# *Creiis lituratus* (Froggatt) (Hemiptera: Psyllidae): a new insect pest of *Eucalyptus dunnii* plantations in sub-tropical Australia

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## Summary

The sap-sucking psyllid *Creiis lituratus* has become a significant pest of young *Eucalyptus dunnii* plantations in north-eastern New South Wales (NSW) and south-eastern Queensland. Previously recorded from native forests and amenity trees, but not as a significant pest or from *E. dunnii*, it has recently (1998–2004) caused severe damage in plantations 1–5 y old. This paper reports observations on *C. lituratus* from routine and specific forest health surveys, as well as preliminary results from a detailed study on the behaviour and pest management of the insect, with the objective of highlighting the presence of this new insect pest in commercial plantations. Damage symptoms associated with *C. lituratus* are chlorosis, reddening and necrosis of leaves. Moderately- to severely-affected trees take on a purple-brown colour and damaged (necrotic) leaves are often retained on trees until re-foliation occurs over summer. Severely-affected trees, where >75% of the tree has been damaged, may experience severe defoliation, tip dieback and the sprouting of epicormic shoots the following growing season. Damage can occur on both immature and mature (fully expanded) juvenile, intermediate and adult foliage. Populations are most active over autumn–winter when nymphs can occur in large numbers, virtually covering the entire (abaxial) leaf surface. *Creiis lituratus* was first observed causing severe damage in several *E. dunnii* plantations south of Bonalbo in north-eastern NSW in 1998. In 1999 and 2000, severe crown damage was observed in more plantations around Bonalbo, as well as in plantations around Casino. In 2003 *C. lituratus* caused severe crown damage in up to 25 *E. dunnii* plantations within 100 km of Bonalbo, with almost 500 ha moderately to severely affected. About 450 ha were sprayed with insecticide (dimethoate). Damage from *C. lituratus* was more localised in 2004, with less than 50 ha significantly affected; most of this was sprayed with insecticide. *Creiis lituratus* has been observed in *E. dunnii* and *E. grandis* plantations from Bulahdelah to south-eastern Queensland, but significant damage has occurred only in *E. dunnii* plantations from Grafton north. The occurrence of *C. lituratus* in plantations south of Grafton is sporadic.

*Keywords*: forest plantations; forest management; defoliation; insect pests; psyllids; *Creiis lituratus*; *Eucalyptus dunnii*; New South Wales; Queensland

## Introduction

Several species of Psyllidae are serious pests of eucalypts in NSW and Queensland. *Cardiaspina fiscella* and *Ca. maniformis* cause chlorosis, reddening and necrosis, often leading to serious defoliation, of *Eucalyptus grandis*, both in native forests and plantations, and are two of the most significant insect pests of this tree species in NSW (Stone 1993a,b; Carnegie 2000). *Cardiaspina* spp. are also significant defoliators of *E. camaldulensis* on the Murray River floodplains in southern NSW (Stone 1993b) and in plantations and native stands in Victoria and South Australia (Collett 2001). *Eucalyptus grandis* plantations in Queensland (Wylie and Peters 1993) and *E. globulus* plantations in South Australia (Phillips 1993) are also damaged by species of *Cardiaspina*, as are a range of species in native forests and plantations throughout Victoria (Collett 2001). Species of *Glycaspis* can cause serious defoliation of *E. saligna* in native forests in NSW (Stone 1996) and *E. delegatensis* plantations in Tasmania (Bashford 1993), but are rarely significant pests in plantations in NSW (Carnegie 2000). *Eucalyptolyma maideni* is common but rarely damaging on species of *Corymbia* in both native forests and plantations in NSW and Queensland (Haddlington and Johnson 1988; Carnegie 2002; S. Lawson, Queensland Department of Primary Industries and Fisheries, 2004, *pers. comm.*). Species of *Spondyliaspis* are uncommon on *E. grandis* in plantations in NSW (Carnegie 2002).

Several species of *Creiis* have been described from eucalypts in Australia (Froggatt 1900), but until recently none was considered a significant pest of plantations. In Western Australia, *C. periculosa* is very common on several species of eucalypts including *E. rudis* and *E. wandoo* (Elliott *et al.* 1998), with severe damage reported on *E. rudis* in native forests around Perth (Clay and Majer 2001) and Manjimup (Carnegie, 2004, *pers. obs.*) in recent years. *Creiis corniculata* causes leaf necrosis and can reach high population densities on *E. camaldulensis* in arid areas of South Australia, while *C. costatus* also causes leaf necrosis (Morgan 1984). *Creiis pellucida* has been reported as a minor pest of *E. racemosa* in Queensland (Browne 1968).

