

**IDENTIFICATION OF COMMON PESTS FOUND IN THE
VEGETABLES OF KITCHEN GARDEN**



Project work by

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Submitted to St. Teresa's College (Autonomous), Ernakulam

Affiliated to Mahatma Gandhi University, Kottayam

In partial fulfilment of requirement for the degree of Bachelor of Science

in Zoology

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CERTIFICATE

This is to certify that the project entitled “**IDENTIFICATION OF COMMON PESTS FOUND IN THE VEGETABLES OF KITCHEN GARDEN**”, submitted by **Ms. AMY MARIA MANOJ**, Reg No: **AB19ZOO001** in partial fulfilment of the request of Bachelor of Science degree of Mahatma Gandhi University, Kottayam, is a bonafide work done under my guidance and supervision and to my best knowledge, this is her original effort.

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1)

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DECLARATION

I, hereby declare that this project work entitled “IDENTIFICATION OF COMMON PESTS FOUND IN THE VEGETABLES OF KITCHEN GARDEN” is submitted to St. Teresa’s College (Autonomous), Ernakulam affiliated to Mahatma Gandhi University, Kottayam in partial fulfilment of the requirements of Bachelor of Science degree in Zoology. This work has not been undertaken or submitted elsewhere in connection with any other academic course and the opinions furnished in the report are entirely my own.

NAME: AMY MARIA MANOJ

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The success and final outcome of this project required a lot of guidance and assistance from many people and I am extremely privileged to have got the support all along the course of my project.

First of all, I express my gratitude and appreciation to my project guide Dr. Reema Kuriakose, who took a keen interest in my project work and guided me all along till the completion of my project work by providing necessary information, corrections and clarifications.

I take this opportunity to convey my gratitude to my parents and friends for extending their support in completing my project. I would also like to thank Krishithottam Group (KTG) who supplied the seedlings of the vegetable plants used in the study. I am also grateful to Ms. Tessy James who helped with the identification of the pests.

Lastly, I thank God Almighty for the successful completion of my project.

Amy Maria Manoj

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ABSTRACT

In the present study of pests found in the vegetables of kitchen garden 9 pests were identified. Observations were collected from a homegrown vegetable garden at Athirampuzha from June 2021 to March 2022. Pests attacking the 8 plants (Brinjal, Cow pea, Lady's-finger, Tomato, Chilli, Bitter gourd, Ivy gourd, Spinach) grown in the kitchen garden were used in the study. Observations were mainly done in the evenings and sometimes in the morning. The pests found attacking were Mealybugs (*Pseudococcidae*), Whitefly (*Bemisia tabaci*), Hadda beetle (*Henosepilachna vigintioctopunctata*), Aphids (*Aphis*), Pumpkin caterpillar (*Diaphania indica*), Hibiscus caterpillar (*Xanthodes transversa*), Leaf roller (*Eublemma olivaceae*), Pod sucking bug (*Riptortus pedestris*) and Snails and slugs (Gastropods). This study provides information about the incidence and severity of damage caused by these 9 pests.

INTRODUCTION

Pest problem is one of the major limitations for achieving higher production in agricultural crops. Pest can be a destructive insect or other animal that attacks crops and pose a nuisance to farmers. The present study is devoted to identifying the common pests that attack plants in a kitchen garden. Proper identification of an insect is important before deciding if there is a need to take action. Because not all insects seen on the plants are harmful, some are benign while some others are beneficial. For example, in the study a large population of fire ants were seen on brinjal which hindered the growth of leaf rollers (pest). Ladybug was another beneficial insect which preyed upon aphids, beetles and whiteflies.

Agricultural crops are attacked by a wide variety of pests, the most important being insects, mites, nematodes and gastropod molluscs. In addition to the direct injury caused by pests to the plant system, fruits and seeds, they also cause indirect damage by transmitting fungal, bacterial and viral infections. Some of the pests are polyphagous having a wide range of hosts which makes their management even more challenging. Meanwhile some others are restricted to a single crop. In many cases, only the larval form damages the crops (Hibiscus caterpillar) while in some others all the stages are damaging (Hadda beetle).

The pests were identified from 3 insect orders and gastropods. The order Hemiptera (true bugs) include aphids, whiteflies and scale insects and have piercing and sucking mouthparts to suck the sap from plants. The order Lepidoptera includes moths. The larvae of the moths are called caterpillar and they chew up the plant matter using mandibles. Beetles are the insects that form the order Coleoptera. They have mandibles for chewing. Slugs and snails are terrestrial gastropod molluscs which chew leaves, stems, flowers, fruits and vegetable debris. They need moist environments and come out to feed only at night.

OBJECTIVES

- To identify the pests commonly seen in homegrown vegetable plants
- To study the symptoms exhibited by the pests on plants

This study will be helpful in assessing the incidence and severity of damage caused by the different pests identified so that proper control measures can be taken.

REVIEW OF LITERATURE

The present study covers the identification and symptoms of pests commonly seen on homegrown vegetable plants. A total of 9 pests were identified on 8 different vegetable plants used in the study.

During the present investigation, maximum number of pests (6) were found on brinjal. In a study on the succession of various insect pests on Brinjal, Ajita et al., (2019) deduced that 8 insect pests remained active on Brinjal during various growth stages. While Nithar (2019) were able to collect and identify about 17 pests of Brinjal, among which 5 were major pests.

As Brinjal is highly cosmopolitan and popularly grown as poor man's crop in India, natural and eco-friendly methods to address the pest issue is necessary. A mixture of neem and bel leaves extract was found effective in controlling the pests on Brinjal according to Nithar (2019). He found that pan traps are also successful. Another study by Elanchezhyan et al., (2008) found that Sweta variety of Brinjal was best at reducing Hadda beetle, Aphids, Mealybugs and Whiteflies. They concluded that total sugar and chlorophyll content has a positive correlation to shoot damage while phenol and ash content has a negative correlation.

Solanaceous crops used in the current study comprised of Chili, Tomato and Brinjal and all 3 were found susceptible to Whitefly (*Bemisia tabaci*). Tufail et al., (2019) recorded that Whitefly was a major pest on the aforementioned solanaceous crops when grown singly as well as in a mixed cropping pattern. Their study confirmed that host selection by pests depends on the attractiveness of the volatile chemicals emitted by the plants. Among the 3 crops, Tomato was the most susceptible followed by Chili and Brinjal showed the most resistance. Incidence of Whitefly transmitted leaf curl disease was also reported in these plants.

In another study conducted by Sunil (2020) on the distribution of Whitefly on Tomato, it was found that the population of the pest remained higher on the upper crop canopy of the Tomato plant followed by the middle and the lower canopy. Gopal et al., (2014) also reported Whitefly as a pest on Brinjal.

Mealybugs were another group of pests found on 3 vegetable plants, Brinjal, Lady's finger and Cow pea. An examination of the host range of mealybugs in 5 districts of Chhattisgarh reported that the highest number of mealybugs were recorded in the family Malvaceae (lady's-finger) followed by Fabaceae (Cow pea) and Solanaceae (Brinjal). (Chandramani et al., 2019).

Diaphania indica commonly known as Pumpkin caterpillar was detected on the 2 cucurbitaceous crops (Bitter gourd and Ivy gourd) and Spinach used in the present study. In a survey conducted to find the incidence and damage of the Pumpkin caterpillar, it was found that Pumpkin caterpillar appears during the vegetative, flowering and fruiting stages in cucurbits. (Neena, 2011).

Aphids and Hadda beetle identified during the course of the present study had 2 host plants each. Two different species of Aphids were identified on Brinjal and Cow pea. Ruchika et al., (2012) studied the occurrence and infestation level of Aphids and found that *Aphis gossypii* and *Aphis craccivora* attacked Brinjal and Cow pea respectively and were considered as a serious threat to the economically important crops of the agro-ecosystem.

Hadda beetle was common to Brinjal and Bitter gourd and caused serious rate of destruction. According to Anoorag et al., (2013), Hadda beetle is a serious pest of Bitter gourd in which all the 4 stages of the pest egg, grub, pupa and adult caused damage to the plants. Even so Vishav et al., (2013) delineated that the growth and development of the different growth stages of the pest was shorter on the leaves of Brinjal than Bitter gourd. According to them food with high nutrients resulted in the quick development of the grubs. So, in a co- existing agro-ecosystem Hadda beetle preferred Brinjal over Bitter gourd.

In the present study, 3 pests viz. Pod sucking bug, Leaf roller and Hibiscus caterpillar each had only a single host. The Pod sucking bug (*Riptortus pedestris*) observed in the current study was identified by Krishna et al., (2005) as a pest on pulse crops particularly on Cow pea. Ajita et al., (2019) reported Leaf roller on Brinjal. Preliminary studies on the incidence of insect pests on Lady's-finger recorded Hibiscus caterpillar as a major pest that caused economic damage on Lady's-finger (Sorapong, 2013). It was reported that temperature and relative humidity had a direct effect on the population trends of all insects. High temperature and humidity resulted in a big expansion of insects.

The only non-insect pest observed during the course of the present study belonged to the Phylum Mollusca, Snails and slugs. Pradeep (2020) reported them as a growing concern and were observed on Solanaceous crops like Brinjal and Chili. These pests can be effectively controlled by plant derived eco-friendly molluscicides, bait formulations and manual removal.

METHODOLOGY

Pests of Vegetables is a qualitative study conducted to identify the common pests affecting vegetable plants.

Location of the study

The site of the study is located near MG University in Athirampuzha panchayat, Kottayam.

Vegetable Plants Used in the Study

Different varieties of vegetables belonging to different families were used in the study.

- *Solanum melongena* – Brinjal/Eggplant
- *Solanum lycopersicum* - Tomato
- *Capsicum frutescens* - Chilli-Pepper
- *Abelmoschus esculentus* - Lady's finger
- *Vigna unguiculata* – Cow pea
- *Momordica charantia* – Bitter Gourd
- *Coccinia grandis* – Scarlet/Ivy Gourd
- *Amaranthus dubius* – Spinach (Green)

Vegetable garden was setup at two sites rooftop (terrace) and backyard. Plants were grown in growbags. Soil was prepared using soil, coco peat, dried cow dung and pseudomonas. The prepared soil was then transferred to the growbags. Pea, Bitter gourd, Lady's-finger and Spinach were cultivated using seeds. Brinjal, Tomato and Chili were cultivated using seedlings. Seedlings of Brinjal, Tomato, Chili were obtained from Krishi Thottam Group (KTG community).

Observations were taken from July 2021 to March 2022.

The goal of the study was to evaluate an ongoing pest attack where morphological changes can be readily seen.

Instruments

- Images were taken using my phone Samsung Galaxy A30. The Samsung Galaxy A30 handset comes with a dual rear camera setup with 16MP (wide, f/1.7) + a 5MP (ultrawide, f/2.2) lens. It also supports PDAF, HDR, an LED flash, Panorama, and more. While the front packs a 16MP (wide, f/2.0) selfie camera.
- Google lens was used to identify the observed pests.

