# *MEGOURA CRASSICAUDA* MORDVILKO (HEMIPTERA: APHIDIDAE), A POTENTIAL THREAT TO FABA BEAN INDUSTRY IN NEW SOUTH WALES

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## Summary

The oligophagous aphid species, *Megoura crassicauda* Mordvilko (Hemiptera: Aphididae), is a legume pest originating from east Asia. It was first detected in Australia in October 2016 in a Sydney home garden and was subsequently found in a faba bean crop in north west New South Wales in 2017. A distribution survey was carried out to determine the presence of *M. crassicauda* in northern NSW in 2018, 2019 and 2020. In 2020 presence of *M. crassicauda* was confirmed at several locations across NSW. The biological characteristics of *M. crassicauda* were examined to evaluate its potential impact on the Australian pulse industry. Host range studies included faba beans, vetches, common pea, lentil, subclover and lucerne. Faba bean was found to be its preferred host with the aphid forming large colonies on leaves, stems and pods in only a few days. As there is no English common name for *M. crassicauda*, we suggest 'Faba bean aphid' because of its clear preference for this host. The aphid was found to transmit *Bean leafroll virus* and *Pea seed-borne mosaic virus* between faba bean plants. This pest presents a serious threat to the Australian faba bean industry due to its fast reproduction and colonisation of faba bean and its ability to transmit important viruses.

**Key words**: faba bean, legume pest, virus transmission, Australia.

## INTRODUCTION

*Megoura crassicauda* Mordvilko is an aphid species widespread in Japan, China, India, Korea, Russia (Siberia), and Taiwan (Lee et al., 2014). There are six species in the *Megoura* genus associated with leguminous host plants in the northern hemisphere (Blackman and Eastop, 2000). In Australia, *M. crassicauda* is the only species of the genus reported with a first record in October 2016 in a home garden on broad beans (*Vicia faba* L. cv. Coles Early Dwarf) in Sydney (Hales et al., 2017).

*Megoura crassicauda* has been known under several synonyms, including *M. coreana*, *M. japonica* (Okamoto & Takahashi, 1927), *M. lathyri* (Shinji, 1924), *M. moriokae* (Shinji, 1923), *M. ussuriensis* (Mordvilko, 1919), *M. vicicola* (Shinji, 1941) and *M. japonicum* (Matsumura, 1918) (Aphid Species File, 2019). *Megoura crassicauda* was referred to as the vetch aphid. However, this name is more appropriate for its close relative, *Megoura viciae* (Buckton, 1876), which is found in Europe, central Asia and the Middle East (Lee et al., 2014). In China and Japan, *M. crassicauda* is referred to as bean aphid (common name) or *M. japonica* (scientific name) (Blackman and Eastop 2006). However, using bean aphid as the common English name could cause confusion with the black bean aphid (*Aphis fabae* Scopoli, 1763), a species exotic to Australia. Therefore, consensus on a common name for *M. crassicauda* for use in Australia and other English-speaking countries is warranted.

*Megoura crassicauda* has a limited host range in the family Leguminosae, including vetches (*Vicia* sp.), faba bean (*Vicia faba* L.), common pea (*Pisum sativum* L.) and grass pea (*Lathyrus sativus* L.) (Lee et al., 2002, Blackman and Eastop 2006, Lee et al., 2014, Hales et al., 2017). In Japan, it is commonly found on vetches, especially on the widely distributed narrowleaf vetch (*Vicia angustifolia* L.) (Takemura et al., 2002), but not on clover (*Trifolium* sp.) (Tsuchida et al., 2011). There is currently no data on *M. crassicauda* host range in Australia. The legume industry is expanding rapidly in Australia. Two of the reported main legume hosts of *M. crassicauda* are widely grown, with faba bean sown on 269,000 ha in 2020-21 (ABARES, 2021), and vetches a common component of crop rotations especially in dry seasons (Matic, 2008).

Aphids can be effective virus vectors (Sylvester, 1980) and faba beans are susceptible to at least ten virus species. In previous studies, *M. viciae*, a close relative of *M. crassicauda*, showed no ability to vector *Bean leafroll virus* (BLRV) and was a very poor vector of *Bean yellow mosaic virus* (BYMV) and *Pea enation mosaic virus* (PEMV) (Gaudchau, 1978, Cockbain & Costa, 1973).

