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Diversity of bird nests and construction materials in selected two areas of Angul District, Odisha, India

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Abstract
Birds are well known for constructing a wide variety of nests, and nest building is an instinctive behavior among them. The materials,design and structure involved in building nests vary by species. These deliberately constructed formations are composed of variety of substances, which include both natural and, more frequently artificial elements. Additionally, bird nests function as microhabitats that harbor ectoparasites, fungi, and various commensal organisms. A single nest functions as a habitat, an environmental sample, an indicator of the breeding status of birds, and a record of species-specific interactions. It represents a remarkable example of animal architecture. The present study was conducted in an urban area of Angul district, Odisha, and includes six species of local birds Red-vented Bulbul (*Pycnonotuscafer*), Black drongo (*Dicrurusmacrocercus*), Indian Robin (*Saxicoloidesfulicatus*), Purplerumped Sunbird (*Leptocomazeylonica*), Black hooded oriole *(Oriolusxanthornus*), Red wattle lapwing (*Vanellus indicus*) focusing on their nest structures and nesting materials. The study also reveals that birds prefer nesting at varied heights depending on their ecological and behavioral suitability. Primary goal of the study was to examine the composition, structure, and design of certain common terrestrial birds that live in the Angul district's metropolitan regions. The data provide insights into how the availability and incorporation rate of anthropogenic materials are correlated with nest construction.

Keywords: Birds, nesting materials, anthropogenic substances, nest building

Introduction

Birds are unique and amazing creatures. Over 10,000 bird species have been identified worldwide. There are over 1364 bird species in India, including 81 endemic species, 3 breeding endemic species, and 85 vulnerable species. Over 300 bird species have been identified in the Angul district, and about 471 bird species are reported in Odisha.

Some animals build nests to lay eggs, defend themselves from dangers like predators and inclement weather, and tend to their young. The ability of birds to build a wide variety of nests is especially well-known. The instinct to build nests for laying eggs and caring for chicks is innate in some bird species. The typical nesting cycle for a bird involves locating an appropriate site for breeding, selecting a mate, constructing a nest, engaging in copulation, forming eggs, laying the eggs, incubating them, hatching, feeding the young, and eventually leaving the nest.

A bird nest's structure is bioengineered. Bird species differ greatly in terms of nest ecology, nesting material, and nest structure. Not all bird species construct nests to rear their young, despite the fact that the term "nest" generally refers to a particular structure created by the birds themselves. While brood parasites like cuckoos lay their eggs in the nests of other birds, Some birds deposit their eggs on the ground, such as red wattled lapwings. Emperor penguins and other birds do not construct nests. Penguin females use their warm feet to nurture their eggs. An attachment, an outside ornamental region, a structural portion, and a lining layer are the four main functional elements of a nest. Not every nest has every component. Lining materials often produce an appropriate microclimate, while structural elements give the nest an overall structure.

As the birds gather nesting materials to build their nests, natural selection puts selective pressure on both the design of the nest and the birds themselves. Historically, it was believed that the design of a complete nest was primarily governed by natural selection and the need to reduce predation risk, but it is now increasingly recognized that sexual selection also plays a role in nest structure and design (Jagiello et. al., 2023) [9]. For instance, Bower birds create elaborately crafted nests specifically to attract potential partners. The choice of nest site is likely to have an impact on an individual's reproductive success and survival, which may then have an impact on the population's structure and growth rate (Clark *et al*., 2014) [4].

Depending on their behavioral tendencies and the location of their nests, certain birds may either exert more effort in locating and gathering nesting materials or choose to use materials that are readily accessible near their nesting site. Nesting materials used for nest building are primarily influenced by that particular habitat. Materials like Sticks and twigs, grasses, leaves, seaweeds, mosses, lichens, tiny bits of yarn, feathers, bark strips, cotton, fur, animal hair, spider silk, and a variety of man-made materials can be used for nesting purpose. The current research indicates that the design, dimensions, and materials utilized in nests are influenced by geographic location. Nests found in cooler environmental conditions tend to be larger and better insulated. Temperatures in urban environments consistently remain high due to urbanization and global warming. It was found that the nests in urban environment are smaller, lighter, and demand less insulation. Birds primarily choose natural materials for nest construction in rural areas, while in urban areas, where man-made materials are more

prevalent, birds often use plastics, paper, strings, and various other synthetic items for their nest construction. As the nesting materials used by birds to build their nests can reveal the ecological conditions of a specific region, they are called bioindicators. Seress & Liker, 2015 [13] suggests that urbanization significantly influences various environmental changes, altering the availability of materials for nesting among bird species Increasing level of urbanization has resulted in a greater incorporation on man-made materials for bird nests. The anthropogenic materials pose substantial risks to birds and other wildlife species (Ferreira et. al., 2025) [6]. The presence of human made materials in bird nests can threaten a bird's survival and reproductive success.

