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RESEARCH ARTICLE

# COMPOSITION ANALYSIS OF TWO SWALLOWS NESTS – *Petrochelidonfluvicola* AND *Hirundorustica*

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ABSTRACT

Indian Cliff Swallows and Barn Swallows build gourd shaped and bracket shaped mud nests respectively, using mud of proper consistency. The nature of the soil and its plasticity in both these cases are almost similar. The chemical and mineral contents of these two types of nests analyzed show a slight variation. In addition total quantity of carbohydrates and protein contents in both these cases are compared in this study.



## INTRODUCTION

Indian Cliff swallows *Petrochelidonfluvicola* and Barn Swallows Hirundorustica build gourd shaped and bracket shaped mud nests respectively. Generally swallows select mud with appropriate proportion of silt and sand to build nest (Kilgore and Knudsen, 1977). Nearly 5% of the bird species use mud as the nesting material mixed with other organic contents (Rowley, 1971). Through the work of Winkler and Sheldon (1993) it is hypothesized that mud nest construction has evolved from burrow adopting ancestors once in the history of the family Hirundinidae that includes swallows and has diversified in Africa due to drier climatic conditions prevailed at that time. Along with this diversification two important aspects regard to nest building seem to have acquired by these birds 1. Preference of suitable soil for construction and 2.The art of building mud nests. The art of nest building will be dealt separately as it is not in the limit of this article The mud used for construction may vary in its water contents, minerals or organic composition which may be preferably selected by these birds for effective construction. Both cliff swallows and Barn swallows mix the wet mud contents with their saliva to mould the pellet into a definite shape; thus some amount of salivary content is invested for nest building. Though these birds mix saliva with soil during nest construction, there is no evidence how much of salivary content is mixed during this process. Where as in cave swallows the nest is built purely of saliva an example of maximum saliva investment. Here in our study we have compared the nest contents of cliff and barn swallow nests that might provide a clue regard to investment of salivary contents. Irrespective of the salivary content as glue, the quality of the soil is important to mould the nest to a definite structure. In this study we have worked out the texture and other qualities of the nest soil as well of soil from where the birds collected the mud.

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## MERIALS AND METHODS

Nests of cliff swallow and barn swallow are collected from two localities and through our observations it is confirmed which soil these birds pick for building nests. Abandoned nests were used for analysis care was taken to use only the portion of the nest free from excreta or pouch eliminates of the birds in both these cases. We have tested the physico chemical parameters of two nest contents. The details of the analysis include pH, EC, Mineral Contents as well total carbohydrates and proteins. The standard qualitative tests are used for qualitative determination of sugars and amino acids.

### Soil pH

pH of the soil was determined using pH meter following the procedure of Jackson (1973).

**Electrical Conductivity (EC)**

Electrical conductivity of the soil suspension (1:2.5 soils: water) was determined using (ELICO) conductivity bridge (Richards, 1954).

**Organic Carbon (OC)**

Organic carbon was determined by Walkley and Black rapid titration method (Jackson 1979). 2 mm size soil was ground and passed through 100 mesh sieve. This sample was used for estimation of organic carbon. The organic carbon was oxidized by using potassium dichromate and conc. $H_2SO_4$. The excess chromic acid was back titrated with standard ferrous ammonium sulphate solution to determine the organic carbon using the ferroin as indicator.

**Available macro (NPK) and micronutrients (Fe, Mn, Cu, Zn)**

The available N was determined by alkaline potassium permanganate ($KMnO_4$) solution and determining the ammonia liberated (Subbaiah and Asija, 1956). Available phosphorus was determined by sodium bicarbonate $NaHCO_3$ (0.5 M) (Watanabe and Olsen, 1965) method. Olsen's method was used because the soils are alkaline. K was determined by neutral ammonium acetate solution method. The potassium in extract was estimated by atomic absorption spectrophotometer. DTPA (DiethyleneTriaminePenta-acetic Acid) (0.005 M) extractable (1:2, Soil: DTPA) Fe, Mn, Zn and Cu were determined as per the procedure outlined by Lindsay and Norvell (1978) using atomic absorption spectrophotometer.

**Particle-size distribution (Sand, Silt and Clay)**

International pipette was used for determination of particle-size distribution. The soil samples were treated with $H_2O_2$ (30%) to remove organic matter and further treated with HCl (1 N) to remove carbonates. Sand (2-0.05 mm), silt (0.05-0.002 mm), clay (<0.002 mm) size fractions were determined (Jackson, 1979). The textural class was determined using USDA textural triangle (Soil Survey Staff, 2000).

