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Ecological and life history aspects of the Kalij Pheasant *(Lophura leucomelanos)* (Latham, 1790): An in-depth review

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Abstract The Kalij Pheasant *(Lophura leucomelanos)* is a widely distributed galliform and an important indicator species of the Himalayan ecosystems. It demonstrates remarkable ecological adaptability, occupying diverse habitats ranging from subtropical forests to temperate mountain regions across the Himalayas and Southeast Asia. This review synthesizes current knowledge on its distribution, population status, morphology, habitat preferences, feeding habits, social structure, breeding behaviour, and conservation challenges, while highlighting critical research gaps. Although classified as Least Concern globally, the species remains poorly studied across its distributional range with emerging evidence of localized declines due to anthropogenic pressures. It exhibits pronounced sexual dimorphism, with males showing conspicuous plumage and females relying on cryptic coloration. Kalij Pheasant typically inhabit mid-elevation zones (up to 2,500 m), preferring dense understory vegetation and proximity to water sources, but may also be found at lower and higher elevations depending on resource availability and human disturbances. The omnivorous diet of Kalij Pheasant includes seeds, fruits, leaves, insects and small invertebrates, reflecting its role in forest ecosystem dynamics. Although territorial and vocal behaviours are well documented, their mating system remains unclear, with studies implicating both monogamous and facultatively polygynous tendencies. Hybridization between subspecies is reported across its range, however, the genetic consequences of this phenomenon remain unexplored. Despite its ecological flexibility, the species faces increasing threats from habitat degradation, hunting, and human encroachment. Conservation efforts should incorporate advanced technologies such as GPS tracking, remote sensing, and molecular techniques to gain deeper insights into the species' behaviour, movement patterns, habitat use, and genetic diversity. Addressing these gaps will enhance our understanding of the Kalij Pheasant's ecology and help inform conservation strategies for this important bird species.

Keywords: conservation, Galliformes, ecology, Kalij Pheasant, Himalayas

Összefoglalás Az ördögfácán *(Lophura leucomelanos)* egy széles körben elterjedt fácánfaj, amely élőhelyein indikátorfajként működik. Figyelemre méltó ökológiai alkalmazkodóképességgel rendelkezik, a Himalája és Délkelet-Ázsia szubtrópusi erdőin át a mérsékelt égövi régiókig különböző élőhelyeken fordul elő. Áttekintő cikkünkben részletesen megvizsgáltuk a faj ökológiáját, különös tekintettel elterjedésére, morfológiájára, élőhelypreferenciáira, táplálkozási szokásaira, szociális kapcsolataira, szaporodási viselkedésére és a természetvédelmi problémáira, miközben kiemeljük a fajjal kapcsolatos kutatások legfontosabb hiányosságait. A fajra ivari dimorfizmus jellemző, a hímek feltűnő tollazatot viselnek, míg a tojók rejtőzködő színezete az álcázást szolgálja. Az ördögfácán elsősorban a középmagasságú zónákban (2500 méterig) él, ahol a sűrű aljnövényzetet és a vízforrások közelségét kedveli, de az erőforrások elérhetőségétől és az emberi zavarástól függően alacsonyabb és magasabb tengerszint feletti magasságokban is előfordulhat. Széles a táplálkozási spektruma, magvakat, gyümölcsöket, leveleket, rovarokat és kisebb gerinceleneket fogyaszt, ami tükrözi az erdei ökoszisztéma dinamikájában betöltött szerepét. A megfigyelések bonyolult vokális és territoriális viselkedésről árulkodnak, de a párválasztási rendszer továbbra is tisztázatlan, mivel a vizsgálatok szerint a faj monogám és fakultatív poligám tendenciákat

egyaránt mutat. Az alfajok közötti hibridizációról az egész elterjedési területéről beszámoltak, azonban e jelenség genetikai következményeit még nem vizsgálták. Alkalmazkodóképessége ellenére a faj egyre nagyobb veszélynek van kitéve az élőhelyének romlása, a vadászat és az emberi jelenlét miatt, különösen az alacsonyabban fekvő területeken. Annak érdekében, hogy a faj mozgási szokásainak, élőhelyhasználatának és genetikai sokféleségének megismerésével hatékony természetvédelmi intézkedéseket lehessen bevezetni, fejlett technológiát (GPS nyomkövetés, távérzékelés, molekuláris technológiák) kell alkalmazni.

