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DENSITY AND NEST-SITE SELECTION OF INVASIVE MYNAS AND STARLINGS IN URBAN AND SUB-URBAN AREAS IN WESTERN SARAWAK

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Abstract: Urban pest bird species, such as the Asian Glossy Starling, Javan Myna, and Common Myna have been a persistent menace to urban properties. This study compares the population densities of each species within urban and sub-urban areas between Kuching and Kota Samarahan. It was found that Javan Myna and Common Myna populations are concentrated in Pending with population densities of 12.9 ind/ha and 13.3 ind/ha, respectively. The Asian Glossy Starling was found to occupy heavily populated areas in Waterfront and the Universiti Malaysia Sarawak campus, with a population density of 15.0 ind/ha at both sites. We also studied the nesting density and habitat requirements of these species. The highest record of nesting density for the Common Myna (0.8 nests/ha) and Javan Myna (0.7 nests/ha) is in Pending, while the Asian Glossy Starling (2.6 nests/ha) is in Waterfront. The following microhabitat variables influenced the birds' nest site selection: i) nest distance from garbage bins; ii) nest distance from shrubs and grass; and iii) nest distance from trees. Additionally, the data indicated that the birds had a strong preference for nesting in artificial structures. The Common Myna (25%) chose to nest inside air vents, whereas the Javan Myna (29.63%) and Asian Glossy Starling (51.95%) preferred to nest in holes and cavities.

Keywords: Habitat requirement, population density, urban bird.
Abbreviations: Universiti Malaysia Sarawak (UNIMAS).

Introduction

Urbanisation is a continuous process involving a concentrated shift of population from rural to urban areas (Moller, 2009). Urban areas are designed to house a large number of people in one location, and they are a governmental subdivision with a population of between 200 and 50,000 people, equipped with paved roads, electric lighting, and sewage (UNICEF, 2012). Additionally, the rapid increase in landscapes and land use changes has altered the distribution of native flora and fauna, contributing to the emergence of urban species. Urbanisation offers them an abundance of cover, nesting locations, and food (Moller, 2009).

The Common Myna (*Acridotheres tristis*) and Javan Myna (*Acridotheres javanicus*) are one of the most commonly introduced bird species in Southeast Asia (Craig & Feare, 2009). These birds are feral and out-compete native birds, thriving in their new environment (Norris & Low, 2005). Both species are typical urban birds inhabiting towns and cities (Myers, 2009).

The Common Myna, as also known as the Indian Myna due to its Indian origins, has spread significantly across most continents (Dhami & Nagle, 2009). The species was initially introduced to Sarawak in the 1980s (Rahman *et al.*, 2015) and is naturally distributed from Central Asia to Southeast Asia (Robson, 2008). In Malaysia, this species is commonly referred to as *Tiong gembala kerbau* due to its frequent perching on the back of buffaloes. However, they are also often observed foraging and perching in other urban areas, such as along roadsides and on buildings.

The Javan Myna, or White-vented Myna (Strange *et al*., 1999), is locally referred to as *Tiong jawa* (Davison & Yeap, 2010). According to Smythes (1999), this species began dispersing in the mid-1980s in Kuching, Sarawak. The species originated from Java and Bali before thriving in their introduced habitat today (MacKinnon & Phillipps, 1993). The bird is distinguished by its small crest atop its yellow bill (Strange *et al*., 1999) and white undertail coverts (Smythes, 1999).

The Asian Glossy Starling (*Aplonis panayensis*) is a red-eyed bird with a glossy green body, and the juveniles of this species have black streaks on their white underparts (Smythes, 1999). According to Smythes (1999), because they are social starlings, they roost and nest in big flocks. They live in high cavities, such as roof voids, tree holes, wall cracks and dense fern habitats (Strange et. al, 1999).

Habitat specialist species have limited tolerance and greater demands of their habitat requirements (McClure, 1989). However, Common Myna and Javan Myna are extremely adapted to urban situations (Dhandukia & Patel, 2012) and reproduce throughout the year (Lim *et al.*, 2020). This enables them to thrive in urban areas. The Asian Glossy Starling can also be found in urban areas, as its natural habitat is open areas and forest edges (Strange *et al*., 1999). Due to its ability to live in less dense forest areas, this species can even expand its population size in urban areas. Apart from that, these three species are omnivores (Strange *et. al*, 1999). This provides them with an edge to forage in urban areas, as they have a diverse range of feeding guilds.

