Adaptive Strategies of The Javan Myna [*Acridotheres javanicus* (Cabanis, 1851)] in Manado City and North Minahasa Regency, North Sulawesi Province, Indonesia

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Abstract: Urbanization provides anthropogenic food subsidies and artificial structures that can be exploited by commensal birds. This study examines the adaptive strategies of the Javan myna (*Acridotheres javanicus*) in Manado City and North Minahasa Regency, and discusses potential implications for a putative competitor, the Asian glossy starling (*Aplonis panayensis*). Surveys were conducted in 2023 and 2025 using exploration-based ad libitum sampling across residential areas, roadsides, church towers, and swiftlet buildings; each encounter recorded habitat type, group size, and activity. Across 41 encounter records, 212 individuals were identified (median group size = 2; mean = 5.17; maximum = 65). Encounters were dominated by residential areas (32 records; 179 individuals), with churches/towers functioning as recurrent nodes (17 records; 78 individuals) and strong use of attics/cavities (5 records; 82 individuals). Perching was the most frequent activity (19 records), whereas breeding was observed less often (4 records) but involved 50 individuals; foraging on garbage/food scraps was recorded in 5 records. These findings indicate that local synanthropic strategies are shaped by the combined effects of access to infrastructure (churches, attics, swiftlet buildings, cables) and anthropogenic food subsidies. Continued monitoring is needed to evaluate population dynamics and potential spatial–trophic overlap with *Aplonis*.

Keywords: *Acridotheres javanicus*; synanthropic adaptive strategy; use of human infrastructure; ad libitum sampling (exploration survey); Manado and North Minahasa

Introduction

Urbanization is an ecological process that rapidly transforms landscapes through the expansion of settlements, increasing building density, road networks, and changes in food production and disposal patterns. These changes not only alter vegetation cover, but also create “novel resources” for wildlife in the form of artificial structures (roof cavities, wall crevices, poles, bridges) and anthropogenic food (food waste, household garbage, and spillover resources from human activities). Reviews of urban bird ecology show that avian communities in cities tend to become homogenized and dominated by disturbance-tolerant species that are flexible and able to exploit human-derived resources (Chace & Walsh, 2006). Conceptual frameworks for birds in an increasingly urbanized world also emphasize the importance of understanding how birds modify behavior, space use, and life-history strategies to persist under urban–peri-urban conditions (Marzluff et al., 2001).

In this context, the Javan myna (*Acridotheres javanicus*) is a relevant model species because it is opportunistic, gregarious, and frequently associated with human environments. Studies in Southeast Asia indicate that *Acridotheres* species and other invasive birds often show strong associations with urbanization indicators and the availability of anthropogenic food and artificial structures. Regional reviews also note that information on the status and impacts of invasive birds in Southeast Asia remains limited, highlighting the need for local studies (Lim et al., 2003; Yap & Sodhi, 2004). In Peninsular Malaysia, for example, the Javan myna has expanded its range and concentrated in metropolitan–suburban areas, underscoring the role of urban landscapes as "corridors" and "novel habitats" (Arazmi et al., 2022). Work in Sarawak further highlights the importance of nest-site selection and the tight linkage between these birds and mosaics of urban habitats and structures (Azizi et al., 2023; Ab Razak et al., 2019).

In North Sulawesi, the Javan myna has been reported in the wild as a species likely established through introduction and/or releases, and has been recorded at multiple sites (Tasirin & Fitzsimons, 2014; Fitzsimons et al., 2011). Recent observations from Manado and North Minahasa likewise suggest broad occurrence and high activity in human-inhabited areas and on buildings (e.g., attics/towers), indicating strong dependence on built infrastructure (Saroyo et al., 2024).