Kulcsszavak: természetvédelem, tyúkalakúak, ökológia, ördögfácán, Himalája

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Introduction

Pheasants (Galliformes: Phasianidae) represent a fascinating suite of ground-dwelling birds in their ecosystems (Fuller & Garson 2000). The family Phasianidae is a vast and ancient family of gallinaceous birds distributed all over the world, comprising of over 180 species and 54 genera, including pheasants, grouses, turkeys, chickens, junglefowls, and quails. The higher diversity of the family occurs in Southeast Asia and Africa (del Hoyo *et al.* 1994, McGowan & Garson 1995, Fuller & Garson 2000). To date, 51 species of pheasants have been recognized in the world (IUCN 2024), of which 50 species are endemic to Asian countries (Fuller & Garson 2000). The sole exception is the Congo Pheasant *(Afropavo congensis)* which is restricted to Zaire in Central Africa (Crowe *et al.* 1986).

Pheasants occupy diverse habitat types ranging from lowland tropical forests (e.g. Crested Fireback *Lophura ignita*), coniferous forests, scrubs, deserts to alpine regions (e.g. Chinese Monal *Lophophorus lhuysii*) in the Himalayas (Ramesh 2003, Sathyakumar *et al.* 2010). They play a phenomenal role in maintaining the food webs of high-altitude ecosystems by forming the primary prey base for raptors and carnivores (Johnsgard 1999) and also acting as excellent seed dispersers. They prefer fragile and undisturbed habitats, exhibiting intense predilection for their environments. By acting as valuable ecological indicators, pheasants determine the health status of an ecosystem (Bhattacharya *et al.* 2009, Grainger *et al.* 2018).

Given the radical land-use changes and habitat disturbances in many parts of the Himalayas, pheasants are facing precipitous population declines over the years owing to several anthropogenic factors (Lawes *et al.* 2006, Bhattacharya *et al.* 2009, Miller 2010, Storch 2013, Zhou *et al.* 2015, Furqan & Ali 2022). Around 20% of pheasant species are threatened with extinction (IUCN 2024). Habitat degradation, hunting, and increased urbanization being the primary drivers of this decline (Ramesh 2003, McNew *et al.* 2013, Gray *et al.* 2018), and these may lead many more species to the verge of extinction in the wild in near future (Dunn *et al.* 2016, Chhetri *et al.* 2018).

The Kalij Pheasant *(Lophura leucomelanos)* belongs to a group of pheasants commonly monikered as the Gallopheasants. Nine subspecies – native to the Southeast Asian and Himalayan forests – have been identified so far, differing morphologically and geographically (Johnsgard 1999). Despite its wide distribution and ecological significance,

the various aspects of the Kalij Pheasant remain understudied (Andleeb *et al.* 2012). Listed as Least Concern by the International Union for Conservation of Nature (IUCN) (BirdLife International 2021), the global population status of the Kalij Pheasant is declining due to various factors such as habitat degradation, illegal hunting, and forest fires (Hussain *et al.* 2002, Andleeb *et al.* 2012, Furqan & Ali 2022). The mapped range of the species has declined by 11.2% over the past three generations, leading to a population decline of between 1–19% during the same period (BirdLife International 2021).

Given its vital role in ecosystems, its adaptability to various habitat types and the conservation issues it faces across its distributional range, a detailed and comprehensive review of the Kalij Pheasant is necessary. This paper aims to synthesize existing knowledge on its various ecological aspects (distribution, population status, habitat preferences, feeding habits, breeding behaviour, social structure, and conservation status) to highlight research gaps and guide future studies. By consolidating the available literature, this review will contribute to a better understanding of the Kalij Pheasant and support evidence-based conservation strategies.

Material and Methods

To ensure a thorough and comprehensive review of the existing information, we conducted an extensive literature survey mainly focusing on research articles from 1970 to 2024. Our search strategy involved the use of multiple academic databases and search engines including Google Scholar, Scopus, PubMed, Web of Science, ResearchGate, and JSTOR. We employed a range of relevant keywords such as 'Galliformes', 'Pheasants', 'Kalij Pheasant habitat', 'Kalij Pheasant diet', 'Kalij Pheasant behaviour', 'Kalij Pheasant threats' and 'Kalij Pheasant conservation' to retrieve all pertinent studies related to the species. This systematic and comprehensive search yielded over 1,000 research papers. After critical investigation of the collected literature, we identified around 180 papers that focused on pheasants in general. From this subset, 60 papers were found directly relevant to our research topic, providing essential information on various ecological aspects of the Kalij Pheasant, including its distribution, status, habitat selection, dietary ecology, behavioural patterns, and conservation challenges. These selected studies formed the scientific foundation of our research, enabling a more detailed understanding of the species and its ecological interactions.

Discussion

Distribution

The Kalij Pheasant has the widest distribution among all the pheasant species. Its natural range extends from western Himalayas in Pakistan, through northern India, Nepal, Bhutan, Sikkim, Assam and parts of Myanmar, reaching as far east as western Thailand *(Figure 1)* (McGowan & Panchen 1994, Johnsgard 1999, BirdLife International 2016, Akhter 2023).

