A Survey of Arthropod Predators of *Leptinotarsa decemlineata* (Say)\(^1\) in Delaware Potato Fields\(^2\)

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**ABSTRACT** In visual, beating, and pitfall trap samples from five Delaware potato fields, the following previously reported predators of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say), were found: *Coleomegilla maculata* (Timberlake) (Coccinellidae), *Chrysoperla carnea* (Stevens) (Chrysopidae), *Lebia grandis* Hentz (Carabidae), *Podisus maculiventris* (Say) (Pentatomidae), *Perillus bioculatus* (F.) (Pentatomidae), and *Phalangium opilio* (L) (Phalangiidae). The carabid *Pterostichus chaetes* Say was also abundant, and was observed feeding on *L. decemlineata* larvae, a fact not previously reported. Other potential predators sampled included other carabids and coccinellids, and a wolf spider (*Lycosidae*) in the genus *Pardosa*.

**KEY WORDS** *Leptinotarsa decemlineata*, predators, biological control, potatoes, Colorado potato beetle, Coleoptera, Chrysomelidae.

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), has a number of arthropod natural enemies that are native to the United States (Riley 1869, 1872, 1877, Trouvelot 1931, Franz 1957, Groden 1989). Although this fauna has been characterized in several site-specific natural mortality studies (e.g. Franz 1957, Groden 1989) and surveys of potato field arthropods (Ihrke and Bartell 1979, Boiteau 1983), knowledge of the diversity and abundance of the Colorado potato beetle's natural enemies in various United States potato growing regions remains incomplete. Knowledge of the Colorado potato beetle's resident arthropod natural enemies is a necessary precursor to the manipulation and/or conservation of populations of these organisms in the context of a biological or integrated control program.

**Materials and Methods**

In 1990, we sampled four sites within four miles of each other near Middletown, Delaware. Three of these were large commercial fields and one was a ca. 0.25-ha field adjacent to experimental plots maintained by University of Delaware researchers. In 1991, only one field was sampled, a different commercial field from those sampled in 1990, also near Middletown, Delaware. All fields were planted in late March or early April with the potato cultivar "Superior." Commercial fields were treated with a variety of conventional and biological insecticides, while the University site was never sprayed. Colorado potato beetles were present in all fields.

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Each commercial farm site was sampled five times between 13 June and 18 July 1990. In 1991 the commercial site was sampled four times between 16 May and 5 July, because plant senescence and damage from Colorado potato beetle feeding were too severe to allow sampling after that date. In the commercial fields, eight sampling locations were randomly chosen within a corridor between 25 and 75 m from the edge of the field at each sampling date. In the smaller University site eight sampling locations were chosen at random from within the entire field. Edges were not sampled.

In all fields, two sampling methods were used: at four locations, 2 m of two adjacent rows were inspected visually and species and numbers of all entomophagous insects seen on the foliage were recorded. The remaining four locations were sampled by beating plants by hand from 2 m of two adjacent rows over an enamel pan (18 by 30 cm) containing approximately 0.5 cm of 95% ethanol. Insects that fell into the pan were taken to the laboratory for identification. Sampling took place between 0900 and 1300 h.

The University field and one commercial field were also used as pitfall trap sites in 1990. One-liter tin coffee cans were buried near the bases of potato plants with their tops flush with the soil. The traps were about half-filled with salt-saturated water mixed with a few drops of detergent, and covered with a linoleum tile (22.5 cm²) elevated about 3 cm above the soil surface. The salt served as a bacteriostat, the detergent to break the surface tension of the water when insects fell in, and the tile to exclude rainwater. Two traps were placed at random in each field on 20 June and collected on 5 July (University field) and 8 July (commercial field). In 1991, two pitfall traps were placed in the same field that was sampled visually and by beating. The traps were emptied and replaced weekly for a total of six samples between 24 May and 27 June. All specimens from pitfall traps and beating samples have been placed in the voucher collection of the University of Delaware Department of Entomology and Applied Ecology Insect Museum.

For three of the potential predators (the carabid, *Pterostichus chalcites* Say, and the coccinellids, *Coleomegilla maculata lengi* Timberlake and *Coccinella septempunctata* [L.]) feeding trials were performed in which predators collected from the field were taken to the laboratory and offered large and small larvae and eggs of *L. decemlineata* as food. Predators were kept individually with their potential prey items in Petri dishes (9 cm diam) in an incubator at 25°C and a photoperiod of 16:8 (L:D). Prey were checked for signs of predation at least twice daily for 3 d.

**Results**

Plant beating and visual sampling yielded similar counts and species of organisms. Therefore, results from these two methods were combined. All visual and beating samples combined yielded a variety of known and potential natural enemies of *L. decemlineata* (Table 1). Of those previously documented as Colorado potato beetle predators, the most abundant were the coccinellid, *Coleomegilla maculata lengi*, the chrysopid, *Chrysoperla carnea*, and the carabid,
Table 1. Known and potential Colorado potato beetle predators sampled in Delaware potato fields.

