Studies on The Nest Construction and Microclimate of Oecophylla Smaragdina

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Abstract- *Weaver ants (Oecophylla smaragdina) build their nest by binding fresh leaves with silk from their larva. They build their nests when the atmospheric temperature is high. Here, we briefly examine the structure of the nests and the processes involved in the construction and maintenance of these nests. We have described the spatial arrangement of weaver ant nests on trees in the Botanical garden of Nirmala College for Women, Coimbatore, South India. Measurements were made for 8 trees with a total of 72 nests in the field site. We have considered a host of biotic and abiotic factors that may be crucial in determining the location of the nesting site by Asian weaver ants. The microclimate (temperature) was also calculated throughout the day using a thermometer of 1°F accuracy. Our results indicate that tree characteristics and architecture followed by leaf features help determine nest location in Asian weaver ants. While environmental factors may not be as influential to nest arrangement, they seem to be important determinants of nest structure.*

Keywords- Oecophylla smaragdina, nest construction, nest microclimate, temperature.

I. INTRODUCTION

Ants are eusocial insects of the family Formicidae and, along with the related wasps and bees, belong to the order Hymenoptera. Ants evolved from wasp-like ancestors in the Cretaceous period, about 99 million years ago, and diversified after the rise of flowering plants. More than 12,500 of an estimated total of 22,000 species have been classified (Agosti and Johnson, 2003).They are easily identified by their elbowed antennae and the distinctive node-like structure that forms their slender waists.

Weaver ants vary in colour from reddish to yellowish brown dependent on the species. *Oecophylla smaragdina* found in Australia often have bright green gasters. These ants are highly territorial and workers aggressively defend their territories against intruders. Because of their aggressive behaviour, weaver ants are sometime used by indigenous farmers, particularly in Southeast Asia, as natural bio control agents against agricultural pests. Although Oecophylla weaver ants lack a functional sting they can inflict painful bites and often spray formic acid directly at the bite wound resulting in intense discomfort.

Here, we look at one system involving Asian weaver ants in an attempt to understand their interactions with the host plant and the environment. This interaction was studied through investigations of nest structure, construction, and arrangement. The aim of this study was twofold:

1) To understand the structure of weaver ant nests as well as the processes involved in their construction, and
2) To determine if the location of each weaver ant nest is influenced by one or more biotic and abiotic parameters.

The focus here is on the specific variables that could affect the habitat use and local distribution of *Oecophylla smaragdina*. In particular, we ask if:

1) Tree characteristics (tree structure and leaf size),
2) Environmental variables (temperature) and
3) Nest characteristics (nest size and relative position), could help determine the nest architecture and arrangement in Asian weaver ants.

II. MATERIALS AND METHODS

Study area

The study was conducted in the Botanical garden of Nirmala College for Women, Coimbatore, Tamil Nadu, South India.

Study Species - *Oecophylla smaragdina*

The Asian weaver ant *(Oecophylla smaragdina)* is a dominant arboreal ant that is widely distributed across tropical Australasia (Holldobler and Wilson, 1977). These ants build complex nests in the canopy that are frequently spread across multiple trees to form a single colony with hundreds of ants in each nest and thousands of ants in a colony. The *O. smaragdina* workers weave leaves of the host plant with silk

from their larvae (Cole and Jones). As with other social organisms that live in groups or colonies, it can be difficult to determine the exact boundaries of a colony of Asian weaver ants.

Measurement of nest site characters

The preferences of nest site selection by *Oecophylla smaragdina* were assessed by studying the following variables.

Plant species

The name of the plant species were identified with the help of a Botanist.

Plant height

Tree height, nest height and the nearest tree height from the floor was measured using an altimeter.

Diameter at Breast Height (DBH)

Diameter at Breast Height (DBH) was measured using a standard tape.

Distance

Distance to nearest plant species and distance to same species of nesting plant was measured using measuring tapes.

Number of branches

The activity of *Oecophylla smaragdina* is influenced by the branches of the nesting plant and the plants adjacent to the same. Therefore, the number of main, primary and secondary branches were counted along with the number of plants touching the nesting tree.

Nesting characters

The nest characters of *Oecophylla smaragdina* were analysed using 72 individual nests. The following measurements were made on all possible nests.

Nest morphology

The length (longest distance from one end to other end), width and maximum depth (shallowness) of nests were measured using a centimetre scale.

Number of leaves

The leaves of the trees play an important role in constructing the nest of *Oecophylla smaragdina*. Hence the number of leaves in the nest was counted. Both number of fresh leaves and dried leaves were counted in each nest.

