PATTERNS OF DAMAGE TO CHERRY BUDS BY ADELAIDE ROSELLAS *PLATYCERCUS ELEGANS ADELAIDAE* IN THE SOUTHERN MT LOFTY RANGES

A. M. FISHER

SUMMARY

The Adelaide Rosella *Platycercus elegans adelaidae* is a pest of cherry orchards in the southern Mt Lofty Ranges, South Australia. Monitoring of bud loss at two orchards showed that some cherry varieties are more heavily damaged than others. William's Favourite and Black Douglas sustain severe damage in comparison to Lustre and Makings. Most of the buds on high branches are removed before the branches lower in the tree are damaged. This may be because the top of the tree provides easier access for rosellas or offers protection from predators, or that the higher buds develop more rapidly. The seasonal pattern of damage is that buds on preferred varieties are taken initially, then, when few buds remain, some buds of other varieties are taken. Possible explanations for this may involve differences between varieties in taste and odour, chemistry, energetic reward, bud development and tree structure. The use of bird-exclusion netting would prevent damage to newly planted orchards.

INTRODUCTION

Birds are a major agricultural pest in many countries, reducing crop yields and causing substantial economic loss. Throughout the world the Common Starling *Sturnus vulgaris* is renowned for damaging fruit and grain crops (Feare 1980). In an Australian context, crop damage by birds ranges from Blackbirds *Turdus merula* and Silvereyes *Zosterops lateralis* attacking wine grapes in South Australia's Riverland (Bailey and Smith 1979), to ducks damaging rice in the Riverina of New South Wales (Davey and Roberts 1990). Various parrot and cockatoo species are also responsible for damaging crops in Australia. In South Australia the Adelaide Rosella *Platycercus elegans adelaidae* is a major pest of cherry orchards, annually damaging buds, flowers and ripening fruit (Halse 1986).

Rosellas detach flower buds with their beaks, make a longitudinal incision along the bud, then scoop out and eat the primordia. Only the floral buds are taken, with the birds apparently distinguishing these from the vegetative buds which usually remain untouched on the spurs (pers. obs.). When the flowers appear these are also nipped off by the rosellas and, later, developing fruits are taken (Ron Sinclair pers. comm.). This paper documents varietal, temporal and spatial patterns in damage to cherry buds by rosellas and discusses potential explanations for the observed patterns.

METHODS

Two orchards were used to document bud damage by Adelaide Rosellas to different cherry varieties. These were Bill Bishop's orchard at Basket Range and Colin Bungay's 'Cockatoo Flat' orchard at Cherryville (Fig. 1).

At the Basket Range orchard five trees of each of four varieties: William's Favourite, Black Douglas, Lustre and Makings were selected for detailed study. Each tree was divided into a low section (up to 2.65 m – able to be reached when standing on the ground) and a high section (from 2.75 to 5.9 m – able to be reached using a ladder). A branch on the north, south, east and west sides of each tree was selected at each of these two levels. In addition, four branches, two at each level, were netted to prevent rosellas having access to the buds. The 12 branches on each tree were marked with a numbered plastic tag and the number of buds between this marker and the end of the branch was counted approximately every three weeks from May to August 1991. Damaged buds can be easily identified as the base of the husk is left on the tree while the rest of the bud is removed. Thus on each occasion the number of intact and damaged buds were scored on each branch. The number of damaged buds was then expressed as a percentage of the total number of buds originally present on that branch. Cherries do not continue to initiate buds after summer, so the combined total of damaged and intact buds remained constant throughout the monitoring period.

Differences in the mean per cent of buds remaining between the four varieties was tested using the Kruskal-Wallis H statistic. This was done for high and low branches on initial and final monitoring. Nonparametric Tukey type multiple comparisons were performed to determine where any significant differences existed in the mean percentage of buds remaining on the four varieties (Zar 1984). Differences in the mean per cent of buds remaining on the high and low branches of all trees of each variety at the six monitoring times was tested using a Kolmogorov-Smirnov two sample test (Sokal and Rohlf 1981).

