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International Journal For Research in  
Applied Science and Engineering Technology



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# **INTERNATIONAL JOURNAL FOR RESEARCH**

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

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**Volume: 8      Issue: V      Month of publication: May 2020**

**DOI: <http://doi.org/10.22214/ijraset.2020.5148>**

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# Traditional Value of Red Weaver Ant (*Oecophylla smaragdina*) as Food and Medicine in Mayurbhanj District of Odisha, India

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**Abstract:** *The current study reveals the documentation of traditional use and ethno-entomological value of Red weaver ant in Mayurbhanj district with special reference to tribal health and safety prospective. The traditional information are collected through questionnaires in six selected zones of Mayurbhanj district. The resident tribes of this district commonly use this species as a delicious food and traditional medicine to treat different aliment in their daily life. The brood of this arboreal species is mostly found in tropical fruit plants. This species is mostly consumed in the form of a Chutney in daily diet. The tribes use this species as medicine in different disease like common cold, fever, Jaundice, enteric problems, Whooping cough and to increase the hungriness. The Rairangpur has the maximum dietary value, ecological value and economic use i.e. 83.54%, 68.99% and 79.11% respectively and highly defensive in nature. In Udala area 79.19% people are mostly use this species as medicine in traditional treatment and 67.79% informants are having cultural beliefs towards this species. The tribes in Baripada, Rairangpur, Jashipur, Betanati and Idala are harvesting these species for commercial use and sell in local markets @ Rs.10/100gm of pouch. The dietary use and medicinal claims suggests that Red weaver ant could be an alternative source of nutrition and medicine for human society. Similar studies should be conducted to find out more edible insects of human interest. The Indigenous techniques of utilizing edible insects should be conserved before vanishing from different tribal culture and the scientific evaluation of these species can direct to build a new era of healthy and prosperous life.*

**Keywords:** *Tribal health, traditional use, Red weaver ant, Mayurbhanj district, scientific evaluation*

## I. INTRODUCTION

Human being is one of the most powerful developed organism in the nature and capable of ruling over other biological species. The intellectual ability of human make them self-sufficient to overcome uncertain drastic situations. Being a social animal human always have some basic needs like food, shelter and medicine for their existence. Human always try to utilize the natural resources to fulfill their daily needs and for development of society. The consistent increasing in population demands more and more foodstuffs with high caloric values [1], [2] better drugs and medicines to treat a wide range of diseases. In 21<sup>st</sup> century, it become an urgency to find out better nutritive foods and effective medication source to maintain a healthy life. To resolve the largescale demand arising in accordance with population explosion the researchers are focusing on both plants and animals species to design better nutritious stuffs and potential medicines. The consumption and zoo therapeutic use of animals been practicing in different communities since ancient times [3]-[6] but the Ethno-biological studies come into exist in human society since the arrival of 18<sup>th</sup> century [7]. The entomophagy is now becoming a common practice in different cultures and the edible insects are not only a good source of delicious food but also a source of medication. Now-a-days many economically developed countries like United States of America (USA), China, India, South Africa, Japan, Brazil, Ghana, Thailand, Netherlands, Mexico and many more about 113 countries have intended their efforts in documenting the entomophagy information [8]-[13]. This traditional ethno-entomophagy practice is an integral part of most of the endogenous people or tribes inhabit at different corner of the world and serving as source of food, medicine, pest-controlling agents and involved in commercial support [14], [15]. Early reports suggest that there are about thousand number of edible insects used as food and folk medicine in various Indigenous Tribal culture of the world [12], [13], [16], [17]. In India, about 255 traditional insects are reported from different states. 158 edible insect species were recorded in Arunachal Pradesh followed by 16 to 40 insects species found in Manipur, Assam, Nagaland, Meghalaya and very least number of insects were described in Kerala, Madhya Pradesh, Odisha Tamil Nadu and Karnataka, which limits only six insect species [17]. Researcher are intensified to enumerate scientific evidence claimed by tribal healers on insect source. Once these local traditional claims are scientifically evaluated, people will be better informed about efficacious medicine and improved health status [18]. Some of the ethnic insects have

scientifically proved of having different medicinal property and presence of nutritional supplements <sup>[19]-[24]</sup>. However, the bioprospecting evaluation of medicinal insects needs to be more focosive for a healthy and hygienic life of present and future generation. The techniques of utilizing edible insects are still not documented and mostly exists as verbal information among the tribal healers. The documentation of edible insects and their use in different cultures will be helpful to conserve before vanishing from the society.