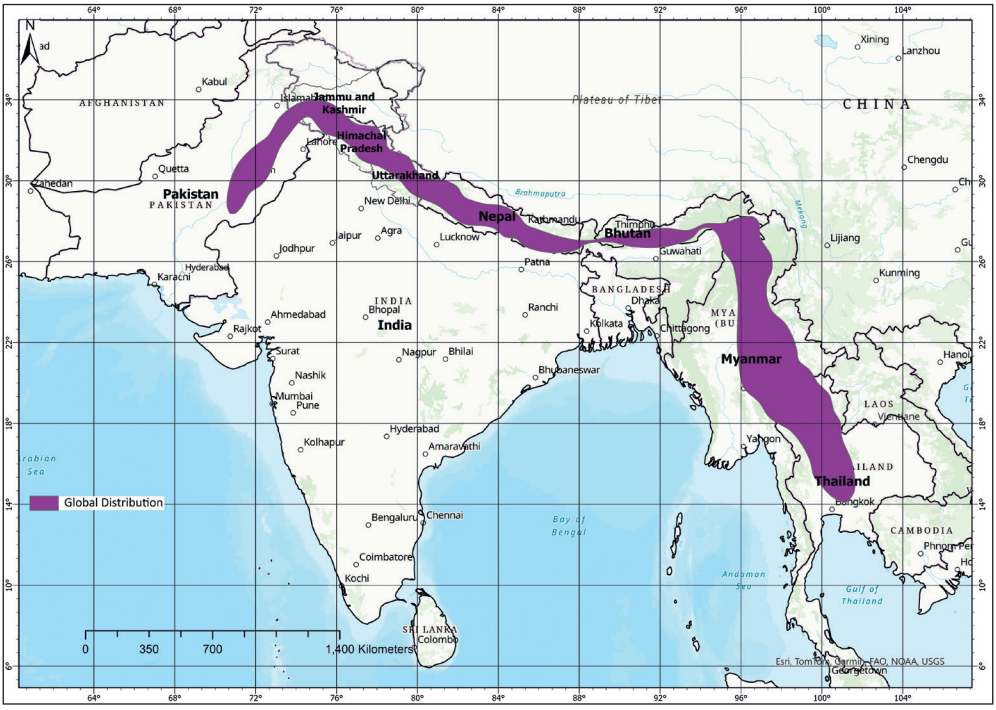

Figure 1. Global distribution of the Kalij Pheasant
1. ábra Az ördögfácán globális elterjedése

The species has also been introduced outside its native range, particularly in the Hawaiian Islands and parts of the United States, where it has adapted well to captivity and semi-wild conditions (Pratt 1976). The Kalij Pheasant is primarily found on the western side of the Himalayan mountains (Barnes 1981), generally adapted for sedentary lifestyles and occurring along foothills, woodland roads, forest clearings, bushy ravines and frequently encountering human habitations (Bump & Bohl 1961, Ali & Ripley 1983, Bisht *et al.* 2002). In India, four subspecies of Kalij Pheasant are known, which inhabit almost all forest types with a thick undergrowth of shrubs (Grimmett *et al.* 2016).

Despite their extensive distribution, the Kalij Pheasant show considerable geographical variation across their range, leading to the recognition of nine subspecies *(Table 1)*. Among these, the White-crested Kalij Pheasant *(L. l. hamiltoni)* is the westernmost subspecies found in the Indian states of Jammu and Kashmir, Uttarakhand, and Himachal Pradesh. On 21st October 2021, the Government of Jammu and Kashmir declared the White-crested Kalij Pheasant as its Union Territory (UT) bird.

Morphology and adaptations

As one moves from west to east across the Kalij Pheasant's distributional range, the male's plumage gradually changes. Generally, subspecies in the western and central parts of their range (White-crested Kalij, Nepal Kalij, Black-backed Kalij, Black Kalij, Horsefield's

Table 1. Various subspecies of the Kalij Pheasant and their distributional range
1. táblázat Az ördögfácán különböző alfajai és azok elterjedési területe

S. No.	Subspecies	Common name	Distribution
01.	*Lophura leucomelanos hamiltoni*	White-crested Kalij	Western Himalayas
02.	*Lophura leucomelanos leucomelanos*	Nepal Kalij	Forests of Nepal
03.	*Lophura leucomelanos melanota*	Black-backed Kalij	Sikkim and Bhutan
04.	*Lophura leucomelanos moffiti*	Black Kalij	Central Myanmar
05.	*Lophura leucomelanos lathami*	Horsefield's Pheasant	Eastern Bhutan and northern India to Myanmar
06.	*Lophura leucomelanos williamsi*	Williams' Kalij	Western Myanmar
07.	*Lophura leucomelanos oatesi*	Oates' Kalij Pheasant	Southern Myanmar
08.	*Lophura leucomelanos crawfurdi*	Crawfurd's Pheasant	Southeastern Myanmar to Thailand
09.	*Lophura leucomelanos lineata*	Lineated Pheasant	Southern Myanmar to northwestern Thailand

