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Studies on the diversity and abundance of butterfly in and around CUTM, Paralakhemundi campus, Odisha (India)

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Abstract
The present investigation on species diversity and abundance of butterfly was carried out in and around, CUTM, Paralakhemundi campus during January-2017 to June-2018. A total of 578 individuals butterfly were recorded during the present study. Out of which, 45 species under 5 families *viz*., Papilionidae, Nymphalidae, Pieridae, Lycaenidae and Hesperiidae were observed. The highest number was recorded from family Nymphalidae (22 species, 48.89%) followed by Pieridae and Lycaenidae (7 species each with 15.56%) however, Papilionidae and Hesperiidae recorded 5 and 4 species with 11.11 and 8.89% of relative abundance, respectively. Out of 45 species, 44 were found in forest ecosystem with total abundance of n= 299 followed by 35 species (n=153) in horticultural ecosystem and then 33 species (n=126) in agro- ecosystem. The forest ecosystem recorded the highest diversity index and evenness (3.59 and 0.95) followed by agro-ecosystem (3.24 and 0.93) and horticultural ecosystem (3.23 and 0.91). The highest number of species was recorded from forest ecosystem and the presence of such diversity in and around the campus reflects the healthiness of the surrounding environment.

Keywords: butterfly, species diversity, abundance, ecosystem, paralakhemundi

1. Introduction
Butterflies are one of the most fascinating and conspicuous creatures of Earth's biodiversity belong to macrolepidopteran clade Rhopalocera from the order Lepidoptera. They are extremely responsive to any changes in their environment *viz*., temperature, humidity, light, and rainfall patterns [1-3], thus are equipped to react any disturbance and change in habitat which make them an ideal ecological indicator [4-8]. They have different requirements for different habitat types for mating, breeding and nectaring and are, thus, in synchronization with the diversity and quality of their habitats. The adult butterflies are also act as good pollinators after bees and dependent on nectar and pollen as their food while the caterpillars are dependent on specific host plants for foliage [9] and few are predaceous to small insects. There are about 18,000 species of butterflies in the world [10] out of which 1504 species are reported from Indian sub-region [11-15] which constitute 65% of total Indian fauna. In central India, 177 spp. of butterflies have been reported by [16], while [15] reported 166 spp. from Vidarbha and 65 species from Kolamarka Conservation Reserve by [17], a sub-region of the Central India. However, still a systematic study of butterflies has not been carried out in many regions of the central India having potential to sustain high biodiversity [18]. Since the butterflies play a very important role in maintaining various kind of ecosystem and also act as a bio-indicator, conservation of them is very much necessary. Therefore, the present study was taken up in order to assess the diversity and abundance of butterfly found in and around CUTM, Campus.

2. Materials and Methods
2.1 Study site
The study was conducted in Centurion University of Technology and Management, Paralakhemundi, Odisha (18.7783° N, 84.0937° E) located at the piedmont of South Odisha Easter Ghats range (Fig. 1). The major types of vegetation included grasslands, open scrub forest, agricultural lands and mango orchards.

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2.2 Sampling period and time

During the study, three sampling sites were selected *viz.* forest ecosystem, Agro-ecosystem and Horticultural ecosystem for observing the butterflies. The butterflies were observed in the sampling sites for a period of more than 1 year between January -2017 to June -2018. Each study site was visited at fortnightly interval and transects were observed from early morning (8:00 am) to evening hours (5:30 pm) during good weather periods (no heavy rain and strong wind).

2.3 Sampling techniques

The butterflies were observed by steadily walking along the survey routes and recording butterflies observed within a 10 m width along the routes, using the "Pollard Walk" method with some modifications [19, 20] in and around the campus of CUTM. This method has been extensively used to survey and monitor butterfly populations and communities [21-23]. Butterflies were photographed from different angles as often as possible to obtain sufficient photographs to enable positive identification of species. Photographs were taken with DSLR camera (Nikon D3300). Butterflies were primarily identified directly in the field with the help of field guides [24] followed by photography and rarely by capture. Collection was restricted to those specimens that could not be identified directly. In such cases specimens were collected with aerial net and further identified with the help of a field guide was done. The observed butterflies were categorized in five categories on the basis of their abundance following [25] in and around CUTM campus. Very Rare (VR)-1 to 2 sightings; Rare (R)-3 to 4 sightings; Uncommon (UC)- 5 to 10 sightings; Common (C)-11 to 16 sightings and Very Common (VC) more than 16 sightings. The relative abundance of the butterflies recorded during the study was also calculated.

