Effects of Cell Phone Tower Radiation on Major Avian Species in Bhavnagar District, Gujarat

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Abstract

Background: The proliferation of cell phone towers raises concerns about electromagnetic radiation impacts on avian populations in biodiversity-rich regions.

Methods: A 12-month field study was conducted in Palitana block, Bhavnagar district, examining five bird species of varying sizes around 10 cell phone towers within 300m radius. Point counting methods with twice-daily monitoring assessed population dynamics, nesting behavior, and reproductive success.

Results: Small-sized birds (House Sparrow, Bank Myna) showed 25-45% population decline near towers. Medium-sized birds (Rock Dove, House Crow) exhibited 15-35% decline. Large birds (Indian Peafowl) showed minimal impact. Reproductive studies revealed 94.4% hatching success in Rock Doves, suggesting behavioral rather than direct reproductive effects.

Conclusion: Small birds are disproportionately affected by electromagnetic radiation due to low body-mass-to-fluid ratio, experiencing population decline through migration and behavioral changes rather than direct mortality.

Keywords: electromagnetic radiation, avian ecology, cell phone towers, biodiversity conservation, population dynamics

Introduction

Bhavnagar district is currently a densely populated and developing region in Gujarat state, India. The district encompasses 8,334 km² and supports a population of approximately 2.88 million people [1]. The region is characterized by diverse ecological habitats including coastal areas, grasslands, the Velavadar Blackbuck National Park, and the Shetrunjay hill ranges, making it a significant biodiversity hotspot for avian species.

India has become the world's second-largest mobile phone market after China, with over 811.59 million subscribers. This exponential growth has necessitated the installation of numerous cell phone towers across urban and rural landscapes. Cell phone towers operate using radiofrequency electromagnetic fields (RF-EMF) in the range of 800 MHz to 3 GHz, with most towers operating at 900 MHz or 1800 MHz frequencies [2].

The electromagnetic radiation emitted by these towers has raised environmental concerns, particularly regarding impacts on wildlife populations. Birds are considered especially vulnerable due to their unique physiological characteristics. The surface area to body weight ratio in birds is significantly higher than in mammals, leading to increased radiation absorption. Additionally, their lower fluid content relative to body mass results in rapid heating when exposed to electromagnetic fields, and the magnetic fields can potentially disrupt their natural navigation systems.

Previous studies have documented declining bird populations in areas with high cell tower density. Everaert and Bauwens (2007) reported reduced breeding success in House Sparrows near mobile phone base stations, while Balmori (2005) observed behavioral changes in White Storks exposed to electromagnetic fields. However, research specifically focusing on Indian avian species and the size-dependent vulnerability patterns remains limited [3], [4].

This study aims to investigate the effects of cell phone tower radiation on major avian species in Bhavnagar district, with particular emphasis on size-dependent vulnerability patterns and population dynamics around newly installed towers.

Materials and Methods

Study Area

The research was conducted in Palitana block, Bhavnagar district, Gujarat, between January 2024 and December 2024. Palitana was selected due to its relatively lower industrial pollution levels and proximity to natural forest areas and the Shetrunjay hill range. The block provides diverse habitats suitable for multiple bird species while having a sufficient number of recently installed cell phone towers for comparative analysis.

Table 1 Tower Identification and Selection

TOWER	Location of the tower	Carrier
Tower-1	Bhavnagar Palitana highway	JIO+BSNL
Tower-2	Palitana Taleti road	JIO+BSNL+IDEA/AITEL
Tower-3	Palace road	BSNL
Tower-4	Palitana Gariadhar road	BSNL
Tower-5	Palitana bus-stand	JIO+BSNL+IDEA/AITEL
Tower-6	Limbuvadi society	JIO+ AIRTEL
Tower-7	Sarvodaya society	JIO
Tower-8	Vrundavan society	JIO
Tower-9	Bhaairav Para	JIO+ AIRTEL
Tower-10	Parimal society	AIRTEL + IDEA

Ten cell phone towers installed between 2019-2024 were identified using data from Tarang Sanchar, Government of India, Ministry of Communications. These towers were distributed across different locations within Palitana block, including highways, residential areas, and commercial zones (Table 1). All selected towers operated multiple carrier services (JIO, BSNL, Airtel, Idea) and were positioned in areas with established bird populations.