In the Manado and North Minahasa region, the adaptive success of the Javan myna is particularly interesting because the local bird community, based on field notes and available local literature, may have relatively few potential wild competitors, notably the Asian glossy starling (*Aplonis panayensis*). In many contexts, *Acridotheres* groups can engage in competitive interactions, especially over access to food and space (notably nesting/shelter sites), and studies of other mynas show potential impacts on other birds through competition for space and changes in species abundances (Grarock et al., 2012). The comparatively simple competitive setting in Manado–North Minahasa offers an opportunity to ask which adaptive strategies most strongly drive the Javan myna's success—use of buildings as nesting/social sites, close daily activity near humans in residential areas and along roads, or foraging flexibility via garbage and food scraps.

Accordingly, this study was designed to document adaptive strategies of the Javan myna through encounters that captured adaptive behaviors across two periods (2023 and 2025), using exploration-based ad libitum sampling. This observational method is commonly used to capture rare or incidental behaviors, but it requires careful reporting of encounter context and potential detection bias (Altmann, 1974). By comparing patterns across years, the study aims to assess consistency or change in the Javan myna's adaptive responses as urban space dynamics shift, while providing an evidence base for understanding commensal bird–human interactions in Manado and North Minahasa.

Methods

Study period and area

The study was conducted in two periods (2023 and 2025) in Manado City and North Minahasa Regency, North Sulawesi Province, Indonesia. Observation sites included residential areas, roadsides, and other built environments frequently used by the Javan myna (*Acridotheres javanicus*).

Field approach and data collection

This research used an observational field-survey approach to document adaptive strategies of the Javan myna across an urban–peri-urban landscape in Manado and North Minahasa. The design emphasized encounter-based documentation of individuals/groups and adaptive behaviors in built environments, consistent with urban bird ecology frameworks that stress the roles of artificial structures and anthropogenic resources in shaping bird behavior and distributions (Marzluff et al., 2001; Chace & Walsh, 2006).

Data were collected using exploration-based ad libitum sampling (walk-through surveys). Ad libitum sampling was selected to capture diverse, incidental behaviors that do not necessarily occur at fixed time intervals; however, encounter recording was standardized to reduce detection bias commonly associated with ad libitum methods (Altmann, 1974). Exploration covered several microhabitat types: residential areas (housing, shop-houses), roadsides (primary/secondary roads), commercial areas (markets/parking lots), and other built open spaces. Each encounter was recorded on an observation sheet, including: (1) date and survey year (2023 or 2025), (2) location (site name and GPS coordinates when available), (3) habitat type, (4) number of individuals/group size, (5) primary activity (foraging, feeding, perching, social/roosting, or breeding indications), and (6) adaptation indicators: use of buildings for nesting/shelter/social activities, proximity to humans (activity in yards/residential areas and along roads), and use of anthropogenic food resources such as scavenging garbage or food scraps. Behavioral categories and nest/roost context followed literature on Sturnidae and myna ecology, including nesting preferences for artificial structures and population dynamics in urban settings (Craig & Feare, 2010; Ab Razak et al., 2019; Azizi et al., 2023; Arazmi et al., 2022). Species identification followed Wallacea field guides and Sturnidae references, and observations were compared with the potential competitor Asian glossy starling (*Aplonis panayensis*) when present at the same sites (Coates & Bishop, 1997; Craig & Feare, 2010).

Data analysis

Analyses were descriptive. Encounter records were summarized as frequencies and proportions of adaptive behaviors by: (a) year (2023 vs. 2025), (b) habitat type, and (c) adaptive strategy category (built structures, proximity to humans, anthropogenic food). Group size summaries (minimum–maximum and simple means) were also presented by habitat and year. Results were complemented with ethological narrative descriptions to highlight consistent and changing patterns across years, and to discuss how urban environments may promote the success of introduced species (Lim et al., 2003; Yap & Sodhi, 2004). To strengthen the local context, findings were qualitatively compared with reports on the occurrence and spread of *A. javanicus* in North Sulawesi (Tasirin & Fitzsimons, 2014; Fitzsimons et al., 2011; Saroyo et al., 2024) and with literature on space/food competition, as *Acridotheres* may compete through access to nesting sites and resources (Grarock et al., 2012).