2.4 Statistical analysis

Total abundance, Species richness (number of species), Diversity and Evenness of butterflies were also studied under Forest ecosystem, Agro-ecosystem and Horticultural ecosystem.

Species diversity

The diversity was calculated by using [26], which is defined as
$$H' = - \Sigma P_i \ln P_i$$
Where, $P_i = ni/N$, ni=number of individual of a species at a time i, N= size of whole community and ln = natural log.

Evenness of butterflies

Evenness of species was calculated by using [27], which is defined as $J' = H'/\ln S$
Where, S = number of species present in the site, ln = natural log and H' is the diversity index. The value of J ranges from 0-1.

3. Results and Discussion

A total of 578 individuals butterfly were recorded during the study out of which 45 species under 5 families *viz.*, Papilionidae, Nymphalidae, Pieridae, Lycaenidae and Hesperiidae were observed in and around CUTM campus. The photographs of the observed butterflies are given in the Plate 1-5. Based on the number of collected species, highest number was recorded from family Nymphalidae (22 species, 48.89%) followed by Pieridae and Lycaenidae (7 species each with 15.56%) however, Papilionidae and Hesperiidae recorded 5 and 4 species with 11.11 and 8.89% of relative

abundance, respectively (Table 1 and Fig. 2). Among these species, 6 were recorded as very rare (*Pachliopta hector, Telinga malsara, Amblypodia anita dina, Spalgis epius, Rapala manea* and *Spialia galba*), 4 as rare species (*Pachliopta aristolochiae, Pantoporia hordonia, Orsotriaena medus* and *Pelopidas mathias*), 11 as uncommon (*Papilio polymnestor, Papilio polytes, Hypolimnas bolina, Junonia orithya, Elymnias hypermnestra, Ypthima ceylonica, Cepora nerissa, Castalius rosimon, Zizina otis indica, Rathinda amor* and *Erionota torus*), 8 as common species (*Ariadne merione, Neptis hylas, Junonia almanac, Junonia atlites, Junonia iphita, Belenois aurota, Anthene emolus* and *Ampittia dioscorides*) and 16 species as very common (*Papilio demoleus, Danaus chrysippus, Danaus genutia, Euploea core, Acraea terpsicore, Phalanta phalantha, Euthalia aconthea, Tanaecia lepidea, Junonia lemonias, Melanitis leda, Mycalesis perseus, Catopsilia pomona, Eurema blanda, Leptosia nina, Delias eucharis* and *Pareronia hippia*). The preference of butterflies for particular habitats is associated with the availability of larval host plants and adult nectar plants. The flora in our campus is a mixed type with herbs and shrubs dominating the vegetation in the tropical climate, trees are comparatively more in number and hence provide diverse habitat, food and breeding sites for the butterflies. Species abundance, richness, diversity and evenness of different butterflies were also studied in forest, agricultural and horticultural ecosystem. Out of 45 species, 44 were found in forest ecosystem with total abundance of n= 299 followed by 35 species (n=153) in horticultural ecosystem and then 33 species (n=126) in agro- ecosystem (Table 2). The forest ecosystem recorded the highest diversity index and evenness (3.59 and 0.95) followed by agro-ecosystem (3.24 and 0.93) and horticultural ecosystem (3.23 and 0.91) (Table 2).

