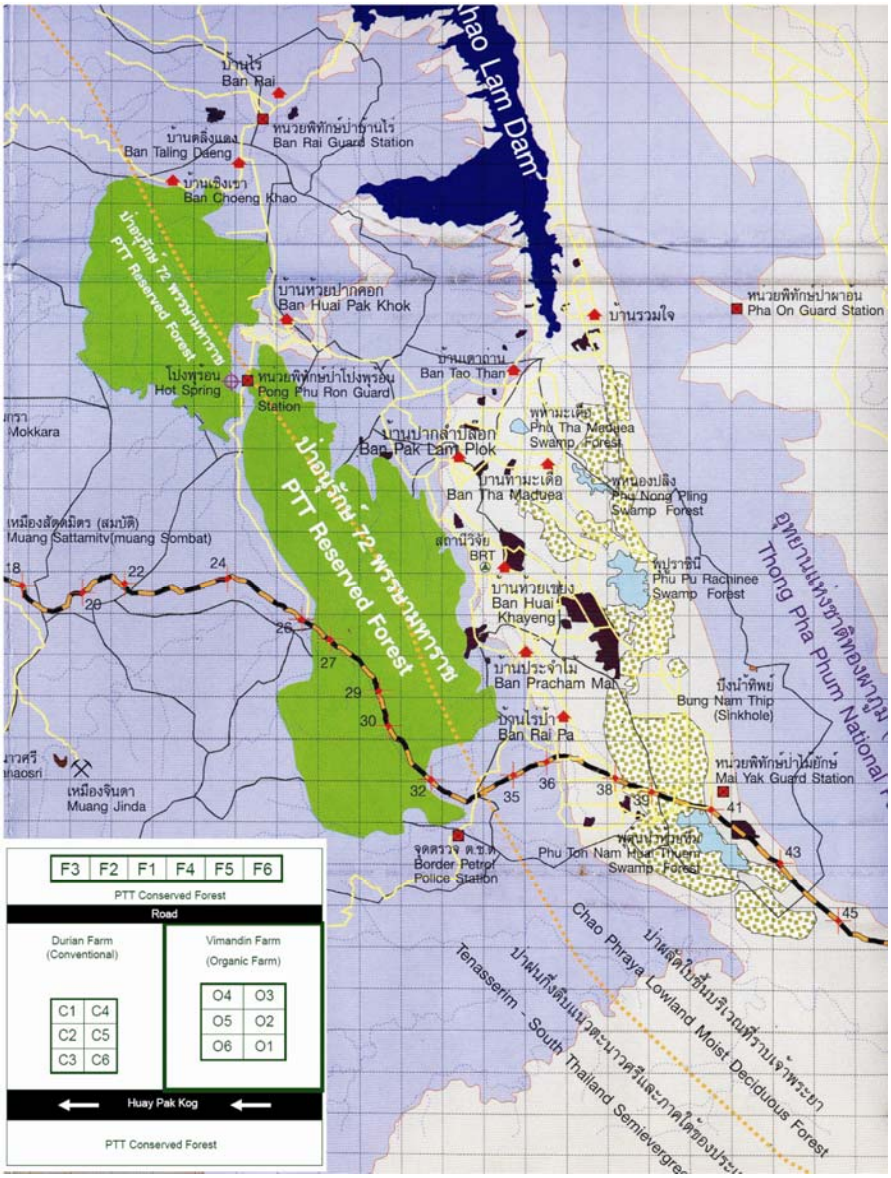

Figure 1. Map of sampling sites in conventional durian farm, organic mixed-cropped farm, and forest edge.

was swept across the sampling area about 1m for five times, and insects collected in the sweepnet were placed in plastic bag, put in alcohol, and later identified. The soil from within the 1x1 m^2 sampling sites was randomly sampled from an area of 10x10 cm^2 to 5 cm depth. Soil was placed in a plastic bag for each sampling sites and then later extracted the soil mites and insects using Berlese's funnel with 2 mm sieve for 7 days. The temperature, humidity, and general weather conditions were recorded.

