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IMPACT OF MINING ACTIVITIES ON DIVERSITY OF ACULEATA (BEES, ANTS & WASPS) UNDER ORDER HYMENOPTERA IN PROVINCES ADJOINING HINGULA OPEN CAST PROJECT, TALCHER, ANGUL, ODISHA, INDIA

Udayanath Sahoo and Yashaswi Nayak
Department of Zoology, Centurion University of Technology and Management, Odisha, India

ABSTRACT
The present study was conducted in provinces adjoining to Hingula Open Cast project of Talcher to document the baseline data of aculeate fauna.The study area was regulated at the elvevation between Lat - 20^o 55'51" North & 20^o 57'24" North and Long-85^o 08'13" East & 85^o 11'14"East.A thorough review was completed during January – 2021 to December – 2021. Aculeata being organic pointers of natural quality assumes a significant part in the genuine working of the biological system. These predacious insects are dynamic during the daytime. Much has been said and done about the deficiency of biodiversity in the mining pockets of Talcher, however very little information is available about the variety and variability of Aculeata. Because of this, the current investigation is a fundamental endeavor to consider the Aculeata in periphery of Hingula Open Cast Project (OCP), Talcher, Angul, Odisha. A complete number of 2239 Aculeata with 5 families and 36 species were recorded during the whole investigation time frame.Shannon – Weiner index (H') was 3.40 in Mallibandha village, followed by 3.41 in Chitalpur village, 3.43 in Kumunda village, and 3.39 in Banbaspur village. Margalef's richness (Dmg) index was found to be 5.25 in Mallibandha, 4.99 in Chitalpur, 5.21 in Kumunda, and 5.09 in Banbaspur village. Other than this, it was noticed that individuals from the family Formicidae were observed to be 52.16% followed by Apidae 39.25%. The most minimal population was foound in Vespidae 0.80%, Sphecidae 0.75%, and Megachilidae with 0.13%. separately. Sweepy net & colored pantraps were used for collection of species.

Keywords: Indicators, Regimen, Biodiversity, Hingula, Aculeata.

INTRODUCTION
Aculeata is viewed as the main fauna of the terrestrial environment. These are most adaptive insects in ecological conditions. Every one of the Aculeata is viewed as the eusocial group of creatures [1]. Aculeata plays a significant role in the modification of soil ecosystem diversity.It takes part in underground natural process and modify the physical, chemical & biological environment leading to an effect on plants, soil micro- and macro-organisms. The abundance and varied ecological role of Aculeata make them influential in the agro-biological system [1].In this way, the investigation of insect diversity in four surrounding areas of Hingula Open Cast Project shows some ecological importance of the niche. The current study is a documentation of the Aculeata fauna variety of the investigated areas.The worldwide record of Aculeata species is around 13,255 [3]. All insects are classified into 21 subfamilies [4]. Sub-family Martialinae has been converged with the family Formicidae [5]. All types of ants fall into the family Formicidae. Family Formicidae is the part of superfamily Vespidae under the order Hymenoptera of class Insecta. Subfamily Myrmicidae is the biggest under the family Formicidae, having 138 genera followed by subfamily Formicinae with 39 genera and Ponerinae with 25 genera.In India, insects possess differentiated environments like leaf litters, trees, soil, and deadwood logs, though tramp species incline toward man-made natural surroundings. Myrmicinae addresses most extreme subterranean insect variety (45%) having genera Pheidole and Crematogaster. Formicinae is the second-biggest subfamily with 25% species variety under genera Camponotus and Polyrhachis. Subfamily Ponerinae involves 14% of species variety having greatest variety in sort Leptogenys [4]. In India, the work on insect diversity is exceptionally poor and discourged. Gunawardene et al. [6] have distributed their work on subterranean insects of the Western Ghat – Sri Lanka area of interest. Sunil Kumar et al. [7] revealed insect fauna of Bangalore City. As of late, Tiwary et al. [8] distributed a rundown of 591 types of subterranean insect from India. As of late Bharati et al. [9, 10] recorded 828 types of subterranean insect in India and the territory of West Bengal has the most elevated number of subterranean insect species (382) under 65 genera among the 30 Indian States. Notwithstanding these investigations, there is still a ton about subterranean insect variety that merits further examination around here, and in this way more examinations are required. The target of this investigation was to discover Aculeata variety and conveyance in fringe towns of the Hingula Open Cast Project. Until now, no examination on Aculeata variety has been done around here. This is the starter endeavor to endeavor to discover the Aculeata dissemination and wealth of subterranean insect species in and around towns of the Hingula Open Cast Project. The current examination will surely be the benchmark for additional investigation on the gathering from the examination region for future scientists.

