Seasonal abundance of *Carpophilus* spp. (Coleoptera: Nitidulidae) in fallen citrus fruit in the Murrumbidgee Irrigation Area of southern New South Wales

David G. James, **Beverley Vogele** and **Richard J. Faulder,** Yanco Agricultural Institute, NSW Agriculture, Yanco, New South Wales 2703, Australia.

Summary

Mature fallen fruit in five citrus (orange) orchards in the Leeton–Yanco district of the Murrumbidgee Irrigation Area was sampled and examined for infestations of adult and larval nitidulids from November 1992 to June 1994. Four species (*Carpophilus* (*Urophorus*) *humeralis, C. davidsoni, C. hemipterus, C. mutilatus*) were found, with *C. humeralis* dominant at all times. Greatest numbers of *C. humeralis* occurred during late summer–late autumn. *C. davidsoni* was abundant in spring and early summer while numbers of *C. hemipterus* and *C. mutilatus* were generally low throughout the sampling period with small peaks in spring and autumn. Larvae were most abundant during spring and autumn. All species were uncommon during winter and larvae were absent. The potential impact of *Carpophilus* populations in citrus orchards damaging nearby ripening stone fruit is discussed.

Introduction

In southern Australia nitidulid beetles (primarily *Carpophilus* spp.) are serious pests of ripening stone fruit, particularly apricots, peaches and nectarines (Gaven 1964, Hely *et al.* 1982). Beetles can enter fruit by chewing through the skin usually around the stem end or in sutures, although they often enter at sites of mechanical damage. Rapid breakdown of the fruit ensues, particularly in the presence of brown rot, *Monilinia fructicola* (Wint.) Honey, which is often vectored by *Carpophilus* spp. (Kable 1969). The importance of *Carpophilus* spp. has increased in recent years, following a decline in insecticide use in stone fruit orchards for key pests such as the oriental fruit moth, *Cydia molesta* Busck, which can now be controlled using synthetic pheromones to disrupt mating (Vickers *et al.* 1985). Current control measures for *Carpophilus* beetles are based on the use of broad-spectrum insecticides applied near harvest which have the potential to initiate outbreaks of other pests such as mites and create residues on harvested fruit. Research in Australia and the United States has recently shown considerable potential for synthetic aggregation pheromones in management of *Carpophilus* populations (Bartelt *et al.* 1992, James *et al.* 1993, 1994). However, a lot more information on the biology and ecology of these pests in stone fruit orchards and their surroundings is required before effective strategies can be developed.

Fallen fruit in citrus orchards provides a potentially important resource for nitidulid beetles in the Murrumbidgee Irrigation Area (MIA) of southern New South Wales. Citrus is one of the major