The aborigines of different countries like Australia, New Guinea, Queensland, Nagaland, Thailand including India are eating chutney and drinking sour juice of eggs, larvae, pupa and worker ants of *Oecophylla smaragdina* <sup>[25]-[28]</sup>. In Java and Indonesia, the larva and pupa of these ants are used as a food of delicacy for human, songbirds and fishes <sup>[29]</sup>. A few reports exist on the traditional use of red weaver ant by the tribes of different states of India. Some tribes reside in forest areas of Wayanadu and Kasaragod districts of Kerala consume the adult worker ant and brood content of *Oecophylla smaragdina* as delicious food in the form of a sauce, which is sour in taste <sup>[22]</sup>. The dietary use of this species as spicy salad, sauce or in the form of a soup are also practiced by the Muria tribes of Chhattisgarh <sup>[30]</sup>, Tamilnadu and Madhya Pradesh <sup>[28], [31], [32]</sup>.

Orissa is the second largest state of having 22.86% tribal population next to Madhya Pradesh in India and only Mayurbhanj district has 58.7% of total tribal population of Odisha state <sup>[33]</sup>. Mayurbhanj district is the largest district of Odisha state characterized with full of dense forest areas, diversified floral and faunal species and dominated by local tribes like Kolha, Munda, Santhal, Majhi and Lodha. These tribes are locally famous as the ethnic tribes as they have expertise in the traditional medicinal knowledge of treating a wide range of disease. These tribes commonly use the raw products of plant and animal species. The Red weaver ant (*Oecophylla smaragdina*) are mostly distributed in tropical countries and inhabiting in different fruit trees. It is well known for effective protection of its host plant as it actively watches canopies and preys upon wide range of pests <sup>[34], [35]</sup>. However, the tribal groups residing in the northern part of Odisha most commonly use this ant species as a delicious food and medicine to treat ailments. The main purpose of this study is to make a documentation of traditional value of red weaver ant among the tribal communities of Mayurbhanj district.

## II. METHODOLOGY

### A. Traditional data collection

Entomological investigation was conducted in selected village arears of Mayurbhanj district (21° 17' and 22° 34' North latitude and 85° 40' and 87° East longitude <sup>[36]</sup>) located in northern part of Odisha, India. The documentation of traditional entomological practice of red weaver ant were obtained through structured questionnaire survey, local interviews as shown in Fig. 4 and field studies in Mayurbhanj district during 2017 to 2018.

### B. Study site

During the field survey the Mayurbhanj district is divided into six selective zones as shown in Fig. 1 and Table I. The selected sites are Rairangpur (Site 1: North Zone), which is full of hilly areas located at north direction (22° 16' 11.32" N and 86° 10' 12.01" E), Baripada (Site 2: North-East zone) a center place of Mayurbhanj district located at the north-east region of the district represents the Baripada town and nearby urban areas (21° 55' 49.69" N and 86° 45' 6.72" E), Betnoti (Site 3: East zone) is one of the most populated area of tribes with a population of 1, 50, 434 as reported by Sethi in 2011<sup>[36]</sup> (21° 44' 23.21" N and 86° 50' 35.56" E), Udala (Site 4: South-East Zone) located on south-east direction with most of the ethnic tribal communities having knowledge on plants and animals (21° 34' 36.05" N and 86° 33' 55.27" E), Karanjia (Site 5: West zone) is the hilly area located in west direction (21° 34' 36.05" N and 86° 33' 55.42" E) and Similipal periphery villages (Site 6: Central zone) rich in forest and village areas (22° 8' 41.28" N and 86° 24' 50.32" E).

During the study period a local guide was taken for the proper communication with the tribal people and the traditional information were collected by frequent visits to each site over a definite time interval through personal discussion and group discussion as shown in Fig. 4. The 20 years and above age group of informants were taken into consideration to get detail and accurate data as shown in Table II. The information were recorded with respect to the type of use, distribution, host plant, population status of present and past time, seasonal availability, preferable stage and body parts of use, collection method, cultural beliefs and mode of preparation, economic use and ingredients used in treating ailments. The views of the informants towards the red weaver ant was maintained in systematic and organized manner for further analysis.

### C. Sample collection and identification

The red weaver ant sample was freshly collected from village areas and preserved in sample containers filled with 70% alcohol. Identification was done in laboratory with help of morphological analysis of the brood content<sup>[37], [38]</sup> and submitted to entomology section of Zoological Survey of India (ZSI), New Alipore, Kolkata to ensure the identification of the species.

