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Nest material selection by Egyptian vulture *Neophron percnopterus*

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Abstract
Searching for nest material and to prepare a home for the young one is a natural instinct and an important task in the life cycle of every animal taxon like birds, fish, mice, squirrels etc. They use specific materials depending upon their mechanical and structural properties and are highly selective and with a strong sense of innate tendency to use the type of nest materials for their nest construction. Here we describe the materials preferred by the Egyptian Vultures for making the nest. In the present study, we identified 15 different materials from the different layers of the nest of Egyptian Vulture in Unnao, Uttar Pradesh. Mesquite sticks, human faeces, cow dung etc. formed the building materials of the outer structural layer. Similarly, in the inner lining materials we observed clothes, jute, linen, cotton, threads etc. Out of these 15 materials the Hosiery clothes were found maximum (42.61%) and threads were observed minimum (0.42%) respectively. The study will establish a baseline on Nest material selection choice by the Egyptian Vultures. From the study it can be inferred that during the nest building process, the hard and sharp materials appeared to be the most effective material for the protection of nest against predators.

Keywords: Egyptian vultures, nest materials, raptor, nest selection, Unnao

1. Introduction
Nest Building is an essential part of the life cycle and taxonomically prevalent activity among birds, mammals, reptiles, fish and even insects [7]. The design of the nest varied among different taxa. Some build a small cup shaped nest while some prepare a huge complex elliptical nest or platform nest. They may be composed of twigs, green leaves, roots etc. or anthropogenic materials like wool, thread, rubber, rope etc. Though the design and shape of nests vary but the function of every nest is same which is to provide a suitable substrate or base for the laying of eggs and developing young ones [9]. Selection of nest site and nest materials are considered as the important factors determining the reproductive success of many birds' species [6, 17, 20, 18, 11, 23]. Once a Nest site is selected the interaction between male and female become less frequent and both get involved in the preparation of nest. They carry nesting material from near and far off areas both. Nest of Egyptian vulture is open elliptical shaped platform nest consisting of different types of nest materials. The boundary of the nest is completely lined with the dried sticks of mesquite tree probably as a protecting fence. The nest of Egyptian vulture is quite complex and different from other raptor species. This complexity of the nest is probably due to the prolonged and marked parental care in Egyptian vultures.
The aim of the present study was to find out the Nest matrix selected by Egyptian Vultures and to analyze the nest characteristics as mechanical, structural support as well as host defense for the sustainability of the nest and its protection against predators.
Nest material influence the overall reproductive success. The findings from this study are expected to establish a baseline on the Nest material selected by the Egyptian Vulture.

2. Materials and Methods
2.1 Study Area
The Study Area Unnao is a district in Uttar Pradesh, India lying between Kanpur and Lucknow, between coordinates 26°.33'0" N and 80°.28'48" E (Plate.1). It is an industrial district and famous for its leather, agro-based and other chemical factories. The maximum temperature recorded is 46.5 °C and minimum 2.5 °C. The rainfall in study area often shows erratic nature and many times the area experiences long dry spells also. The average annual rainfall of the district is 838 mm. Almost 90% of annual precipitation occur during the period mid-June to September. The study area is a part of the vast central Ganga Plain which is one of the physiographic units of India.

Rivers Sai and Ganga form the north-eastern and south-western boundaries, respectively. It has an area of 4558 $km^{2.}$ The surrounding districts are Lucknow, Kanpur, Rae-Bareli and Hardoi. The area has a number of slaughterhouses nearby, the waste of which provides a good and stable source of food for the Egyptian Vultures.

