

A Report on Invading Species LEVEL 3

A

For the Ministry of the Environment

A report on Invading Species: Ladybugs

*“To an English farmer, a ladybug signals a good harvest.
In a French vineyard, a ladybug is a sign of good weather.
A ladybug walking on the hand of a Swedish girl
is said to be measuring for wedding gloves and in Canada,
ladybugs wintering in your garage mean good luck.” (www.cnf.ca)*

Stepping back a few years, to 2000-2001, many rural residents living in the southern areas of Ontario would have noticed a population increase in ladybugs. That population increase was due to the dilemma that had arisen regarding aphids and crop destruction (vegetables, grain crops, legumes, strawberries, tree crops, etc.). Additional ladybugs were brought in to save the crops before ruin. A ladybug can munch up to 500 aphids a day, taking a big bite out of the pest problems. However, now that the aphid population has been stabilized (for the time being), the invading species of ladybugs has created a new problem in our ecosystem.

Key characteristics

Part of the Coccinellidae beetle family, ladybeetles, ladybugs, ladybirds or Coccinellids (*Coccinella septempunctata*), are of the most commonly known of all beneficial insects. Back in Europe, over 600 years ago, these beetles were known as “ladybirds”, as the lady for whom they were named was none other than the Virgin Mary.

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Physical Appearance:

Among the 400 ladybeetle species in North America (5000 species worldwide), adult ladybugs are typically dome-shaped (oval or convex), often shiny, with short legs and antennae. Their exterior layer is usually reddish-orange to pale yellow, with or without black spots or irregular marks. Some ladybugs are solid black or black with a red spot. The head of a ladybug is concealed from above, while the lower torso ranges from one to ten millimetres, depending on the species and if they have wings.

Life Cycle:

There are four distinct stages in a ladybugs life cycle: egg, larval, pupa and adult stage. The cycle varies depending upon temperature, humidity, and food supply. Usually the cycle from egg to adult stage requires about three to four weeks, or up to six weeks during cooler spring months.

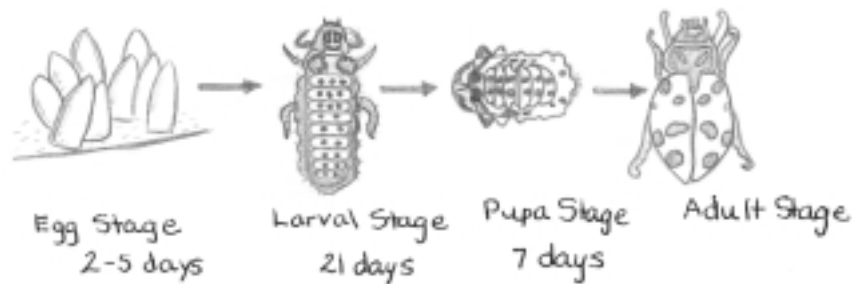
Ladybugs hibernate in winter as adults beneath leaf litter, rocks, bark and protective places, (including buildings. After hibernating in large aggregations, consisting of up to 10,000 ladybugs, the ladybugs disperse in the spring in search of prey and suitable egg-laying spots. (Fact: ladybugs will not reproduce indoors, only outdoors near food supply.) Female ladybugs, normally larger than males, lay from twenty to more than one thousand eggs over a one to three month period, commencing in spring and early summer. Eggs are usually laid near prey, such as an aphid colony, often in small clusters in protective sites such as on leaves and stems. The eggs are cream, yellow or orange, are exceptionally small, only one millimetre, and emerge to larva (larval stage) after a mere two to five days. The newly hatched larvae, greyish-black with yellow or orange spots, feed on aphids (fifty to three hundred as they grow) for up to three weeks then attach themselves by the abdomen to a leaf or other surface to pupate (pupa stage). Pupae may be dark or yellow-orange, and remain in the pupal stage for three to twelve days, depending on the species and temperature. The emerged adults then mate, search

LEVEL 3

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for prey or prepare for hibernation, depending on the availability of prey and time of year. Adult ladybugs may live for a few months to over a year, and may produce up to six generations of ladybugs per year.