Investigation on nesting behaviour is crucial for understanding the ecology and evolution of bird species. Birds are often very specific about the materials they incorporate into their nests, which possess known anti-parasitic or anti-pathogenic properties. The composition of bird nests mirrors the materials found in their local environment. Research into the nesting patterns and behaviours of various bird species are necessary for avian conservation and protection of native vegetation in landscapes. Additionally, studying nesting materials can help in identifying the nesting needs of birds, which can help in supplying appropriate materials as part of efforts for avian conservation and restoration of habitat.

Materials and Methods

Study Area

City Angul is located in the central part of Odisha, India. The city stands at an average elevation of 195 meters (640 feet) above sea level and spans an area of approximately 6375 km². The research work was carried out from January 2024 to September 2025. Government (Auto) College, Angul Campus and Manjor Dam, Athmallik are the 2 study sites that were selected for the research. The study sites provide essential nesting support and food resources that are essential for the successful reproduction and survival of various bird species.

Table 1: Characteristics of the sampling sites.

Ecological Parameters	Government (Auto) college,Angul	Manjor dam, Athmallik
Duration of collection	10/01/2024-28/09/2025	11/05/2024-01/09/2025
Area	40 Acres	20 Acres
Coordinate	20°49'47"N 85°06'"E	20°50'8"N 84°25'51"E

Fig 1: Study Site a- Government (Auto) College, Angul

Fig 2: Study site b-Manjor dam

Methods

1. Nest Observation

The data collection period is ranging from November 2024 to September 2025. Nesting sites were observed between 6:00 AM and 10:00 AM in the morning and again from 5:00 PM to 6:30 PM. In the evening. The nests were examined through visual inspection. The vegetations and substrates that might provide suitable conditions for nest construction were thoroughly examined. The position and location of every nest was photographed and recorded using a GPS-enabled camera. The nesting sites of the birds were noted and marked with micro-flags for later counting while walking in the study areas. The condition of the nest, whether it is active or inactive, was assessed by examining its contents at regular intervals using Nikon Aculon 8x42 binoculars.

2. Nest Collection

The counts of nests, types of nests, nest lengths, cup nest diameters, nest depths, preferred nesting sites in trees or houses, as well as weight and height, were documented. Discarded and unutilized nests were gathered as samples and taken to the department for morphometric examination.

3. Nest Deconstruction

The collected nests were placed under the sun for four to five hours to eliminate moisture. The net weight of each nest after drying was recorded using a Mettler Toledo ME204 ME series balance and a Bulfyss Electronic Digital Luggage weighing scale. Deconstruction of the nests was performed with forceps to minimize damage to the nesting materials. Nest components were categorized based on whether they were natural or man-made. The details regarding the nest construction process, observations of nesting materials, and visits to nesting sites were carried out with precautions to avoid disturbing the birds and their natural behaviours.

Data Analysis

Statistical analyses of data were performed using Microsoft Excel 2007.

Results

In this study, a total of 30 bird nests were gathered, comprising 6 from red-vented bulbuls, 4 from black drongos, 5 from black-hooded orioles, 6 from purple-rumped sunbirds,6 from Indian robins, and 3 from red-wattled lapwings from 2 distinct locations. Various bird

species utilize different substrates for nesting purpose (Table 2). Of the total nests, 86.66% were located on natural substrates (such as trees and shrubs), while 13.33% were found on artificial substrates (like ceiling fan hooks and holes in walls).

Table 3 indicates the average height measurement of nests. Birds like red vented bulbul (Mean height of 4.5 feet) tend to build nests near the ground, whereas Indian robin (mean height of 5 feet) and purple rumped sunbird (averaging 6.8 feet) construct their nests slightly above ground level. From the study it was found that the heaviest nest was constructed by black hooded oriole, averaging 10.9 grams, making it largest among the nests studied. In contrast the smallest and lightest nest was constructed by red vented bulbul i.e. 5.09 grams. 5 different types of nests were studied during this research (Fig 3: cup nests (33.33%), pad nests (20%), pendent nests (20%), and hammock nests (16.66%), and scrape nests (10%).

