Temporal and spatial dynamics of guilds of Hymenopteran parasitoids attacking aphids in various agricultural crops

THESIS

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Abstract

Aphids (Aphidoidea) are cosmopolitan, polyphagous insects which attack many of the agricultural crops and cultivated plants in Israel. Aphids are abundant in all regions of the country on a variety of crops nearly year round. They cause extensive damage, including injury to plant tissues, honeydew secretion and resulting sooty mold development, and transmission of viral pathogens. The use of chemical pesticides to control aphids has increased greatly over the last few decades; this trend not only increases production costs and harms the environment, but is also deleterious to natural enemies in the field.

Aphids are attacked by numerous hymenopteran parasitoids. Most of the species of primary parasitoids belong to two families, the Aphidiidae (Ichneumonoidea) and Aphelinidae (Chalcidoidea). Parasitoids from both of these families oviposit within the body of the host, where the larva then develops, killing the aphid. The remains of the aphid's body form a mummy within which the wasp pupates. Some aphid species can serve as hosts for more then one parasitoid species, and most parasitoids can develop on a number of aphid species. Secondary parasitoids, which attack the primary parasitoids at various stages of development, are also present in the system.

This study of the guild structure of aphid parasitoids was conducted with two major goals in mind. The first was to compare the parasitoid guilds on aphids in different crops, in order to test the possibility that parasitoids move among plant-aphid systems. The second goal was examining the relative importance of the aphid host and plant host in determining the composition of parasitoid guilds on aphids. In this research, data on parasitic wasps and aphids were collected from wheat, cotton, corn, cucurbits, and broccoli, and also from weeds at field margins. Aphids were sampled for three years in two different regions of the country, and were transferred to the lab and held there until the parasitoids emerged.

During the course of the study, 16 species of aphids were collected from 28 species of plants. Percent parasitism was relatively low (less then 10 percent) in most of the crops. In some cases, parasitism exceeded 10 percent, but only for a short time. In general, the pattern of parasitism repeated itself in all the years on the various crops: primary parasitoids were abundant at the beginning of the season, and as the season progressed the abundance of secondary parasitoids increased, reaching a peak at the season's end. The number of species was similar in the same crop in different regions,

in spite of the geographical distance (100 km'). *Aphidius spp.* were abundant mostly in wheat, *Lysiphlebus* spp were most common cotton and *Diaeretiella rapae* was most abundant in broccoli. Species richness was relatively high on marginal vegetation. Wheat was the only crop in which a number of aphid species were found consistently in the sampling years. In general, similarity was found in parasitoid species richness on the most abundant aphids in wheat.

Aphis gossypii was the only aphid found on cotton and cucurbits. The aphidiid parasitoids *Lysiphlebus spp.* were abundant in cotton, while aphelinids were more common on curcurbits. Variation was found among the major parasitoids attacking the aphid *Rhopalosiphum maidis* on different crops: on wheat, *Aphidius spp.* were dominant, as opposed to corn, on which aphelinid parasitoids were most abundant. On broccoli, *D. rapae* was the most common parasitoid of two aphids, *Brevicoryne. brassicae* and *Lipaphis erysimi*. These findings indicate the importance of the host plant in determining the composition of the parasitoid guild.

In wheat, percent parasitism peaked at the end of the growing season, unlike in cotton, which showed a peak in percent parasitism at the beginning of the season. Although these two peaks overlapped temporally (April-May), different parasitoids were present in each crop, thus no evidence was found for movement of parasitoids between wheat and cotton. In contrast, the secondary parasitoids that were abundant at the end of the wheat season and the beginning of the cotton season have not yet been identified, so the question of movement between crops has yet to be clarified in this case.

In conclusion, results indicate the potential contribution of marginal vegetation for harboring parasitoids and natural enemies which may move, in time, to the infested crops. On the other hand, marginal vegetation can also harbor aphids and secondary parasitoids which may invade target fields and thus increase pest infestation levels. In addition, host plants proved important in determining the composition of parasitoid guilds. The primary parasitoids were highly specialized: *Aphidius spp.* in wheat, *Lysiphlebus spp.* in cotton and *D. rapae* in broccoli.

Finally, it is recommended that biological control by parasitoids be integrated with other control methods in order to maximize their beneficial effects in controlling aphid populations on various crops.