Our paper provides details on *M. crassicauda*'s morphological identification, describes damages in the field and examines its distribution in 2017, 2018, 2019 and 2020 in northern NSW. Additionally, the aim of our study was to determine the preferred hosts and virus transmission capabilities of the aphid as a base for further research.

## MATERIALS AND METHODS

### Morphological identification

Live aphid specimens, collected in 2017 from faba bean plants were examined and identified based on morphological characteristics (Blackman and Eastop, 2000). Detailed morphology of different instars and both wingless and winged adults were examined under

a stereomicroscope (Leica M205 C) and described. Wingless adult aphids were preserved in 96% ethanol and submitted to Biosecurity Collections at Orange Agricultural Institute in Orange (NSW, Australia) for confirmation of morphological identification.

**Field study and distribution**

An aphid colony was detected in experimental faba bean plots at Liverpool Plains Field Station (LPFS) in Breeza (NSW, Australia) in October 2017. Field observations were conducted to observe aphid colony development and subsequent damage to plants. Five plants in 10 points of experimental plots were observed each week. After three weeks, insecticide Aphidex (500g pirimicarb/kg) was applied to eradicate the colony. The efficacy of the insecticidal treatment was evaluated after 7 days.

Inspections for the aphid's presence and field observations continued during 2018, 2019 and 2020 in experimental faba bean plots at LPFS and Tamworth Agricultural Institute (TAI) in Tamworth (NSW, Australia). Additional data on aphid's distribution were based on observations of commercial faba bean crops and received samples collected from private gardens in NSW.

**Host range**

A preliminary host range study, including analysis of feeding preferences and reproduction, were conducted under controlled greenhouse conditions at the TAI using a wide range of legume hosts: chickpea (*Cicer arietinum* L.), field pea (*Pisum sativum* L.), desmanthus (*Desmanthus virgatus* L.), lentil (*Lens culinaris* L.), lucerne (*Medicago sativa* L.), lupin (*Lupinus albus* L.), mungbean (*Vigna radiata* L.), snail medic (*Medicago scutellata* L.), subclover (*Trifolium subterraneum* L.) and different vetch species (*Vicia sativa L.*, *V. villosa* Roth, *V. palaestina* Boiss., *V. cretica* Boiss. & Heldr, *V. disperma* DC., *V. hyrcanica* Fisch. & C.A.Mey., *V. ervilia* L., *V. lutea* L., *V. graminea* Sm. and *V. epetiolaris* Burkart). Host plants were grown in 20 cm diameter pots and placed inside entomological cages (33 x 32 x 77 cm). Infestations of 10 aphids / plant were repeated fortnightly three times. Number of aphids were counted weekly for two months. Legume species on which aphids did not feed or reproduce were considered non-hosts and removed from the further experiment after two months.

A comprehensive host range study was conducted on faba bean (cv. Fiord), lentil (cv. PBA Hurricane), vetch – *V. sativa* (cv. Timok), field pea (cv. Kaspa), lucerne (cv. Hunter River) and subclover (cv. Clare). Fifteen plants of each host were infested with 10 wingless adults 7-10 days after plants emerged. After infestation, the plants were covered with aphid proof mesh bags. Adults and nymphs were counted 1, 4, 7 and 14 days after infestation (DAI).

**Virus transmission**

The suitability of *M. crassicauda* as a vector of BLRV and *Pea seed-borne mosaic virus* (PSbMV) on faba bean was studied. Virus infected faba bean plants were placed in an insect cage together with aphids for three days, after which healthy faba bean plants were placed in the cage together with original infected plants. Three days later aphids were killed using Aphidex (500g pirimicarb/kg, rate 50g/100l) and original infected plants were removed from the cage. Two weeks after the insecticide application plants were tested for virus presence using Tissue blot immunoassay (TBIA) (Freeman et al. 2013).

## RESULTS AND DISCUSSION

**Morphology**

*Megoura crassicauda* is a large aphid whose body length exceeds 3 mm. An adult has a spindle-shaped bright green body with dark head, antennae, prothorax, legs, siphunculi, cauda and genital plate. The antennae exceed the body length and its intense red eyes are one of the most easily recognised characters in fresh specimens (Figure 1). The thorax and abdomen are pale with irregular dark sclerites on the mesothorax and two dark lines at the 7$^{th}$ and 8$^{th}$ abdominal segments. The siphunculi are swollen with a dark plate on the abdomen at their base. The winged adults are usually darker in colour than the wingless forms. According to Ishikawa and Miura (2007), morphological differences between forms are often a result of density conditions and interactions between individuals. Nymphs are lighter coloured than adults (Figure 1) and newly hatched nymphs are pale green with red eyes and pale legs. After a few hours, their head, antennae, legs and siphuncili become darker.