**PLASTICITY or Coefficient OfLinear Extensibility (COLE)**

COLE was determined as per method of Schafer and Singer (1976). The COLE is defined as the ratio of the difference between the moist length and dry length of a clod to its dry length.

COLE is expressed as,

$$COLE = \frac{Lm - Ld}{Ld}$$

Where, Lm = length of soil clod at 33 kPa tension and Ld = length of soil clod when dry (room temperature). Linear Extensibility (LE) was calculated from the COLE value using the formula LE = COLE x thickness of horizon (Soil Survey Staff, 1999).Quantitative analysis of carbohydrates was done by following Anthrone reagent method and proteins contents were quantified by Lowry's method (Lowry *et al*., 1951). The Qualitative analyses of proteins were done through Ninhydrin test, Millon's test and Xanthoprotein test (cf Philip B Hawk, 1965). Qualitative analyses of carbohydrates were done by using Molisch's test, Benedict's test and Picric acid test.

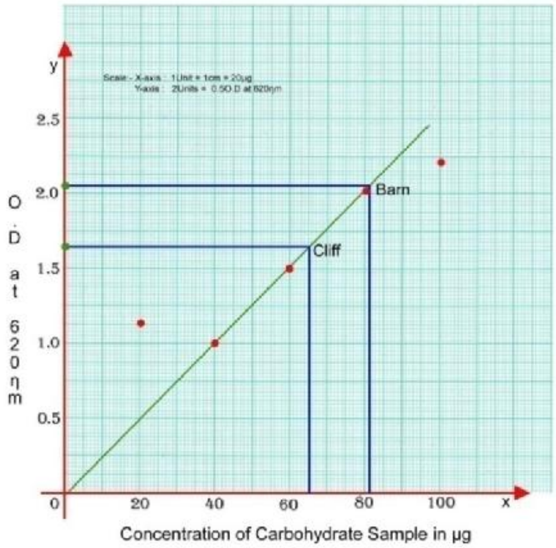


**Figure 1. Graph plot of the Carbohydrate Contents in Cliff Swallows and Barn Swallows nests**

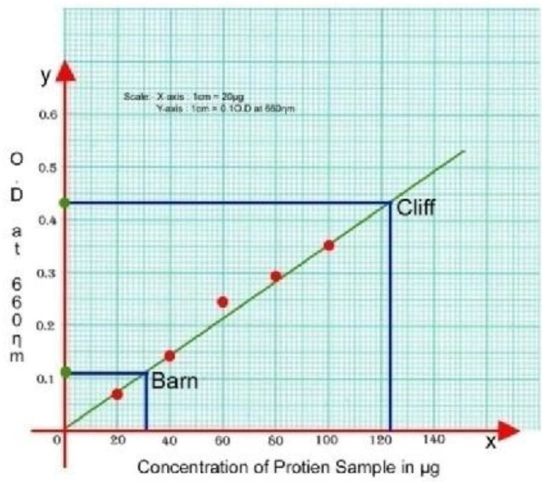


**Figure 2. Graph plot of the Protein Contents in Cliff Swallows and Barn Swallows nests**

**Observation**

The nest composition had revealed the presence of Organic Carbon, Nitrogen and Mineral Contents like Phosphorus, Potassium, Iron, Manganese, Copper and Zinc (Table 1). The pH is similar in both control sites in respect to both the species but it is slightly lower in nest than the control sites in both cases (7.6) (Table 1). The EC of barn swallow nest is less than the cliff swallows and the EC of both these nests was less than that of the original soil. The available Nitrogen and Carbon content show little variation between these two species nests, as well the potassium, iron, manganese, copper and zinc contents show very little variation among the nest as well between the control values of the original soil, original soil has