The analysis of nest building materials (Table 2) revealed that all nests contained the highest percentage of plant materials, such as dry grass, twigs, leaves, and bark strips. Additionally, some nests included animal materials, including spider egg sacs, indarbela caterpillar droppings, lichens, and animal feathers. The proportions of anthropogenic materials were as follows: threads (40%), nylon (33%), plastic strings (12%), polythene pieces (9%), and tissue pieces (6%). Sixty percent of the nests (n=30) included at least one kind of human-made materials (Fig 4).

The measurement of both natural and human-made materials utilised by these typical bird species for building their nests indicated that the purple-rumped sunbird nests contained the greatest proportion of human-made materials, accounting for 3.5% of the overall nest weight, while the nest with the least amount of anthropogenic materials was that of the Red wattled lapwing. (Table 3).

Table 2: Natural and artificial substrates used by birds.

Sl. No.	Bird species	No. of nest	Nest type	Natural substrate	Artificial substrate	Anthropogenic materials Yes/ No	Nesting materials
1	Red vented bulbul	6	Cup nest	Blackboard tree, papaya tree	-	No	Branches, dried foliage, spider webs, and pieces of bark.
2	Black drongo	4	Cup nest	Java plant, Tamarind tree, Neem Tree	-	Yes	Brittle foliage, spider webs,branches, filaments,synthetic fibers.
3	Black hooded oriole	5	Hammock nest	Blackboard tree,Mango Tree	-	Yes	Strips of bark, moss, desiccated grass, string, synthetic fabric, and withered leaves.
4	Purple rumped sunbird	6	Pendent nest	Bakula tree, Mango tree, Rangoon creeper tree	Ceiling fan hooke	Yes	Dried foliage, slender desiccated fibers, fluff, slender branches, strips of bark, droppings from the indarbela caterpillar, silk from spiders, egg sacs of spiders, feathers from animals, tissues, pieces of plastic, nylon, and threads.
5	Indian robin	6	Pad nest	Mango tree, Neem Tree	Hole in the wall	Yes	Dehydrated grass, branches, delicate jute, withered leaves, plastic fragments,
6	Red wattled lapwing	3	Scrape nest	On ground	-	No	Dry grass, Small stones,Small twigs,Soil particles

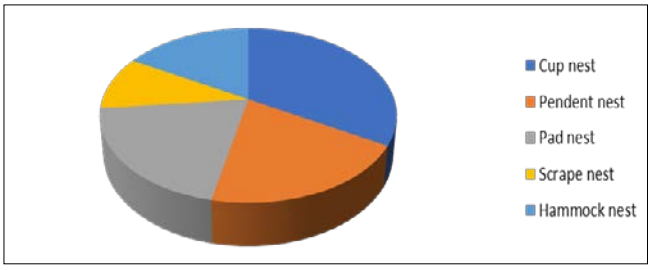

Fig 3: Various kinds of nests.

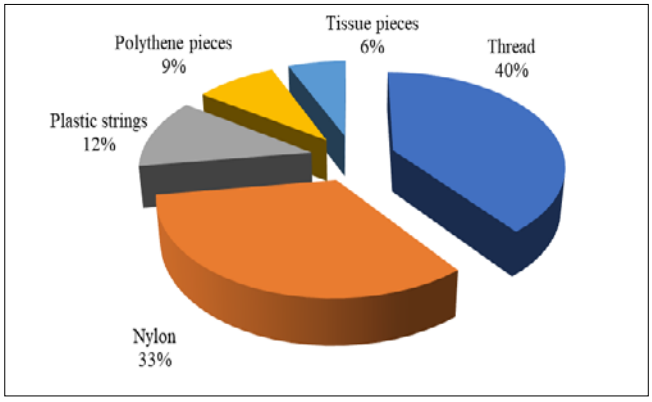

Fig 4: Percentage of occurrence of different synthetic materials

Disscussion

The study sites that were selected had rich bird diversity and provided suitable habitats for feeding and breeding. Common species are found predominantly in these study sites. Different birds showed variations in the nesting materials they used for nesting. The aim of this study was to investigate the nesting requirements of some common bird species and to quantify the amount of anthropogenic materials present in their nests. During the observation period, most of the bird nests were found to be inactive, while only a small number of nests were in active condition. Further detailed observation were conducted on the nests those were active, and later collected after the fledglings had grown and fledged.