Number of branches

Often, the weaver ants used adjacent branches to make the nest. Hence, the number of branches involved in the nest construction was counted.

Nest placement

Weaver ants placed their nest in different locations on the branch. In order to investigate the preference of placement in a branch, the location of the nest was noted as tip or axial or middle.

Shape of nest

The nest showed diversity in shape. Hence the shape of the nest was noted as oval or round or rectangular or triangular.

Nature of nest

The nest nature was noted from the external shape either as smooth or serrated. The whitish silk material made the nest smooth externally.

Components of nest

The content of nest such as leaves and flowers were noted from the external inspection.

Plant diameter at nest

The placement of the nest was supported by the strength of the branch. Hence the thickness of the branch on both sides of the nest was measured using vernier caliper.

Nest entrance morphology

The nest entrance morphology, i.e. shape of the entrance, location of entrance, its length and width were noted.

Nearest nest distance

The nearest nest for each focused nest was identified and the distance was measured using a centimetre scale.

Nest microclimate

The physiographic factors that were influencing the nest site selection by weaver ants were assessed by studying the following parameter.

Temperature

The temperature was measured using a digital thermometer (CIE 302k Thermometer, Thermocouple type – K Nicr – Ni Ai) of 1°F accuracy.

Statistical analysis

The basic statistics namely arithmetic mean and standard deviation were calculated for all the replicative variables and are given as $\bar{X} \pm SD$. Analysis of variance (One way ANOVA) was used to compare means of different groups of data.

III. RESULTS

Nest Structure and Construction

The workers of *Oecophylla* build nests by weaving together the leaves from the host plants using silk produced by their larva. The workers typically manipulate the white larvae between their mandibles by touching each larva individually and one at a time onto target locations on the substrate. The points at which the larva touch the substrate (the leaf) result in the production of silk by the larva. This silky mesh exuded by the larva is used to bind the leaf structures together. Occasionally, certain particles such as bark and soil are added to the larval silk mesh. The process was the same irrespective of whether:

1) The weaving of nests was just starting,
2) The nests that are already built were extended, or
3) The existing nests were repaired.

Nest entrance

The entrance of nest had oval (46 nests), round (18 nests), triangular (5 nests) and rectangular (3 nests).

Nest morphology

The morphometric measurement and characteristic features of arboreal nests constructed by weaver ants in different species of plants are given in table 1. The highest nest height was 528.0 $\pm$ 221.0, seen in *Terminalia arjuna*. Among the tree species, *Eucalyptus globulus* had the nests at the lower level of 96.6 $\pm$ 29.4.

Materials used for nest construction

Weaver ants used leaves as a main substratum for the nests. In majority of the nests, fresh leaves were the main component and few others, dried leaves were also used to construct the nests. Furthermore, they did use two adjacent branches to make a sturdy nest. *Syzygium cumini* had 35.4 $\pm$ 25.87 leaves in their nest, whereas, *Eucalyptus globulus* had only 4.7 $\pm$ 2.56 in their nests. The nests of *Terminalia arjuna* and *Santalum album* had both fresh leaves and dried leaves.

Nest entrance characteristics features

In majority of the nests, only one entrance was located and in few others, either two or more than two were present. The highest number of nest entrances were seen in *Atrabotrys odoratissimus* (1.2 $\pm$ 0.45). The nest entrance length and width vary much among the nests. The highest entrance diameter was found in *Ixora coccinea* (0.6 $\pm$ 0.30).

Nest microclimate

Social insects like ants are well known for their nest temperature regulation. In this study, the atmospheric temperature (°F), temperature outside the nest, near the nest entrance and inside the nest were measured from morning 8:00 to evening 17:00 hours to investigate the thermoregulation capacity across the day, in relation to atmospheric temperature and the data are given in Table 3.

Atmospheric temperature gradually increased from the morning i.e., 8:00 – 8:30 am (75.1 ± 2.68°F) until 13:00 – 13:30 and reached the peak of 84.1 ± 2.77°F. The similar trend was also noticed outside the nest, near the nest entrance and inside the nest. However, the morning temperature was retained above 70°F inside the nest.

IV. CONCLUSION

Given the lack of information about *Oecophylla smaragdina*'s nest distribution and arrangement, as well as the processes that determine resource selection in such invertebrates, the main aim of this study was to test some common hypotheses corresponding to weaver ants and habitat selection by them. This study has helped identify the important determinants of nest structure and arrangement, by showing that tree characteristics significantly influence choice of nest location in weaver ants. Since the leaves of the host plant are used in the construction of the nest by Asian weaver ants, we hypothesised that leaf characteristics such as size and shape could be important factors in nest location and arrangement. While certain environmental factors, such as

temperature and wind intensity, too seem to affect the arrangement of weaver ant nests, these did not seem as significant as tree and leaf morphology. Our study also indicates that canopy size and tree height (referring to resource availability and tree architecture) are good predictors of nest arrangement in trees.

