

Tracking from the traces: forensic tools to combat Galliformes trafficking

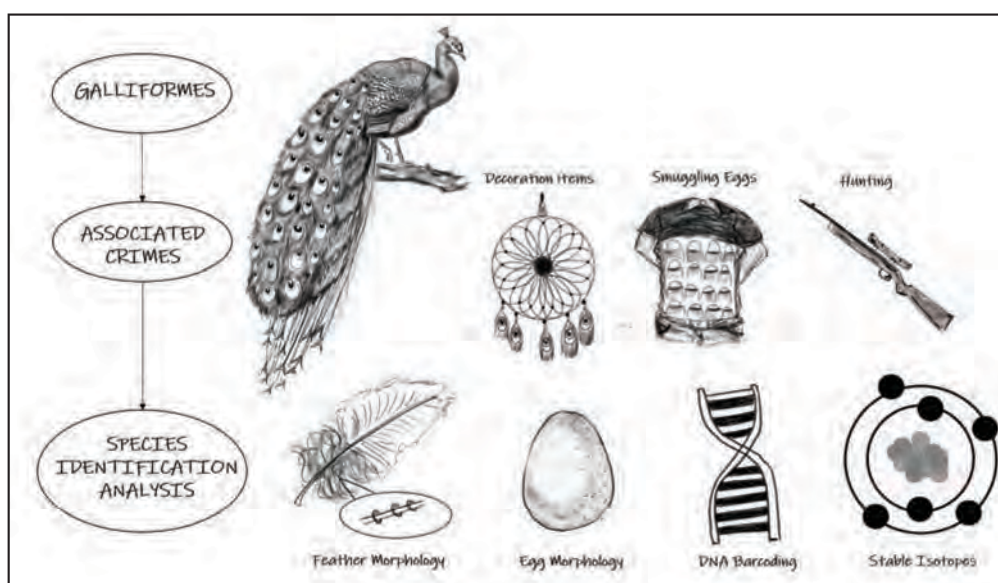
“Stolen from the wild, secretly sold in silence” – illegal wildlife trade is a major threat to global biodiversity. Wildlife crime thrives in secrecy, but forensic science uncovers the truth. It isn’t just about poaching, it is a multibillion-dollar illegal industry where feathers, meat, bones, and eggs are monetized. India ranks among the top 20 countries, serving both as a source and transit country for wildlife products. According to NCRB (National Crime Records Bureau) data, seven (7) Indian states registered for large number of wildlife crime cases in the last eight years (2014–2021) (Rana & Kumar 2023). What was once practised for subsistence has now turned into a ruthless trade, and India has become a major hub for wildlife trafficking.

Illegal bird trade is a growing concern in India, with Galliformes among the most commonly trafficked groups. Of the 290 species worldwide, over 25% are at risk of extinction

as per IUCN (McGowan & Garson 2002). India has a rich diversity of 43 Galliformes, all are protected under the Wildlife (Protection) Act, 1972, including 22 Schedule-I species and 21 Schedule-II species. Recently, the IUCN Red List categorized two species as ‘Critically Endangered’ (*Perdica manipurens* & *Ophrysia superciliosa*), one as ‘Endangered’ (*Pavo muticus*), five as ‘Vulnerable’ (*Megapodius nicobariensis*, *Tragopan melanocephalus*, *Tragopan blythii*, *Syrmaticus humiae*, & *Catreus wallichii*), three as ‘Near Threatened’ (*Arborophila mandellii*, *Ortygornis gularis*, & *Coturnix japonica*), and the remaining 32 as ‘Least Concern’ (Praveen & Jayapal 2025).

Threats to Galliformes

Gamebirds are targeted for plumage, meat, sport, and cultural value. Poachers use traps, and even raise chicks from wild eggs using domestic fowls and sell as an ornamental pet



An illustration depicting the bird-associated crimes and modes of species identification using forensic ornithology.

(Aiyadurai 2011). Exotic Galliformes are also bred in zoos and private aviaries for aviculture collection in India (Fernandes 2018).

Meanwhile, ornamental pheasants especially the *Pavo cristatus*, is admired for its vibrant feathers and deep cultural significance in Indian culture. Peacock feathers can be found being sold in market places-they have become an inseparable part of tradition, spirituality, and fashion. With rising demand, feathers are widely sold via e-commerce platforms for use in souvenirs, costume decorations, fashion accessories, and craft materials (Singh & Israruddin 2022). Even, social media platforms (Sharma 2024) have further fueled this trend, making these colorful feathers a must-have accessory in every household. Though Indian law permits the legal domestic trading of naturally shed feathers, poachers often trim the base, making it difficult to distinguish between illegally plucked ones, thereby raising concerns about their true origin. In the battle against this crime, forensic ornithology is emerging as a breakthrough.

Forensic Ornithology

1. Morphological analysis: Feather morphology

Feathers are key evidences in forensic ornithology. A feather consists of a calamus, rachis, barbs, barbules, and sometimes afterfeather. Pennaceous barbs interlock with hooklets and plumulaceous barbs have nodes and internodes. This arrangement vary across different feather types such as contour, flight, down, semiplume, filoplume, and bristle. Under a light microscope & scanning electron microscope, structures like hooklets, ventral

teeth, cilia, spined nodes, and ring nodes can be observed in Galliformes feathers. The diagnostic characteristic ring nodes along with multiple ring nodes (multiple anuli) are distinguishable characteristic feature (Dove & Koch 2010) (Figure). Therefore, a reference feather database can aid law enforcement for solving mysteries related to Galliformes cases (Sabat et al. 2025). Egg morphology: Galliformes eggs are typically oval to elliptical and show distinct variation in size, color, and shell texture.

A morphometric and photographic egg database would be useful for identifying smuggled eggs (Ivan et al. 2015; Hicks et al. 2023).

2. Molecular analysis: DNA barcoding

This technique uses mitochondrial gene to identify species from degraded samples like blood, tissue, eggshell membranes, and feathers. DNA is extracted, amplified, FINS (forensically informative nucleotide sequencing) sequenced, and compared with databases like NCBI (National Center for Biotechnology Information) and DDBJ (DNA Data Bank of Japan) (Singh et al. 2020). This approach is vital where traditional morphological analysis is challenging and when the samples are in ornamental forms and not in its original form.

3. Stable isotope analysis

This emerging tool traces the origin, animal diet, migration pattern, and distinguish wild from captive birds by analyzing natural variations in stable isotopes like carbon ($^{13}\text{C}/^{12}\text{C}$, $\delta^{13}\text{C}$), and nitrogen ($^{15}\text{N}/^{14}\text{N}$, $\delta^{15}\text{N}$). For instance, $\delta^{13}\text{C}$ values are influenced by relative proportion

of C3 and C4 plants at the base of the food chain whereas $\delta^{15}\text{N}$ values are influenced by diet and trophic position. This technique, thus, helps in verifying wild birds from those raised in captivity, as captive diets tend to be more uniform and reflect artificial feeding regimes (Hill et al. 2025).

With rising avian crimes, forensic ornithology is advancing through tools like scanning electron microscopy, UV vis spectroscopy, transmission electron microscopy for accurate species identification. Studies like Ray et al. (2022) on the Common Myna highlight the need for more feather-based research in India. Expanding plumology and developing comprehensive forensic databases will significantly aid law enforcement in protecting both native and exotic avifauna. To achieve further databases for different birds, wildlife forensic laboratories must be modernized and staffed with skilled technicians. By building strong forensic databases, we will not just be identifying birds, we could give them a voice to fight against wildlife crime.

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