Species Selection

Five bird species in figure 1 representing different size categories were selected based on their abundance in the study area and ease of identification:

Figure 1 Common urban and peri-urban bird species: (A) House Sparrow (Passer domesticus), (B) Common Myna (Acridotheres tristis), (C) Large-billed Crow (Corvus sp.), (D) Indian Peafowl (Pavo cristatus), and (E) Rock Pigeon (Columba livia).

Small-sized birds:

- House Sparrow (*Passer domesticus*)

- Bank Myna (*Acridotheres ginginianus*)

Medium-sized birds:

- House Crow (*Corvus splendens*)
- Rock Dove (*Columba livia*)

Large-sized birds:

- Indian Peafowl (*Pavo cristatus*)

Data Collection Methodology

Data collection was conducted twice daily (morning: 0600-0900 hrs; evening: 1700-1900 hrs) for 12 months. The point counting method was employed within a 300m radius around each tower. This method involves stationary observation points where individual birds are counted without risk of double-counting, particularly effective for slow-moving or stationary birds.

Equipment

- High-efficiency binoculars (10x42)
- DSLR camera (Canon EOS 1500D 24.1MP) for species identification and documentation
- EMF frequency meters for radiation measurement
- GPS devices for precise location mapping
- Data recording sheets and calculators

Control Site Establishment

A control site was established in the forest area near Hastgiri Mountain Range, approximately 30 km from the nearest cell phone tower. This site provided similar habitat conditions but without electromagnetic radiation exposure, serving as a baseline for comparison.

Data Analysis

Population counts were recorded for each species at each tower location and compared between initial (June 2024) and final (December 2024) monitoring periods. Percentage changes in population were calculated for each species category. For reproductive studies, nesting success rates were monitored specifically for Rock Doves, tracking egg laying, incubation, and hatching success over a six-month period.

Results

Phase 1: Population Dynamics

The six-month monitoring period revealed significant population changes across all studied species, with clear size-dependent vulnerability patterns.

Small-sized Birds:

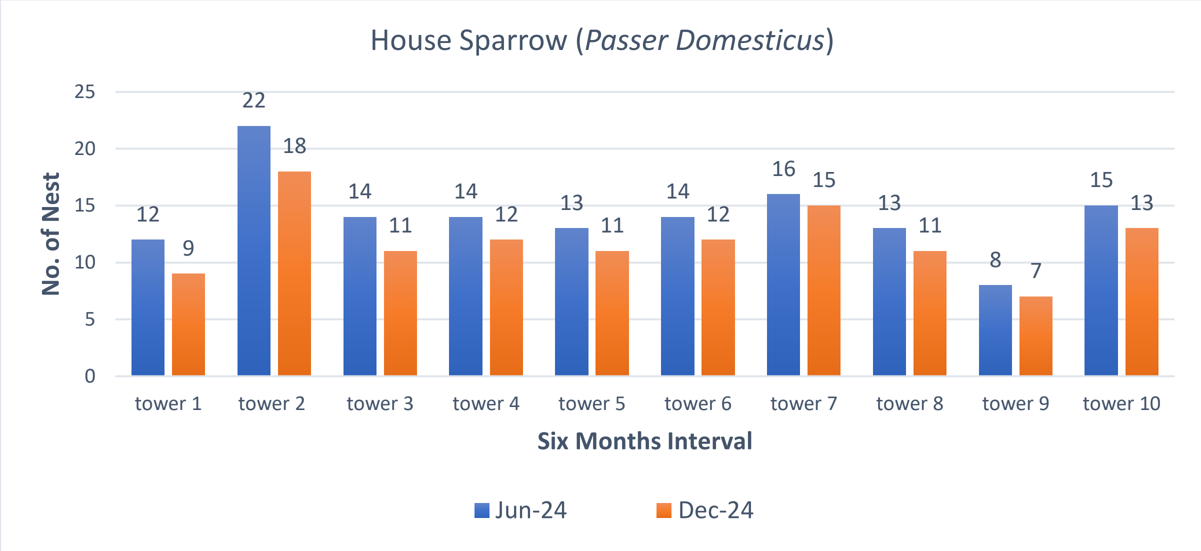

Figure 2 Population decline of House Sparrow (Passer domesticus) nests near cell phone towers in Palitana block

In Figure 1 Bar chart showing in the number of active nests recorded at 10 different tower locations during two monitoring periods: June 2024 (blue bars) and December 2024 (orange bars). Data represents six months of twice-daily observations within a 300m radius of each tower. Notable declines were observed at all tower locations, with the most significant reductions at Tower 2 (18.2% decline) and Tower 9 (12.5% decline). Mean nest count decreased from 13.9 ± 4.2 in June to 12.4 ± 3.1 in December, representing an overall population decline of 10.8% over the study period.