The increase in urban bird population size concerns both the government and the local community. This is due to the fact that the birds cause property damage and pose a public health risk. The property damages done by these pests can be observed in our daily life. For example, their droppings have been seen covering the surfaces of human properties, such as cars, building walls and roofs. The accumulation of bird droppings on structures and public areas can result in an unsightly appearance, and the acidic properties of the droppings may cause corrosion and damage over time The droppings also carry parasites that can be transmitted to other organisms. These transmissions lead to diseases in areas inhabited by humans. By providing annual statistics on the distribution pattern and dynamics of pest bird species inside urban areas, short- and long-term management measures can be developed. As such, the objectives of this study are i) to determine the nesting density and habitat requirements; and, ii) to estimate the population density of invasive birds in Kuching and Kota Samarahan, Sarawak.

Materials and Method

Data Collection

This study was conducted in urban and suburban areas of Kuching and Kota Samarahan, Sarawak, Malaysia. The bird count survey was carried out from October 5, 2016, to April 30, 2018 (19 months). The data collection for nest parameters was conducted from February 12, 2017, to February 23, 2018 (12 months). An active searching method was used, where a 1km x 100m line transect was constructed to survey the birds and their nests. The transects were visited twice per month. Every visit was divided into two sessions, which are i) morning (0700-1000), and ii) evening (1600-1900). The observers continuously walked along the line transects and stoppped only when the targeted species were encountered. Then, the birds were tracked by binoculars to see if they were going to their nest. This process takes 10 minutes. This is to identify the species that utilise that particular nest. Range finders and binoculars were used for measuring distance and nest searching, respectively, while a Nikon P900 camera was used to record the essential particulars for data reference and validation. A satellite navigation device was used to record the coordinates of each transect for data collection and to ensure accurate site revisits. The areas in this study have been classified into different types according to land use (Tables 1 and 2).

Table 1: Description of land-use types for the transects in Kuching and Kota Samarahan, Sarawak (Razak *et. al*, 2019)

Land use type	Code	Description
Private apartment	PRI	Private high-rise apartments and condominiums
House	HOU	Low-rise (3 surface storey) residential buildings
Commercial	COM	Buildings for commercial purposes; retails centres; shopping areas
Institution, community facilities and office	INS	Schools; sports facilities; civic and community buildings; army camp; office buildings; shop lots
Industrial	IND	Warehouse; heavy industrial buildings; light manufacturing buildings; port

Table 2: The study area with different land use

District	Transects	Coordinate	Land use
Kuching	Pending	110.3888733,1.5520712	HOU, COM, IND
	Ajibah Abol	110.3381281, 1.5570218	HOU, COM, INS
	Waterfront	110.3458611,1.5596599	PRI, COM, INS
	Matang	110.3003263,1.5722902	HOU, COM
	Kubah Ria	110.321279,1.554694	HOU, COM
	Taman BDC	110.3599655,1.5070681	HOU, COM, INS
	Spring Kenyalang	110.3621272,1.5386740	HOU, COM
	Satok	110.3374260,1.5502994	HOU, COM, INS
	Jalan Song	110.3597743,1.5194976	PRI, HOU, COM
	Tabuan Jaya	110.389697,1.513515	PRI, HOU, COM
	Kota Sentosa	110.3296816,1.4701780	HOU, COM, INS
	Batu 3	110.3356143,1.5204286	PRI, HOU, COM, INS
	MJC (New township)	110.3030980,1.5138092	PRI, HOU, COM, INS
Samarahan	UNIMAS	110.428448,1.470142	COM, INS
	Desa Ilmu	110.461795,1.450592	HOU, COM
	Samarindah	110.411038, 1.4492091	HOU, COM
	Unijaya	110.43348526, 1.4630622	HOU, INS
	Riveria	110.3993541, 1.4939607	PRI, HOU, COM
	Muara Tuang	110.4906009, 1.4605515	HOU, COM, INS

Data Analysis

All raw data were recorded in Microsoft Excel 2016. The species population density was analysed using Distance 7.0. The coordinates for individual detection for the birds were recorded in Microsoft Excel as a comma-separated values file and visualised as a map using QGIS 3.6.1. The nesting density was analysed using QGIS 3.2.3. The nesting substrate preferences were analysed using principal component analysis (PCA) in Minitab 19 and generalized linear model (GLM) using the Akaike information criterion (AIC) on R-3.4.3. Histograms were used to visualise the results independently, while a biplot obtained from PCA was used to visualise the nesting substrate preferences for each species.

