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Cover: Indian Grey Wolf *Canis lupus pallipes* and Smooth-coated Otter *Lutrogale perspicillata* sharing the territory in Chambal basin. Digital art on Procreate by Aakanksha Komanduri.

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ARTICLE

Snake diversity based on rescue records in urban Jaipur, Rajasthan, India

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Abstract: We documented the snakes of Jaipur City, Rajasthan, India, using rescue records generated through a structured volunteer network, comprising primary data collected between January 2024 and October 2025, supplemented by historical records. A total of 787 primary rescue events along with past records (before January 2024), yielded records of 21 snake species across six families, including three venomous and 18 non-venomous taxa. Rescue records were dominated by *Naja naja* (65.4% of all rescues), while other frequently recorded species included *Platyceps ventromaculatus* and *Spalerosophis atriceps*. In contrast, fossorial taxa such as *Indotyphlops braminus* and *Pseudoindotyphlops porrectus* were rarely encountered. In addition to confirmed records, the study identifies five species whose occurrence in Jaipur is considered plausible based on regional distribution patterns and habitat continuity. Findings are interpreted as occurrence records and baseline diversity data rather than estimates of abundance.

Keywords: Citizen-derived data, human-snake interaction, *Naja naja*, snakes checklist, urban biodiversity, urban herpetofauna, urban ecology, wildlife conservation.

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Author contribution: AK and JG facilitated the fieldwork, with AK also conducting fieldwork activities. AK designed the methodology and was responsible for data analysis and manuscript preparation. JG provided subject-matter expertise and guidance throughout the study. DS provided assistance with spatial mapping and proofreading. All authors contributed to the critical revision of the manuscript and approved the final version.

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INTRODUCTION

Urban environments host a wide variety of species, yet reptiles, especially snakes, remain underrepresented in biodiversity surveys. Herpetofaunal inventories in India have recently grown, but most urban-focused research remains limited to a small number of cities. Research from Delhi (Prasad 2018; Barhadiya & Ghosh 2021), Ujjain in Madhya Pradesh (Ingle et al. 2019), Ahmedabad in Gujarat (Urfi 2005; Shroff & Mehta 2024) and Guwahati in Assam (Purkayastha et al. 2011; Purkayastha 2018) shows that Indian cities can sustain a significant variety of reptiles despite rapid land-use changes. Documenting species richness, finding new locality records, learning more about their natural history and ecology, exposing temporal activity patterns, and determining local conservation priorities have all been made possible by these inventories.

Rescue-based data collection has also been successfully implemented in a few Indian cities, including Ahmedabad (Urfi 2005; Shroff 2016), Surat, Surendranagar, Valsad, Dahod, and Vadodara (Vyas 2013) in Gujarat; Kannur in Kerala (Roshnath 2017); Bengaluru in Karnataka (Kalki et al. 2021); Kolkata in West Bengal (Kuttalam et al. 2025) and Hyderabad in Telangana (Visvanathan et al. 2026). These datasets have produced reliable baseline inventories and insightful information on urban snake records when supported by photographs and cross-referenced with secondary sources.

As far as Jaipur is concerned, early research on the diversity of the local herpetofauna has been made possible by studies conducted in protected areas within and outside Jaipur city. Surveys of reptile assemblages from Jamwa Ramgarh and Nahargarh wildlife sanctuaries revealed the diversity associated with the Aravalli hill systems and dry deciduous forest habitats in the Jaipur District (Sharma 1998, 2000). These investigations show the existence of a diverse regional species pool, even though they were restricted to secured landscapes and did not address species occurrence within the urban matrix. Therefore, the goal of this study is to create a baseline dataset of the snakes of urban Jaipur.