*Creiis lituratus* was originally described from *E. robusta* in native forests and amenity plantings around Sydney and Tumut in NSW (Froggatt 1900) and has since been reported on several eucalypt species in NSW, including *E. saligna*, *E. botryoides*, *E. ovata* and *E. cladocalyx* (C-A. Urquhart, NSW Department of Primary


**Figure 1.** Map of NSW showing distribution of young eucalypt plantations and relevant towns mentioned in the text.

Industries, unpublished data). In Queensland, *C. lituratus* occurs as a minor pest in native stands of *E. hemiphloia* and *E. racemosa* (Browne 1968). Prior to 1998 it had not been reported from *E. dunnii* in NSW (Stone 1993a,b; Stone *et al.* 1998a), Queensland (Wylie and Peters 1993) or elsewhere in Australia (Elliott and de Little 1984; Abbott 1993; Bashford 1993; Neumann 1993; Phillips 1993, 1996; Elliott *et al.* 1998). There are also no published records of significant damage to plantation eucalypts by *C. lituratus*, other than recent brief reports relating to the current work (Carnegie 2000, 2002; Angel *et al.* 2003).

This paper reports observations on *C. lituratus* from routine and specific forest health surveys, as well as preliminary results from a detailed study on the behavior and pest management of the insect, with the objective of highlighting the presence of this new insect pest in commercial plantations.

## Methods

Forests NSW (formerly State Forests of New South Wales) manages over 26 000 ha of young eucalypt plantations planted since 1994 (S. Arnold, NSW Department of Primary Industries, 2004, *pers. comm.*), most being planted in north-eastern NSW (Fig. 1). The main species planted are *E. pilularis*, *E. grandis*, *E. dunnii* and *Corymbia citriodora* subsp. *variegata*, and often multiple species are planted per site. Plantations range in size from 20 ha to 1000 ha, mostly on ex-agricultural land (improved pastures). There are about 8500 ha of young *E. dunnii* plantations, from Gloucester just north of Sydney to the Queensland border. Prior to 1994 the distribution of *E. dunnii* in NSW was mainly restricted to native forests and trial plantings.

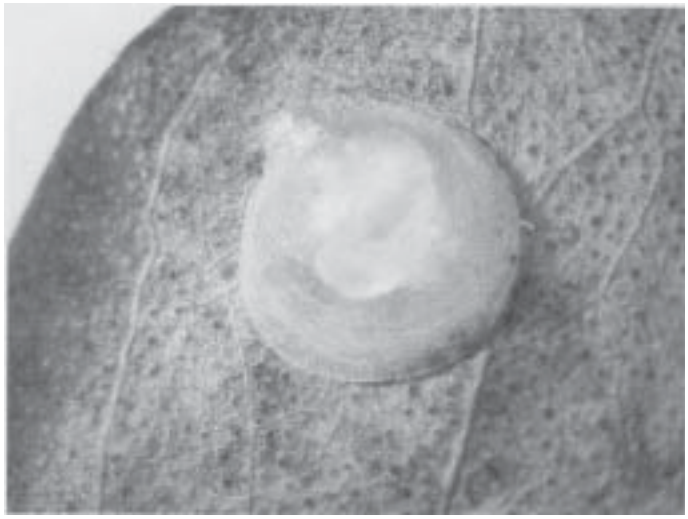
Most of these plantations were surveyed annually from 1996 to 2004 by the Department of Primary Industries' (formerly State Forests of NSW) Forest Health Survey Unit (FHSU) for damage from pests and diseases. These surveys are undertaken from December to April each year, during the time of peak insect activity and fungal damage. Surveys are conducted by vehicle (whereby most roads within the plantations are travelled) and also by foot (whereby transects are walked through the plantation). On several occasions (e.g. 1999, 2000, 2003, 2004) aerial surveys were conducted prior to ground surveys. Insects and fungi within plantations were recorded during surveys, and data on the incidence (proportion of trees affected in a plantation) and severity (proportion of leaf area damaged on affected trees) of significant pests and diseases were collected. More intensive ground surveys, specifically for *C. lituratus*, were conducted by the FHSU and operational field staff from 1998 onwards, including aerial surveys in 2003 and 2004. During these surveys, damage was assessed as the 'proportion of total leaf area on a tree with damage symptoms associated with *C. lituratus*', based on a precursor to the Crown Damage Index (CDI) assessment method developed by Stone *et al.* (2003).