### D. The Following Formula Used To Determine The Percentage Value Of Different Parameters

The percentage of people as shown in Table II was determined by the following formula:

Percentage (%) of people = [(No. of people of a given parameter) / (Total no. of informants)] × 100

The percentage of use of red weaver ant as shown in Table V at different site was calculated by the following formula:

Percentage (%) of use = [(No. of informant of a given parameter of a specific site) / (Total no. of informants of that particular site)] × 100

## III. RESULTS

The tribes of Mayurbhanj district mostly inhabiting near the urban areas are dependent on forest products for their livelihood. These tribes have developed their own skills, tools and techniques for harvesting forest resources. The richness of biological resources and traditional communities of this district have provided opportunity for evolving numerous ethno zoological knowledge. Some of the tribal groups belong to economically weak category are living separately in forest and have less communication with the modern society.

Many informants were found to have formal schooling education but they have knowledge regarding traditional use of red weaver ant species. An inventory on traditional knowledge on the red weaver ant records are as follows:

### A. Demographic Information Of The Survey

The survey was conducted in a regular basis in each site and 2200 people take part in the discussion and out of which, 1182 positive respondent were recorded during the study period as shown in Fig. 3.

Most of the informants are belong to the age group ranging from 41-50 years and 51-60 years, which represents 20.81% and 19.37% of the total positive respondent respectively as shown in Table II. Very Least no of informants were found of more than 80years, which is about 8.29% of the total no positive informants.

Very interestingly the male are having more ethnic knowledge than that of the female informants i.e. 62.26% and 37.73% respectively, this may be due to most of the male people are usually visit to the forest areas for collecting goods and may have more interest to learn the traditional techniques inherited from their fore fathers as shown in Table II. Almost all the informants are having the schooling level of education (43.73%), which enable them to interact with the modern day techniques involving in the proper utilization of natural resources in a sustainable manner as shown in Table II.

### B. Scientific Classification Of Red Weaver Ant

- 1) Kingdom: Animalia
- 2) Phylum: Athropoda
- 3) Class: Insecta
- 4) Order: Hymenoptera
- 5) Family: Formicidae
- 6) Subfamily: Formicinae
- 7) Tribe: Oecophyllini<sup>[39]</sup>
- 8) Genus: *Oecophylla*<sup>[40]</sup>
- 9) Species: *smaragdina*<sup>[41]</sup>

### C. Traditional value of red weaver ant

- 1) **Dietary use:** The Red weaver ant (RWA) as shown in Fig. 5 is locally called as “Kaii” or “Kurkuti”. This species is of diversified use in all study zones of the Mayurbhanj district. Most commonly, it is used in the form of a delicious chutney as a dietary food mixed with green chili and is a regular food item of greater food value. The tribal communities of Rairangpur (DU: 83.54%), Baripada (DU: 80.19%), Betanati (DU: 74.12%), Udala (DU: 81.2%), Karanjia (DU: 81.68%) and Similipal periphery (DU: 63.78%) are most preferably using this species in their day-to-day life as shown in Table V and Fig. 2. The tribes think

that the ant along with its eggs is a nutritious one. The tribes use all the stages (egg, pupa, juvenile and worker ant) present in the brood content of its life cycle except the sub-adult and adult form (winged stage).

