Economical, Cultural, and Educational Importance of Argya striata (Jungle Babbler): A 30-Day Field Observational Study and Community Survey from Maripur, Muzaffarpur, Bihar, India

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Abstract: The present study investigates the economical importance and the cultural and educational importance of the Jungle Babbler (*Argya striata*) through a 30-day field observational study conducted at Maripur village, Muzaffarpur District, Bihar, India (26.12°N, 85.40°E) during January 1–30, 2026. Two resident A. striata flocks (Flock A and Flock B) were identified and monitored over approximately 75 observation hours using ad libitum sampling methods. Both flocks were observed on 20 days, only one flock on 8 days, and no flock was sighted on 2 days. A total of 393 feeding events and 100 group-size records were documented. A structured questionnaire survey was simultaneously administered to 150 local residents (80 farmers, 70 non-farmers) to assess cultural recognition, perceived economic value, and educational awareness. Results revealed that A. striata foraging was concentrated on ground substrates (40.4%) and in agricultural fields and orchards (54.1% of feeding events), exhibiting a bimodal diurnal pattern peaking at 08:00–09:00 h and 16:00–17:00 h ($\chi^2 = 112.4$, df = 7, $p < 0.001$). Mean group size was 7.0 ± 1.1 individuals (range: 5–9). Flock A (mean 7.4 individuals) was larger and more site-faithful than Flock B (mean 6.4). The community survey showed 96.7% species recognition and 93.3% knowledge of the local name "Saat Bhai." Among farmers, 81.3% considered the species economically beneficial through insect pest consumption. The dominant cultural association was "family unity and brotherhood" (40.0%), and 86.7% of all respondents supported conservation. The study provides field-based evidence that A. striata is an economically valuable natural pest-control agent, a culturally embedded living symbol of social cohesion, and a species with strong potential for nature education in rural Bihar.

Keywords: *Argya striata, Jungle Babbler, economic ornithology, pest biocontrol, Saat Bhai, feeding ecology, cultural ornithology, community survey, Muzaffarpur, Bihar*

1. Introduction

The Jungle Babbler (*Argya striata*) is a medium-sized, obligately gregarious passerine belonging to the family *Leiothrichidae*, widely distributed across the Indian subcontinent (Ali & Ripley, 1987; Grimmett et al., 2011). Originally described under *Cossyphus* and subsequently placed in Turdoides, the species was transferred to the resurrected genus Argya following a comprehensive molecular phylogenetic study (Cibois, 2003; Gill et al., 2022). Characterized by obligate group living in cohesive flocks of six to ten individuals, cooperative breeding with non-breeding helpers, and a predominantly insectivorous diet, the species inhabits a wide range of habitats from dense deciduous forests to urban gardens across India, Pakistan, Nepal, Bangladesh, and Sri Lanka (Gaston, 1978; Ali & Ripley, 1987; Rasmussen & Anderton, 2012). Universally known in Hindi-Urdu as "Saat Bhai" (Seven Brothers) and in Indian English as the "Seven Sisters," the species is one of the most culturally recognised birds of the subcontinent (Ali, 2002).

Despite its ecological abundance and behavioural prominence, rigorous assessments of the broader significance of A. striata to human society remain scarce. Economic ornithology—the quantification of the economic roles of birds in agricultural and ecological systems—is a critically underdeveloped discipline in India, notwithstanding the country's rich avifauna of over 1,300 species with diverse roles in agroecosystems (Dhindsa & Saini, 1994; Whelan et al., 2015). Globally, insectivorous birds have been demonstrated to provide substantial pest-control services: Johnson et al. (2010) estimated USD 310 per hectare per year in Jamaican coffee; Mols & Visser (2002) reported a 50% reduction in caterpillar damage and 66% yield increase in Dutch apple orchards; and Koh (2008) attributed 9–26% fruit-loss prevention to avian pest control in Bornean oil-palm plantations. Such species-specific economic assessments are virtually absent for common Indian passerines.

Concurrently, the cultural significance of birds in Indian society—their roles in folklore, naming traditions, proverbs, and community identity—constitutes a rich but underexplored domain of ethnoornithological inquiry (Tidemann & Gosler, 2010). The educational value of accessible, behaviorally complex avian species for teaching ecology, evolution, and conservation is also increasingly recognized (Koenig & Dickinson, 2004; Sullivan et al., 2009).

The present study was undertaken with the following objectives:

a) To study the economical importance of *Argya striata* through field-based observation of feeding ecology, foraging behaviour, habitat use, and community perception of pest-control services at Maripur, Muzaffarpur, Bihar.

b) To study the cultural and educational importance of *Argya striata* through a structured questionnaire survey assessing cultural recognition, folklore associations, perceived educational value, and conservation attitudes among local residents.

2. Study Area

The study was conducted at Maripur area and its surrounding agricultural landscape in Muzaffarpur District, northern Bihar, India (26.12°N, 85.40°E; elevation approximately 54 m above sea level). Muzaffarpur District lies within the Upper Gangetic Plains biogeographic zone and experiences a subtropical monsoon climate. January, the study month, represents the cool-dry winter season characterized by mean daily temperatures of 8–22°C, negligible precipitation, and comparatively reduced—though not absent—insect activity relative to monsoon months.

The study area comprises a heterogeneous mosaic of land-use types:

(a) agricultural fields

(b) mango (*Mangifera indica*) and litchi (*Litchi chinensis*) trees, Muzaffarpur

(c) homestead gardens with mixed fruit and shade trees including *Azadirachta indica*;

(d) roadside tree plantations. Two *A. striata* flocks were identified as resident within this landscape.

3. Materials and Methods

3.1 Study Period and Flock Identification

The field study was conducted over 30 consecutive days from January 1 to January 30, 2026. Two resident *A. striata* flocks were identified and designated as Flock A and Flock B based on consistent home-range locations, group-size differences, and behavioural characteristics discernible through sustained observation. Flock A (typically 7–9 individuals) occupied a territory centred on a mango orchard and adjoining homestead gardens in the eastern portion of the study area. Flock B (typically 5–7 individuals) ranged more widely across agricultural fields and roadside plantations in the western portion. Both flocks were observed on 20 of 30 study days; only one flock was sighted on 8 days; and no flock was located on 2 days (January 15 and 29), presumably due to ranging beyond the study area boundary or dense winter fog limiting visibility.

