Multicoloured Asian Lady Beetle (MALB)

Questions and Answers about *Harmonia axyridis* (Pallas)

Prepared by Kevin W. Ker, M.Sc. P.Ag
and Neil Carter, M.Sc.

kker@brocku.ca or kcms@sympatico.ca
(905) 688-5550 ext 4717 or (905) 945-8228
neil.carter@omaf.gov.on.ca, (905) 562-3833

Fig. 1. The multiple colour variations observed in Ontario (Ker/Brewster 2003)

1. Where did this beetle come from?

This particular species, *Harmonia axyridis* (Pallas) is from the Far East regions of Asia. It has been identified as native to Korea, Japan, China, the Himalayas, Taiwan, Siberia and the Bonin Islands. It was introduced into France in 1982 from China for biological control in orchards.

H. axyridis goes by a variety of common names depending on the area and reflective of its variable colours. This species has been called the Asian lady beetle, Japanese lady beetle, Halloween lady beetle, and Southern lady beetle, but the accepted common name is the multicoloured Asian lady beetle (MALB).

The first reports of this beetle in North America were as introductions for biological control of scale and aphid insects in California in 1916. Further releases of MALB took place in the mid 1960's without successful establishment. From 1978 through 1982, this species was released in the eastern United States and Canada (Nova Scotia). There are some questions about true establishment, as these release programs

did not appear to be successful. The first reports of successful establishment (recovery) were in 1988 in Louisiana.

Though debate continues on the exact point of origin for establishment, this species is found throughout the eastern seaboard with observations from Florida through Quebec, Texas through Missouri and western locales such as Oregon, British Columbia, Washington and central states such as Ohio, Wisconsin, Kentucky and Illinois.

An extremely comprehensive review of MALB was published by Koch (2003) and implications for grape pest control identified by Ker and Pickering (2004).

2. Is this a new insect to Ontario?

This is not really a new insect to Ontario, though its appearance is relatively recent. *H. axyridis* was first identified in Ontario by Dr. Steve Marshall (University of Guelph) in 1994. It was identified the same year in Quebec apple orchards and in Ontario orchards (Hagley 1999). What made this an unusual find was the large number of "morphs' or patterns on the wing covers (elytra) and colours for the same species (Figure 1). In a survey of beneficial insects in orchards, Dr. Hagley found more than 20 variants of the same insect. He admits his surprise when the specimens submitted for identification by specialists in Ottawa revealed that the bulk of the lady beetles were the same species. By 1999, this species had become the dominant lady beetle in orchards in southern Ontario.

In the United States this species is a very aggressive feeder and appears to be displacing some of the native species in Ohio, Michigan, West Virginia and other areas. This species of lady beetle has been found in many crops where food sources such as aphids and scales exist including grain crops, soybeans, conifers, ornamentals, and fruit crops.

3. How can I identify them?

Like most lady beetles, this insect is about 6 to 10 mm (approximately 1/3 of an inch) long, oval in shape and domed or convex in appearance. (Figure 2)

Figure 2. MALB size relative to a one cent coin (Ker / Brewster 2003)

The common name of this beetle reflects its many different colours and forms. Body colour can vary dramatically from yellows to reds. Some may have many spots, or few spots or even no spots on the elytra where the wide range of colours and spotting appears. The closest thing to a simple identifying feature is located on the pronotum (the area just behind the head). On most individuals, the spots on the pronotum form a black “M” (Figure 3)