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Aculeata is one of the little to medium-sized creepy crawlies. They have four membranous wings with a limited midsection. Their mouthparts might be either gnawing type or gnawing sucking type. Transformation is finished ie. They are separated into two suborders ie, Symphyta and Apocrita. Symphyta incorporates sawflies and horntails while Apocrita separates into two sub-divisions, the stinging structure Aculeata incorporates wasp, honey bees, subterranean insects and parasitic incorporates most parasitic structures.

These bugs total their life cycle in 4 stages viz. egg, hatchling, pupa, and grown-up. They are huge spineless creatures in earthbound biological systems and are credited for being a significant food hotspot for some rodents. Their sex assurance is normally controlled by whether an egg is prepared. Treated eggs form into females while unfertilized eggs form into guys.

In the former days, Talcher was known for its extraordinary and splendidly rich biodiversity of verdure in Odisha. Loss of Biodiversity has been concentrated widely in the Talcher mining hall yet fauna especially Aculeata stays an ignored area of study. Along these lines, the current lady study was directed to investigate the wealth, species lavishness, and variety of Aculeata around the fringe towns of Hingula OCP i.e.Mallibandha, Chitalpur, Kumunda, and Banbaspur.

2. MATERIALS AND METHODS

2.1 Study Area

Talcher coalfield is located on the Brahmani river in the Angul District in the Indian state of Odisha. It covers an area of 50 km^2. It lies in the latitude of $20^0$53' to $25^0$12' North and longitude 84^0 to $85^0$23'East. Coal was discovered in Talcher Coalfield at Gopal Prasad in 1837. Before industrialization, it was rich in biodiversity.

There are around 9 open cast projects and 3 underground mines locked in the Talcher Coal mines area. Hingula Open Cast Project was opened in 1998 to supply coal to the different areas of Odisha and India. The all out region covered by this venture is 1870.01 hectares. Its creation limit is about 15.0 Metric tons each year, It lies in the scope of 200 57' 39 " and 200 58' 18 " North and Longitude 85^0 09' 33 " and 85^0 12' 82 ". The environment of this locale is by and large dry besides in the rainstorm season. The Coalfield is depleted by the Brahmani stream streaming along the eastern edge of coalfields. Singhidajhor, Nandira, Tikira, and Bangurnala are significant feeders of the Brahmani stream. The investigation region covered Mallibandha, Chitalpur, Kumunda, and Banbaspur town regions which are adjoining Hingula Open Cast Project with a 15 km span. Coal mineshafts have genuinely albeit furtively added to the debasement of biodiversity. Notwithstanding, the populace development of Aculeata has been because of expanded dampness, contamination, mugginess in specific regions.