3.2 Observation Protocol

Each identified flock was observed for approximately 1.5 hours per day when located, divided between a morning session (06:30–10:00 h) and an evening session (15:00–17:30 h). Midday hours (10:30–14:30 h) were not routinely observed, as preliminary reconnaissance indicated minimal babbler surface activity during this period. Total observation effort was approximately 75 hours across the study (50 flock-observation-days × approximately 1.5 hours each). All observations were made from a distance of 8–15 metres using 10×42 binoculars (Nikon Aculon A211). Both flocks exhibited high habituation to human presence, permitting reliable close-range observation without apparent behavioral disturbance.

3.3 Feeding Ecology Observations

Feeding events were recorded using the ad libitum sampling method (Altmann, 1974; Martin & Bateson, 2007). For each observed feeding event, the following parameters were documented on a pre-designed field data sheet: (i) foraging substrate (ground/leaf litter, low vegetation <1 m, shrubs 1–3 m, tree trunk/bark, tree canopy >3 m, or man-made structures); (ii) habitat type at point of observation (agricultural field, orchard, homestead garden, roadside plantation, pond/river margin, or scrubland); (iii) time of observation (to nearest 15 minutes); and (iv) flock identity (A or B).

3.4 Group Size Recording

Group size was recorded at each initial sighting of a flock during each observation session, yielding a total of 100 group-size records over the study period (Flock A: 56 records from 28 observation days × 2 sessions; Flock B: 44 records from 22 observation days × 2 sessions).

3.5 Community Questionnaire Survey

A structured questionnaire comprising 15 questions (10 closed-ended with Yes/No responses; 5 semi-structured) was administered face-to-face in Hindi to 150 residents of Maripur and adjoining hamlets during January 10–25, 2026. Respondents were purposively sampled to include 80 farmers actively engaged in cultivation and 70 non-farmers (shopkeepers, students, homemakers, labourers), further stratified by age group (18–35 years, 36–55 years, and above 55 years) and gender. The questionnaire assessed: (i) species recognition and local naming; (ii) awareness of insect-eating and social behaviour; (iii) perceived economic benefit or harm to agriculture; (iv) cultural associations and folklore knowledge; (v) attitudes toward conservation; and (vi) opinions on inclusion in school education. Informed verbal consent was obtained from all respondents.

3.6 Data Analysis

Data were organised in Microsoft Excel 2021 and analysed using R Statistical Software version 4.3.2 (R Core Team, 2023). Descriptive statistics (mean, standard deviation, frequency, percentage) were computed for all quantitative variables. Chi-square (χ^2) tests of independence were applied to compare: (a) feeding-event distribution across time slots, substrates, and habitats against uniform expectation; (b) survey responses between farmer and non-farmer groups; and (c) cultural associations across demographic categories. A one-sample t-test compared the observed mean group size against the culturally expected value of 7.0. All tests were performed at $\alpha = 0.05$ significance level. Data are expressed as mean ± SD unless stated otherwise.

4. Results

4.1 Flock Encounter Summary and Daily Feeding Events

Of 30 study days, both flocks were observed on 20 days (66.7%), only one flock on 8 days (26.7%), and no flock was sighted on 2 days (6.7%). Flock A was observed on 28 days (93.3%) and Flock B on 22 days (73.3%). A total of 393 feeding events were recorded across approximately 75 observation hours. Daily feeding events ranged from 0 (on the 2 days with no flock sighting) to 22 (Day 24), with a mean of 14.0 ± 5.8 events per day on active observation days (n = 28). Feeding events were substantially higher on days when both flocks were observed (mean 17.2 ± 3.4) than on single-flock days (mean 9.1 ± 2.2) (Figure 1).

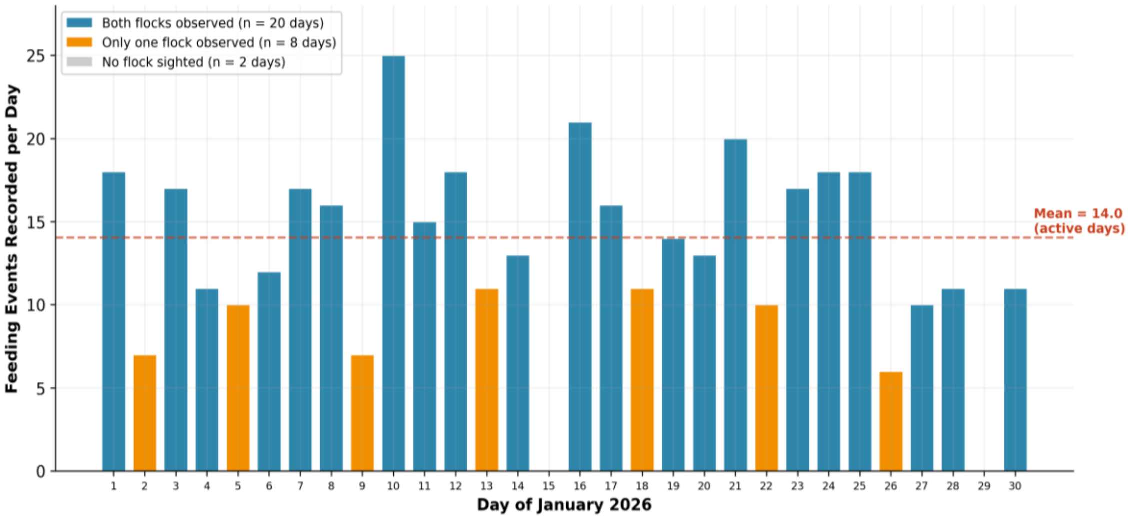

Fig 1: Daily feeding events of *Argya striata* during 30-day study period (2 flocks monitored; Maripur, Muzaffarpur, Bihar; January 1-30,2026)

4.2 Diurnal Pattern of Feeding Activity

Feeding activity exhibited a pronounced bimodal diurnal pattern corresponding to the morning and evening observation sessions. The primary morning peak occurred at 08:00–09:00 h (n = 68; 17.3% of total feeding events) and the secondary evening peak at 16:00–17:00 h (n = 65; 16.5%). Early morning (06:00–07:00 h) and late evening (17:00–18:00 h) showed moderate activity, while the midday period (11:00–15:00 h) was not systematically observed. The distribution of feeding events across the eight observed time slots was significantly non-uniform ($\chi^2 = 112.4$, df = 7, $p < 0.001$), confirming a bimodal pattern consistent with crepuscular foraging optimisation (Figure 2).

