CITY SLICKERS: HABITAT USE AND FORAGING IN URBAN COMMON MYNAS *Acridotheres tristis*

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The introduced Common Myna *Acridotheres tristis*, often considered a pest species in Australia, appears to compete with some native birds for nest sites and potentially could also compete with native birds for food resources. We documented its breeding season habitat use and foraging behaviour in Melbourne to help promote a better understanding of its urban ecology, upon which future control efforts might draw. Myna density varied 5.7-fold among the five urban habitat types surveyed, but differed significantly only between streetscapes and open parkland and wooded parkland and open parkland. Mynas mainly foraged on the ground on grass and sealed surfaces; foraging behaviour was dominated by gleaning (70% of records) and varied as a function of the substrate occupied by the bird and on which the food resource occurred, but not of habitat. The diet comprised insects, seeds, fruit and human food-refuse, but insects and/or seeds predominated. Mynas engaged in interspecific aggression infrequently (0.8 encounters observation h⁻¹). Most interactions were with native honeyeaters and the exotic Common Starling *Sturnus vulgaris*, but they usually only resulted in displacement of either combatant by a few metres. In urban Melbourne in the breeding season, Common Mynas were thus habitat generalists, but specialized in ground-feeding, mainly on insects and/or seeds and primarily by gleaning. They did not seem to be significant aggressive interference competitors with other bird species for food resources.

INTRODUCTION

Although most introduced species fail to become naturalized and some that do have neutral or even beneficial environmental impacts, exotic species constitute the second most significant cause of biodiversity loss globally in recent historical times (Ewel *et al.* 1999). They can cause the extinction of native species directly through predation and competition (Savidge 1987; Petren and Case 1996), but also indirectly by changing community composition, introducing novel pathogens and impairing ecosystem functioning (Porter and Savignano 1990; Vitousek 1990; Morell 1994). Some of them also have negative impacts on human health and economies (Real 1996; Pimentel *et al.* 2000).

More than sixty vertebrate species have been introduced into Australia since European settlement, about half of which are birds (Healey 2002). About 15 of these bird species have become established and common in the wild, many in cultural steppe habitat (New 2000) in urban centres and rural agricultural areas in temperate Australia. However, it has been unfashionable to study these invasive bird species and consequently we have a somewhat restricted understanding of the extent and nature of any threat that they may pose to the native flora and fauna, including native birds. A detailed evaluation of the possible threat posed by these introduced birds to Australia's urban and rural biodiversity is overdue.

The Common Myna *Acridotheres tristis*, native to central and southern Asia, was first introduced into Australia from the 1860s to the 1880s for both aesthetic and biological control reasons (Martin 1996; Pell and Tidemann 1997a). It is now distributed patchily along the eastern seaboard from northern Queensland to South Australia and its range is still expanding (Martin 1996). It is regarded by many

people as a pest species because it nests in buildings, feeds on domestic crops and can carry pathogens inimical to humans (Martin 1996; Feare and Craig 1999). It appears to compete for nest hollows with some native birds (Pell and Tidemann 1997a), but whether it also a competitor for food resources is less clear, because only a few studies have been conducted on the species' ecology in Australia (Counsilman 1974; Pell and Tidemann 1997b).

Our aim was to quantitatively document the habitat use and foraging ecology of the Common Myna in urban Melbourne during its spring and summer breeding season as a prelude to a more empirical evaluation of the species' possible impact as a competitor on co-habiting, native birds. The information obtained is likely to be important for future management of the species.

