COMPARATIVE ANALYSIS OF BAYA WEAVER NEST IN RURAL, SUBURBAN AND URBAN HABITAT

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "**Comparative analysis of Baya Weaver nest in rural, suburban and urban habitat**" is based on the results of investigations carried out by me in the (Zoology) at the School of Biological Science and Biotechnology, Goa University under the supervision of Dr. Minal Desai Shirodkar and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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COMPLETION CERTIFICATE

This is to certify that the dissertation report "Comparative analysis of Baya Weaver nest in rural, suburban and urban habitat" is a bonafide work carried out by Ms. Aayushi A. Ghadi under my supervision in partial fulfilment of the requirements for the award of the degree of Master's in the Discipline of Zoology at the School of Biological Science and Biotechnology, Goa University/College.

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PREFACE

This thesis is submitted for the fulfilment of the requirement for the degree of Masters in Zoologyand comprises research work carried out by the author under the supervision of Dr. Minal Desai Shirodkar, Assistant Professor, Zoology Discipline, School of Biological Sciences and Biotechnology, Goa University from 2023-2024.

The baya weaver (Ploceus philippinus) is a remarkable bird species renowned for its intricate nest-building skills. They construct elaborate, pendulous nests that hang from tree branches, showcasing their architectural prowess and adaptation to various habitats. While their nesting behaviour has been studied in different regions, there is a need for a comprehensive understandingof how urbanization influences their nesting strategies. The study aims to provide a comparative analysis of the nest architecture of baya weavers across rural, suburban, and urban habitat. By exploring the similarities and differences in nest structure and construction materials preferences,we can gain valuable insights into the adaptability and resilience of these skilled avian architects.

The study holds significant importance in the context of urban biodiversity conservation and the preservation of traditional nesting habitats. As urban sprawl continues to encroach upon natural landscapes, it is crucial to understand how species like the baya weaver respond and adapt to thesechanges. The findings of this research can contribute to the development of effective conservation strategies and inform urban planning initiatives that promote the coexistence of wildlife and humansettlements.

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ABBREVIATION USED

Entity	Abbreviation
Diameter at breast height	DBH

ABSTRACT

Baya weaver (*Ploceus philippinus*) is a remarkable avian architect known for constructing intricate pendulous nests. This study investigated the nest architecture and nesting materials usedby baya weavers across rural (Aldona), suburban (Bostoda), and urban (Campal Panjim) habitats in Goa, India. Nests were found hanging from coconut trees in all three sites, using coconut leaf fibers and grass strips as the construction materials. Statistical analysis revealed no significant differences in fiber dimensions utilized for nest construction among the sites. No artificialmaterials were incorporated into the nests.

Keywords: *Ploceus philippinus,* clay deposit, fiber dimension.

CHAPTER 1: INTRODUCTION

1.1 Background

Avian nest construction is a remarkable feat of nature, showcasing the intricate architectural abilities and material preferences of different bird species. Traditionally, birds have relied on natural materials such as twigs, leaves, grasses, and mud to construct their nests (Hansell, 2000). However, with the increasing urbanization and anthropogenic modifications of natural habitats, some bird species have adapted by incorporating artificial materials into their nest structures (Antczak; *et. al*. 2010; Malaki; *et. al*. 2019).

The use of anthropogenic materials in nest construction has been documented across various bird taxa, including passerines, raptors, and seabirds (Wysocki; *et. al.* 2015; Guravaiah; *et. al*. 2022). These materials can range from synthetic fibers, plastic fragments, and discarded man-made objects to more unconventional items like cigarette butts, paper, and even metal wires (Antczak *et. al*. 2005; Malaki; *et al*.2019).

Several factors may contribute to the incorporation of artificial materials in avian nests. Proximityto human settlements and the availability of these materials in the immediate surroundings can influence their use by birds (Antczak; *et. a*l. 2010). Additionally, some bird species may perceive certain artificial materials as advantageous for nest construction, such as providing insulation, structural stability, or deterring predators (Malaki; *et. al*. 2019; Guravaiah; *et. al*. 2022).