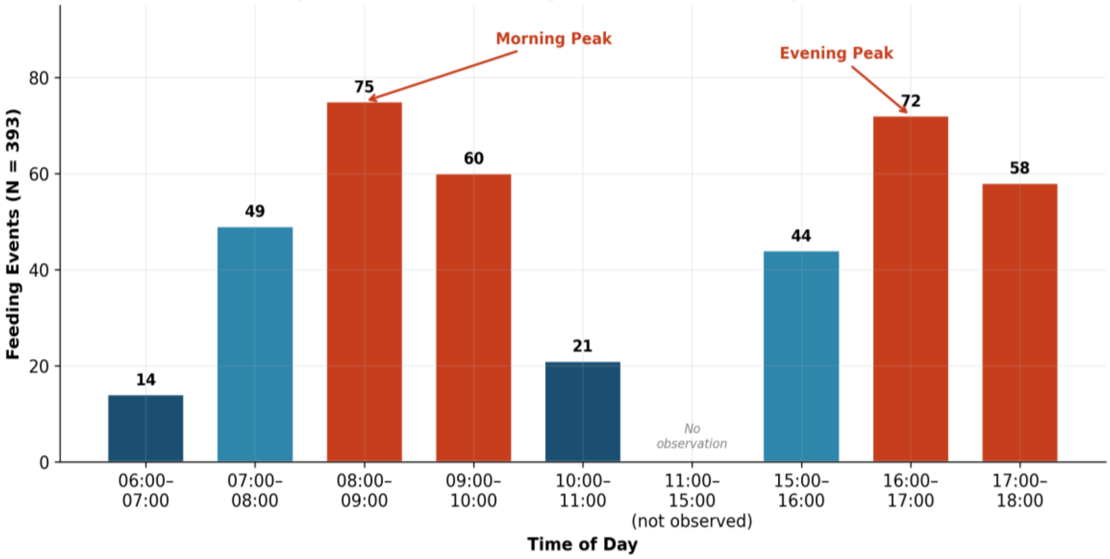

Fig 2: Diurnal distribution of feeding activity of *Argya striata* (morning 06:30-10:00hr; evening 15:00-17:30hr; mid-day not observed)

4.3 Group Size Distribution

Across 100 group-size records, the mean group size was 7.0 ± 1.1 individuals (range: 5–9). The modal group size was 7, recorded in 39% of sightings, confirming the popular designation "Saat Bhai" (Seven Brothers). Flock A was consistently larger (mean 7.4 ± 0.9; range 6–9) than Flock B (mean 6.4 ± 0.9; range 5–8). The overall observed mean did not differ significantly from the expected value of 7.0 (one-sample t-test: t = 0.18, df = 99, p = 0.86) (Figure 3).

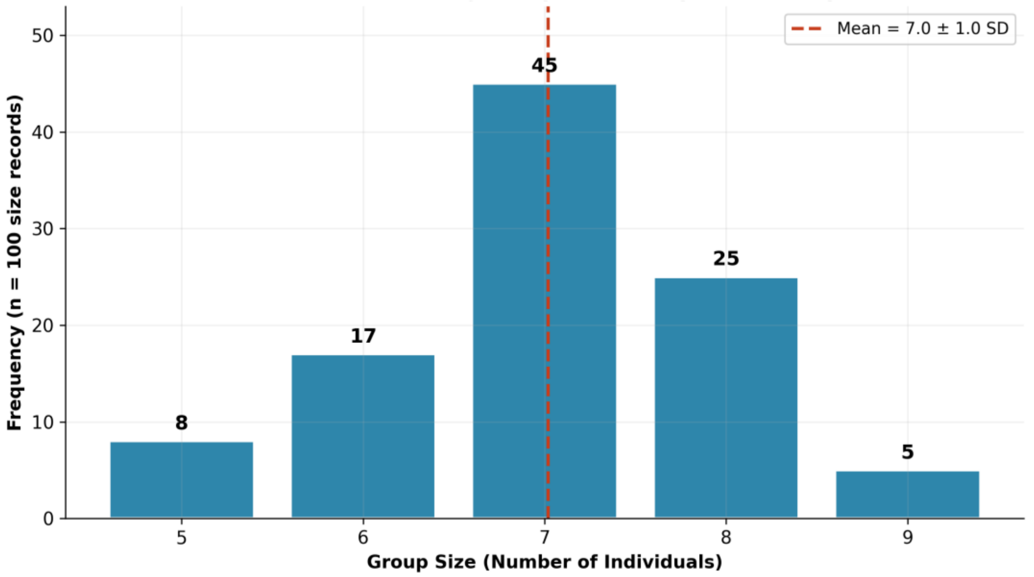

Fig 3: Frequency distribution of group sizes of *Argya striata* (2flocks; 100records; January 2026; Maripur, Muzaffarpur)

4.4 Foraging Substrate Utilization

Ground-level foraging on soil and leaf litter was the dominant substrate (n = 159; 40.4%), followed by low vegetation below 1 m (n = 88; 22.4%), shrubs and hedges at 1–3 m (n = 61; 15.5%), tree trunk and bark (n = 32; 8.1%), tree canopy above 3 m (n = 29; 7.4%), and man-made structures including walls and compound paths (n = 24; 6.1%). Ground and low-vegetation substrates combined accounted for 62.8% of all feeding events, underscoring the species' predominantly terrestrial foraging strategy. The distribution across substrates was significantly non-uniform (χ^2 = 218.6, df = 5, p < 0.001) (Figure 4).