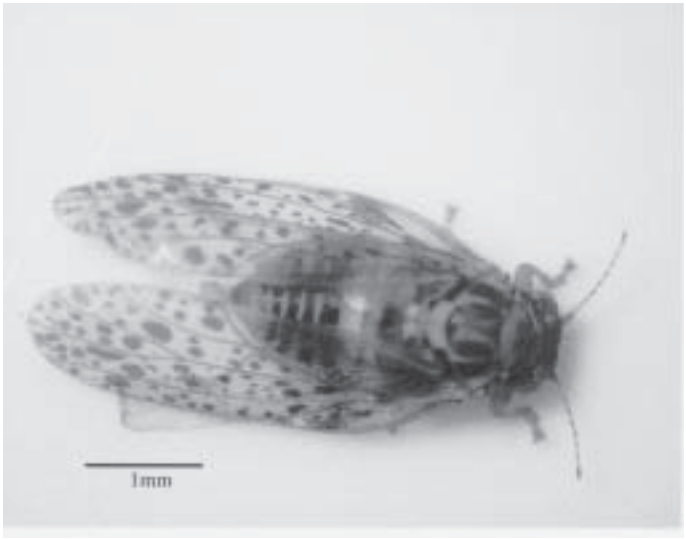
Due to the perceived importance of this new pest, a detailed study on *C. lituratus* was initiated in 2000. This involved various aspects of the biology and population dynamics of *C. lituratus*, the factors that predispose *E. dunnii* plantations to severe attack, the impact of *C. lituratus* in young plantations and potential control strategies. Results reported here are preliminary observations mainly from the field and laboratory examination of collected specimens.

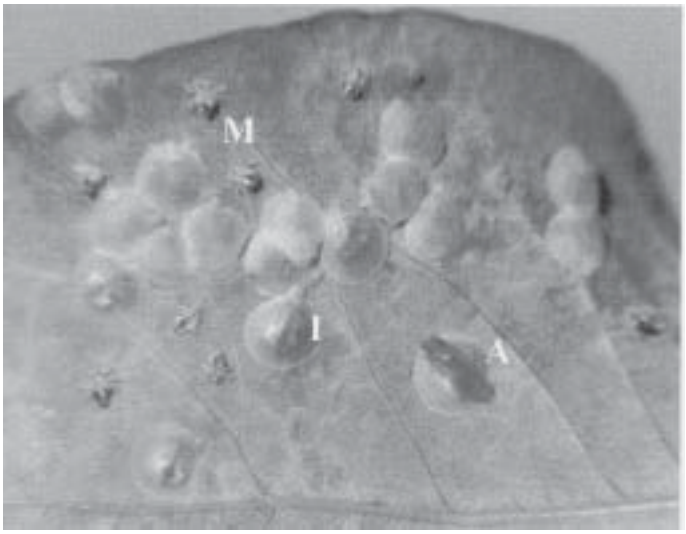
## Results

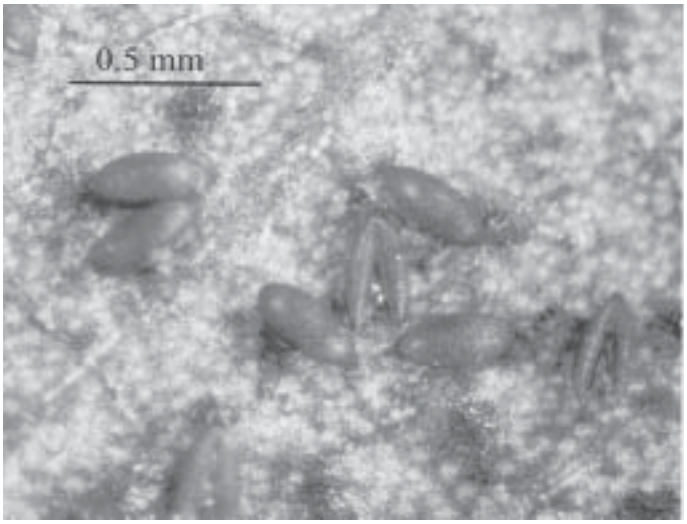
### *Creiis lituratus*: description, biology and behaviour