OBSERVATION

SI.NO	PEST	HOST PLANT	SYMPTOMS
1	Mealybugs	Cow pea, Lady's-finger, Brinjal	Feed on plant sap, produce honey dew causing black sooty molds on leaves
2	Whitefly	Tomato, Chili, Brinjal	Feed on leaves, seen on the lower side; sooty molds are seen
3	Pumpkin caterpillar	Bitter gourd, Scarlet/Ivy Gourd, Spinach	Young larva scraps the chlorophyll content of leaves; Folds and webs the leaves; Attacks developing fruits causing fruit rot
4	Hadda beetle	Bitter gourd, brinjal	Skeletonized leaves; Leaves become transparent; Scraping the chlorophyll content of leaves
5	Aphids – 2 species	Brinjal, Cow pea	Curling of leaves; ants are seen on the lower surface of leaves
6	Snails and slugs	Brinjal, chili	Irregularly shaped holes in leaves; slimy trails of snails and slugs on the leaves
7	Leaf Roller	Brinjal	Fold leaves lengthwise; leaves become brown and dry
8	Hibiscus caterpillar	Lady's-finger	Feed on leaves
9	Pod sucking bug	Cow pea	Feed on the sap of pea pods; shriveling of pods



a



b



c

Fig.1 Mealybugs on Cow pea(a),
Brinjal (b) and Lady's finger (c)



a



b



c

Fig.2 Whitefly on Tomato (a), Brinjal
(b) and Chili (c)



a



b



c

Fig 3. Pumpkin Caterpillar on Spinach (a), Bitter gourd (b) and Ivy gourd (c)



Fig.4 Hadda beetle on Brinjal



Fig.5 Aphids on Brinjal



Fig.6 Hibiscus caterpillar on Lady's finger



Fig.7 Pod sucking bug on Cow pea



a



b

Fig.8 Leaf roller on Brinjal (a &b)



a



b

Fig.9 (a & b) Snails on Brinjal

RESULT

During the course of the present study, 9 pests were identified. Of the 9 pests, 8 are insects coming under 8 genera, belonging to 3 insect orders (Lepidoptera, Coleoptera, Hemiptera) and 8 families (Noctuidae, Coccinellidae, Crambidae, Aleyrodidae, Aphididae, Pseudococcidae, Nolidae, Alydidae) found on 8 vegetable host plants belonging to diverse families (Solanaceae, Malvaceae, Fabaceae, Amaranthaceae). One pest found in the study belongs to the class Gastropoda of phylum Mollusca.

Out of the 9 pests identified in the present study, 3 pests were seen on 3 plants each, 3 pests were found on 2 plants each and 3 pests were seen on 1 plant each.

Maximum number of pests were found on brinjal followed by cow pea. Brinjal hosted 6 pests like Mealybugs, Whitefly, Leaf roller, Hadda beetle, Snails and Aphids. Cow pea was suitable for 3 pests like Mealybugs, Pod sucking bugs and Aphids. Lady's finger hosted Hibiscus caterpillar and Mealybugs. Chili was susceptible to 2 pests, Whitefly and Snails. Bitter gourd was attacked by Hadda beetle and Pumpkin caterpillar. Ivy gourd and Spinach hosted Pumpkin caterpillar. Tomato hosted whitefly.

The pests identified belong to 3 insect orders and class Gastropoda. They are:

Order: Hemiptera

The 4 hemipteran insect pests identified were Mealybug, Whitefly, Aphid and Pod sucking bug.

- Mealybug is the common name of insects belonging Pseudococcidae, a family constituting unarmored scale insects. They are small, soft-bodied, sap sucking insects. They were seen clustered together on the leaves, stems and fruits of Lady's-finger, Brinjal and Cow pea. Mode of attack is by feeding on the sap resulting in stunted growth. Excretion of honey dew causes formation of black sooty molds on leaves.
- *Bemisia tabaci* commonly called Whitefly is included in the Aleyrodidae family. They are tiny moths with pale yellow bodies and four white wings. Whitefly is one of the major insect pests of solanaceous crops (Tomato, Chili, Brinjal), which damage the crop by direct sucking of phloem juice and transmitting a number of viral diseases. Since they are present on the lower side of leaves, it's difficult to notice them. When the plants are disturbed cloud of whiteflies take flight. They also produce honey dew causing formation of sooty molds.

- Aphids belong to the family Aphididae. Green and yellow aphids (*Aphis gossypii*) were found on the leaves (lower side) on Brinjal which resulted in curling of the leaves and ants were seen associated with them. Cow pea aphids also called *Aphis craccivora* were dark brown to black in colour. Clusters of them were present on the leaves, stems, flowers and fruits feeding on the plant sap.
- The Pod sucking bug or *Riptortus pedestris* belongs to the family Alydidae. These bugs were seen perched on the pea pods and fed on the sap causing the pods to shrivel. They also produced an offensive smell.

Order: Lepidoptera

The 3 lepidopteran insect pests identified were Leaf roller, Hibiscus caterpillar and Pumpkin caterpillar.

- *Eublemma olivaceae* commonly called as Brinjal leaf roller belongs to the family Noctuidae. Only the larval stage of the moth caused damage to the plant. The female moths laid eggs on the leaves, preferably younger. The larva then folded the leaves longitudinally and fed on it. The leaves became brown, withered and dry, in severe cases infestation spread to the entire plant. The larva is purple brown in colour with long hairs on yellow- or cream-coloured tubercles on the dorsal and lateral sides of the body.
- *Diaphania indica* or Pumpkin caterpillar belongs to Crambidae family and were found on Bitter gourd, Ivy gourd and Spinach. The young larva is green in colour and it scrapes the chlorophyll content of the leaves. Later on, it folds and webs the leaves. They also attack the fruits causing it to rot.
- The Hibiscus caterpillar (*Xanthodes transversa*) belonging to the family Nolidae is a pest on Lady's-finger and it feeds on the leaves. The caterpillar has a green hairy body with 2 rows of black spots and a red spot on one end.

Order: Coleoptera

Only 1 coleopteran insect pest was identified during the course of the present study.

- Hadda beetle or *Henosepilachna vigintioctopunctata* are a species of lady beetle in the Coccinellidae family. Infestations were seen on brinjal and bitter gourd. They feed on the chlorophyll content of the leaves resulting in skeletonized brown leaves. Premature falling of leaves was also noted. The Hadda beetle had 4 different life stages: elongated cigar shaped yellow eggs; grubs were yellowish with 6 rows of long spines; yellowish pupa and adults were yellow to copper brown mottled with black spots.

Phylum: Mollusca

- Snails were the only non-insect pest identified in the present study. They are Molluscans belonging to class Gastropoda. Brinjal and Chili were susceptible to snails. They use a rasping action to chew on the plant leaves. Feeding time is from late evening till early morning. During daytime they hide under the growbags and come out in the evening. They can be identified by the slimy trails left behind on the leaves.

DISCUSSION

Pests on Brinjal

The 6 pests found on Brinjal were Leaf roller, Hadda beetle, Whitefly, Mealybugs, Aphid and Snails.

In the present study, *Eublemma olivaceae* (leaf roller) was observed from August to December. The occurrence of this pest was also reported from various parts of India like Jharkhand, (Ajita et al., 2019) and West Bengal. (Nithar (2019). In Jharkhand it was recorded from mid-July to November.

Leaf roller was found only on the Brinjal plants cultivated on the roof top. A total absence of their population was witnessed in the Brinjal plants of the backyard. It may be due to the fire ant colonies present in the backyards which inhibited the multiplication of the Leaf rollers as fire ants liked to feed on small and honeydew secreting pests.

The second pest of Brinjal, *Henosepilachna vigintioctopunctata* (Hadda beetle) was observed in August and September during the present study. Elanchezhyan et al., (2008) and Ajita et al., (2019) also reported Hadda beetle as a pest of Brinjal in Madurai and during Kharif season in Jharkhand respectively.

Another pest on brinjal observed in the study was *Bemisia tabaci* (whitefly). It was also reported from Bangladesh by Gopal et al., (2014) and Jharkhand by Ajita et al., (2019). As whitefly favoured warm and moist weather it was reported from last week of July to mid-December in Jharkhand.

Mealybugs were seen on Brinjal for a brief time during the present study. Nithar (2019) recorded Mealybugs as a minor pest on Brinjal in West Bengal while Chandramani et al., (2019) reported Brinjal as a host plant with high level of Mealybug infestation.

Aphis gossypii (Aphids) was another important pest on Brinjal in the present study. Aphids were also reported from other places in India like West Bengal by Nithar (2019) and Jharkhand by Ajita et al., (2019).

Slugs and Snails fed on the leaves and were active at night. Pradeep (2020) reported snails and slugs as a pest of many vegetables including Solanaceous crops based on a study conducted in Uttar Pradesh.

Pests on Pea

Among the 3 pests that attacked Cow pea, Aphids and Pod sucking bugs were major pests and Mealybugs were minor. Krishna et al., (2005) reported Pod sucking bug as a serious pest of Cowpea in Andhra Pradesh. In Gujarat a severe damage by *Aphis craccivora* (Cow pea aphid) was documented, Ruchika et al., (2012). A minor attack of Mealybugs was noted on Cow pea by Chandramani et al., (2019) in Chhattisgarh.

Pests on Lady's-finger

From the 2 pests that attacked Lady's finger during the present study, caterpillar of *Xanthodes transversa* (Hibiscus caterpillar) was observed during June and July months. Sorapong (2013) reported the incidence of Hibiscus caterpillar from June to October months in Thailand.

The second pest of Lady's-finger, Mealy bugs were observed as a minor infestation. Lady's-finger was documented as a common host of Mealybugs in Chhattisgarh, Chandramani et al., (2019).

Pest on Bitter Gourd

All the 2 pests, Hadda beetle and Pumpkin caterpillar observed on Bitter gourd in the present study were major pests and caused severe loss. Anoorag et al., (2013) and Vishav et al., (2013) recorded Hadda beetle as serious pest on Bitter gourd from eastern Uttar Pradesh and Jammu respectively.

Neena (2011) reported Pumpkin caterpillar (*Diaphania indica*) as a destructive pest on Bitter gourd in survey was conducted in Thiruvananthapuram. The occurrence of the pest was noted during active vegetative, flowering and fruiting stage.

Pest on Chilli

Whitefly and Snails were the 2 pests observed on Chilli in the current study. Tufail et al., (2019) reported whitefly as a major pest of Chili in Africa. Snails and slugs fed on the leaves of Chili during the rainy season. Pradeep (2020) recorded Snails as a pest of Chili in a study conducted in Uttar Pradesh.

Pests on Tomato

In the present study, high infestation of Whitefly (*Bemisia tabaci*) was seen on Tomato. Tufail et al., (2019) and Sunil (2020) reported Whitefly as a serious pest of Tomato in Africa and West Bengal respectively. Both the studies documented the side-by-side occurrence of yellow leaf curl virus transmitted by the Whitefly.

Pest on Ivy Gourd

Major infestation of Pumpkin caterpillar was seen during the flowering and fruiting stages of Ivy gourd in the current study. During vegetative and flowering stages low level infestation and high infestation during fruiting stages was documented by Neena (2011) in Thiruvananthapuram.

Pest on Spinach

In the current study, attack of Pumpkin caterpillar was seen in green Spinach (*Amaranthus dubius*) in which the caterpillar fed on the leaves. In a survey conducted in Thiruvananthapuram Neena (2011) also reported green Spinach as a host of Pumpkin caterpillar.

CONCLUSION

In the present study, 9 pests identified from the vegetables of kitchen garden include Mealybugs, Whitefly, Pumpkin caterpillar, Aphids, Hadda beetle, Hibiscus caterpillar, Leaf roller and Snails and slugs. Brinjal hosted the highest number of pests (6) followed by Cow pea (3). Mealybugs, Whitefly and Pumpkin caterpillar attacked 3 types of vegetable plants each. Leaf roller, Pod sucking bug and Hibiscus caterpillar attacked only a single host each.

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STUDY ON BUTTERFLY DIVERSITY



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Fulfillment of requirement for the degree of Bachelor of Science

In Zoology

2019-2022

STUDY ON BUTTERFLY DIVERSITY

CERTIFICATE

This is to certify that the project report entitled “**STUDY ON BUTTERFLY DIVERSITY**” submitted by **Ms. Lakshmi L**, Reg. No. **AB19ZOO012** in partial fulfillment of the requirements of Bachelor of Science degree of Mahatma Gandhi University, Kottayam, is a bonafide work done under the guidance and supervision of Dr. Meera Jan Abraham and this is her original effort.

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EXAMINERS

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DECLARATION

I, hereby declare that this project work entitled “STUDY ON BUTTERFLY DIVERSITY” is submitted to St.Teresa’s College (Autonomous), Ernakulam affiliated to Mahatma Gandhi University, Kottayam in partial fulfillment of the requirements of Bachelor of Science degree in Zoology. This work has not been undertaken or submitted elsewhere in connection with any other academic course and the opinions furnished in the report is entirely my own.

