Polistes Olivaceus: A Potential Biocontrol Agent

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ABSTRACT

Pesticides gained importance in agriculture due to their ability to reduce insect pest populations and help in increasing food grain production. However, the impact was short lived for three reasons: (1) the insect pests quickly evolved resistance against many pesticides, (2) they indiscriminately targeted both harmful and beneficial insects, and (3) their biomagnifications lead to health hazards for both humans and their live-stock. This necessitated introspection within the agriculture sector and use of natural modes of pest management and control. Use of biological agents such as natural predators and parasites of insect pests is one of the effective pest management practices that is engaged in identifying and quantifying the extent of pest control by different agents. In this study we ascertained the role of Hymenopteran wasps as potential pest management agents. Among the two wasps species studied we found that the primitively eusocial wasp, Polistes olivaceus can potentially be used as a biological control agent in northern India.

Keywords: Biocontrol, pesticides, self sustaining, health effects

1. INTRODUCTION

The changing life-style of human race from nomadic to settlements and civilizations necessitated the large scale cultivation of edible plant species and domestication of various animal species for milk, meat and pastoral purposes. With civilization came the greater need for food grains and fodder to sustain the ever growing human and live-stock populations. With greater understanding of the genetic mechanisms that influence various biological characters of plant and animals alike, agriculture saw 'green revolution' that helped human race to increase the food production many fold. Green revolution by itself was accompanied by population explosion of crop pests that lead to indiscriminate use of synthetic pesticides. However, pesticides work against both the target and non-target species [1]. Further, due to the short generation cycle of the insect species compared to the live-stock and humans they tend to evolve resistance against the pesticides thus making the pesticide less effective. This in turn forces the farmers to increase the concentration leading to an evolutionary arms race for survival. Furthermore, the indiscriminate use of pesticides has lead to bio-magnification eventually adversely affecting the health of human beings and their live-stock

[2]. There are several reports that have implicated specific organo-compounds used in pesticide formulations to be the responsible for the birth of malformed children and live-stock [3]. There is an urgent need to revert back to traditional methods of pest management and control. Besides using the pesticide formulations with natural plant extracts such as neem, biological agents such as natural predators and parasites of insect pests have been used at a low scale in the past. Biological control and management of pests involves the use of another living organism to regulate the pest population to minimize the economic loss. No chemicals are needed, there is no environmental contamination with pesticides and the pests don't become resistant to the control method. Biological control is self regulating that require little monetary investment and management [4,5]. Wasps (Order: Hymenoptera) are usually carnivorous that nurture their young on the flesh of various Lepidopteran caterpillars- that form the bulk of pest species and other arthropods and hence might be another source of biological control agents. In this study, we compared the amount of prey items consumed by two wasps species, one that was distinctly solitary in nature and the other that resides in groups and perhaps is social.

2. MATERIALS AND METHODS

2.1. Study site

The North Campus of University of Delhi was chosen as the study site. The study site consists of various gardens and buildings which provide ample nesting places for the wasps. There are various crop species, such as arhar, beans, cabbage, cauliflower, mustard, etc being cultivated for experimental work at the departments of Botany and Zoology thus providing a suitable habitat for pest species to thrive.

2.2. Model organism

Among the many species of wasps that are noticed in the campus, two most abundant species were chosen for the study. *Sceliphron sp.* is a solitary mass-provisioning wasp that builds mud nest with multiple cells. *Polistes olivaceus* is perhaps a primitively eusocial wasp that builds open nests and is a progressive feeder nurturing its young growing larvae with the masticated flesh of Lepidopteran caterpillars.

2.3. Surveys and marking

The study site was surveyed every alternate day from the start of the spring season (February) to check for any activity of wasps mainly *Polistes sp.* as they start initiating their nests around that time [6]. Colonies were located which were monitored on a daily basis. The foundresses as well as the emerging progeny were marked with Testors paints for easy identification. In case of solitary

wasp, *Sceliphron sp*. the nest surveys started around the rainy season (June) as it was found that this was the period when they initiate the nests. The female was marked in this case also.

2.4. Collections

The social wasp colonies used in this study were either single foundress or two-foundress colonies. Total of 30 nests were located. The wasps which go to search for food for the developing larvae are referred to as foragers. Behavioural observations were made on the social wasps during cool hours (morning or evening) to record the number of foraging trips made per hour and the type of forage brought to the colony. In the case of the solitary wasps the number of prey items in each of the cells was counted and summed over all cells for given nest and an average was calculated. This study was conducted over two calendar years of 2012 and 2013.

3. RESULTS

3.1 Food samples collected

We found that the social wasp, *P. olivaceus* was consuming significantly ($t = 4.4052$, $p < 0.05$) more number of prey items compared to the soiltary wasp, *Sceliphron sp.* (Figure 1). Further, the solitary wasp consumed spiders as prey while social wasp consumed Lepidopteran caterpillars as prey.