The Cherryville orchard was used to confirm the

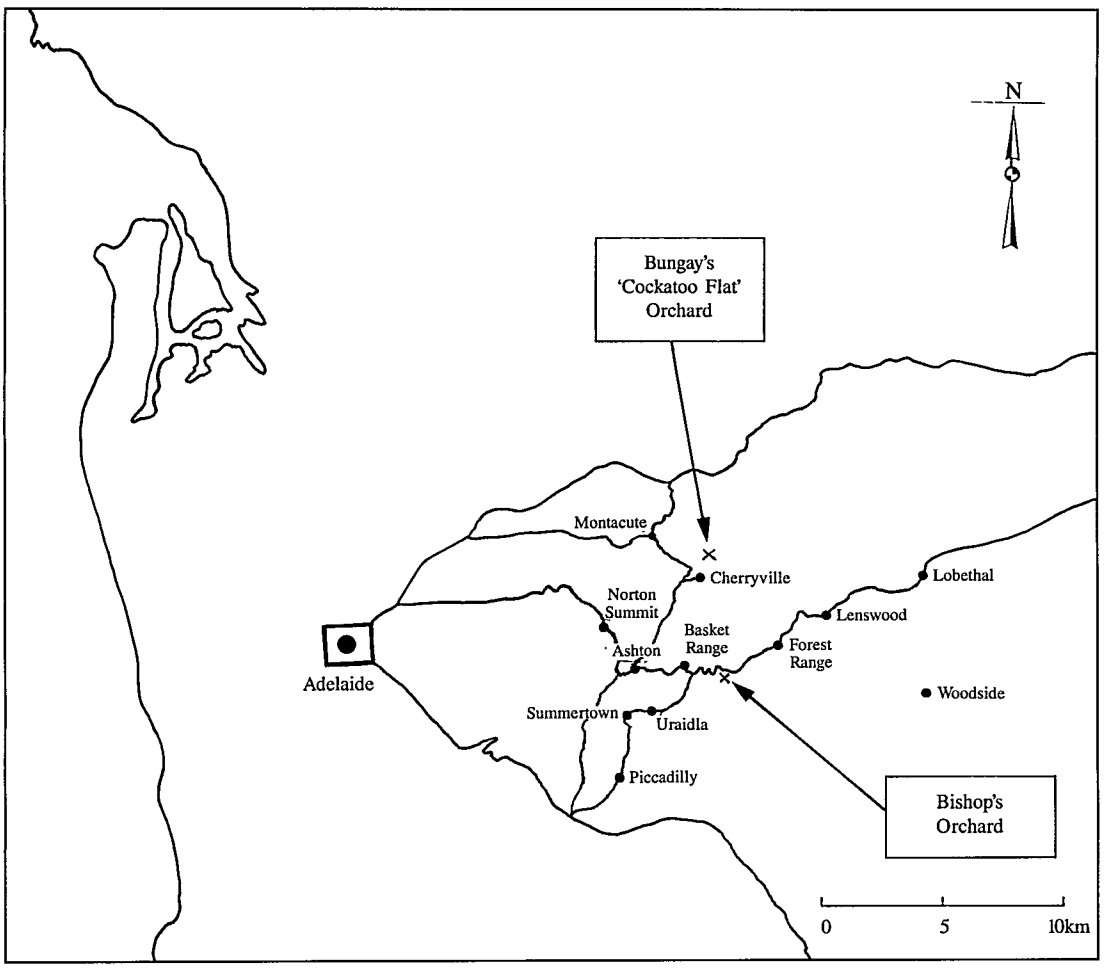


Figure 1. Location of study sites.

consistency of patterns of bud damage by Adelaide Rosellas demonstrated at the Basket Range orchard. At the Cherryville orchard eight trees were selected from each of three varieties: William's Favourite, Lustre and Tartarian. Beneath each tree six ice-cream containers were placed in a line extending across the diameter of the tree roughly parallel to the access tracks between the rows. Containers were positioned approximately a third, half and two-thirds of the way from the trunk to the edge of the canopy on either side of the tree. Buds removed by rosellas from the trees above fell into these containers. The remains of damaged buds were counted every two weeks from May to September 1991.

Before flowering (on 18 September 1991) bud damage was assessed for all trees in the Cherryville orchard, using a visual estimation technique. This involved placing each tree in one of seven damage categories as follows:

1: nil/negligible damage
2: 0-5% of buds on the tree damaged
3: 5-25% of buds on the tree damaged
4: 25-50% of buds on the tree damaged
5: 50-75% of buds on the tree damaged
6: 75-90% of buds on the tree damaged
7: greater than 90% of buds on the tree damaged

RESULTS

At the Basket Range orchard bud loss on the William's Favourite and Black Douglas trees was much greater than for Makings and Lustre (Fig. 2).