Name:

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The success and final outcome of this project required a lot of guidance and assistance from many people and I am extremely privileged to have got this all along the completion of my project. All that I have done is only due to such supervision and assistance and I would not forget to thank them.

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Last but not least I would like to thank God Almighty for the successful completion of my project.

Name of student

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ABSTRACT

A survey was conducted on the month of January and February 2022 to study butterfly diversity in two different regions in Ernakulam district. Around 200 species of butterflies were recorded by line transect method from two different places like Hill palace and Subhash Park, Ernakulam district, Kerala. Hill palace, the least polluted compared to Subhash park shows the maximum abundance($n=80$) which include Nymphalidae, Papilionidae, Pieridae and Riodinidae; Subhash park ($n=40$) includes Pieridae, Papilionidae, Nymphalidae and Riodinidae, has less abundance. Bio diversity indices like Shannon diversity, Margalef's index were calculated. . The butterflies caught were identified up to the family level with the help of Google lens, IUCN, iNaturalist app. The observed butterflies belongs to Nymphalidae, Pieridae, Riodinidae and Papilionidae families. The diversity and species richness was calculated from the collected data. The present study reflects the richness and diversity of butterflies in two different localities. Abundance may vary in different sites due to the presence of large amount of nectar producing plants and suitable conditions for their growth. Our findings are important with respect to monitoring butterfly and plant diversity and defining conservation strategies.

INTRODUCTION

Lepidoptera is occupying a major part in the global biodiversity and are the second largest order in the class Insecta. Lepidoptera regarded as one of the important components of biodiversity and are the second largest order among insects, approximately 1,50,000 species are so far known to the literature. Butterflies are winged insects, they are the important natural resources which provide economic and ecological benefits. Butterflies are good environmental indicators and pollinators of plants. Butterflies are broadly considered as potent ecological indicators and are sensitive to the temperature, humidity, light levels and also to the habitat disturbance. Butterflies occupy different environmental conditions in the ecosystem. Due to the harmful gases and chemicals liberated by the industries, affects the life of butterflies. Radiation from various resources also affects butterflies in the ecosystem. Very little documentation has been done on butterfly fauna in Kerala. The main causes for the decline of butterfly populations are deforestation, habitat destruction for urbanization, industrialization and agriculture causes changes in temperature, humidity and rainfall. Prevalence of unfavorable weather conditions often affect habitat suitability leading to local extinction of butterflies. Unfortunately, developmental activities and resulting habitat fragmentation create threats to the survival of butterflies worldwide. The present study mainly concentrates on butterfly abundance, habitat preference like gardens, grasslands, shrubs Ornamental plants such as bougainvillea and roses were observed in Hill palace. The migration of pollens induces genetic variation in plants species and give a better chance at survival against different disease. These insects also provide food for other organisms such as birds, reptiles, amphibians, also acts as biological pest control. Butterflies are of economic importance in nature. They are the second largest pollinators of world after bees. But the population of these insects decline rapidly due to human activities, habitat destruction, uses of pesticides and unawareness of people about the importance of butterflies. When those get reduced, the pollination also gets decreased. As a result, in future people will starve for food. Some species of butterfly help to reduce the air pollution like Monarch butterflies. These species decrease the carbon dioxide in the air. When those species get destroyed, the amount of CO₂ in the air increases. Today butterflies are facing threat due to change in climate and pollution. Butterflies are the primary consumers of food chain. So, reduction in their number will ultimately affect the other living organisms depending upon them. Human activities destroy the butterfly habitat. Global climate fluctuation also affects the butterfly habitat. Governmental policy on forestry, farming and road planning has great effect on the abundance and distribution of butterfly. So, as a Zoology student, it's our duty to study about them and to find various problems in their survival.

AIMS AND OBJECTIVE

- To study butterfly fauna in 2 different sites- Subhash park and Hill palace.
- Observation and identification of butterflies.
- To study morphological features of butterfly, their behavior and habit.
- To study different families, scientific names of butterflies.
- Importance of butterfly and their contribution to environment.
- Role of butterfly in nature and current diversity in 2 different sites.
- To study the population of butterfly families.
- To study species diversity, species richness and to know about the relative dominance of each species of butterfly.

REVIEW OF LITERATURE

Very little documentation has been done on butterfly fauna in Kerala. Some of the earlier documentation on butterfly fauna from Kerala and adjacent areas include (Mathew & Rahamathulla, 1993), who had reported 100 species of butterflies from Silent Valley National Park, (Sudheendrakumar et al., 2000), who reported 124 species of butterflies from Parambikulam Wildlife Sanctuary, (Arun, 2003), reported 75 species from Siruvani Reserved Forests (Ambrose & Raj, 2005) reported 24 species from Kalakkad-Mundanthurai Tiger reserve, (Eswaran & Pramod, 2005) reported 75 species from Anaikatty near Coimbatore, (Prasad et al., 2010) recorded 52 species from Kerala University campus, Thiruvananthapuram, while (Toms et al., 2010) reported 109 species from Mahatma Gandhi University campus, Kottayam. In the present study, an attempt has been made to document about butterfly fauna in Suvarnodhyanam biological park, Subhash park and Hill palace. Survey was conducted to know about the importance of butterfly and their contribution to environment, reasons for the reduction in number of butterflies and after effects.

In popular esteem the butterflies among the insects are the most attractive and beautiful members. They are primarily day fliers and are remarkable for the delicacy and beauty of their membranous wings, covered with myriads of tiny scales that overlap one another like the shingles on a house and show an infinite variety of hue through the coloring of the scales and arrangement upon the translucent membrane running between the wing veins. It is this characteristic structure of the wings that gives to the great order of butterflies and moths its name Lepidoptera, meaning scale-winged (Moore & Weed, 1923). Butterflies, because of their beauty and mystique, are our most visible insects. Their images appear in clothing, jewellery, advertisements, magazines, movies, books, literature and on television. In warm seasons, living butterflies attract our attention as they sip nectar from flowers, lazily fly by, or spiral together upward in the air. Entire museums and conservatories are devoted to helping us learn about their life pattern. Great museum collections house millions of butterfly specimens from all over the world, striving to record their diversity in an ever-shrinking natural landscape. Butterflies are familiar, fascinating, and admired, but few people really know them well. (Klass et al., 1992). These colorful insects frequent open, sunny wildflower gardens grasses and orchards, feeding on nectar from flowering plants. Butterflies are common throughout the world. Although they symbolize different things to different cultures, universally butterflies represent change and transformation. Some butterflies are mysterious, appearing always to be rare in the sense of being found singly at long intervals of time and space. (Austin, 2000)

Scales provide a number of functions, which include insulation, thermoregulation and aiding gliding flight, amongst others, the most important of which is the large diversity of vivid or indistinct patterns they provide which help the organism protect itself by camouflage, mimicry and to seek mates. Some of the commonly found species of butterflies in Kerala includes:

Common Pierrot- *Castalius rosimon* , Blue Mormon- *Papilio polymnestor* , Grey Pansy- *Junonia atlites*, Psyche- *Leptosia nina* ,Common Mime *Papilio clytia* ,The Blue Tiger- *Tirumala limniace* ,Common Mormon- *Papilio polytes* ,Red Pierrot- *Talicerca nyseus*

,Banded Blue Pierrot- *Discolampa ethion* ,Oriental Plains Cupid- *Chilades pandava*,Common Sailor- *Neptis hylas* ,Tailed Jay- *Graphium Agamemnon*, The Grass Demon- *Udaspes folus* ,Chestnut Bob Butterfly- *Lambrix salsala* ,The Water Snow Flat- *Tagiades litigiosa* , Indian lime blue- *Chilades lajus* . (David ,2017)

As well as being an indicator of climate change, butterflies are also sensitive to other threats such as habitat destruction. Changes in the behavior of butterflies can warn people of the future effects of habitat loss on other animals. Diversity of butterflies increases with increasing of habitat scale and vegetation structure complex. This shows that a forest habitat with more forest canopy layers and high vegetation diversity supports more insect species than a forest habitat with less forest canopy layers and less vegetation diversity.

The diversity of butterfly communities has been studied in different habitat types in different parts of the world including tropical forest of Southeast Asia. However, there have not been many studies on the diversity of butterfly communities in tropical forests within different habitat types including stream sides in the forest. Stream side habitats in the forest may play an important role in conserving a portion of tropical biodiversity, of which insects are a major part, but little data is available. The forest edge which has more exposure to the open also has the greatest diversity of butterflies.

The gaps in the forest have higher diversity of butterflies than the closed forest areas. The stream sides with more open space should therefore have a high diversity of butterflies. According to the scientists, there are estimated 28,000 species of butterflies throughout the world. The diversity of butterflies may occur some changes depending on the climate, whether it is changing or constant. According to some biologist butterfly are diversified all throughout the world, even above the Arctic Circle, but they do not occur on Antarctica. In the diversity of the butterflies, the demographic and socioeconomic may affect it. Insect diversity is highest in habitats with the most plant diversity and is lowest in shrub, grass and open areas. The human development and the resultant habitat fragmentation can be sufficient to cause the extinction of butterfly species. As well as being an indicator of climate change, butterflies are also sensitive to other threats such as habitat destruction. Changes in the behavior of butterflies can warn people of the future effects of habitat loss on other animals. As many species, of butterflies are highly specialized, individual species can be of particular benefit to science.

Scientists use the presence or absence of butterflies as a predictor of whether an ecosystem is healthy. Adult and larval forms are sensitive to pesticides. Changes in climate will impact butterflies because temperature changes and rainfall amounts may alter migration patterns and timing.

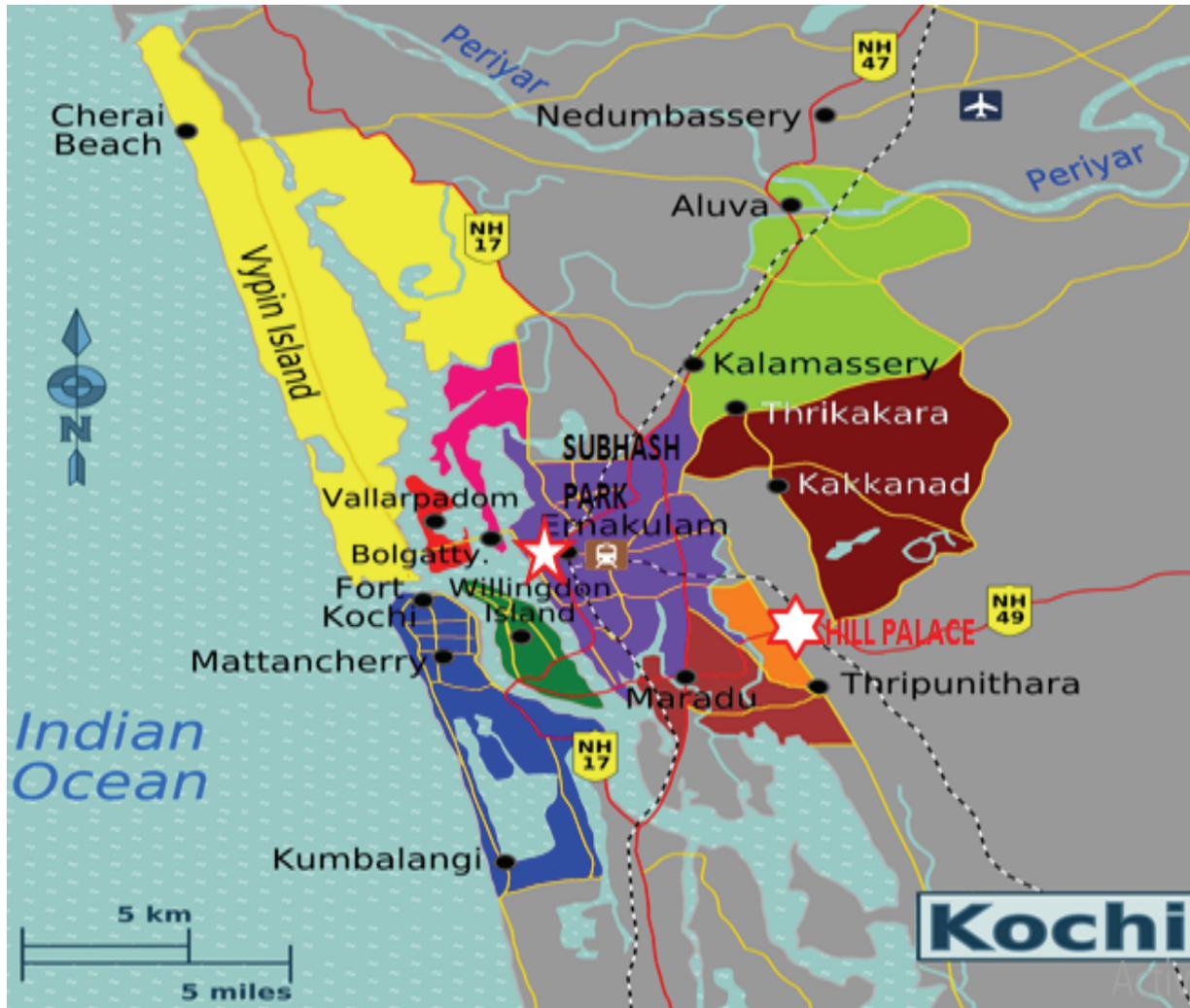
Loss or fragmentation of habitat - for example, losing chunks of cover as a result of construction or defoliation - increases predation and also affects migration. Ecologists study butterfly behavior, population numbers and migration patterns to help determine the impact of these environmental issues.

