PIED CURRAWONGS AND INVADING ORNAMENTALS: WHAT'S HAPPENING IN NORTHERN NEW SOUTH WALES

D.A. Bass
Centre for Coastal Management, Southern Cross University, PO Box 157, Lismore, New South Wales 2480, Australia

Summary The abundance and feeding patterns of pied currawongs was investigated in 1988–1991 in Armidale, New South Wales to assess their role in the seed dispersal of ornamental weeds. Pied currawongs congregated each April and dispersed in the following September coincident with a shift in diet from invertebrates to fruit coupled with breeding pressure. In 1989 regurgitated seeds of ornamental plants were collected from two sites where pied currawong feeding flocks congregated. Seeds of 22 species of introduced plants were dispersed by pied currawongs. A key group of plants comprising privets (*Ligustrum* spp.) and firethorns (*Pyracantha* spp.) were the most common genera accounting for >90% of all seeds recovered. A smaller but significant group comprising about 5% of seeds recovered included *Crataegus phaenopyrum, Pistacia chinensis, Nyssa sylvatica, Hedera helix* and *Parthenocissus quinquefolia* formed a secondary group of dispersed plants. The remaining species, accounting for <1%, were rarely dispersed by pied currawongs. A significant trend in the data suggests that many of the council planted street trees in Armidale are at the early stages of invasion. In an area that is dominated by invading *Crataegus monogyna, Ligustrum* and *Pyracantha* spp., the weed seed dispersal shadow is now seeing an increase in the proportion of *P. chinensis, N. sylvatica* and *C. phaenopyrum* which are all now establishing wild populations in urban and rural bushland throughout the district. This paper demonstrates the interaction between introduced plants and native birds, documents the seed dispersal of weeds and recognizes a new wave of invading ornamentals. The management of this situation requires an integrated plant and animal control strategy which challenges traditional conservation ethics.

INTRODUCTION

Pied currawongs (*Strepera graculina*) have long been recognized as important seed dispersal vectors of introduced ornamental plants: in particular the invasion of *Ligustrum* and *Pyracantha* species (Mulvaney 1986, Bass 1989, 1990). Pied currawongs are large gregarious omnivorous birds that congregate during cooler months in large feeding flocks. At Armidale, pied currawongs are resident all year but increase dramatically in abundance during April. They remain in the township feeding on fruit of ornamental trees and shrubs. In September pied currawongs disperse away from Armidale. This pattern of changing behaviour and abundance has been associated with seasonal food availability: as invertebrate abundance falls in autumn and winter, birds switch to very abundant fruit resources. In spring the birds disperse in response to breeding pressure (Readshaw 1968, Wimbush 1969). As a consequence pied currawongs disperse seeds of many ornamental plants (Buchanan 1983, 1989, Mulvaney 1986, Bass 1989, 1990) thus promoting extensive modifications of regional floras. Recher and Lim (1990) suggested that ornamental weeds have increased the over-winter survival of pied currawongs leading to an increase in pied currawong populations and resulted in a higher level of predation on small bush birds. With this type of ecosystem impact it is both timely and necessary to document and understand plant-animal interactions associated with weed invasions and use this information to develop appropriate strategies to manage weed invasions.

Earlier studies documented the abundance and daily movements of pied currawongs in the Armidale region and their role in the dispersal of *Ligustrum* and *Pyracantha* (Bass 1989, 1990). The extent of pied currawong facilitated seed dispersal of other introduced fleshy-fruiting species and the representation of these species in the weed flora in Armidale is not known. Intuitively the higher the pressure of introduction of a particular species (represented by the proportion of species planted in urban situations) should translate into a higher degree of invasiveness (represented by the proportion of species established as weeds away from original plantings). More abundant fleshy-fruiting ornamental species should make up a larger proportion of seed disperser diets, have more seeds dispersed and subsequently dominate the weed flora compared to less abundant species. This paper reports other ornamental species that are incorporated into pied currawong diets, their level of seed dispersal, and the relationship to the established weed flora.