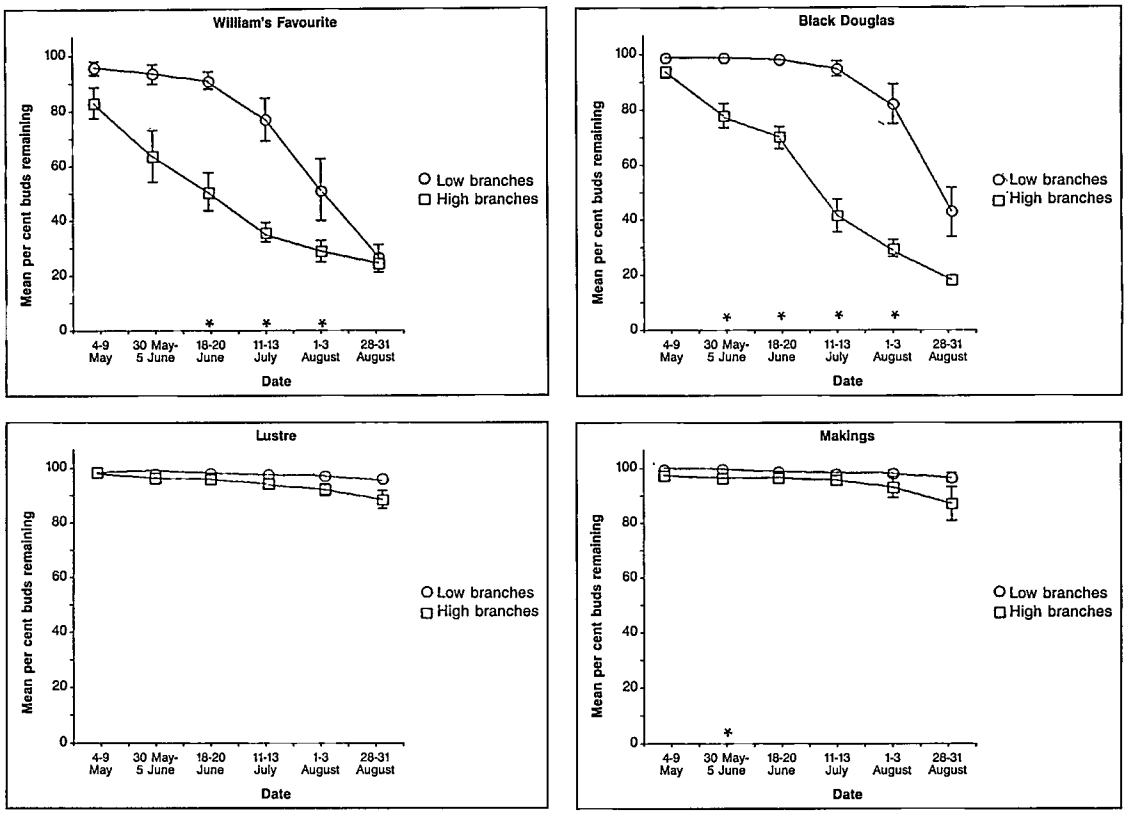


Figure 2. Bud loss for four cherry varieties at Bishop's Basket Range orchard from May to September 1991. Each point represents mean per cent buds remaining (± SE) of 20 branches from five trees of each variety. Losses on both low branches (1.0-2.65m) and high branches (2.75-5.9m) are shown for each variety.
* indicates a highly significant difference ($p < 0.001$, as determined by a Kolmogorov - Smirnov two sample comparison) between buds remaining on high and low branches of the variety at the given monitoring time.

In the late August, just before flowering, William's Favourite had 26.4 per cent and Black Douglas 21.0 per cent of buds remaining undamaged on marked high branches, whereas Lustre and Makings had 88.7 and 86.5 per cent remaining respectively. This pattern was repeated for the marked low branches, with 28.6 per cent of buds undamaged on William's Favourite in late August, 44.6 on Black Douglas, 95.8 per cent on Lustre and 95.5 per cent on Makings. Negligible bud loss occurred on the netted branches for all trees (Table 1). Therefore, all bud losses recorded can be attributed to rosellas.

In early May there was no significant difference in the mean percentage of buds remaining on the low branches between the four varieties ($H = 2.49$, $p > 0.05$). There was, however, a significant difference in the mean percentage of buds remaining on the high branches between the varieties ($H = 14.388$, $p < 0.05$), with William's Favourite suffering greater damage than the other three varieties. Before flowering late in August a significant difference was seen in the mean percentage of buds remaining on the low branches of the four varieties ($H = 55.582$, $p < 0.001$). At the same time the mean percentage of buds remaining on the high branches of the four varieties differed significantly ($H = 60.002$, $p < 0.001$). In both cases this was because bud losses on William's Favourite and Black Douglas were much higher than those on Lustre and Makings.