Baya Weaver *Ploceus philippinus* is a peaceful, intelligent, and gregarious sparrow-sized bird with remarkable nest-weaving abilities (Quader 2006). It is commonly found across the Indian Subcontinent and Southeast Asia. Non-breeding males and females have a similar appearance, with dark brown feathers streaked with fulvous buff above and plain feathers below (Arigela; *et. al.*

2021). Breeding males have a yellow forehead and a black mask around their eyes (Ali 2002). Baya weavers breed during the monsoon season, which runs from June to November (Rasmussen and Anderton, 2005).

Baya Weavers are best known for the elaborately woven nests constructed by the male bird. A complete baya weaver nest is a retort-shaped construction consisting of three parts: stalk, body and entrance tube (Sharma 1995). The nest construction involves different stages, including the wad, ring and helmet stages, and the male bird takes around 18 days to complete a single nest (Asokan*; et. al*. 2008). In agricultural landscapes, the nests are observed on various plant species, with a high percentage oriented towards the east, and predation by avian species like House Crows and Shikras recorded (Thiruvenggadam 2022). In rural areas, Baya weavers exhibit nesting habits on power cables despite the availability of nest-supporting trees, with abnormal nests constituting a significant portion. In South and Southeast Asia, where Baya weavers build overhanging nests, the nest structureis linked to the microclimate, influenced by surrounding temperatures, and reproductive success is tiedto optimal conditions within the nests. The nests are typically retort-shaped, woven from strips of leaves and mud, and built on branches over water bodies for protection from predators (Pandian 2022).

Baya weaver uses fibers from sugarcane leaves, coconut leaves, Indian Date Palm leaves, Narrow-leaf cattail leaves, and strips of grass for the construction of the nest (Pandian 2022, Taprobanica 2023). The birds exhibited a differential use of nesting fibers to fabricate the different zones of the nest, probably to provide added comfort to the altricial young and incubating parent and to afford the required resistance against wear and tear owing to frequent movements of the mother bird while ferrying food to the young (Borges *et.al*.2002)

Baya Weaver usually prefers open cultivation areas for the construction of nests, but they have also been found in urban areas where they are close to human habitation. This study compares rural, suburban, and urban habitats and the architecture of the nest, the types of fiber used in the construction of the nest and its tread dimension.

1.2 Objectives

- To study the fibers utilized in nest construction.
- To study the structural detail of the nest (suspension, nest length, nest depth, entrance tube).
- To know if fibers and their dimensions, utilized by the bird in rural, suburban, and urban areas, varied.

1.3 Hypotheses

Baya weaver may be using artificial fiber in its nest.

1.4 Scope

Further studies can be conducted to study the nests of birds and whether they are using artificial materials or no

CHAPTER 2: LITERATURE REVIEW

Baya Weaver (*Ploceus philippinus*) is a small sparrow-like bird known for its beautiful and delicate nests that hang from various platforms (Dhande; *et. al*. 2015). It has a stout conical bill and a short square tail. The Baya Weaver, a common weaver bird in South-Central India, is known for its intricate nest-building habits (Achegawe 2016). Construction of the nest is a critical aspect of mate attraction, with females selecting partners based on the quality and complexity of the nest. Once mating is complete, the male builds the nest by building the entry tunnel, while the female focuses on the interiors. Male birds build multiple half-nests, and court females build multiple partially completed nests, as they are polygamous (Arigela; *et. al.* 2021).

Baya weavers favor nesting locations near bodies of water, cultivated areas, and woodland borders because nest-building materials and food are readily available. Thorny bushes and shrubs provide a good grip to weave the nest first and protect it from ground predators (Verma; *et. al*. 2022). Using their beak and feet, male weavers meticulously weave together strands of grass, leaves, and twigs to create a nest-pendulous shape, resembling a retort, with a central nesting chamber often suspended from the tips of the branches.

Baya Weavers choose a range of trees for their nests, they are most attracted to the tall, unbranched trunks and long, swaying foliage of palm trees, which deters predators and offers suitable leaf strips for nest construction (Pandian 2022). *Prosopis juliflora* and *Acacia nilotica* are two thorny trees preferred by Baya Weaver. In addition to thorny plants, they prefer high foliage trees like *Aegle marmelos, Albizia amara, Albizia lebbeck, Bauhinia racemosa, Butea monosperma,* and species of Ficus to build their nests and feed their chicks during the monsoon season (Arigela; *et. al*. 2021). Nesting birds prefer *Cocos nucifera* (Arecaceae) on the west coast of the Indian

Peninsula, *B. fabellifer* (Arecaceae) on the east coast, and *Vachellia nilotca* (Fabaceae) in the dry northwestern region (Pandian 2023).