**Figure 1. *Megoura crassicauda* adult with different nymph stages**

**Field study**

Observations at LPFS during the 2017 winter cropping season showed that *M. crassicauda* created large colonies on faba bean plants in a few days. The infestations showed a patchy distribution, caused by spread of the aphids from early infested, severely stunted, plants. Generally, colonisation was concentrated on stem tips and underside of leaves, but could progress to include the whole stem, leaves and pods. Colonies often consisted of more than a few hundred individuals on a single plant, similar to observations by Kasai (2016). The dense colonies consisted of predominantly wingless aphids and spreading was mainly to neighbouring plants. This observation is consistent with similar findings of *M. viciae*, which shows a tolerance to crowding rather than development of winged adults (Lees, 1967).

In 2018 and 2019, the aphid was not found in experimental faba bean plots at TAI and LPFS. In 2020, *M. crassicauda* was noted on a few faba bean plants next to a fence line at TAI. Aphidex (500 g pirimicarb/kg) was applied and no aphid survival was found after one week. However, three weeks later re-infestation occurred from the same starting point, likely originating from woolly pod vetch (*V. vilosa*) from the neighbouring paddock. No aphicide was applied as the faba bean plants were soon to be harvested. The maturing faba bean plants became covered with dense colonies from tips of the plants and moving down, causing additional damage like necrosis, wilting, stunting and defoliation. The aphids moved from necrotic leaves and petioles and to stems and pods (Figure 2). At this stage, more winged form aphids were noted.

**Figure 2. Colony of *M. crassicauda* on matured faba bean plants at TAI in 2020**

**Distribution**

*Megoura crassicauda* presence was confirmed in September 2017 in faba bean trials at two sites: TAI (-31.146, 150.970) and LPFS Breeza (-31.178, 150.424). Severe drought during 2018 and 2019 caused a substantial reduction of commercial faba bean sowings in NSW (ABARES, 2020). During this period, the aphid was not found in commercial fields or experimental plots. Improved seasonal conditions during 2020 allowed for increased faba bean sowings throughout northern NSW. In July 2020, *M. crassicauda* was noted in faba bean disease screening trials at the Grafton Primary Industries Institute (-29.617, 152.963). This institute is located on the northern NSW coast and, apart from experimental plots at the institute, faba bean in this region is only grown in home gardens. The infestation was limited to a few plots only, but all plants in the plots showed a high level of colonisation. The aphid was eradicated after the application of Aphidex (500 g pirimicarb/kg).

Later in the 2020 season, *M. crassicauda* was found in a commercial faba bean crop in Warrah (-31.670, 150.648) and was present on woolly pod vetch (*V. vilosa*) along the fence line on the same property. Aphid presence was noted during the season in faba bean trials at TAI (-31.144, 150.971), LPFS Breeza (-31.178, 150.422) and in Piallamore (-31.177, 151.058). During October 2020, there were also sightings on faba beans in private gardens at Tamworth (-31.260, 150.212), Killara (-33.773, 151.149), Mittagong (-34.273, 150.263), and on common vetch (*V. vilosa*) in grassland in Western Sydney NSW (-33.869, 151.013). It is likely that the aphid used annual legume weeds, such as woolly pod vetch, as a host plant to maintain its population across two drought seasons.

**Host range**

*Megoura crassicauda* feeds selectively on *Vicia* plants such as broad bean (*V. faba*) and narrowleaf vetch (*V. angustifolia*) (Cheng et al., 2018). This is consistent with our preliminary host range study where fast reproduction of the aphid was observed in both faba bean and vetches (*V. sativa*). The comprehensive host range studies found faba bean to be the primary host plant and preferred over vetches, with the highest population recorded on faba bean 14 DAI (mean number of 81 adults and 133 nymphs) (Figure 3).