Study Area

Jaipur City (26.91° N, 75.79° E) (Image 1), the capital city of Rajasthan, covers approximately 467 km² and supports a population exceeding four million. The city falls in the hot semi-arid (BSh) zone under the updated Köppen–Geiger classification (Kottek et al. 2006) characterised by extremely hot summers, monsoonal rainfall, and mild winters with sharp day-night temperature drops. Most of its ~650 mm annual rainfall occurs between July and September. Temperature fluctuations are substantial: while winter days remain warm and pleasant, night-time lows frequently plunge to around 5°C, in sharp contrast to summer peaks above 45°C.

The city exhibits distinct spatial and ecological heterogeneity: eastern Jaipur is shaped by the Aravali hill systems and fragmented forests, western sections are densely residential and industrial, and southern Jaipur transitions into peri-urban agricultural landscapes (Vaishnav et al. 2024; Dadhich & Dadhich 2026). Broadly categorised within an arid-to-semi-arid zone, the city's overall urban green cover spans only 24.75 km², resulting in a remarkably low per capita green space of 5.75 m² per resident (Oraon et al. 2025). Urban expansion has altered Jaipur's ecological character through increased built-up area, road networks, and drainage alterations (Jalan & Sharma 2014; Vaishnav et al. 2024; Dadhich & Dadhich 2026).

MATERIALS AND METHODS

To create a verified inventory of snakes in Jaipur City, primary and secondary data, in the form of rescue records, were used. The primary dataset used in this study was derived from rescue records attended by Hope & Beyond, Jaipur (a registered NGO active in wildlife conservation since 2015), between January 2024 and October 2025. During the study period, a 24 × 7 rescue helpline operated with 5–6 active rescuers, enabling coverage of all municipal zones in Jaipur City. All rescue and release activities followed Indian wildlife protection regulations and standard operating protocols of the Rajasthan Forest Department. Secondary data included historical rescue records from Hope & Beyond (2015–2023). Opportunistically derived biodiversity datasets, such as rescue records, are increasingly recognised as valuable sources of species occurrence information, particularly in urban and data-deficient landscapes, despite known limitations associated with uneven reporting effort and species detectability (Chandler et al. 2017; Johnston et al. 2022). To triangulate the data collected from primary and secondary sources, supplementary information on unusual rescue events and species occurrences was gathered through interview schedules with independent rescuers and members of other organisations operating in Jaipur city and its outskirts, including the Eco Rescuers Foundation and the Nature Care NGO. Wherever possible, records were cross-validated using photographic records and locality information.