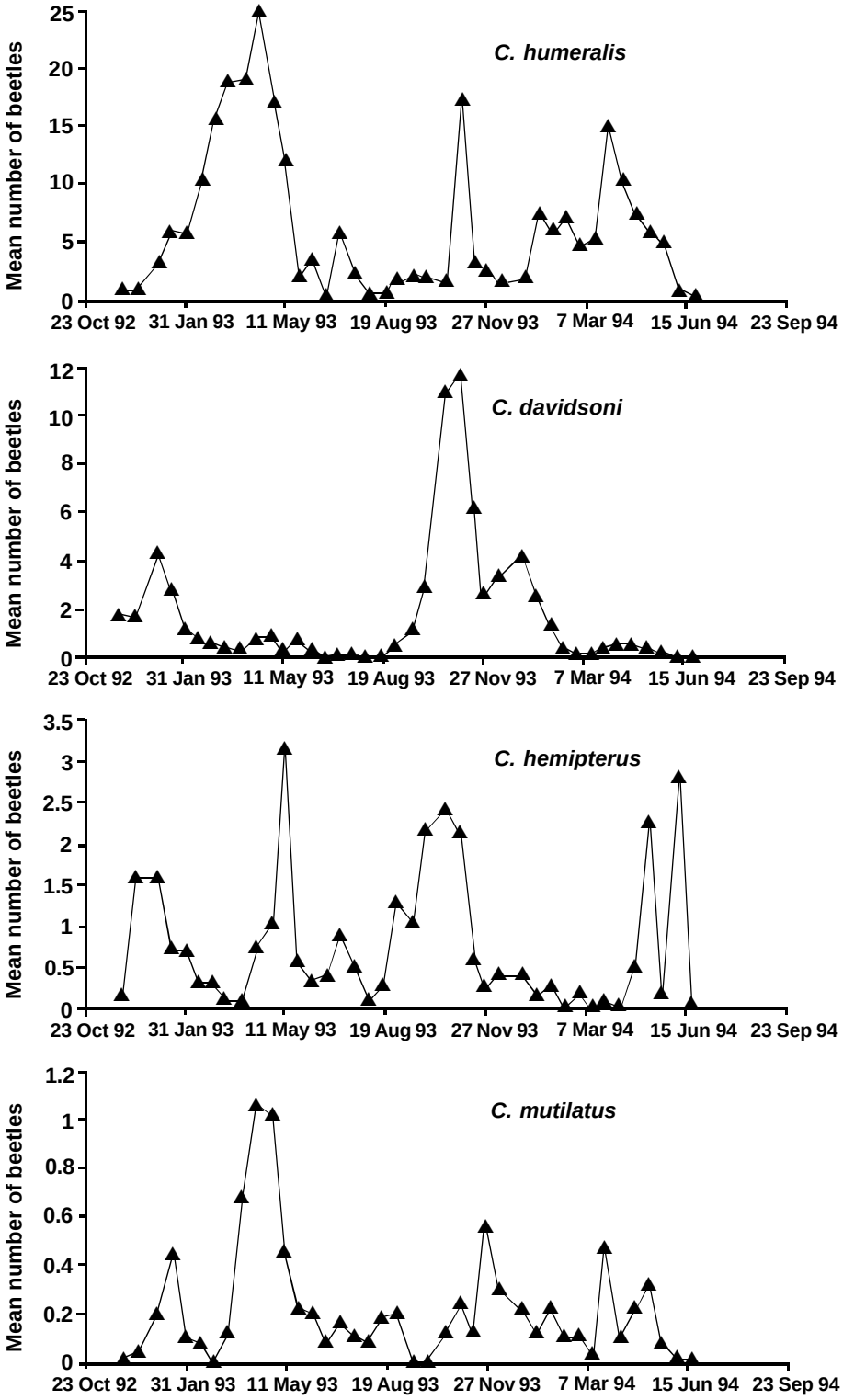

Figure 1. Mean number of adult *C. humeralis, C. davidsoni, C. hemipterus* and *C. mutilatus* per fruit in fallen citrus sampled from five orchards in the Leeton–Yanco district during October 1992–June 1994.