Pheasant) have a glossy bluish-black plumage with white rumps, while those in the eastern regions (Williams' Kalij, Oates' Kalij Pheasant, Crawfurd's Pheasant, Lineated Pheasant) exhibit thicker vermiculation and more extensive white markings on the tail and upperparts (Herman 1986, McGowan 1994). The westernmost subspecies (White-crested Kalij) is distinguished from the rest of the subspecies by its white crest, while all other subspecies have a bluish-black crest *(Figure 2)*. In contrast, females of all subspecies exhibit less variation and are uniformly brownish. Despite these morphological variations, all Kalij Pheasants share key characteristics, such as a red facial patch and grey legs, a feature that differentiates them from the closely related Silver Pheasant *(Lophura nycthemera)*, which has red legs (McGowan & Panchen 1994). Further studies on subspecies variation, especially in relation to environmental factors and potential genetic divergence, would be valuable for refining conservation strategies for this widely distributed species.

Despite distinct morphological differences and geographical preferences (Johnsgard 1999), hybridization between different subspecies has been reported in areas where subspecies' ranges overlap (Herman 1986). This is particularly evident in introduced populations such as those in Hawaii, where individuals show mixed characteristics of White-crested Kalij Pheasant and Horsefield's Kalij (Pratt 1976). However, the genetic implications of such hybridization on survival and adaptability remain poorly studied, indicating a critical research gap that could be explored using molecular phylogenetics.

The Kalij Pheasant exhibits pronounced sexual dimorphism, with males displaying striking bluish-black plumage, a prominent white/bluish black crest, and a contrasting white rump, while females have cryptic brownish coloration that blends seamlessly with their surroundings (Zeng *et al.* 2016). This sexual dichotomy may play a crucial role in survival strategies, as the subdued plumage of females provides effective camouflage, reducing predation risk, especially during nesting and chick-rearing periods. In contrast, the conspicuous appearance of males, though advantageous for attracting mates, and establishing dominance also makes

Figure 2. White-crested Kalij Pheasant (A: Male with a white crest, B: Female, © Arif Nabi)
2. ábra Ördögfácán (A: hím fehér koronával, B: tojó, © Arif Nabi)

them more visible to predators and hunters. This increased vulnerability is particularly pronounced in winter when reduced foliage cover exposes them further, likely contributing to higher hunting pressures on males compared to females (Lone *et al.* 2024).

While the adaptive significance of these morphological differences is well recognized, several knowledge gaps remain. The extent to which male plumage variation influences mating success or dominance hierarchies in Kalij Pheasant has not been thoroughly examined. Furthermore, while the cryptic coloration of females is assumed to enhance survival, quantitative studies assessing its effectiveness in different habitat types and levels of disturbance are lacking. Additionally, the role of environmental factors, such as seasonal changes and habitat degradation, in influencing plumage maintenance, and survival strategies warrants further investigation. Understanding these aspects could provide deeper insights into the adaptive evolution of sexual dimorphism in Kalij Pheasant and its implications for their conservation in varying ecological conditions.

Population status

Despite its wide distribution, the population status of the Kalij Pheasant remains largely understudied across much of its range, particularly in the western Himalayas. The species is currently categorized as Least Concern by the IUCN (BirdLife International 2021) due to its extensive distribution; however, localized population trends suggest varying degrees of decline, primarily attributed to anthropogenic pressures such as habitat degradation, illegal hunting, and increasing human encroachment (Hussain *et al.* 2002, Furqan & Ali 2022, Lone *et al.* 2024). Studies by Selvan *et al.* (2013) reported a population density of 6.7 birds/km^2 of Kalij Pheasant in the eastern Himalayas of Arunachal Pradesh, India. Similarly, Subedi (2006) while working on the Nepal Kalij in central Himalayas of Nepal, documented population densities ranging from 8.9 birds/km^2 in October to 1.94 birds/km^2 in March.

Furqan *et al.* (2024) while working on habitat suitability of Kalij Pheasant in Mirpur Division of Azad Jammu and Kashmir, Pakistan, reported a maximum population density of 2.33 birds/ha from Gaian area followed by Glater palian with 1.67 birds/ha.