From the 3-D modelling, we could notice distributions clumped on certain parts of the tree, indicating a strong preference of certain micro-habitats over others. However, parameters such as wind direction and ambient light (which could be associated with this) were found to be inconsequential. The temperature near the nest and wind intensity emerged as important among the environmental factors.

The process of determining the key factors that drive the selection of locations for nests is challenging and complex, especially in social insects such as weaver ants. This is due to difficulties in demarcation of boundaries, since some colonies could be spread across multiple trees and large tracts of land.

REFERENCES

[1] Agosti D; Johnson, N F (2003). La nueva taxonomía de hormigas.. Introducción a las hormigas de la región neotropical. *Instituto Humboldt, Bogotá*. pp. 45–48.
[2] Holldobler B, Wilson E (1977). Weaver Ants. *Scientific American*. 1977; 237.

PARAMETERS	PLANT SPECIES					
	Eucalyptus globulus	***Ficus benghalensis***	***Terminalia arjuna***	***Syzygium cumini***	***Ixora coccinea***	***Vallaris solanaceae***
Nest height (cm)	**96.6 ± 29.4**	**514.3 ± 146.4**	**528.0 ± 221.0**	**412.0 ± 202.21**	**141.3 ± 37.23**	**111.2 ± 51.70**
Nest length (cm)	**10.7 ± 3.50**	**14.0 ± 4.43**	**15.6 ± 6.72**	**11.3 ± 9.31**	**12.5 ± 4.91**	**11.8 ± 5.07**
Nest width (cm)	**4.9 ± 1.46**	**11.6 ± 4.83**	**11.0 ± 5.59**	**7.7 ± 4.94**	**5.0 ± 2.66**	**5.3 ± 2.03**
Nest depth (cm)	**5 ± 2.45**	**13.0 ± 6.38**	**9.4 ± 5.88**	**4.7 ± 1.79**	**5.5 ± 0.91**	**6.1 ± 5.53**
Distance nearest to the nest (cm)	**12.1 ± 9.06**	**22.1 ± 10.35**	**78.9 ± 98.70**	**17.8 ± 6.99**	**38.2 ± 25.14**	**103.0 ± 220.0**
Plant diameter at nest (cm)	**0.5 ± 0.39**	**0.6 ± 0.11**	**0.6 ± 0.55**	**0.7 ± 0.22**	**0.7 ± 0.55**	**1.3 ± 4.72**
Number of fresh leaves	**4.7 ± 2.56**	**15.4 ± 8.48**	**28.4 ± 23.70**	**35.4 ± 25.87**	**5.7 ± 2.50**	**6.2 ± 2.73**
Number of dried leaves	—	—	**8.0 ± 12.03**	—	—	—
Number of branches	**1.1 ± 0.34**	**1.7 ± 0.95**	**1.8 ± 0.85**	**1.1 ± 0.35**	**1.0 ± 0.00**	**1.2 ± 0.41**
Number of entrances	**1.0 ± 0.00**	**1.0 ± 0.00**	**1.0 ± 0.00**	**1.1 ± 0.51**	**1.0 ± 0.00**	**1.0 ± 0.00**
Diameter of entrance (cm)	**0.4 ± 0.21**	**0.4 ± 0.11**	**0.4 ± 0.05**	**0.6 ± 0.22**	**0.6 ± 0.30**	**0.4 ± 0.17**
Width of entrance (cm)	**0.4 ± 0.12**	**0.3 ± 0.15**	**0.3 ± 0.09**	**0.3 ± 0.10**	**0.4 ± 0.22**	**0.4 ± 0.18**

TABLE: 1 - MORPHOMETRIC MEASUREMENT AND CHARACTERISTIC FEATURES OF ARBOREAL NESTS CONSTRUCTED BY *OECOPHYLLA SMARAGDINA* IN DIFFERENT