- 2) **Medicinal use:** The zoo therapeutic information of red weaver ant involves the use of whole body of worker ant, juvenile (milky white in color), pupa and eggs (creamy white in color) in the form of raw extract. As per the informants, *Oecophylla smaragdina* species is involved in various ailments brings significant remarkable results as shown in Table III & IV. The percentage of medicinal use (MU) at Udala region and represents 79.19% of the total informants reported in Udala region. Similarly, the percentage of medicinal use of *O. smaragdina* in Baripada, Rairangpur, Karanjia, Betanati and Similipal periphery are 70.13%, 67.09%, 66.34%, 65.88% and 49.73% respectively as shown in Table V. In common cold, especially in case of babies (5 years) and adult person it is used as medicine with a small dose. The whole body with the eggs was crushed and makes aqueous form, mixed with required amount of green chili (locally in Oriya language it is called Dhanua Lanka, English name: Tabasco peppers, scientific name: *Capsicum frutescens*) and spoon-feed to the baby or adult patient as a medicine. The effective result will found within 2-3 days of consumption. In Betanati and Rairangpur area the smell of crushed freshly collected red weaver ant are allowed to inhale for several times in a day and remarkable result will found within 2-3 days. This inhaling process is applicable for all age groups. The crude extract of this ant also used as an acidizing agent for enteric gas problem. The crude homogenate is prepared and allowed to filtrate to get the juice; the consumption of only one cup of this juice will give relief within 1 to 2 hours. In vomiting, the brood content is crushed to obtained aqueous extract and then the juice will be given to the patient. It has seen that the vomiting will stop within 5-7 hours. In case of Whooping cough, the aqueous extract of whole body of worker ants and the juveniles are used and the patient will cure within 2 to 3 days. It is also useful for Jaundice; the aqueous extract of whole body along with the eggs is used. The aqueous extract is given to take orally to the patient and also the extract is smoothly rubbed on the skin to avoid the yellowish color, effective result is found within 1 to 2 week. Particularly in Rairangpur area the jaundice patient are allowed to put about 100 and more solidier ants over the skin surface, the vigorous biting of this red weaver ants can cure the jaundice patient. Besides that, it is also used as appetizer to make a person feeling hungry within 15 to 20 minutes. In Whooping cough, the aqueous extract is given to treat the patient and continued at an interval of 2-3days (consumption rate is 2 times per day). If the patient will not cure after the treatment, the same procedure is continued for several days.
- 3) **Economical use:** The tribal people usually collect these ants from forest and hilly regions of Mayurbhanj district (Badampahad, Rairangpur and Jashipur) and sold at a price of Rs.10/100gms of a pouch in the local markets (Station bazar, Laxmiposi, Uadala, Podaostia, Jashipur), which provides them an economic support to maintain their family in their daily life as shown in Fig. 4.
- 4) **Ecological significance:** This ant is mostly build their brood at high apical branches in their host plants and are available throughout the year. The number of brood found in a host plant may varies from 20-30. The most preferable plant of the red weaver ant is mango trees (*Mangifera indica*) besides that they also build their nest in other plants like Sal tree (*Shorea robusta*), Kusuma tree (*Schleichera oleosa*, as shown in Fig. 5), Kendu tree (*Diospyros melanoxylon*), Sapeta tree (*Manilkara zapota*) and sometimes found on the rock surface in the hilly areas covered with dense forest as shown in Fig. 5. During the survey, we found this species can feeds on every category of foods but the most preferable food item is sweet fruits. The omnivore ability, highly defensive and dominancy nature over its prey makes this species more efficient to protect its host plant.
- 5) **Cultural significance:** The spiritual belief is very high in tribal communities in Mayurbhanj district. The tribes observe their festivals in a joyful manner for a happy and prosperous life. The red weaver ant is used among the tribes in all most all the cultural festivals in the Mayurbhanj district and the harvesting rate of this ant is found more in winter season.

#### IV. DISCUSSION

The traditional knowledge of red weaver ant among the tribes of Mayurbhanj is diversified but limited as the technique of use is only verbally transferred from generation to generation without being scripted. Therefore, it is an imperative and urgent task to draw attention towards documenting Indigenous Knowledge as much as possible. In the present era of science many researcher are putting efforts towards the use of edible insects. Since long time the scientists have been trying to enlist the significance of beneficiary insects involve in various Indigenous Treatment. Maximum traditional information have collected from the age group of more than 80years. Although the percentage of respondents in age group of 80years and more are few but the traditional information

provided by them were quite more in comparison to other age groups. This traditional information on insects including other animals and plants are consistently lacking towards the young age groups, which indicates that, may be the existing ethno-biological information will vanished in this region after 30-40 years. The educational level among the informants are sufficient, which make them to utilize the natural resources in sustainable manner.

It was surprising to know that red weaver ant besides being used as food have also involve in treating of certain diseases. Being an ethnic food the red weaver ant plays a vital role in the life style of the tribes act as a potential source of medicine and a delicious food. The scientific claim behind the nutritional value of this red weaver ant have estimated by many researchers, which represents that this species constitutes carbohydrate, protein, lipid, cholesterol, triglycerides, amino acids, vitamins and minerals [22], [42], [43]. It is obvious the consumption of this species will provide more or less nutritive supplements to the human body. The effeteness of red weaver ant against jaundice by using the ant bite has studied in Bastar village of Chhattisgarh an adjacent state of Odisha [44]. It is reported that the formic acid stored in the abdominal poison gland of adult worker will injected during the bite reduces the bilirubin to biliverdin in the blood [22], [44]. This species also have antimicrobial activity reports against human pathogenic bacteria and *Candida* species [22], [45]. The antimicrobial peptides are isolated from the Asia harvester ant claimed to be use as medicine [46] indicates that, as like the Asia harvester ant this Red weaver ant may also have some beneficiary bioactive metabolites, which cure enteric infection and Whooping cough disease. This species offers many ecological significance [47]-[49] and social benefits to the nature. The extensive information provided by the tribes with regard to the ethno entomological uses of this species could bring a general awareness among other people regarding the beneficiary use of this species in health and healing. Red weaver ant harvested from village areas are often sold in the urban markets. More and more collection of this species from its natural habitat for socioeconomic use can cause depletion of its rural biodiversity. However, more explorations, surveys and collection of information on other insect faunas can provide logistic knowledge on edible insects. More research should conduct with respect to scientific bioprospecting evaluation, which can flourish the rest of the mysteries behind this Indigenous Knowledge, which will build up a key path to discover reliable source of nutrition and medicines to humankind.