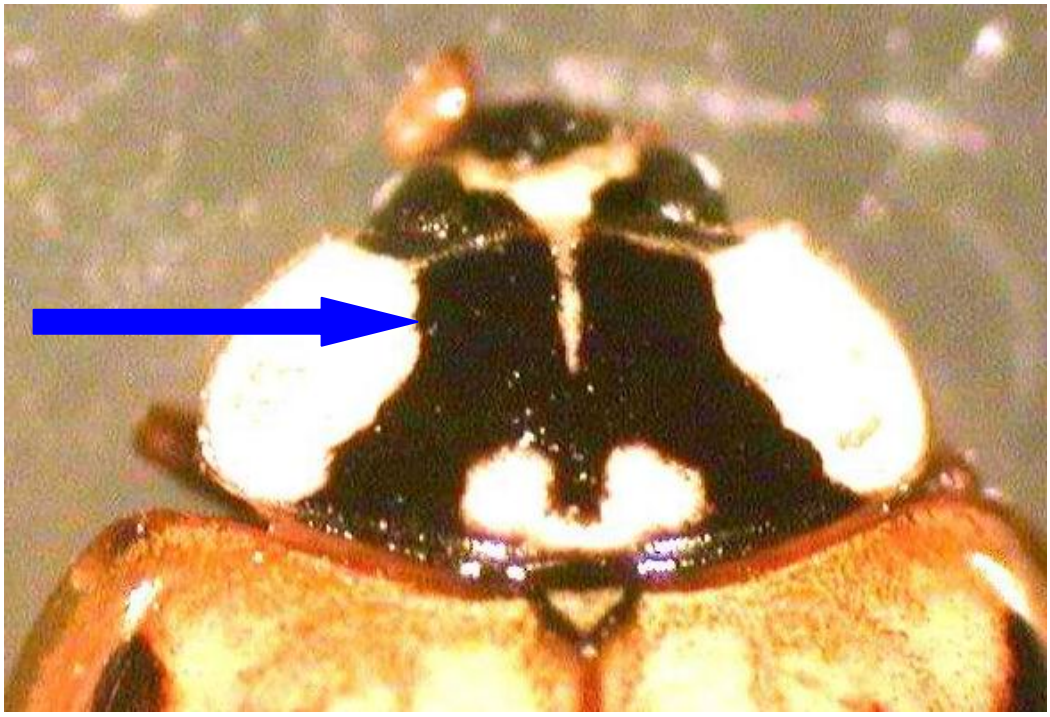

Figure 3. “M” marking on the pronotum of MALB (Ker/Brewster 2003)

There are many colour variations (Figure 1). However, the “M” is consistent on all MALB. In contrast, a species commonly found in Ontario, ***Coccinella septempunctata***, (commonly called “C-7”) has 7 spots and a very consistent colour for the elytra. The pronotum of C-7 is mostly black and does not resemble the “M” pattern on the pronotum of MALB (Figure 4).

Figure 4. *C. septempunctata* (seven spotted lady beetle) on the left and *H. axyridis* (MALB) on the right (Ker/ Brewster 2003)

See the list of web locations and publications listed in the appendix for photographs and additional identification of *H. axyridis* and other species.

4. Why were there so many of them a few years ago (in 2001)?

Lady beetles are excellent predators and are considered to be beneficial insects. These predators feed upon such harmful pests such as aphids, scale insects, mealybugs, mites and even eggs and larvae of moths.

H. axyridis is a voracious feeder with adults capable of eating 15 to 65 aphids per day and each larva eating 90 to 370 aphids during its development. Large explosive populations of the beetles can often be attributed to massive abundance of prey (aphids, scales, etc.) and lack of competition and natural enemies. There are very few predators or parasites that attack MALB, and those that do have a very limited impact on the population of beetles.

In 2000, the central regions of the United States had reports of massive outbreaks of a new pest of field crops - the soybean aphid. Similar outbreaks of this aphid were reported across Ontario in the spring through summer of 2001. The hot dry spring of 2001 in Ontario was ideal for early soybean development and provided a great food source for the aphids. The lady beetle population probably followed this vast food source and multiplied dramatically.

This lady beetle also feeds on pest species that can attack many crops – orchards, ornamentals, grain crops, and natural ecosystems such as forested areas. The levels of aphids in all those areas were not known for 2001, but there are normally many aphids throughout the environment. The natural food sources for MALB plus the exceptional outbreak of soybean aphids combined with the beetles' natural ability to multiply rapidly, made the rapid rise in MALB numbers possible in 2001.