Western butterfly populations are declining at an estimated rate of 1.6% per year, according to a new report. The report looks at more than 450 butterfly species, including the western monarch, whose latest population count revealed a 99.9% decline since the 1980s. (Forister et al.,2021)

METHODOLOGY

The first step of our study was to identify the sites for study and we selected the following sites:

HILL PALACE, SUBHASH PARK



STUDY AREA

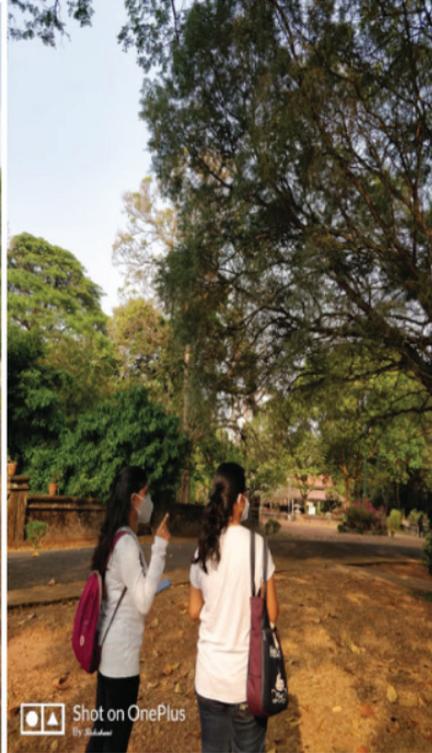
1. SUBHASH PARK (URBAN)

Subhash Park is a beautiful park located next to the boat jetty and opposite to Maharaja's College in the heart of Ernakulam. It's a public park which is maintained by the Corporation of Cochin and overlooks the Vembanad Lakes, backwaters and Cochin harbor. While stepping inside you will find a Breezy, Lakefront park featuring lush lawns, a children's playground & benches with water views. Recently, plants on which butterfly feeds are being planted to create a butterfly garden along with a nature interpretation centre to support the theme 'urban biodiversity'.



2.HILL PALACE MUSEUM

Located about 10 km from Kochi, the Hill Palace Museum was the official residence of the erstwhile rulers of Kochi. Built in 1865, it is now famous for being a full-fledged Ethno-Archaeological Museum and Kerala's first ever Heritage Museum. The palace complex itself comprises 49 buildings. It has over 52 acres of terraced land around it. The place is surrounded by many trees and herbs which adds greenery & hence many butterfly species wander around.



COLLECTION METHODS

The present study was carried out in Subhash park on 29th January and in Hill palace on 3rd February (evening 3.00-6.00 p.m). Ernakulam district, Kerala. The survey of butterflies was undertaken by line transect method. The butterflies were recorded using standard transect counting method, counted while walking along the selected transect route of 1 km, in each habitat. The nomenclature used in the check list of Butterflies in IUCN (2020) was followed. All the transects surveyed were segments of existing garden, shrubs and herbs, grassland and small pond areas. Typical and unique features of the wings, abdomen and pattern of coloration of all body parts were noted down.

Sketches were made accordingly using pencils and marked the pattern of color patches and print distribution. Butterflies were photographed from different angles as often as possible to obtain sufficient photographs to enable positive identification of species. Photographs were taken with an i phone, One plus 5 and Samsung galaxy A12. All the butterflies observed were recorded and identification of butterflies was done on the site itself and was confirmed with the help of Google lens and IUCN(2020) .Some rare and small butterflies which are difficult to identify were caught by using insect net (Nylon net with long handle was used for sweeping free flying butterflies) and closely observed. Then they were released to the same habitat from where they were caught.

Descriptions, photographs and drawings were compared with literature and the species were identified based on the collected data and available reference, both printed and electronic. Species identity was confirmed with the help of Google lens and IUCN.

The materials used for collection were

- hand gloves
- white cloth
- net/mesh.

Two of the simplest method is by aerial netting and handpicking. An aerial net is used to collect organism on the top of flower heads and other vegetations. It tends to catch aerial insects lots of flies particularly you font really hit the vegetation. You just very quickly sweep over it and butterfly feeding or resting on the vegetation will fly up into the net. You need to flick it.



Identification

Identification is based on morphological features of butterflies .

Data analysis

Abundance

- **Species diversity calculation**

The index used for diversity calculation is Shannon- Wiener diversity index.

Diversity index = $H = - \sum [(P_i) \ln(P_i)]$

Where, H= Shannon index, is used to characteristic species diversity and abundance in a community.

P_i = the proportion of individuals in the sample belonging to i th species.

$P_i = S/N$

S is number of individuals of one species

N is the total number of all individuals in the sample

\ln = natural logarithm

Shannon - Wiener diversity index

Shannon - Wiener diversity index showed that the total butterfly diversity.

Shannon diversity index's range of values is usually **1.5 - 3.5**. The species diversity of the three different habitats ranged from 1.898 to 2.183. The maximum diversity was reported in Hill palace and minimum diversity was found in Subhash park

- **Species richness calculation**

The index used for richness calculation is Margalef's index.

Margalef's index = $(S-1)/\ln N$

S is the total number of species

N is the total number of individuals in the sample

\ln is the natural logarithm

Measurement of Diversity

Relative dominance index of the species was calculated by the formula,

Relative Dominance (%)

=Number of individuals of one species(n)/ x100

Number of individuals of all species(N)

RESULT

From the collected specimens, identification was done using proper identification techniques. The results are given in table 1 to table 10 and figure 1 to figure 4.

TABLE 1: NUMBER OF BUTTERFLIES IN HILL PALACE

SPECIES	SCIENTIFIC NAME	FAMILIES	NO:OF BUTTERFLIES
Common crow	<i>Euploea core</i>	Nymphalidae	8
Glassy tiger	<i>Parantica aglea</i>	Nymphalidae	15
Lemon emigrant	<i>Catopsilia pomona</i>	Pierida	5
Indian jezebel	<i>Delias eucharis</i>	Pieridae	5
Common jay	<i>Graphium doson</i>	Papilionidae	4
Black swallow tail	<i>Papilio poiynenes</i>	Papilionidae	7
Common rose	<i>Pachliopta aristolochiae</i>	Papilionidae	5
Common albatross	<i>Appias albina</i>	Pieridae	17
Common baron	<i>Euthalia aconthea</i>	Nymphalidae	6
Plum judy	<i>Abisara echerius</i>	Riodinidae	8

TABLE 2: HOST PLANTS IN HILL PALACE

SL NO.	SPECIES	HOST PLANTS	NO:OF BUTTERFLIES
1	<i>Euploea core</i>	Hibiscus rosasinesis, <i>Nerium oleander</i> , apocynacea	8
2	<i>Parantica aglea</i>	Napier grass	15
3	<i>Catopsilia Pomona</i>	Grass, Mimosa pudica	5
4	<i>Delias eucharis</i>	<i>Mangifera indica</i> (Mango) Bougainvillea, Lantana	5
5	<i>Graphium doson</i>	Ferns	4
6	<i>Papilio poiynenes</i>	Ixora red plant	7
7	<i>Pachliopta aristolochiae</i>	Hibiscus	5
8	<i>Appias albino</i>	Grass, Tridax procumbens	17
9	<i>Euthalia aconthea</i>	Mango tree, Hibiscus rosasinesis	6
10	<i>Abisara echerius</i>	Hibiscus rosasinesis	8

TABLE 3: SPECIES DIVERSITY IN HILL PALACE

SPECIES	NO:OF BUTTERFLIES(S)	PROPORTION $p_i = S/N$	$\ln(p_i)$	$P_i \ln(p_i)$
<i>Euploea core</i>	8	0.1	2.303	0.230
<i>Parantica aglea</i>	15	0.188	1.671	0.314
<i>Catopsilia Pomona</i>	5	0.063	2.765	0.174
<i>Delias eucharis</i>	5	0.063	2.765	0.174
<i>Graphium doson</i>	4	0.05	2.996	0.150
<i>Papilio poiynenes</i>	7	0.088	2.430	0.214
<i>Pachliopta aristolochiae</i>	5	0.063	2.765	0.174
<i>Appias albino</i>	17	0.213	1.546	0.329
<i>Euthalia aconthea</i>	6	0.075	2.590	0.194
<i>Abisara echerius</i>	8	0.1	2.303	0.230

Shannon-Wiener diversity index $H = -\sum[(P_i) \ln(P_i)]$

Where $P_i = S/N$

N=80

H=2.183

TABLE 4: SPECIES RICHNESS IN HILL PALACE

SPECIES	N	SPECIES RICHNESS
<i>Euploea core</i>	8	37.991
<i>Parantica aglea</i>	15	29.172
<i>Catopsilia Pomona</i>	5	49.085
<i>Delias eucharis</i>	5	49.085
<i>Graphium doson</i>	4	56.986
<i>Papilio poiynenes</i>	7	40.598
<i>Pachliopta aristolochiae</i>	5	49.085
<i>Appias albino</i>	17	27.884
<i>Euthalia aconthea</i>	6	44.091
<i>Abisara echerius</i>	8	37.991

TABLE 5: RELATIVE DOMINANCE IN HILL PALACE

SPECIES	n	RELATIVE DOMINANCE n/N X100
<i>Euploea core</i>	8	10
<i>Parantica aglea</i>	15	18.75
<i>Catopsilia Pomona</i>	5	6.25
<i>Delias eucharis</i>	5	6.25
<i>Graphium doson</i>	4	5
<i>Papilio poiyyenes</i>	7	8.75
<i>Pachliopta aristolochiae</i>	5	6.25
<i>Appias albino</i>	17	21.25
<i>Euthalia aconthea</i>	6	7.5
<i>Abisara echerius</i>	8	10

N=80

DETAILS OF BUTTERFLIES OBSERVED IN HILL PALACE

COMMON CROW(CRAMER)

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Lepidoptera
Family	Nymphalidae
Genus	<i>Euploea</i>
Species	<i>Core</i>
Scientific name	<i>Euploea core</i>



MORPHOLOGY

- The common crow, is a common butterfly found in South Asia to Australia.
- In India it is also sometimes refers to as the common Indian crow, and in Australia as the Australian crow.
- Common crow is a glossy black butterfly with brown underside with white marks along the outer margins of the wing. The wingspan is about 8-9 cm and the body also has prominent white spots.
- This butterfly also gathers of damaged parts of plants such as crotalaria, heliotropism to forage for chemicals precursors to produce pheromones. (Muller & Tennet,1905)

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side of wings black, with rows of sub marginal and marginal white spots on both wings and forewing with a short brand in male.
- Upper side of wings black or glossy brown; fore wing 'with a sub marginal and a marginal row of white spots, posterior towards inner margin spots larger than the anterior ones

➤ **HABITS**

The butterfly is slow flying. It may be seen sailing lazily along in all types of regions or flying about shrubs and bushes for its foodstuff.