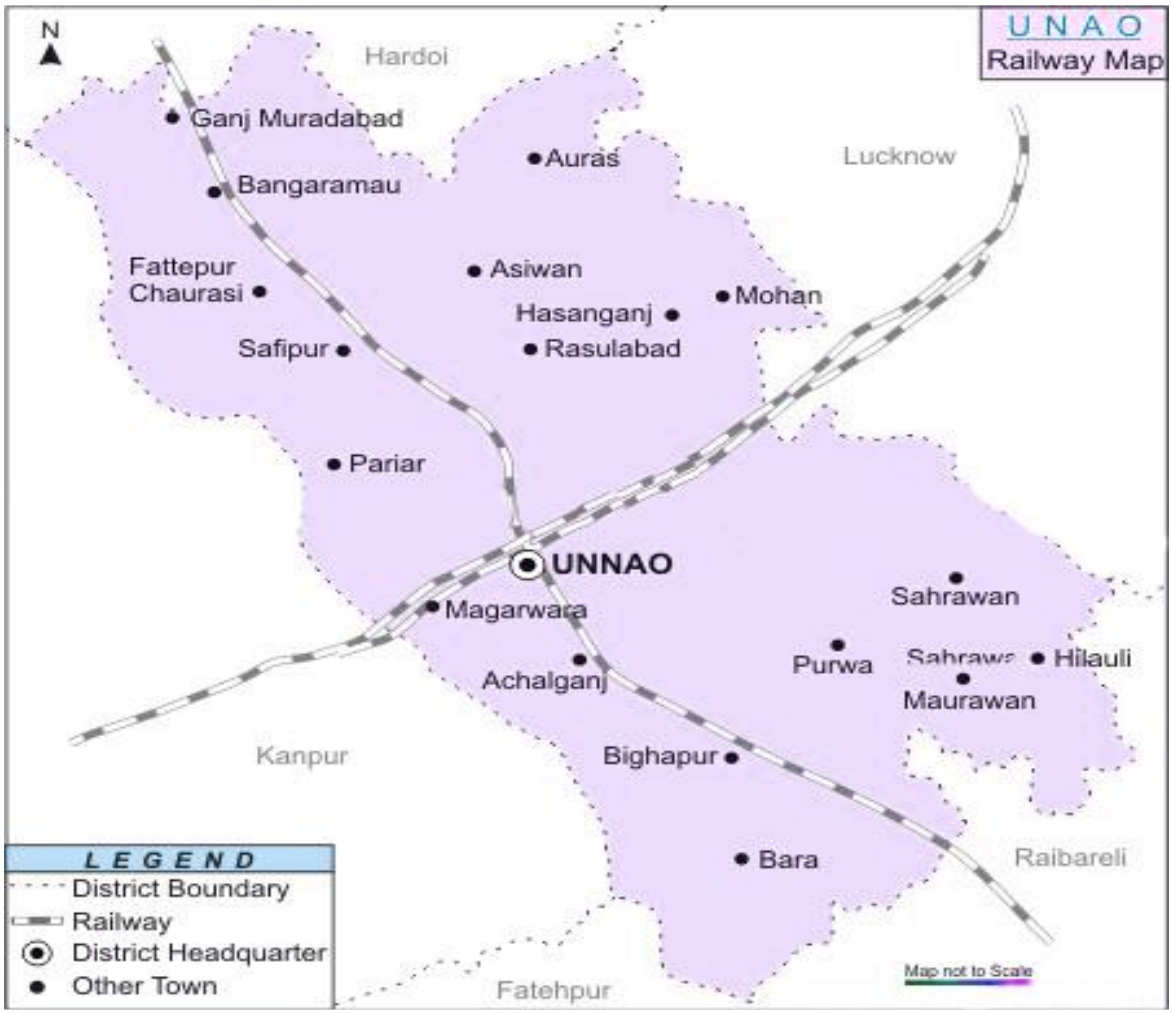


Plate 1: Map of Study Area: Unnao, Uttar Pradesh, India

2.2 Data Collection

During the study period (March 2015- July 2017) the nesting sites of Egyptian Vultures were more or less surveyed in five districts of Uttar Pradesh (Table.1) and five active nests were recorded respectively. Nest monitoring was conducted for a week per nest. Direct observations were made. The nest location was identified with the help of behavioral cues like adult carrying nest material in the mouth during nest preparation and adult bringing food for Juvenile. The nest from Unnao was then collected on 17th July2017 after it left abandoned in the year 2017. Nest was examined after reaching near the top of the water tank which was accessed by steps/ladders of the water tank. The nest materials obtained after the deconstruction of nests were weighed separately using the Tula man weighing balance and data was supported by photographs using camera Nikon Coolpix P900 (16.1-megapixel with 83x Zoom).