Results

Population Density

The population densities of the Common Myna and Javan Myna are high in the Pending area at 13.3 ind/ha and 12.9 ind/ha, respectively. In contrast, the Asian Glossy Starling exhibited higher population densities in Jalan Song and UNIMAS in Kuching, as well as in Kota Samarahan, with 15.0 ind/ha recorded at each location (Table 3). There have been no sightings of the Javan Myna in Kota Samarahan during this survey with the exception of Riveria (0.7 ind/ha), which is located on the border between Kota Samarahan and Kuching. In addition, the Asian Glossy Starling is absent from Muara Tuang, Kota Samarahan, and Batu 3, Kuching. Comparatively lower densities of Common Myna and Javan Myna populations were also recorded in these areas (0.2 ind/ha) (Figure 1).

Many areas in Kuching and Kota Samarahan have comparable land uses, including low-rise residential structures, commercial and institutional structures, communal facilities, and offices. Most residential areas in Kota Samarahan lack individual apartments with more than three storeys. Partly because of this, mynas occupy sparsely populated areas in Kota Samarahan. Lower densities were recorded in Kota Samarahan, perhaps due to

Table 3: Population density of the Common Myna, Javan Myna and Asian Glossy Starling in urban and suburban areas of Kuching and Kota Samarahan

Transects	Population Density (ind/ha)		
	Common Myna	Javan Myna	Asian Glossy Starling
Ajibah Abol	4.3	4.3	4.4
Taman BDC	2.2	1.7	0.7
Kota Sentosa	6.5	6.5	5.1
Kubah Ria	0.5	0.5	0.5
Matang	7.5	7.5	7.8
MJC (New township)	0.5	1.0	0.4
Pending	13.3	12.9	10.9
Spring Kenyalang	2.3	2.3	1.6
Batu 3	0.2	0.2	0.0
Jalan Song	8.3	8.3	15.0
Tabuan Jaya	5.9	5.8	6.0
Muara Tuang	0.2	0.2	0.0
Waterfront	7.2	7.3	11.9
Satok	3.7	3.7	5.0
Desa Ilmu	3.7	0.0	5.6
Riveria	0.7	0.7	0.4
Samarindah	6.3	0.0	7.9
Unijaya	0.3	0.0	0.3
UNIMAS	3.6	0.0	15.0

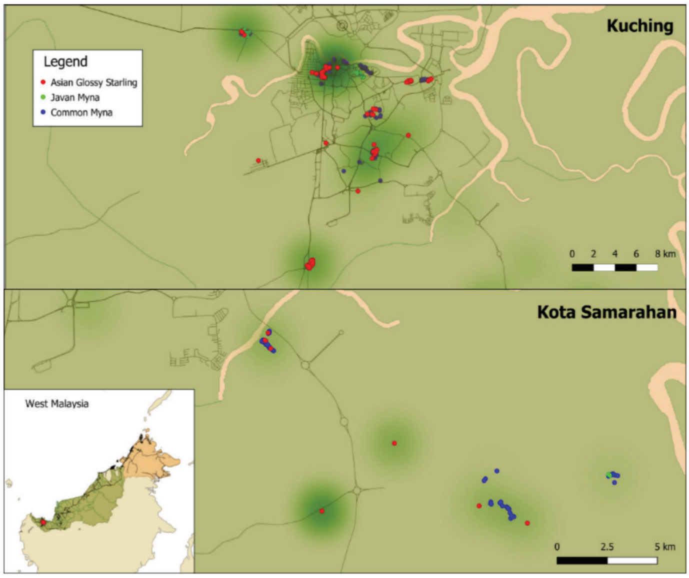

Figure 1: A heatmap showing areas with different population densities of the Common Myna, Javan Myna and Asian Glossy Starling in Kuching and Kota Samarahan, Sarawak. High and low densities are indicated by degrading green shades from the centre point