Similar results were also reported by Deokar and Shukla [17] who reported 65 species of butterflies from Kolamarka Conservation Reserve, Central India and the highest number of species was observed from family Nymphalidae and lowest from Hesperiidae. Aiswarya *et al.* [28] reported 49 species in Sarojini Naidu Campus, Kolkata and found highest number of population in Nymphalidae family. Thakur and Bhardwaj [29] Harsh [30] and Siva and Swamy [31] also reported that the Nymphalidae is the most diverse family in lower Himachal Pradesh, Madhya Pradesh and Andhra Pradesh, India respectively. However, Mukherjee *et al.* [32] reported the presence of 96 butterfly species, dominated by Lycaenidae (31.25%) over Nymphalidae (28.13%), Hesperiidae (18.75%), Pieridae (12.50%), and Papilionidae (9.38%) in and around Kolkata metropolis. Agarwala *et al.* [33] observed that the species diversity of butterflies was 3.023 and 2.734 in rural site and urban site respectively in north east India. Kumar *et al.* [34] reported the species diversity of butterfly fauna as 3.342 and 2.565 across the two years of study within Gurukula Kangri Vishwavidyalaya Campus at Haridwar, Uttarakhand, India. Majumder *et al.* [35] also recorded the Shannon Weiner diversity (H') as 3.62 and Pielou's Evenness Index (J') as 0.89 for butterfly communities in the Trishna Wildlife Sanctuary, in South Asia. Guptha *et al.* [36] recorded the maximum value of Shannon Weiner Index (H') as 3.247 for butterflies in the Seshachalam Biosphere reserve, Eastern Ghats, Andhra Pradesh, India. However, Tyagi *et al.* [37] reported the mean Shannon diversity (H') of 1.318 and 1.319 in the first and second year of study, respectively in Nainital district, Uttarakhand, India.