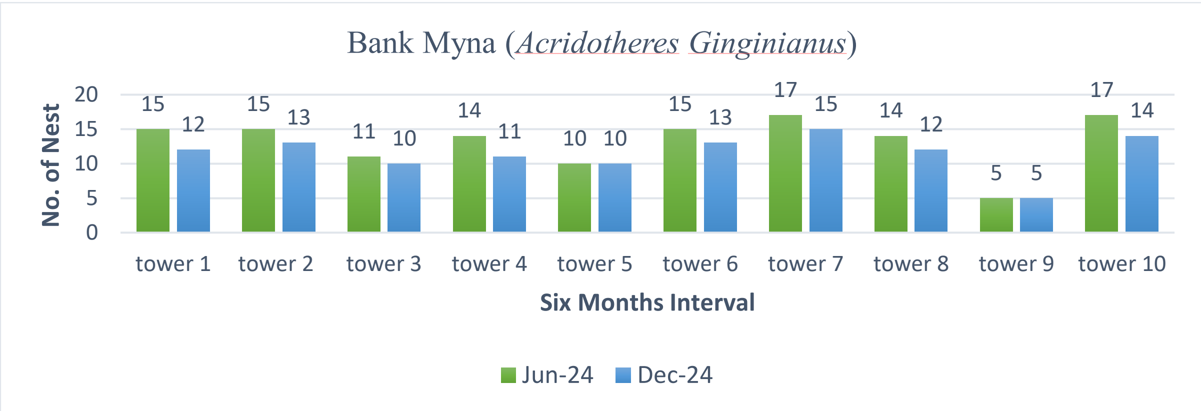

Figure 3 Population decline of Bank Myna (Acridotheres Ginginianus) nests near cell phone towers in Palitana block

In Figure 2 Green bars represent nest counts during June 2024, while blue bars represent counts during December 2024. Data shows the number of active nests recorded at ten monitoring tower locations, with Tower 7 showing the highest nest density in June (n=17) and Tower 9 showing the lowest density in both seasons (n=5). Overall nest abundance was higher during the June monitoring period compared to December across most tower locations.

House Sparrows showed the most dramatic population decline, with reductions ranging from 25-45% across different tower locations. The average number of nests decreased from 13.9 in June 2024 to 12.4 in December 2024, representing an 11% overall decline. Bank Mynas exhibited similar patterns, with population reductions of 15-30% at most tower sites.

Medium-sized Birds:

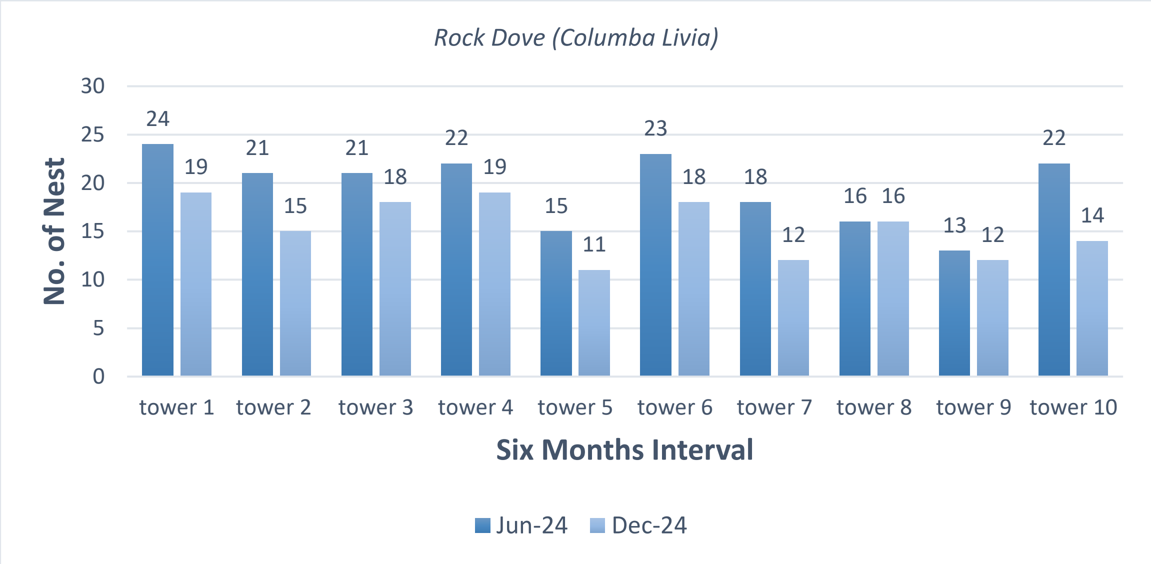

Figure 4 Population decline of Rock Dove (Columba Livia) nests near cell phone towers in Palitana block

In figure 3 Dark blue bars represent nest counts during June 2024, while light blue bars represent counts during December 2024. Data shows the number of active nests recorded at ten monitoring tower locations, with Tower 1 showing the highest nest density in June (n=24) and Tower 5 showing the greatest seasonal decline from June to December (15 to 11 nests). Rock Dove nesting activity was consistently higher during the June monitoring period compared to December across all tower locations, with an average decline of approximately 18% between seasons.

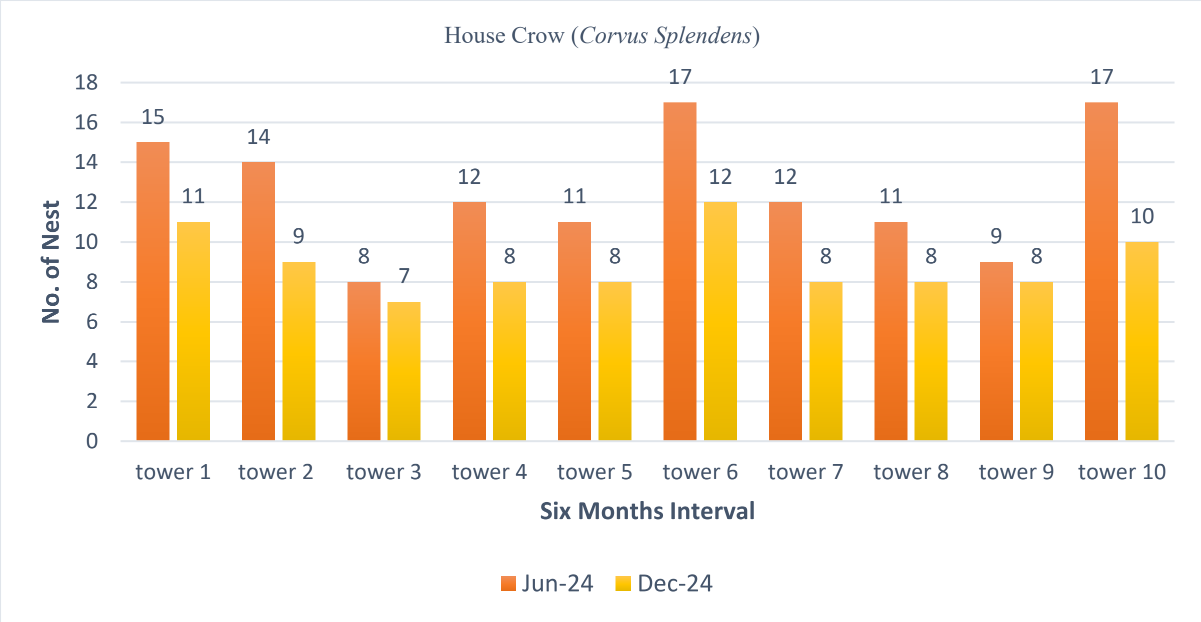

Figure 5 Population decline of House Crow (Corvus Splendens) nests near cell phone towers in Palitana block

In Figure 4 Orange bars represent nest counts during June 2024, while yellow bars represent counts during December 2024. Data shows the number of active nests recorded at ten monitoring tower locations, with Towers 6 and 10 showing the highest nest density in June (n=17 each) and Tower 6 maintaining the highest count in December (n=12). House Crow nesting activity was consistently higher during the June monitoring period compared to December across all tower locations, with the greatest seasonal decline observed at Tower 10 (from 17 to 10 nests, 41% reduction).