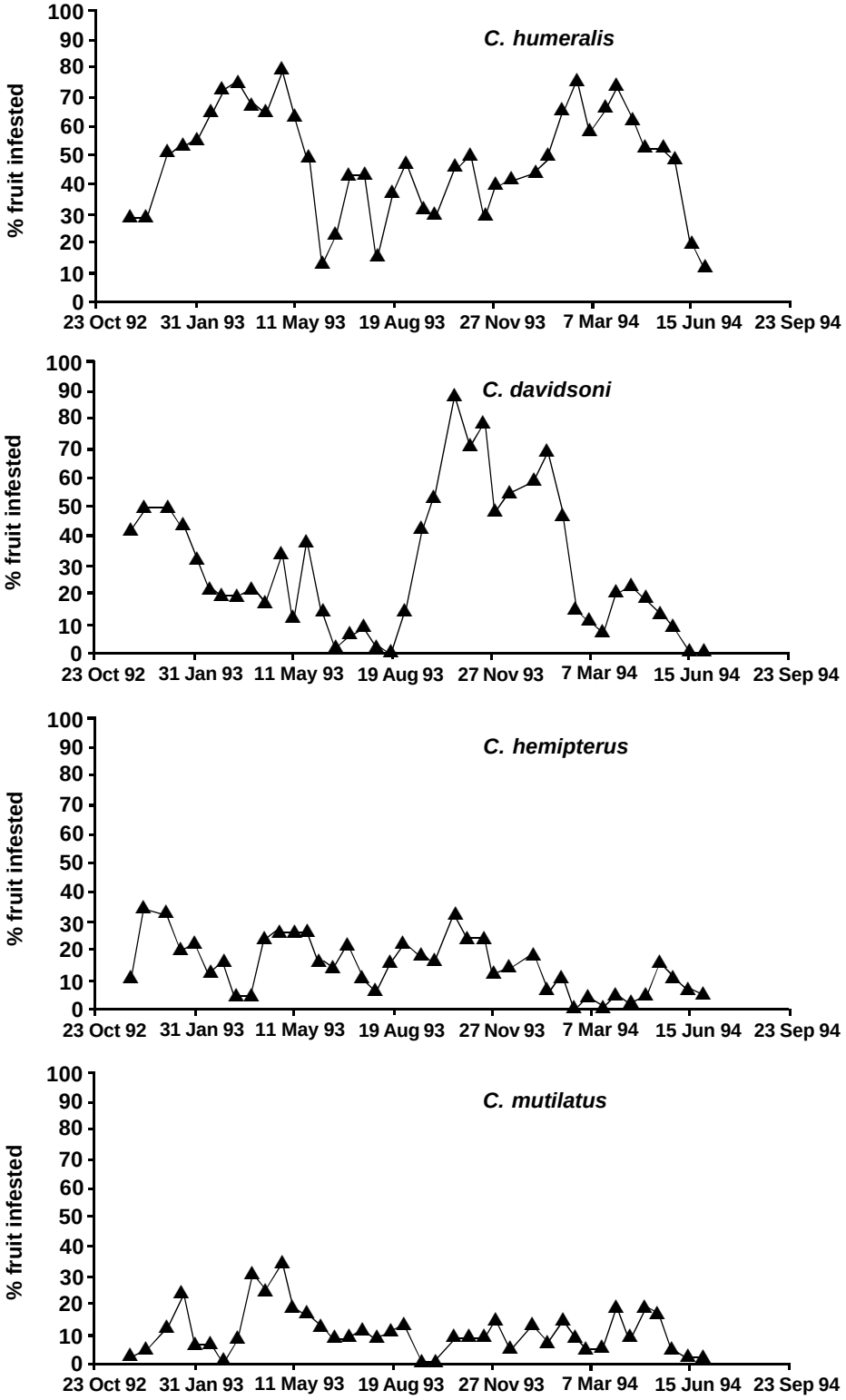

Figure 2. Percentage of fallen citrus fruit infested with adult *C. humeralis*, *C. davidsoni*, *C. hemipterus* and *C. mutilatus* sampled from five orchards in the Leeton–Yanco district during October 1992–June 1994.

crops of the MIA interspersed with vineyards and stone fruit orchards. It is likely that *Carpophilus* populations which develop in citrus orchards invade stone fruit orchards as fruit ripens. This study provides data on the fauna and seasonal abundance of nitidulid populations in fallen citrus fruit in the MIA during a two year period.

Materials and methods

Mature fallen fruit in five citrus orchards (vars. Valencia and Navel orange) in the Leeton–Yanco district of the MIA was sampled and examined for infestations of adult and larval nitidulids from November 1992 to June 1994. Fallen fruit was present throughout the year with peaks in spring and autumn. Valencia oranges were sampled from August to April and Navel oranges from May to July. Sampling was conducted fortnightly with 10 fallen fruit selected randomly from each orchard. Fruit showing signs of breakdown, but not advanced decomposition, were chosen. Fruit was stored in individual plastic containers, transported to the laboratory and dissected. Adult and larval beetles were removed from fruit, counted and adults identified to species using the keys of Dobson (1954, 1964). No attempt was made to identify the larvae to species. Data were analysed using analysis of variance and LSD procedures.

Results

The incidence and seasonal abundance of nitidulid species did not vary significantly between the orchards and data were combined. Four species of *Carpophilus* were found in fallen citrus fruit (*Carpophilus davidsoni* Dobson, *C. hemipterus* (L.), *C. mutilatus* Erichson and C. (*Urophorus*) *humeralis* (F.)). Individual fruit usually harboured more than one species and often all four, but relative abundance of the species differed considerably (Figures 1 and 2). Over the whole sampling period *C. humeralis* was significantly more abundant ($P<0.05$) (mean ± SE: 6.39 ± 1.7 per fruit) than *C. davidsoni* (1.66 ± 0.4), *C. hemipterus* (0.76 ± 0.39) or *C. mutilatus* (0.22 ± 0.08). *C. humeralis* was always the dominant species with up to 220 adults found in single fruit during April 1993. Numbers of this species peaked during late summer–late autumn in both years (Figures 1 and 2). The next most abundant species was *C. davidsoni* which approached the levels of *C. humeralis* during October–December 1993. This species was most common during spring and early summer (October–December) in both years (Figures 1 and 2). During the rest of the sampling period numbers of *C. davidsoni* were low and similar to those of *C. hemipterus* and *C. mutilatus*. Numbers of *C. hemipterus* rarely exceeded 1.5 adults per fruit and peaked at 3.1 per fruit in May 1993. Greatest numbers of this species occurred in spring–early summer and late autumn (April–May) (Figure 1). *C. mutilatus* was even less abundant, occurring at a level of less than 0.5 per fruit for most of the sampling period and showing little seasonal variation except for a short period of increased abundance in April–May 1993 (Figure 1). All species occurred in low numbers during winter (May–September) (Figures 1 and 2). Larvae were most abundant during spring and autumn and were absent during winter (Figure 3).

