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A Study on the Biodiversity of Ladybird Beetles in Soybean Agroecosystems of Northwestern Ohio

Mohammed Albaaj
malbaaj@bgsu.edu

A STUDY ON THE BIODIVERSITY OF BIODIVERSITY OF LADYBIRD BEETLES IN SOYBEAN AGROECOSYSTEMS OF NORTHWESRERN OHIO

By

Mohammed Albaaj

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INTRODUCTION

Lady or Ladybird beetles (Coleoptera: Coccinellidae) represent a large and diverse group of beetles found worldwide. Approximately six thousand (6,000) ladybird species are known globally (reference). In eastern North America, there are 60 genera containing approximately 480 species (Evans, 2014). Most species are predatory, feeding on life stages of other insects, such as aphids, caterpillars, and insect eggs, as well as plant-feeding mites, and thus provide an essential ecosystem service for humans in terms of pest control (Obrycki and Kring, 1998). Thus, this group of beetles is important for the reduction of arthropod pest populations on a variety of fruit, vegetable, forage, field crops, forests, and on landscape and ornamental plants.

Ladybird species in any region are either native species or adventive species. Adventive species are those which arrive from another location; they invade an area and then they may establish and multiply. Adventives may have been deliberately introduced into a locality or they may be simply immigrants. Two widespread adventive species in North America are the multicolored Asian lady beetle, *Harmonia axyridis*, and the seven-spotted ladybird beetle, *Coccinella septempunctata*. Both species were intentionally introduced into the United States for control of a variety of pest aphid species. Many entomologists are concerned that these adventive species may be driving native coccinellids to extremely low numbers or even to extinction in many regions (Bahlai et al. 2015).

Soybean, *Glycine max*, is a widely grown and important crop for humans in many regions of the world, including the North Central Region of the United States. Ladybird beetles play a crucial role in regulation of phytophagous insect and mite populations in soybean in the United States, especially since the accidental introduction of the invasive soybean aphid, *Aphis glycines*, in

2000 (Ragsdale et al. 2000). The soybean aphid has caused significant economic losses in soybean in the United States since its introduction (Ragsdale et al. 2000). Although the adventive ladybird beetle species, *Harmonia axyridis* and *Coccinella septempunctata* have had negative impacts on populations of native ladybird species (Bahlai et al. 2009, Camacho-Cervantes et al. 2017), both species have been shown to have a large capacity for reducing populations of the soybean aphid (Xue et al. 2009).

The term biodiversity is used to denote a wide range of variety of life in an ecosystem or within a particular habitat. Biodiversity also encompasses the interrelationship between various components in an environment. Biodiversity of insects in an area can be viewed from the perception of the number of species in that area and the inherent relative abundance (Vanclay, 1992). Richness in species is an important metric of diversity (Magurran, 1988).

The term ladybird refers to a family of beetles not just a single classification. Ladybirds are of various species and many of such species are regarded to be of importance to human beings because they eat plant pests (KASHIF, ANJUM, JAVAID, & ZEESHAN, 2003). It should, however be noted that not all ladybirds eat plant pests.

Depending on wings, adult ladybirds range from a length of 1mm to 10mm or slightly more. They also have wings and are oval in shape. Generally, males are smaller than females. Ladybird species chew using their mandibles. Their blood (hemolymph) is yellow, has a disgusting smell and may contain antigenic poison in some species. The toxicity and repellency of the blood is regarded as a way of keeping away predators and making ladybirds a secure species. It is also argued that the bright colors in some adult species scare away potential predators. The

developmental stages, i.e., egg, larvae and pupae of ladybird beetles also contain the toxins like their adult counterparts. Dorsal glands in larvae are responsible for the production of toxins. The female adult species produce secretions which protect the eggs from being consumed by other animals. When there is insufficient prey for the adults' consumption, mature ladybird beetles feed on their eggs, larvae and pupae. Larva, which are characterized by a considerate level of mobility, are also protected by waxy secretions.

The first objective of the study conducted was to determine the diversity of predatory lady beetles of soybean agroecosystems of Northwestern Ohio. The second objective was to compare of the relative abundance of the native species to the relative abundance of the adventive species.

MATERIALS AND METHODS

Six soybean fields were sampled once per week in Wood County, Ohio, during the 2016 growing season. Sampling began in mid-June and ended the third week of August. In each field, 100 sweeps were collected using a sweep net with a 38 cm diameter net opening. The sample from each field was emptied into a 2-gallon zip lock bag and placed in a standard freezer. Samples were pooled for each field for the entire sampling period. Ladybird beetles were later removed from the samples and identified to species.

Species richness (*S*, the total number of species), the Shannon diversity index (*H*'), and the Shannon evenness value (*E*) were calculated for all of the fields for the season. The Shannon diversity index is calculated by the formula

$$H' = - \sum p_i \ln p_i$$

Where the quantity p_i is the proportion of individuals found in the *i*th species.