the scarcity of suitable nesting locations. The Asian Glossy Starling has the highest population density in Kota Samarahan, probably due to the abundance of ideal nesting substrates and foraging resources. The high number of Asian Glossy Starlings in UNIMAS can be attributed to the large human population in the area due to it being a learning institution. This large human population leads to food waste being more readily available, elevating the population size of this species by increasing its chance of survival in the area. The high nesting density of this species also contributes to a higher population density in Kota Samarahan.

The areas with high densities of urban birds appear to be associated with commercialised and heavily populated areas. The results of this study suggest that population density and nest density are closely related. A high number of nests results in a larger population, while a large population infers more nests. The Pending industrial district and Kuching Waterfront city centre are densely populated urban areas that produce abundant food sources or waste for these urban exploiter species with a wide range of feeding guilds (Strange *et. al*, 1999).

No Javan Myna population was recorded in Kota Samarahan, except for near the Kuching-Kota Samarahan border, suggesting that Javan Mynas are progressing into Kota Samarahan from Kuching. There was no record of Javan Myna nests in the boundary area of Riveria and other areas in Kota Samarahan, as the low population density made nest detection difficult. However, there have been opportunistic sightings of this species in Kota Samarahan since 2021.

The birds are likely to be detected at a perpendicular distance of 18.7m, and the detection probability of the birds sharply declined beyond this distance (Figure 2).

Nesting Density

A higher nest density of the Common Myna was recorded in the Pending, Kuching, at 0.8 nest/ha, while the Javan Myna was lower at 0.7 nest/ha (Table 4). Comparatively, Asian Glossy Starling nest density was higher in Waterfront, Kuching, at 2.6 nest/ha. No Common Myna nets were recorded in Taman BDC, Kuching. Similarly, Tabuan Jaya, Kuching have no records of nest

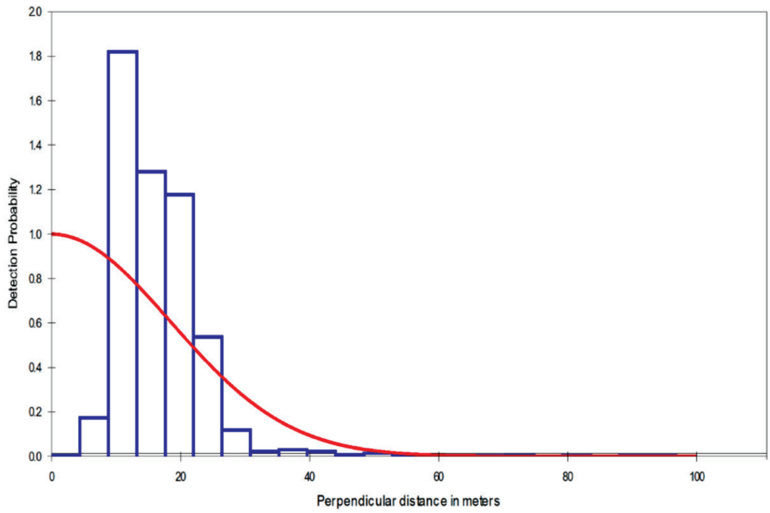

Figure 2: A graph showing the detection probability of the three species against perpendicular distance in Kuching and Kota Samarahan, Sarawak

Table 4: Nesting density of the three species in urban and suburban areas of Kuching and Kota Samarahan, Sarawak

Transects	Nesting Density (nest/ha)		
	Common Myna	Javan Myna	Asian Glossy Starling
Ajibah Abol	0.3	0.1	0.3
Taman BDC	0.0	0.1	0.1
Matang	0.1	0.3	0.2
Pending	0.8	0.7	0.1
Spring Kenyalang	0.1	0.1	0.1
Jalan Song	0.2	0.1	0.0
Tabuan Jaya	0.1	0.0	0.0
Waterfront	0.5	1.0	2.6
Satok	0.1	0.3	1.8
Desa Ilmu	0.1	0.0	0.3
UNIMAS	0.1	0.0	1.5

sightings for the Javan Myna and Asian Glossy Starling (Figure 3). It is also important to note that at the point of this survey in 2017-2018, neither individuals nor the nests of the Javan Myna were recorded in Kota Samarahan. This might be caused by the absence of this species or an extremely small population size, leading to decreased possibility of individual and nest detection by observers.