Life Cycle of the Ladybug



Interesting Facts about ladybugs:

- Larvae grow and shed their skin three times before they pupate
- Not often do ladybugs have spots in the first twenty-four hours of adulthood
- The spots on a ladybug fade as they get older
- Ladybugs feed on their stored fat during hibernation
- Cannibalism of eggs, larvae and pupae is common
- Ladybugs migrate hundreds of miles by riding in the winds
- Ladybugs will not fly if the temperature is below 55 degrees Fahrenheit

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Food Habits

Although ladybugs are harmless to furniture, buildings, etc., they are voracious eaters and may be numerous where prey is plentiful and insecticides are limited. Ladybugs' preferred cuisine is aphids, yet they do feed on mites, small insects, insect eggs, flower nectar, water, honeydew, and pollen. A single ladybug can eat up to hundreds of aphids per day, and up to 5000 aphids in a lifetime. As a result, ladybugs are extremely beneficial to crop production since aphids are herbivores (destroy crops) and ladybugs are carnivores (eat the aphids and save the crops). Hence, they are known as phytophagous insects ("pests of plants" – sometimes called "plant pests").

Facts:

- Ladybugs use physical contact, rather than sight or smell to locate their prey, and use their mandibles (inside of the insect's mouth) to chew from side to side (rather than up and down like people)
- Ladybugs will not eat so much, that there is not enough left for their offspring
- Ladybugs may be cannibalistic if food supply is scarce
- Ladybugs that feed on aphids develop faster, age faster, move faster, are typically larger, and lay their eggs in cluster. Ladybugs that feed on scale insects are naturally opposite

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Pre-Adaptations

Ladybugs are relatively small and are successful at adapting to the environment. Ladybugs have very few predators because of their distinguishing spots and brightly coloured backs that warn of poison. This poison is their blood (hemolymph), which they bleed from their leg joints to protect themselves. Their blood acts as a repellent, having a repulsive smell, bad taste, and containing various alkaloid toxins which may be lethal or dangerous to predators. Because of this protection, birds and other predators do not like to eat ladybugs, making them abundant and successful enemies of aphids. It has been noticed that ladybugs are only effective predators if aphids are abundant (high pest density), and are thought to be less effective at low pest density. Secondly, ladybugs have high reproduction rates of three to four weeks and low life expectancies, which allow them to be triumphant and stay on top. Next, ladybugs are tolerant to some chemical insecticides that are used for aphid and crop protection depending on the rate of spray and susceptibility to the insecticide. This allows the ladybugs to tolerate the insecticide and survive, as well as assist in pest control. Lastly, there is a larger amount and varied food supply for ladybugs. Once ladybugs have eliminated an aphid colony, they will search for additional food or will stop eating until the colony has been replenished.

As a result, ladybugs are successful at adapting to their current environment through their combat exterior, reproduction rate/life cycle and food habits.

Predators:

Although the ladybugs have many qualities that ward off predators, they still have a few predators to deal with. Predators of the adult ladybug are: parasites, parasitoids, and most commonly braconid wasps. While native tachinid flies, eulophid wasps, weevils and pterophorid moths are best known to attack the ladybug larvae and pupae.

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Fact:

- Ladybugs play dead when in danger because many predators don't eat insects when they don't move

Scientific Analysis of the Problem

As already stated above, in 2000 there was an abundant amount of aphids found on varied crops. To resolve this dilemma, additional Asian ladybugs were brought in to save the crops in southern Ontario in 2001, since ladybugs eat aphids (500 per day).

Biodiversity Factors:

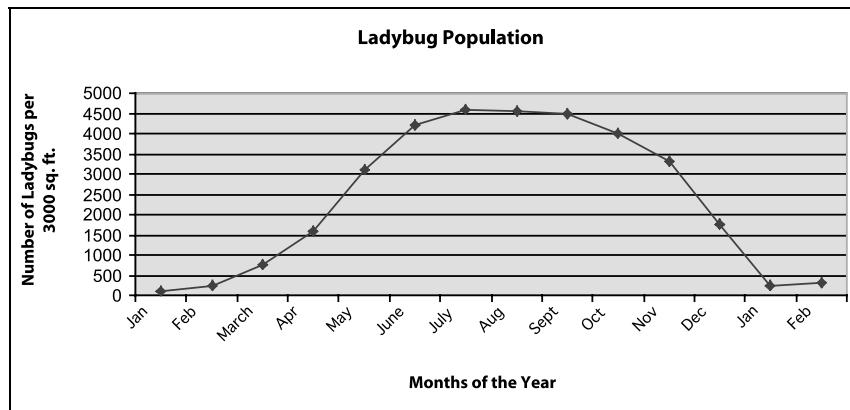
Recent data show that over 4500 ladybugs (half a pint) cover a territory of 3000 square feet. That's a lot of bugs! Also incorporated into this recent data are the imported ladybugs brought over from Asia to assist in pest control since the 1980's. As a result, biodiversity takes toll on our ecosystem.

The more species of lady beetles, the more flexible the ecosystem is, and the better it can withstand shocks. Therefore, the introduction of the Asian beetle may increase the number of species of lady beetles, but in time may eliminate more species if one species becomes dominant and the others can't compete for food, and habitat. On the other hand, research signifies that when a combined species becomes dominant, that the beetles share similar genes and may be more vulnerable to a new disease or parasite that could, again, wipe them out and leave nothing to eat the aphids, throwing the ecosystem dangerously off balance.

LEVEL 3

G

The following graph shows the population of ladybugs in a 3000 square foot area, over a one-year scenario.



In conclusion, the biotic factors at risk include:

- Reduction / elimination of the native species of ladybugs
- Effect on ecosystem / biodiversity: over population of prey (aphids), under population of predators (i.e. wasps)
- If there is a complete explosion of ladybugs, insecticides may have to be used to control the vast population. This causes harm to the environment and ecosystem

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Impact on the environment in Ontario:

Immediate:

With the introduction of Asian ladybugs, the economy has been benefited. For example, if:

Ladybug population increased → Aphid population decrease → increased profitability from crop commodities (better crops) → healthier economy and food supply.

On the other aspect, the immediate notice of ladybugs could cause to be a nuisance. Outdoor activities may be interrupted by visiting ladybugs. Many individuals would consider this to be very inconvenient.

Long Term:

Over time, if the ladybug species were to be affected drastically because of biodiversity, the end result would be the economy suffering.

For example, if:

Ladybugs suffer (Insufficient population) → Aphids over populate → crops damaged → unsatisfactory crops → economy and food supply suffer.

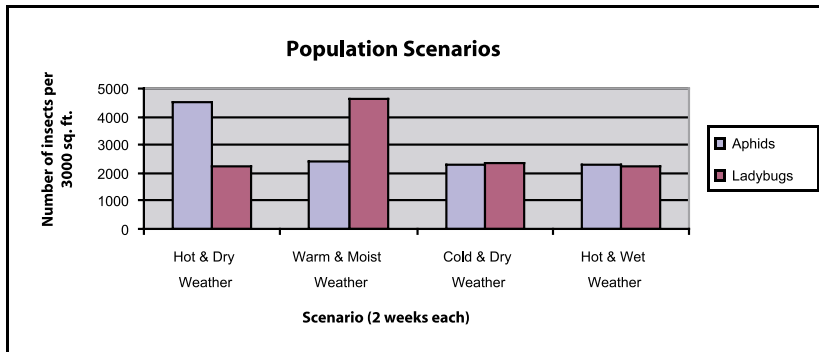
On the other hand, if the ladybug population continues to skyrocket, they could soon become a major nuisance when hibernation arrives. Some species of ladybugs prefer to hibernate indoors in large groups of hundreds. They crawl into the cracks and crevices of homes and stay in dormant state until the warm spring

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weather wakes them. If people aren't fond of sharing their homes ("home invasion"), they may not be able to tolerate the long-term effects of ladybug overpopulation.

Predictions for the future

Since ladybugs enjoy warm, damp conditions and aphids prefer dry, hot conditions, the future population of ladybugs depends on the temperature and climate in the seasons to come. However, as long as there are sufficient quantities of aphids, there will be sufficient numbers of their predators, ladybugs. The following graph displays how different scenarios would effect the population of aphids and ladybugs.