The Shannon evenness value is calculated by the following formula:

$E = H/\ln S$

In my samples, most coccinellid species collected were adults. In the sampled areas, some coccinellidae larvae were also found. Only adults were identified to species for this study. To avoid instances of double counting in the species, we keenly examined each sample and ensured that we only counted each species once.

RESULTS AND DISCUSSION

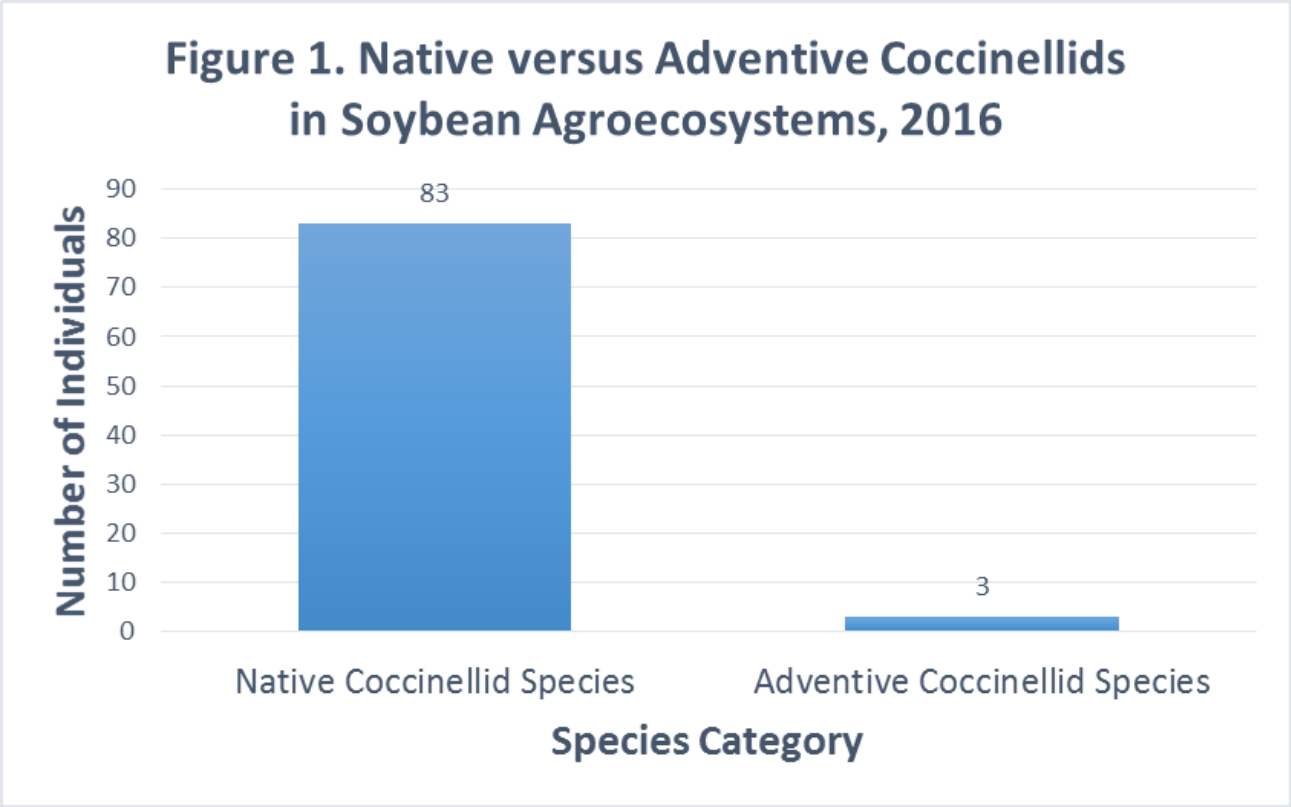
The species and the number of each species are listed in Table 1.

Table 1. Coccinellid Species Collected in Soybean Agroecosystems, 2016.

Species	Number of Individuals
Harmonia axyridis	3
Coccinella septempunctata	1
Coleomegilla maculata lengi	6
Hippodamia variegata	1
Hippodamia convergens	62
Hippodamia parenthesis	3
Cycloneda munda	9

Anisosticta bitriangularis	1
Total	86

Hippodamia convergens was the dominant species, accounting for 72% of all coccinellids collected. Both adventive species, *Harmonia axyridis* and *Coccinella septempunctatata*, were collected in extremely low numbers (3 and 1 individuals, respectively). Species richness (S) of coccinellids in the soybean agroecosystems was 8. The Shannon diversity index value is 1.516 and the Shannon evenness value is 0.729.