In regions like Jammu and Kashmir, reliable population estimates remain scarce and are often inferred through indirect methods such as field sightings. Preliminary observations from protected areas suggest that while the Kalij Pheasant may be locally common in undisturbed habitats, its populations are fragmented and potentially declining in degraded landscapes (Hussain *et al.* 2002). A recent study by Lone *et al.* (2024) on population status of White-crested Kalij Pheasant in Limber Wildlife Sanctuary of western Himalayas recorded the highest mean encounter rate of 2.25 birds/km of transect walk. They also observed male-biased sex ratio for the Kalij Pheasant, with the highest mean flock size of 3.38 individuals. There is a pressing need for systematic, long-term population monitoring using standardized techniques such as distance sampling, call counts, and camera trapping to better understand population dynamics of the Kalij Pheasant and inform conservation strategies.

Habitat and altitudinal preferences

The Kalij Pheasant exhibits remarkable ecological plasticity, inhabiting a wide range of habitats from subtropical forests to temperate montane regions. It is largely sedentary, preferring forested foothills and mountainous areas between 600 m and 3,400 m altitude (Delacour 1977, Johnsgard 1999). The species is commonly associated with broad-leaved forests, temperate deciduous and mixed forests, riparian zones, grassy slopes and even agricultural landscapes near human settlements (Ali & Ripley 1983, McGowan & Panchen 1994, Zeng *et al.* 2016, Lone *et al.* 2024). However, it shows strong preference for habitats with dense shrub understory, which provides essential cover for foraging and protection (Madge *et al.* 2002, Grimmett *et al.* 2016). The species flourishes in dense undergrowth in subtropical and temperate forests, often near water sources (Sathyakumar & Kaul 2007). The presence of dense undergrowth is necessary for the species' foraging and nesting behaviour, besides offering protection from predators (Lone *et al.* 2024). Shrub density appears to be a critical factor in habitat selection, as studies have documented that Kalij Pheasant favours areas with abundant understory vegetation and minimal tree or grass cover (Sathyakumar *et al.* 1992). Additionally, the species frequently occurs near water sources, especially in drier seasons, suggesting that water availability is a key determinant of habitat suitability (Sathyakumar & Kaul 2007, Dohling & Sathyakumar 2011, Furqan *et al.* 2024).

In terms of altitudinal distribution, the Kalij Pheasant is generally found at mid-elevations, with most sightings occurring below 2,500 m. It is frequently observed between 450 m and 2,150 m (Lewin & Lewin 1984), with similar trends reported from the upper Beas Valley of Himachal Pradesh (1,200–2,500 m) (Gaston *et al.* 1981) and Garhwal Himalayas (< 2,400 m) (Chandola-Saklani *et al.* 1988). Studies by Hussain and Sultana (2013) likewise observed Kalij Pheasant occurring below 2,700 m in Kumaon Himalayas, Uttarakhand. Recent study from Jammu and Kashmir confirms a higher occurrence of Kalij Pheasant below 2,300 m (Lone *et al.* 2024). This altitudinal preference is likely shaped by a combination of biotic and abiotic factors. At lower elevations, habitat fragmentation, livestock grazing and hunting

pressure increases, while higher elevations pose challenges related to food scarcity and harsh climatic conditions (Herzog *et al.* 2003). The species, therefore, appears to favour mid-elevation zones where moderate temperatures, adequate shrub cover, and sufficient food resources provide optimal conditions for survival. However, studies quantifying the effects of habitat fragmentation and climate change on the species' distribution remain scarce. Furthermore, while some populations have been recorded at higher elevations (Lewin & Lewin 1984), the extent of their seasonal movements and the factors influencing such altitudinal shifts require further investigation. Given the increasing anthropogenic pressures on montane ecosystems, long-term monitoring of habitat changes and their impact on Kalij Pheasant populations is crucial for effective conservation planning.

Feeding habits

Pheasants play a crucial ecological role in mountain ecosystems as prey base for large carnivores and raptors as well as seed dispersers that facilitate plant regeneration. However, despite their ecological significance, the dietary ecology of the pheasants remains poorly studied in the wild. Their secretive behaviour and preference for dense and often inaccessible forested habitats make direct observation and dietary analysis challenging (Hill 1985). Additionally, the seasonal variation in food availability due to dynamic climatic conditions in high-altitude ecosystems further influences their feeding ecology, which remains largely undocumented (McShea 2000).