**Table 1. Mineral Contents in Cliff Swallows and Barn Swallows nests with control values**

| Physical & Chemical Parameters | | Barn Swallow Nest | Cliff Swallow Nest | Control (P.fluvicola) site | Control (H.rustica) site |
|---|---|---|---|---|---|
| pH | | 6.3 | 6.4 | 7.6 | 7.6 |
| EC dSm$^{-1}$ | | 0.09 | 0.11 | 0.15 | 0.14 |
| OC gm/kg | | 10.3 | 13.1 | 18.5 | 18.4 |
| Available Nitrogen gm/kg | | 0.0001321 | 0.0001388 | 0.0001295 | 0.0001273 |
| Phosphorus Available gm/kg | | 0.0000152 | 0.0000125 | 0.0000142 | 0.0000142 |
| Potassium Availablegm/kg | | 0.0001473 | 0.0001321 | 0.0001197 | 0.0001197 |
| Sand % | | 14 | 16 | 15 | 16 |
| Silt% | | 37 | 39 | 36 | 36 |
| Clay% | | 49 | 45 | 47 | 45 |
| Plasticity | Room Temp. | 0.27 | 0.23 | 0.24 | 0.24 |
| | 110$^{o}$ | 0.35 | 0.38 | 0.32 | 0.32 |
| Iron Fe mg/kg | | 16 | 17 | 2.0 - 4.5 | 2.0 - 4.5 |
| Manganese Mnmg/kg | | 13 | 12 | 0.3 - 1.0 | 0.3 – 1.0 |
| Copper Cu mg/kg | | 7 | 7 | 0.3 - 1.0 | 0.3 – 1.0 |
| ZincZn mg/kg | | 3 | 4 | 0.5 - 1.0 | 0.4 – 0.9 |
| Carbohydrate (per grams) mg/ml | | 0.081 | 0.065 | 0.003 | 0.003 |
| Protein (per grams) mg/ml | | 0.3 | 1.2 | 0.05 | 0.05 |

lesser contents of minerals than the nest mineral contents. The plasticity at room and at higher temp (100$^{o}$C) is almost consistent to the specific nest type as well to the control soil.The sand, silt and clay contents are all similar in its percentage between nest and control. The total carbohydrates content between the nests had shown variations that barn swallows have slightly higher content than cliff swallows. The protein contents are more in cliff swallows than that of barn swallows. The carbohydrates and protein in the control sample are far less than that of nest contents. The carbohydrates and proteins in control soil may be due to organic composition in the soil. The qualitative tests revealed the presence of reducing sugars, aromatic amino acids and phenolic amino acids.

## DISCUSSION

Composition and quality of the soil seems a key factor that determines a firm nest construction. The information obtained through analysis shows that the soil composition selected by both cliff swallow P.fluvicola and barn swallow H.rustica were almost similar in composition of clay, sand and silt showing only slight variations and have almost similar range of plasticity at room temp and at 110$^{o}$C, had similar PH and EC. This type of consistent soil selection speaks the knowledge of these bird species, regard to composition of the soil. The soil consistency is a kind of cohesion and adhesion between the soil particles, which is variable during moist and dry conditions. The soil consistency in these two case studies was firm and hard. The consistency of the soil depends on the soil mineral contents and water content. The mineral content of both the nest was slightly higher than that of the control indicates the mineral contents have come from the saliva of these birds mixed with the soil. The carbohydrates and proteins of the nest must have come from saliva of the bird as these contents are higher than that of control soil.Thus saliva application as gluing material while building the nest to the collected wet soil is imminent in both these cases. Compared to these two species of mud nesters the investment of saliva is very high in cave swallows. The cave swallows salivary composition for every 100gms of dry swallow nest contains 49.9gm of water soluble proteins 30.6gm of carbohydrates, 4.9gm of Iron, 2.5gm of inorganic salt that includes Na, Ka, Ca, S, P, Si, 1.4gms of fibers, 10.7gms of others (Ou Ming, 1988).

Winker and Sheldon (1993) have revealed that mud nest constructions have revealed once in the history of the family Hirudinidae and also these authors have stated that using mud to construct hanging nest is unique and this has increased complexity during evolution of nest from cups to gourd shape nest in swallows. As well this increase in complexity has paved way for the high density colonial mud nesting. Through our study it could be concluded that in course of evolution of mud nesting, composition of the soil seems to have played a vital role. Particularly the Plasticity and COLE consistency had decided the way of nest construction that diverged between mud nest constructors and salivary nest constructors. The non-availability of the consistent mud may be the reason for use of saliva in total to construct the nest by ancestors of cave swallows. It has to be confirmed through further tests. Our evaluation of these nests shows the availability of the mud with a definite consistency, and composition is crucial to site selection because we had come across many suitable locations for nest construction by swallows remained unused within the range of a few kilometers of our studies, where the soil composition consistency was much sandier and less clay.

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