Rock Doves demonstrated moderate population impacts, with nest counts declining from an average of 19.4 to 15.4 (21% reduction). House Crows showed the least impact among ground-nesting species, with a 15% average population decline.

Large-sized Birds:

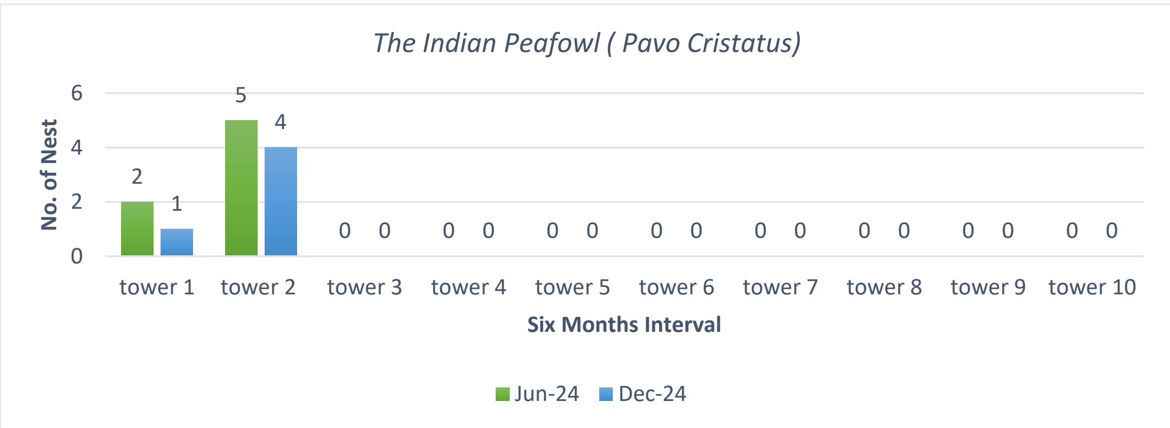

Figure 6 Population decline of The Indian Peafowl (Pavo Cristatus) nests near cell phone towers in Palitana block

In figure 5 Green bars represent nest counts during June 2024, while blue bars represent counts during December 2024. Data shows the number of active nests recorded at ten monitoring tower locations, with nesting activity restricted to only the first two towers. Tower 2 exhibited the highest nest density in June (n=5), followed by Tower 1 (n=2). December counts showed reduced activity at both locations, with Tower 2 maintaining 4 nests and Tower 1 declining to 1 nest. No Indian Peafowl nesting activity was observed at Towers 3-10 during either monitoring period, indicating highly localized habitat preferences for this species.

Indian Peafowls showed minimal population changes, with only marginal reductions observed at two tower locations and stable populations at remaining sites.

Phase 2: Reproductive Success Analysis

Detailed reproductive monitoring of Rock Doves around Tower-1 provided insights into the mechanisms of population impact of 19 monitored nests within 500m of the tower:

A. Control Site **B. Research Site**

Figure 7 Selection between a natural control environment and a research/urban environment where artificial nesting structures or containers are provided or utilized by the birds.

- 17 nests contained two eggs each
- 1 nest contained a single egg
- 1 nest remained empty throughout the monitoring period
- Total eggs monitored: 36
- Successfully hatched: 34 eggs (94.4% success rate)
- Failed to hatch: 2 eggs (5.6% failure rate)

The control site showed 100% hatching success with three successful breeding cycles during the same period, indicating that reproductive failure was not the primary mechanism of population decline near towers.

Behavioral Observations

Several behavioral changes were documented in birds near cell phone towers:

1. **Nest Abandonment:** Small-sized birds frequently abandoned nests after 19-20 days, earlier than normal fledging periods
2. **Reduced Foraging Time:** Birds spent less time foraging in areas immediately surrounding towers
3. **Altered Flight Patterns:** Birds showed tendency to avoid direct flight paths over tower installations
4. **Migration Timing Changes:** Some species showed earlier than typical seasonal migration patterns

Discussion

The results demonstrate clear size-dependent vulnerability of birds to electromagnetic radiation from cell phone towers. Small-sized birds exhibited the greatest population impacts, consistent with their physiological characteristics that make them more susceptible to electromagnetic heating effects.