The Kalij Pheasant is an omnivore primarily adapted for ground scratching, allowing it to forage efficiently. It uses its stout bill to displace small stones, dig into the soil, and extract invertebrates, which constitute a major portion of its diet during the breeding season to fulfil the protein demands of growing chicks (Lewin & Lewin 1984). Diet studies reveal a diverse spectrum of food items including grasses, herbs, seeds, roots, flowers, tubers, earthworms, crustaceans and even small vertebrates such as reptiles (Johnsgard 1986). Stomach content analysis by Lewin and Lewin (1984) identified 19 plant species, while Furqan and Ali (2022) documented 45 plant species in the diet of Kalij Pheasant in Pakistan which included trees, shrubs, herbs, grasses and one climber. However, studies on the seasonal variability of their diet across different altitudes and habitats are scanty, limiting our understanding of how food resource fluctuations impact their foraging behaviour and nutritional ecology.

The Kalij Pheasant follows a distinct diurnal feeding pattern, with peak foraging activity occurring during early morning and late afternoon, periods with minimal human disturbance. Mid-day feeding is significantly reduced, likely due to higher human activity levels (Johnsgard 1986). Feeding groups vary in composition, with individuals foraging alone, in male-female pairs, or in family groups with chicks. Males have been observed to perform lateral displays and offer food to females as part of courtship behaviour (Johnsgard 1986). Seasonal movements in response to food availability have also been reported, with Kalij Pheasant descending from higher elevations in autumn to forage near agricultural fields, roads and trails, where they form loose aggregations of two to ten individuals (Lewin & Lewin 1984). These foraging sites are typically located close to forest cover and near water sources, indicating a strong association between feeding activity and water availability

(Furqan & Ali 2022). Despite these observations, there is a lack of detailed studies on their foraging behaviour across different habitat types and elevations, particularly in response to human disturbances such as agriculture expansion and habitat fragmentation.

Unlike other pheasant species that avoid human settlements, Kalij Pheasant frequently exploit agricultural fields adjacent to forests, particularly during late autumn and winter when food scarcity at higher elevations forces the pheasants to migrate lower areas (Kaul *et al.* 2004) to seek alternative food sources. They primarily feed on leftover grains such as paddy in cultivated fields but exhibit strict temporal feeding patterns, restricting foraging to early morning and late evening to avoid human disturbances. Feeding ceases at dawn when visibility increases and resumes at dusk before roosting. This behaviour suggests an adaptation to human presence, yet the extent to which agricultural landscapes contribute to their overall diet and survival during food-scarce periods remains unexplored. Furthermore, their reliance on agricultural crops raises concerns about potential human-wildlife conflicts, which have not been systematically documented.

An important aspect of the Kalij Pheasant's feeding ecology is its role in seed dispersal. While consuming seeds, the species also ingests small pebbles and grit, which aid in grinding food in the gizzard. However, not all seeds are digested, and many pass through the digestive tract intact, contributing to seed dispersal across their habitats (Lewin & Lewin 1984). Additionally, seeds may adhere to their feathers and be transported to new locations, promoting plant diversity and aiding forest regeneration. This underscores the species' ecological importance in maintaining habitat integrity. Despite these observations, there is limited research quantifying the effectiveness of Kalij Pheasant as seed dispersers, including germination rates of dispersed seeds and their impact on plant community dynamics.

Social structure

The social structure of the Kalij Pheasant is characterized by communal roosting, group foraging and complex vocal communication. Larger aggregations of the species have been observed post-monsoon, likely due to the presence of chicks accompanying their mothers (Hussain *et al.* 2002). Studies in Kedarnath Wildlife Sanctuary have reported a higher occurrence of males than females, with a consistent sex ratio across seasons (Sathyakumar *et al.* 1993). This could be attributed to the more conspicuous plumage of males, making them easier to detect than females (Delacour 1977). The male-biased sex ratio was also documented by Zeng *et al.* (2016) and reported an average ratio of 2.1 males to 1.0 females. However, it remains unclear whether the apparent male-biased detection is due to actual differences in abundance or behavioural factors such as habitat use and predator avoidance strategies. The occurrence of more males than females in a group might also be attributed to the cooperative breeding shown by the Kalij Pheasant (Zeng *et al.* 2016). Moreover, unlike males which are quite agile, females – being less active – become more susceptible to hunting and predation, resulting in the higher occurrence of males in a group (Lone *et al.* 2024).

Although the Kalij Pheasant is considered territorial, the extent of its territory and seasonal variations remains undocumented (Johnsgard 1986). Males assert dominance through loud crowing calls and wing-whirring displays, which serve as territorial warnings (Ali & Ripley

1983). However, quantitative studies on call frequency, propagation distance and the role of habitat structure in territorial communication are lacking. Kalij Pheasant also exhibit a range of vocalizations for social cohesion and predator avoidance, including contact calls during foraging and alarm calls in response to threats (Bump & Bohl 1961, Ali & Ripley 1983). Despite these observations, the acoustic structure of these calls and their functional significance remain unexplored. Additionally, the species shows strong fidelity for its roosting sites, typically perching on tree branches at heights of 4.5 to 8 meters in small groups of four to five individuals (Gautam 1999). These sites are used consistently unless disturbed by predators or human activity, yet the specific factors influencing roost-site selection remain unclear (World Pheasant Association 1980). While faecal accumulation beneath roosts provides an indicator of site fidelity, the potential role of communal roosting in disease transmission or predator avoidance has not been studied. Further research is needed to understand the behavioural and ecological factors driving group formation, the role of social interactions in survival and reproduction, and how habitat disturbances influence these dynamics.