## V. CONCLUSION

The study concluded that consumption of red weaver ant species is remained unchanged over the years among the tribe but the information regarding why it should be consumed are lacking day by day. The prevalence of entomophagy practice of this red weaver ant species is still clearly remarkable among the tribes of Mayurbhanj district, but many practices and importance of use of this red weaver ant among these tribes need further more documentation in a wide area. Besides the red weaver ant, these tribes also utilize a wide range of biological resources in diverse ways. So further more insects to be investigated and popularized, which will make efforts to deal with food crises and generation of new medicines in forth coming days. Further systematic scientific exploration on nutritional and medicinal values of this insect and its impacts on human health have to be investigated. It's become mandatory to undertake research on traditional rearing, cultivation, sustainable management, while practicing on edible insects to maintain an integrity in insect biodiversity.

## VI. ACKNOWLEDGEMENT

Authors are very much thankful to UGC-RGNF (University Grant Commission-Rajiv Gandhi National Fellowship), Govt. of India funded by Ministry of Social Justice & Empowerment and Ministry of Tribal Affairs and P.G. Department of Zoology, North Orissa University, Baripada-757003, Mayurbhanj, Odisha for providing departmental facilities. Also thankful to local respondents for providing valuable information and Entomological section, ZSI, New Alipore, Kolkata for helping in identification of the species. Hearty thanks to Mr. Tanmoy Chatterjee, Ph.D. scholar and DST (Department of Science and Technology) inspire fellow, Govt. of India, Department of Earth Science, Sambalpur University for designing the study area map.

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TABLE I  
DETAILS OF SIX SELECTED ZONES OF THE MAYURBHANJ DISTRICT

Sl. No.	Parameters	Zones of the Mayurbhanj district						
		RA	BA	BE	UD	KA	SP	
1	GPS co-ordinate	°N	22°16'	21°55'49.69	21°44'	21°34'	21°34'	22°8'
		°E	11.32"	"	23.21"	36.05"	36.05"	41.28"
2	Location in the district		86°10'	86°45'	86°50'	86°33'	86°33'	86°24'
			12.01"	6.72"	35.56"	55.27"	55.42"	50.32"
3	Topology	North	North East	East	South East	West	Central	
4	No. of village (Sethi, 2011)	Village, Hilly and forest	119	104	227	89	156	NA
		Urban and town	36664.4	6244.5	2530	39945.5	84481	NA
5	Forest areas (in Acers US)	1180	1596	1451	1197	1407	NA	
6	Annual rainfall (in mm)	16789	19306	27201	18717	23189	NA	
7	Agriculture area (in Ha)	Male	26,080	34,061	75,706	38,104	45,310	NA
		Female	27,240	33,135	74,728	38043	46,208	NA
8	Population (Sethi, 2011)	Total	53,320	67,196	1,50,434	74,147	91,518	NA
		SC	NA	12,797	6259	7326	9,818	NA
		ST	NA	20,603	42975	76,310	68,771	NA

\*NA: not available, °N: latitude, °E: longitude, mm: millimeter, Ha: hector, RA: Rairangpur, BA: Baripada, BE: Betanati, UD: Udala, KA: Karanjia, SP: Similipal Periphery

Table II  
DEMOGRAPHIC PROFILE OF THE INFORMANTS OF THE SURVEY (N=1182) IN MAYURBHANJ DISTRICT

Demographic features	Number of people	Percentage (%)
Age (in years)		
30 years	163	13.79%
31-40	176	14.89%
41-50	229	19.37%
51-60	246	20.81%
61-70	143	12.09%
71-80	127	10.74%
above 80	98	8.29%
Gender		
Male	736	62.26%
Female	446	37.73%
Education		
a. Able to read and write	517	43.73%
b. Elementary school	224	18.95%
c. Diploma	158	13.36%
d. Degree	183	15.48%
Cattle herders		
a. Goat	234	19.79%
b. Cow	298	25.21%
c. Pig	267	22.58%