PARAMETERS	PLANT SPECIES					
	Eucalyptus globulus	*Ficus benghalensis*	*Terminalia arjuna*	*Syzygium cumini*	*Ixora coccinea*	*Vallar solanac*
Tree height (ft.)	8.0 ± 0.00	21.0 ± 0.00	25.0 ± 0.00	40.0 ± 0.00	8.0 ± 0.00	2.0 ± 0.
DBH (cm)	2.0 ± 0.00	11.0 ± 0.00	27.5 ± 3.53	30.0 ± 0.00	3.0 ± 0.00	2.0 ± 1.
Main branch	1.0 ± 0.00	1.0 ± 0.00	3.0 ± 2.82	5.0 ± 0.00	4.0 ± 0.00	1.0 ± 0.
Primary branch	2.0 ± 0.00	2.0 ± 0.00	4.5 ± 3.53	16.0 ± 0.00	6.0 ± 0.00	7.7 ± 4.
Secondary branch	25.0 ± 0.00	8.0 ± 0.00	6.0 ± 2.82	15.0 ± 0.00	1.0 ± 0.00	4.0 ± 3.
Nearest plant distance (cm)	2.0 ± 0.00	300.0 ± 0.00	285.0 ± 190.92	20.0 ± 0.00	255.0 ± 0.00	25.0 ± 8
Nearest same species distance (cm)	60.0 ± 0.00	600.0 ± 0.00	750.0 ± 424.26	600.0 ± 0.00	840.0 ± 0.00	650.0 ± 8
Distance to nearest tree (cm)	1.0 ± 0.00	10.0 ± 0.00	4.5 ± 2.12	17.0 ± 0.00	24.0 ± 0.00	6.0 ± 0.
Number of trees touching nest tree	0.00 ± 0.00	2.0 ± 0.00	1.5 ± 0.07	0.00 ± 0.00	2.0 ± 0.00	1.7 ± 1.

TABLE: 2 - PLANT CHARACTERISTICS AND HABITAT FEATURES OF DIFFERENT SPECIES OF PLANTS W
***OECOPHYLLA SMARAGDINA* WERE LOCATED IN NIRMALA COLLEGE CAMI**

TIME (AM TO PM)	ATMOSPHERIC TEMPERATURE (°F)	TEMPERATURE OUTSIDE THE NEST (°F)	TEMPERATURE NEAR NEST ENTRANCE (°F)	TEMPERATURE INSIDE THE NEST (°F)
8.00 - 8.30	75.1 ± 2.68	75.6 ± 2.54	74.9 ± 2.76	77.6 ± 3.71
8.30 - 9.00	74.9 ± 1.71	75.1 ± 1.80	75.0 ± 1.60	77.6 ± 2.30
9.00 - 9.30	78.8 ± 2.58	79.2 ± 2.55	78.9 ± 2.51	81.0 ± 3.07
9.30 - 10.00	79.5 ± 2.65	79.8 ± 2.65	79.5 ± 2.65	81.8 ± 3.72
10.00 - 10.30	80.3 ± 2.32	80.6 ± 2.36	80.3 ± 2.32	81.9 ± 2.78
10.30 - 11.00	81.2 ± 1.99	81.4 ± 2.05	81.2 ± 1.97	83.1 ± 2.61
11.00 - 11.30	82.1 ± 2.77	82.3 ± 2.10	82.0 ± 2.56	83.7 ± 2.69
11.30 - 12.00	83.1 ± 2.85	83.4 ± 2.75	83.0 ± 2.83	84.5 ± 2.94
12.00 - 12.30	83.4 ± 2.30	83.8 ± 2.18	83.4 ± 2.29	85.1 ± 2.65
12.30 - 13.00	83.4 ± 1.49	83.5 ± 1.61	83.5 ± 1.53	85.2 ± 1.78
13.00 - 13.30	83.7 ± 1.95	83.5 ± 1.90	83.6 ± 1.93	85.5 ± 2.76
13.30 - 14.00	84.1 ± 2.77	83.1 ± 1.94	84.0 ± 2.78	85.6 ± 3.24
14.00 - 14.30	83.3 ± 2.28	83.1 ± 2.24	83.3 ± 2.27	85.2 ± 3.23
14.30 - 15.00	83.9 ± 1.77	83.9 ± 1.89	83.8 ± 1.86	85.8 ± 2.48
15.00 - 15.30	81.7 ± 5.12	81.9 ± 1.36	81.7 ± 5.12	84.1 ± 2.43
15.30 - 16.00	81.5 ± 1.77	81.1 ± 1.52	81.6 ± 1.79	83.2 ± 1.96
16.00 - 16.30	80.9 ± 2.05	80.3 ± 1.68	80.8 ± 2.04	82.3 ± 2.22
16.30 - 17.00	80.3 ± 1.76	80.0 ± 1.68	80.3 ± 1.77	81.7 ± 1.89

TABLE: 3 - COMPARISON BETWEEN ATMOSPHERIC TEMPERATURE AND NEST TEMPERATURES DURING DIFFERENT HOURS OF THE DAY THROUGHOUT THE STUDY PERIOD.