The comprehensive host range study confirmed vetch (*V. sativa*) as host, with the highest aphid numbers of 33 adults and 61 nymphs recorded 7 DAI (Figure 3). Fourteen DAI aphid numbers on vetch declined due to the lack of food source to support the population growth. A similar result was noticed on lentil, where the mean number of nymphs decreased from 64 to 35, from 7 to 14 DAI respectively. This is consistent with previous studies reporting vetch species can host of *M. crassicauda*, except the tiny vetch (*Vicia hirsuta* (L.) Gray) (Lee et al., 2002, Blackman and Eastop, 2006, Tsuchida et al., 2011, Ohta et al., 2006). Also, Kasai (2016) reported *M. crassicauda* as the dominant aphid on vetch (*Vicia sativa* subsp. nigra (L.) Ehrh.) during spring. The aphid survived and reproduced on stems, tendrils and growing tips of field pea in our study, which is consistent with observations by Lee et al. (2002). We found that field pea supported aphid reproduction, with the highest mean number of established aphids observed 14 DAI (39 adults and 46 nymphs).

Lucerne and subclover appeared to be the least favourable host plants in the comprehensive study as the aphids did not establish on all tested plants and the mean number of both adults and nymphs was low. However, lucerne and subclover may function as alternative hosts because the aphids were able to feed and reproduce inside the insect cages on these hosts for over four weeks during preliminary host range study (Figure 4). There are no records of chickpea, desmanthus, lupin, mung bean and snail medic as hosts and they appeared to be non-host plants in our study.

**Virus transmission**

Our study of virus transmission of BLRV and PSbMV by *M. crassicauda* showed successful transmission between faba beans. Symptoms on infected faba bean plants were yellowing and upward rolling of leaves and stunting of plants for BLRV and yellow and green mosaic patterns on leaves for PSbMV. There are no prior virus transmission studies on this aphid species and this result demonstrates the ability of *M. crassicauda* to vector both non-persistently and persistently transmitted viruses (BLRV and PSbMV, respectively).