Results and Discussions

Based on the survey data (41 encounter records; exploration-based ad libitum sampling), 212 Javan mynas were recorded. Median group size was 2 individuals and mean group size was 5.17 individuals, with a maximum of 65 individuals at a single site. The pattern of a small median but larger mean suggests occasional aggregation into large groups (e.g., at roosting/nesting sites), which is common in social Sturnidae that readily aggregate at stable resource points (Craig & Feare, 2010).

Encounter distribution by habitat type

Encounters were strongly dominated by residential areas. Of 41 records, 32 (78.0%) occurred in residential settings, totaling 179 individuals (84.4%) (**Table 1**). This reinforces the synanthropic nature of the Javan myna: the built environment is not merely a transit area, but a primary activity space.

Table 1. Summary of encounters by habitat type

Habitat type	n	% of encounters	Total individuals	% of individuals	Mean group size	Median	Range (Min–Max)
Agricultural forest	1	2.4	5	2.4	5.00	5.0	5–5
Agricultural forest (near road)	1	2.4	5	2.4	5.00	5.0	5–5
Residential area	32	78.0	179	84.4	5.59	2.0	1–65
Residential area (roadside)	1	2.4	6	2.8	6.00	6.0	6–6
Residential area (near road)	4	9.8	13	6.1	3.25	3.5	2–4
Roadside	1	2.4	2	0.9	2.00	2.0	2–2
Shrubland	1	2.4	2	0.9	2.00	2.0	2–2

Locally, the dominance of residential areas aligns with documentation of *A. javanicus* as an introduced bird that has established and expanded in North Sulawesi (Fitzsimons et al., 2011; Tasirin & Fitzsimons, 2014) and with reports of its increasing distribution and activity in Manado and North Minahasa (Saroyo et al., 2024). More broadly within Indonesia, records of *Acridotheres* establishment elsewhere (e.g., Borneo) suggest that human-mediated mobility and "city habitat" can facilitate the formation of free-living populations (Iqbal et al., 2013), consistent with the idea that bird trade can contribute to the establishment of non-native invasive populations (Nijman et al., 2022).

Activity structure: perching most frequent; large aggregations tied to movement and nesting sites

When grouped descriptively, perching/resting was the most frequent category: 19 records (46.3%) involving 39 individuals (18.4%). The high frequency of perching underscores the role of cities as landscapes rich in physical structures (buildings, wires, towers) for resting and scanning surroundings, a typical urban bird pattern (Marzluff et al., 2001; Chace & Walsh, 2006). Movement/flight was infrequent (3 records; 7.3%) but involved 70 individuals (33.0%), dominated by a single large-group record (65 individuals) at a building attic. Breeding/nesting, although only 4 records (9.8%), accounted for 50 individuals (23.6%) (**Table 2**), indicating aggregation at core sites (e.g., high/cavity structures) important for sociality and reproduction in mynas/starlings (Craig & Feare, 2010).

Table 2. Summary of activity categories

Activity category	n (encounters)	% of encounters	Total individuals	% of individuals	Mean group size
Perching/resting	19	46.3	39	18.4	2.05
Foraging & feeding	9	22.0	26	12.3	2.89
Social/roosting	6	14.6	27	12.7	4.50
Breeding/nesting	4	9.8	50	23.6	12.50
Flying/movement	3	7.3	70	33.0	23.33

Conceptually, these findings support the view that the success of urban species is not determined solely by food acquisition, but also by access to safe shelter, nesting sites, and roosts (Marzluff et al., 2001). In the context of invasive birds, nest/roost sites may be a key determinant of establishment success (Yap & Sodhi, 2004) and are often reflected in density patterns and nest-site choices of mynas/starlings across urban–suburban settings (Azizi et al., 2023; Ab Razak et al., 2019).