The insects and mites collected from each site were identified to family level, and were counted to species using assigned number within the family. Other non-insect and mite arthropods were identified to order level with similar number assignment to each species within the order. Then the insects and mites were classified into their guilds, chewing herbivore, sucking herbivore, predator, parasitoid, scavenger/detritivore for the vegetation insects and herbivore, predator and scavenger/detritivore for the soil mites and insects, and compared for the percentage of each guild in each area. Amount of individuals and species in each sampling sites were used to calculate Shannon-Weiner's diversity index (H) according to the following formula:

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

p_i is the proportion of individuals in species I to the total individuals of all species.

Results

The prevalent guild of insects sampled in sweepnets was herbivore, with approximately 38-62% of all insects (Fig. 2). The common sucking herbivore was leafhoppers (Homoptera: Cicadellidae), and the common chewing herbivore was grasshopper (Orthoptera: Acrididae). Ants (Hymenoptera: Formicidae) and spiders (Arachnida: Araneae) were the most abundant groups of predators. Parasitoids consisted of Hymenopterans in the families Aulacidae and Chalcidae. Scavengers commonly found were springtails (Collembola: Entomobryidae) and Milichilid flies (Diptera: Milichilidae).

The guild composition of soil mites and insects was primarily scavengers, approximately 60% of species of all soil mites and insects in all three sampling areas (Fig. 3). The common scavenger mites were Oribatid mites in family Oppiidae and family Scheloribatidae and Collembollans in family Entomobryidae and Sminthuridae. Predators in the soil were primarily mites in the order Mesostigmata (family Laelapidae and family Cunaxidae) and ants (Hymenoptera: Formicidae). The herbivores, primarily aphids (Homoptera: Aphidae) were rarely found in soil of the two agricultural areas and none in the forest edge.

There was no significant differences among species richnesses or the Shannon-Weiner's diversity index of the insects collected with sweepnets in the three areas (Fig. 4). However, the species richness and Shannon-Weiner's diversity index from soil insects and mites are significantly higher in the forest edge area than the two agricultural area which are not significantly different within themselves (Fig. 4). The species richness of soil insects and mites in forest edge was 22.50±2.57 comparing to 12.50±2.32 and 12.17±2.83 from the organic farm and the conventional farm, respectively. The Shannon-Weiner's diversity index from soil insects and mites from the forest edge is 2.68±0.17 comparing to 2.02± 0.23 and 1.79±0.22 from the organic farm and the conventional farm, respectively.

Discussion and Conclusion

The preliminary results from this study showed the non-difference in diversity between the insects in ground cover plants in the non-cropped areas of the three sampling area but a rather high diversity in soil insects and mites in the forest edge area compared with the two agricultural areas. The effects of soil compaction and disturbance, although not the use of synthetic pesticides, in the agricultural area may have effects on the diversity of the soil insects and mites (Shah et al., 2005). The diversity of insects and mites in the conventional and organic farms were not distinguishable in one sampling date. However, the effects of rain and abundance of ground cover plants during the sampling may influence the abundance of the insects in vegetation in all three areas (Clough et al., 2005). Also the consistent rain prohibited any new spray of pesticides in the conventional farms and perhaps reduced the effects of pesticides on insects in the non-cropped area. Moreover, the organic practice may not increase the species richness but rather increase the