A total of 135 nests were found on four power cables in the Villupuram district, Tamil Nadu (Pandian 2018). Baya Weavers chose power lines as nesting places despite the presence of three nest-supporting trees within 500 meters of the cables. When nesting, they preferred to locate power lines away from dams and trails in farmland, presumably to avoid human disturbance (Pandian 2022). Ali (2009) found that nesting trees had higher values than non-nesting trees, and potential habitats such as agricultural lands, water sources, and electric lines were closer to nesting trees. Borges et al. (2002) observed that the birds preferred eucalyptus trees over coconut palms due to their wider anchoring area and protection against monsoon vagaries. Asokan; *et. al*. (2008) found that the birds constructed nests in palm, coconut, and date palm trees, with the male bird taking 18 days to construct a single nest.

The position of the nest on the tree is crucial for its stability against wind and predators. Baya Weavers prefer branches on the opposite side of wind flow (Ali, 1931; Sharma, 1990), with the majority of nests found in the southeast corner of a tree in southern India (Arigela *et. al*. 2021). Males store wet mud and dung pellets in a helmet-shaped nest to maintain balance against the wind. Subsequently, females use these pellets to create a plastered chamber within the nest (Davis, 1973).

The birds used leaf fibers of the Indian date palm *Phoenix sylvestris* and sugarcane *Saccharum officinarum* as nest materials (Molur, 2023). Long strands of cattail or bulrush, grasses, rushes, sedges, and long ripped palm fronds are weaved into the nests (Arigela; *et. al*. 2021). Achegawe (2016) reported that the male Baya Weaver constructs and displays the nests using locally available

grass and leaf blade threads and the birds exhibit a high nesting success rate. The materials are used to create different parts of the nest, with specific fibers chosen for their properties, such as stability and comfort (Borges; *et. al.* 2002). Nests made of prickly bushes and woven with fine fibers are highly effective (Quader, 2006). The birds used different nesting fibers for different parts of the nest. Sugarcane fiber likely provides better anchorage and stability because of its interlockingsiliceous spicules, which are utilized in constructing the base, stalk, and roof of the brood chamber.Coconut leaf fibers were used to build the entrance tube and floor of the brood chamber (Borges; *et. al.* 2002). The grass substructure contains nest chambers that are not interconnected (Maclean, 1973). The nest architecture varied significantly based on the construction patterns. These variances could be related to the nest owner's age and experience and the nest microclimate variedamong nests at different hours of the day (Asokan; *et. al*. 2008).

Chapter 3: Methodology

3.1 Study Area

The study was conducted at three sites located in Aldona (rural), Bostoda (suburban), and Campal Panji (urban).

Site 1

The study site is located in a village field of Aldona (Lat 15.592888° N & Long 73.891635° E) surrounded by paddy and vegetable cultivations. The vicinity of human habitation is 100 m. A small body of water was located near the tree.

Site 2

The study site is located in Bostoda (Lat 15.580918° N & Long 73.838674° E). It was located near a vegetable field. It is 30 m away from human habitation, bypassing the road in the middle that separates the study location from human habitation.

Site 3

The study site is located at Campal in Panjim (Lat 15.488416°N, Long 73.815609°E). On the one hand, it is surrounded by hotels and shops, with roads passing nearby. The nesting tree is located inside human habitation.

Fig 3.1.1 a) Map showing nesting of Baya Weaver in Aldona b) Nesting on Coconut tree *Cocos nucifera*