Use of human infrastructure as "functional habitat"

Built structures, especially churches and church towers, were frequently used. Churches/church towers were recorded in 17 encounter records (41.5% of encounters), comprising 78 individuals (36.8% of all individuals). These structures functioned as recurrent sites for perching, social aggregation, and occasional nesting. This is consistent with literature emphasizing *Acridotheres* and other Sturnidae preferences for high and/or cavity-bearing structures (attics, building gaps, towers) that offer protection, stability, and elevated visibility (Craig & Feare, 2010). Studies in Sarawak show that nest-site choice and density of invasive mynas/starlings are influenced by the availability of suitable urban structures (Azizi et al., 2023), while urban–suburban gradient studies indicate that built patches often become population activity cores (Arazmi et al., 2022).

Beyond churches, swiftlet buildings also emerged as important resources (2 records; 13 individuals), including records of "nesting above a swiftlet-nest building" (**Table 3**). Swiftlet buildings typically contain multiple cavities/spaces, are relatively tall, and often have limited direct human disturbance, conditions favorable for shelter and potential colonization (Craig & Feare, 2010). Utility structures such as wires/cables/power poles were also commonly used (9 records; 20 individuals). Perching on cables and poles is a characteristic urban adaptation because it provides linear resting sites near road corridors, facilitates movement among habitat patches, and positions birds close to anthropogenic food sources (Marzluff et al., 2001; Chace & Walsh, 2006). In Southeast Asian urban invasive-bird frameworks, infrastructure features and road corridors can facilitate spread, especially for human-tolerant generalists (Lim et al., 2003; Yap & Sodhi, 2004).

Table 3. Apparent resource features used by birds

Resource feature (indicated in the activity column)	n (encounters)	Total individuals	Mean group size
Church/church tower	17	78	4.59
Attic/cavities (buildings)	5	82	16.40
Swiftlet house / swiftlet-nest building	2	13	6.50
Wires/cables/power poles	9	20	2.22
Garbage/human food scraps	5	11	2.20
Association with livestock (cattle)	1	5	5.00
Natural food: nectar (*Spathodea*)	1	6	6.00

Locally, the dominance of churches as activity points can be interpreted as key "nodes" in the urban spatial network: sites that are relatively safe, elevated, easily accessed in flight, and close to human activity (residential areas and roads). Such nodes can form centers of social aggregation and promote population persistence, particularly when close to anthropogenic food subsidies (Marzluff et al., 2001; Chace & Walsh, 2006). These findings add substantial microhabitat detail for North Sulawesi, complementing prior occurrence and spread records for *A. javanicus* (Fitzsimons et al., 2011; Tasirin & Fitzsimons, 2014; Saroyo et al., 2024) with specific information on structure types and activity contexts.

Foraging and feeding adaptations: exploiting anthropogenic food and dietary flexibility

Foraging and feeding accounted for 9 records (22.0%) and 26 individuals (12.3%). Of these, “scavenging garbage” appeared in 5 records (11 individuals), a strong indicator of adaptation to anthropogenic food resources—often cited as a driver of success for commensal and invasive birds in cities (Yap & Sodhi, 2004; Lim et al., 2003). Although Lim et al. (2023) focused on feral pigeons, the ecological principle is relevant: proximity to human food sources can strongly influence roosting/nesting locations and population persistence in urban birds. For the Javan myna, access to garbage and food scraps likely functions as an energetic subsidy that reduces dependence on seasonal natural foods and broadens tolerance of built environments.

Two additional unique records highlight dietary flexibility. First, “foraging/associating with cattle” in an agricultural-forest setting (5 individuals) suggests use of agricultural landscapes as supplementary foraging opportunities, consistent with the species’ opportunistic ecology and ability to exploit interactions with large animals. Second, “foraging on *Spathodea* nectar” (6 individuals) indicates use of non-traditional food sources in urban environments (ornamental/street trees). Such dietary flexibility is frequently cited as an attribute that helps invasive birds persist in novel and rapidly changing habitats (Yap & Sodhi, 2004) and is consistent with the adaptive biology of Sturnidae (Craig & Feare, 2010).