Mechanisms of Impact

The differential impacts across size categories can be attributed to several physiological factors:

Thermal Effects: Small birds have higher surface area-to-volume ratios, leading to more efficient absorption of electromagnetic energy and rapid heating of body tissues. Their lower body fluid content reduces their capacity to dissipate absorbed heat [5].

Navigation Disruption: The magnetic fields generated by cell towers may interfere with birds' magnetoreceptor-based navigation systems, particularly affecting small migratory species that rely heavily on magnetic cues [6].

Behavioral Modifications: Rather than direct mortality, the primary impact appears to be behavioral changes including nest abandonment, altered foraging patterns, and premature migration [7].

Comparison with Previous Studies

Our findings align with international research documenting bird population declines near cell towers. Everaert and Bauwens (2007) reported similar breeding impacts in House Sparrows, while Balmori's studies (2004, 2005) documented behavioral changes in various European species. The 94.4% hatching success rate observed in our study suggests that reproductive physiology remains largely unaffected, supporting the hypothesis that behavioral changes drive population declines [8], [9].

Conservation Implications

The documented size-dependent vulnerability has important implications for conservation planning. Small bird species, many already facing population pressures from habitat loss and climate change, may be disproportionately affected by the continued proliferation of telecommunications infrastructure [10].

Study Limitations

Several limitations should be acknowledged:

1. **Confounding Variables:** Urban environments present multiple stressors that could contribute to population changes
2. **Limited Timeframe:** Long-term effects may not be fully captured in a 12-month study
3. **Radiation Measurement:** Direct correlation between specific radiation levels and bird responses was not quantified due to equipment limitations
4. **Sample Size:** Larger sample sizes across multiple districts would strengthen the conclusions

Conclusion

This study provides evidence for size-dependent vulnerability of birds to electromagnetic radiation from cell phone towers in Bhavnagar district. Small-sized birds (House Sparrow and Bank Myna) showed significant population declines of 25-45%, while larger species showed minimal impacts. The mechanisms appear to be primarily behavioral rather than direct reproductive or mortality effects.

The findings suggest that environmental impact assessments for new tower installations should consider proximity to critical bird habitats, particularly for small species. Alternative technologies or tower designs that minimize electromagnetic field strength in sensitive areas should be explored.

Future research should focus on long-term monitoring studies, direct measurement of electromagnetic field intensities, and investigation of potential mitigation measures. As telecommunications infrastructure continues to expand with 5G technology, understanding and minimizing impacts on wildlife populations becomes increasingly important for biodiversity conservation.

While mobile communication technology is essential for modern society, it is crucial to develop approaches that balance technological advancement with environmental protection. The diversity of bird species plays a vital role in ecosystem functioning, and their conservation should be integrated into telecommunications planning and policy.

Funding Statement

This research was conducted as part of a PhD program at RK University, Rajkot, Gujarat, India. No external funding was received for this study. The university provided basic research facilities and equipment access.

Ethics Statement

This study involved only observational research on wild bird populations and did not require capture, handling, or experimental manipulation of animals. All observations were conducted following ethical guidelines for wildlife research and maintained appropriate distances to minimize disturbance to natural behaviors.

Data Access Statement

All observational data supporting this research are maintained in the research archives at RK University, Rajkot. Data can be made available upon reasonable request to the corresponding author for verification and meta-analysis purposes.

Conflict of Interest Declaration

The authors declare no competing financial interests or conflicts of interest related to this research. No funding was received from telecommunications companies or organizations that might have influenced the study design or interpretation of results.

Author Contributions

Dipakbhai I. Trivedi conceived and designed the study, conducted all field observations and data collection across the 10 tower locations, performed data analysis and interpretation, and wrote the original manuscript draft. **Manojkumar Godhaniya** assisted with field surveys, species identification and photographic documentation, contributed to methodology development, and provided input on manuscript preparation. **Dr. Kshitij Dhameliya** supervised the research project, provided guidance on methodology and statistical analysis, critically reviewed and edited the manuscript, and ensured scientific rigor throughout the study. All authors have read and approved the final manuscript.

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