➤ **PLANTS**

- *Hibiscus rosasinesis*
- *Nerium oleander*
- *Holarrhena antidysenterica*
- *Ficus benghalensis* (Banyan)
- Apocynacea

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

GLASSY TIGER

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Nymphalidae
Genus:	<i>Parantica</i>
Species:	<i>P. aglea</i>
Scientific name	<i>Parantica aglea</i>



MORPHOLOGY

Common name: Glassy tiger

Diagnostic characters:

- Ground colour fuliginous black with subhyaline bluish-white streaks and spots
- Antennae black; head and thorax black spotted with white; abdomen blackish brown

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side: forewing—interspace 1 with two comparatively long
- Broad streaks united at base, truncate exteriorly; cell with a very broad
- Basal spots in interspaces 2 and 3
- An irregular discal series of three spots and two elongate streaks and a sub terminal series of spots
- The two series curved inwards opposite apex of wing, the latter continued along the apical half of the costa.
- Finally a terminal row in pairs in the interspaces, of much smaller spots.

➤ **HABITS**

- This is a moderately fast, casual flier which feeds on flowers of herbs and scrubs.
- Males extrude yellow colored hair pencils from the back of their abdomen to attract females.
- It is a migratory species.

➤ **PLANTS**

- Napier grass

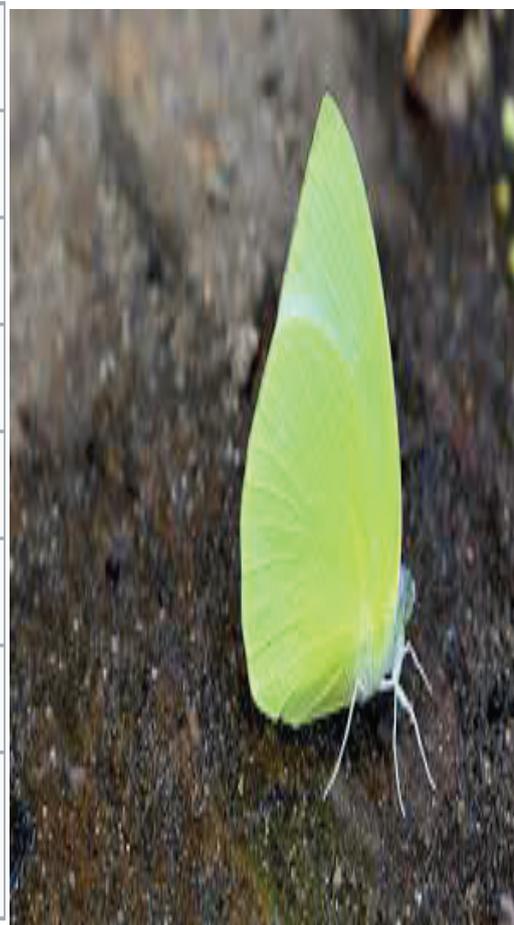
➤ **STATUS**

- Common

(Varshney et al., 2015)

LEMON EMIGRANT

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Catopsilia</i>
Species:	<i>C. pomona</i>
Scientific name	<i>Catopsilia pomona</i>



MORPHOLOGY

Common name: Common emigrant

Diagnostic characters: Upperside of wings with ground colour white and proximal areas yellow; fore wing black at apex and with a marginal narrow border macular.

➤ **MORPHOLOGICAL CHARACTERS**

- Male- upper side of both wings with ground color white and the proximal areas yellow; fore wing with costal margin black at apex
- Outer marginal narrow border
- Female- like male but upper side sulphur yellow to white
- Fore wing with costa only black for about the apical third or less
- Outer marginal black border much narrow

➤ **HABITS**

- Its flight is powerful and rapid and it proceeds in a series of upward and downward curves.
- It is fond of settling on flowers and it is found in large numbers in gardens in plains during and after rains.

➤ **PLANTS**

- Grass
- *Mimosa pudica*

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

INDIAN JEZEBEL

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Delias</i>
Species:	<i>D. eucharis</i>
Scientific name	<i>Delias eucharis</i>



MORPHOLOGY

Common name: Common Jezebel

Diagnostic character: Upperside white with black veins and hind wing underside yellow with red border

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side white both for and hind wings with a black outer discal band fore wing with black veins
- Sub marginal row of seven white spots the latter
- Underside of fore wing white and all the veins heavily marked
- Hind wing yellow with black veins and black border bearing a sub marginal row of six large red spots, each spot edged with a dusting of dull white and having a shape of a square.

➤ **HABITS**

- It is an ornament among the butterflies occurring in India
- The male emits very strong scent which is like that of sweet briar.
- They drink at moist patches on roads and in river beds in the hot weather.

➤ **PLANTS**

- *Mangifera indica* (Mango)
- Bougainvillea
- Lantana

➤ **STATUS**

- common

(Gupta & Mridula, 2012)

COMMON JAY

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Graphium</i>
Species:	<i>G. doson</i>
Scientific name:	<i>Graphium doson</i>



MORPHOLOGY

Common name: Common Jay

Diagnostic character: Pale blue semi-transparent central wing bands that are formed by large spots. There is a marginal series of smaller spots.

➤ **MORPHOLOGICAL CHARACTERS**

- Pale blue semi-transparent central wing bands that are formed by large spots.
- There is a marginal series of smaller spots.
- The underside of wings is brown with markings similar to upper side but whitish in color.
- The sexes look alike.

➤ **HABITS**

- Common jay is active throughout the day and constantly on the move; it rarely settles down.
- Its flight is swift and straight.
- When feeding from flowers, it never settles down and keeps its wings vibrating.

➤ **PLANTS**

- Ferns

➤ **STATUS**

- Common

(Moore,1905)

BLACK SWALLOW TAIL

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Papilio</i>
Species:	<i>P. polyxenes</i>
Scientific name:	<i>Papilio poiixenes</i>



MORPHOLOGY

Common name: Swallow tail

Diagnostic character: The members of this tribe all have tails on the hindwings, and therefore include species named swallowtail.

➤ **MORPHOLOGICAL CHARACTERS**

- The black swallowtail has a wingspan of 6.9–8.4 cm, and females are typically larger than males.
- The upper wing surface is black with two rows of yellow spots – these spots are large and bright in males and smaller and lighter in females.

➤ **HABITS**

- They are usually found in open areas like fields, parks, and they prefer tropical or temperature
- Exhibit sexual dimorphism
- Mimicry

➤ **PLANTS**

- Ixora plant (Red)

➤ **STATUS**

- Common

(Lederhouse et al.,1989)

COMMON ROSE(FABRICIUS)

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Pachliopta</i>
Species:	<i>Aristolochiae</i>
Scientific name	<i>Pachliopta aristolochiae</i>



MORPHOLOGY

- The Common Rose is black with grey shading between the veins on its wings.
- Its swallow-tailed hindwings (back wings) have large white patches and grayish-red crescent-shaped markings.
- Its underside is similar to its top side, but with striking red or pinkish spots. Its body is bright red.
- It is very common almost all over the plains of India, and is not threatened as a species. During and after the monsoon it is extremely abundant.

(Collins et al. ,1985)

➤ **MORPHOLOGICAL CHARACTERS**

- Mostly black and wings elongated, hind wing tailed and with elongate white spots around lower end of cell.
- Underside crimson and black.

➤ **HABITS**

- The flight of the butterfly, when not alarmed, is slow, direct and on the level.
- It visits flowers and groups sometimes in large companies.

➤ **PLANTS**

- *Hibiscus rosasinensis*

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

APPIAS ALBINA (COMMON ALBATROSS)

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Appias</i>
Species:	<i>albina</i>
Scientific name	<i>Appias albina</i>



MORPHOLOGY

Common name: Common Albatross.

Diagnostic characters:

- Upperside white.
- Fore wing with edge of basal black area slightly incurved and blackish apical and marginal markings narrow in male but broader in female.

➤ **MORPHOLOGICAL CHARACTERS**

- Male: Upper side white
- Fore wing with narrow black apical and marginal markings, basal black area with edge slightly incurved
- Hind wing with small spots at ends of veins.
- Underside of wings unmarked; fore wing with apical area and hind wing pale dull
- Female- like male but upper side of forewing with light basal black scaling

➤ **HABITS**

- It is a fast flier and is found in wooded regions. It frequently visits flowers.
- The males settle in large numbers on wet patches and damp roads but the females do not. Both sexes go to rest on the undersides of leaves during the heat of the day. It is migratory in habits.

➤ **PLANTS**

- Grass
- *Tridax procumbens*

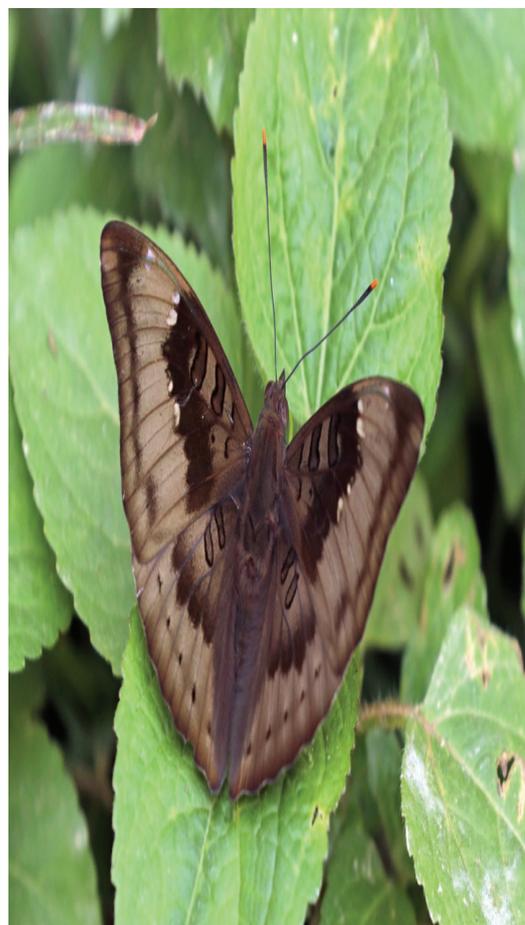
➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

COMMON BARON

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Nymphalidae
Genus:	Euthalia
Species:	E. aconthea
Scientific name	<i>Euthalia aconthea</i>



MORPHOLOGY

Common name: Common baron

Diagnostic Characters: It flies with stiff wing beats and often glides. The wing is not flapped very far below the horizontal.

➤ **MORPHOLOGICAL CHARACTERS**

- Brown with slight traces of olive.
- The forewing has two transverse short black lines at the base, a black loop across the middle, and another beyond the apex of the cell, with their centers dark brown.
- Antennae, head, thorax and abdomen dark brown

➤ **HABITS**

- This butterfly has a stiff flap glide style of flying.
- It flies at low heights and maintains a territory.

➤ **PLANTS**

- *Hibiscus rosasinesis*
- Mango tree

➤ **STATUS**

- common

(Varshney et al. ,2015)

PLUM JUDY

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Riodinidae
Genus:	<i>Abisara</i>
Species:	<i>A. echerius</i>
Scientific name	<i>Abisara echerius</i>



MORPHOLOGY

Common name: Plum judy

Diagnostic characters: Antennae black with scattered pale specks; head, thorax and abdomen maroon-brown; beneath, the palpi, thorax and abdomen paler brown

➤ **MORPHOLOGICAL CHARACTERS**

- Brown with slight traces of olive.
- The forewing has two transverse short black lines at the base, a black loop across the middle, and another beyond the apex of the cell, with their centers dark brown.
- Antennae, head, thorax and abdomen dark brown

➤ **HABITS**

- This active butterfly is usually seen at the tops of trees and amidst foliage.
- It has a habit of landing and turning around almost immediately after alighting.
- It repeats this turning movements as it moves along branches.