A total of 939 rescue-calls were recorded. A total of

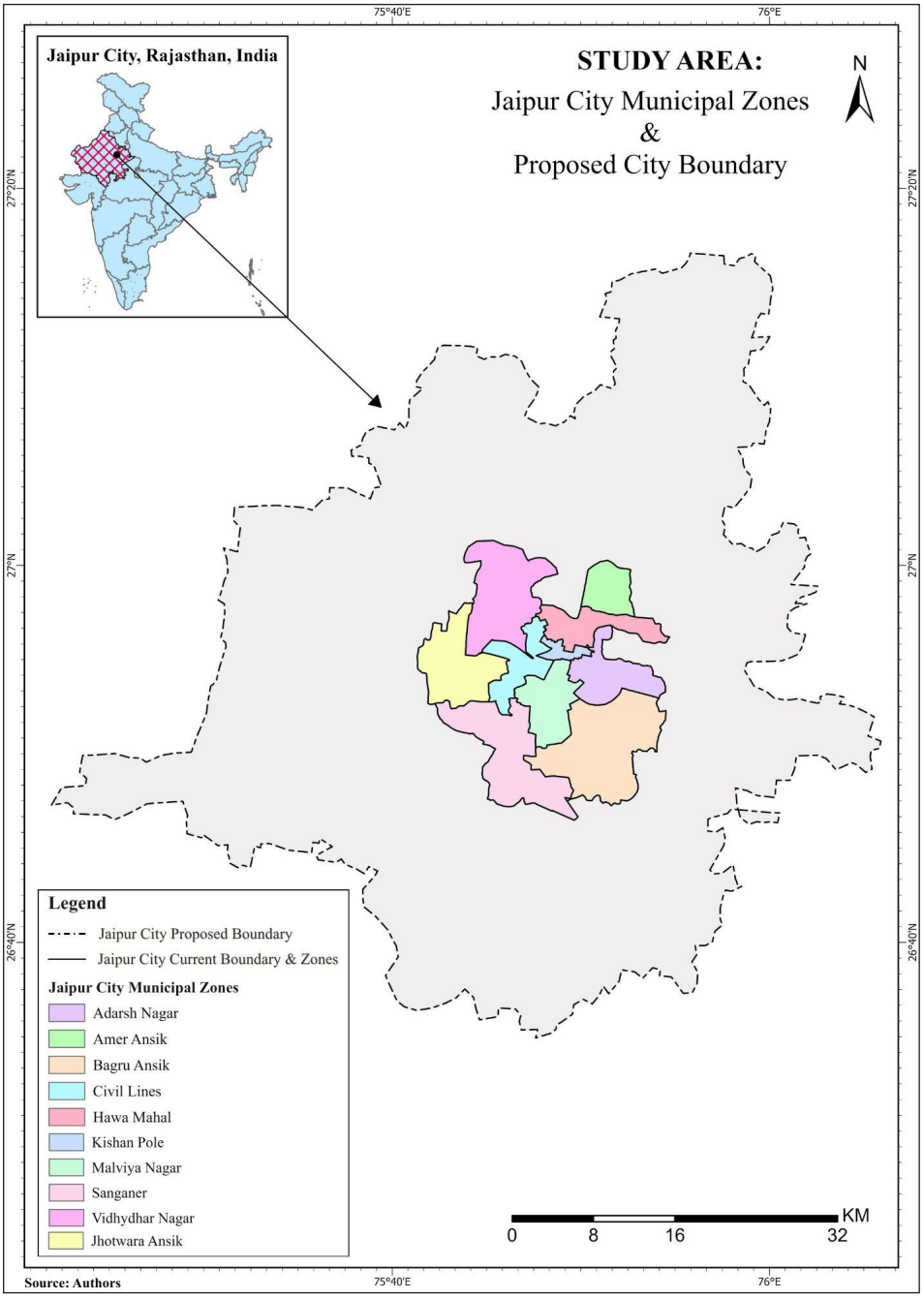

Image 1. Study area – Jaipur City, Rajasthan, India.

787 successful snake rescues were retained as primary data for analysis, after 'no rescue at location' and rescue of other wildlife incidents were eliminated. For each event, standardised forms were used to document date, time, GPS coordinates (WGS84), habitat notes, rescuer identity, and photographs (Dorcas & Willson 2009). These successful rescues occurred across 356 unique field days, representing the study's temporal sampling effort. All primary and secondary records were consolidated in a master spreadsheet in MS Excel (2013 version) for cleaning and preparation before computing rescue frequencies. Species encounter frequencies were evaluated using two independent parameters (2024–2025): (a) proportional representation in total rescues (n = 787) and (b) proportional representation in unique rescue days (n = 356). This dual-parametric system avoids biases associated with single-day clustering and effort variation while remaining appropriate for encounter-

based datasets.

Taxonomic identification and nomenclature of recorded species follow standard herpetological literature and recent taxonomic revisions, including Smith (1943), Whitaker & Captain (2004), Vogel & van Rooijen (2011), Pyron & Wallach (2014), Wallach et al. (2014), Boundy (2020), Bandara et al. (2022), Moradi et al. (2024), and Sidharthan et al. (2024). Previous studies on snakes from Jaipur were reviewed to identify gaps between pre-existing data and current findings; this was also done to anticipate potential species not yet reported from Jaipur City or the broader district.