TABLE III  
TRADITIONAL USE OF RED WEAVER ANT AS FOOD AND MEDICINE IN MAYURBHANJ DISTRICT

Parts used	Purpose of use	Used as	Mode of preparation	Results
Eggs	Common cold (specially in baby)	Medicine	Aqueous extract of red weaver ant eggs is prepared and feed them to the baby; sometimes-crushed extract is inhaled.	After 2-3 days the baby will cure
	Jaundice	Medicine	Aqueous extract of egg and worker ants are used and solidier ants.	After 5-7days patient will recover and cure after 1 to 2 week
			Deployed on the skin surface of the patient and the bite of the ants cure the patients.	It is believed to be highly effective and result will find within 8-10days
Worker ants and eggs	To increase hungriiness	Appetizer	Aqueous extract of whole body and egg is used.	Person will feel hungry within 15-20 minutes
	Food value	Dietary substance	Both the whole body and eggs were crushed with small chili (Tabasco peppers, <i>Capsicum frutescens</i> ) to make a paste so called as Chutney (as per local language)	Provides nutrition to their body
Whole body of worker ant	Enteric gas problem	Acidizing agent	Aqueous solution of whole body is used	Result seen within 1-2 hours
	Vomiting	Medicine	Aqueous solution of whole body is used	Vomiting will stop after 5-7 hours
	Whooping cough	Medicine	Aqueous extract of whole body of worker ant is used	Continued at an interval of 2-3 days two times per day

TABLE IV  
RESPONDENTS IN DIFFERENT ZONES OF THE MAYURBHANJ DISTRICT BASED ON TRADITIONAL PARAMETERS

Sl. No.	Parameters	Selected study sites							Grand total
		RA	BA	BE	UD	KA	SP		
1	Male	110	200	111	93	115	107	736	
	Female	48	118	59	56	87	78	446	
	Total	158	318	170	149	202	185	1182	
2	DU	132	255	126	121	165	118	917	
3	MU	106	223	112	118	134	92	785	
4	EB	109	163	99	74	82	78	605	
5	EU	125	225	83	85	113	102	733	
6	CU	85	178	102	101	118	112	696	

\*INF: Informants, DU: Dietary use, MU: Medicinal use, EB: Ecological benefits, EU: Economic use, CU: Cultural use, RA: Rairangpur, BA: Baripada, BE: Betanati, UD: Udala, KA: Karanjia, SP: Similipal Periphery

TABLE V  
PERCENTAGE OF USE OF RED WEAVER ANT IN MAYURBHANJ DISTRICT

Sl. No.	Site name	DU	MU	EB	EU	CU
1	Rairangpur	83.54%	67.09%	68.99%	79.11%	53.80%
2	Baripada	80.19%	70.13%	51.26%	70.75%	55.97%
3	Betanati	74.12%	65.88%	58.24%	48.82%	60%
4	Udala	81%	79.19%	49.66%	57.05%	67.79%
5	Karanja	81.68%	66.34%	40.59%	55.94%	58.42%
6	Similipal Periphery	63.78%	49.73%	42.16%	55.14%	60.54%

DU: Dietary use, MU: Medicinal use, EB: Ecological benefits, EU: Economic use, CU: Cultural use