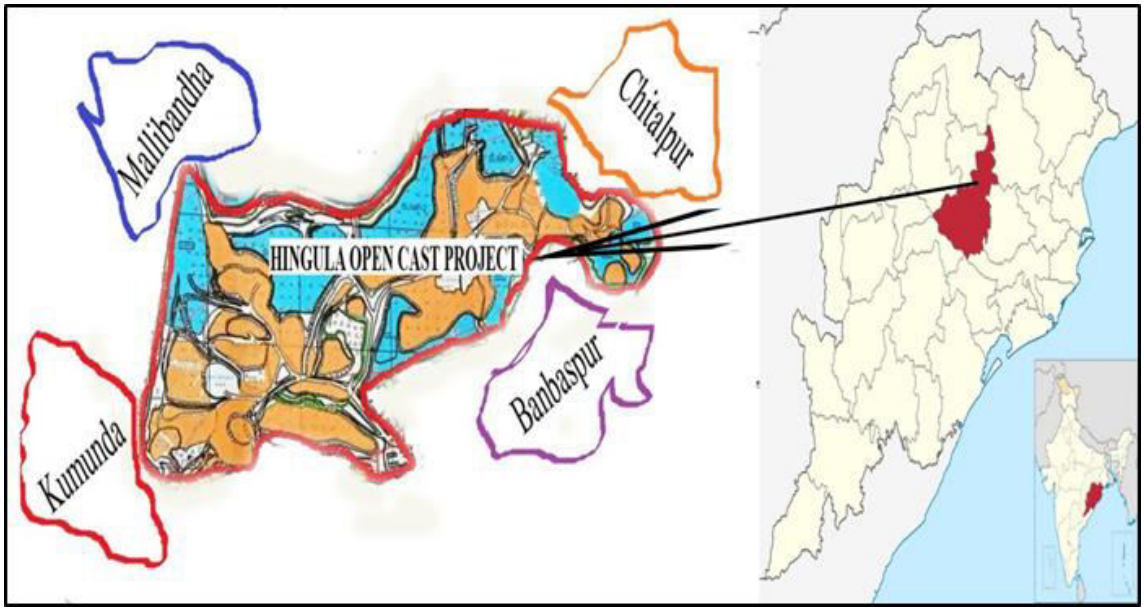

Figure 1- Study Areas of Hingula Open Cast Project, Talcher, Angul, Odisha, India

2.2 Study Design

Four locales were chosen from the fringe spaces of the Hingula Open Cast Project dependent on natural surroundings which might be significant as per Clark and Swamy. Study districts were partitioned into four regions as follows.

1. Area-I- Mallibandha Village

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2. Area -II- Chitalpur Village
3. Area -III-Kumunda Village
4. Area -IV-Banbaspur Village

As they are poikilotherms and being temperature-delicate and cognizant, generally they work between 10 am. furthermore, 4 pm. whose openness further develops energy with an increment in temperature. In light of their accessibility, Aculeata can be arranged as extremely customary (VR,>50views), regular(Re,11-50 perspectives), Rare(Ra,3-10views).

2.3. Sampling and Identification

An examining of Aculeata was completed from January – 2021 to December – 2021 in various investigation regions in and around of Hingula Open Cast Project. Irregular examining was completed by direct looking through strategies following Sutherland. (Sutherland, 1996) [18] at a thirty days span during the time of 10:00 to 16:00 hours, in light of the fact that Aculeata is observed to be generally dynamic during the center of the day. A scope net example was taken, utilizing a creepy crawly airborne net with a four-foot handle, in the vegetation encompassing 20m by 20m inspecting plot to set up insect local area structure. The vegetation structure was overwhelmed by grasses and forbs, with few bushes. An equivalent number of 50 compasses were taken while strolling rapidly[24]. Clear net examples were frozen, and Aculeata were subsequently distinguished as species in the research facility. The recognizable proof of Aculeata has likewise been completed with the assistance of an Aculeata ID guide [17,18,31]Most of the species were photograph archived. Photos are taken by a Stemi DV4 sound system camera with a microlens. Aculeata is recognized by ID key [ ] up to class and species level basing on the Literature accessible [ ]. The legitimacy of species, name, authority, and spelling has been followed to the Balton synopsis.[ ]Suspected species were gathered through entomological nets and safeguarded in liquor. Some were recognized by Google focal point. Examples of Aculeata species variety were inspected utilizing mathematical species extravagance, Shannon file of species variety, and Simpson equality index.[26].

3. Data Analysis

A rundown of animal types and a total check of the quantity of people for every territory have been accomplished for species lavishness and species variety calculation.