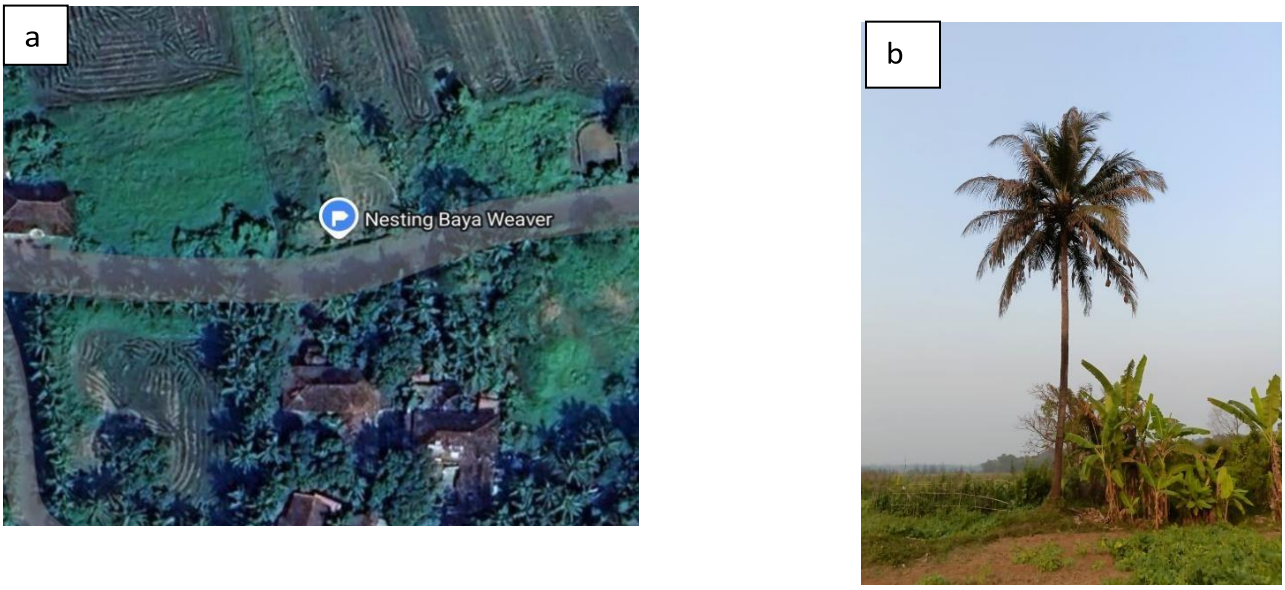

Fig 3.1.2 c) Map showing nesting of Baya Weaver in Bastoda d) Nesting on Coconut tree *Cocos nucifera*

Fig 3.1.3 e) Map showing nesting of Baya Weaver in Bastoda f) Nesting on Coconut tree *Cocos nucifera*

3.2 Methods

The study was conducted in three separate locations. Aldona is rural; Bostoda is suburban; and Campal Panjim is urban. The study site was inspected, the total number of nests was counted and the fallen nests were collected. The height of the tree and the height of the nest from the ground were measured using a smartphone application tree (height measurement). The DBH of the tree was measured using a standard measuring tape. Parameters of each nest (suspension, nest length, stalk and entrance tube) were measured using standard measuring tape. From each nest 10 fibers each, were taken from the stalk, nest body, egg chamber and entrance tube, diameter of the fiber was measured using a screw gauge (125×100mm). The nest was cut open to check if any artificial materials were used in nest construction. Photographs of the study sites and nests were taken with a Samsung F23 (50mp). The Kruskal-Wallis test was used to compare the thread dimension of the stalk, nest body, egg chamber and entrance tube along the three sites using GraphPad Prism.

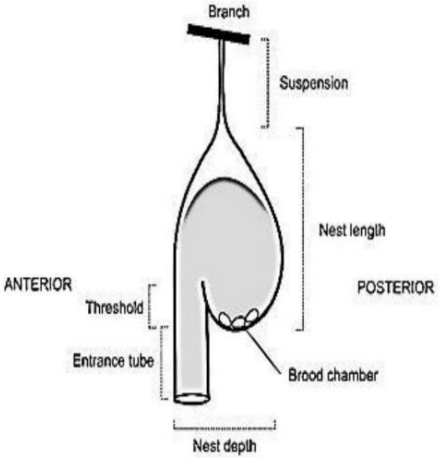

Fig 3.2.1 Parameter measurement of the nest (after Quader S.)