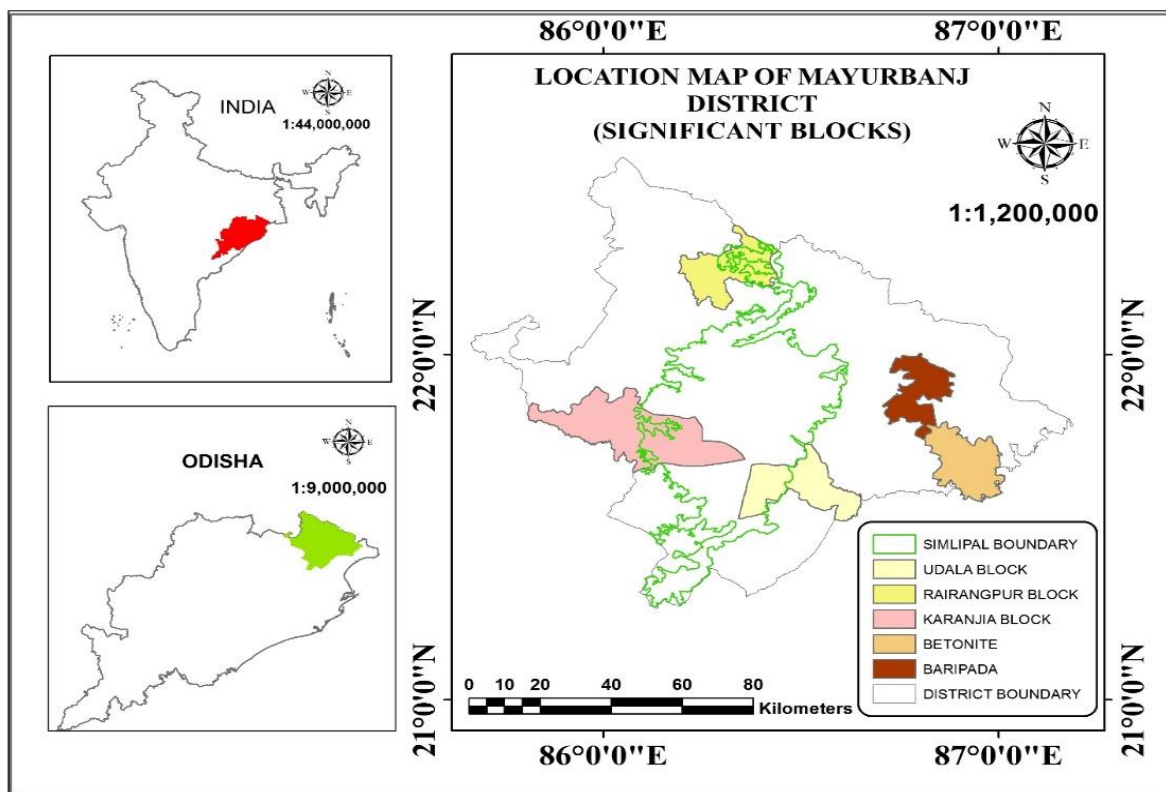


Fig. 1 Study area map of Mayurbhanj district, Odisha, India

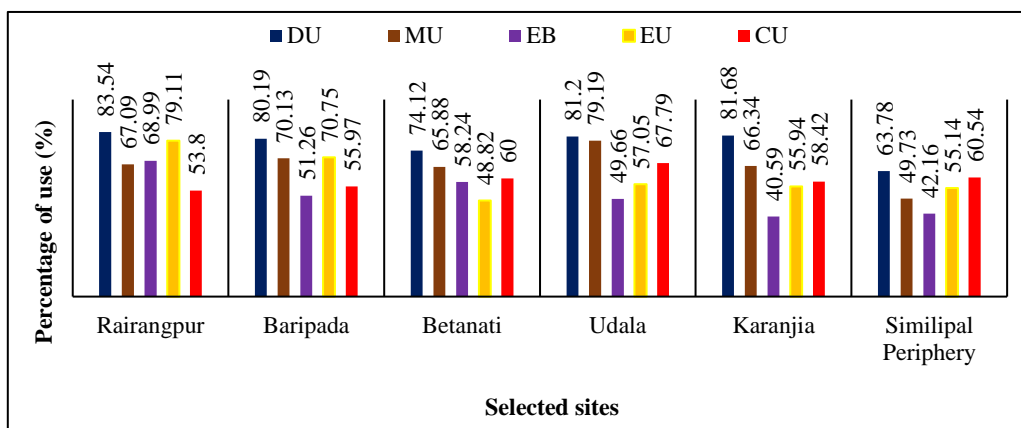


Fig. 2 Percentage of traditional use of Red weaver ant in different sites of Mayurbhanj

