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## Global Expansion of *Pavo cristatus*: Comparing Ecology in Native vs Invasive Ranges

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### Abstract

Indian Peafowl (*Pavo cristatus*) is one of the most widely recognized bird species native to India's sub-continent and Sri Lanka. Its visual beauty and values it has held within cultures across most of the world, have contributed to it being introduced globally: United States, Australia, South Africa, and various islands have all seen populations of this species. Though the International Union for Conservation of Nature (IUCN, 2023), currently lists this species as least-concern. The establishment of this peafowl's range outside of its traditional range creates many significant environmental issues. This study will investigate and document the ecology of *Pavo cristatus* in both its indigenous and introduced ranges. In the native range this species inhabits primarily dry forest, agricultural, and village habitats; therefore, their established population numbers are also usually kept relatively low by their natural predation. Peafowl in areas where they are non-native frequently resided in residential neighbourhoods, on estates or in landscapes dominated by humans where they face reduced predation. Invasive populations are generally successful at establishing themselves into a new area because they are capable of adapting to their new environments as well as feeding behaviours; they can utilise a versatile diet; and they tolerate living in close association with humans. The paper explores differences in habitat selection, feeding habits, reproductive adaptations, predator-prey interactions, and ecological effects of *Pavo cristatus* in native compared to exotic sites as well as identifying gaps in our current knowledge including a lack of long-term population monitoring and very few in-depth, long-term genetic and ecological studies related to this species. Improving our understanding of how *Pavo cristatus* adapts to disparate habitats will contribute to our understanding of invasion ecology, ecological plasticity and wildlife management during the Anthropocene epoch.
**Keywords***: Pavo cristatus*, ecological, predator pressure, adaptable behavior, ecological plasticity

### Introduction

The Indian peafowl (*Pavo cristatus*) is among the most well-known bird species due to its distinctive coloration and elaborate mating rituals. The native range of this species is the Indian subcontinent (including India and Sri Lanka), but it has also been introduced all over the world for decoration, cultural reasons, and religious practices. The International Union for Conservation of Nature (IUCN) has classified the Indian peafowl as a "least concern" species because it has a wide distribution and stable number of individuals globally (IUCN, 2023). However, due to human-assisted migration of the species, feral and wild populations of the Indian peafowl exist outside its original range. In the Indian subcontinent, the species is typically found in dry, tropical forest, shrubland, agricultural areas, and around villages. According to The Book of Indian Birds, it is, "closely associated with human habitation and agriculture" (Ali, 2002). The adaptability of the Indian peafowl to human-modified habitats has enhanced its ability to thrive in different ecological conditions. The Indian peafowl is an omnivore (the species eats seeds, insects, small reptiles, and crops), which also helps maximize the species' opportunity to succeed in a variety of ecological situations. The worldwide distribution of the peafowl (*Pavo cristatus*) has created invasive or naturalized colonies in many countries, such as Australia, South Africa, United States and multiple Pacific islands. Once introduced into non-native areas, most peafowl find success in urban/suburban environments, protected areas, and semi-natural habitats. The Encyclopaedia Britannica states that peafowl have been "introduced as ornamental birds throughout the world" (Encyclopaedia Britannica, 2022). Most peafowl were defined as being introduced for ornamental reasons, while other groups of peafowl are self-sustaining and also affect their ecosystem. To better understand how habitat use, diet composition, reproductive strategies, predator-prey interactions, population dynamic relationships have changed in regard to where they are naturally found (native habitats) or where they are newly found (invasive habitats), we need to conduct ecological comparisons of these two geographic locations. In native habitats, peafowl are controlled by natural predators (e.g. leopards, jackals, and large raptors), whereas their introduced ranges likely experience lower levels of predation and thus can have greater density levels. Ecological release in these newly introduced habitats may result in peafowl exhibiting new behaviours, different resource use patterns, or have new levels of competition with other species. In addition, introduced peafowl can also impact local biodiversity by depredating crops, competing with native birds that forage on the ground, and altering habitat structure. According to the invasion biology literature, "species introduced outside their native range may affect the functioning of ecosystems and the composition of native species populations" (Lockwood, Hoopes, and Marchetti, 2013). Thus, by comparing the ecology of native and invasive populations of *Pavo cristatus*,

we can gain insight into the mechanisms that underlie successful invasion, adaptability, and ecological effects of invasive species. As *Pavo cristatus* is a culturally significant species in India (the national bird) and is increasingly found worldwide, it serves as a useful model for studying avian invasions, the role of anthropogenic processes in dispersal of non-native species, and ecological plasticity. The aim of this review is to combine existing literature on the habitat use, feeding ecology, reproductive behaviour, population genetics, and ecological effects of *Pavo cristatus* in its native and invasive ranges into a single synthesis to inform broader discussions on invasion ecology and management of wildlife. Understanding how species respond differently to their native and non-native ranges will contribute to the greater dialogue on ecological plasticity, adaptation, and dynamics of invasions in the Anthropocene.