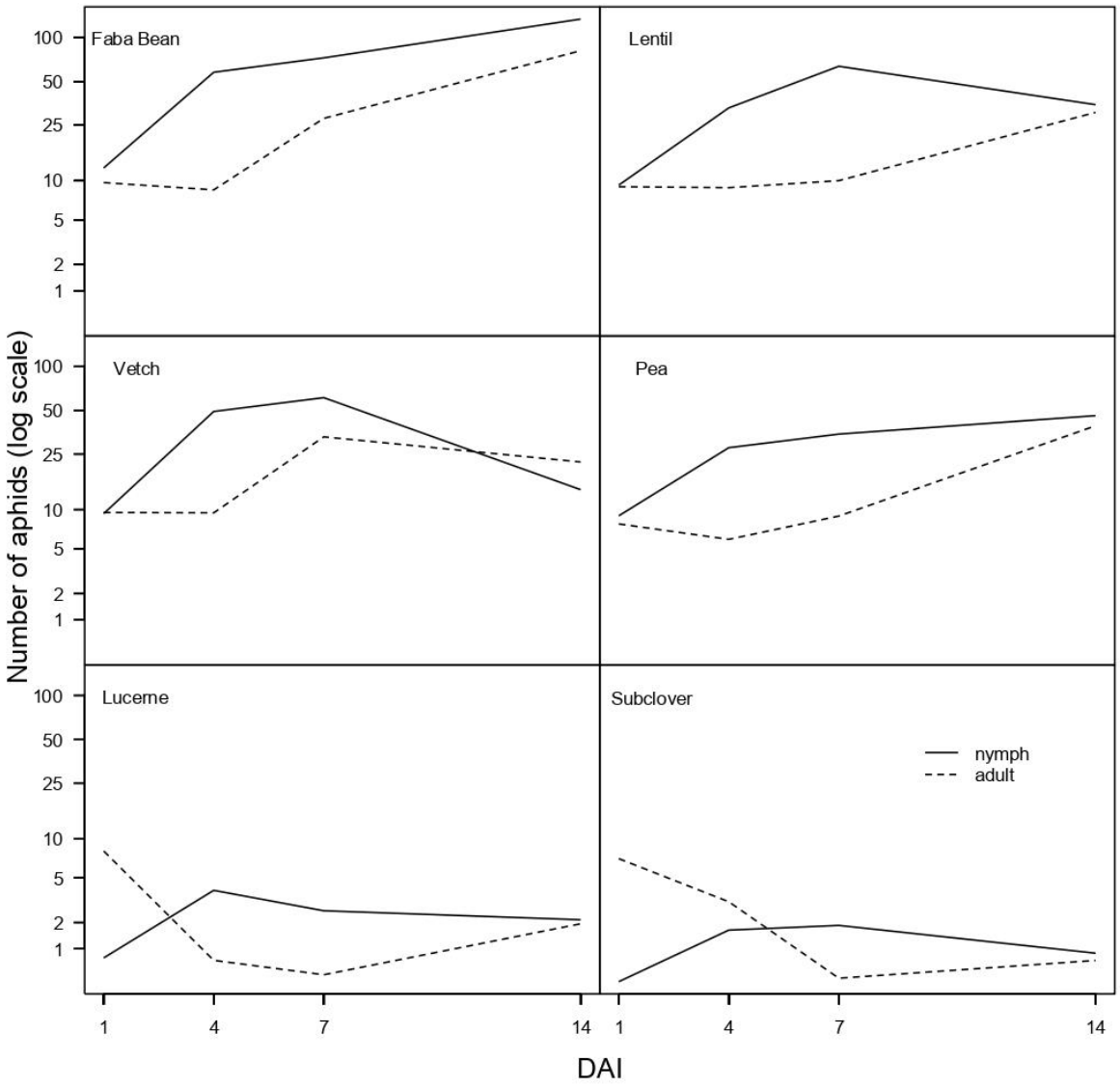


**Figure 3. Mean numbers of adults and nymphs of *M. crassicauda* on different hosts 1, 4, 7 and 14 days after infestation (DAI)**

## CONCLUSIONS

There is currently no consistency for the common name of *M. crassicauda* in the English language. Our observations clearly indicate a preference of *M. crassicauda* for faba bean over other hosts like vetches and other pulses. We therefore suggest 'Faba bean aphid' (FBA) as the common name for *M. crassicauda*.

FBA could be a serious threat to the faba bean industry, primarily through feeding damage and its ability to form large colonies in a few days. Its ability to transmit viruses presents an additional risk, although its slow movement through a crop would reduce the speed of virus transmission and development within a crop.

FBA is not yet established throughout all faba bean growing regions in Australia. Research on the FBA persistence on lucerne and native vetches and its ecology in the Australian environment is needed to fully understand its potential impact on the local faba bean industry and, if needed, to develop effective control measures.

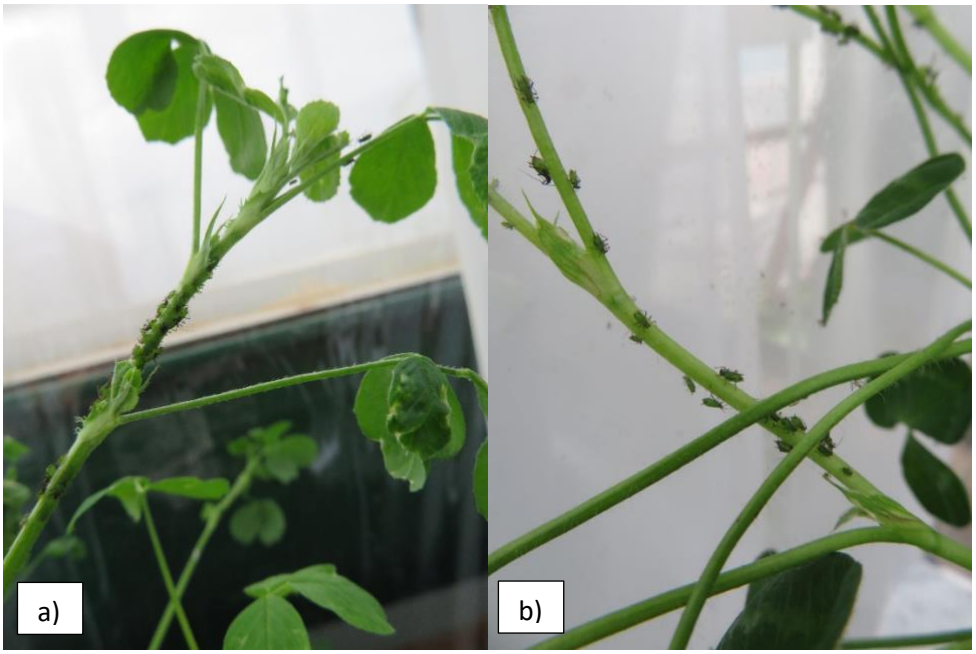


**Figure 4. *Megoura crassicauda* on a) lucerne and b) subclover**

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