Discussion

Fallen citrus fruit is clearly an important resource for *Carpophilus* spp. in the MIA. However, its importance as a host varies according to species. The four species found in fallen citrus fruit, *C. hemipterus*,

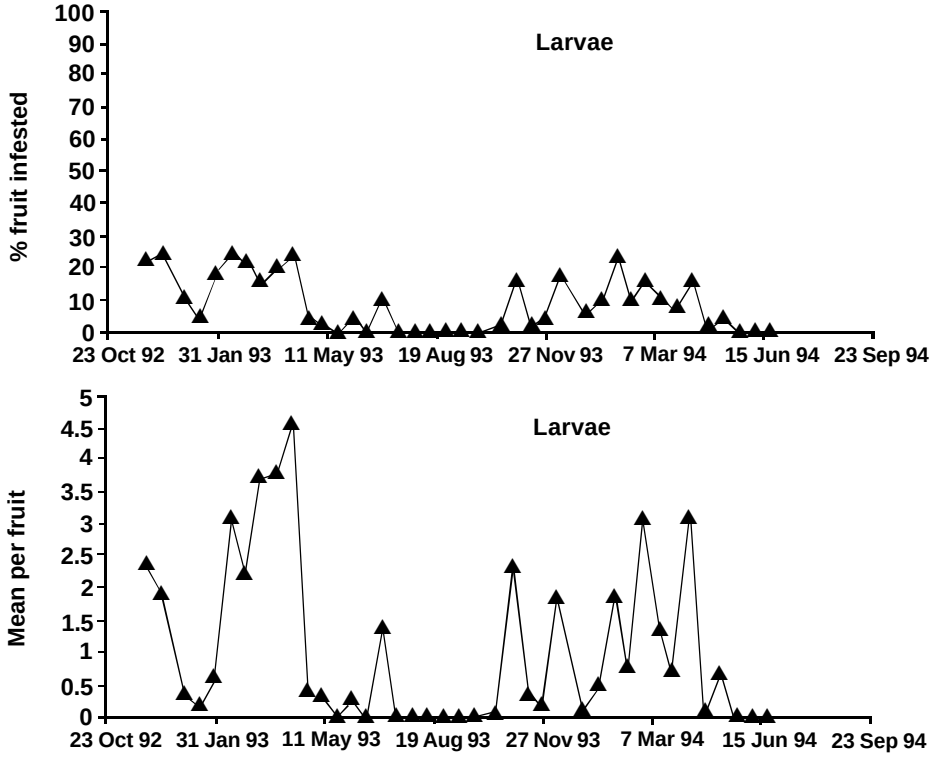

Figure 3. Abundance of nitidulid larvae in fallen citrus fruit sampled from five orchards in the Leeton–Yanco district during October 1992–June 1994 and percentage of fruit infested.

C. mutilatus, *C. davidsoni* and *C. humeralis*, are all commonly trapped in MIA stone fruit orchards using synthetic aggregation pheromone-baited traps (James *et al.* 1993, 1994, Bartelt and James 1994). The first three species (together or separately) are considered to be the most damaging species to ripening stone fruit in south-eastern Australia (James *et al.* in press). The pest status of *C. humeralis* in stone fruit orchards is uncertain. Large populations can occur in fallen stone fruit but are relatively poorly represented in pheromone-baited traps hung from tree branches (James unpublished observation). Bartelt *et al.* (1994) showed greater numbers of *C. humeralis* were caught when traps were placed near to the ground, indicating a reluctance to leave this zone. In addition, *C. humeralis* is reported mostly to be a pest of fruits which ripen at or near ground level, for example, pineapple (Schmidt 1935). It is therefore possible that this species is adapted to utilization of fallen or ground fruits and may have little impact on ripening stone fruit. The dominance of *C. humeralis* in fallen citrus fruit certainly supports this idea and citrus may be the primary resource of this species in the MIA.

Carpophilus davidsoni was the second most abundant species, due primarily to the large numbers which occurred during spring–summer 1993–94. *C. hemipterus* and *C. mutilatus* were always present but in relatively small numbers. *C. davidsoni* , *C. hemipterus* and *C. mutilatus* were abundant in MIA stone fruit orchards during spring–autumn 1992–93 as determined by pheromone-trapping (James *et al.* 1994 and unpublished observation). *C. davidsoni* dominated stone fruit nitidulid populations in spring–early summer 1993–94 (Bartelt and James 1994 and unpublished observation). It is likely that the populations of these species in fallen citrus fruit during spring, the only widely available host resource at this time, contribute significantly to the district-wide populations which invade stone fruit orchards during fruit ripening. *Carpophilus* populations are most vulnerable during spring because of limited host resources, and this is indicated by pheromone-trapping data which typically show a substantial reduction in beetle numbers during late spring–early summer (James *et al.* 1993, 1994, in press). Few adults and no larvae were found during June–July indicating that *Carpophilus* spp. do not use fallen citrus fruit for overwintering.