➤ **PLANT**

- *Hibiscus rosasinesis*

➤ **STATUS**

- Common

(Kunte, 2006)

TABLE 6: NUMBER OF BUTTERFLIES IN SUBHASH PARK

SPECIES	SCIENTIFIC NAME	FAMILIES	NO:OF BUTTERFLIES
Indian jezebel	<i>Delias eucharis</i>	Pieridae	8
Common albatross	<i>Appias albina</i>	Pieridae	8
Glassy tiger	<i>Parantica aglea</i>	Nymphalida	6
Common mormonn	<i>Papilio polytes</i>	Papilionidae	4
Southern birdwing	<i>Troides minos</i>	Papilionidae	3
Plum judy	<i>Abisara echerius</i>	Riodinidae	5
Common yellow grass	<i>Eurema hecabe</i>	Pieridae	6

TABLE 7: HOST PLANTS OF BUTTERFLIES IN SUBHASH PARK

SL NO.	SPECIES	HOST PLANTS	NO:OF BUTTERFLIES
1	<i>Delias eucharis</i>	Ixora ,Marigold	8
2	<i>Appias albina</i>	Victoria plant ,Grass, <i>Tridax procumbens</i>	8
3	<i>Parantica aglea</i>	<i>Hibiscus rosasinesis</i>	6
4	<i>Papilio polytes</i>	Globe amaranth, <i>Mangifera indica</i>	4
5	<i>Troides minos</i>	Hibiscus,Ixora	3
6	<i>Abisara echerius</i>	Grass	5
7	<i>Eurema hecabe</i>	<i>Tridax procumbens</i> ,lantana	6

TABLE 8: SPECIES DIVERSITY IN SUBHASH PARK

SPECIES	NO:OF BUTTERFLIES(S)	PROPORTION $p_i = S/N$	$\ln(p_i)$	$P_i \ln(p_i)$
<i>Delias eucharis</i>	8	0.2	1.609	0.322
<i>Appias albino</i>	8	0.2	1.609	0.322
<i>Parantica aglea</i>	6	0.15	1.897	0.285
<i>Papilio polytes</i>	4	0.1	2.303	0.230
<i>Troides minos</i>	3	0.075	2.590	0.194
<i>Abisara echerius</i>	5	0.125	2.079	0.260
<i>Eurema hecabe</i>	6	0.15	1.897	0.285

Shannon-Wiener diversity index $H = -\sum[(P_i) \ln(P_i)]$

Where $P_i = S/N$

N=40

H=1.898

TABLE 9: SPECIES RICHNESS IN SUBHASH PARK

SPECIES	N	SPECIES RICHNESS
<i>Delias eucharis</i>	8	18.755
<i>Appias albina</i>	8	18.755
<i>Parantica aglea</i>	6	21.766
<i>Papilio polytes</i>	4	28.133
<i>Troides minos</i>	3	35.499
<i>Abisara echerius</i>	5	24.232
<i>Eurema hecabe</i>	6	21.766

TABLE 10: RELATIVE DOMINANCE IN SUBHASH PARK

SPECIES	n	RELATIVE DOMINANCE n/N X100
<i>Delias eucharis</i>	8	20
<i>Appias albino</i>	8	20
<i>Parantica aglea</i>	6	15
<i>Papilio polytes</i>	4	10
<i>Troides minos</i>	3	7.5
<i>Abisara echerius</i>	5	12.5
<i>Eurema hecabe</i>	6	15

DETAILS OF BUTTERFLIES OBSERVED IN SUBHASH PARK

INDIAN JEZEBEL

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Delias</i>
Species:	<i>D. eucharis</i>
Scientific name	<i>Delias eucharis</i>



MORPHOLOGY

Common name: Common Jezebel

Diagnostic character: Upperside white with black veins and hind wing underside yellow with red border

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side white both fore and hind wings with a black outer discal band
fore wing with black veins
- Sub marginal row of seven white spots the latter
- Underside of forewing white and all the veins heavily marked
- Hind wing yellow with black veins and black border bearing a sub marginal row of six large red spots, each spot edged with a dusting of dull white and having a shape of a square.

➤ **HABITS**

- It is an ornament among the butterflies occurring in India
- The male emits very strong scent which is like that of sweet briar.
- They drink at moist patches on roads and in river beds in the hot weather.

➤ **PLANTS**

- Ixora
- Marigold

➤ **STATUS**

- common

(Gupta & Mridula, 2012)

APPIAS ALBINA (COMMON ALBATROSS)

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Appias</i>
Species:	<i>albina</i>
Scientific name	<i>Appias albina</i>



MORPHOLOGY

Common name: Common Albatross.

Diagnostic characters:

- Upperside white.
- Fore wing with edge of basal black area slightly incurved and blackish apical and marginal markings narrow in male but broader in female.

➤ **MORPHOLOGICAL CHARACTERS**

- Male: Upper side white
- Fore wing with narrow black apical and marginal markings, basal black area with edge slightly incurved
- Hind wing with small spots at ends of veins.
- Underside of wings unmarked; fore wing with apical area and hind wing pale dull
- Female- like male but upper side of forewing with light basal black scaling

➤ **HABITS**

- It is a fast flier and is found in wooded regions. It frequently visits flowers.
- The males settle in large numbers on wet patches and damp roads but the females do not. Both sexes go to rest on the undersides of leaves during the heat of the day. It is migratory in habits.

➤ **PLANTS**

- Victoria plant
- *Tridax procumbens*
- Grass

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

GLASSY TIGER

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Nymphalidae
Genus:	<i>Parantica</i>
Species:	<i>P. aglea</i>
Scientific name	<i>Parantica aglea</i>



MORPHOLOGY

Common name: Glassy tiger

Diagnostic characters:

- Ground colour fuliginous black with subhyaline bluish-white streaks and spots
- Antennae black; head and thorax black spotted with white; abdomen blackish brown

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side: forewing—interspace 1 with two comparatively long
- Broad streaks united at base, truncate exteriorly; cell with a very broad
- Basal spots in interspaces 2 and 3
- An irregular discal series of three spots and two elongate streaks and a sub terminal series of spots
- The two series curved inwards opposite apex of wing, the latter continued along the apical half of the costa.
- Finally a terminal row in pairs in the interspaces, of much smaller spots.

➤ **HABITS**

- This is a moderately fast, casual flier which feeds on flowers of herbs and scrubs.
- Males extrude yellow colored hair pencils from the back of their abdomen to attract females.
- It is a migratory species.

➤ **PLANTS**

- Napier grass

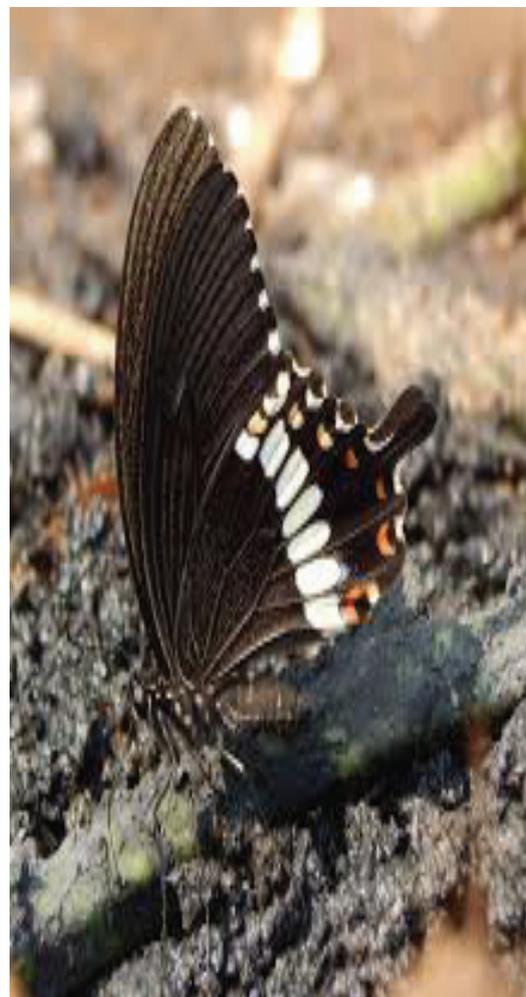
➤ **STATUS**

- Common

(Varshney et al.,2015)

COMMON MORMON

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Papilio</i>
Species:	<i>P. polytes</i>
Scientific name	<i>Papilio polytes</i>



MORPHOLOGY

Common name: Common mormon

Diagnostic characters: Tailed, Upperside black, fore wing with a marginal row of white spots, the latter decreasing in size apically and hind wing with a discal series of elongate white spots.

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side black
- Forewing with prominent marginal white spots, the latter decreasing in size towards apex
- Underside dull black
- fore wing with prominent streaks in cell and between veins
- Hind wing with series of white spots

➤ **HABIT**

- This species shows sexual dimorphism, and polymorphism in female.
- It seldom rises far from the ground. It prefers the shelter of bushes

➤ **PLANTS**

- Globe amaranth
- *Mangifera indica*

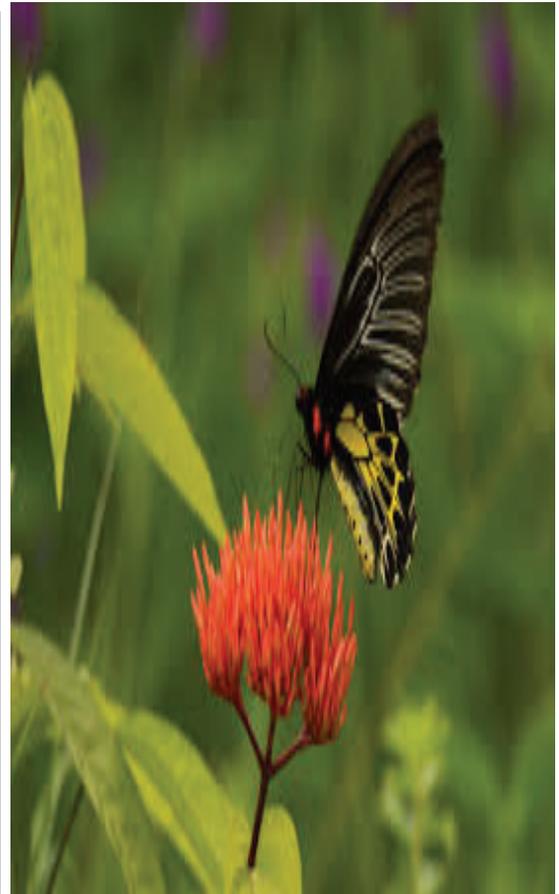
➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

SOUTHERN BIRDWING

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Troides</i>
Species:	<i>T. minos</i>
Scientific name	<i>Troides minos</i>



MORPHOLOGY

Common name: Common mormon

Diagnostic Characters :Upperside fore wing of male black with a few grey white vein stripes and hind wing golden with black borders and veins , female fore wing with grey white vein stripes and hindwing with a discal row of large triangular black spots.

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side of fore wing glossy black, veins 2-6 edged with white but veins 2-4 prominently white striped than others these stripes continued to cell and united ,hind wing golden with inner area black as far as the cell, veins back and a broad outer marginal black border
- Cone shaped black spots separated by yellow from the broad black border.

➤ **HABIT**

- It has a slow flight and flies high over the trees.

➤ **PLANTS**

- Hibiscus
- Ixora

➤ **STATUS**

- Not rare

(Gupta & Mridula, 2012)

PLUM JUDY

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Riodinidae
Genus:	<i>Abisara</i>
Species:	<i>A. echerius</i>
Scientific name	<i>Abisara echerius</i>



MORPHOLOGY

Common name: Plum judy

Diagnostic characters: Antennae black with scattered pale specks; head, thorax and abdomen maroon-brown; beneath, the palpi, thorax and abdomen paler brown

➤ **MORPHOLOGICAL CHARACTERS**

- Brown with slight traces of olive.
- The forewing has two transverse short black lines at the base, a black loop across the middle, and another beyond the apex of the cell, with their centers dark brown.
- Antennae, head, thorax and abdomen dark brown

➤ **HABITS**

- This active butterfly is usually seen at the tops of trees and amidst foliage.
- It has a habit of landing and turning around almost immediately after alighting.
- It repeats this turning movements as it moves along branches.