MATERIALS AND METHODS

Abundance of ornamental plants The relative abundance of introduced fleshy fruiting ornamental plants in Armidale was estimated by surveying a 6 km road

transact through the middle of Armidale. A strip ten metres wide on both sides of the road was surveyed (total area 12 ha) and the canopy dimensions recorded for all species that produced fruit characteristically ingested by vertebrates (van der Pijl 1972). This included all plants in hedges, on road verges (street trees), in residential properties and council gardens. This survey was an adjunct to investigation of the invasiveness of *C. monogyna* at Armidale (Bass 1994) and therefore an emphasis was placed on *C. monogyna*. The groupings of ornamental plants reflect both the diverse varieties within genera (e.g. *Cotoneaster*, *Pyracantha* and *Ligustrum*) and the dominance of *Pistacia chinensis* as a street tree. The species were grouped into six genera/species groupings: *Cotoneaster*, *Pyracantha*, *C. monogyna*, *Ligustrum*, *P. chinensis* and others which included *C. phaenopyrum*, *N. sylvatica*, *H. helix* and *P. quinquefolia*.

Pied currawong abundance and diet Pied currawong abundance was determined from continuous records kept from March 1988 to September 1990. All birds seen while driving along a 6.8 km route from home to work at the University of New England were counted. Regurgitated seeds were collected weekly from two sites in Armidale between April and October 1989. Seeds were identified to species where possible, based on a reference collection made during the study. Where it was difficult to assign seeds to individual species they were left as genera (e.g. *Pyracantha*).

Established weed flora A 1986 survey by Smith (unpublished) and reproduced in Bass (1994) recorded the proportion of established wild ornamental plants >1 m tall invading six sites around the Armidale district. These data were grouped into the same species/genera categories used above.

RESULTS

The most commonly planted ornamentals in this study were *Cotoneaster* which accounted for 38% of all canopies of fruiting species. *Pyracantha*, *C. monogyna*, *Ligustrum* and *P. chinensis* all had similar levels of representation of between 11 and 19% (Table 1).

Pied currawongs congregated in Armidale during March and April reaching abundances up to 16 and commonly 10 times higher than in summer. Abundances declined markedly during spring to less than one bird per day in October (Bass 1995). There were 34 525 seeds of 22 different ornamental species recovered from the two regurgitate seed sampling sites (Appendix 1). The samples from both sites show similar trends and were pooled. *Pyracantha* and *Ligustrum* were the most common species accounting for 55.5 and 38.4% of seeds recovered respectively. A second group comprising *C. phaenopyrum*, *P. quinquefolia*, *P. chinensis*, *H. helix* and *N. sylvatica* accounted for <5% of seeds. A third group of rarely ingested species accounted for <2% of seeds. There were no *Cotoneaster* seeds recovered.

The established weed flora of the six surveyed sites was co-dominated by *Pyracantha* and *Ligustrum* which accounted for 30 and 29% of all plants respectively. *C. monogyna* made up 15% of the weeds with *Cotoneaster* accounting for 10%.

Table 1. Proportion of canopy volumes, regurgitated seeds, and established weeds for six categories of ornamental plants in Armidale.

Genus/species	% Canopy	% Regurgitated seeds	% Established weeds
Cotoneaster	38	0	10
Pyracantha	19	55.5	30
C. monogyna	16	0.1	15
Ligustrum	13	38.4	29
P. chinensis	11	0.8	1
Others	3	5.2	15

DISCUSSION

Pied currawong abundance and diet The regular influx of pied currawongs into Armidale is consistent with other studies throughout south eastern Australia (Bass 1995).

The range of seeds that are actually ingested by pied currawongs is diverse with some 22 species represented in regurgitated pellets. All plant species are represented in residential gardens, parks and as street trees. However pied currawongs favour a limited set of available species. *Pyracantha* and *Ligustrum* represent a key group accounting for 94% of all seeds dispersed by pied currawongs. The secondary group includes the council planted street trees *C. phaenopyrum, P. chinensis* and *N. sylvatica* which accounted for nearly 5% of seeds dispersed. Significant is the non-occurrence of *Cotoneaster* despite it dominating the plantings in Armidale. It is apparent that pied currawongs prefer *Pyracantha* and *Ligustrum* over other species to the exclusion of *Cotoneaster*. All species have fruits which are characteristically dispersed by vertebrates therefore any differences in ingestion by seed dispersers are likely to be explained in terms of physical or biochemical differences in fruit. *Pyracantha*, *Ligustrum*, *Cotoneaster*, and *P. chinensis* all have similar sized fruit (0.5–0.7 cm diameter). *C. monogyna* has larger fruit (0.8–1.0 cm diameter). Larger fruit containing larger seeds are likely