Competition implications: emphasis on nest/roost space and potential trophic overlap

A potential wild competitor in Manado–North Minahasa is the Asian glossy starling (*Aplonis panayensis*). Although the encounter table does not include direct observations of interactions with *Aplonis*, the literature provides a basis to identify likely competitive arenas, notably access to nesting cavities/roost spaces and easily available food. A study of the common myna in Australia showed that one mechanism of impact on other birds can occur through competition for nesting space (Grarock et al., 2012). However, subsequent work also emphasizes the “driver vs. passenger” framework: whether invasive species are primary causes of declines in other species or simply “ride along” with prior habitat change (Grarock et al., 2014). In Manado–North Minahasa, the pronounced intensity of church/tower and swiftlet-building use suggests that access to nest/roost structures is a key candidate factor for *A. javanicus* success.

From a dietary perspective, *Aplonis panayensis* has documented feeding patterns in relation to roosting locations (Hashim et al., 2021). If Javan mynas increasingly rely on garbage scavenging and human food subsidies, potential niche overlap in feeding may increase along the residential–road corridor. Thus, even where potential competitors are limited, the present study helps characterize the Javan myna’s “adaptation package”: (i) concentrating activity on human structures for sociality and nesting, and (ii) using anthropogenic food resources to support daily activity, a combination frequently reported for Southeast Asian urban invasive birds (Lim et al., 2003; Yap & Sodhi, 2004) and in reports of Javan myna spread in urban environments (Arazmi et al., 2022; Ab Razak et al., 2019).

Linking local findings to regional and temporal dynamics

The presence of *A. javanicus* as an introduced bird in North Sulawesi has been noted previously (Fitzsimons et al., 2011; Tasirin & Fitzsimons, 2014), and its expanding distribution/activity in Manado–North Minahasa has been reported (Saroyo et al., 2024). Against this background, the present data provide important micro-ethological evidence: where adaptation occurs (primarily residential areas), how it occurs (use of towers/attics/cables), and which feeding strategies are evident (garbage, livestock association, nectar). Across Southeast Asia, changes in urban bird abundance can also unfold over decades and be shaped by city policies, environmental management, and green-space dynamics (Chong et al., 2012). Therefore, year-to-year comparisons (2023 vs. 2025) could reveal whether certain adaptations intensify over time (e.g., increased use of buildings or garbage), as urban-gradient studies elsewhere show that distribution and habitat concentration may shift as urbanization proceeds (Arazmi et al., 2022; Lim et al., 2003).

At the same time, because the surveys used ad libitum sampling, results should be interpreted as pattern descriptions and an inventory of adaptive strategies, rather than estimates of absolute density. Altmann (1974) cautioned that ad libitum records tend to be biased toward conspicuous events (e.g., large groups at towers) or the most accessible locations. However, for the purpose of documenting adaptive strategies (built structures, proximity to humans, anthropogenic foraging), the approach remains informative as long as results emphasize consistent patterns and repeated evidence across specific sites and activities (Marzluff et al., 2001; Chace & Walsh, 2006).

Conclusion

This study shows that the Javan myna (*Acridotheres javanicus*) exhibits strong adaptive strategies in Manado City and North Minahasa Regency during 2023–2025. Encounters were dominated by residential areas and roadsides, reflecting a highly synanthropic lifestyle and high tolerance of human activity. The birds used infrastructure, church towers, attics, swiftlet buildings, and power lines, for perching, sociality, and potential nesting, with large aggregations at particular nodes. In terms of foraging–feeding, individuals flexibly exploited garbage/food scraps as well as agricultural resources and nectar. The combination of shelter opportunities provided by artificial structures and anthropogenic food subsidies likely underpins persistence and expansion. Because few wild competitors were observed, continued monitoring is recommended to evaluate impacts and interactions.

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