The seasonal pattern of bud loss at Bishop's orchard involves a steady loss of buds on the high branches of William's Favourite and Black Douglas until flowering (Fig. 2). Bud loss initially occurs on the high branches of damaged varieties and only becomes significant for the lower branches as the season progresses (Fig. 2). Significant bud loss does not occur on the low branches of William's Favourite until the end of June and not until late July for Black

Table 1. Mean per cent bud loss (± SE) on netted and exposed branches of four cherry varieties at Bishop's Basket Range orchard, before flowering (30 August 1991). On each tree two high and two low branches were netted to prevent rosellas having access to the buds. Where some buds were lost on netted branches this was because the net had worked loose and left a few buds exposed.

	William's Favourite		Black Douglas		Lustre		Makings	
	High	*Low*	*High*	*Low*	*High*	*Low*	*High*	*Low*
Netted	1.7±4.3	1.2±3.8	1.6±2.6	0.6±1.6	0	0	0	0
Exposed	73.6±3.1	71.4±4.3	79.0±1.8	65.4±8.6	11.3±3.0	4.2±0.5	13.5±5.7	4.5±1.5

Table 2. Bud loss for three cherry varieties at Bungay's 'Cockatoo Flat' orchard, Cherryville, from May to September 1991. The mean (± SE) number of buds (minus primordia) collected under the eight trees of William's Favourite, Lustre and Tartarian is presented for the ten monitoring occasions. The number of buds collected in the six containers under each tree was summed, and this figure used in the calculation of the mean value.

Date	William's Favourite	Lustre	Tartarian
15 May	1.3±0.6	0	0.1±0.1
27 May	2.8±0.8	0.1±0.1	0.3±0.3
18 June	2.0±0.9	0.4±0.3	0.3±0.2
28 June	3.3±1.2	0	0
5 July	5.5±2.2	0.3±0.2	0.4±0.4
17 July	24.1±7.5	0.4±0.2	0.8±0.5
6 Aug	67.9±15.7	1.8±1.0	0.4±0.2
19 Aug	70.0±22.6	0.5±0.3	1.9±0.3
28 Aug	54.9±15.7	0.6±0.4	1.1±0.5
17 Sept	27.0±4.7	1.0±0.3	16.0±4.0

Douglas (Fig. 2). Where significant differences in damage at the two heights exists, reference to Fig. 2 reveals that in each instance high branches are more heavily damaged than low branches.

At the Cherryville orchard bud loss on William's Favourite was much greater than for Lustre or Tartarian (Table 2, Fig. 3), confirming the pattern demonstrated at Bishop's orchard.

Negligible bud loss was recorded from mid May to early July for the three varieties at the Cherryville orchard. For the 12 day period from 5 to 17 July the mean number of buds collected under William's Favourite trees was 24.1 (± 7.5) buds per six containers and heavy damage was sustained on William's Favourite during the four subsequent sampling periods (Table 2). Negligible bud loss was recorded for the eight Lustre trees throughout the study period. Only for the 20 days to 17 September was any significant bud loss recorded for Tartarian (mean = 16.0 ± 4.6) although this was less than the continued loss for William's Favourite in the latter part of the study period (Table 2).

The estimations of bud loss at the Cherryville orchard immediately before flowering placed only William's Favourite in the three damage categories where greater than fifty per cent of the buds on a tree were lost. All the Lustre trees lost less than five per cent of their buds, while all but three of the Tartarian trees lost less than twenty-five per cent of their buds (Fig. 3).

DISCUSSION

Certain cherry varieties are more prone to bud loss by Adelaide Rosellas than other varieties. At the