We acknowledge certain limitations within which this study functions: (i) Rescue-based datasets are influenced by human reporting behaviour, rescuer accessibility, and species detectability, and therefore represent encounter-based occurrence records rather than direct measures of abundance; (ii) Hope & Beyond, Jaipur, follows a coexistence-oriented rescue approach; therefore, not all received calls resulted in rescue visits. Calls were often declined when snakes were identified as non-venomous and capable of dispersing naturally, when sightings were reported several hours later, when snakes entered inaccessible spaces, or when callers withdrew requests. Such filtering may have reduced records of non-venomous, fossorial, arboreal, nocturnal, and less conspicuous species; (iii) The present study is intended as an encounter-based indication of snake diversity, and not as a systematic assessment of snake abundance or occupancy.

RESULTS

Table 1 shows that primary rescue data documented 12 snake species from Jaipur City during the study period, with an additional record of *Python molurus* retained as a noteworthy out-of-study-period case. *Naja naja* (Linnaeus, 1758) was the most frequently rescued species with 515 rescue records, followed by *Platyceps ventromaculatus* (Gray, 1834) (109 rescues) and *Spalerosophis atriceps* (Fischer, 1885) (46 rescues). Moderate rescue frequencies were recorded for *Eryx conicus* (Schneider, 1801) (29 rescues), *Ptyas mucosa* (Linnaeus, 1758) (28 rescues), and *Coelognathus helena helena* (Daudin, 1803) (25 rescues). Less frequently encountered species included *Fowlea piscator* (Schneider, 1799) (13 rescues), *Eryx johnii* (Russell, 1801) (10 rescues), *Bungarus caeruleus* (Schneider, 1801) (5 rescues), and *Lycodon aulicus* (Linnaeus, 1758) (4 rescues). Rare rescue records included single observations of *Grypotyphlops acutus* (Duméril & Bibron, 1844) and *Pseudoindotyphlops porrectus* (Stoliczka, 1871). An additional rescue record of *Python molurus* (Linnaeus, 1758) was documented outside the defined primary study period; however, owing to the unusual occurrence of the species within the urban landscape of Jaipur City, the record was retained and discussed separately in the next section.

Table 1. Primary data (Jan 2024–Oct 2025) on snake rescues in Jaipur, Rajasthan, India.

	Species	Total rescues	% of total rescues	Rescue days	% of rescue days
1.	*Naja naja*	515	65.4%	246	69.1%
2.	*Platyceps ventromaculatus*	109	13.8%	95	26.6%
3.	*Spalerosophis atriceps*	46	5.8%	41	11.5%
4.	*Eryx conicus*	29	3.6%	29	8.0%
5.	*Ptyas mucosa*	28	3.5%	28	7.8%
6.	*Coelognathus helena helena*	25	3.1%	25	7.0%
7.	*Fowlea piscator*	13	1.6%	13	3.6%
8.	*Eryx johnii*	10	1.2%	10	2.7%
9.	*Bungarus caeruleus*	5	0.5%	5	1.3%
10	*Lycodon aulicus*	4	0.4%	4	1.0%
11.	*Grypotyphlops acutus*	1	0.12%	1	0.28%
12.	*Pseudoindotyphlops porrectus*	1	0.12%	1	0.28%
13.	*Python molurus* *	1	0.12%	1	0.28%

*Unique case study: Rescued outside of primary data collection duration, i.e., in December 2025.

Table 2 shows that secondary data compiled from Hope & Beyond records and interviews with other NGOs revealed eight additional snake species not recorded during primary data collection. These records included *Indotyphlops braminus* (Daudin, 1803), *Dendrelaphis proarchos* (Wall, 1909), *Dendrelaphis tristis* (Daudin, 1803), *Oligodon russelius* (Daudin, 1803), *Oligodon taeniolatus* (Jerdon, 1853), *Boiga trigonata* (Schneider, 1802), *Sibynophis subpunctatus* (Duméril, Bibron & Duméril, 1854), and *Echis carinatus sochureki* Stemmler, 1969. Integration of 12 species recorded during the defined primary study period, one additional out-of-period record of *Python molurus*, and eight species from historical and supplementary records resulted in a consolidated dataset of 21 snake species representing six families documented from Jaipur City (Table 3; Image 2).