5. How long does it live?

To understand how the population escalates, you must understand the life cycle. It is believed that nonmated adults may form the bulk of the overwintering population in hibernation. Mating takes place just before dispersal, as the adults emerge from hibernation structures in the spring.

The lady beetle life cycle involves complete metamorphosis – egg to larva to pupa to adult. In laboratory conditions at 25 C, this cycle can take from 14 to 20 days. In the outdoors, with variable temperatures (cool springs) this can take up to 36 days or more. In normal spring patterns, egg hatch can occur in 3 to 5 days, larval feeding 12 to 14 days and the pupal stage about 5 to 6 days. Once the adults emerge they can remain active from 1 to 3 years depending on site and other variables. Many of these beetles survive as adults for only 30 to 90 days, but obviously a significant proportion of the population (adults that survive the winter) lives longer.

Hagley (1999) reported females normally capable of laying 600 to 800 eggs. Other researchers have reported much higher egg numbers in laboratory studies (Koch 2003). Combined with a life cycle of approximately 1 month which allows for 5 to 6 generations per year, this can lead to a very rapid population explosion if the food source is not limiting.

6. In 2001 and 2003, there were many beetles around my house. Will this happen again in 2004?

The beetles may or may not aggregate in similar places each year. Most of the beetles in any given aggregation are "new" in the current year, and there is no information on whether older beetles "remember" where they have overwintered previously. Population levels (see above) will partly determine size of aggregations. In general, structures that were attractive to beetles for overwintering sites one year will probably be attractive in subsequent years.

Currently, Dr. Mark Sears of the University of Guelph, Neil Carter of OMAF, and Kevin Ker of KCMS and CCOVI Brock University are undertaking studies to monitor aphid development in area field crops, track the population of MALB around vineyards in Niagara, check for MALB presence on other plant hosts of aphids and investigate the use of volatile or scent taps to see if MALB activity can be better predicted.

Lady beetles often aggregate or form large groupings. Many of the different species enter a diapause (hibernation) mode to survive the winter. In autumn, as temperatures begin to fall and day length shortens, the beetles begin to seek locations for overwintering. In native environments, these hibernation sites would be cracks and crevices of rock outcroppings.

Mannix (2001) reported that typical fall behaviour has the beetles moving en masse to tall, light covered buildings. In 2001 in Ontario this appeared to be predominantly on the south and west exposures of light coloured buildings (homes, barns, sheds, etc.). A favoured location for diapause has been eaves and attics of homes and buildings. Other locations include door frames, window sills, beneath siding, shingles, and wall openings.

From this landing point they move internally into dark areas, periodically becoming active as temperatures warm to non-seasonal levels. As with many insects, their activity is temperature driven, with warmer temperatures encouraging movement. Combine this with their small size and capacity to move through small openings, and conditions are ideal for the insects to start wandering about inside buildings and dwellings as spring returns. Since they appear to be attracted to light, the beetles often move to windows and light fixtures if they inadvertently emerge indoors rather than outside.

Additional research is ongoing to explain why when a single beetle lands, many others soon follow. There is reason to believe that this species aggregates at certain locations based on visual cues, chemical cues (pheromones) or a combination of the two.

7. Does it harm plants or structures?

MALB is a nuisance pest for buildings but it does not cause any structural damage. They do not eat carpet or clothes; they do not bore holes in wood or walls; they do not eat human food and do not transmit disease. While in hibernation, they do not feed at all but survive on stored fat reserves in their bodies. They are predatory insects and do not feed on plants other than to acquire some moisture and pollen for basic nourishment in the absence of prey. It appears that the beetles stop feeding on protein sources (prey insects) and “load up” on carbohydrates (sugar sources, etc.) in the fall. Presumably, this behaviour ensures that sufficient energy reserves are accumulated within the body of the beetle to survive hibernation and then support emergence and mating the following spring.