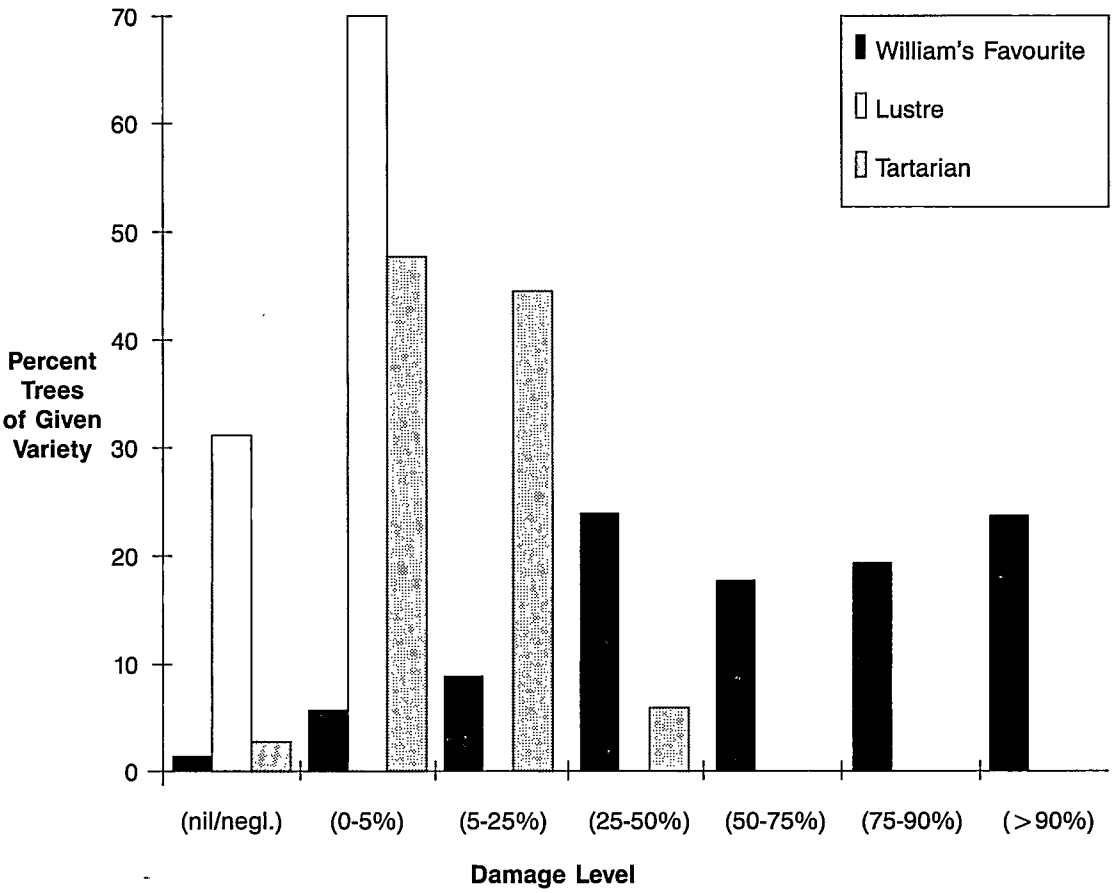


Figure 3. Estimates of bud damage immediately before flowering for three cherry varieties at Bungay's 'Cockatoo Flat' orchard, Cherryville. Each tree in the orchard was placed in one of seven damage categories on the basis of a visual estimation of total bud loss (see methods for details). All estimations were made on 18 September 1991. The number of trees of each variety in the orchard were: 68 William's Favourite, 39 Lustre and 34 Tartarian trees.

Basket Range orchard William's Favourite and Black Douglas trees were damaged far more heavily than those of either Makings or Lustre, while at the Cherryville orchard William's Favourite suffered greater bud loss than Lustre or Tartarian.

There are a number of possible explanations for rosellas preferring the buds of certain cherry varieties over other varieties. Taste and odour may be important in that the buds of heavily damaged varieties may be more appetising to rosellas than those of other varieties. In England, Bullfinches *Pyrrhula pyrrhula* damage pear buds and show feeding preferences analogous to those demonstrated for Adelaide Rosellas damaging cherry buds. Greig-Smith (1985) found the flavour of less preferred varieties to be more offensive to Bullfinches. High concentrations of fructose and free amino acids occurred in buds from preferred pear varieties (Greig-Smith *et al.* 1983). In this way the taste perceived by the birds was closely associated with the chemistry of the buds. Bullfinches also feed heavily on the seeds of ash trees *Fraxinus exelsior.* The fat content of these seeds increases their attractiveness and the phenolic content decreases their attractiveness to these birds (Greig-Smith and Wilson 1985). Thus if the buds of different cherry varieties differed in taste, odour and chemistry, then this may play a role in the damage patterns shown by Adelaide Rosellas. In addition, the buds of favoured varieties may yield a higher energetic reward for the bird than less damaged varieties.

Taste trials using captive rosellas suggest that taste plays a minor role in determining varietal bud preference. In the aviary, Adelaide Rosellas were reluctant to feed on excised cherry buds but there was no selection between sunflower seeds soaked in juice extracts of buds from preferred and non-preferred varieties (Fisher 1991).

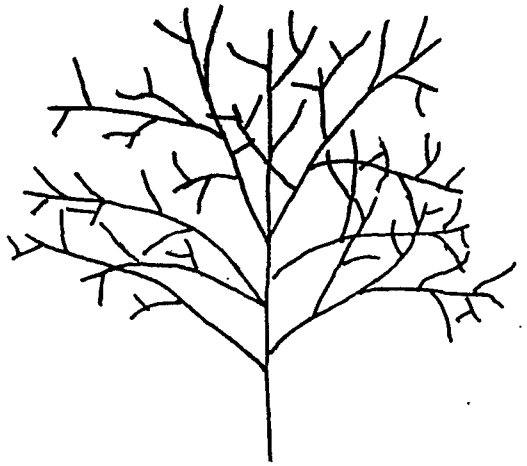
Bud development could also influence the varietal preference of cherry buds by Adelaide Rosellas. In cherry growing areas of North America damage by birds is consistently greatest for early-ripening cultivars (Tobin *et al.* 1991). Although this applies to cherry fruit, the same may be true for buds in Australia. In this way the buds of heavily damaged varieties may develop more rapidly and earlier than those of less preferred varieties. However, all varieties flower within three weeks of each other, suggesting little difference.