The removal of fallen citrus fruit, particularly on a district scale, would undoubtedly have an impact on *Carpophilus* populations in the MIA. Population development, particularly during spring, would be inhibited thereby delaying or even preventing the occurrence of economically-damaging populations on ripening stone fruit. This strategy would also improve the prospects of using synthetic aggregation pheromones to mass-trap *Carpophilus* spp. (James *et al.* 1993, 1994). The fact that *Carpophilus* spp. are not pests of citrus will, unfortunately, mitigate against a whole-hearted response from citrus growers to remove fallen fruit from their orchards.

Acknowledgments

We thank Merv Graham and Peta Hassall for assistance in collecting and processing samples and the citrus orchardists who allowed us to sample from their properties. The Australian Horticultural Research and Development Corporation and the Canned Fruits Industry Council of Australia provided financial support.

References

Bartelt, R.J. and James, D.G. (1994). Aggregation pheromone of the Australian sap beetle, *Carpophilus davidsoni* (Coleoptera: Nitidulidae). *Journal of Chemical Ecology* 20, 3207-19.

Bartelt, R.J., Dowd, P.F., Vetter, R.S., Shorey, H.H. and Baker, T.C. (1992). Responses of *Carpophilus* hemipterus (Coleoptera: Nitidulidae) and other sap beetles to the pheromone of *C. hemipterus* and host-related co-attractants in California field tests. *Environmental Entomology* 21, 1143-53.

Bartelt, R.J., Vetter, R.S., Carlson, D.G. and Baker, T.C. (1994). Influence of pheromone dose, trap height and septum age on effectiveness of pheromones for *Carpophilus* mutilatus and *C. hemipterus* (Coleoptera: Nitidulidae) in a California date garden. *Journal of Economic Entomology* 87, 667-75.

Dobson, R.M. (1954). The species of *Carpophilus* Stephens (Coleoptera: Nitidulidae) associated with stored products. *Bulletin of Entomological Research* 45, 389-402.

Dobson, R.M. (1964). A new species of *Carpophilus* Stephens (Coleoptera: Nitidulidae) from New South Wales. Proceedings of the Royal Entomological Society of London, (B) 33, 71-2.

Gaven, M.J. (1964). *Carpophilus* beetles as pests of peaches. *Journal of the Entomological Society of Australia* (*NSW*) 1, 59-62.

Hely, P.C., Pasfield, G. and Gellatley, J.G. (1982). 'Insect pests of fruit and vegetables in NSW'. (Inkata Press, Melbourne).

James, D.G., Bartelt, R.J., Faulder, R.J. and Taylor, A. (1993). Attraction of Australian *Carpophilus* spp. (Coleoptera: Nitidulidae) to synthetic aggregation pheromones and fermenting bread dough. *Journal of the Australian Entomological Society* 32, 339-45.

James, D.G., Bartelt, R.J. and Faulder, R.J. (1994). Attraction of *Carpophilus* spp. (Coleoptera: Nitidulidae) to synthetic aggregation pheromones and host-related coattractants in Australian stone fruit orchards: Beetle phenology and pheromone dose studies. *Journal of*

Chemical Ecology 20, 2805-19.

James, D.G., Faulder, R.J. and Bartelt, R.J. (in press). Fauna and seasonal abundance of *Carpophilus* spp. (Coleoptera: Nitidulidae) in four stone fruit growing regions of south-eastern Australia as determined by pheromone-trapping. *Journal of the Australian Entomological Society*.

Kable, P.F. (1969). Brown rot of stone fruits on the Murrumbidgee Irrigation Areas. 1. Aetiology of the disease in canning peaches. *Australian Journal of Agricultural Research* 20, 301-16.

Schmidt, C.T. (1935). Biological studies on the nitidulid beetles found in pineapple fields. *Annals of the Entomological society of America* 28, 476-511.

Vickers, R.A., Rothschild, G.H. and Jones, E.L. (1985). Control of the oriental fruit moth, *Cydia molesta* Busck (Lepidoptera: Tortricidae), at a district level by mating disruption with synthetic female pheromone. *Bulletin of Entomological Research* 75, 625-34.