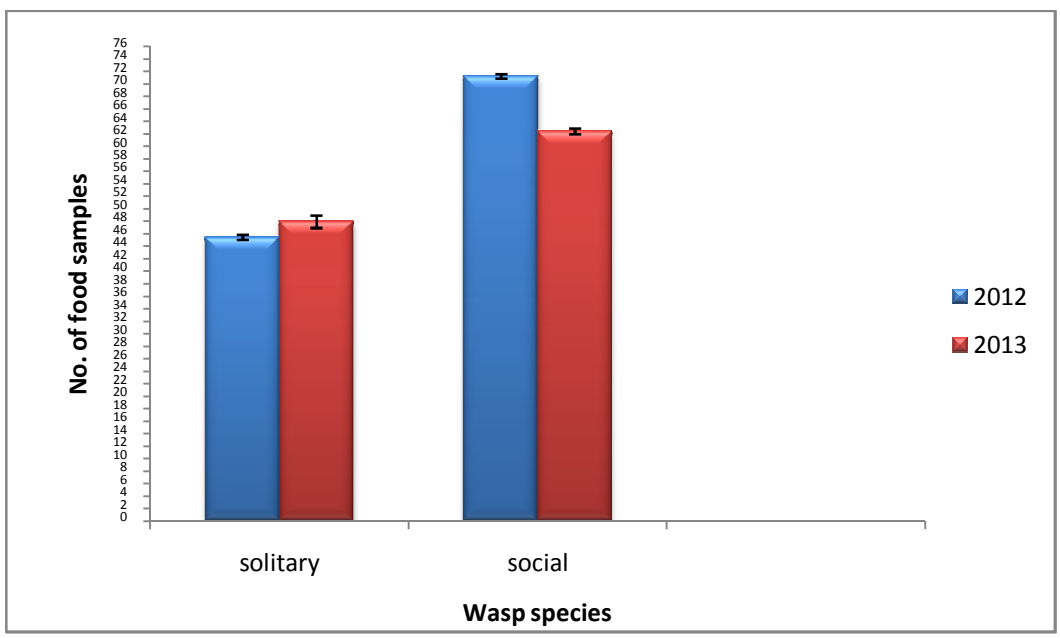
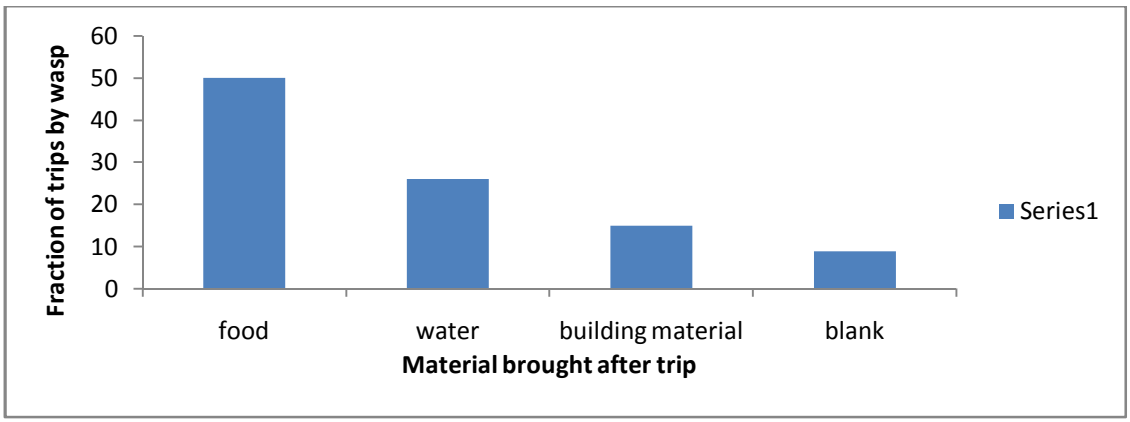


Figure 1. The number of prey items brought back to nest over the entire colony cycle period social and solitary wasps.

4.2 Foraging trips

In the social wasp, it was found that 50 percent of the foraging trips were dedicated to bringing solid food, *i.e.*, prey item while the other 50 percent consisted of unsuccessful trips, forgaing for building material and foraging for liquid items such as nectar and water.



4.3 Statistical analysis

The statistical analysis were carried out using students T-test.

4. DISCUSSION

Our results show that wasps, be it solitary or social, collect a large number of arthropods for their developing larvae. In case of solitary wasp, *Sceliphron sp*. the food prey item consisted of paralysed spiders. Hence, solitary wasp, *Sceliphron sp*. is not suitable as biological control agents, perhaps this species might have a negative effect by way of reducing the spider populations that might be effective biocontrol agents of Lepidopteran adults. Social wasps on the other hand, bring tiny pieces of flesh for their young which means each time they bring food to the nest, they are killing a Lepidopteran caterpillar [7]. Most of the dangerous crop pests are reported to be Lepidopteran caterpillars. The results reported here for the social wasps, *P. olivaceus* are from the behavioural data collected over a three hour period per day either in the morning or evening. The most conservative estimate of the number of prey items consumed per colony during its annual cycle is twice the number mentioned suggesting that the social wasps *P. Olivaceus* can potentially be exploited as a biological control agent in northern India. The only danger is the sting of the wasps that is not fatal but only mild. Benefits of obtaining food grains devoid of harmful pesticide out weight the seemingly negligible cost in terms of the pain and discomfort of the sting. Hence, farmers should be educated band encouraged to provide nesting spaces in terms of small insect cages installed on post-poles in their agricultural field through extension education and help in reducing the harmful effects of pesticides on the environment and the human populations.

5. CONCLUSION

The adverse affect of heavy pesticide usage are too numerous, that are not only economically taxing but also have lead to birth of malformed children and live-stock that is causing unbearable trauma to the effected families thus necessitating the need to explore alternative forms of pest control. Although it was known that social wasps feed on Lepidopteran caterpillars, their potential of being used as biological control agents was not explored perhaps due to the fear of being stung by the adult wasps. Hence, it advisable to educate and encourage farmers to set up nesting sites for these social wasps and harvest a healthy crop.

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