Margalef variety list (Margalef, 1958) (DMg) can be determined as follows

$$D_{Mg} = \frac{S-1}{\ln N}$$

Where 'S' is the no. of species and 'N' represents the total no. of individuals in the study area. It explains the species richness of the study area.

The Shannon-Weiner file (Shannon and Weaver,1949) is utilized to ascertain the variety of species in various regions adjoining Hingula Open Cast Project. The Shannon-Weiner list (H^') is determined as follows:The Shannon-Weiner file (Shannon and Weaver,1949) is utilized to figure the variety of species in various regions nearby Hingula Open Cast Project. The Shannon-Weiner list (H^') is determined as follows:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

Where $pi = ni/N$, n_i = No of Individuals of a Species at a time, N= Size of the whole community and ln = Natural Logarithm

Evenness of Aculeata **(j')**

The equity of an animal types was determined by utilizing [27, Pielou EC.] which is characterized as $J' = \frac{H'}{\ln S}$

Where S= No. of Species present in the site, ln = Natural logarithm, and H' is the diversity Index.

The Value of J' varies from 0 to 1.

Jacard's index (Cj)

It was utilized to ascertain the comparability of Aculeata species between two environments among various sorts of regions contemplated.

It was given by the accompanying connection

Cj= $\frac{a}{a+b+c}$

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Where a=Total number of species observed in both Area-I & Area-II.

b=Species found in Area-I, but not in Area-II.

c=Species found in Area-II, but not in Area-I

Table-1.List of Aculeata diversity in and around areas of Hingula Open Cast Project, Talcher, Odisha.

	Scientific Name	**Area-I**	**Area-II**	**Area-III**	**Area-IV**	**Status**	**Total**
Sl.No	Family-Formicidae						
1	Camponotus atriceps (Smith,1858)	32	19	27	12	VR	90
2	Camponotus floridanus (Fabricius,1804)	9	33	21	30	VR	93
3	Camponotus sp.(Mayr,1861)	27	13	19	21	VR	80
4	Camponotus pennsylvanicus(Fabricius,1776)	14	23	11	18	VR	66
5	Camponotus ligniperda(Mayr,1865)	19	21	13	12	VR	65
6	Formica fusca (Linnaeus,1758)	12	11	12	13	VR	48
7	Formica sanguinea (Latreille,1798)	16	21	17	23	VR	77
8	Formica cunicularia (Latreille,1798)	09	21	13	17	VR	60
9	Megaponera analis (Latreille,1802)	17	21	18	14	VR	70
10	Oecophylla smaragdina (Fabricius,1775)	12	11	12	23	VR	58
11	Paraponera clavata (Fabricius,1775)	11	27	17	12	VR	67
12	Pheidole pallidula (Nylander,1894)	13	14	12	16	VR	55
13	Polyergus brevicep (Emery,1893)	14	21	12	19	VR	66
14	Paratrechina longicornis (Latreille,1802)	21	17	21	22	VR	81
15	Paratrechina solitaria(Smith,1858) .	19	14	12	09	VR	54
16	Paratrechina impressa (Roger,1861)	17	18	21	22	VR	78
17	Solenopsis invicta (Buren,1972)	12	14	13	21	VR	60
	Family-Apidae						
18	Apis dorsata(Fabricius,1793)	04	18	21	06	Re	49
19	Apis cerena (Fabricius,1793)	21	27	19	15	VR	82
20	Apis mellifera (Lepeletier,1836)	23	17	21	18	VR	79
21	Apis florea(Linnaeus,1758)	24	16	21	21	VR	82
22	Apis laboriosa (Smith,1871)	19	21	23	12	VR	75
23	Bombus terrestris(Latreille,1758)	24	23	29	17	VR	93
24	Melissodes bimaculatus(Lepeletier,1825)	21	26	19	18	VR	84
25	Xylocopa micans(Lepeletier,1841)	14	17	25	14	VR	70
26	Xylocopa latipes(Drury,1773)	19	29	23	22	VR	93
27	Xylocopa violacea(Linnaeus,1758)	26	25	19	23	VR	93
28	Xylocopa femorata(Smith,1876)	22	16	18	23	VR	79
	Family-Vespidae						
29	Vespa crabro(Linnaeus,1758)	03	-	-	01	Ra	4
30	Vespa tropica (Linnaeus,1758)	04	-	03	02	Ra	9
31	Polistes bellicosus(Cression,1872)	-	02	-	-	Ra	2
32	Vespa orientalis(Linnaeus,1758)	01	-	02	-	Ra	3
	Family: Sphecidae						
33	Chalybion californicum(Saussure.1867)	08	07	11	06	Re	32
34	Chalybion japonicum(Dahlbom,1843)	11	19	21	13	VR	64
35	Sphex pensylvanicus(Linnaeus,1763)	16	21	17	21	VR	75
	Family: Megachilidae						
36	Megachile zombae(Latreille,1802)	-	02	01	-	Ra	3
	Total	534	605	564	536		2239
	Margalef Index($D_{Mg)}$	5.25	4.99	5.21	5.09		
	Shannon-Weiner Index(H')	3.40	3.41	3.43	3.39		
	Evenness($j^{'}$)	0.96	0.98	0.97	0.97		
	VR-Very Regular(>50 views), Re-Regular(11-50 views),Ra-Rare(2-10 views)						