METHODS

Study area

The study was conducted in the Central Business District (CBD) and inner and outer eastern suburbs of Melbourne (37°50'S, 145°00'E) from October 2004 to January 2005. Inner suburbs included Balwyn, Bentleigh, Camberwell, Caulfield, Glen Iris, Hawthorn, Kew, Malvern and Mont Albert; outer suburbs, which tend to be of more recent origin, included Blackburn, Burwood, Clayton, Glen Waverley, Nunawading, Oakleigh, Ringwood, Vermont and Wantirna. Mean daily minimum and maximum temperatures during this period were 11.9°C and 22.8°C, respectively. Data were obtained from five qualitatively defined, but visually distinct habitat types: *Bushland* — remnant or planted forest, with dense vegetation dominated by native woody plants, especially *Eucalyptus*; *Wooded Parkland* — woodland dominated by native woody plants, but trees much more widely spaced than in bushland; *Open Parkland* — open, grassy areas, sometimes with fringing trees and shrubs; *Industrial Areas* — dominated by commercial buildings, little vegetation; and *Streetscapes* — residential streets dominated by houses and gardens. These habitats varied in their relative representation in the CBD, inner and outer suburbs.

Habitat use

To determine whether mynas used the various urban habitats differentially, their abundance was surveyed weekly throughout the study. Unlike Wood (1995) and Pell and Tidemann (1997b), we used a survey strategy in which the emphasis was on spatial replication, so transect length was relatively short. Thus one survey was conducted at each of 64 sites: six *Bushland,* seventeen *Wooded Parkland,* fifteen *Open Parkland,* eight *Industrial Areas* and eighteen *Streetscapes.* At each site, the observer walked along the midline (or occasionally the side) of a 300 metres long by 30 metres wide belt transect at a constant, slow speed and counted all mynas seen, except those flying high overhead. An area of transect not visible to the observer was discounted from the total in calculating myna abundance per hectare. Morning surveys commenced one hour after sunrise and afternoon surveys two hours before sunset on fine days. Surveys were systematically distributed among habitat and suburb types over time to give representative abundance estimates for the various habitat types in the central and eastern city throughout the four-month period.

To determine in more detail how the habitats used by mynas varied in composition, we surveyed the occurrence of 11 habitat features on a presence/absence basis in the fifteen 20 metres long by 30 metres wide segments comprising each Common Myna survey belt transect. The features included vegetation types and human-made structures (Table 2 legend gives full details).

Foraging ecology

Observations of Common Myna foraging behaviour and diet were made at 43 sites distributed across the three city zones and all habitat types. They were made throughout the day, but on hot days were focused in the early morning and evening. To increase statistical independence of the data, we set maxima of three foraging records and five minutes of observation per myna encountered; multiple records were obtained when the focal bird switched substrate, behaviour or food item. Similarly, only two birds were recorded when a flock was encountered.

A foraging record comprised (a) the substrate that the foraging bird occupied (myna substrate) and from which it obtained the food item (food substrate), (b) the behaviour of the bird and (c) the food item consumed. Substrates were: grass, sealed surface, leaf litter, building, air, trunk of tree, branch off main trunk, twig attached to branch, foliage, soil, gravel and rock. Foraging behaviours were categorized (after Remsen and Robinson 1990) as near-perch and aerial maneuvers as follows:

Near-perch on surface: (i) gleaning — picking a food item off a solid surface with bill without stretching, (ii) reaching up, out or down — stretching legs and/or neck to reach a distant food item without leaving substrate, (iii) lunging — using rapid ambulation to approach a food item.

Near-perch below surface: (iv) flaking — brushing aside loose substrate with lateral bill movements.

Aerial: (v) leaping — legs used to launch into the air to obtain food item, (vi) sally-strike — flying from perch to grasp aerial prey in bill and return to perch, (vii) sally-pounce — as for sally-strike, but landing briefly to take food item from substrate.

Food items consumed were recorded as accurately as possible. However, it was often difficult to determine the identity of a food item precisely, especially small ones taken from the ground, and so we qualified all records as being either 'definite' or 'probable'.

Interspecific aggression

All interspecific aggression involving mynas that occurred during foraging observation sessions was systematically recorded. We recorded the other species involved, type of behaviour exhibited, number of participants, outcome and likely cause. Aggressive encounters were categorized as comprising (a) supplanting, (b) chasing or (c) fighting. Their outcome was categorized as (a) no response — no displacement from immediate area, (b) local displacement — target individual disturbed and/or fled up to five metres and (c) site displacement — target bird decamped to another tree or left vicinity entirely.