➤ **PLANT**

- Grass

➤ **STATUS**

- Common

(Kunte ,2006)

COMMON GRASS YELLOW

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Eurema</i>
Species:	<i>E. hecabe</i>
Scientific name	<i>Eurema hecabe</i>



MORPHOLOGY

Common name: Common grass yellow

Diagnostic characters: Upperside (dorsal surface): yellow, variable in tint from sulphur to rich lemon yellow according to season and locality.

Forewing: apex and termen deep black, this colour continued narrowly along the costal margin to base of wing, near which it often becomes diffuse.

➤ **MORPHOLOGICAL CHARACTERS**

- Forewing: two small spots or specks in basal half of cell and a reniform (kidney-shaped) spot or ring
- Hind wing: a slightly curved
- Sub basal series of three small spots
- An irregular slender ring or spot
- Antennae, head, thorax and abdomen similarly colored

➤ **HABITS**

- Females also have a reduced patch of ultraviolet-reflecting scales located in the proximate region of the dorsal forewing.
- The mechanism responsible for this coloration is the same as in males but the reflectance is less bright.

➤ **PLANT**

- *Tridax procumbens*
- Lantana

➤ **STATUS**

Common

(Swinhoe & Charles, 1905)

FIGURE 1: THE SPECIES DIVERSITY OF BUTTERFLY IN HILL PALACE & SUBHASH PARK

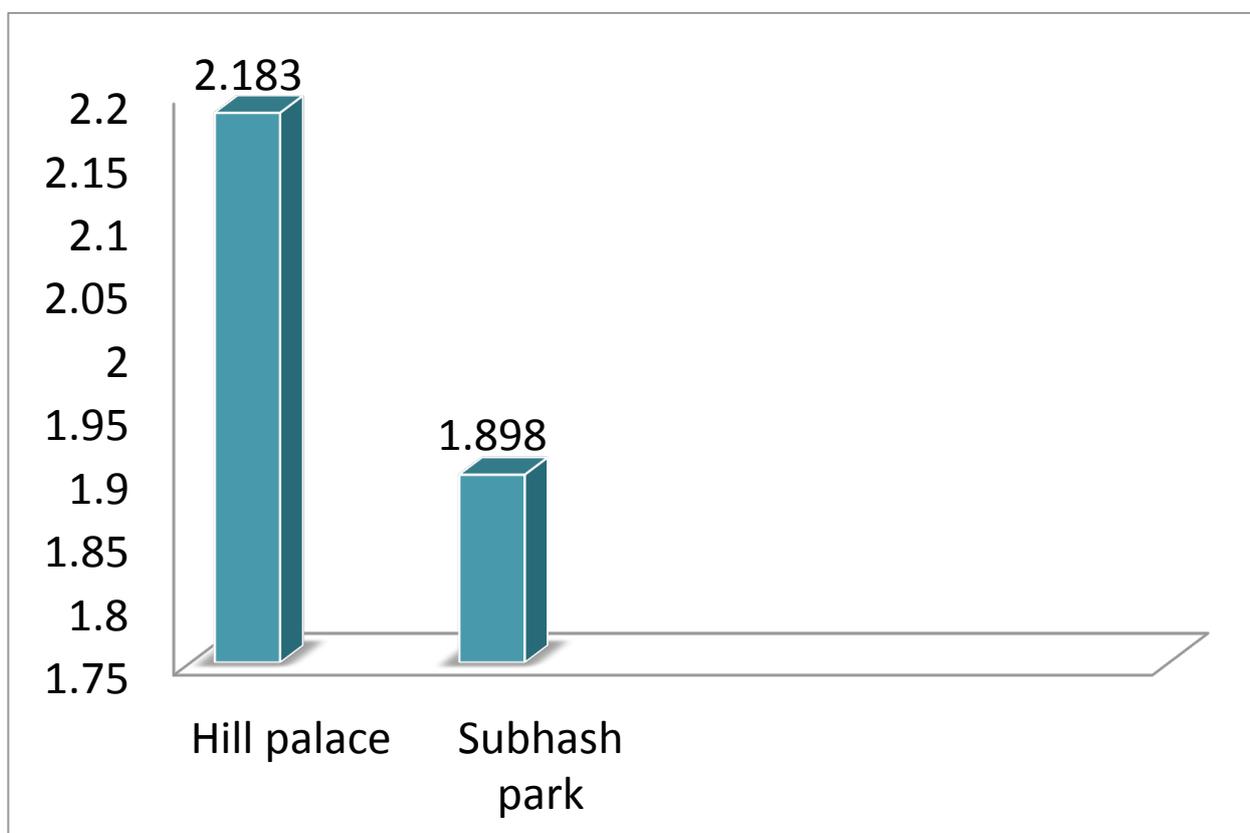


FIGURE 2: THE SPECIES DIVERSITY OF BUTTERFLY IN HILL PALACE & SUBHASH PARK

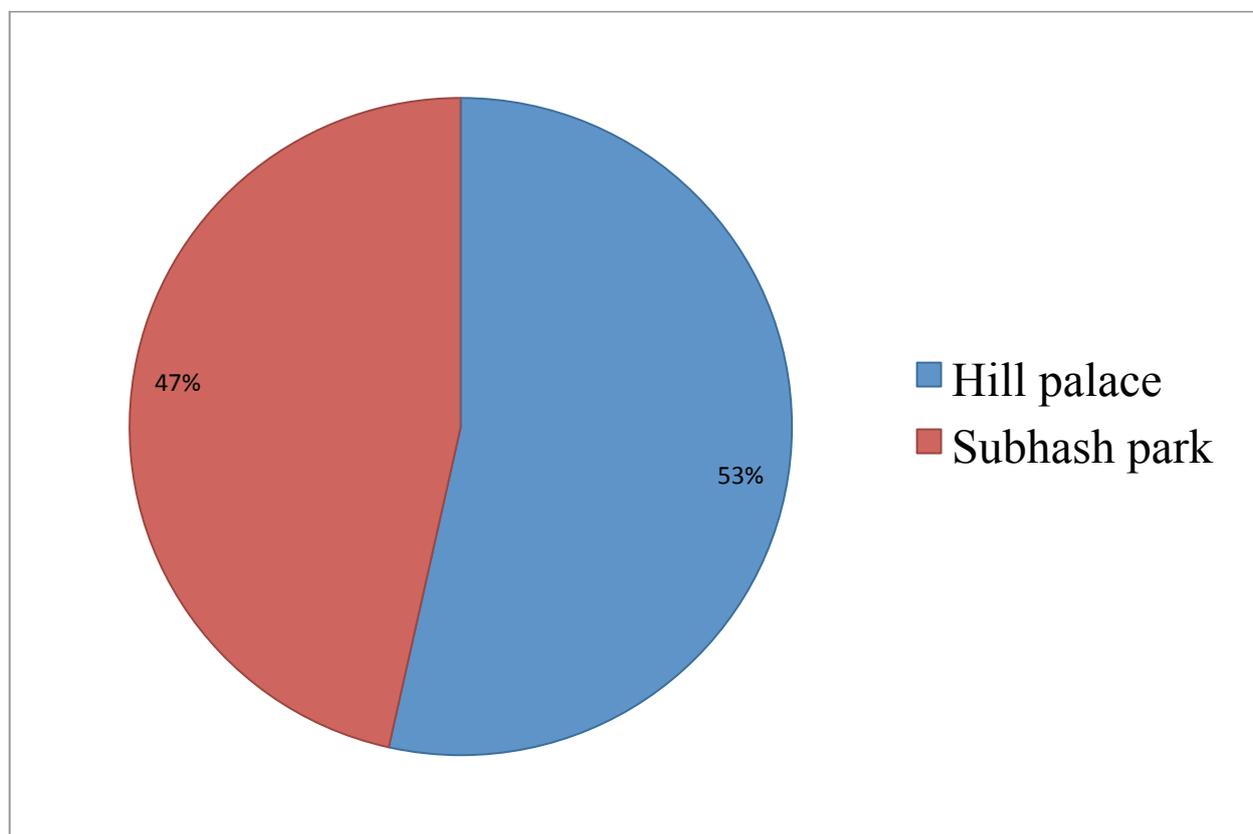


FIGURE 3: RELATIVE DOMINANCE OF BUTTERFLY SPECIES IN HILL PALACE

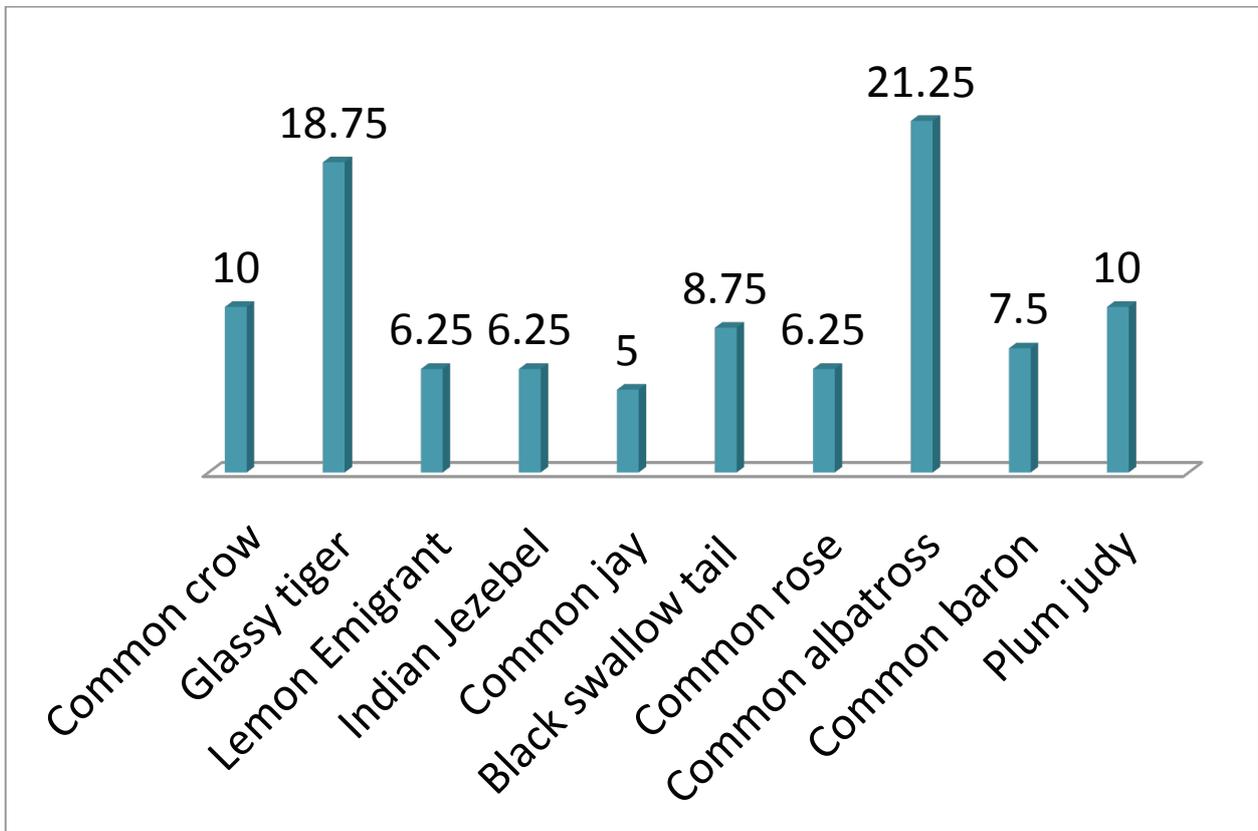
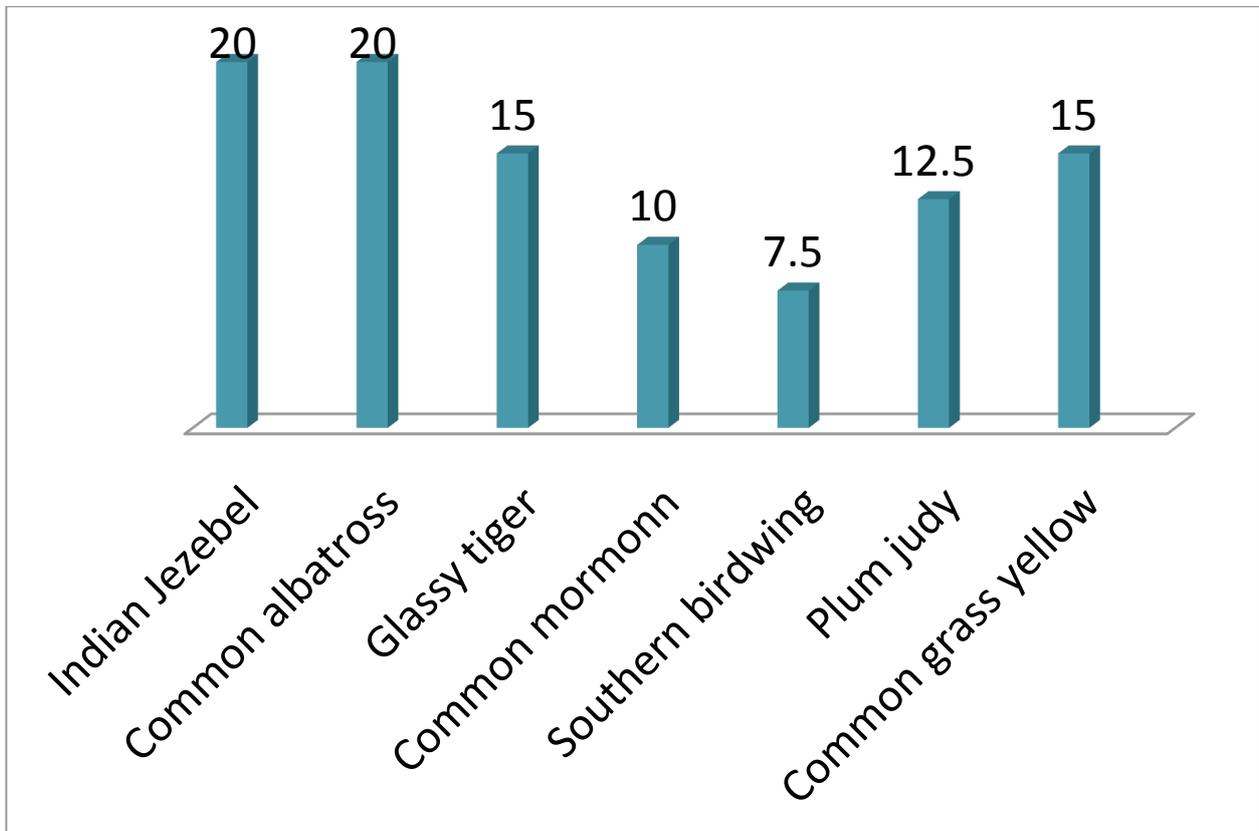