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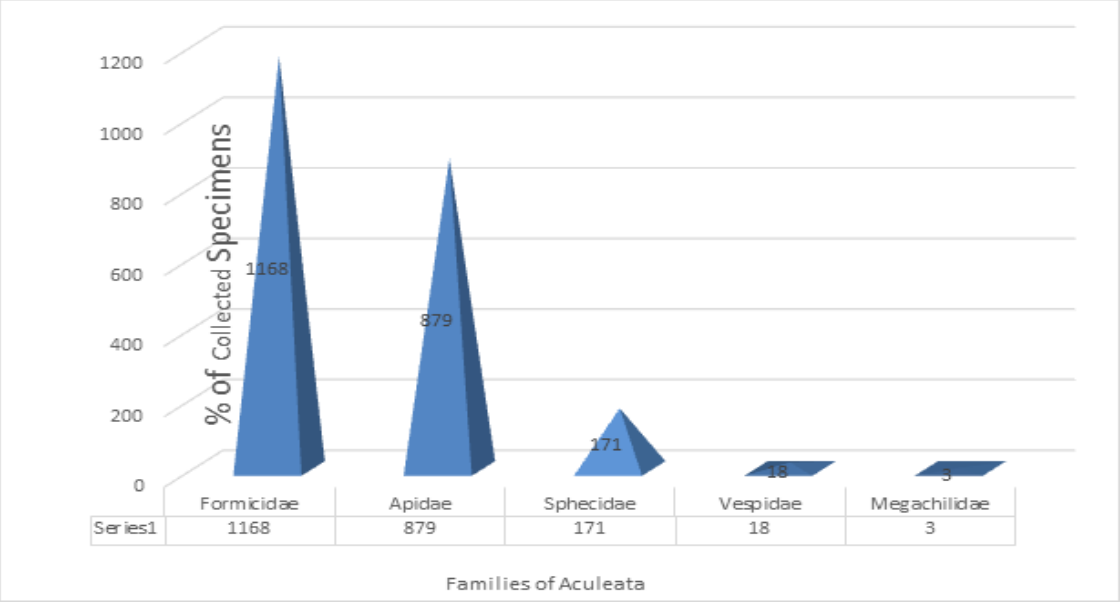
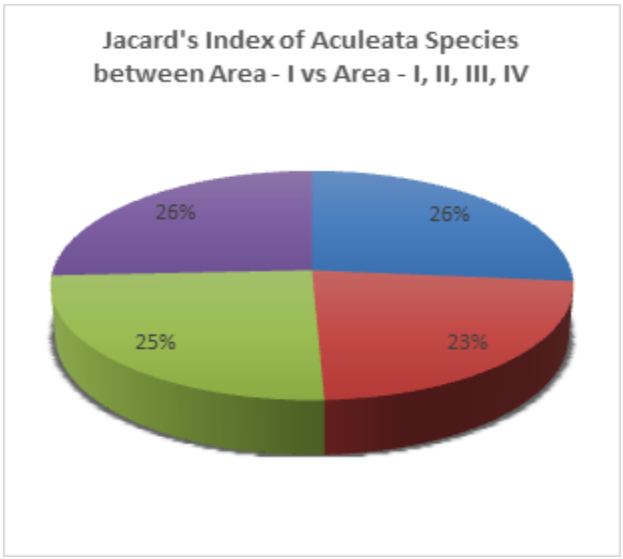