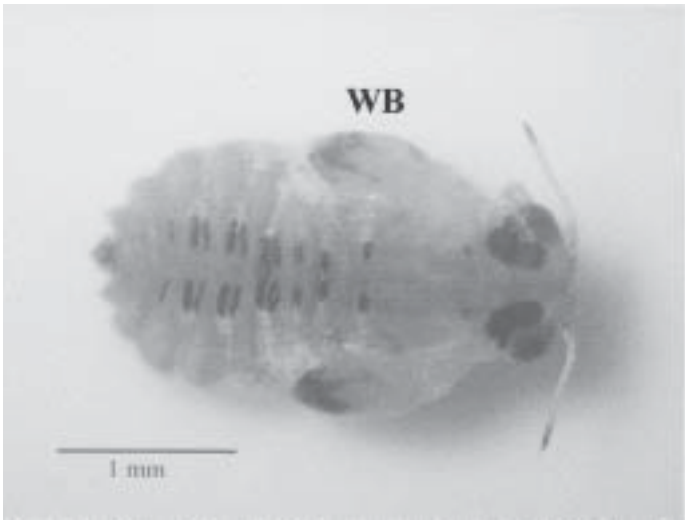
A detailed taxonomic description of *C. lituratus* was given by Froggatt (1900). Following is a brief description of *C. lituratus*, including recent observations by the authors. Lerps (Figs 2 and 3) are shaped like the valve of a scallop shell, up to 4.7 mm in diameter, round and convex, initially semitransparent becoming opaque. Nymphs (Fig. 4) are variable in colour: young nymphs

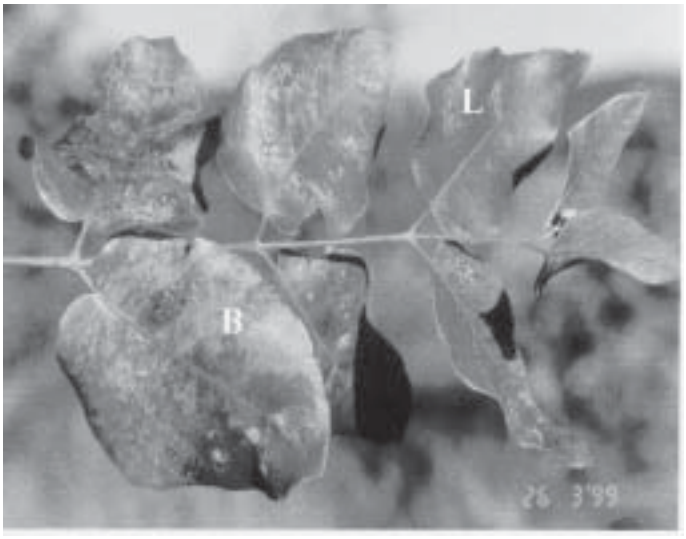





**Figures 2–4 (left, top to bottom) & 5–7 (right, top to bottom).** *Creiis lituratus* on *E. dunnii*: **(2)** lerp on abaxial surface; **(3)** lerps, later stage instars under lerps (I), moults (M) and an adult (A); **(4)** 4th instar showing markings and wing buds (WB); **(5)** adult; **(6)** eggs showing longitudinal split; **(7)** localised damage (L) associated with solitary insects on younger leaves and blighting damage (B) associated with many insects on older leaves

are yellow, older nymphs are pale greenish-yellow with dark brown wing covers and a blotched-red thorax. Adults (Figs 3 and 5) are initially bright red in colour but quickly turn to the more typical patterns of tan-brown; wings are light brown, mottled with irregular brown spots.

The eggs of *C. lituratus* are reddish-brown, elliptical in shape and about 0.3 mm in length (Fig. 6). They are laid most frequently at the nodes on green stem tissue but also occur on both surfaces of leaves as well as other areas of the stem. They are attached to the plant by a small stalk and open by splitting longitudinally.

Two parasitoid wasps, *Psyllaephagus atratus* and *P. ovatus*, have been observed ovipositing in juvenile *C. lituratus* instars. The pupal stage of the wasp can be observed inside juveniles. The emerging adult wasp creates a small, circular exit-hole in the lerp.

**Damage caused by *C. lituratus***

Damage associated with *C. lituratus* can be observed as localised chlorosis and reddening of leaves (Fig. 7), and occurs on both immature and mature (fully expanded) juvenile, intermediate and adult foliage. Each feeding nymph causes damage in a localised area. When nymphs occur in large numbers per leaf, these localised areas coalesce and the reddening becomes more blighting, covering much of the leaf (Fig. 7). Severe damage results in the leaf turning purple and eventually dying. Necrotic leaves are often retained on trees for up to 2 y. This gives the tree a purple-brown appearance and helps identify damaged trees within a plantation. When many trees are damaged, the affected area in the plantation takes on a purple-brown colour. This appearance persists until new foliage is produced.