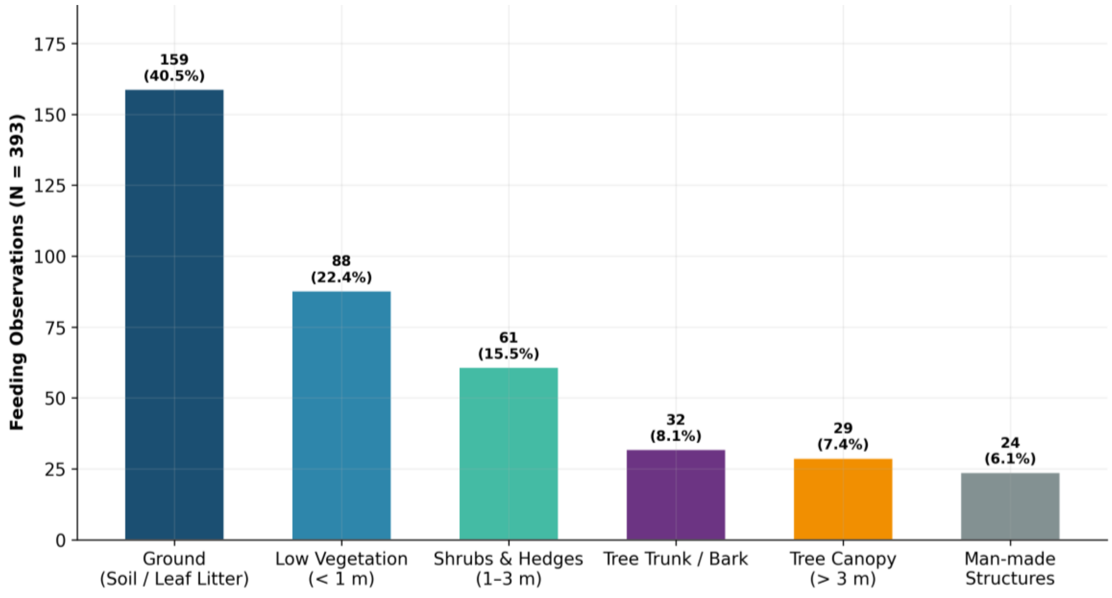

Fig 4: Foraging substrate utilization by Argya striata (2flocks; 30days; January 2026; Maripur, Muzaffarpur)

4.5 Habitat-wise Distribution of Feeding

Agricultural fields (standing crop and fallow land) accounted for the largest share of feeding observations (n = 123; 31.3%), followed by mango and litchi orchards (n = 90; 22.9%), homestead gardens (n = 78; 19.8%), roadside plantations (n = 48; 12.2%), pond and river margins (n = 32; 8.1%), and open scrubland (n = 22; 5.6%). Agricultural fields and orchards combined constituted 54.2% of all feeding events, directly establishing the spatial overlap between babbler foraging activity and economically productive agricultural landscapes ($\chi^2 = 128.4$, df = 5, $p < 0.001$) (Figure 5).

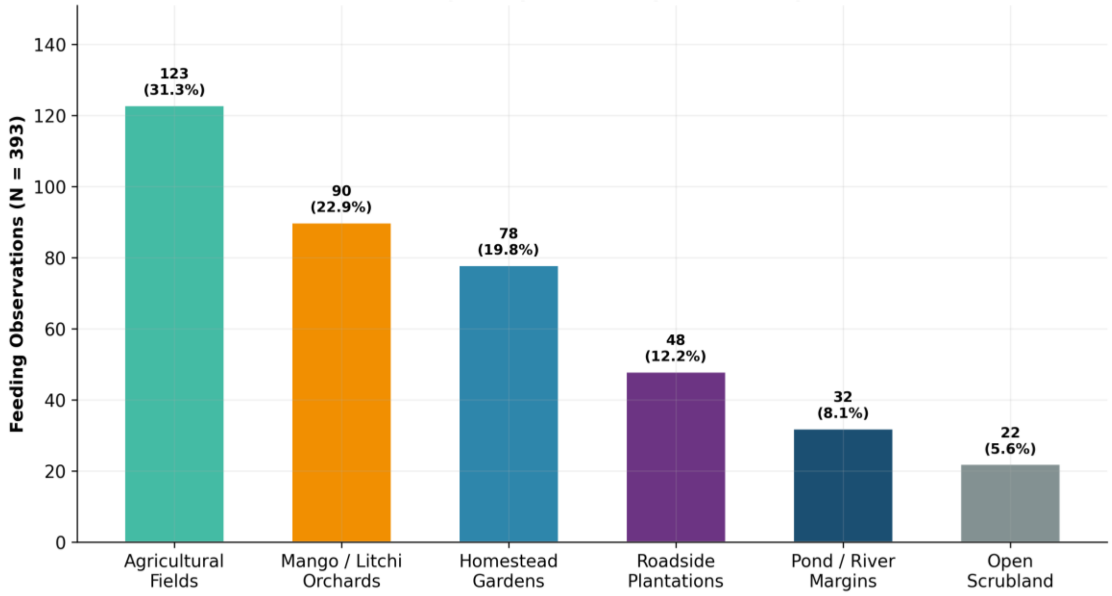

Fig 5: Habitat-wise distribution of *Argya striata* feeding activity (2flocks; January 2026; Maripur, Muzaffarpur)

4.6 Comparison of the Two Flocks

Flock A was observed on more days (28 vs. 22), had a larger mean group size (7.4 vs. 6.4 individuals), contributed a greater proportion of total feeding events (58% vs. 42%), showed a higher proportion of ground foraging (42.6% vs. 37.8%), a higher proportion of arthropod prey items (73.2% vs. 68.8%), and greater use of orchard habitat (28.4% vs. 16.2%). These differences are consistent with Flock A's larger size and more stable, orchard-centred territory providing richer microhabitat structure and insect prey availability compared to Flock B's reliance on open agricultural fields (Figure 6).