<table>
<thead>
<tr>
<th>Sampling Method</th>
<th>Organism</th>
<th>Number of Individuals</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>1990&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Visual and Beating</td>
<td>Coleoptera&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Coleogetella maculata lengi</td>
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<tr>
<td></td>
<td></td>
<td>Timberlake</td>
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<tr>
<td></td>
<td></td>
<td>Coccinella septempunctata (L.)</td>
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<tr>
<td></td>
<td></td>
<td>Cycloneda munda (Say)</td>
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<tr>
<td></td>
<td></td>
<td>Carabidae</td>
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<tr>
<td></td>
<td></td>
<td>Coleoptera&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lebia grandis Hentz</td>
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<tr>
<td></td>
<td></td>
<td>Pterostichus chalcites Say</td>
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<tr>
<td>Pitfall</td>
<td></td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neuroptera</td>
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<tr>
<td></td>
<td></td>
<td>Chrysopidae</td>
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<td></td>
<td></td>
<td>Hemiptera</td>
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<tr>
<td></td>
<td></td>
<td>Staphylinidae</td>
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<tr>
<td></td>
<td></td>
<td>Araneida (Arachnida)&lt;sup&gt;f&lt;/sup&gt;</td>
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<tr>
<td></td>
<td></td>
<td>Lycosidae</td>
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</tbody>
</table>

<sup>a</sup> Total of all samples from four sites.
<sup>b</sup> Total of all samples from one site.
<sup>c</sup> Only adult specimens are tabulated.
<sup>d</sup> Includes 6 eggs, 5 larvae, and 3 adults.
<sup>e</sup> Includes 1 nymph and 2 adults.
<sup>f</sup> Both adults and immatures are included.

Lebia grandis, although the latter two were not observed in the commercial field sampled in 1991.

In the pitfall traps, Pterostichus chalcites, a carabid, was the dominant insect species found (Table 1). A wolf spider (Lycosidae), Pardosa sp. was also found in large numbers at the University site and in the commercial field sampled in 1991. The University site also produced low numbers of Phalangiopum opilio (Opiliones:
Phalangiidae), while large numbers of this harvestman were consistently found in the commercial field sampled in 1991. Staphylinid beetles recovered were of various species, nearly all very small (< 5 mm long).

In laboratory feeding tests, both Coleomegilla maculata lengi and Pterostichus chalcites fed readily on large and small larvae and on eggs of the Colorado potato beetle. Coccinella septempunctata, in contrast, rejected larvae and ate very sparingly of eggs.

Discussion

Coccinellidae. Of the Coccinellids observed during this survey, only Coleomegilla maculata is known to prey on the Colorado potato beetle. Riley (1869), Franz (1957), and Groden et al. (1990) reported egg and small larval predation by this species, and our own laboratory tests confirmed this. Coccinella septempunctata, a palearctic aphid predator first introduced into the United States in the 1950's (Gordon 1985), was found in about the same numbers as C. maculata, but based on our laboratory feeding trials does not feed on Colorado potato beetle eggs or larvae.

Chrysopidae. Chrysopid larvae were observed feeding on egg masses of L. decemlineata in the field on several occasions in 1990. Sorokin (1976) reported L. decemlineata predation by Chrysopa (= Chrysoperla) spp. in the Soviet Union. Releases of these predators in Soviet eggplant fields resulted in impressive control of L. decemlineata in some trials (Ridgeway and Murphy 1984).

Carabidae. Lebia grandis is thought to feed almost exclusively on the Colorado potato beetle (Lindroth 1969, Groden 1989). Adults forage nocturnally in potato foliage, where they prey on Colorado potato beetle eggs and larvae (Groden 1989, Hazzard et al. 1991). Larvae exhibit a parasitoid-like lifestyle by developing to maturity on a single Colorado potato beetle larva or pupa (Groden 1989). A recent study indicated that this carabid "may be the most important endemic predator" of the Colorado potato beetle (Groden 1989).

There are no published reports of Pterostichus chalcites as a natural enemy of the Colorado potato beetle, but during this study two were observed feeding on a single larva in the field, and the beetle readily fed on such prey in the laboratory. P. chalcites is common in cultivated fields, and has been shown to feed on a variety of prey, including eggs and larvae of the black cutworm, Agrotis ipsilon (Hufnagel) (Best and Beegle 1977), eggs, larvae, and adults of the western corn rootworm, Diabrotica virgifera virgifera LeConte (Kirk 1975), and eggs and larvae of June beetles, Phyllophaga spp. (Seaton 1939). Two other Pterostichus species, P. lucublandus Say and P. melanarius Illiger, found in potato fields in Massachusetts, consumed Colorado potato beetle eggs in the laboratory but did not forage for eggs in the foliage when leaves did not touch the ground (Hazzard et al. 1991).

Staphylinidae. Riley (1872) cited an unidentified staphylinid as a Colorado potato beetle predator. However, the species collected in our study were much smaller than the one described by Riley. In previous diurnal and nocturnal sampling, staphylinids have not been found foraging in potato foliage (Groden 1989, Hazzard et al. 1991). Because the staphylinids caught in the current study were so tiny and have never been observed in potato foliage, they were unlikely to have much, if any, impact on potato beetle populations.
Pentatomidae. Both predacious pentatomids found here are known to prey on the egg and larval stages of the Colorado potato beetle (Tamaki and Butt 1978, Drummond et al. 1984). During this survey Podisus maculiventris (Say) was observed feeding on larvae in the field.

Lyosidae. Members of the genus Pardosa have been implicated in the natural control of various agricultural pests (Agnew and Smith 1989, Oraze and Grigarick 1989), but we know of no reports of these spiders feeding on the Colorado potato beetle.

Phalangiidae. Riley (1872) reported L. decemlineata predation by "an undetermined species of Phalangium." A recent study confirmed that P. opilio feeds on Colorado potato beetle eggs and first and second instars, but concluded that the harvestman is probably not a major source of L. decemlineata morality (Drummond et al. 1990).

In summary, a variety of known and potential Colorado potato beetle predators were found in Delaware potato fields. Additional research is needed to assess the impact of these organisms on beetle populations.

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