DISCUSSION

The sampling bias associated with rescue-based datasets requires reiteration to avoid misinterpretation

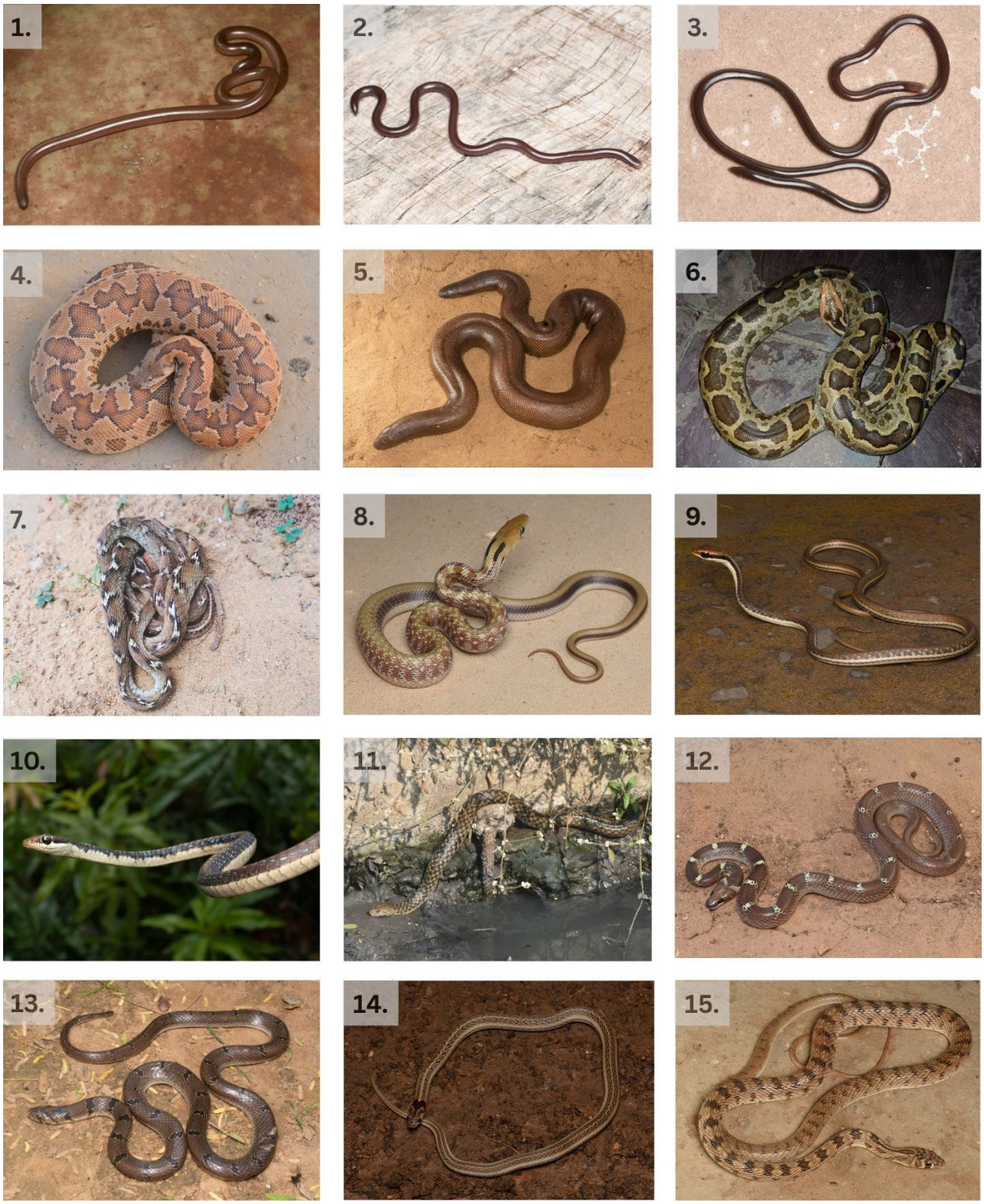

Image 2. Photo records of snakes of Jaipur City: 1—*Grypotyphlops acutus* | 2—*Indotyphlops braminus* | 3—*Pseudoindotyphlops porrectus* | 4—*Eryx conicus* | 5—*Eryx johnii* | 6—*Python molurus* | 7—*Boiga trigonata* | 8—*Coelognathus helena helena* | 9—Dendrelaphis proarchos | 10—*Dendrelaphis tristis* | 11—*Fowlea piscator* | 12—*Lycodon aulicus* | 13—*Oligodon russelius* | 14—*Oligodon taeniolatus* | 15—*Platyceps ventromaculatus*. © Authors and volunteers of Hope & Beyond, Jaipur.

Image 2 continued. 16—*Ptyas mucosa* | 17—*Sibynophis subpunctatus* | 18—*Spalerosophis atriceps* | 19—*Bungarus caeruleus* | 20—*Naja naja* | 21—*Echis carinatus sochureki*. © Authors and Volunteers of Hope & Beyond, Jaipur.

Table 2. Secondary data from Hope & Beyond (2015–2023) and supplementary data from other organisations (2009–2026): additional species and unique rescue records.

	Snake species rescued	Total rescues	Rescue days	Year	Citation/ Organisation
1.	*Indotyphlops braminus*	19	1	2023	Hope & Beyond
2.	*Dendrelaphis proarchos*	4	4	1 in 2022 2 in 2023 1 in 2026	Sharma et al. 2023 Raksha Foundation and Hope & Beyond Hope & Beyond
3.	*Echis carinatus sochureki*	4	4	2 in 2017 1 in 2021 1 in 2023	Nature Care Eco Rescuers Hope & Beyond
4.	*Boiga trigonata*	3	3	2016	Hope & Beyond
5.	*Oligodon russelius*	2	2	2018	Hope & Beyond
6.	*Oligodon taeniolatus*	2	2	2017	Hope & Beyond