Nest-site Selection

Nesting Substrate Preferences

A total of 17 nesting substrates were identified and regularly used by the Common Myna, Javan Myna and Asian Glossy Starling (Figure 4).

The first three rankings in preferences of nesting substrates chosen by Javan Myna are as follows: i) holes in the wall (30%), ii)

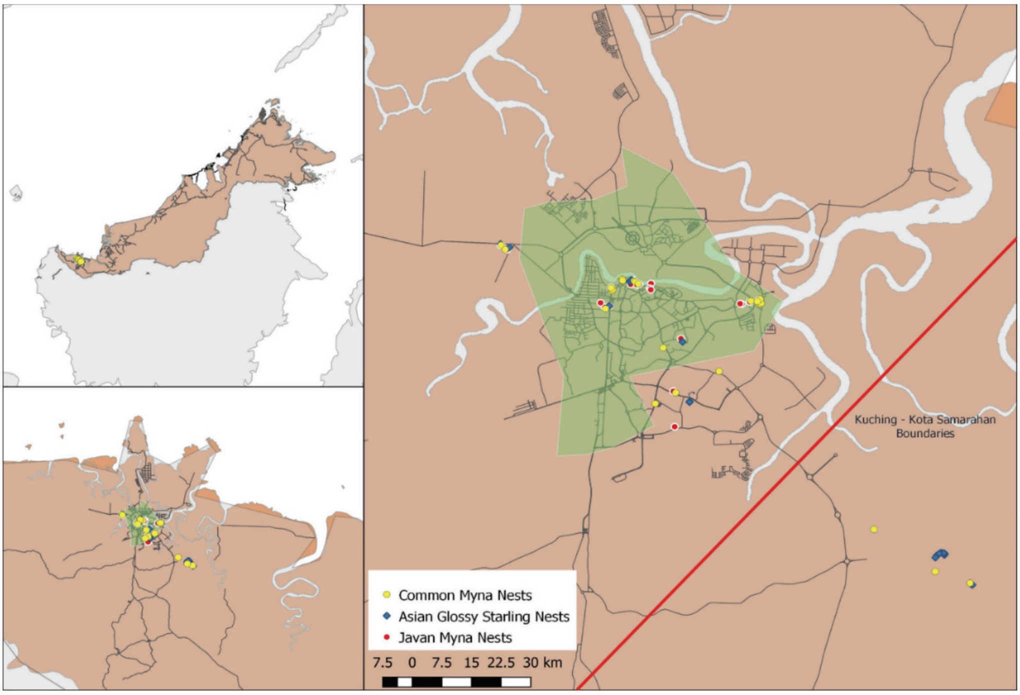

Figure 3: A map showing the nest distribution of the Common Myna, Javan Myna and Asian Glossy Starling in Kuching and Kota Samarahan, Sarawak

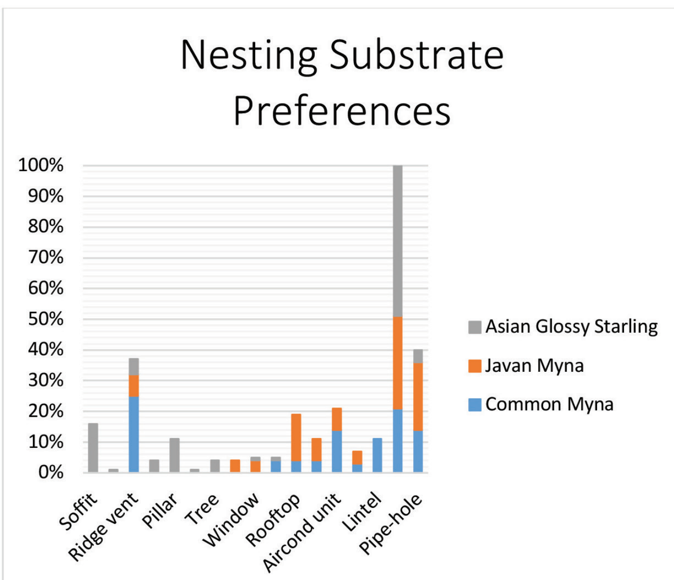

Figure 4: The nesting substrate preferences of the Common Myna, Javan Myna and Asian Glossy Starling in Kuching and Kota Samarahan