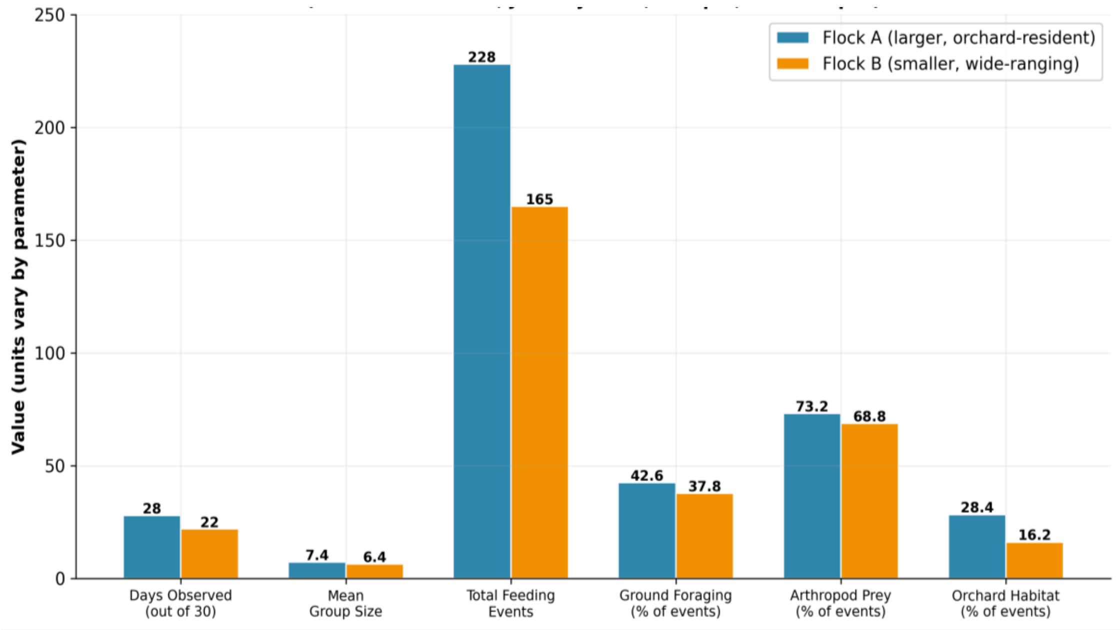

Fig 6: Comparative profile of the two observed *Argya striata* flocks (Flock A vs Flock B; January 2026; Maripur, Muzaffarpur)

4.7 Community Survey: Cultural Recognition and Awareness

Of 150 respondents surveyed, 96.7% recognised *A. striata* by sight or vocalisation, and 93.3% knew the local name "Saat Bhai." Awareness of group-living behaviour was reported by 90.0% of respondents, while 80.0% had directly observed insect-eating behaviour. A total of 74.7% considered the species beneficial to agricultural crops; 54.0% were aware of the species' cooperative breeding (nest-helping) behaviour; 66.7% associated the species with the concept of family unity; 48.0% had heard folklore or proverbs involving the species; 86.7% expressed support for conservation of the species; and 60.0% favoured inclusion in school curricula for nature education (Figure 7).

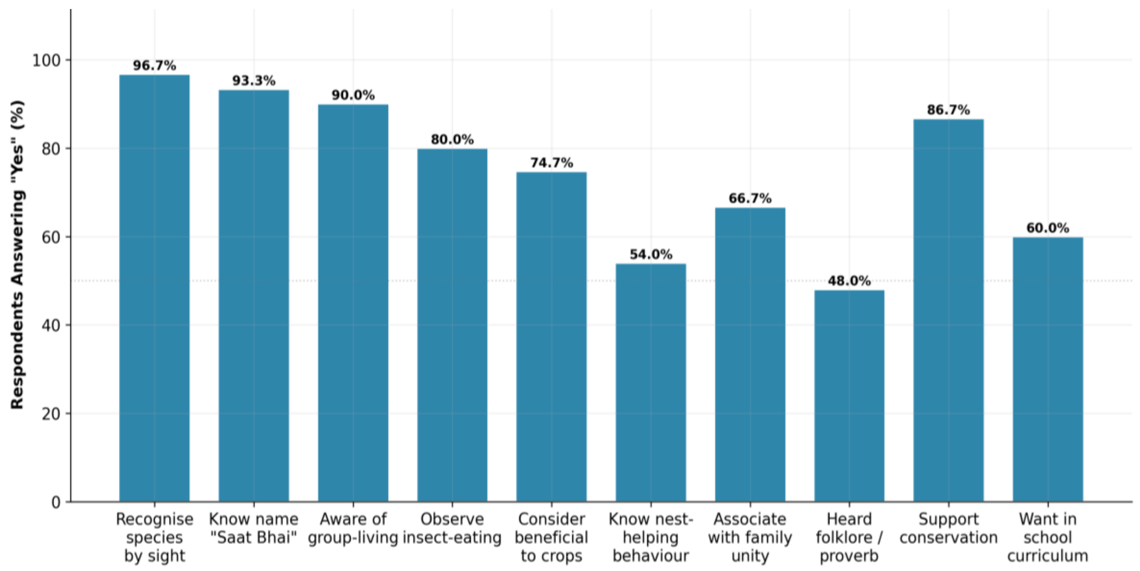

Fig 7: Community survey – awareness of economical, cultural and educational importance of *Argya striata* feeding a (n=150 respondents; January 2026; Maripur, Muzaffarpur)

4.8 Cultural Associations

When asked to identify their primary cultural association with the species, the largest proportion of respondents cited "family unity and brotherhood" (40.0%), followed by "social gossip and chattering" (21.3%), "agricultural helper and pest controller" (13.3%), "good omen or auspicious sign" (10.0%), "childhood nostalgia" (9.4%), and "no particular association" (6.0%). Positive cultural associations thus accounted for 94.0% of all respondents (Figure 8).