to be less favoured by birds as they need to compromise between energy expended in searching, feeding and flying with energy obtained from fruit pulp. Birds can eat more smaller fruit and process their meals faster compared to ingestion of larger fruit. This may explain why *C. monogyna* is less favoured. However the complete avoidance of *Cotoneaster* may better be explained in terms of biochemical differences.

Another factor which can confuse the pattern of pied currawong feeding is the phenology of fruiting. *P. chinensis,* despite being a small part of pied currawong diets in fact dominates their diet during April when *P. chinensis* is the only species with ripe fruits. This coincides with the early influx of pied currawongs. All *P. chinensis* fruit has been consumed by May by which time pied currawongs have began to feed on *Pyracantha* and other sequentially ripening fruits.

In general there appears to be no direct relationship between pressure of invasion, as represented by the proportion of ornamental plantings, and the representation in pied currawong diets.

Established weed flora *Pyracantha* and *Ligustrum* are represented similarly in pied currawong ejecta and established weed flora. However *C. monogyna* despite similarly represented in ornamental plantings and in the local weed flora, is a very minor part of pied currawong diets. *C. monogyna* was one of the earliest ornamental species introduced to the Northern Tablelands. It was common in hedges and windbreaks throughout the region (Bass 1994) and represented a very abundant fruit source where there were few other alternatives for local birds. As such it was incorporated into pied currawong diets and dispersed widely. However with changing garden fashions there was a move to Asian ornamental species such as *Pyracantha.* These later species produced fruit more favoured by pied currawongs and displaced *C. monogyna* from pied currawong diets. The high proportion of *C. monogyna* in the local weed flora is an historical artefact.

P. chinensis only makes a minor proportion of pied currawong diets and weed flora. Smith (unpublished) only recorded plants >1 m tall. Many *P. chinensis* plants were <1 m and therefore not recorded. More recently Borgis (1993) reported high levels of *P. chinensis* in the local weed flora and suggested that this species is increasing in local importance.

The under representation of *Cotoneaster* in pied currawongs diets at Armidale is important in that it demonstrates the ineffective translation of invasion pressure into invasiveness in the absence of high levels of seed dispersal. The omission from pied currawong diets is probably related to the nutritional status of the fruit. There is some dispersal of *Cotoneaster* seed but pied currawongs are not apparently an important vector. *Cotoneaster* seeds were recovered from wallaroo (*Macropus robustus*) and brush-tailed possum (*Trichosurus vulepecula*) faeces. It is likely that other birds are also dispersing seeds (e.g. silvereyes *Zosterops lateralis*, starlings *Sturnus vulgaris*) however the seed dispersal shadows are dwarfed by pied currawong dispersal of *Pyracantha* and *Ligustrum.*

Pied currawong mediated seed dispersal appears to be driving the current pattern of ornamental weed invasion in Armidale. The dietary analysis suggests that a new wave of invasions are taking place and that in time the weed flora will gradually change to reflect the history of planting fashions. This raises the issue of whether invasions can be managed. If pied currawongs are the dominant dispersal vector driving ornamental weed invasions then three courses of action present themselves:

1. Replace the key group of invading weeds (e.g. *Ligustrum* and *Pyracantha*) with suitable native species. Without a corresponding decrease in pied currawong numbers this may increase predation on small birds. This also may promote invasion by other secondary plants (e.g. *P. chinensis, N. sylvatica*, *C. phaenopyrum*).
2. Develop ornamental species which produce infertile seeds thereby breaking the seed dispersal weed invasion link. There are significant populations of wild plants that produce fertile seeds and are dispersed by pied currawongs so the existing winter food resources would not be reduced unless accompanied by widespread removal of established weeds which would be extremely costly and laborious.
3. Intensively cull pied currawongs to reduce the level of pied currawong mediated seed dispersal. This may be effectively undertaken using the strategically located sites below pied currawong flightlines which are used morning and night as birds move between roost and feeding sites (Bass 1990). This may be a distasteful option at odds with many conservation proponents. An integrated approach using components of all three options may provide a compromise between short- and long-term objectives.