**Table 1:** List of butterfly species with their relative abundance and status in CUTM, Paralakhemundi campus

Sl. No.	Common name	Scientific name	Family	Frequency	Relative Abundance (%)	Status
1	Blue Mormon	*Papilio polymnestor* Cramer, 1775	Papilionidae	8	1.38	UC
2	Common Mormon	*Papilio polytes* Linnaeus, 1758	Papilionidae	10	1.73	UC
3	Common Rose	*Pachliopta aristolochiae* Fabricius, 1775	Papilionidae	3	0.52	R
4	Crimson Rose	*Pachliopta hector* Linnaeus, 1758	Papilionidae	1	0.17	VR
5	Lemon Butterfly	*Papilio demoleus* Linnaeus, 1758	Papilionidae	22	3.81	VC
6	Dakhan Common Castor	*Ariadne merione* Cramer, 1777	Nymphalidae	12	2.08	C
7	Plain Tiger	*Danaus chrysippus* Linnaeus, 1758	Nymphalidae	29	5.02	VC
8	Striped Tiger	*Danaus genutia* Cramer, 1779	Nymphalidae	20	3.46	VC
9	Indian Common crow	*Euploea core* Cramer, 1780	Nymphalidae	27	4.67	VC
10	Tawny Coster	*Acraea terpsicore* Linnaeus, 1758	Nymphalidae	30	5.19	VC
11	Common Leopard	*Phalanta phalantha* Drury, 1773	Nymphalidae	22	3.81	VC
12	Common Baron	*Euthalia aconthea* Cramer, 1777	Nymphalidae	21	3.63	VC
13	Grey Count	*Tanaecia lepidea* Butler, 1868	Nymphalidae	17	2.94	VC
14	Common Sailor	*Neptis hylas* Linnaeus, 1758	Nymphalidae	11	1.90	C
15	Common Lascar	*Pantoporia hordonia* Stoll, 1790	Nymphalidae	3	0.52	R
16	Great Eggfly	*Hypolimnas bolina* Linnaeus, 1758	Nymphalidae	5	0.87	UC
17	Peacock Pansy	*Junonia almana* Linnaeus, 1758	Nymphalidae	15	2.60	C
18	Grey Pansy	*Junonia atlites* Linnaeus, 1763	Nymphalidae	14	2.42	C
19	Chocolate Pansy	*Junonia iphita* Cramer, 1779	Nymphalidae	15	2.60	C
20	Lemon Pansy	*Junonia lemonias* Linnaeus, 1758	Nymphalidae	20	3.46	VC
21	Blue Pansy	*Junonia orithya* Linnaeus, 1758	Nymphalidae	5	0.87	UC
22	Common Palmfly	*Elymnias hypermnestra* Linnaeus, 1763	Nymphalidae	7	1.21	UC
23	Common Evening Brown	*Melanitis leda* Linnaeus, 1758	Nymphalidae	27	4.67	VC
24	Common Bushbrown	*Mycalesis perseus* Fabricius, 1775	Nymphalidae	21	3.63	VC
25	White Line Bushbrown	*Telinga malsara* Moore, 1857	Nymphalidae	2	0.35	VR
26	Dark Grassbrown	*Orsotriaena medus* Fabricius, 1775	Nymphalidae	3	0.52	R
27	Common Four ring	*Ypthima ceylonica* Hewitson, 1865	Nymphalidae	9	1.56	UC
28	Lemon Emigrant	*Catopsilia pomona* Fabricius, 1775	Pieridae	20	3.46	VC
29	Three spot Grass Yellow	*Eurema blanda* Boisduval, 1836	Pieridae	27	4.67	VC
30	Psyche	*Leptosia nina* Fabricius, 1793	Pieridae	26	4.50	VC
31	Common Jezebel	*Delias eucharis* Drury, 1773	Pieridae	17	2.94	VC
32	Common wanderer	*Pareronia hippia* Fabricius, 1787	Pieridae	19	3.29	VC
33	Indian Pioneer	*Belenois aurota* Fabricius, 1793	Pieridae	16	2.77	C
34	Common Gull	*Cepora nerissa* Fabricius, 1775	Pieridae	7	1.21	UC
35	Common Ciliate Blue	*Anthene emolus* Godart, 1823	Lycaenidae	14	2.42	C
36	Common Pierrot	*Castalius rosimon* Fabricius, 1775	Lycaenidae	10	1.73	UC
37	Indian Lesser Grass Blue	*Zizina otis indica* Fabricius, 1787	Lycaenidae	9	1.56	UC
38	Monkey Puzzle	*Rathinda amor* Fabricius, 1775	Lycaenidae	5	0.87	UC
39	Indian Purple Leaf Blue	*Amblypodia anita dina* Fruhstorfer, 1907	Lycaenidae	1	0.17	VR
40	Apefly	*Spalgis epius* Westwood, 1851	Lycaenidae	1	0.17	VR
41	Slate Flash	*Rapala manea* Hewitson, 1863	Lycaenidae	1	0.17	VR
42	Bush hopper	*Ampittia dioscorides* Fabricius, 1793	Hesperiidae	11	1.90	C
43	Indian Skipper	*Spialia galba* Fabricius, 1793	Hesperiidae	2	0.35	VR
44	Banana Skipper	*Erionota torus* Evans, 1941	Hesperiidae	10	1.73	UC
45	Small Branded Swift	*Pelopidas mathias* Fabricius, 1798	Hesperiidae	3	0.52	R

**Note**** VR: Very Rare; R: Rare; UC: Uncommon; C: Common and VC: Very Common

Table 2: Different ecological indices for different habitats in CUTM, Paralakhemundi campus

