SPIDER DIVERSITY (ARACHNIDA: ARANEAE) OF THE TEA PLANTATION AT SERANG VILLAGE, KARANGREJA SUB-DISTRICT, DISTRICT OF PURBALINGGA

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ABSTRACT

Spiders are crucial in controlling insect pest population. The various cultivation managements such as fertilizer and pesticide application, weeding, pruning, harvesting, and cropping system affect their diversity. In the plantation, vegetation diversification has applied various practices, including monoculture, and intercropping, which influence the spider community. Thus, this study was intended to determine the spider abundance and diversity of the tea plantation, and the intercropping field (tea and strawberry) at Serang village, Karangreja Sub-District, District of Purbalingga. A survey and purposive sampling techniques were conducted, then the spiders were hand collected. Shannon-Wiener diversity (H'), Evenness (E), Simpson's dominance (D), and Sorenson's similarity (IS) indices were used to measure the spider diversity. The results revealed a total number of 575 individual spiders from 10 families, i.e., Araneae, Annidae, Clubionidae, Linyphiidae, Lycosidae, Nephilidae, Oxyopidae, Salticidae, Tetragnathidae, Theridiidae, and Thomisidae. Araneidae was the most abundant in both fields. The total abundance of spiders in tea plantation (379 individuals), however, was greater than that in the intercropping field (196 individuals). Shannon-Wiener diversity reached $H' = 1.873$ in the plantation, and $H' = 1.975$ in the intercropping field.

KEY WORDS: diversity, Araneae, spider, plantation

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INTRODUCTION

An agroecosystem is a man-modified ecosystem to produce desired crops. It provides a habitat for cultivated plants, wild plants, weeds, animals, and microbes. The habitat is grouped into the annual plant, and the seasonal plant habitats (Altieri & Nicholls, 2004). The former might potentially increase spider population on a landscape scale, and spider abundance in cultivated fields (Schmidt & Tscharntke, 2005).

Spiders are common in agroecosystem such as plantation. They contribute immensely to biodiversity in agroecosystem and play a major role as an effective component of natural pest control (Symonds et al., 2002). Various cultivation activities such as fertilizer and pesticide application, weeding, pruning, harvest, and crop systems, performed by the human in plantation fields, affect the spider community (Altieri & Nicholls, 2004). Intensive management for better crop production involving the use of synthetic pesticides and inorganic fertilizers has raised concerns in reduced diversity and abundance of arthropods, including spiders (Thomas & Marshall, 1999). Nevertheless, cropping systems with conservation techniques might stimulate predatory arthropods diversity and abundance (Altieri & Nicholls, 2004).

Diversification of vegetation in plantation involves various practices, such as monoculture and intercropping, which affect the spider diversity and abundance (Andow, 1991). According to Russell (1989), intercropping provides more niches than monoculture, thereby, increasing the spider diversity and abundance, the natural enemies of the pest.

Serang village belongs to the typology of Near-Forest Village in the area of Karangreja Sub-District, District of Purbalingga, Province of Central Java. The village is on the Mount Slamet slope which has rich soil spreading across 2,096.916 Ha. This area mostly is agricultural (strawberry cultivation) or plantation (tea) fields (Sugito, 2016).

Tea plantation is a stable and complex ecosystem which provides a habitat for many species of spiders that play a role in controlling insect pest population of tea plant (Das et al., 2010; Yan et al., 1998). However, plant cultivation practices may decrease their diversity and abundance (Thomas & Marshall, 1999). Biological control refers to natural biotic management and regulation of insect pest suppression below economic injury level (Hazarika et al., 2001). Understanding the spider community within plant scope is important to improve pest control, and comprehend the compelling factors affecting conservation strategy (Raychaudhuri, 2016).

This study was aimed to investigate the spider abundance and diversity in tea plantation and intercropping field (tea and strawberry) in Serang Village, Karangreja Sub-District, District of Purbalingga. The scientific information of this study was expected to contribute to spider diversity knowledge in plantation field and to highlight the importance of spiders as a biological control agent.