Table 1: Nest status during the Study Period

S. No.	Nest Number	District	Nest status		
			2015	2016	2017
1	N1	Unnao	Active	Active	Abandoned
2	N2	Rae bareli	Active	Active	Active
3	N3	Gonda	Active	Active	Active
4	N4	LakhimpurKheri	Active	Active	Active
5	N5	Aligarh	Active	Active	Active

3. Results

The nest status was recorded in all the five districts of Uttar Pradesh during the study period. In Unnao, the sampling point was selected during the breeding season and monitored each year. It was then found that in Unnao the nesting was successful in 2015-2016, but it did not occur in 2017 and the nest was abandoned. Nest was located on the top of a tank approximately at the height of 80 to 100 ft above the ground (Plate.2.A-D). As these are globally endangered species so any harm to the nest during its active period was avoided. The nest was collected in July 2017 after the nest was deserted. The abandoned nest from Unnao was then deconstructed for the study of nest matrix.

A. Active Nest (2016)

B. Abandoned Nest (2017)

C. View of Nest site

D. Collection of Deserted Nest

Plate 2(A-D): Nest at Unnao District

3.1 Nest Deconstruction

Nest was deconstructed into different materials. Similar materials were collected on separate sheets (Plate.3.A and B). Weight of each material was taken and the percentage was calculated.

Plate 3A: Separation of the materials used

Plate 3B: Constituent materials

3.2 Nest characteristics and Composition

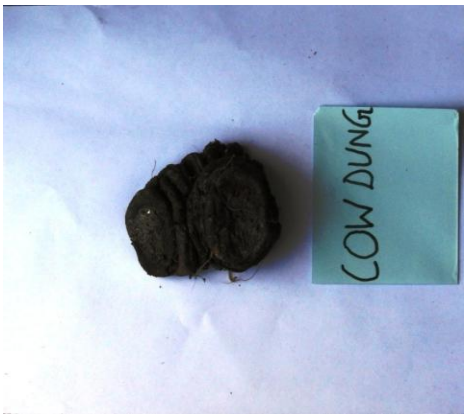
In the present study 15 different materials were observed and identified from the different layers of nest (Plate.5. A-M). Out of these 15 materials the Hosiery clothes were found maximum (42.61%) and threads were observed minimum (0.42%) respectively (Table.2, Plate.4). The nest of Egyptian Vulture is an open, broad, elliptical shaped and loosely built platform type.

The nests are constructed using a wide variety of materials. There is no nest concealment. Based on their construction type and variety of material used the nest materials can be classified into the decorative, structural and lining materials. Structural materials provide the structural support for parents and young ones while the lining materials create a type of optimum microclimate in which the off springs can be raised successfully [7, 8].

The nest materials have been classified as plant matter, animal matter, anthropogenic matter, and unidentified (materials which got dried and converted into powder form, thus could not be identified).