Severe damage, where >75% (CDI) of the foliage has been affected, can result in defoliation, tip dieback, the sprouting of epicormic shoots the following growing season and even tree death. The degree of loss of growth depends on the extent of re-foliation and on the capacity of the site to facilitate this. The impact of infestation by *C. lituratus* on the growth of young *E. dunnii* has recently been quantified (Angel *et al.* 2003).

*Eucalyptus dunnii* has been found to be the most susceptible of the plantation species on which *C. lituratus* has been recorded, but individual trees within plantations have shown resistance to *C. lituratus* attack. Scions of these resistant trees have been grafted onto rootstocks and are presently being evaluated for *C. lituratus* oviposition preference and survival of nymphs.

*Creiis lituratus* was also observed on *E. grandis* and on *E. grandis* hybrids (*E. grandis* x *E. camaldulensis*, *E. grandis* x *E. tereticornis*, *E. grandis* x *E. urophylla*) during surveys. On *E. grandis*, *C. lituratus* is often solitary (i.e., one insect per leaf) and is often observed with other psyllids such as *Ca. fiscella* and *Ca. maniformis*, the last two species being more numerous. *Creiis lituratus* has not been observed causing extensive damage in *E. grandis* plantations.

**Distribution of *C. lituratus* in eucalypt plantations in NSW**

*Creiis lituratus* was first observed causing damage to three 2–3-y-old *E. dunnii* plantations in north-eastern NSW (Fig. 1) in December 1998. These plantations were situated south of Bonalbo in a series of plantations scattered over a distance of about 50 km. In all, about 150 ha of these plantations had been severely affected, with most trees having a CDI score >75%. Extensive and detailed surveys during spring and autumn from 1996 to 1998 in these and surrounding plantations had not revealed any *C. lituratus* damage. However, there is a single record of *C. lituratus* in the State Forests of NSW insect collection (FCNI), collected from an *E. grandis* plantation near Byron Bay in February 1997. There are no other records of *C. lituratus* from young eucalypt plantations in central or northern NSW prior to this (Plant Health Australia 2004).

Further surveys for *C. lituratus* were conducted from spring to autumn each year from 1998 to 2004 in most *E. dunnii* plantations from Gloucester to the Queensland border (Fig. 1). In 1999, *C. lituratus* was observed in *E. dunnii*, *E. grandis* and hybrids of *E. grandis* in a plantation east of Kyogle. *Cardiaspina fiscella* and *Ca. maniformis* caused most of the damage on *E. grandis*, but *C. lituratus* caused moderate damage to *E. grandis* x *E. camaldulensis*, *E. grandis* x *E. tereticornis* and *E. grandis* x *E. urophylla*.

In early autumn 2000 low levels of damage by *C. lituratus* were observed in 10 ha of a 1-y-old *E. dunnii* plantation south of Bonalbo. By late autumn, up to 100 ha had been severely damaged. The damage in this plantation continued to extend, and over 200 ha were severely damaged by winter 2000. Several other 1–2-y-old plantations of *E. dunnii* around Bonalbo and Casino were observed with localised damage in 2000 (<5 ha affected in each plantation). Similar localised damage was again observed in several *E. dunnii* plantations in 2001–2002 around Bonalbo and Casino.

During autumn 2003 severe outbreaks of *C. lituratus* were observed in up to 25 *E. dunnii* plantations around Grafton, Bonalbo and Kyogle, including privately owned plantations. This was the first record of significant damage as far south as Grafton and the first record of significant damage in 5-y-old trees. Significant but localised damage, similar to that observed in north-eastern NSW, was also seen in one *E. dunnii* plantation in south-eastern Queensland in September 2003 (S. Lawson, Queensland Department of Primary Industries and Fisheries, 2003 *pers. comm.*).

Specific aerial and ground surveys were conducted during autumn and winter 2003 to quantify the area affected and the severity of damage in north-eastern NSW. Of about 7500 ha of *E. dunnii* plantations surveyed in this region (Grafton to NSW–Queensland border); some 400 ha were severely affected, with a CDI of >75%, while 150 ha had 25–75% damage (CDI). About 450 ha were targeted for chemical control (dimethoate) by Forests NSW and private companies.