Tree structure may be important in determining the varietal preference of Adelaide Rosellas in cherry orchards. The average bud whorl on William's Favourite and Black Douglas contains at least two more buds than those on Lustre and Makings (Table 3). The mean spur length on a William's Favourite branch is twice that of Lustre, so the branches are closer together, resulting in a greater density of buds on William's Favourite (Fisher 1991). The implication of this for a rosella landing on a branch is that a greater number of buds can be reached from one place on a William's Favourite than on a Lustre. This may allow rosellas to consume more buds for less energy expenditure because less movement is needed.

A further aspect of tree structure is that the branch arrangement of less damaged varieties may make the buds less accessible for rosellas. Canopy structure is known to influence the feeding habits of herbivores (Küppers 1989) and the growth habits of the varieties studied differ markedly. Lustre has a typically vase-shaped arrangement, while Makings has a distinctive growth form in which long spurs arise from the same point on a main branch. William's Favourite and Black Douglas have a 'random' growth habit with the branches and spurs forming an interlocking network (Fig. 4). When in a William's Favourite or Black Douglas tree, rosellas can easily move from one branch to another across the network of branches. For Lustre or Makings such movements are not possible so the birds either have to fly or retrace their path along a branch in order to reach another branch on which to feed.

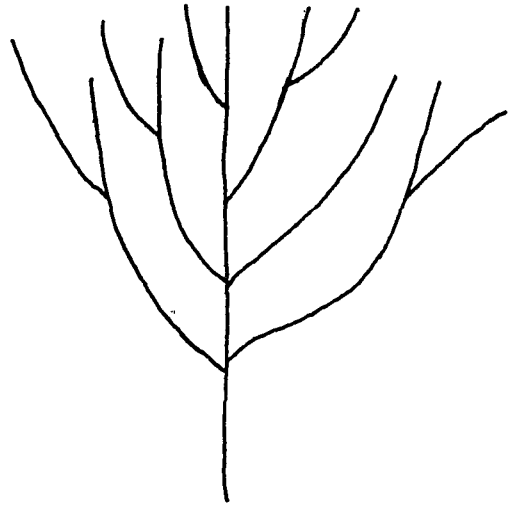
Table 3. Structural features of four cherry varieties at Bishop's Basket Range orchard. Buds per whorl is the mean of 200 whorls for each variety, using the first ten whorls on each marked branch of the five trees monitored. The remaining features show a comparison between two William's Favourite and two Lustre trees. The number of bud groups per metre of branch was counted and the length of each spur measured for each branch. The minimum distance between a bud group at a given position on each branch and the nearest bud group on another branch was measured. Measurements were made from the bud group at the tip of each branch, then using the bud groups a third and two-thirds of the way in from the branch tip. The density of buds was determined by counting the number of buds within a 200mm radius of the bud groups at these three positions along a branch. All values given are means (±SE).

Feature	William's Favourite	Black Douglas	Lustre	Makings
Buds per whorl	9.81±0.25	9.05±0.02	6.67±0.17	7.03±0.02
Bud groups/m	28.6±3.9	–	27.89±2.9	–
Spur length	265.0±33.1	–	121.5±12.4	–
Minimum distance (mm) to bud group on nearest branch				
- at branch tip	543±70.3	–	637±62.5	–
- a third in	329±39.0	–	427±29.0	–
- two thirds in	263±25.0	–	318±35.5	–
Bud Density (no. buds within 200mm of a bud group)				
- at tip	66.6±12.0	–	31.6±3.2	–
- a third in	72.4±12.7	–	55.8±6.1	–
- two thirds in	54.9±6.1	–	41.2±4.8	–



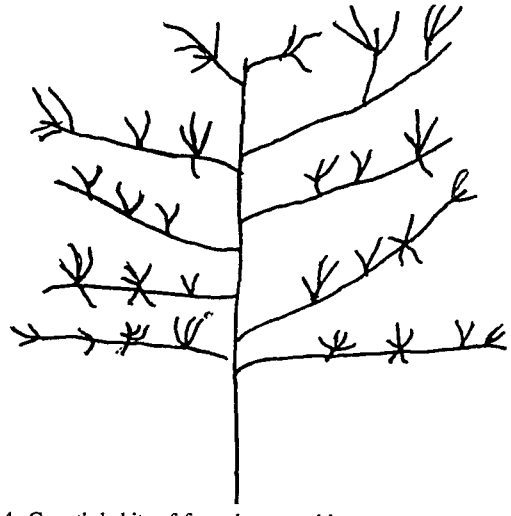
WILLIAM'S FAVOURITE
AND
BLACK DOUGLAS

- random network of interlocking branches



LUSTRE

- traditional vase shape



MAKINGS

- a number of long spurs arise from the same node on a branch

Figure 4. Growth habits of four cherry varities.