Birds like black drongo, red vented bulbul, black hooded oriole and purple rumped sunbird make use of natural substrates such as trees and shrubs to construct their nests, whereas red wattle lapwing builds its nest by scraping the ground and shows a high degree of camouflage with the ground (Table 2). Birds like the purple-rumped sunbird use both natural and artificial substrates like ceiling fan hooks to construct their nests. Indian robins also opt for both natural and artificial substrates e.g. holes of walls of abandoned buildings to built their nests (Table 2). The diameter and dimensions of nests vary among different species of birds.

Indian robin builds a pad nest, whereas purple-rumped sunbird construct pendant shaped nests. Very minimum amount of nesting materials is used by Red wattled lapwing during the construction of its scrape nest while black hooded oriole nest resembles with hammocks in their appearance. The nest heights that are recorded during the study indicate that birds use different nesting height according to their preferences. Birds like red vented bulbuls prefer nesting sites near the ground (Awaiset et. al., 2014). Their nests are located in the branches of trees which are located at a lower elevation. As the nests are near the ground so they are highly susceptible to human intervention and predation. In contrast birds like the Indian robin and purple-rumped sunbirds built their nests just above the ground. They are comparatively less susceptible for human activity and disturbances. Other species, such as black hooded oriole, prefer to built their nests in taller trees, allowing the easier access to and from their nests.

The nesting materials used by different birds for their nest construction vary greatly among species. For construction of different sections of the same nest, birds use different nesting materials. During the observation period, fallen nests were collected. A considerable flexibility in nesting material choice for nest construction was observed in case of purple rumped sunbird. Soft substances like plant fluff were used for inner lining of nests whereas spider egg sacs of Iderbela moth were used for exterior decoration of the nest. Incorporation of spider egg sacs helps in camouflaging the nest with the branches to which the nest is attached and reflecting light to merge the nest with its outer surrounding environment (Hansell 1996) [8]. Cobwebs were used as nesting materials for their sticky property of spider silk and it help to hold the nesting materials together. Panigrahi et. al., 2025 [12] demonstrated that birds like black drongo and black hooded oriole and Indian robin have also used both natural and artificial substances for their nest building. Threads were found in majority of nests with a total 21 nests out of 30 nests and used as inner lining layer. Materials such as plastics, nylon, polythene pieces and tissue fragments were used in different of the nests (Fig 4). Maximum amount of anthropogenic materials were used by purple rumped sunbird i.e. 3.5% of total nest weight (Table 3). The result highlighted the occurrence of anthropogenic wastes in bird nests, as 60% of the total nest (n= 30) had some degree of anthropogenic materials. Esquivel et. al. (2020) [5] reported a quite similar outcome (52.6%) in their study.

Behavioural activities of different birds were also documented during the research period. In case of the purple-rumped sunbird, gathering of nesting materials for nest building were done by both male and female parents. The male typically guards at the nest while returning to the nesting site and the female is responsible for nest construction. Khareet et. al., 2020 demonstrated that the nests were designed in such a way that entrance facing north direction to minimize the exposure to direct sunlight.

Adaptive nesting behaviours of birds have noted by various researchers. Habitat change can influence the adaptations among many bird species. The study sites were relatively biodiversity rich and featuring a good amount of greenery. Rate of incorporation of anthropogenic materials are directly proportional to amount of anthropogenic materials found in that particular environment (Sheardet et. al., 2024) [14].

Conclusion

The study notable enhances our knowledge about the nesting materials of different bird nests and highlights the use of anthropogenic substances by birds for their nest building. Environmental factors like strong winds, heavy rainfall, human interference and threats from enemies negatively affects the breeding success of bird species. The result suggests that some birds are at extremely high risk of habitat destruction, while others can adjust to environmental changes. Human intervention can negatively affects the nest building behaviour of many birds whereas some birds tend to construct nests in areas with higher human presence because it offers them protection from their natural enemies like snakes, squirrels and other threatening birds such as crows. Bird populations can be directly linked with the shortage of natural vegetation and excess of human made materials and there is a possibility that all bird population could be affected in the near future. The extent to which anthropogenic materials are incorporated to the bird nests id directly proportional to the level of environmental disruption. As the plastic pollution is increasing day by day, the adverse effects are likely to persist going forward. Decrease in plastic usage and the adoption of bioplastics is necessary because complete elimination of anthropogenic materials from our environment is impossible. The areas where pollution is high, providing naturals materials for birds and removing solid debris from environment has resulted in a reduced amount of wastes used in nest construction. Protecting the natural habitats of bird populations and engaging the community are two essential steps for their conservation. As environmental pollution and urbanization continue to rise, we can anticipate an enhancement in the frequency and amount of anthropogenic materials incorporated into nests in the near future.

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