The beetles do have a defensive action when threatened or disturbed (such as by squeezing). They respond by forcing some of their haemolymph (blood) through their joints. This behaviour is called “reflex bleeding”. The yellow orange body fluid has a foul odour and can stain cloth items and porous surfaces.

8. Can it harm people?

Recently there have been published reports (Yarborough et al. 1999) of dermal allergies by very few people from contact with the beetles. This appears to be sensitivity to the fluid secretions of the beetles that can cause contact dermatitis and a stinging sensation. Lady beetles do not sting but many people have experienced a “nibbling, nip or bite” from MALB. There have been generalized reports of some people noting a respiratory response to the presence of the beetles but these have not been fully investigated. There are also reports of some increase in asthma-like symptoms for sensitive people.

Dermal reactions and breathing problems associated with insect exposure are not unique to MALB. Human reactions have been reported from exposure to ants, cockroaches, moth scales, hairs of caterpillars, dust mites, and other insects.

9. Observations of MALB activity in Ontario

In 2001 there were extremely high populations of soybean aphids on soybeans throughout Ontario. *Harmonia axyridis* is an opportunistic predator that followed the path of this massive food source. High aphid populations supported the large increase in beetle numbers. Following normal ecological principles, when the food source (soybean aphids) declined and fall temperature cues for the beetle to enter diapause (hibernate) took over, the beetles dispersed over huge areas within southern Ontario and neighbouring US locales seeking winter refuge.

Similar events occurred in 2003 but with much lower numbers of beetles and activity much later in the calendar year. Soybean aphid presence occurred much later and crop development was also delayed, reflecting the very cold wet spring weather. Other species of aphids upon which MALB feed are always present in other crops such as tree fruit (e.g. peaches, apples, and others), vegetable and ornamental crops, field crops, and other wild plants and likely supported the development of MALB throughout the growing year of 2003.

For 2004, a comprehensive set of monitoring programs are being established in Ontario with cooperating researchers from Brock University, University of Guelph and OMAF. These are the first studies in Ontario to look at behaviour of MALB and its feeding preferences and activity patterns especially as it pertains to vineyards.

10. Why does MALB like Niagara and certain areas of southwestern Ontario?

The beetles' nuisance behaviour is not restricted to these areas, as many homeowners throughout Ontario reported MALB as being a nuisance pest in September and October (as did vineyard managers, tender fruit growers and others). The beetles were observed at different times and on different fruit crops depending on location in 2001. If the suspicion that the beetles are attracted to particular chemical cues is correct, there may be some volatile chemicals released from grapes as they ripen (and possibly the presence of other insects in the vineyard) that are attractive to the beetles and result in their aggregation. Preliminary work in the United States has revealed very low-level response by MALB to some chemicals, but the over riding factor in beetle aggregation appears, so far, to be visual orientation.

Speculation exists that the beetles move to already damaged fruit (grapes and peaches especially) that are leaking or have leaked juice in order to consume some sugar prior to diapause. A combination of visual cues of the arboreal escarpment, presence of sugar source, and possibly some volatiles released as the fruit rots or matures, may have contributed to the beetle presence. The production of grapes at locations that remain warmer late into the fall along with nearby natural overwintering sites may also have supported the late season occurrence in Niagara.

11. Will MALB be a problem in 2004?

There is no easy answer to this question in light of the relative novelty of this insect in Ontario and in light of how little is known about its population dynamics. However, MALB is here to stay and there will likely be some level of nuisance activity by this pest every year. This observed activity should be tempered with the knowledge that the beetle is also beneficial much of the time. The best bet for homeowners troubled by the beetle is to seal their houses at likely points of infestation to keep the beetles out. The best strategy for vineyard owners troubled by MALB is to follow closely the research now underway and to instigate a comprehensive late season monitoring program so that they have full knowledge of the beetles' activity in their vineyards.