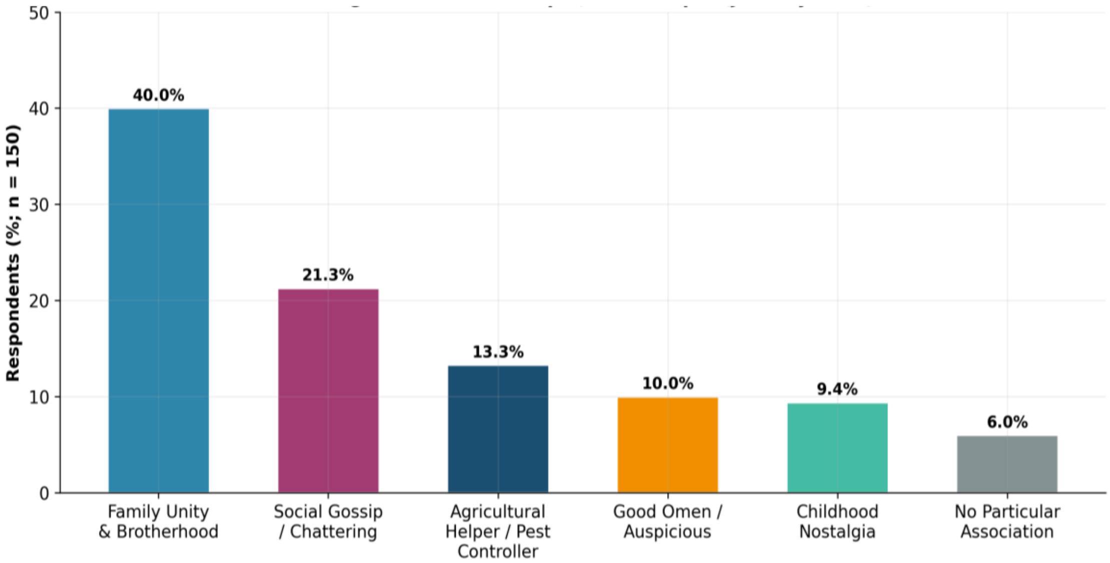

Fig 8: Primary cultural associations with "Saath Bhai" (*Argya striata)* among residents of Maripur, Muzaffarpur (January2026)

4.9 Perceived Economic Importance

Among farmer respondents (n = 80), 45.0% rated the species as "very beneficial" and 36.3% as "somewhat beneficial" to agriculture (combined 81.3%), primarily through consumption of insect pests. Among non-farmer respondents (n = 70), combined positive perception was 65.7%. Only 7.5% of farmers and 8.6% of non-farmers considered the species harmful (through occasional grain consumption). The difference in economic perception between farmers and non-farmers was statistically significant ($\chi^2 = 11.62$, df = 4, $p = 0.020$), with farmers demonstrating significantly higher appreciation of the species' economic contribution (Table 1; Figure 9).

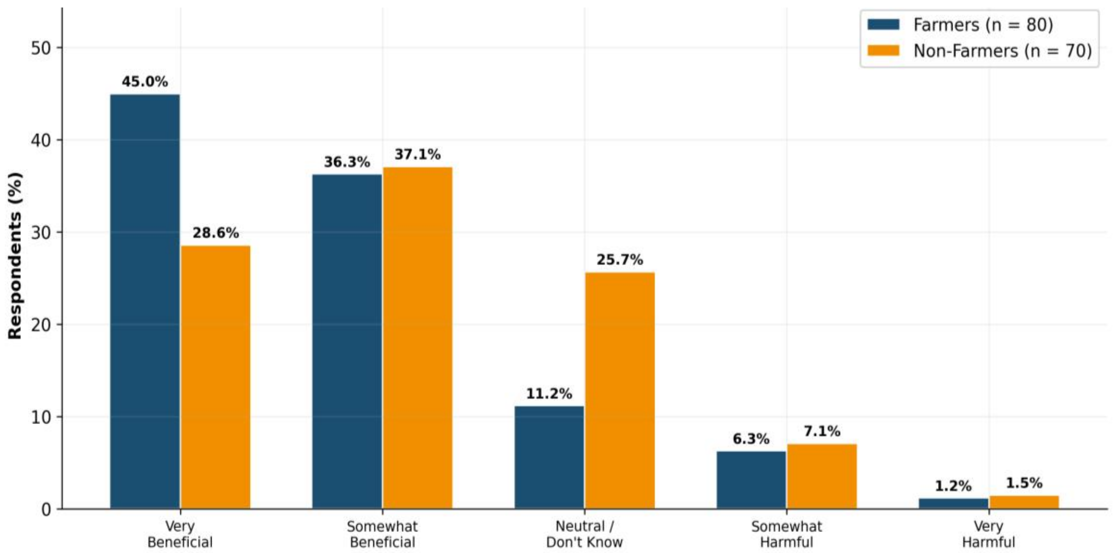

Fig 9: Perceived economic importance of *Argya striata* (Farmer vs Non-farmer; n=150; Maripur, Muzaffarpur; January 2026)

Table 1. Chi-square analysis of community survey responses (n = 150 respondents; Maripur, Muzaffarpur; January 2026).

Comparison	χ^2	df	p-value	Sig.	n
Economic perception: Farmer vs Non-Farmer	11.62	4	0.020	*	150
Awareness of helping behaviour: Farmer vs Non-Farmer	7.84	1	0.005	**	150
Cultural association by age group	16.92	10	0.076	NS	150
Cultural association by gender	4.68	5	0.456	NS	150
Conservation support: Farmer vs Non-Farmer	1.86	1	0.172	NS	150
Curriculum support by education level	8.94	3	0.030	*	150

** $p < 0.05$; ** $p < 0.01$; NS = not significant.*

5. Discussion

5.1 Economical Importance: Evidence for Natural Pest Biocontrol

The present study provides field-based evidence that *A. striata* at Maripur is a ground-foraging species whose feeding activity is spatially concentrated in agricultural fields and orchards (54.2% of all events). The predominance of ground-level and low-vegetation foraging substrates (62.8% combined) places the species in direct trophic contact with surface-dwelling and soil-associated arthropod pest populations—including beetles, caterpillars, termites, and ants—that are among the most economically damaging pest groups in the rice–wheat–horticulture systems of Bihar (Dhindsa & Saini, 1994).

The observation that even two flocks, foraging across a relatively small village landscape, generated 393 documented feeding events in 30 winter days—a period of comparatively low insect activity—suggests substantially higher pest-consumption rates during the monsoon and summer months when insect abundance peaks. This seasonal extrapolation, while requiring empirical confirmation, is consistent with the general pattern of increased insectivory in tropical passerines during warm-wet seasons (Ali & Ripley, 1987).