Chapter 4: Analysis and Conclusions

4.1 Observation

Baya Weaver mostly prefers open cultivation areas for nest construction. In Aldona (rural), nest construction was observed in the cultivation area of the field. The nests were hung from coconut tree. Eleven nests were discovered, of which seven were complete and four incompletes. The height of the tree was 5m. At Bostoda (suburban) nests are located on the coconut tree, with a total of 31 nests recorded: 11 complete nests and 20 incomplete nests. The height of the tree was 10m. At Campal Panjim, nests were located on coconut trees; a total of 25 nests were recorded, with 10 complete and 15 incomplete nests. The tree's height was 6.3m.

ALDONA

Nest structure

Baya Weaver's nest is intricately constructed and hung from tree branches. It is typically flask-shaped, with a downward-facing entrance hole. The suspension length of the nest ranged from 10 to 55.5 cm, the nest length from 20 to 34 cm, the entrance tube from 3.5 to 43 cm, and the nest depth from 14.5 to 17.5 cm. The average length of nest suspension is 28.77 cm, the nest length is 26.54 cm, the entry tube is 15.90 cm, and the nest depth is 16.63 cm.

Nest fiber

Nests were made up of coconut leaf fibers (cocoas nucifera) and grass strips. The thin fibers were woven on the outside, whereas the strips of grass were woven inside the stalk of the nest. The nest body consisted of a blend of thinner and thicker fibers. The egg chamber contains green grass that has not been braided but is used as padding for the egg, and a small amount of clay deposits is wound in the inner lining of the walls. The entrance tube consists of small fibers.

Dimension of fiber

The nest contained thick and thin fibers; the fiber diameter of the stalk ranged from 0.015-0.021 mm, the nest body was 0.015-0.020 mm, the egg chamber was 0.016-0.022 mm and the entrance tube was 0.014-0.018 mm. The average diameter of the tread of the stalk is 0.017mm, the nest body is 0.019mm, the egg chamber is 0.017 and the entrance tube is 0.015mm

BASTODA

Nest structure

The nest structure is flask-shaped with suspension ranges from 65-21cm, nest lengths is 21-36cm, entrance tube is 6-30cm, and nest depths is 18-21cm. The average length of the stalk is 40.83 cm, the nest length is 29.50 cm, the entrance tube is 19 cm and the nest depth is 19.08 cm. One pseudo-bistoreyed nest was observed, it is monostoreyed in structure, having one egg chamber like a normal nest but they have a false appearance of being a double egg chamber and double storeyed.

Nest fiber

The nest was constructed using coconut leaves and grass strips. The stalk was constructed using a larger fiber inside and a thinner fiber outside the stalk. The nest body consisted of a mixture of smaller and larger woven fibers. The helmet stages of the nest contained clay deposits on the inner lining of the wall. The egg chamber contained green grass, which was not woven along the fibers of the nest.

Dimension of fiber

The stalk of the nest contained a thread diameter ranging from 0.015-0.023mm, the nest body was 0.020-0.024mm, the egg chamber was 0.018-0.023 mm and the entrance tube was 0.018-0.023mm. The average diameter of the stalk is 0.018mm, the nest body is 0.19mm, the egg chamber is 0.021mm and the entrance tube is 0.019mm, respectively.

CAMPAL PANJIM

Nest structure

The nest was flask-shaped with a suspension of 10–49 cm, a length of 17–40 cm, an entrance tubeof 5–30 cm, and a nesting depth of 18–22 cm. The average length of suspension is 22.08cm, the length is 26.25cm, the entrance tube is 7.83cm and the depth of nest is 19 cm. One is somewhat like a guitar-shaped incomplete nest with a large, rounded end was found.

Nest fiber

The nest was constructed using the smaller and larger fiber of coconut leaves and the grass strips. The incomplete helmet-shaped nest contains clay deposition on the wall's inner side. The egg chamber contained grass material that was not woven into the nest.

Dimension of fiber

The tread diameter ranges from 0.015-0.023mm, the nest body is 0.015-0.024mm, the egg chamberis 0.018-0.024mm and the entrance tube is 0.017-0.022mm. the average diameter of the stalk is 0.019mm, the nest body is 0.019mm, the egg chamber is 0.019mm and the entrance tube is 0.021mm.

Host plant

The nesting of Baya weavers prefers coconut trees (*Cocos nucifera*) for the construction of a nest across all three habitat types - rural, suburban, and urban. At the rural site of Aldona, the nests were found hanging from coconut trees in the cultivation area. Similarly, in the suburban site of Bostoda and the urban site of Campal Panjim, the baya weaver nests were located on coconut treesinside the human settlement.