Whichever strategy becomes attractive the dispersal of ornamentals will not stop. The interactions between weeds and components of ecosystems are complex. It is obvious that even if pied currawongs are the dominant vector involved in weed invasions in Armidale they are by no means the only dispersal agent. Other vertebrates both native and introduced disperse seeds of ornamental weeds. By reducing or removing pied currawong mediated seed dispersal existing minor dispersal agent(s) will fill the void.

ACKNOWLEDGMENTS

This study was undertaken while in receipt of an Australian Postgraduate Research Award at the University of New England, Armidale. The study was also supported by the Internal Research Grants scheme through the University of New England and Southern Cross University.

REFERENCES

Bass, D.A. (1989). Seasonal changes in the behaviour and abundance of pied currawongs *Strepera graculina* and the consequences for seed dispersal. *Australian Bird Watcher* 13, 78-80.

Bass, D.A. (1990). Pied currawongs and seed dispersal. *Corella* 14, 24-7.

Bass, D.A. (1994). 'The invasiveness of *Crataegus monogyna* and *Prunus mahaleb*, at Armidale, New South Wales, Australia.' Ph.D. thesis, department of Geography and Planning, University of New England, Armidale.

Bass, D.A. (1995). Contribution of introduced fruits to the winter diet of pied currawongs in Armidale, New South Wales. *Corella* 19, 127-32.

Borgis, S. (1993). 'Observations on the early stage of invasion by the Chinese Pistachio (*Pistacia chinensis*) around Armidale, and its dispersal by frugivorous birds'. Dip. Nat. Res. Project Report. University of New England, Armidale.

Buchanan, R.A. (1983). Seasonal variation in population size of pied currawongs at Thornleigh, NSW. *Australian Birds* 3, 49-55.

Buchanan, R.A. (1989). Pied currawongs (*Strepera graculina*): their diet and role in weed dispersal in suburban Sydney, New South Wales. *Proc. Linn. Soc. NSW.* 111, 241-55.

Mulvaney, M. (1986). Birds, berries, and bad bushes. *Canberra Bird Notes* 11, 94-9.

Readshaw, J.L. (1968). The distribution, abundance and seasonal movements of the pied currawong, *Strepera graculina* (Shaw), an important bird predator of Phasmatidae in eastern Australia. *Aust. J. Zool.* 16, 37-47.

Recher, H.F. and Lim, L. (1990). A review of current ideas of the extinction, conservation and management of Australia's terrestrial vertebrate fauna. *Proc. Ecol. Soc. Aust.* 16, 287-301.

Van der Pijl, L. (1972). 'Principles of Dispersal in Higher Plants' 2nd Edition. (Springer-Verlag, Berlin).

Wimbush, D.J. (1969). Studies on the pied currawong *Strepera graculina* in the Snowy Mountains. *Emu* 69, 72-80.

Appendix 1. Seeds collected from regurgitated pied currawong pellets.

Species	No seeds	% seeds
Pyracantha spp.	19157	55.5
Ligustrum lucidum	12358	35.8
Ligustrum sinensis	910	2.6
Crataegus phaenopyrum	636	1.8
Parthenocissus quinquefolia	300	0.9
Pistacia chinensis	298	0.8
Hedera helix	210	0.6
Nyssa sylvatica	123	0.4
Sophora japonica	100	0.3
Schinus areira	79	0.2
Melia azedarach	62	0.2
Unidentified species	61	0.2
Ilex sp.	58	0.2
Crataegus monogyna	35	0.1
Crataegus sp.	30	0.09
Livistona australis	30	0.09
Amyema sp.	22	0.06
Prunus sp.	17	0.04
Vitis sp.	13	0.04
Rubus spp.	12	0.04
Malus domestica	8	0.02
Euonymous sp.	6	0.02