METHODS

Materials included spiders and 70% alcohol, and the tools were specimen jars, measuring tape, plastic string, stationery, stereo microscope, petri dish, camera, and self-adhesive labels.
Results and Discussion

There was a total of 575 individual spiders observed from tea plantation and intercropping field belonging to 10 families. Most families (6) including Clubionidae, Linyphiidae, Theridiidae, Thomisidae, Nephilidae, and Oxyopidae consisted of one morphospecies each. Two morphospecies were observed each in Lycosidae and Tetragnathidae. Araneidae had five morphospecies whereas the most diverse morphospecies was observed in Salticidae (8) (Table 1).

Compared to the intercropping field, the spider abundance was higher on the tea plantation, to which this contributed to 65.91% of the total spider collected (379 individuals). In the intercropping field, it reached 196 individuals (34.09%) (Table 1). The difference most likely was caused by different crop practices and management of each area which in turn affected spider abundance. The tea plantation was a monoculture field that created a favorable environment for insect pests thus stimulated their populations to increase as the spider available food. As a result, this condition might promote spider abundance. Aswad (2014) reported that monoculture plantation field could cause pest outbreak or an increase in particular insect pest population which results in the growth of spider population as their natural enemy.

Tea plantation of the study site was less managed than in the intercropping field, thus influenced spider abundance. In the intercropping field, crop intensification (regular weeding) was applied, while in tea plantation this was done irregularly. Altieri& Schmidt (1986) claimed that habitat with intensive soil management showed low numbers of individual spiders. Araneidae was the most spider family observed in either tea plantation (69.13%) or intercropping field (Figure 1).

In the intercropping field, 196 individual spiders were recorded, and 142 of them (72.45%) belonged to Araneidae. According to Riechert& Lockley (1984), Araneidae was a spider family distributed worldwide and able to live in various habitats by creating circular and sticky web traps. Araneidae was one of the most successful families within order Araneae (approximately 2,600 species). This group of spiders was easy to identify due to their body size, body coloration, and net shape or pattern (Jimenez-Valverde & Lobo, 2007).

Clubionidae within order Araneae was the rarest family (one individual, 0.17%). According to Riechert & Lockley (1984), worldwide distribution members of Clubionidae lived freely as nocturnal hunters and usually place their sac-like traps in plant leaves. Spiders from genus Clubiona moved on plant stems and leaves at night. During the daytime, they hid in silk sacs made of grass leaf folds or other similar leaves. Members of this genus had small to medium body size. The abdomen was covered with pale yellow hair, and their mouth was often brown in color (Dippenaar-Schoeman, 1988).
### Table 1. Total Number and Proportion of Spiders in Tea Plantation and Intercropping Field

| Family     | Morphospecies | Type of habitat | Tea plantation | Proportion (%) | Intercropping field | Proportion (%) | Total |
|------------|---------------|----------------|---------------|----------------|---------------------|----------------|-------|
| Araneida   | Arigiope spp1.|                | 5             | 1.32           | 9                   | 4.59           | 14    |
|            | Arigiope spp2.|                | 1             | 0.26           | 0                   | 0              | 1     |
|            | Cyclosa spp1. |                | 88            | 23.22          | 58                  | 29.59          | 350   |
|            | Cyclosa spp2. |                | 30            | 7.92           | 14                  | 7.14           | 39    |
|            | Cyclosa spp3. |                | 138           | 36.41          | 61                  | 31.12          |       |
| Clubionidae| Clubiona spp. |                | 0             | 0              | 1                   | 0.51           | 1     |
| Linyphiidae| Erigoninae spp.|             | 10            | 2.64           | 9                   | 4.59           | 19    |
| Lycosida   | Pardosa spp1. |                | 1             | 0.26           | 1                   | 0.51           | 2     |
|            | Pardosa spp2. |                | 4             | 1.06           | 4                   | 2.04           | 8     |
| Nephilidae | Nephila spp.  |                | 3             | 0.79           | 0                   | 0              | 3     |
| Oxyopidae  | Oxyopes spp.  |                | 8             | 2.11           | 5                   | 2.55           | 13    |
| Salticidae | Bianor spp.   |                | 2             | 0.53           |                     |                |       |
|            | Chalcotropis spp.|             | 0             | 0              | 2                   | 1.02           | 1     |
|            | Cosmaphisis spp1.|            | 3             | 0.79           | 0                   | 0              | 4     |
|            | Cosmaphisis spp2.|            | 2             | 0.53           | 1                   | 0.51           | 2     |
|            | Emathis spp.  |                | 4             | 1.06           | 1                   | 0.51           | 4     |
|            | Harmochirus spp.|              | 3             | 0.79           | 0                   | 0              | 4     |
|            | Hasarius spp. |                | 2             | 0.53           | 2                   | 1.02           | 10    |
|            | Palpeulus spp.|                | 2             | 0.53           | 1                   | 0.51           | 3     |
| Tetragnathidae| Leucauge spp.|            | 66            | 17.41          | 23                  | 11.73          | 86    |
|            | Tetragnatha spp.|            | 7             | 1.85           | 2                   | 1.02           | 7     |
| Theridiidae| Cryptachaea spp.|            | 0             | 0              | 3                   | 1.53           | 5     |
|            | Cerinus spp.  |                | 0             | 0              | 1                   | 0.51           | 1     |
| **Number of individuals** |               |               | 379           | 100             | 196                 | 100           | 575   |
| **Number of morphospecies** |             |               | 19            | 18              |                     | 23            |       |
| **Number of families**       |               |               | 8             | 9               |                     | 10            |       |
| **Total proportion**         |               |               | 65.91 %       | 34.09 %         |                     | 100%         |       |