### Biogeography and Global Distribution Patterns

The native distribution of the Indian Peafowl (*Pavo cristatus*) is primarily concentrated in the Indian subcontinent, including large parts of India and Sri Lanka. Within this region, the species inhabits diverse ecological landscapes ranging from dry deciduous forests and scrublands to forest edges and agricultural mosaics.



**Figure 1. Typical agro-forest mosaic habitat in India supporting populations of *Pavo cristatus*.**

Habitat types such as forests, grasslands, wetlands, and agricultural areas provide critical habitat components like roosting sites, nesting materials (e.g., ground cover), and food sources (e.g., grains, seeds, insects, and small reptiles) necessary to the survival of these species. The IUCN listed the Indian Peafowl (*Pavo cristatus*) as an example of a species that has had a broad geographic range with stable population dynamics throughout its native distribution range mainly due to its ecological adaptability and cultural protection that exist in parts of India where it is viewed as an important and sacred symbolic bird. The Indian Peafowl has been purposefully introduced into numerous countries outside its native habitat including the U.S., Australia, South Africa, and several island ecosystems. Historical documentation indicates that many of these intentional introductions occurred from collections of ornamental birds kept by royalty, zoos, and private gardens. Individuals that escaped/ were released from these collections created feral populations that successfully maintained themselves

in their newly established territories. Encyclopaedia Britannica (2022) reports that there was an increase in aesthetic appeal and cultural prestige associated with the introduction of peafowl. The establishment success of introduced populations is often linked to ecological conditions that are favourable for the survival and reproduction of introduced species. Factors such as a mild climate, the use of human-modified landscapes, and low densities of predators will significantly increase the overall ability of introduced species to persist in their new habitat. These types of ecological characteristics correspond with the broader general principles of invasion biology, in which species that possess greater ecological adaptability and are considered generalist feeders are more likely to establish themselves successfully in new environments (Blackburn *et al.*, 2011; Lockwood *et al.*, 2013). Therefore, the Indian Peafowl is a relevant example of a species that has been introduced due to its cultural significance and whose occurrence has increased via human-mediated dispersal to locations around the world.

## Habitat Use and Landscape Ecology

**Native Range Ecology-** The Indian Peafowl is an adaptable species found naturally throughout India. They are generally found in semi-open habitats and often times these habitats are modified, such as by man. In India, places you are likely to find the Indian Peafowl include cultivated land, the outskirts of villages, orchards and along forest edges because these areas provide an abundance of food and shelter. According to Salim Ali (2002), the Book of Indian Birds, the Indian Peafowl typically forages in agricultural and rural areas primarily for grains, seeds, insects and small reptiles. These locations offer many opportunities for feeding and nesting which are necessary to sustain a stable population. Their roosting behaviour at night is also important for survival; it allows them to roost in trees which greatly minimize their risk of predation by ground-level predators. The Indian Peafowl is often preyed upon by natural predators like the Indian Leopard (*Panthera pardus*), the Golden Jackal (*Canis aureus*), and various raptors, whose presence has an important role in maintaining ecological balance and influencing peafowl behaviour through increased vigilance and habitat use (Ali 2002; Johnsgard 1999).

**Invasive Range Ecology-** Peafowl are often able to adapt to new environments and are found in many areas outside of their natural distribution. Areas where peafowl are newly introduced, such as the United States and Australia, tend to have more urban/suburban, ornamental grounds, golf courses, parks, and ranch land than areas where they naturally occur on the Indian subcontinent. The open space for feeding, scattered trees for roosting, and anthropogenic food supplies are conducive to the establishment of stable feral populations, as long as climate conditions are equally favourable. The peafowl's establishment as a feral population in these newly introduced areas can be partly attributed to the concept of ecological release. Ecological release occurs when a species is re-located to a new geographic area in which they are free from the natural predators, parasites and competitors they experienced in their native range resulting in an expansion of their ecological niche. The reduced diversity of predators in many introduced areas has allowed peafowl to use open, human-inhabited areas for foraging, movement and habitat use. In addition to ecological release, peafowl exhibit behavioural flexibility, which has been identified as an important trait in birds that have successfully established themselves in new environments (Sol *et al*. 2002; Lockwood *et al*. 2013).

**Feeding Ecology and Trophic Flexibility-**The Indian Peafowl (*Pavo cristatus*) has a versatile omnivorous feeding strategy that allows it to make use of many different types of food found in various habitats. The peafowl's native range covers India, and its diet usually consists of seeds, grains, fruits, insects, small reptiles and amphibians. According to Salim Ali's The Book of Indian Birds (2002), peafowl often forage for food on agricultural fields and forest floors where they can find such diverse options of food to eat. By having a broad dietary spectrum, the Indian Peafowl is also able to adapt to seasonal changes in the availability of food resources and changing conditions of the environment.



**Figure 2. Ground foraging behaviour of *Pavo cristatus* illustrating omnivorous feeding strategy.**

In areas that have been introduced to non-native species, humans will provide different anthropogenic resources including ornamental plants, food scraps, and grains available on purpose. This flexibility in diet represents an important trait for invading species in terms of their ability to be successful when invading a new area ecologically. Generalist feeders, or species that are not restricted to one or two food sources, are much more adaptable to changing environments than specialist feeders (Williamson, 1996;

Lockwood *et al*., 2013). Urban ecology studies show that birds that utilize human kind's impact on ecosystems (that includes the creation of urbanized habitats) are often better able than other birds to establish themselves as successful breeding populations and grow larger populations than non-urban birds (Bonier *et al*., 2007).