Table 2: Constituents of Egyptian Vulture Nest layers

S. No	Nest Materials	Percentage	Nest layer	Physical and Mechanical Properties
1.	Bones	17.89	Decorative	Decoration and defense
2.	Linen	3.40	Lining	Natural fabric for coolness and comfort in warm weather
3.	Mesquite Sticks *(Acacia nilotica)*	12.78	Structural	Protective fence
4.	Cow dung	1.56	Decorative	Keeps soil evenly moist
5.	Faeces	1.98	Decorative	Pigmentation from ungulate faeces
6.	Woolen sweater	7.10	Lining	To keep the nest dry and warm
7.	Hosiery clothes	42.61	Lining	Provides softness
8.	Cotton	2.27	Lining	Moisture control
9.	Rubber	0.71	Lining	Provides resistance to scratches and injury
10.	Thread	0.42	Structural	As a binding material
11.	Leather	0.56	Lining	Resistance to fire, fungal infection and other mites
12.	Soil and other particles	4.26	Lining	Probably helps in maintaining temperature balance and sticking together the particles.
13.	Foam	1.42	Lining	Insulation
14.	Jute	1.70	Lining	Ecofriendly and provides strength
15.	Root	1.27	Decorative	Maintains Nest architecture



A. Cowdung

B. Hosiery Clothes

C. Foam

D. Linen

E. Leather

F. Threads

G. Soil and other particles

H. Cotton

I. Mesquite Sticks

J. Root

K. Bones

L. Wool

M. Jute

Plate 4(A-M): Nest material constituents selected by Egyptian Vultures

3.3 Nest Zones

There are four functionally important areas in a nest which can be recognized easily. From the innermost part of the exterior most these layers are lining, structural layer, outer (decorative) layer, and attachment.

The Lining Layer: is the thin layer which remains in direct contact with the eggs and the nestling. Primarily constitute of softer materials like hosiery clothes, wool, foam, linen, cotton, leather, foam, jute, soil and other particles etc. In some situations, anthropogenic materials could be a beneficial resource, enabling nest construction in places where natural materials are limited.

The structural layer: forms the base of the nest and constituted predominantly of plant matters specifically the dried plant sticks (Mesquite) and threads. These all are important according to the function. The most important of which is the Structural layer as it gives strength and durability to the nest shape, thereby preventing it from distortion and falling apart. The materials present in this layer are considered as the component of structural layer. There may be more than one structural layer. Kulczycki studied about the nest of the common Raven (*Corvuscorax)* composed of three structural and two lining layers [10].

Outer Decorative Layer: This is the layer which is composed of the decorative nest materials which are placed outside the structural layer as Bones, cow dung, faeces, root. It is also either present or absent as according to the type of nest.

Attachment: It records or consists of the materials used to secure the position of the nest. It may be present or absent as according to the type of nest. It is generally absent in those nests which have a support from below. This layer is absent in the present study as the nest found was on a stair of the water tank which provided it a suitable base.

4. Discussion

Riper observed the use of sheep wool as a binding material in the structural layer of nests of Hawaiian birds [19]. In some bird species like bowerbirds males primarily build nests to attract females for mating [3, 15] while in other species nest is prepared for purpose, mate attraction and subsequent nesting [7]. The maximum utilization of anthropogenic materials indicates association of a bird with Human habitation [5].Some species use social information to decide where to build their nest [12,13], and also use social information to learn how to build a nest, including the selection of material to use and how to handle that material for nest preparation. The nest material composition also varies according to the local availability of materials [24].

The materials have been classified into four different categories on the basis of their origin. Anthropogenic matter constituted the maximum percentage which shows their link with human beings, followed by Animal matter, Plant matter, Soil and other unidentified materials (Table.3, Plate 5).

Table 3: Composition Differentiation of Egyptian Vulture Nest Layers

Matter Origin	Percentage
Plant matter (Babool Sticks, Root, Cotton)	16.32%
Animal matter (Bones, cowdung, faeces)	21.43%
Anthropogenic matter (Linen, Wool, Hosieryclothes, Rubber, Thread, Foam, Jute)	57.92%
Unidentified (Soil and other particles)	4.26%