Late emergence of adults looking for overwintering sites and late feeding to establish fat reserves before diapause could lead to more beetles observed than in 2003. The late season presence of prey aphids in late maturing soybeans could allow for a population increase from 2003 to 2004. However, soybean aphid populations have been low in Ontario in general up to mid-August, 2004. As noted above, aphid populations in other commercial agricultural crops and wild areas are also important

determinates of the population levels of MALB. Commercial crop control of aphids on cereal grains and soybeans will also limit sources of food for the lady beetles.

Experience has shown that any newly introduced insect, be it pest or beneficial, often increases in the first few years after introduction then settles down to some lower level. This is partly due to the expansion of natural controls (parasites, predators) of the new species and eventually some lower level of the invasive species may be achieved. Natural factors such as weather play a huge role in the population dynamics of insects. Even native species may suddenly appear in previously unheard-of numbers.

12. What should I watch for in the vineyard?

MALB does not cause direct fruit injury but instead will infest previously damaged fruit (damage by other insects, pathogens, rots, birds, wasps, etc.) (Koch et al. 2004). Late maturing grapes, breakdown of fruit in the vineyards, and cluster deterioration is likely to result in attraction of the beetles to vineyards, especially those near alternate food sources, wooded areas, and those near preferred overwintering sites. Regular observation in vineyards will be critical to assess when fruit has begun to deteriorate. A preliminary procedure for tracking MALB has been suggested and will be refined as research to support methods is documented. Currently, many of the suggestions are speculative and intuitive and will need further research.

Any MALB found in vineyards before grape maturation begins are of no concern. This beetle is highly mobile and normally travels far in search of prey. Beetles that are in vineyards early in the season will not cause any damage and will not impart any offensive flavours to the grapes. Observations and monitoring should begin 14 days prior to expected harvest for each cultivar.

To follow the activity of MALB across North America in 2004 refer to website http://www.pmcenters.org/northcentral/MALB/. This site is coordinated by the North Central Pest Management Center out of Michigan State University. Data reporting is voluntary so this site is not comprehensive but it is a useful site to follow MALB activity and other widespread pests.

13. How many is too many?

There are no published thresholds for this pest in the vineyard or in use to evaluate levels found in bins at the winery prior to processing. Some work on wine impact by Dr. Gary Pickering (CCOVI Brock University, St. Catharines, Ontario) and Dr. Roland Riesen (Youngstown State University, Ohio) and others have shown that 1 beetle per litre of wine can result in off aromas. Further work by Pickering and Ker in 2003 for the cultivar Riesling showed that actual beetle numbers on harvested fruit that result in off flavours in juice and wine may be in the 1.7 beetle per kg range. Initial tests indicated that the beetle impact does not take place at harvest but rather during the crush/destem or fruit pressing phase of processing. However, currently there is no accepted threshold for number of beetles present on clusters prior to harvest that will not produce off flavours.

There is a need to look further at beetle behaviour in vineyards to determine what level of stress or agitation induces reflex bleeding and the amount of the beetle bleeding that is necessary to produce the off flavour. Concern exists that sub lethal insecticide doses which induce reflex bleeding or pesticide applications that kill beetles after they have embedded themselves in clusters may still generate a negative effect on wine flavours.

Additional research has examined the impact of beetle contamination on wine quality and the potential for removal of the offensive methoxypyrazine chemical compounds that are associated with the off flavour and aromas in affected wines. Dealing with wines after the beetle flavour has been found has been relatively ineffective to date. For additional information on this research and other projects, see the articles in the references by Dr. Pickering and colleagues at Brock University via his web site at www.brocku.ca/ccovi/people/gary.html.

There has not been any work published until 2004 (Pickering and Ker) where the beetle has been induced into reflex bleeding on the fruit prior to processing and then followed through the fermentation process. Preliminary results seem to indicate that preharvest agitation does not affect juice or wine quality. Questions still remain on how to accurately assess beetle populations in the vineyard and relate to final impact on wine quality. Dr. Roger Williams of Ohio State University and others (Ker, Sears and Carter in Ontario) have been following the pest activity patterns and looking at beetle numbers in vineyards.