**Reproductive Ecology and Population Dynamics-**The mating system of the Indian Peafowl (*Pavo cristatus*) is lek dominated, and the two sexes exhibit extreme differences in their physical attributes, are characterized by displays. The male indo games make use of long beautiful trains for mating purposes, and display them prominently while courting prostitutes, making this a good example of sexual selection.



**Figure 3. Courtship display of male *Pavo cristatus* showing train erection during mating behaviour.**

reported by Marion Petrie and Tim Halliday (1994) suggested that female preference in mate selection could be based in large train size, with embellishments possibly indicating the quality of male genes. Peafowl are generally bred to produce their offspring within areas of their native habitats of India and its neighboring territories during the monsoon season, when the vegetation is lush and abundant for food. The average size of a peafowl's clutch is between three and six eggs, and is placed in nests hidden under vegetation. The ability of a chick to survive is affected by predation, climate changes and the condition of the habitat where the clutch is laid. In introduced environments, the lack of predation and the availability of man-made food sources positively impact the reproductive success and population increase of peafowl. According to the Enemy Release Hypothesis, introduced species may suffer from significantly less mortality through natural enemies (i.e., predators and parasites) than native species, thus providing means for the demographic expansion of introduced species (Keane and Crawley, 2002; Lockwood *et al*., 2013). Although some studies have demonstrated established populations of introduced peafowl have larger reproductive success, a larger comparison study between introduced populations and native populations has yet to be conducted, thereby leaving a critical gap in the scientific literature on the ecology of the peafowl population.

**Predator–Prey Interactions and Enemy Release-** In native Indian ecosystems, predation acts as a controlling factor. When compared with natural systems, anti-predatory behaviour includes roosting at height, group vigilance and alarm calling. Invasive systems usually have simplified predator communities (Elton, 1958; Keane & Crawley, 2002). The release from enemy pressure may provide improved survival and allow population increase (i.e., based on invasion theory). Experimental evidence based on comparative studies between the parasite load and mortality and vigilance patterns across geographic distributions would be necessary to test the enemy release hypothesis for *P. cristatus*.
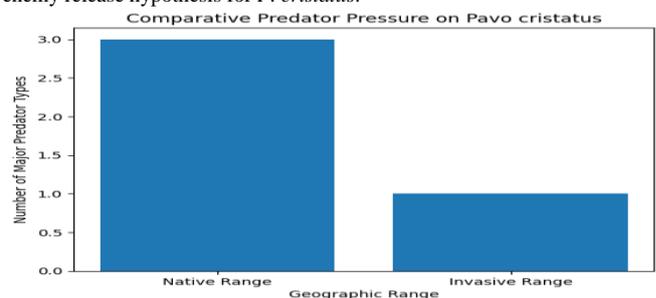


## Ecological Impacts in Invasive Ecosystems

Although not universally categorized among the most damaging invasive birds, localized ecological impacts may occur:
•Competition with native ground-foraging birds
•Soil disturbance through scratching behaviour
•Crop depredation in agricultural zones
•Noise and nuisance conflicts in suburban areas

Invasion biology literature emphasizes that introduced species can alter trophic interactions and ecosystem processes (Simberloff *et al*., 2013; Lockwood *et al*., 2013). However, quantitative ecosystem-level studies specifically focused on *P. cristatus* are still limited.

## Conclusion

The Indian Peafowl (*Pavo cristatus*) illustrates how civilization interacts with nature, thereby creating conditions for expanding its range over the globe due to ecological adaptability. This species is originally from the Indian subcontinent, with the majority of Indians and Sri Lankans being the point of origin. The Indian Peafowl is found in a variety of habitat types including dry deciduous forests, scrubland, agricultural landscapes, or at the edges of villages. The dynamics of the Indian Peafowl populations are driven by the effect of natural predation within its natural ecosystems, as well as the availability of food and resources based on seasonal changes, food availability, and environmental variability. The Indian Peafowl also has substantial symbolic value to Indian culture and religion, providing additional concern for its continued habitat protection and cohabitation with human populations. The Indian Peafowl has been intentionally spread to many other areas of the world through ornamental and decorative means; however, due to the relatively mild climate, abundant food supply, and limited number of predators that exist in some introduced regions, feral populations have been able to survive in these locations. The peafowl's ability to thrive in several habitats that include suburban areas, agriculture, and semi-natural habitats, combined with its flexibility regarding food choices and how it behaves are additional reasons why this species has been documented in a number of regions. The Indian Peafowl has been introduced into several areas and can inhabit many regions as well as exhibit several negative ecological behaviours common to highly invasive species, which are typically associated with intense ecological disruptions. However, negative interactions with agriculture and native plants/animals have been noted locally. Consequently, additional detailed ecological studies are needed to document population dynamics, ecological interactions, and possible long-term evolutionary changes between native and introduced populations.

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