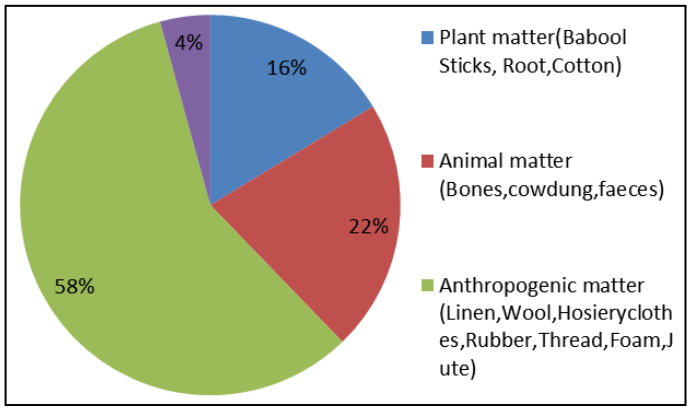


Plate 5: Percentagewise Matter Composition Differentiation

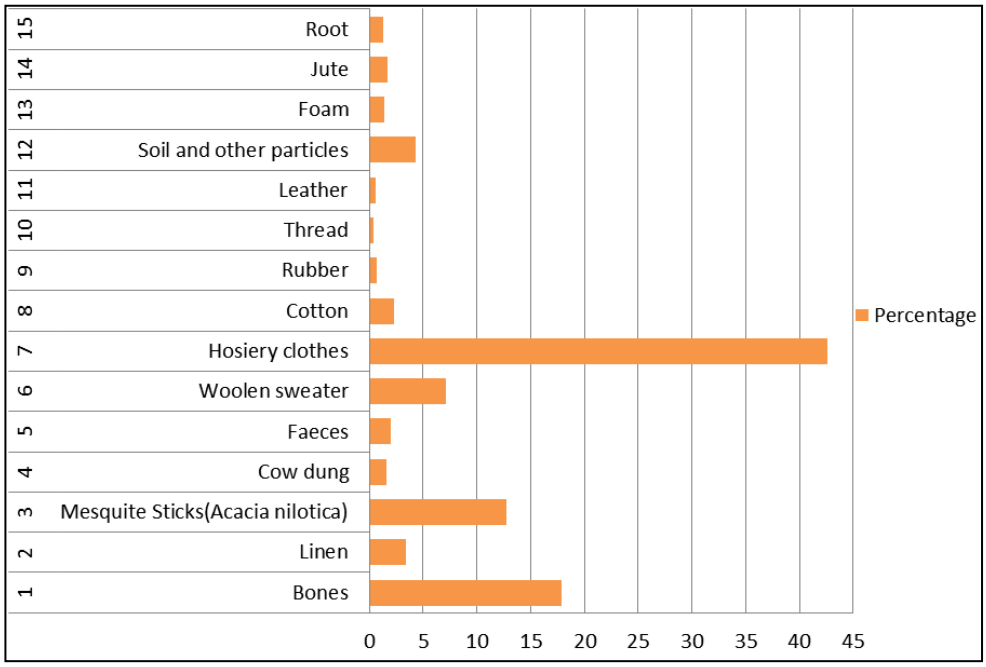


Plate 6: Percentagewise Nest Material used

4.1 Mechanical and physical Properties of the construction materials

There were remarkable differences between the properties of the materials used and their arrangement in the nest respectively. In the outer region of the nest the materials used were significantly stronger, sharp and rigid than the inner part of the nest which consisted of relatively softer and smoother materials. The sharp and thorny mesquite sticks and the bones were probably used as a defense fence along with cow dung and mammal's/ungulate faeces on the outer region as decoration. Mesquite has several antimicrobial properties too which prevents the nest from decay and other infections. The woolen fabric, cotton and other clothes used is to provide warmth and comfort to the juveniles. The other materials give the nest proper architecture and help with maintenance of environment inside the nest.

5. Conclusion

From the study it can be inferred that during the nest building process, the hard and sharp materials appeared to be the most effective material for the protection of the nest. The mesquite sticks and bones were decorated as a host defense. The anthropogenic matter constituted the maximum percentage of all the materials preferred which shows the association between Egyptian vultures and human beings. The data also allow postulating a hypothesis that Egyptian Vultures are able to distinguish between materials based on physical and mechanical properties and thus selective in their use for nest construction.

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