However, now there are the imported lady beetles (that bite), which were brought in for pest control and may soon take over the original ladybug species. If this were to occur, the biodiversity and ecosystem would be hurt, as well as an unsatisfied economy with the nuisance of ladybugs to cope with.

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Recommendations:

As of yet, there is no gigantic problem involving the invasion of ladybugs. However, because of 2000-2001's explosion of aphids and ladybugs, gardeners and food producers are able to purchase ladybugs for crop protection. If the ecosystem is to remain as "normal" or "natural" as possible, the government or agricultural society should be monitoring the retail of these ladybugs, as well as their exact species. If ladybugs are going to be retailed, only the native species in the area should be sold/purchased, so as not to affect the biodiversity and ecosystems in the surrounding areas.

An alternative solution for if the problem were to become out of hand would be for agronomists and researches to produce / retail an insecticide that would eliminate either a specific species of ladybugs or one that could be used to stabilize the population (so as not to effect the ecosystem of biodiversity).

Hopefully, this time, no one introduces one of the ladybugs' predators, as they did for the aphids, and instead, they let nature take its own course if it comes to that.

Either way, whatever may happen, researchers must ensure that they look at both immediate solutions and future solutions. This ensures that future outbreaks do not arise and the problems of invading species can be solved.

LEVEL 3

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Teacher’s Notes**Knowledge/Understanding**

- The student demonstrates considerable understanding of how the invading species has adapted. He or she links a number of adaptations to the success of the species within the environment, such as being a voracious predator and a prolific reproducer, and experiencing a lack of predation (e.g., “Female ladybugs ... lay from twenty to more than one thousand eggs over a one to three month period”; “Their blood acts as a repellent”). However, some of the information is irrelevant (e.g., “low life expectancies, which allow them to be triumphant”).

Inquiry

- The student analyses the actual or potential problem with considerable effectiveness. He or she identifies both positive and negative aspects of ladybug presence (e.g. “Ladybug population increased → Aphid population decrease → increased profitability from crop commodities (better crops) → healthier economy and food supply”; “the biotic factors at risk include ... Reduction/elimination of the native species of ladybugs”). However, the student gives no indication of the magnitude of the economic benefits or costs.
- The student predicts the future impact of the invading species with considerable effectiveness. He or she recognizes that future population numbers will depend on both abiotic and biotic factors (climate and food), and that there will be different long-term impacts if the ladybug population goes up or down. The student speculates that “the imported lady beetles (that bite) ... may soon take over the original ladybug species.” However, he or she provides no scientific evidence to support this possibility.

Communication

- The student communicates information in graph/chart/table format with considerable clarity. The graphs show how the ladybug population depends on the time of year, summer weather, and the food supply. However, the graphs are useful for predicting only short-term population fluctuations, not future trends. The graphs are clearly labelled, with the exception of “Scenario (2 weeks each)” on the second graph.

LEVEL 3

- The student communicates ideas and information with considerable clarity. The report is organized into logical sections. However, some of the information in them is not connected to the task (e.g., lists of interesting facts). The writing is generally clear, but there are some exceptions (e.g., “one species becomes dominate”, “an unsatisfied economy”). The report includes the use of non-metric units (e.g., “half a pint”, “3000 square feet”).

Making Connections

- The student recommends and justifies a course of action of considerable effectiveness. For example, he or she states: “If ladybugs are going to be retained, only the native species in the area should be sold/purchased, so as not to affect the biodiversity and ecosystems in the surrounding areas.” However, the student offers no justification for one of the other possibilities, i.e., to “let nature take its own course” in controlling the invading species.

Comments

This work is representative of a solid level-3 performance. The student demonstrates a considerable degree of achievement of the expectations in all four categories of knowledge and skills.

Next Steps

In order to improve his or her performance, the student needs to:

- edit and proofread the report to ensure that all information is relevant;
- describe the economic impact of the invading species;
- use scientific evidence to support all predictions;
- include graphs that show future population trends;
- edit and proofread the report to correct unclear statements;
- use SI units throughout the report;
- justify all recommendations.