Ecological indices	Ecosystem		
	Forest ecosystem	Agro ecosystem	Horticultural ecosystem
Total Abundance (n)	299	153	126
Species richness (S)	44	33	35
Shannon-Wiener diversity index (H′)	3.59	3.24	3.23
Evenness (J′)	0.95	0.93	0.91
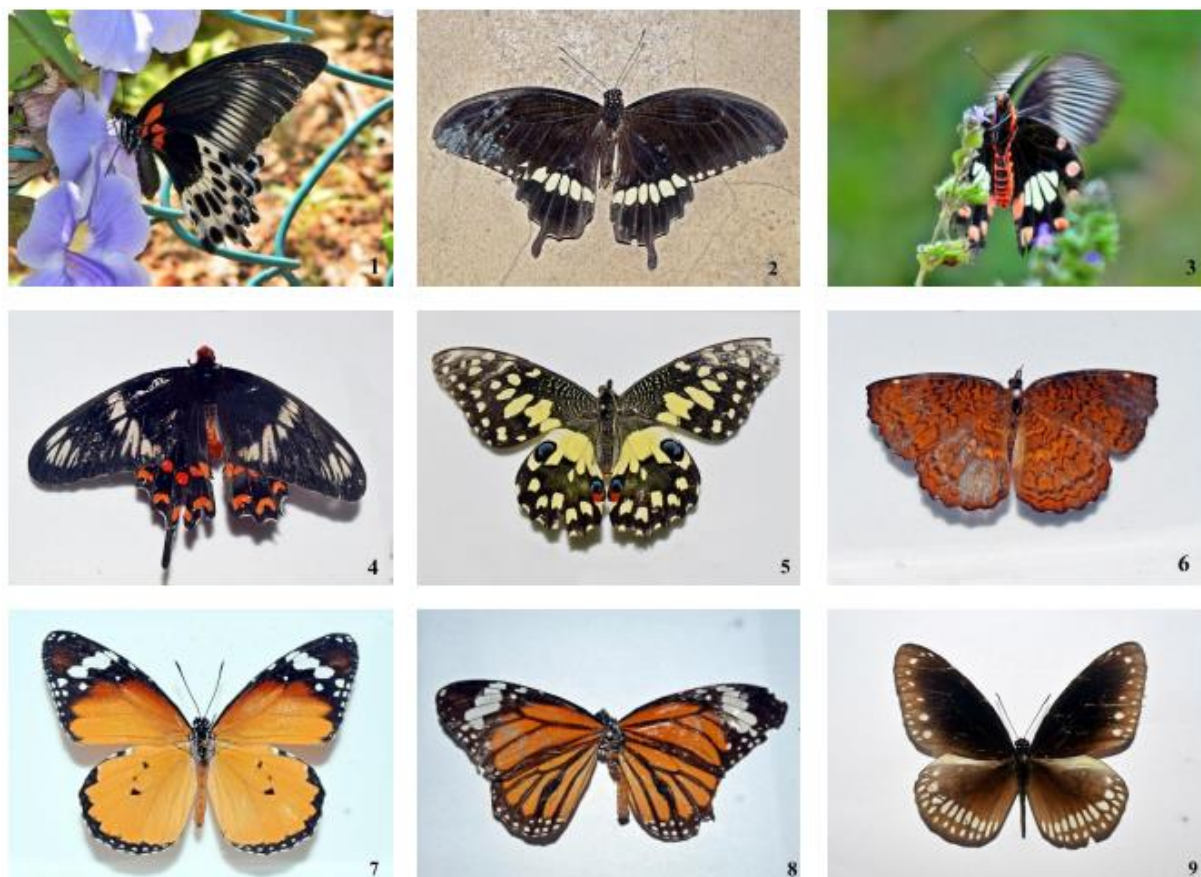
Plate 1: Different species of butterflies reported from CUTM, campus. 1. Blue Mormon 2.Common Mormon 3.Common Rose 