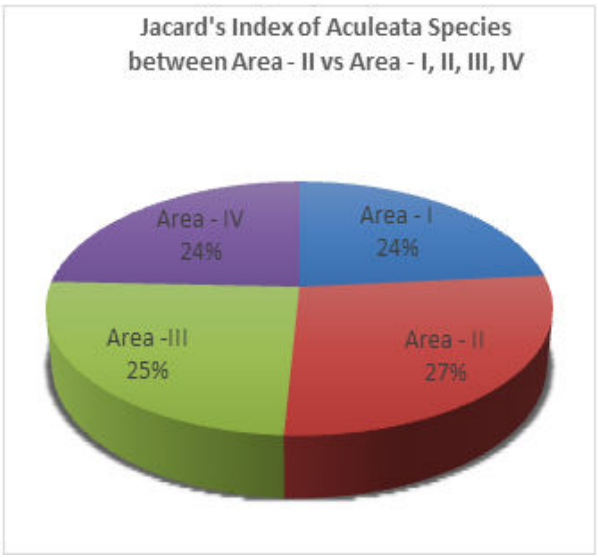
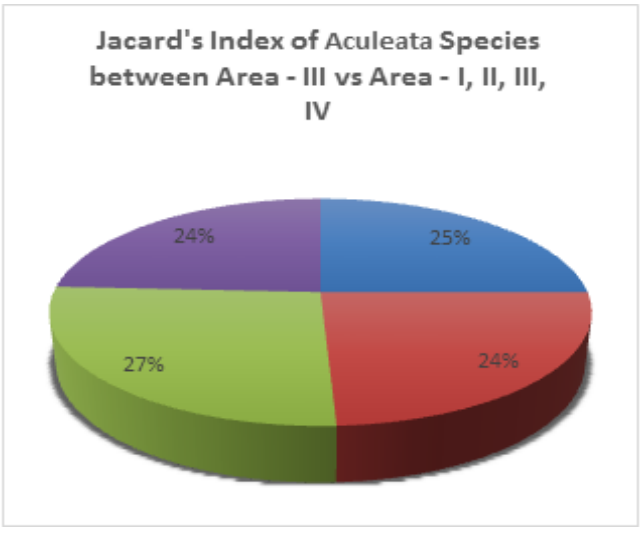
Table-2 Showing Jaccard's similarity index (Cj)