Bud damage was evident at the Basket Range orchard in early May whereas at the Cherryville orchard significant losses were not recorded until July. This temporal difference in damage pattern may be because the buds on the trees at Basket Range develop more rapidly than those at Cherryville. A further explanation may be that alternative food sources are more plentiful in the Cherryville area, thereby delaying the onset of cherry bud damage by rosellas.

Before flowering some damage was sustained on Tartarian at Cherryville and Makings at Basket Range, yet little bud loss was recorded for these varieties earlier in the season. This may be because the preferred variety had been virtually exhausted of buds and the rosellas then switched to less preferred varieties.

The spatial pattern of damage within a tree is that high branches are damaged earlier than those lower down. This may be because the top of the tree provides easier access for the rosellas. The birds generally entered the orchard from adjacent pines or eucalypts that were taller than the cherry trees, so the most direct route would be to fly to the top of the selected tree. Similarly, escape from the orchard when threatened would be easier from the top of a tree and a better view of the surrounding area is possible from this position. Aerial predators such as the Collared Sparrowhawk *Accipter cirrhocephalus* are probably more successful at catching prey low in vegetation (Brown and Amadon 1989). Furthermore shooters probably find it difficult to target rosellas when they are high in a tree as their view is obscured by the intervening canopy. Both William's Favourite and Black Douglas are generally among the taller trees in an orchard, so a tendency for Adelaide Rosellas to prefer high branches might account for these varieties being attacked first. Another plausible explanation for this spatial pattern of damage within a tree is that the primordia within buds at the top of the tree develop more rapidly than those lower down and, therefore, are more desirable to the rosellas.

Having established a varietal preference in bud damage by Adelaide Rosellas, further research is required to explain this phenomenon. The timing of growth and the development of buds should be investigated, focusing on energy content and size of the primordia. Chemical analysis of buds of preferred and non-preferred varieties may reveal differences in the chemical constituents of the buds. Black Douglas is a cherry variety derived from William's Favourite and these varieties are both heavily damaged. Chemical analysis of the buds may be useful in elucidating the compound(s) present/absent in these varieties which may be responsible for their attractiveness to rosellas.

The role of cherry tree structure in determining varietal preference by Adelaide Rosellas needs to be investigated. This would involve documentation of the physical differences between varieties coupled with field observations of the feeding behaviour of Adelaide Rosellas to identify which factors may influence their choice.

While Adelaide Rosellas do not avoid declining branches as such (Fisher 1991), branch angle may influence the feeding behaviour of these birds. Cannon (1977) found that Eastern Rosellas *P. eximius* spent significantly more time feeding on inclining branches than on other branches. If it could be demonstrated that Adelaide Rosellas avoid declining branches when feeding, orchard owners could be directed accordingly for pruning and training trees.

The clear directive which arises from this study is for cherry growers to concentrate their effort on minimising damage to William's Favourite and its derived varieties. Shooting is the most widely practiced form of bird control in Australia although it is among the least effective, being expensive and time consuming. As rosellas learn to avoid shooters this method is unlikely to affect bird numbers and so is not a viable long term solution (Fleming 1990).

Recognition of the fact that damage by Adelaide Rosellas is a part of growing cherries in the southern Mt Lofty Ranges may lead some growers to sacrifice a portion of their crop and concentrate their production effort on less preferred varieties. In planning an orchard, varieties likely to be severely damaged may be separated from other varieties, although the need for cross pollination may restrict such separation (Baxter and Tankard 1987). Loss can be reduced by decreasing the number of William's Favourite and Black Douglas trees in an orchard.

Enclosing an entire newly planted orchard in bird netting may add greatly to the cost of establishing an operation. However by selecting a level site and planting trees close together the grower has much more control over the orchard. All trees can be kept to an accessible height and trained to maximise fruit-bearing potential. As a result harvesting costs are greatly reduced. Netting excludes all birds, thus removing the possibility of bud loss to Adelaide Rosellas as well as the threat of damage to fruit by other birds. The cost-benefit of netting cherries

depends on the density of the planting, the yield per tree, the market price and the extent of damage (Sinclair 1990). In new orchards with high tree density, little damage is necessary before the use of permanent netting becomes economical. This will increase the quality of the fruit and yield per tree so a higher market price can be obtained. Therefore, it is prudent to enclose a new close-planted orchard in bird-exclusion netting, despite the initial capital outlay, knowing that the full production potential of the orchard should be harvestable.