Table 4.1.1 Details of three different sites studied of Baya Weaver nests

Location	Aldona	Bastoda	Campal, Panjim
Latitude & Longitude	15.592888°N 7.3891635°E	15.580918° N 73.838674° E	15.488416°N, 73.815609°E
Proximity to human habitation	150m	30m	3m
Name of the host plant	Coconut tree	Coconut tree	Coconut tree
Height of the tree	5m	9m	6.30m
Height of the nest from the ground	4m	8m	4.5m
DBH of the tree	0.7m	1.05m	1.15m
No. of nest	11	25	31

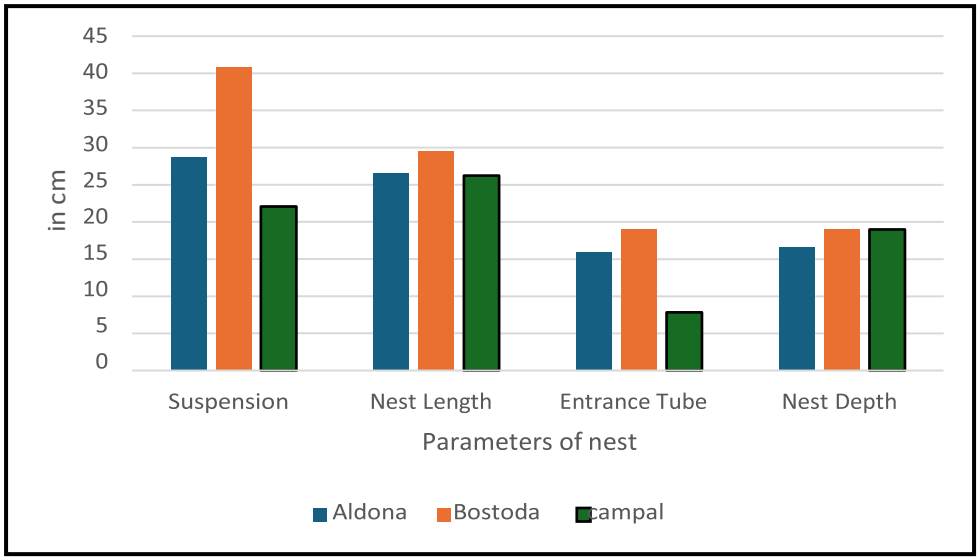

Fig 4.1.1 Graph showing parameters measurement of nests.