pipe-holes (22%), and iii) rooftops (15%). On the other hand, the three lowest substrates with records of 4% are utility boxes, artificial structures and windows. Approximately 52% of Asian Glossy Starling nests are in the holes of building walls. This is followed by soffits and pillars as the second (16%) and third (11%) most preferred nesting substrates, respectively. The least preferred substrates are ridge boards, signboards, gutters and windows (1%).

There were no records of mynas nesting on soffits, ridge boards, eaves, pillars, gutters and trees. These substrates are preferred by the Asian Glossy Starling. On the other hand, Asian Glossy Starling did not nest on rooftops, ledges, air-conditioner units and artificial structures or statues. The Common Myna and Asian Glossy Starling were observed using signboards as preferred nesting substrates (4 % and 1%, respectively), with no records of the Javan Myna nesting on this substrate. However, the Javan Myna and Asian Glossy Starling utilised windows (50%) as a preferred nesting substrate. The substrates used by all three species in this study were ridge vents, holes in the wall and pipe-holes.

Ridge vents and holes in the wall were the most preferred by the Common Myna to nest, with a percentage of 25% and 21%, respectively. This species was rarely seen nesting on rooftops, ledges, signboards and statues or artificial structures, with encounters of only 4% in both Kota Samarahan and Kuching, Sarawak.

The birds involved in this study are secondary cavity nesters, often reusing their old nests or of other species (Choi *et al.*, 2007). An example of old nest substrates are holes in the wall and soffits. All three species utilise holes in the wall as one of the most preferred substrates to nest as they are easily found in urban areas regardless of height as they are used for many commercial and residential purposes. Additionally, high-density materials, such as concrete, bricks and tiles, have high thermal mass (Reardon *et al.*, 2013). This provides an optimum condition for the egg incubation phase of the birds. Urbanisation limits the number of natural resources for the birds to build their nests. As such, these species are known to use artificial materials to construct their nests (Wang *et al.*, 2009).

The Asian Glossy Starling appears to nest in soffits and pillars, which are easily found in urban areas. It showed high preferences for nesting inside holes and crevices within the eaves of rooftops. Apart from easy access and availability, the soffits could also provide protection from harsh weather. The Asian Glossy Starling prefers higher buildings or structures to build its nest near trees. This allows easy access to the Ficus trees, which are among their favourite roost spots and food source. The Common Myna and Javan Myna preferred man-made cavities compared with the Asian Glossy Starling (Dhandhukia & Patel, 2012).

Nest-site Preferences

The distance from rubbish bins appears to be the most influential factor for the Common Myna's choice of nesting location (Table 5). In contrast, the distance of the nest to shrubs and grass is important for the Javan Myna in choosing their nest sites. The Asian Glossy Starling chooses their nest sites based on the distance of the nest from the nearest tree. According to Razak *et al.* (2019), the Javan Myna preferred enclosed spaces as their nesting location. Meanwhile, the Common Myna is less specialised in the nest location choices. Therefore, they are able to exploit both urban and suburban areas.

The distance of the nest from the main road, drainage, rubbish bins and lamp posts has a high positive association (Figure 5). This shows that these four parameters were potentially influential for these birds when choosing nest sites.