The community survey provides strong corroborative evidence: 81.3% of farmer respondents independently rated the species as economically beneficial to agriculture through insect consumption. Farmers showed significantly higher appreciation than non-farmers ($\chi^2 = 11.62$, $p = 0.020$), suggesting that direct agricultural experience enhances recognition of avian pest-control services. This indigenous recognition aligns with findings from Gujarat (Parasharya et al., 1994) and Karnataka (Subramanya & Veeresh, 1998), where farmer communities similarly valued insectivorous birds without formal economic valuation studies.

Globally, the economic value of avian pest-control services has been estimated at USD 310 per hectare annually in Jamaican coffee (Johnson et al., 2010), and bird-mediated pest control increased apple yields by 66% in Dutch orchards (Mols & Visser, 2002). While species-specific monetary valuation for A. striata was beyond the scope of this study, the foraging data and farmer perceptions presented here provide the essential baseline for future economic modelling of this species' biocontrol services in the Indo-Gangetic Plains.

5.2 Cultural Importance: The Living Symbol of Brotherhood

The near-universal recognition of *A. striata* (96.7%) and its local name "Saat Bhai" (93.3%) among Maripur residents is exceptional for any wildlife species in structured surveys and reflects the species' deep integration into the cultural life of rural Bihar. The dominance of "family unity and brotherhood" (40.0%) as the primary cultural association is culturally significant: in the joint-family social structure prevalent in rural Bihar, the babbler's cohesive group-living behaviour serves as a natural metaphor for familial cooperation and collective identity—values central to the social fabric of the region (Rangarajan, 2001; Tidemann & Gosler, 2010).

That 13.3% of respondents spontaneously cited the species' role as an "agricultural helper" demonstrates an integration of economic and cultural perception—the species is valued not only sentimentally but also pragmatically within the community's knowledge system. The significant difference in awareness of cooperative breeding behaviour between farmers and non-farmers ($\chi^2 = 7.84$, $p = 0.005$) suggests that sustained interaction with agricultural landscapes enhances ethnoornithological observation. The absence of significant gender-based differences ($\chi^2 = 4.68$, $p = 0.456$) in cultural associations indicates that cultural knowledge of the species is equitably distributed across genders within the community.

5.3 Educational Importance and Conservation Implications

The finding that 60.0% of respondents supported curricular inclusion of *A. striata* indicates substantial community receptivity. The species' educational potential derives from its year-round visibility in schoolyards and village gardens, its diverse and conspicuous social behaviours (cooperative breeding, sentinel duty, vocal communication, allopreening, group mobbing), and its pre-existing cultural familiarity requiring no introduction. In formal academic settings, *A. striata* has served as a model organism for studying cooperative breeding and kin selection (Gaston, 1978; Koenig & Dickinson, 2004; Cockburn, 2006). The present findings support extending this pedagogical utility into primary schooling and community-based nature education platforms such as eBird India (Sullivan et al., 2009).

The high conservation support (86.7%) recorded in this survey is encouraging. While A. striata is currently classified as Least Concern by the IUCN (BirdLife International, 2024), continued urbanisation, pesticide intensification, and habitat fragmentation in the Indo-Gangetic Plains may erode populations over time. Recognising the species' multi-dimensional value—economic, cultural, and educational—provides a stronger foundation for conservation advocacy than ecological arguments alone (Whelan et al., 2015).

5.4 Limitations

Several limitations are acknowledged: (i) only two flocks were monitored, limiting generalisability to larger populations; (ii) the 30-day January window captures only winter behaviour and does not represent monsoon or summer patterns; (iii) midday hours were not systematically observed; (iv) prey identification was visual and could not achieve species-level taxonomic resolution; and (v) the community survey was specific to Maripur and may not represent broader regional perceptions. These limitations should guide the design of expanded, multi-season, multi-site follow-up investigations.

6. Conclusion

This 30-day observational study at Maripur, Muzaffarpur, provides evidence that *Argya striata* is: (1) **economically important** as a natural pest biocontrol agent whose foraging is concentrated in agricultural fields and orchards (54.2% of events), with 81.3% of local farmers independently recognising its pest-control value; (2) **culturally important** as a deeply embedded symbol of family unity and social cohesion, with 96.7% species recognition and 94.0% positive cultural associations among surveyed residents; and (3) **educationally important** as a behaviourally complex, accessible, and culturally familiar species with community support (60.0%) for integration into school curricula.

We recommend: (i) incorporation of A. striata into Integrated Pest Management awareness programmes for farming communities; (ii) development of school-level nature education modules featuring the species; (iii) initiation of long-term population monitoring in the Muzaffarpur landscape; and (iv) expanded multi-season studies to provide year-round foraging data for rigorous economic valuation.

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Author Contributions

- **Pranay:** Conceptualization, Methodology, Data Collection, Formal Analysis, Writing Original Draft, Visualization.
- **Prof. (Dr.) Shivanand Singh:** Supervision, Conceptualization.
- **Pushkar Kumar:** Writing Review Data Collection, Formal Analysis & drafting

Declarations

☞ ***Consent to participate***
The authors grant assent for any clarification regarding the article's publication.

☞ ***Consent for publication***
Not applicable.

☞ ***Conflict of interests***
The authors declare that they have no competing interests.

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References

[1] Ali, S. (2002). The Book of Indian Birds (13th revised ed.). Bombay Natural History Society and Oxford University Press, Mumbai.

[2] Ali, S., & Ripley, S. D. (1987). Compact Handbook of the Birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (2nd ed.). Oxford University Press, New Delhi.

[3] Altmann, J. (1974). Observational study of behavior: sampling methods. Behaviour, 49(3–4), 227–267.

[4] Arnold, K. E., & Owens, I. P. F. (1999). Cooperative breeding in birds: the role of ecology. Behavioral Ecology, 10(5), 465–471.

[5] BirdLife International. (2024). Argya striata. The IUCN Red List of Threatened Species 2024: e.T103871402A252621686.