7.	*Pseudoindotyphlops porrectus*	2	2	2023	Hope & Beyond
8.	*Python molurus*	2	2	1 in 2017 1 in 2019	Raksha Foundation Hope & Beyond
9.	*Dendrelaphis tristis*	1	1	2021	Hope & Beyond
10.	*Sibynophis subpunctatus*	1	1	2009	Raksha Foundation

of the present study's scope. Consequently, the absence of particular species from rescue records should not be interpreted as definitive evidence of their absence from the urban environment (Kéry 2002). This limitation may be especially relevant for fossorial, arboreal, nocturnal, or cryptic species, which are less likely to be encountered or reported through rescue-based approaches (Henderson et al. 2016). Reptile detectability is often influenced by factors such as habitat use, activity patterns, and behavioural strategies that reduce visibility to observers (Boback et al. 2020). Arboreal species often occupy vertically complex microhabitats that restrict visibility and access to observers, while fossorial species may remain concealed underground or within substrate layers for extended periods (Henderson et al. 2016).

Indotyphlops braminus and *P. porrectus*, both small fossorial species, were poorly represented in rescue records, despite *I. braminus* being widely regarded as one of the most common snakes in India and frequently encountered as incidental bycatch during soil excavation or gardening activities (Whitaker & Captain 2004). The low detectability of both species is likely linked to their

Table 3. Snake diversity of Jaipur City (Rajasthan, India), compiled from primary and secondary/supplementary rescue records.