The research was conducted for a period of three months from June to Auguts 2016. A total of 86 specimens of coccinellids were captured which comprised of bot adventive and native species. *Coccinella septempunctata, Hippodamia variegate* and *Anisosticta bitriangularis* were the least dominant species where only one individual was collected for each species. From the study, it was established that there exists eight different types of predatory lady beetles of soybean agroecosystems of Northern Ohio. As represented in the bar graph above, native coccinellids were the most dominant species representing 96.5% of the individuals sampled. On the other hand, adventive coccinellids represented a small proportion of 3.5% in all the six soybean fields sampled.

CONCLUSIONS

Coccinelids continue to play a role in naturally occurring and human-assisted biological control measures. In soybean agroecosystems of Northwestern Ohio, native coccinellids are the most dominant as opposed to their adventive counterparts. They play an important role in insect pest management. Insecticides remain the single most detrimental factor to the survival of coccinellids in an agroecosystem. Conservation techniques and measures ought to be adopted so as to enhance the effectiveness of naturally occurring and released coccinellids. Use of food sprays in commercial production fields should be closely monitored to safeguard the existence of coccinellids.

Biological control has been enhanced by conservation, importation, and augmentation of coccinellids in numerous agroecosystems, but further application and refinement of these technologies is needed.

REFERENCES

Christine A. Bahlai ,Manuel Colunga-Garcia, Stuart H. Gage, Douglas A. Landis, 2013. *The role of exotic ladybeetles in the decline of native ladybeetle populations: evidence from long-term monitoring*.1-21

Morelia Camacho-Cervantes, Adrián Ortega-Iturriaga and Ek del-Val, 2017. *From effective biocontrol agent tosuccessful invader: the harlequin ladybird(Harmonia axyridis) as an example of good ideas that could go wrong*. Peerj, 1-16

Ragsdale, D.W., D. J. Voegtlin, and R.J. O'Neil. 2004. *Soybean aphid biology in North America. Annals of the Entomological Society of America* 97(2): 204-208.

Coley, P., & Aide, T. (1991). *Comparison of herbivory and plant defenses in temperate and tropical broad-leaved forests.* John Wiley & Sons, Inc.

Frank, & McCoy. (1994). *introduction to insect behavioral ecology : the good, the bad, and the beautiful: non-indigenous species in florida.*

Hammond, P., & Miller, J. (1998). *Comparison of biodiversity of Lepidoptera with 3-forested ecosystems.* Ann Entomol.

Hutcheson, K. (1970). *A test for comparing diversities based on the Shannon Formula.* J. Theoret.

KASHIF, Z., Anjum, S., Javaid, I., & Zeeshan, Z. (2003). Biodiversity of Predaceous Coccinellids and Their Role as Bioindicators in an Agro-ecosystem. *international journal of agriculture & biology, Vol. 5*(No. 4).

Kikkawa, J. (1996). *Complexity, diversity and Stability.* Melbourne, Australia: Blackwell Science Publishers.

MacArthur, R., & Wilson, E. (1967). *The Theory of Island Biogeography.* Princeton University Press.

Magurran, A. (1988). *Ecological Diversity and Measurement.* (A. Press, Ed.) USA: Princeton University Press.

Peet, R. (1974). *The Measurement of species diversity.* Ann Rev.

Vanclay, J. (1992). Species richness and Productive Forest Manageent Proc. Oxf.Con. Trop. Forest. *Biodiversity and Environment*, 18-31.

Hayat, Alia and Muhammad Rafique khan. 30 Sept. 2014, "*Biodiversity and Species Composition of Lady Bird Beetles (Coccinellidae: Coleoptera) from Mirpur Division of Azad Jammu & Kashmir, Pakistan.*" *Sarhad Journal of Agriculture*, vol. 30, no. 3,pp. 341-350

Obrycki, John J. and Timothy J. Kring. Jan. 1998, "*Predaceous Coccinellidae in Biological Control." Annual Review of Entomology,* vol. 43, no. 1, p. 295

Hodek, Ivo, et al, 2012. *Ecology and Behaviour of the Ladybird Beetles (Coccinellidae)*. vol. 2nd ed, Wiley-Blackwell.

Honěk, and F. Kocourek.1988, *"Thermal Requirements for Development of Aphidophagous Coccinellidae (Coleoptera), Chrysopidae, Hemerobiidae (Neuroptera), and Syrphidae (Diptera): Some General Trends.*" *Oecologia*, no. 3,p. 455

Obrycki, John J. and Timothy J. Kring. Jan. 1998, *"Predaceous Coccinellidae in Biological Control." Annual Review of Entomology,* vol. 43, no. 1, p. 295

Wajnberg, E. and Helen E. Roy. 2008, *From Biological Control to Invasion: The Ladybird Harmonia Axyridis as a Model Species*. Springer.