Surveys in autumn 2004 revealed levels of *C. lituratus* were considerably lower than in 2003. Observations of plantations that experienced severe damage (>75% CDI) in 2003 revealed that many trees on upper slopes or poor soils had died, with up to 100 ha killed. Only four plantations had damage sufficiently severe to require chemical control: about 45 ha were sprayed.

Surveys in the past few years have found that *C. lituratus* is present in most *E. dunnii* plantations in north-eastern NSW, usually at 'background' levels comprising solitary insects causing little damage. Low levels of *C. lituratus* have also been observed

in *E. grandis* plantations as far south as Bulahdelah. However, significant outbreaks have been observed only in *E. dunnii* around Grafton, Casino and in the Bonalbo area. The environmental and biotic factors that contribute to population outbreaks leading to tree damage and the loss of growth increment are currently being examined.

## Discussion

*Creiis lituratus* was first recorded in plantations in late 1998, in several 2–3-y-old *E. dunnii* plantations in north-eastern NSW. Since then it has been recorded in most private and state-managed *E. dunnii* plantations in north-eastern NSW, as well as in several in south-eastern Queensland. It is now considered to be the most significant insect defoliator of young *E. dunnii* plantations in north-eastern NSW and south-eastern Queensland. The effect of damage to young *E. dunnii* by *C. lituratus* has recently been quantified (Angel *et al.* 2003). The growth of *E. dunnii* is not significantly affected below a threshold damage level which corresponds to about 40% leaf damage (CDI). Damage above this level proportionally reduced the growth increment over the following 6 mo. Severe damage (where >75% of the crown is affected) can result in substantial defoliation, tip dieback and the production of epicormic shoots the following growing season. This can result in substantial loss of growth and form, and may render trees unmerchantable. These early results are consistent with those from other studies of insect herbivory in eucalypt plantations, which have demonstrated that severe damage leads to significant reductions in growth of young trees (Carne *et al.* 1974; Kile 1974; Abbott 1993; Elliott *et al.* 1993; Stone and Bacon 1994; Neumann and Collett 1997a,b; Stone *et al.* 1998b). Similarly, damage from other species of psyllids (*Ca. fiscella* and *Ca. maniformis*) has resulted in a reduction in growth of young *E. grandis* in northern NSW (Stone 1993a). In 2002, *C. lituratus* was observed in amenity trees in Auckland, New Zealand (Forest Research 2002a,b).

There is a limited number of records and information on *C. lituratus* in Australian insect collections (Plant Health Australia 2004) and none from plantations or *E. dunnii*. *Eucalyptus dunnii* has a restricted natural occurrence in north-eastern NSW and south-eastern Queensland (Boland *et al.* 1984), and most plantations in north-eastern NSW and the new plantations in south-eastern Queensland are within 100 km of this natural distribution. Several authors have reported that most insect pests of 'non-local' plantation eucalypts have originated from local native eucalypt forests, such as has occurred with *E. nitens* in Tasmania (de Little 1989) and *E. globulus* in Western Australia (Loch and Floyd 2001). Further work is needed to determine whether *C. lituratus* damaging plantations originated from native stands of *E. dunnii* or other local eucalypt species.

Observations of the *E. dunnii* plantations affected by *C. lituratus* in north-eastern NSW indicate that, during wet years, tree damage was more severe in those areas of the plantations where soils are poorly drained. Soil analysis of several plantations around Bonalbo revealed that these areas had mottled clayey subsoils of poor drainage (J. Grant, Southern Cross University, 2000, unpublished data). Further work is needed to confirm the link between soil composition, soil drainage and damage from *C. lituratus*, but early results indicate that trees stressed by waterlogging are more susceptible to attack from *C. lituratus*, and take longer to recover. This suggests that selecting sites that favour growth of *E. dunnii*, such as areas that are not prone to waterlogging, may reduce the impact of *C. lituratus* in these young plantations. Conversely, during years of below-average rainfall, damage by *C. lituratus* was predominant on upper slopes where trees might be expected to be suffering more from drought stress. Trees on upper slopes in several plantations around Bonalbo severely damage by *C. lituratus* in 2003 have since died.

Early results from soil application of the insecticide imidacloprid (Bayer®), and fertiliser, after damage to trees by *C. lituratus*, are promising. Imidacloprid significantly protected trees for up to 2 y after application, and trees damaged by *C. lituratus* significantly recovered growth after nutrient addition (P. Angel, 2004, unpublished data). This treatment is now being trialled on an operational scale. Future management to reduce the impact of *C. lituratus* in young *E. dunnii* plantations could include improved site-species matching, selective application of soil-based insecticides and the application of fertiliser after damage.

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