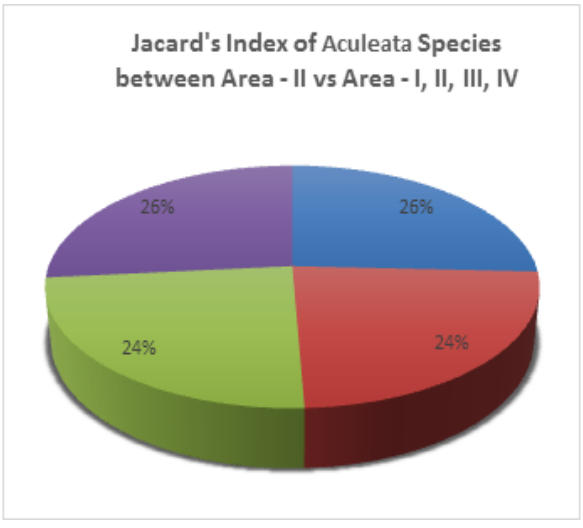
	Area-I	**Area-II**	**Area-III**	**Area-IV**
Area-I	1	0.86	0.94	0.97
Area-II	0.86	1	0.91	0.89
Area-III	0.94	0.91	1	0.91
Area-IV	0.97	0.89	0.91	1











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4. RESULTS AND DISCUSSION

The current examination was led at fringe spaces of the Hingula Open Cast Project to investigate the Aculeata fauna. An all out number of 36 types of Aculeata in 18 genera and 5 families were recorded in the investigation regions. (Table-1) During the examination, Formicidae was observed to be more assorted and prevailing with 17 species having a place with 9 genera, contributed 52% followed by Apidae with 11 species and 4 genera. They likewise contributed a 39% variety of absolute Aculeata recorded in fringe spaces of the Hingula Open Cast Project. Family Vespidae with 4 species and 2 genera contributed 0.8%. Family Sphecidae with 3 species and 2 genera contributed 7.6% and Family Megachilidae with 1 class and contributed 0.13%. (Table.1)

The Shannon-Weiner Index (Area-I = 3.40, Area – II = 3.41, Area-III = 3.43 and Area - IV =3.39) as displayed in the Table-1 doesn't change among the various environments. Species lavishness or Margalef's extravagance (D Mg) Index was observed to be 5.25 in Area-I, 5.21 in Area-III and 5.09 in Area-IV. Region II has shown nearly low wealth ie.4.99. The Jaccard's similitude record (Cj) as displayed in Table-2 was most elevated (0.97) between Area-I and Area-IV and least (0.86) between Area-I and Area-II. Equity (j) in species wealth of) Area-III and Area-IV are something similar while Area-I and Area-II show little variety with 0.96 and 0.98 separately.

In the current investigation greatest assortment of Aculeata was done in July and August. Present information uncovered that the Aculeata of the investigation locale is rich and broadened might be because of an assortment of vegetation and complex natural conditions, precipitation examples, and temperature.

Ale size, various territory, and accessibility of normal and counterfeit water bodies may be the reasons for the greatest variety of Aculeata in the fringe towns of the Hingula Open Cast Project. The size of water bodies remains as a significant factor to decide the species extravagance and variety of Aculeata. In any case, the investigation additionally uncovered that the Aculeata and their natural surroundings are under danger because of extreme anthropogenic exercises like environment modification, coal unearthing, contamination, deforestation, and so on

5. CONCLUSION

A complete number of 2239 Aculeata were seen in fringe spaces of the Hingula Open Cast Project. As per IUCN red rundown information, Aculeata is the most un-worried about normal changes in the climate. From the current information, the Aculeata populace has diminished because of anthropogenic activities like coal removal and environment fracture in the Talcher Area which could be a risk signal for the vanishing of this magnificent animal, particularly in Talcher. Up until now, less investigations have been done on the peril of this sublime life form, energetic examinations are fundamental.

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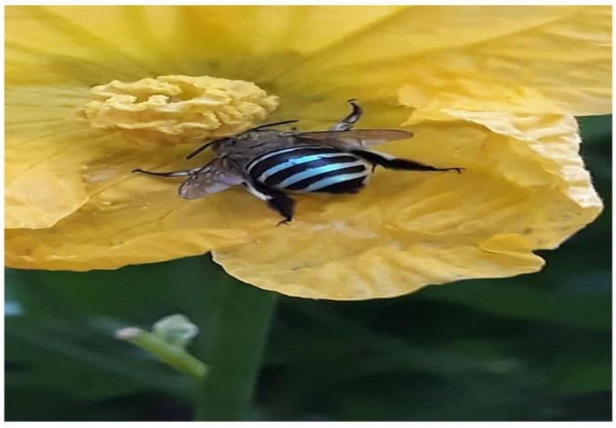
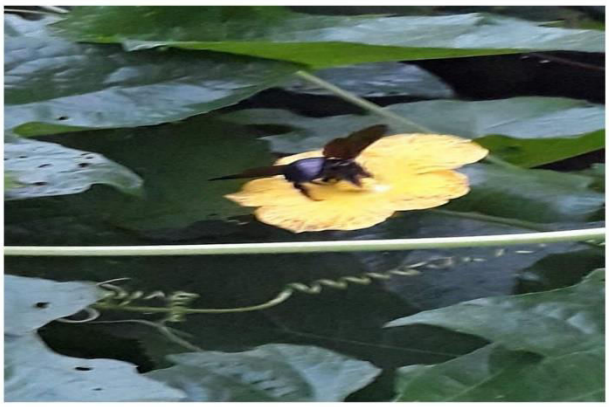