Data analysis

Statistical analysis was conducted with SYSTAT v. 10 and PRIMER v. 5.0. Single factor analysis of variance (ANOVA) and *post hoc* Tukey tests were used to examine variation in myna density among habitat types. Data were square root transformed. Variation among habitats in habitat feature profiles was examined visually with non-metric multi-dimensional scaling (MDS) ordination plots. Dissimilarity among pairs of habitats in habitat profiles and similarity among sites within habitat types in their habitat profiles were analysed with Analysis of Similarity (ANOSIM) and the Similarity Percentage (SIMPER) procedure.

Chi square analyses of independence indicated that using up to three records for a focal bird yielded the same foraging profile as using only the first record, with respect to foraging behaviour, substrates and food items consumed (χ^2 with 3–6 d.f. ranged from 2.059 to 6.014, P in all cases >0.05). Therefore we used all records in analyzing foraging ecology. Log linear modelling (Agresti 1996) was used to examine the relationships among the various foraging variables. Two 3-way contingency tables were constructed, with some pooling of initial categories being necessary. The factors in the tables were foraging habitat, myna or food substrate and foraging behaviour. The most parsimonious models were used to determine relationships among the variables; they were obtained by hierarchical removal of terms to arrive at the smallest model that fitted the data and retained all first-order terms. The ratio of log-linear parameter estimates to their asymptotic standard errors, λ/(S.E.λ), was used to indicate significant parameters for interaction terms (Wilkinson 1996).

RESULTS

Habitat features and usage

Horizontal clustering of sites in the MDS ordination plot suggested that there was considerable variation in habitat feature profiles among the five qualitatively defined habitats (Fig. 1) and ANOSIM supported this interpretation (global R = 0.388, P < 0.001). With the exception of the *Wooded Parkland* × *Bushland* combination, for which sites overlapped quite substantially in the MDS plot, pair-wise habitat comparisons revealed significant dissimilarities in feature profiles (Table 1). SIMPER analysis showed that similarity in habitat feature profiles was greatest among *Bushland* (average similarity 91.1%) and *Industrial* sites (85.2%), which formed the two tightest clusters in the MDS plot; the other three habitats had average similarities of 67.6 per cent (*Wooded Parkland*), 69.7 per cent (*Open Parkland*) and 70.5 per cent (*Streetscape*). The comparatively low average similarity among *Streetscape* sites resulted from the lack of houses, native trees, shrubs, herbs and grass and presence of other buildings in the six CBD *Streetscapes* in comparison with the inner and outer suburban *Streetscapes*; the two groups of *Streetscapes* formed spatially distinct clusters in the MDS ordination plot (Fig. 1). Table 2 shows the features that contributed most to dissimilarities between pairs of habitats. The presence of roads (sealed surfaces) was particularly important in distinguishing the habitats in six of the pair-wise combinations, whilst the presence of eucalypts, other native trees and native shrubs especially distinguished *Wooded Parkland* from *Open Parkland* and *Open Parkland* from *Bushland*, respectively.