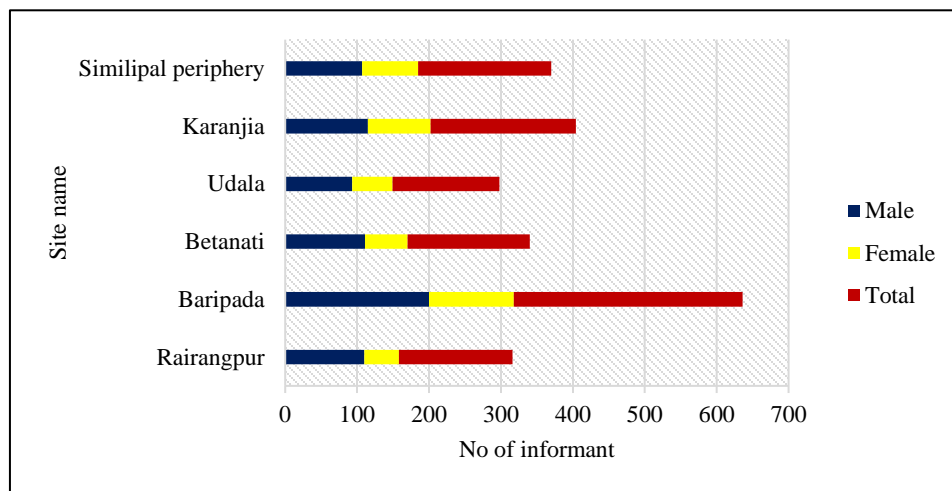


Fig. 3 No of informants in different sites of Mayurbhanj



Fig. 4 (a) & (b) Field visit in Mayurbhanj district and local interaction during field study, (c) Selling of red weaver ant in local market, (d) A red weaver ant pouch of weighing 100gms @ 10.

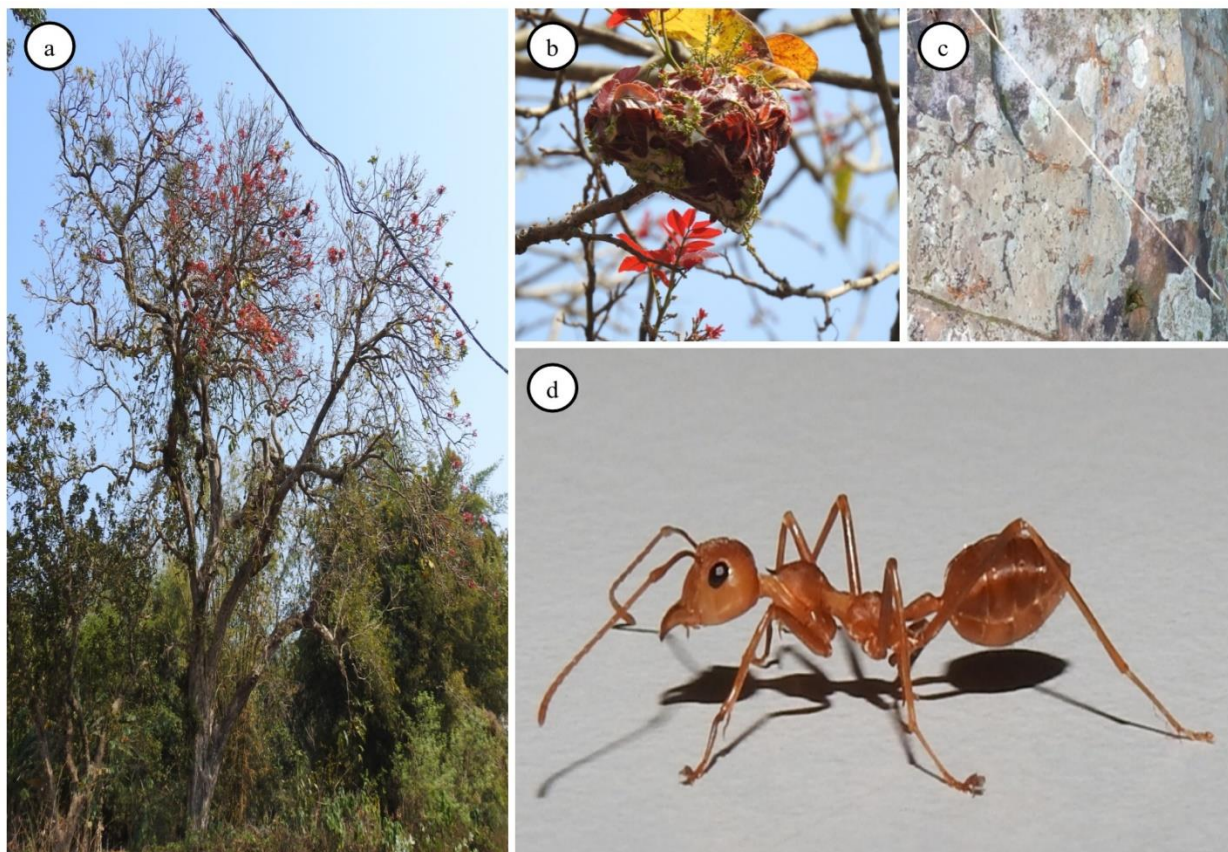


Fig. 5 (a) Red weaver ant host plant (Kusuma tree: *Schleichera oleosa*), (b) Brood of Red weaver ant in Kusuma tree, (c) Distribution of red weaver ant on rock surface, (d) Red weaver ant species (*Oecophylla smaragdina*)



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