1.Apis florea

2.Camponotus pensylvanicus

3.Apis mellifera

4.Chalybion californicum



5.Xylocopa femorata

6.Negachile zombae

7.Camponotus sp.

8.Megaponera anali

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9.Sphex pensylvanicus

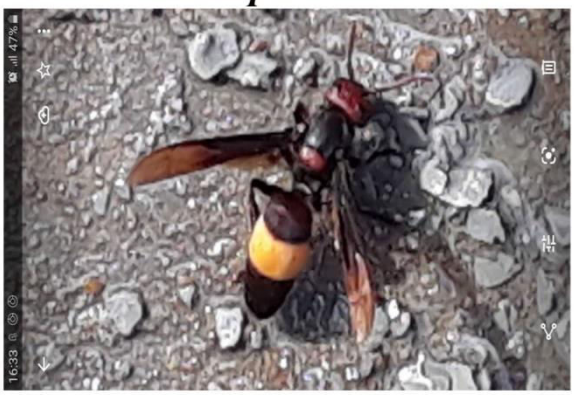
10. Oecophylla smaragdina

11. Pheidole pallidula

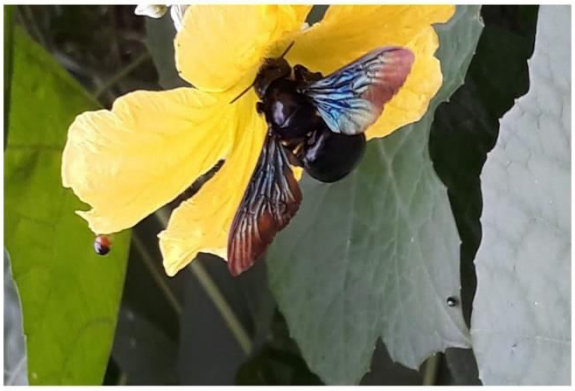
12. Pachycondyla impressa

13. Solenopsis invicta

14. Vesa orientalis



15. Vespa tropica



16. Xylocopa femorata

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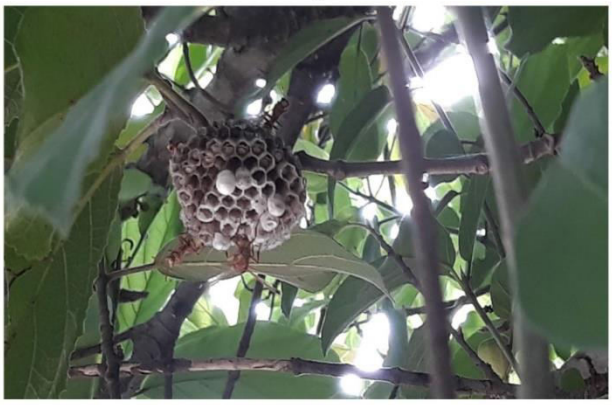
17. Xylocopa micans

18. Pachycondyla solitaria

19. Megaponera analis



20. Vespa carbo

21. Oecophylla smaragdina

22. Camponotis ;ogmo[erda

23. Paratrechina longicornis

24. Polistes bellicosus