4.Crimson Rose 5.Lemon Butterfly 6.Dakhan Common Castor 7.Plain Tiger 8.Striped Tiger 9.Indian Common crow.
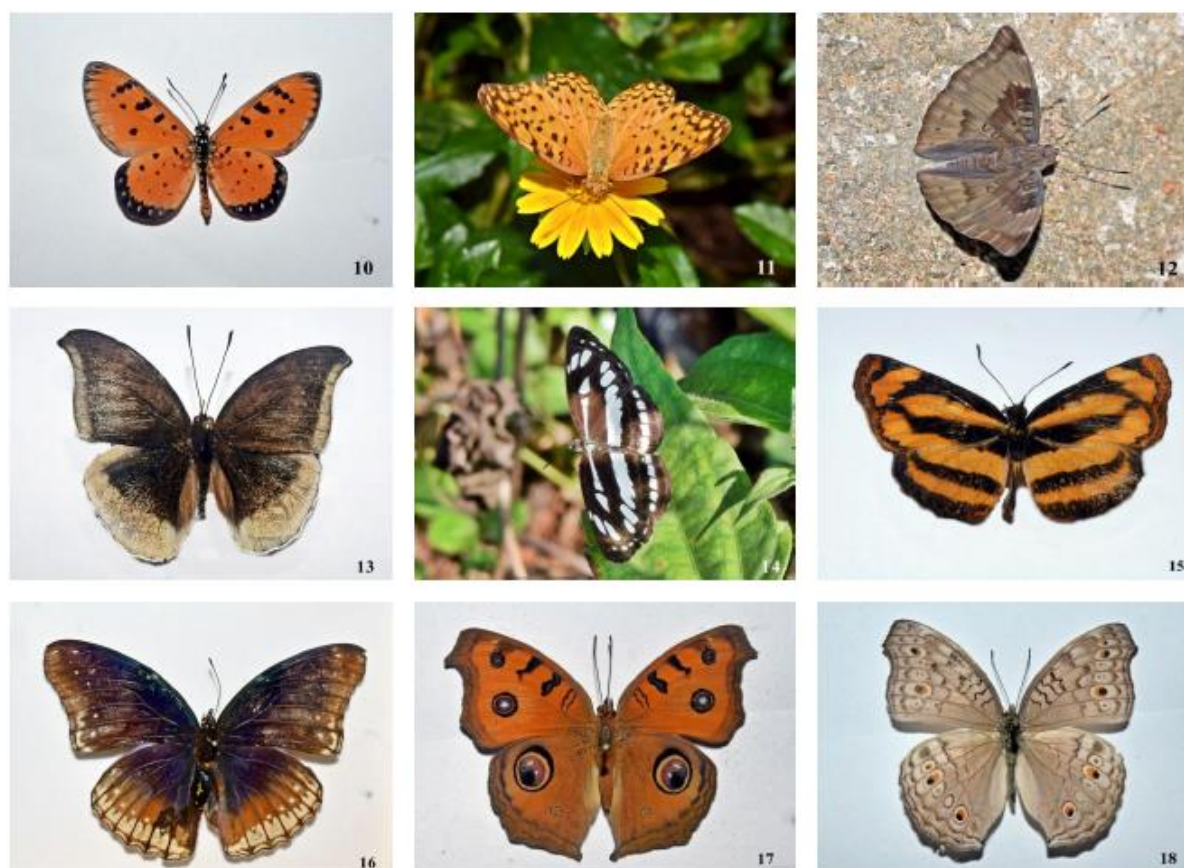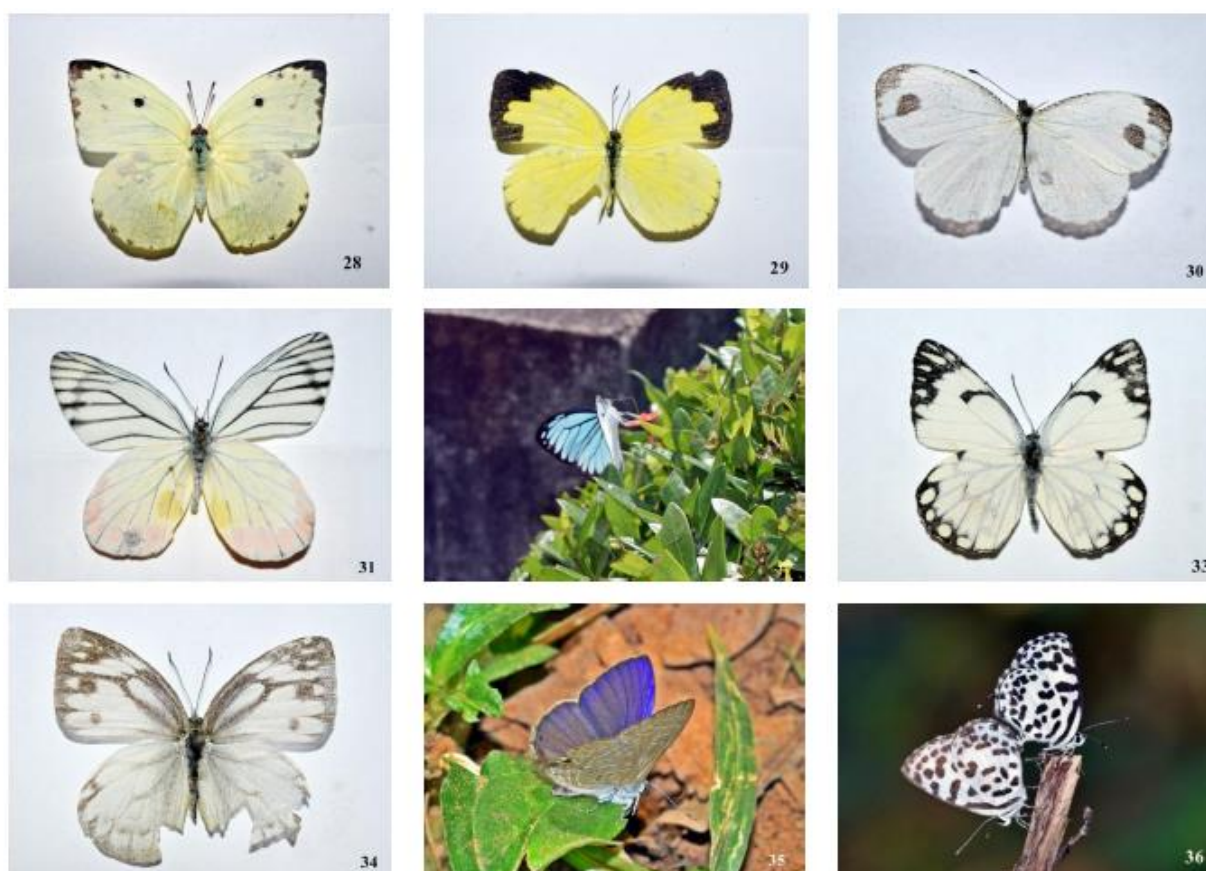