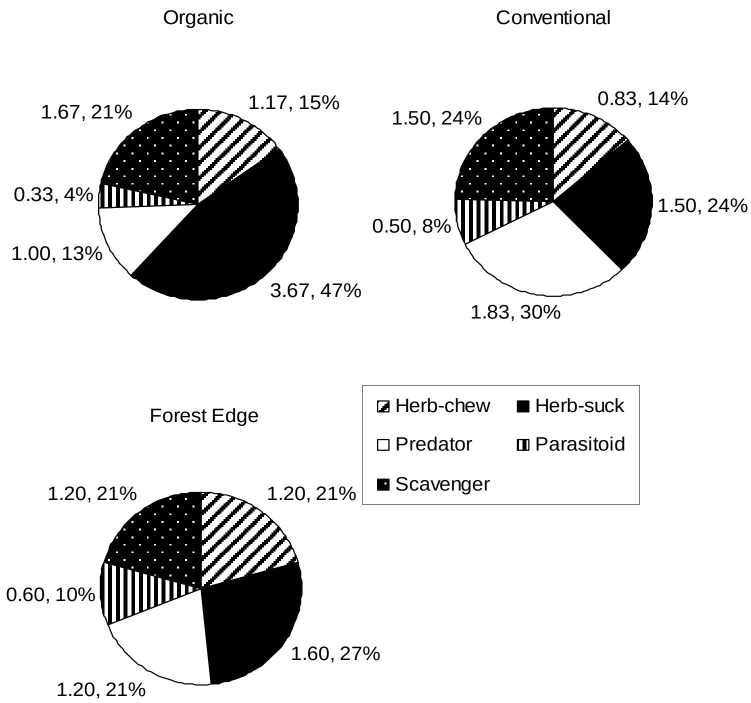

Figure 2. Guild compositions in number and percentage of species as Chewing herbivores, Sucking herbivores, Predators, Parasitoids, and Scavengers, collected by sweep net within a conventional durian farm, an organic multi-crop farm, and a forest edge in Thong Pha Phum, Kanchanaburi Province in August 2006.

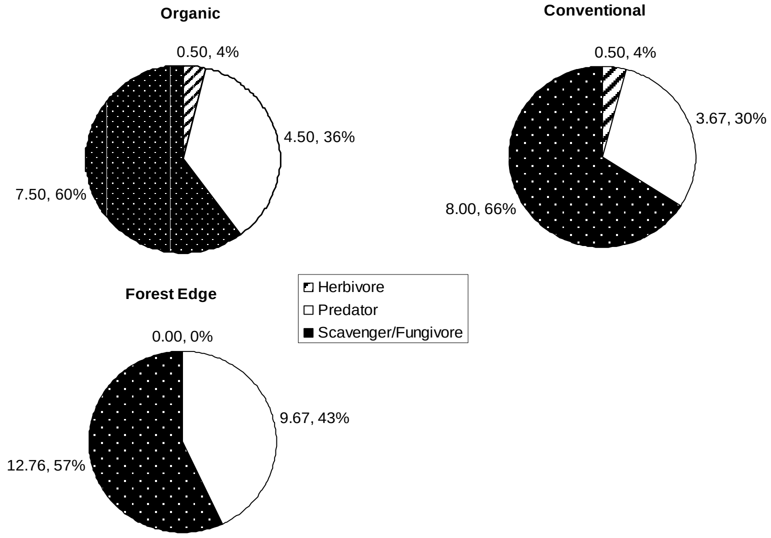

Figure 3. Guild compositions in number and percentage of species as Herbivores, Predators, and Scavengers collected from soil using Berlese's funnel in a conventional durian farm, an organic multi-crop farm, and a forest edge in Thong Pha Phum, Kanchanaburi in August 2006.

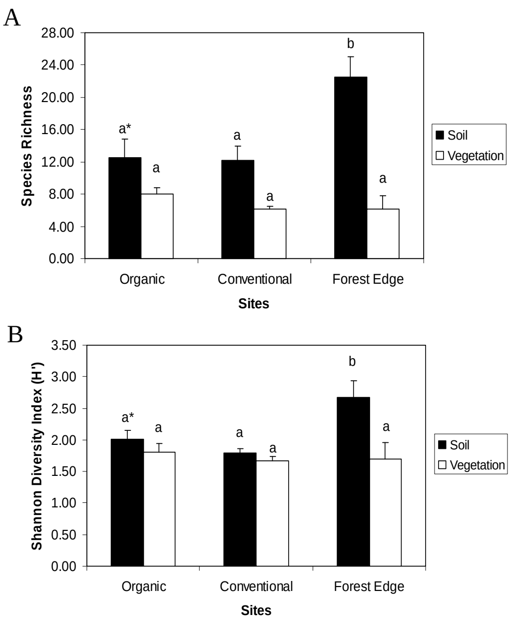

Figure 4. A) Species richness and B) Shannon-Weiner's diversity index in each of three sites: Organic multi-crop farm, Conventional durian farm, and Forest edge, from soil and vegetation sampling. *The same letter means no significant difference within the type of sampling (P<0.05).

abundance of each species which may reduce the diversity index (Schmidt et al., 2005).

Further sampling will be conducted to compare the seasonal effects on the diversity and any physical conditions that may affect the diversity. The higher diversity in forest edge, especially the scavengers, may have some interaction with other scavengers and detritivores, such as bacteria and fungi, which is worth studying.

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