Breeding behaviour

The breeding behaviour of the Kalij Pheasant remains poorly understood, particularly its mating system, which is debated between monogamy and polygyny. Ali and Ripley (1983) suggested that the species is primarily monogamous, with polygamy occurring only under specific conditions, while Lewin and Lewin (1984) observed both monogamous and polygynous tendencies based on group compositions. Johnsgard (1986) hypothesized facultative polygyny, wherein males may mate with multiple females in a breeding season if the opportunity arises and abandon one female post egg laying to assist another in brood-rearing. However, field evidence for this hypothesis remains limited, and more detailed behavioural studies are needed to determine the extent and ecological drivers of different mating strategies in Kalij Pheasant. Zeng *et al.* (2016) while studying the introduced population of Kalij Pheasant in Hawaiian Islands observed that the species exhibits cooperative breeding, which may have arisen as a result of overcrowding and shortage of breeding opportunities in an insular environment. Compared to what is known in their native ranges, the complex social and breeding system of Kalij Pheasant in Hawaii reflects the overall flexibility of its mating patterns in response to environmental conditions. Understanding the factors influencing monogamy or polygyny – such as resource availability, habitat conditions, or population density – would provide valuable insights into the species' reproductive ecology.

The breeding season of the Kalij Pheasant commences from March and may extend into late July. However, their breeding associations in their native areas are not well documented (Delacour 1977, Ali & Ripley 1983). A study by Chandola-Saklani *et al.* (1988) in Garhwal reported that the breeding season of Kalij Pheasant varies with the altitude. They observed that at higher elevations (> 2,100 m), it started from April to June, whereas, at lower elevations (< 2,100 m) it extends from May to August. This variation could be due to the reason that the hatching occurs at a time when the food supply and

invertebrate content in the soil is abundant to meet the protein requirements of the growing chicks. Male Kalij Pheasants usually begin courting females in April which initiate nesting shortly thereafter (Zeng *at al.* 2016). The female usually lays 7–10 eggs per clutch (Wayre 1969, Johnsgard 1986). The nesting period can prolong into July, and the chicks hatch after ~25 days (Johnsgard 1986, Zeng *et al.* 2016), and subsequently remain in the group. Only female incubates and guards the nest from predators and unfavourable conditions (Chandola-Saklani *et al.* 1988). Males appear to play no role in the incubation or protection of nests. The juveniles become sexually mature adults by the start of the next breeding season (March – April) (Zeng *et al.* 2016).

During courtship, females typically initiate interactions and males respond with a series of elaborate displays including 'wing-fluttering,' 'rum-jump' and 'tail-fanning' (Lewin & Lewin 1984). These displays, characterized by rapid wing strokes, running towards the female and fanning tail feathers, are thought to reinforce pair bonds and signal male fitness. Interestingly, 'wing-fluttering,' previously believed to be exclusive to paired males, has also been observed in unmated males and, on rare occasions, in females (Lewin & Lewin 1984). While these behaviours likely play a crucial role in mate selection, their specific functions, hormonal influences and evolutionary significance remain unclear. Additionally, the impact of environmental factors such as habitat fragmentation, hunting pressure, or climatic variations on breeding success and mate selection remains unstudied. Future research should focus on long-term field observations and experimental studies to clarify the mating system, the influence of social and environmental factors on courtship displays, and their implications for reproductive success in Kalij Pheasant.

Threats and predators

The Kalij Pheasant, despite its ecological adaptability, faces multiple anthropogenic and natural threats that have led to localized population declines (Andleeb *et al.* 2012). Habitat destruction and hunting are the primary factors affecting the species' survival across its distributional range. Rapid deforestation due to agricultural expansion, infrastructure development and illegal logging has led to the degradation of critical habitats, particularly dense understory vegetation essential for breeding and foraging (Sathyakumar *et al.* 1992, Lone *et al.* 2024). Studies from the western Himalayas indicate that large-scale deforestation, particularly of oak (*Quercus* spp.) forests, has significantly reduced habitat suitability for the species by depleting essential cover and food resources (Hussain *et al.* 2002, Kaul *et al.* 2004). However, long-term data on habitat loss and its direct impact on Kalij Pheasant populations remain limited.