The overall mean density of Common Mynas in all habitats combined was 2.5 birds per hectare. Mean population density varied by a factor of 5.7 among the five habitats (F $_{(4, 58)}$ = 3.449, P < 0.05), from 0.9 ± 0.6 birds per hectare in *Open Parkland* to 5.1 ± 1.6 birds per hectare in *Wooded Parkland.* A *post hoc* Tukey test indicated that
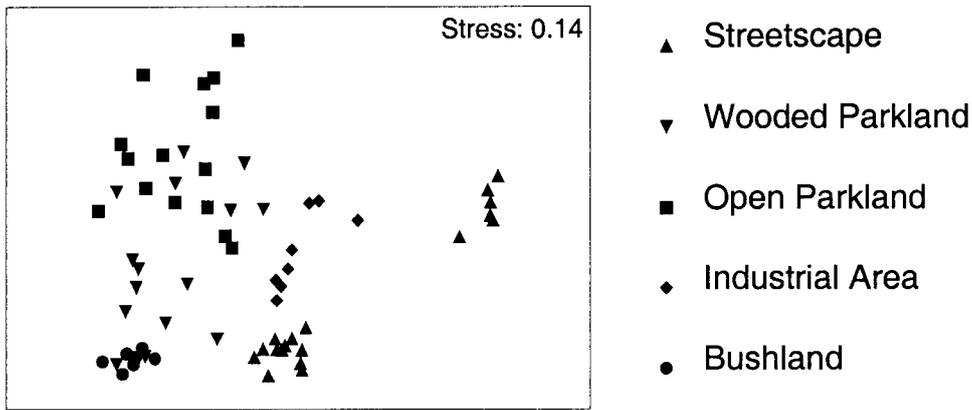
Figure 1. *MDS ordination plot of survey sites based on measured habitat variables.*

TABLE 1

Dissimilarity between pairs of urban habitats in their feature profiles.

Habitat pairs	R value	Probability
Streetscape		
Wooded Parkland	0.491	0.001
Open Parkland	0.511	0.001
Industrial Areas	0.209	0.021
Bushland	0.441	0.003
Wooded Parkland		
Open Parkland	0.255	0.005
Industrial Areas	0.445	0.001
Bushland	-0.094	>0.05
Open Parkland		
Bushland	0.519	0.001
Industrial		
Bushland	1.000	0.001

Larger R statistics generated by ANOSIM indicate greater dissimilarity.

TABLE 2

Most significant features distinguishing pairs of urban habitats used by Common Mynas

Habitat pairs	Habitat feature and per cent contribution to dissimilarity
Streetscape:	
Wooded Parkland	Sealed surface (16.4)
Open Parkland	Sealed surface (17.8), houses (10.2), other exotics (10.2)
Bushland	Sealed surface (13.9), other exotics (11.9), eucalypts (11.2)
Industrial Areas	Houses (14), other exotics (13.2), other buildings (12.7)
Woodland Parkland:	
Open Parkland	Other native trees (16.1), native shrubs (15.8), eucalypts (15.1)
Industrial Area	Sealed surface (22.2), other buildings (14.1), eucalypts (10.2)
Open Parkland:	
Industrial Area	Sealed surface (25.2), other buildings (14.8), vertical structures (10.9)
Bushland	Native shrubs (22.3), other native trees (20), herbs (except grass) (18.3)
Industrial Area:	
Bushland	Sealed surface (18.8), other native trees (12.4), other buildings (11.4)

Habitat features were: sealed surfaces (roads, paths), houses, other buildings, artificial vertical structures (signs, posts), *Eucalyptus* trees, other native trees, native shrubs, introduced conifers, other exotic trees, herbs (except grass) and grass. Percentage contribution to dissimilarity derived from ANOSIM. Up to three most important features contributing to dissimilarity listed for each pair-wise habitat comparison.

density was significantly higher in (a) *Streetscape* than *Open Parkland* (mean difference +2.5 birds ha^{-1}, P = 0.017), habitats which were distinguished particularly by the former having more sealed surfaces, houses and exotic plants other than conifers, and (b) *Wooded Parkland* than *Open Parkland* (mean difference +4 birds ha^{-1}, P = 0.02), habitats which were distinguished especially by the former having more eucalypts, other native trees and native shrubs (Table 2). However, there were no other significant pair-wise density differences between habitats (mean differences 0.4 to 3.6, P > 0.05 in all cases).