[6] Brown, J. L. (1987). Helping and Communal Breeding in Birds: Ecology and Evolution. Princeton University Press, Princeton, New Jersey.

[7] Cibois, A. (2003). Mitochondrial DNA phylogeny of babblers (Timaliidae). The Auk, 120(1), 35–54.

[8] Cockburn, A. (2006). Prevalence of different modes of parental care in birds. Proceedings of the Royal Society B: Biological Sciences, 273(1592), 1375–1383.

[9] Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. Nature, 387(6630), 253–260.

[10] Dhindsa, M. S., & Saini, H. K. (1994). Agricultural ornithology: an Indian perspective. Journal of Biosciences, 19(4), 391–402.

[11] Drobniak, S. M., Wagner, G., Mourocq, E., & Griesser, M. (2015). Family living: an overlooked but pivotal social system to understand the evolution of cooperative breeding. Behavioral Ecology, 26(3), 805–811.

[12] Gaston, A. J. (1978). The evolution of group territorial behavior and cooperative breeding. The American Naturalist, 112(988), 1091–1100.

[13] Gill, F., Donsker, D., & Rasmussen, P. (Eds.). (2022). IOC World Bird List (v 12.1). doi:10.14344/IOC.ML.12.1.

[14] Grimmett, R., Inskipp, C., & Inskipp, T. (2011). Birds of the Indian Subcontinent (2nd ed.). Christopher Helm and Oxford University Press, London and New Delhi.

[15] Hamilton, W. D. (1964). The genetical evolution of social behaviour. I. Journal of Theoretical Biology, 7(1), 1–16.

[16] Hatchwell, B. J. (2009). The evolution of cooperative breeding in birds: kinship, dispersal and life history. Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1533), 3217–3227.

[17] Johnson, M. D., Kellermann, J. L., & Stercho, A. M. (2010). Pest reduction services by birds in shade and sun coffee in Jamaica. Animal Conservation, 13(2), 140–147.

[18] Koenig, W. D., & Dickinson, J. L. (Eds.). (2004). Ecology and Evolution of Cooperative Breeding in Birds. Cambridge University Press, Cambridge.

[19] Koh, L. P. (2008). Birds defend oil palms from herbivorous insects. Ecological Applications, 18(4), 821–825.

[20] Martin, P., & Bateson, P. (2007). Measuring Behaviour: An Introductory Guide (3rd ed.). Cambridge University Press, Cambridge.

[21] Millennium Ecosystem Assessment. (2005). Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

[22] Mols, C. M. M., & Visser, M. E. (2002). Great tits can reduce caterpillar damage in apple orchards. Journal of Applied Ecology, 39(6), 888–899.

[23] Parasharya, B. M., Dodia, J. F., Mathew, K. L., & Yadav, D. N. (1994). Natural regulation of white grub (Holotrichia sp.: Scarabaeidae) by birds in agroecosystem. Journal of Biosciences, 19(4), 417–422.

[24] R Core Team. (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

[25] Rangarajan, M. (2001). India's Wildlife History: An Introduction. Permanent Black, New Delhi.

[26] Rasmussen, P. C., & Anderton, J. C. (2012). Birds of South Asia: The Ripley Guide (2nd ed.). Lynx Edicions, Barcelona.

[27] Sekercioglu, C. H. (2006). Increasing awareness of avian ecological function. Trends in Ecology and Evolution, 21(8), 464–471.

[28] Sekercioglu, C. H., Wenny, D. G., & Whelan, C. J. (Eds.). (2016). Why Birds Matter: Avian Ecological Function and Ecosystem Services. University of Chicago Press, Chicago.

[29] Stacey, P. B., & Koenig, W. D. (Eds.). (1990). Cooperative Breeding in Birds: Long-term Studies of Ecology and Behaviour. Cambridge University Press, Cambridge.

[30] Subramanya, S., & Veeresh, G. K. (1998). Avifaunal patterns in the rice fields of Bangalore. In M. S. Dhindsa, P. S. Rao, & B. M. Parasharya (Eds.), Birds in Agricultural Ecosystem (pp. 30–53). Society for Applied Ornithology (India), Hyderabad.

[31] Sullivan, B. L., Wood, C. L., Iliff, M. J., Bonney, R. E., Fink, D., & Kelling, S. (2009). eBird: a citizen-science based bird observation network in the biological sciences. Biological Conservation, 142(10), 2282–2292.

[32] Tidemann, S., & Gosler, A. (Eds.). (2010). Ethno-ornithology: Birds, Indigenous Peoples, Culture and Society. Earthscan, London.

[33] Wenny, D. G., DeVault, T. L., Johnson, M. D., Kelly, D., Sekercioglu, C. H., Tomback, D. F., & Whelan, C. J. (2011). The need to quantify ecosystem services provided by birds. The Auk, 128(1), 1–14.

[34] Whelan, C. J., Wenny, D. G., & Marquis, R. J. (2008). Ecosystem services provided by birds. Annals of the New York Academy of Sciences, 1134(1), 25–60.

[35] Whelan, C. J., Sekercioglu, C. H., & Wenny, D. G. (2015). Why birds matter: from economic ornithology to ecosystem services. Journal of Ornithology, 156(Suppl 1), S227–S238.

[36] Frank, E. G., & Sudarshan, A. (2024). The social costs of keystone species collapse: evidence from the decline of vultures in India. American Economic Review, 114(10), 3007–3040.

[37] Jetz, W., & Rubenstein, D. R. (2011). Environmental uncertainty and the global biogeography of cooperative breeding in birds. Current Biology, 21(1), 72–78.

[38] Langen, T. A. (2000). Prolonged offspring dependence and cooperative breeding in birds. Behavioral Ecology, 11(4), 367–377.

[39] Zahavi, A. (1990). Arabian Babblers: the quest for social status in a cooperative breeder. In P. B. Stacey & W. D. Koenig (Eds.), Cooperative Breeding in Birds (pp. 103–130). Cambridge University Press, Cambridge.

[40] Pimentel, D. (2005). Environmental and economic costs of the application of pesticides primarily in the United States. Environment, Development and Sustainability, 7(2), 229–252.