Illegal hunting is another major threat to the species, with reports of widespread trapping and shooting, particularly in the western Himalayas (Khan 1997, Hussain *et al.* 2002). After habitat degradation, overhunting has immensely contributed to the recent animal extinctions (Diamond & Case 1986, Reid 1992), and may continue to lead future species extinctions. Hunting pressure remains highest in late autumn and winter when heavy snowfall forces the birds to lower elevations, making them more vulnerable (Kaul *et al.* 2004). A study in Azad Jammu and Kashmir, Pakistan, recorded 142 hunting incidents over two years, with the

primary hunting methods involving nylon snares and direct shooting (Furqan & Ali 2022). Despite these observations, there is a lack of quantitative studies assessing the impact of hunting on population demographics and reproductive success.

Livestock grazing and non-timber forest product collection, particularly mushroom harvesting, also pose significant threats by degrading the forest floor and trampling nesting sites. Excessive livestock grazing has been negatively correlated with the Kalij Pheasant abundance in the Kumaon Himalayas (Hussain *et al.* 2002), but studies quantifying grazing-induced habitat degradation in different parts of the pheasant's range are scarce. Similarly, mushroom collection overlaps with the critical breeding season, potentially disturbing nesting females and reducing chick survival, yet there is little empirical data on its specific impact on Kalij Pheasant populations.

Forest fire, whether natural or anthropogenic, is another emerging threat to the Kalij Pheasant. Fires during the breeding season may destroy nests, eggs and even adult birds, further reducing reproductive success (Kimothi & Jadhav 1998). A study by Furqan and Ali (2022) in Pakistan identified forest fires as the most significant threat (41.2% of reported cases), but data from other parts of its range, particularly in India and Nepal, remain limited. There is a critical need for studies assessing the frequency, extent and direct impact of forest fires on Kalij Pheasant populations and their nesting success.

Natural predation by carnivores such as the Red Fox *(Vulpes vulpes)*, Yellow-throated Marten *(Martes flavigula)*, and Leopard *(Panthera pardus)* is a part of the species' ecological interactions (Bahuguna & Mallick 2010). However, habitat fragmentation and hunting may be amplifying predation pressure by reducing available cover and forcing birds into suboptimal habitats with higher predator densities (Furqan & Ali 2022). Despite anecdotal reports of predation on both chicks and adults, detailed studies on predator-prey dynamics involving Kalij Pheasant remain lacking.

While several studies have documented the threats to Kalij Pheasant, key knowledge gaps persist. There is limited long-term monitoring data to assess population trends in response to habitat degradation, hunting pressure and climate-induced changes such as forest fires. The species' response to habitat fragmentation and landscape-level changes remains poorly understood. Quantitative assessments of human-induced threats, such as livestock grazing and mushroom collection, are needed to determine their direct effects on breeding success and survival. Additionally, studies on predator-prey interactions and how hunting pressure alters predation risk for Kalij Pheasant would enhance conservation strategies. Addressing these gaps is crucial for developing targeted conservation measures and ensuring the long-term survival of the species.

Conclusion

This review provides a comprehensive synthesis of the ecology, behaviour, status, and conservation challenges of the Kalij Pheasant. As a native species of the Himalayan and Southeast Asian forests, the Kalij Pheasant exhibits remarkable adaptability, thriving in diverse habitats due to its flexible diet, which includes leaves, tubers, seeds, fruits and

small invertebrates. Its complex social structure, characterized by monogamous pairs and elaborate courtship displays, further underscores its ecological significance.

The species shows a strong affinity for dense understory shrubs and mixed forest environments, highlighting the importance of preserving these critical habitats. However, increasing habitat degradation – driven by deforestation, firewood collection, timber extraction and agricultural expansion – poses significant threats to its populations. Despite some studies on the species' habitat preferences and threats, major research gaps remain, particularly in its ecology, conservation genetics and long-term population dynamics. Addressing these gaps is crucial for developing effective conservation and management strategies.

Future research should incorporate advanced technologies such as GPS tracking, remote sensing and molecular techniques to gain deeper insights into the species' behaviour, movement patterns, habitat use and genetic diversity. Additionally, integrating traditional ecological knowledge from local communities could provide valuable context for conservation efforts.

As an indicator species, the Kalij Pheasant reflects the health of its forest ecosystems. Protecting this species not only preserves its unique genetic heritage but also contributes to broader biodiversity conservation. A multi-faceted approach – combining scientific research, habitat protection, community involvement, and policy interventions – is essential to ensuring the long-term survival of this species. Proactive conservation measures, backed by robust scientific research, will be key to mitigating threats and securing viable populations of the Kalij Pheasant in its natural habitat.

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