### Figure 1. Abundance Proportion of Spider Families in Tea Plantation and Intercropping Fields in Serang Village, District of Purbalingga

Besides Clubionidae, Thomisidae was also among the rarest families to find (0.17%). This might be because members of this family mostly created webs in flowers and only a small number of flowers grew in both study sites. According to Jimenez-Valverde and Lobo (2007), spiders of Thomisidae had crab-like body shape and often hid in flowers and had cryptic coloration.

The tea plantation and intercropping fields showed different diversity indices (Table 2). The indices of tea plantation reached $H' = 1.873$, and the intercropping field was $H' = 1.975$. This difference indicated that spiders in the intercropping field were more diverse than those in tea plantation. According to Russell (1989), intercropping fields provided more niches than monoculture fields. Thus, the diversity of natural enemies including spiders was also high.

### Table 2. Diversity, Evenness, and Similarity Indices of Spiders in Tea Plantation and Intercropping Field

| Parameter | Tea Plantation | Intercropping Field |
|-----------|----------------|---------------------|
| $H'$      | 1.873          | 1.975               |
| $E$       | 0.343          | 0.399               |
| $IS$      | 75.68%         |                     |

Tea plantation showed lower evenness index than the intercropping field (Table 2). According to Brower et al. (1998), evenness level was considered low if it was less than 0.4, medium if between 0.4 and 0.6, high when it was greater than 0.6. Spider evenness indices in both study sites were from 0.343 up to 0.399. This range indicated low spider evenness level in both tea plantation and intercropping fields. Suana (2005) stated that evenness index tends to be low when there were one or few dominant species in the sample, and other species of the same sample were in small number.
Sorensen’s similarity index revealed species similarity level in two different sites. Similarity index of spiders in tea plantation and the intercropping fields was 75.68% (Table 2). According to Brower et al. (1998), a similarity index of 25% or lower indicated strong dissimilarity, 25–50% showed no similarity between two sites, and an index of 50% or greater was strongly similar. The index indicated that tea plantation and intercropping field had strong spider species similarity. This criterion was based on Suin (1991) who claimed that two ecosystems were considered to have a similar community if their similarity index was greater than 50%. The macroarthropods similarity of two communities, such as spiders, might be due to the adjacent fields which allowed spiders to move actively from one location to other nearby locations.

CONCLUSION

A total of 379 individual spiders was recorded from tea plantation with diversity index $H'$ of 1.975, higher than that of intercropping field ($H' = 1.873; 196$ individuals). The evenness in tea plantation and intercropping field were low with a range from 0.343 up to 0.399. Araneae community in tea plantation and intercropping field revealed a similarity of 75.68% by Sorensen’s similarity index.

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