14. Can I spray for this insect?

Emergency use registrations for Ripcord (cypermethrin) and Malathion (malathion) have been obtained for grapes in Ontario during the 2004 harvest. It must be stressed that these are not suggested protective sprays; rather, they should be used only if MALB are present in significant numbers in vineyards and other predisposing factors to infestation are occurring (grape damage, breakdown etc. as mentioned previously). Observations and monitoring should begin 14 days prior to expected harvest for each cultivar. Species identification should be confirmed before any pesticides are applied for MALB.

For optimum efficacy, use all best management practices for spraying (sufficient water volume to ensure thorough coverage, attention to spray mixture pH, ideal weather conditions for application, etc.). Growers must observe the preharvest intervals on the emergency labels to avoid unacceptable residue levels at the time of harvest. Growers using unregistered products or registered products in unapproved ways put themselves at risk.

There are no registered products for control of lady beetles in or on structures in Canada. Insecticide applications on houses may cause harm to people and pets. Instead of spraying any insecticides, homeowners should eliminate entry points for the beetles. Screen repair, vent screening, caulking and weather-stripping will suffice in most cases.

15. What about other areas? Can they spray?

In the northeast US, there are four products under emergency registration for MALB in NY, Pennsylvania and Ohio. However, there are some restrictions on their use. The pyrethroid Danitol has worked in lab studies but has an extremely long pre harvest interval (PHI: 21 Days). The long period between application and harvest leaves the crop vulnerable to attack by MALB and is therefore not expected to be of use for effective control of this pest in wine grapes. As well, the pyrethroids are considered harsh on other beneficial insects that may be present in the vineyard. Similarly, “Capture” (bifenthrin) is approved on grapes in Ohio but has a 30 day PHI.

Another product, carbaryl (trade name Sevin) has registration in the US but is not considered an acceptable material by winemakers due to potential residue concerns in finished products. Sevin is a member of the carbamate family of insecticides and is also considered harsh on other beneficial insects. The fourth product labelled for use in some areas of the United States is Provado (active ingredient imidacloprid). It is labelled for use on grapes in the US and has a very short PHI. This product looks the most promising according to US colleagues. A fifth material, “Azadirect” (active ingredient azadirechtin, derived from neem oil) has been evaluated but preliminary investigations indicate this product may cause off-flavour in wine. This work is still underway at time of publication of this information.

16. Should I spray?

The bigger question appears to be should I spray for control of the beetle? This insect is considered a beneficial insect and is responsible for significant control of harmful insects such as aphids and scale insects. There is no use in spraying early in the season for this insect as it is primarily a beneficial and

the population occurs over a long period of time. For grapes, presence in the vineyard does not occur until very close to harvest so pre harvest spray intervals are important.

Control materials are being investigated along with other novel methods of repellency or exclusion using fine netting over the rows. We are investigating the use of traps to see if we can detect MALB movement into vineyards. Preliminary work is looking at determining if we can find a material that would help assess first migration to vineyards by trapping in perimeters and known sources of the beetle.

There are currently no action thresholds to indicate when to spray a vineyard if MALB are present near harvest. Current management strategies are unfortunately based on intuition and not on scientific data. Growers should consult a qualified crop consultant to determine if their vineyard is at risk when MALB are found in the vineyard in the two weeks preceding harvest.

The Internet has various suggestions for attempting to attract and capture the beetles ranging from vacuums to the use of scent repellents. These are suggested for structural use and not for agricultural actions due to potential for crop contaminations with unwanted aromas and flavours (the deterrents noted are camphor and menthol). Dr. Jeffrey Aldrich of the USDA in Maryland (pers comm.) has been looking at this repellency issue for a few years with mixed results for commercial application, but studies continue.

(Information for this sheet was compiled from sources below and personal communications directly with research entomologists and biologists). The authors do not endorse or recommend the specific use of any materials reported above and are not liable for outcomes. Please feel free to use the information and photographs of this publication and circulate provided author/source credit is given. For additional clarification see the various web sites and journal publications listed below

Appendix - Some Sources of Additional Information

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