ACKNOWLEDGEMENTS

Thanks to David Paton for advice on the project and for constructive criticism of an earlier manuscript. Thanks also to Ron Sinclair for sharing his knowledge of the rosella problem in cherry orchards and to Tim Reynolds whose assistance with the bud counts was invaluable. Special thanks to Bill Bishop and Colin Bungay for allowing free access to their orchards. Stephen Phillips and Brian Stone deserve recognition for their help with the figures and tables.

REFERENCES

Bailey, P. T. and Smith, G. 1979. Methiocarb as a bird repellent on wine grapes. *Journal of Experimental Agriculture and Animal Husbandry,* 19, 247-250.

Baxter, P. and Tankard, G. 1987. *Growing fruit in Australia.* Nelson, Melbourne.

Brown, L. and Amadon, D. 1989. *Eagles, Hawks and Falcons of the World.* Spring Books, London.

Cannon, C. E. 1977. The comparative feeding biology of two Australian Parrots, *Platycercus eximius* and *P. adscitus.* Ph.D. Thesis. Department of Zoology, University of Queensland.

Davey, C. and Roberts, J. 1990. The duck problem on rice fields in New South Wales. In *National Bird Pest Workshop Proceedings,* held at The University of New England, 8-9 February 1990. P. Fleming, I. Temby and J. Thompson (eds). pp 42-50. Department of Conservation, Forests and Lands, Victoria and NSW Department of Agriculture and Fisheries.

Feare, C. J. 1980. The economics of starling damage. In *Bird Problems in Agriculture.* E. N. Wright., I. R. Inglis and C. J. Feare (eds). pp 39-55. British Crop Protection Council, London.

Fisher, A. M. 1991. Bud damage by Adelaide Rosellas *(Platycercus elegans adelaidae)* to different varieties of sweet cherry grown in the southern Mt Lofty Ranges. Honours Thesis. Departments of Botany and Zoology, The University of Adelaide.

Fleming, P. 1990. Some other Bird Control Techniques. In *National Bird Pest Workshop Proceedings,* held at The University of New England, 8-9 February 1990. P. Fleming, I. Temby and J. Thompson (eds). pp 143-147. Department of Conservation, Forests and Lands, Victoria and NSW Department of Agriculture and Fisheries.

Greig-Smith, P. W. 1985. The importance of flavour in determining the feeding preferences of Bullfinches *(Pyrrhula pyrrhula)* for the buds of two pear cultivars. *Journal of Applied Ecology,* 22, 29-37.

Greig-Smith, P. W. and Wilson, M. F. 1985. Influences of seed size, nutrient composition and phenolic content on the preferences of bullfinches feeding in ash trees. *Oikos,* 44, 47-54.

Greig-Smith, P. W., Wilson, M. F., Blunden, C. A. and Wilson, G. M. 1983. Bud eating by Bullfinches, *Pyrrhula pyrrhula,* in relation to the chemical constituents of two pear cultivars. *Annals of Applied Biology,* 103, 335-343.

Halse, S. A. 1986. Parrot damage in apple orchards in south-western Australia – A review. Technical report No. 8. Department of Conservation and Land Management, WA.

Küppers, M. 1989. Ecological significance of above-ground architecture patterns in woody plants: A question of cost benefit relationships. *Trends in Ecology and Evolution,* 4, 375-379.

Sinclair, R. 1990. The economics of netting for bird control in New South Wales. In *National Bird Pest Workshop Proceedings,* held at The University of New England, 8-9 February 1990. P. Fleming, I. Temby and J. Thompson (eds). pp 134-142. Department of Conservation, Forest and Lands, Victoria and NSW Department of Agriculture and Fisheries.

Sokal, R. R. and Rohlf, F. J. 1981. *Biometry.* Second edition. W. H. Freedman, New York.

Tobin, M. E., Dolbeer, R. A., Webster, C. M. and Seamans, T. W. 1991. Cultivar differences in bird damage to cherries. *Wildlife Society Bulletin,* 19, 190-194.

Zar, J. H. 1984. *Biostatistical Analysis.* Second edition. Prentice-Hall, New Jersey.

Andrew M. Fisher: School of Information Technology, Charles Sturt University — Mitchell, Panorama Avenue, Bathurst, N.S.W. 2795

Received: 21 January 1993