Foraging ecology

The most parsimonious log linear models that fitted the 435 foraging records obtained for mynas contained three factors (habitat, substrate and behaviour) and two significant two-way interaction terms (substrate × habitat and substrate × behaviour). For Model 1, in which the substrate was that on which the foraging myna stood or perched, the Pearson $\chi^2_{(144)}$ was 66.985 (P = 1.0) and the Likelihood ratio $\chi^2_{(144)}$ was 66.914 (P = 1.0). For Model 2, in which the substrate was that on which the food item occurred, the Pearson $\chi^2_{(80)}$ was 43.577 (P = 1.0) and the Likelihood ratio $\chi^2_{(80)}$ was 42.6 (P = 1.0). In log linear analysis, a model accurately describes the dataset when these two goodness-of-fit test statistics are equivalent and P > 0.05 in both cases (Agresti 1996).

SUBSTRATE USE

Common Mynas foraged on grass (67% of records), sealed surfaces (16%), leaf litter (7%), buildings (4%), branches (2%), gravel (1%), twigs, soil and trunks (all <1%). However, myna substrate and habitat type were significantly related ($\chi^2_{(20)}$ = 85.34, P < 0.001 after removal of interaction term from model). Foraging on grassy substrates was particularly common in *Wooded Parkland* and *Open Parkland*, as indicated by the large associated λ/(S.E.λ) values (Table 3). Not surprisingly, buildings and sealed surfaces were particularly significant myna substrates in *Streetscapes* and leaf litter was a key myna foraging substrate only in *Wooded Parkland*. Foraging on grass was

more common in suburban than CBD *Streetscapes*, which had much less grassy substrate.

The main food substrates used by Common Mynas were grass (56%), sealed surfaces (15%), air (10%), leaf litter (8%), buildings (4%) and foliage (3%); the other six substrates were used less than one per cent each. Food substrate varied significantly with habitat type ($\lambda^2_{(16)}$ = 66.26, P < 0.001 after removal of interaction term from model). Grass was very common as a food substrate in all urban habitats except *Streetscapes*, but sealed surfaces were especially significant in *Industrial Areas* and *Streetscapes* and air in *Open Parkland* (Table 2).

BEHAVIOUR PATTERNS

Common Mynas exhibited nine foraging behaviours, but gleaning dominated their repertoire, accounting for 70 per cent of records (Fig. 2); no other foraging behaviour accounted for more than 10 per cent of observations.

Lunging and reaching out were the next most frequently observed foraging behaviours. Interestingly, foraging behaviour did not vary significantly among urban habitats (i.e. there was no significant behaviour × habitat interaction term in the most parsimonious log linear model), but it did vary with myna substrate ($\chi^2_{(30)}$ = 57.62, P < 0.002 after removal of interaction term from the model). Thus gleaning was particularly dominant when mynas were foraging on grass and sealed surfaces and lunging and reaching out were significantly more common on grassy substrates too (Table 3). Behaviour also varied with food substrate ($\chi^2_{(16)}$= 230.78, P < 0.001 after removal of term from the model). Aerial foraging maneuvers were particularly significant not only, as expected, for exploiting airborne prey, but also for plant-based food items. Flaking was a key foraging behaviour for prey on grassy substrates, gleaning for prey on both grass and sealed surfaces, and lunging for airborne prey (Table 4).

TABLE 3

$\lambda/(S.E.\lambda)$ values for myna substrate × habitat interaction and food substrate × habitat interaction terms in the log linear model of foraging behaviour.

Substrate			Habitat		
	Bushland	Industrial Area	Open Parkland	Streetscape	Wooded Parkland
Myna substrate:					
Building	0.106	0.610	-0.087	2.682	-2.239
Grass	**-3.039**	**-2.037**	2.628	-0.524	4.624
Litter	0.241	-1.118	0.522	-1.346	2.178
Plant	0.704	-0.672	-0.165	-0.633	0.937
Sealed surface	-1.458	1.737	-1.664	3.495	0.024
Other	2.672	1.323	0.053	-2.038	-1.613
Food substrate:					
Air	-0.466	-1.432	3.458	-2.281	1.523
Grass	-0.627	-0.312	1.947	-1.715	-0.751
Plant	0.835	-0.008	-0.981	0.446	1.100
Sealed surface	-0.904	2.460	-1.242	3.196	-1.291
Other	1.227	0.203	-0.483	0.327	-1.693

Values >2 are in bold and indicate significant positive or negative associations (Wilkinson 1996) between habitats and substrates used by Common Mynas. Positive associations are boxed. For example, row 2 shows that grass featured significantly as a myna foraging substrate in wooded and open parkland, but not in bushland and industrial areas.