	Snake species	Common names
Family Typhlopidae		
1.	*Grypotyphlops acutus* (Duméril & Bibron, 1844)	Beaked Worm Snake
2.	*Indotyphlops braminus* (Daudin, 1803)	Brahminy Worm Snake
3.	*Pseudoindotyphlops porrectus* (Stoliczka, 1871)	Slender Worm Snake
Family Boidae		
4.	*Eryx conicus* (Schneider, 1801)	Common Sand Boa
5.	*Eryx johnii* (Russell, 1801)	Red Sand Boa
Family Pythonidae		
6.	*Python molurus* (Linnaeus, 1758)	Indian Rock Python
Family Colubridae		
7.	*Boiga trigonata* (Schneider, 1802)	Common Cat Snake
8.	*Coelognathus helena helena* (Daudin, 1803)	Common Trinket
9.	*Dendrelaphis proarchos* (Wall, 1909)	Eastern Bronzeback
10.	*Dendrelaphis tristis* (Daudin, 1803)	Common Bronzeback
11.	*Fowlea piscator* (Schneider, 1799)	Checkered Keelback
12.	*Lycodon aulicus* (Linnaeus, 1758)	Common Wolf Snake
13.	*Oligodon russelius* (Daudin, 1803)	Northern Kukri Snake
14.	*Oligodon taeniolatus* (Jerdon, 1853)	Streaked Kukri Snake
15.	*Platyceps ventromaculatus* (Gray, 1834)	Glossy-bellied Racer
16.	*Ptyas mucosa* (Linnaeus, 1758)	Indian Rat Snake
17.	*Sibynophis subpunctatus* (Duméril, Bibron & Duméril, 1854)	Dumeril's Black-headed Snake
18.	*Spalerosophis atriceps* (Fischer, 1885)	Black-headed Royal Snake
Family Elapidae		
19.	*Bungarus caeruleus* (Schneider, 1801)	Common Krait
20.	*Naja naja* (Linnaeus, 1758)	Indian Cobra
Family Viperidae		
21.	*Echis carinatus sochureki* Stemmler, 1969	Sochureki's Saw-scaled Viper

subterranean habits, small body size, and harmless appearance, which reduce the likelihood of rescue calls. In the case of *I. braminus*, rescue calls were generally made only when many individuals were observed together; for example, a 2023 secondary-data record from Jaipur city documented 19 individuals coiled at a single location. Conversely, the medically significant *N. naja* was disproportionately represented in the dataset, likely reflecting heightened public fear, rapid reporting, and greater willingness of rescuers to attend such calls. Rescue frequency of highly visible venomous species should therefore not be interpreted as a direct indicator of ecological dominance within the urban assemblage.

Records of *Python molurus* further highlight the importance of integrating secondary and primary datasets. Secondary records document the species from Vatika (in 2019) located within the Sanganer municipal zone. Vatika is a south-east peri-urban region of Jaipur City, characterised by mostly open or agricultural land and a sparsely built-up area, with the Dravyavati River running through it alongside other seasonally accumulated surface drainage sites. Additionally, a juvenile *P. molurus* (approximately 36 inches in length) with visible injuries near the head was rescued near Hawa Mahal, outside the defined primary study period, in December 2025. Its unusual presence in a heavily built-up, human-dominated area, with no resemblance to its known habitat, prompted enquiry. Local enquiries suggested that the animal had fallen from a vehicle, raising suspicions of accidental translocation or illegal transport.