Plate 2: Different species of butterflies reported from CUTM, campus. 10. Tawny Coster 11.Common Leopard 12.Common Baron 13.Grey Count 14.Common Sailor 15.Common Lascar 16.Great Eggfly 17.Peacock Pansy 18.Grey Pansy.

Plate 3: Different species of butterflies reported from CUTM, campus. 19.Chocolate Pansy 20.Lemon Pansy 21.Blue Pansy 22.Common Palmfly 23.Common Evening Brown 24.Common Bushbrown 25.White Line Bushbrown 26.Dark Grassbrown 27.Common Four ring.


Plate 4: Different species of butterflies reported from CUTM, campus. 28.Lemon Emigrant 29.Three spot Grass Yellow 30.Psyche 31.Common Jezebel 32.Common wanderer 33.Indian Pioneer 34.Common Gull 35.Common Ciliate Blue 36.Common Pierrot.

Plate 5: Different species of butterflies reported from CUTM, campus. 37.Indian Lesser Grass Blue 38.Monkey Puzzle 39.Indian Purple Leaf Blue 40.Apefly 41. Slate Flash 42.Bush hopper 43.Indian Skipper 44.Banana Skipper 45. Small Branded Swift.
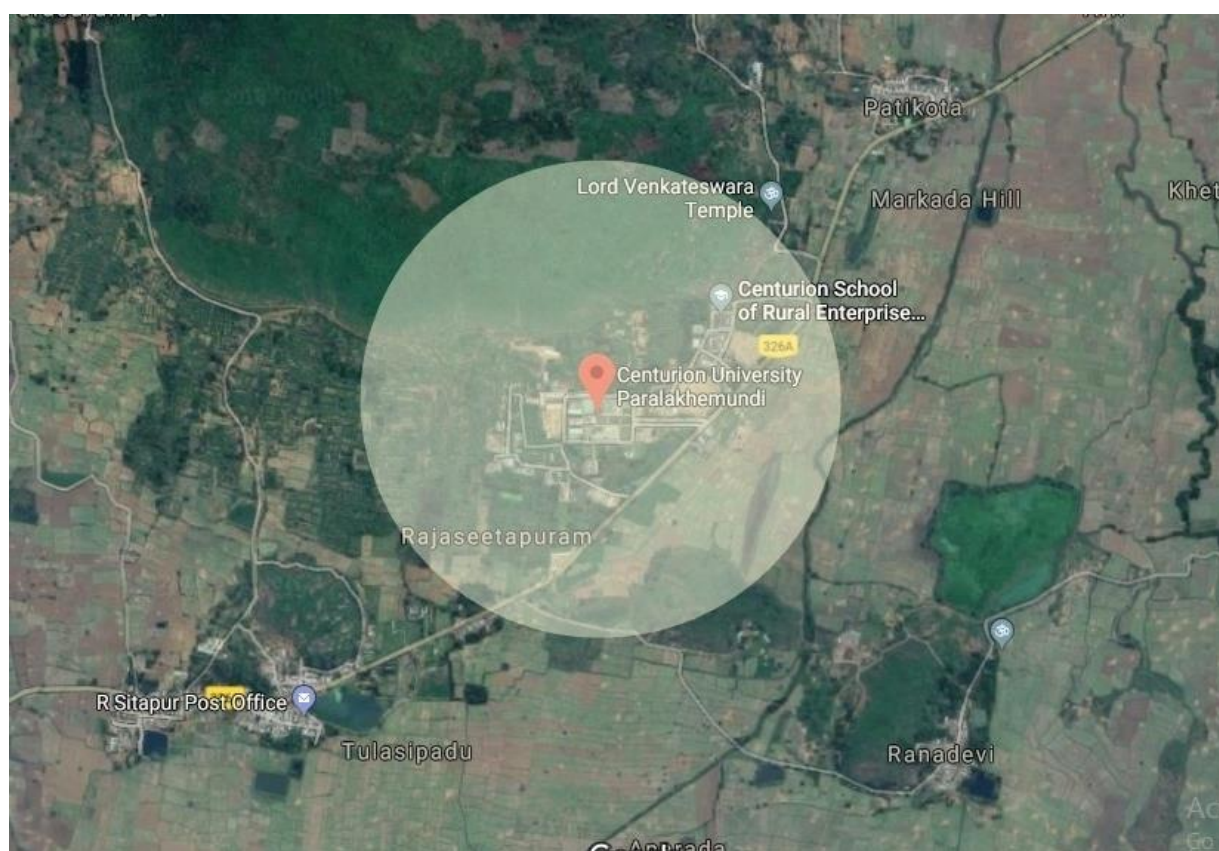
Fig 1: Map showing the study sites of CUTM, Paralakhemundi, Campus.
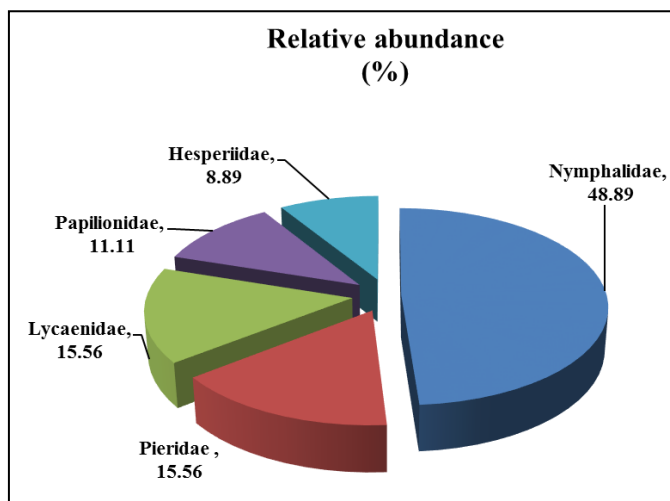
Fig 2: Relative abundance of different families of butterfly

4. Conclusion

During the present study, highest number was recorded from family Nymphalidae (22 species) followed by Pieridae and Lycaenidae (7 species each) however, Papilionidae and Hesperiidae recorded 5 and 4 species, respectively. Among the species, 6 were recorded as very rare (*Pachliopta hector, Telinga malsara, Amblypodia anita dina, Spalgis epius, Rapala manea* and *Spialia galba*) and 4 as rare species (*Pachliopta aristolochiae, Pantoporia hordonia, Orsotriaena medus* and *Pelopidas mathias*). The highest number of species was recorded from forest ecosystem and this might be due to the presence of sufficient host plants and favorable climatic conditions for the growth and development of butterflies. As they are also act as a bio-indicator, the presence of such diversity in and around the campus reflects the healthiness of the surrounding environment. It is also necessary to identify the rare species of butterfly and conserve them in the area.

5. Acknowledgement

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