TABLE 4

$\lambda/(S.E.\lambda)$ values for foraging behaviour × myna substrate and foraging behaviour × food substrate interaction terms in log linear model of foraging behaviour.

Substrate				Foraging Behaviour			
	A	F	G	Lu	RD	RO	RU
Myna substrate:							
Building	0.012	-0.113	0.013	-0.301	0.586	-0.691	0.507
Grass	-1.078	0.523	4.510	2.531	-2.366	2.721	-2.104
Litter	-0.656	1.511	-0.580	0.415	-0.064	-0.795	0.351
Plant	1.984	-0.130	-1.406	-0.955	0.570	-0.710	0.489
Sealed surface	-0.429	-1.176	3.327	-0.136	0.236	-0.251	0.388
Other	0.138	0.013	-2.565	-0.156	0.710	1.292	-0.087
Food substrate:							
Air	3.203	-0.871	-3.874	4.454	-1.439		
Grass	-1.647	2.230	2.583	-1.802	1.693		
Plant	2.872	-0.500	-0.196	-1.453	0.809		
Sealed surface	-0.567	-0.683	2.632	0.506	0.014		
Other	-1.126	1.842	0.738	0.442	-0.725		

Behaviour abbreviations are: A= aerial, F = flake, G = glean, Lu = lunge, RD = reach down (or all reaching combined for food substrate data), RO = reach out and RU = reach up. Values >2 are in bold and indicate significant positive or negative associations (Wilkinson 1996) between behaviours and substrates used by Common Mynas. Positive associations are boxed. Thus row 2 shows that gleaning, lunging and reaching out were significantly associated with grass substrates, but reaching down and reaching up were not.
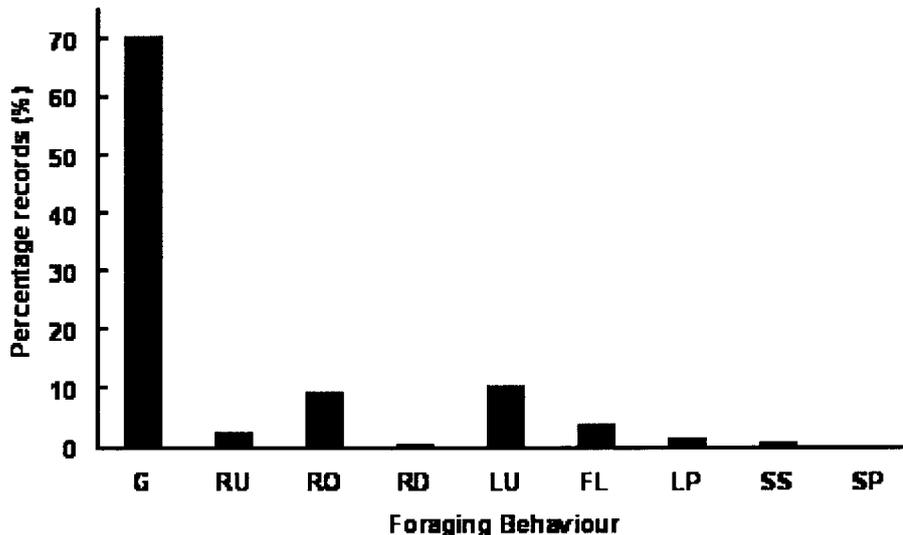
Figure 2. *Percentage occurrence of the nine foraging behaviours used by Common Mynas. G = gleaning, RU = reaching up, RO = reaching out, RD = reaching down, LU = lunging, FL = flaking, LP = leaping, SS = sally-strike and SP = sally-pounce. N = 435 foraging records. Precise values for RD (0.5%) and SP (0.2%) too small to be distinguishable on this scale.*