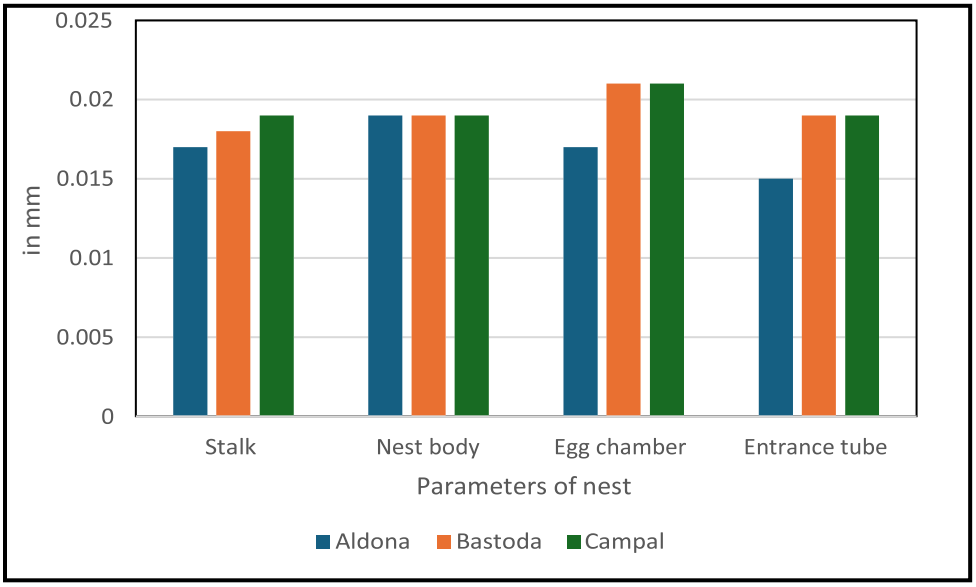

Fig 4.1.2 Graph showing measurement of thread dimension of the nest

Fig 4.1.3 Clay deposition in the incomplete nest

Fig 4.1.4 Strips of grass used in stalk

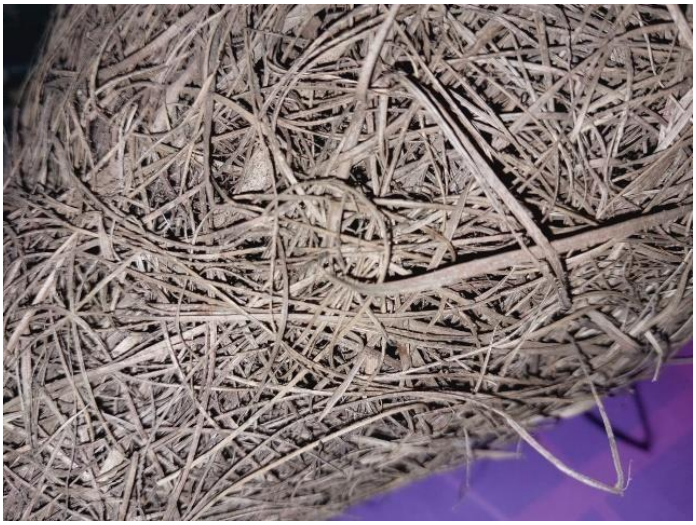

Fig 4.1.5 Coconut leaves fiber used in nest construction

4.2 Discussion

This study was conducted on the nesting behavior of the Baya Weaver (*Ploceus philippinus*) in rural, suburban, and urban habitats. The present study suggests that Baya Weavers predominantly prefer open cultivation areas for nest construction, as observed at the rural sites of Aldona and Bastoda. In addition, previous studies have reported species' affinity for areas near water bodies, cultivated lands, and woodland borders, where nesting materials and food sources are readily available (Verma et al., 2022; Pandian, 2022).

Baya weaver prefer nesting away from human habitation (Pandian 2022) but in the present study, nesting was also found in urban areas close to human habitation where daily activities of humans are present. The nesting along the three sites was observed on the coconut tree, as they mostly preferred nesting on tall and thorny plants which helped them to avoid the predators (Arigela; *et al*. 2021 Pandian 2022)

The nest structures across the three study sites exhibited similarities, with a characteristic flask-shaped design and a downward-facing entrance hole. However, this study also revealed some variations in nest dimensions, such as suspension length, nest length, entrance tube length, and nest depth, which could be influenced by factors such as the age and experience of the nest owners, as well as the microclimate within the nests (Asokan; *et. al.* 2008).

Analysis of the nest fibers used for construction showed a predominant use of coconut leaf fibers (Cocos nucifera) and grass strips, with specific fibers selected for different parts of the nest based on their properties, such as stability and comfort (Borges; et al., 2002). The dimensions of the fibers along the tree sites were mostly similar. The presence of clay deposits in the inner lining of the nest walls further aligns with the observations of Davis (197) and Pandian (2022), suggesting their role in maintaining nest balance against wind and predators.

The statistical analysis revealed no significant differences in the dimensions of fibers used for nest construction among the rural, suburban, and urban sites. This consistency in material usage and fiber dimensions suggests that baya weavers maintain their traditional nest-building techniques and material preferences despite the varying degrees of urbanization and habitat modifications.

4.3 Conclusion

The study shows the nesting and nest architecture of the Baya Weaver (*Ploceus philippinus*) across three different habitats: rural (Aldona), suburban (Bostoda), and urban (Campal Panjim) in Goa, India. Baya Weavers prefer to construct their elaborate, pendulous nests on coconut trees in open cultivation areas, though they can also adapt to urban environments with human habitation nearby. The nests were found to be intricately woven using a combination of coconut leaf fibers (*Cocos nucifera*) and grass strips. The statistical analysis shows fiber dimension (diameter) and material utilized in the nest construction in rural, suburban and urban habitat areas are similar. No artificial material is used in nest construction.

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