The occurrence of *Dendrelaphis proarchos* in Jaipur is worth discussing. Because, so far, the species is understood to be primarily associated with the wet forests of northeastern India and the Indo-Burmese region (Biakzuala et al. 2022). Its documentation from Jaipur (Rajasthan) and Gwalior (Madhya Pradesh) has piqued researchers' curiosity about its presence in climatically dissimilar and geographically distant parts of north-western and central India (Sharma et al. 2023; Sharma & Verma 2023). Additional published reports from Surat (Gujarat), where the species has been interpreted as a stray introduction, and from Thane (Maharashtra), where its occurrence has been suggested as part of a possibly overlooked population, along with inconclusive bronzeback records from Mumbai, further indicate that comparable forms are being encountered across north-western India (Parmar et al. 2024; Mohandas & Dnyaneshwar 2025; Puranik et al. 2025). However, the biogeographic significance of these records requires a larger sample size from new ranges with dissimilar habitats. More recently, another study has reported a road-killed specimen of the species from Dudhwa Tiger Reserve, Uttar Pradesh, interpreting it in the context of range expansion and adding more complexity to the species' distributional status in the Indian subcontinent (Sainy et al. 2026). Informal communication within the snake rescue network has further indicated three additional unpublished records from Jaipur (bringing the total to four), as well as one each from multiple districts of Rajasthan (Alwar, Tonk, Udaipur, and Sirohi); Delhi and Dehradun (Uttarakhand), suggesting that its occurrence

may not be entirely isolated. Nevertheless, these records were not independently verified in the present study. With these new records coming to light, we believe they provide reasonable doubt that this population is more widespread in north, north-western and central India and warrant further scrutiny to understand its ecology.

Another noteworthy observation from the primary dataset was the record of *Grypotyphlops acutus*. Within Rajasthan, the species has previously been reported from Udaipur (Sharma 1999; Sharma et al. 2001; Bhatnagar & Mahur 2008, 2009) and Bikaner (Kumawat & Purohit 2021), while its northernmost known record in India is from Delhi (Barhadiya & Ghosh 2024). The present study further extends its documented occurrence to Jaipur City.

Acknowledging the previously mentioned limitations, the current data includes a subset of species likely to occur within Jaipur City, based on regional distribution and habitat continuity. The presence of *Ahaetulla laudankia* has been confirmed from Sariska Tiger Reserve in Rajasthan, representing a northern extension of its known range within the Aravalli system (Sengupta & Chandramouli 2020). Similarly, *Lycodon striatus* has been recorded from semi-arid rocky landscapes across northwestern India, including Rajasthan (Amarasinghe et al. 2023). Both *Myriopholis blanfordi* and *M. macrorhyncha* / *M. hamulirostris* complex (fide Wallach et al. 2014; Boundy 2020; Moradi et al. 2024) have historically been reported from arid and semi-arid regions of northwestern India, including records from Ambala (Haryana) and from Pilani and Jodhpur (Rajasthan). At the same time, the aforesaid taxa have also been confirmed from multiple localities in Gujarat (Patel et al. 2022). Their occurrence across the arid and semi-arid belt of the Aravalli-associated landscapes makes their presence in the peri-urban fringes of Jaipur ecologically plausible, even if undetected by rescue-based surveys that necessarily under-represent small burrowing snakes. *Psammophis leithii* is widely distributed across northwestern India and occupies habitat types comparable to those persisting in Jaipur's peri-urban landscape (Whitaker & Captain 2004). These species are associated with rocky outcrops, scrublands, open plains, and dry deciduous habitat mosaics that continue to persist in fragmented form within and around Jaipur City. Given their broad regional distribution and repeated records from areas immediately surrounding Jaipur, their complete absence from the intervening urban matrix appears unlikely. Their non-detection is therefore interpreted as a consequence of low encounter probability rather than ecological unsuitability.

In conclusion, urban ecology often exposes dissonance between how cities are envisioned and planned and the wildlife they inadvertently host. Among these, snakes remain particularly misunderstood and structurally excluded from urban decision-making, despite their continued persistence in densely modified landscapes. The present study, with its contribution to the existing literature and its exposed limitations, highlights the need for a more systematic, standardised, and collaborative framework for documenting urban snake diversity in Jaipur. Integration of rescue networks through coherent long-term data collection by volunteers trained in basic snake ecology, responsible data sharing, and supervision by relevant authorities seems to be the way forward.

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