DIET

Dietary items identified with precision were invertebrates (24.5% of total feeding records), human food-refuse (4.8%), fruit (1.1%) and seeds (<1%); items identified with less precision were invertebrates *or* seeds (68% of total records) and invertebrates (<1%). No further analysis was conducted due to the limited precision possible in identifying food items.

Interspecific aggression

Mynas were involved in just 35 inter-specific aggressive interactions (0.8 observation h⁻¹) during the study and initiated 49 per cent of them. Fourteen bird species were involved, eleven of which were native, but only seven featured in more than one interaction. The three most frequent combatants were the Red Wattlebird *Anthochaera carunculata* (n = 8 interactions, one initiated by Common Myna), Noisy Miner *Manorina melanocephala* (n = 7, two initiated by myna) and Common Starling *Sturnus vulgaris* (n = 6, all initiated by myna). Most interactions were supplanting (75%) with chases and fights accounting for only 22.2 per cent and 2.8 per cent of encounters, respectively. Outcomes of aggressive interactions were: no displacement (31.4%), local displacement (60%), and site displacement (8.6%). Only Noisy Miners and Red Wattlebirds initiated most of their encounters with Common Mynas.

DISCUSSION

Habitat use

The significant differences in feature profiles between most pairs of habitats and the considerable clustering of sites by habitat type in the MDS ordination indicated that our qualitative categorizations of urban habitats were realistic. The significant variation in Common Myna density among habitats indicated that the species' urban spatial distribution was partly a result of preference, rather than being purely dependent on habitat availability. Mynas were

nonetheless not strong habitat specialists; significant population density differences only occurred between the two most occupied habitats (*Wooded Parkland* and *Streetscapes*) and the least occupied habitat (*Open Parkland*). Counsilman (1974) found that Common Mynas did not use native bushland in central Auckland, but they occurred in five other 'habitat' types. Green (1980) found a comparable difference (5-fold) in Common Myna density between streets and eucalypt woodland in Melbourne to that observed in the present investigation between *Streetscape* and *Open Parkland*.

Mean myna population density in bushland in the present study agreed well with that recorded for this habitat in the same general area of Melbourne by van Polanen Petel and Lill (2004). However, the mean density that we recorded for streetscapes (3.4 birds ha⁻¹) was substantially less than that reported for Townsville streetscapes by Jones and Wieneke (2000) (4.4–8.1 birds ha⁻¹). Mean overall population density in urban Melbourne was higher than that recorded for suburban Wollongong (1.45 birds ha⁻¹) (Wood 1995) and two grassy woodland reserves and adjacent suburbs in Canberra (0.8 birds ha⁻¹) (Pell and Tidemann 1997b). However, mynas have been present for a much longer period in Melbourne than Canberra, where their density has probably not yet peaked (Pell and Tidemann 1997b). A fuller understanding of disparities in myna abundance and habitat use among Australasian cities will eventually emerge from more detailed investigations of the species' ecology in those cities.

Foraging behaviour

Common Mynas were predominantly ground feeders, as noted also by Counsilman (1974) in Auckland. They foraged on several substrates, but did not use all substrates in a given habitat type equally, foraging particularly on grass in parkland, but mainly on roads, pathways and buildings in streetscapes. This pattern suggests that their substrate use probably depended considerably on relative availability, but this requires rigorous testing. Not

surprisingly, this pattern also applied substantially to the substrates from which mynas obtained their food, except that grass was used equally in all habitats. Again, relative food substrate availability probably influenced the pattern of exploitation considerably. Mynas were predominantly gleaners; their foraging behaviour was similar in all habitats, but varied on different substrates. Green (1980) also reported that most (97%) myna foraging in eastern suburban Melbourne occurred on the ground on grass, particularly mown grass (71% of records). In the present study, mynas were omnivorous, consuming insects, fruit, seeds and human food-refuse. This is similar to their reported diet from Auckland (Counsilman 1974).