The invasive mynas and Asian Glossy Starling thrived well in urban settings due to their opportunistic and generalist feeding behaviour (Razak *et al.*, 2019). They consume a wide range of food sources and nest in many man-made structures. The mynas typically frequent leftovers on the ground, roadsides and exposed rubbish bins or dumpsters from nearby

Table 5: GLM of the Common Myna, Javan Myna and Asian glossy starling using AIC

	Common Myna	Javan Myna	Asian Glossy Starling
Akaike information criterion (AIC)	Distance of nest from rubbish bins	Distance of nest to shrubs and grass	Distance of nest from trees

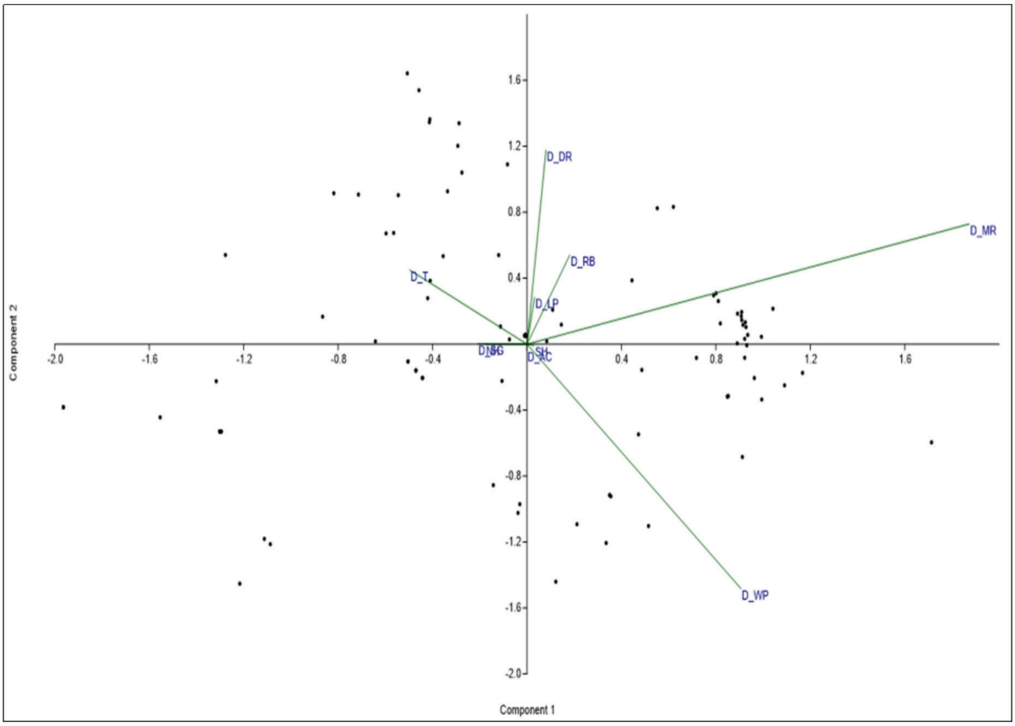

Figure 5: The d_mr as one of the microhabitat parameters influenced the nest-site preferences of the invasive mynas and the Asian Glossy Starling. Other parameters, such as d_dr, d_rb) and lp, have positive loadings on component 1. (nh: nest height, sh: structure height, d_dr: distance from drainage, d_mr: distance from the main road, d_sg: street light, d_wp: distance from walking pavements, d_rb: distance from rubbish bins, d_lp: distance from a lamp post, d_ac: distance from air-conditioner unit)

restaurants and wet markets. Additionally, feeding feral pigeons with pigeon feed is a common sight in a central town like Waterfront and the Satok area, enticing mynas and Asian Glossy Starling to congregate along.

Conclusion

The Common Myna population is expected to increase and disperse to more suburban areas in the near future, emerging as a potential pest species in these areas. It is also noticeable that a small number of Javan Myna encroaches on Kota Samarahan. It is predicted that the population size of this species in Kota Samarahan will also increase in the near future. The Common Myna, Javan Myna and Asian Glossy Starling are hole and cavity nesters. This information can be used to develop an effective trapping method for the birds. Additionally, studying their foraging behavior would supplement the findings of this study, enabling the development of effective mitigation measures to control population growth of these species. More intensive awareness programmes, such as bird nest management, bird feeding and food waste management, should be carried out to engage the general public, rural communities and city council authorities. A survey on the public's opinion about bird feeding in urban areas should also be conducted to effective methods for persuading the public to stop feeding the birds.

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