Interspecific aggression

Myna involvement in interspecific aggression was infrequent, involved mainly two common native honeyeaters and the exotic Common Starling and mostly comprised supplanting. Common Mynas initiated about half of these encounters and the most frequent outcome, displacement over a short distance, was equally common for mynas and the other combatant species. Our results thus suggested that mynas were not major competitors with co-habiting bird species for food resources through aggressive interference. The possibility of exploitation competition (Caughley and Sinclair 1994) for food resources with other urban bird species still needs to be explored, but it seems unlikely that invertebrates would constitute a limiting resource. Thus our data suggest that food competition with other bird species may be negligible in urban Melbourne in the breeding season.

Counsilman (1974) observed aggressive encounters between mynas and several exotic and native bird species in Auckland, but did not report the frequencies. He stated that mynas aggressively dominated Common Starlings at roosts, nest-sites and food resources. Pell and Tidemann (1997a) recorded an apparently much greater involvement of mynas in interspecific agonistic behaviour in the breeding season in two reserves in Canberra than we observed in Melbourne. In these reserves, mynas 'won' (i.e. supplanted) the majority of their encounters with Common Starlings and Crimson *Platycercus elegans* and Eastern Rosellas *P. eximius*. There may be several reasons for the disparate findings of the two investigations, but one is probably that our observations were less focused on nest sites where mynas can be quite aggressively dominant (Wilson 1973; Pell and Tidemann 1997a), and another that the two most common combatant species in our study, the Noisy Miner and Red Wattlebird, are much more aggressive than rosellas and starlings.

Common Mynas as successful urban invaders and future research directions

Our results strengthen the view that Common Myna ecology is similar in the various Australasian cities that the species has colonized. There appear to be several likely keys to the myna's success as an urban invader in Australasia. We showed that it inhabited a range of habitats in urban Melbourne. It exploited the abundant open, grassy areas in suburbia for ground-foraging and thus its evolutionary history in open woodland may have facilitated

its invasion of urban habitats (Counsilman 1974). It also has a long history of successfully living commensally with humans, using buildings for nest sites and consuming our discarded food (Sengupta 1968; Counsilman 1974). Our investigation suggested that it was not involved in strong interference competition for food with other urban birds in the breeding season, a conclusion also reached by Counsilman (1974) for Auckland. However, Counsilman (1974) and Pell and Tidemann (1997a) showed that urban Common Mynas aggressively acquire and retain nest sites, despite strong competition from other hollow-nesting birds, both native and exotic. Common Mynas have a broad, omnivorous diet (Counsilman 1974), although it was strongly dominated by invertebrates (mainly arthropods) and/or seeds in suburban Melbourne. Tolerance of disturbed conditions created by human activity, broad habitat usage, a catholic diet and absence of significant competitor species are common, but not universal, characteristics of successful invasive species (Lodge 1993).

Our data could be useful in devising and interpreting an empirical test of whether Common Mynas are competing with native birds for food resources in cities (e.g. a myna removal or a food supplementation experiment). However, they constituted only a 'snapshot' of Common Myna urban ecology in one breeding season and should be extended to include the non-breeding season, replication in additional years and a more definitive diet breakdown. We also need a more detailed analysis of the precise habitat features that most influence myna spatial dispersion in Australian cities. If Common Mynas prove to be a significant threat to native animal diversity in Australian cities, there are ways of reducing their abundance, at least locally, through habitat manipulation. Yap *et al.* (2002) found in Singapore that reducing tree canopy density near roosts by pruning reduced Common and White-vented *A. javanicus* Myna local abundance substantially.

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