FIGURE 4: RELATIVE DOMINANCE OF BUTTERFLY SPECIES IN SUBHASH PARK



DISCUSSION

A study was conducted to find out the diversity of butterflies at two different sites in Kochi. Butterflies are one of the most conspicuous species of Earth's biodiversity. Being extremely responsive to any changes in their environment, namely temperature, humidity, light and rainfall patterns, these insects are identified as useful bio indicators. Population growth and increased pollution will also affect the occurrence of butterfly species.

Butterflies were collected from different places like Hill palace and Subhash Park on the month of January and February 2022. A total number of **40** butterflies were observed from Subhash Park and **80** from Hill palace. Of these some species were collected from these places using collecting nets and other methods. The butterflies caught were identified up to the family level with the help of Google lens. The observed butterflies falls in 4 families and 13 species. Nymphalidae, Pieridae, Rionidae, and Papilionidae are the families.

The species diversity, relative dominance and species richness were calculated from the collected data. The present study reflects the richness and diversity of butterflies in less polluted, area such as Hill palace. This was due to the presence of large amount of nectar producing plants and suitable conditions for their growth. Through the case study conducted in Subhash Park, it was observed how the increase in population may affect the diversity of butterfly species. Hill palace is less polluted and many species were also observed due to large area.

Among the two sites taken, Hill Palace had the highest diversity of species. In case of Hill Palace, mean species diversity was 2.183. More number of species were found in Hill palace than in Subhash park. Hill palace had species diversity 2.183 while in Subhash Park diversity was 1.898. During the study butterflies were recorded from two study sites and these belongs to the four families namely Pieridae, Papilionidae, Nymphalidae and Rionidae. The most abundant species recorded from the study sites was common albatross butterfly. Indian jezebel, common albatross, glassy tiger, plum judy were found in all places. Lemon emigrant found in both Hill palace and Subhash park was roaming around the grass. The butterflies collected were of different sizes. Some were brightly colored, attractive and hence easily found. Shannon-Wiener diversity index was more in Hill palace and less was observed in Subhash park. Species richness was calculated using Margalef's index.

From the above observations, even though Subhash park has butterfly garden, which is located at the centre of the city, is found to be more polluted due to the high amount of pollutants released from the vehicles and lesser number of trees compared to other areas.

Hill palace had more trees, shrubs, climbers, creepers. It comprises of many flowering plants (*Ixora coccinea*, *Saraca asoca*), citrus plants (*Citrus limon*, *Citrus grandis*) and all are beautifully maintained. Ornamental plants such as bougainvillea and roses were also observed in Hill palace. Habitat and host plants were also observed. The following plants were Ixora, marigold, grass, *Tridax procumbens*, victoria, globe amaranth, *Mangifera indica*, Hibiscus, lantana, nerium, mimosa, ferns, bougainvillea, ficus, acasia, citrus, bamboo,

Ashoka tree etc. Common albatross were found mostly surrounding the grass. Common grass yellow was mainly seen roaming around *Tridax procumbens*.

Due to pollution and radiation, number of butterflies observed were less in Subhash park as compared to Hill palace. Due to the presence of large amount of nectar producing plants and suitable conditions for the growth, more number of species were observed in Hill palace. Relative dominance were also calculated. Due to the harmful gases and chemicals liberated by the industries, affects the life of butterflies. Radiation from various resources also affects butterflies in the ecosystem. The main causes for the decline of butterfly populations are deforestation, habitat destruction for urbanization, industrialization and agriculture causes changes in temperature, humidity and rainfall. Prevalence of unfavorable weather conditions often affect habitat suitability leading to local extinction of butterflies. Unfortunately, developmental activities and resulting habitat fragmentation create threats to the survival of butterflies worldwide. The present study mainly concentrates on butterfly diversity, habitat preference like gardens, grasslands, shrubs.

Butterflies, perhaps because they are mobile exotherms, respond extremely rapidly to environmental disturbance or degradation, especially those involving temperature changes, and are well studied ecologically. The greatest threats to butterflies are habitat change and loss due to residential, commercial and agricultural development. Climate change is also threatening species of butterfly because of the unscientific developmental activities of man, the habitats of many species of butterflies have been altered, threatening to their survival. Species loss has tremendous implications on the survival of mankind in this universe. It has been estimated that there has been a loss of 50% forest cover in the past 50 years in the Western Ghats (Goanker,1996).

Due to large scale ecological disturbances, many species are facing extinction. Since the butterflies are good bio indicators of environment, they can be used to identify ecologically important landscapes for conservation purpose (Barlow et al.,2008). Butterfly gardens help in caring wild butterfly population and to maintain the biodiversity in natural ecosystems, which in turn, may increase the existence of human beings.

CONCLUSION

A total number of 40 butterflies were observed from Subhash Park and 80 from Hill palace. The observed butterflies falls in 4 families and 13 species. Nymphalidae, Pieridae, Rionidae, and Papilionidae are the families. Among the two sites taken, Hill Palace had the highest diversity of species. In case of Hill Palace, mean species diversity was 2.183. More number of species were found in Hill palace than in Subash park. Hill palace had species diversity 2.183 while in Subhash Park diversity was 1.898. Indian jezebel, common albatross, glassy tiger, plum judy were found in all places. The above observations, Subhash park which is located at the centre of the city, is found to be more polluted due to the high amount of pollutants released from the vehicles and lesser number of trees compared to other areas. Due to pollution and radiation, number of butterflies observed were less in Subhash park as compared to Hill palace. Due to the presence of large amount of nectar producing plants and suitable conditions for the growth, more number of species were observed in Hill palace. The main causes for the decline of butterfly populations are deforestation, habitat destruction for urbanization, industrialization and agriculture causes changes in temperature, humidity and rainfall. Prevalence of unfavorable weather conditions often affect habitat suitability leading to local extinction of butterflies. The present list of butterfly species is not conclusive and exhaustive therefore future exploration will be continued to update this checklist. Further studies are needed to explore more species in the study area. Furthermore, long term research and monitoring on the diversity of butterflies with special reference to ecological aspects may be taken up in the area. In addition further research is required inorder to protect species of concern.

HILL PALACE





SUBHASH PARK



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STUDY ON BUTTERFLY DIVERSITY



Project work by

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Submitted to St.Teresa's college (Autonomous) Eranakulam

Affiliated to Mahatma Gandhi University, Kottayam in partial

Fulfillment of requirement for the degree of Bachelor of Science

In Zoology

2019-2022

STUDY ON BUTTERFLY DIVERSITY

CERTIFICATE

This is to certify that the project report entitled “**STUDY ON BUTTERFLY DIVERSITY**” submitted by **Ms. Megha Francis**, Reg. No. **AB19ZOO013** in partial fulfillment of the requirements of Bachelor of Science degree of Mahatma Gandhi University, Kottayam, is a bonafide work done under the guidance and supervision of Dr. Meera Jan Abraham and this is her original effort.

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EXAMINERS

1.

2.

DECLARATION

I, hereby declare that this project work entitled “STUDY ON BUTTERFLY DIVERSITY” is submitted to St.Teresa’s College (Autonomous), Ernakulam affiliated to Mahatma Gandhi University, Kottayam in partial fulfillment of the requirements of Bachelor of Science degree in Zoology. This work has not been undertaken or submitted elsewhere in connection with any other academic course and the opinions furnished in the report is entirely my own.

Name:

Signature

Reg.No:

ACKNOWLEDGEMENT

The success and final outcome of this project required a lot of guidance and assistance from many people and I am extremely privileged to have got this all along the completion of my project. All that I have done is only due to such supervision and assistance and I would not forget to thank them.

I owe my deep gratitude to my project guide Dr. Meera Jan Abraham , who took keen interest on my project work and guided me all along, till the completion of my project work by providing all necessary information for developing a good system.

I take this opportunity to express my profound gratitude to my parents and friends who helped me a lot in finishing the project within the limited time. Also, I would like to extend my sincere esteems to all staff in laboratory for their timely support.

Last but not least I would like to thank God Almighty for the successful completion of my project.

Name of student

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ABSTRACT

A survey was conducted on the month of January and February 2022 to study butterfly diversity in two different regions in Ernakulam district. Around 200 species of butterflies were recorded by line transect method from two different places like Hill palace and Subhash Park, Ernakulam district, Kerala. Hill palace, the least polluted compared to Subhash park shows the maximum abundance($n=80$) which include Nymphalidae, Papilionidae, Pieridae and Riodinidae; Subhash park ($n=40$) includes Pieridae, Papilionidae, Nymphalidae and Riodinidae, has less abundance. Bio diversity indices like Shannon diversity, Margalef's index were calculated. . The butterflies caught were identified up to the family level with the help of Google lens, IUCN, iNaturalist app. The observed butterflies belongs to Nymphalidae, Pieridae, Riodinidae and Papilionidae families. The diversity and species richness was calculated from the collected data. The present study reflects the richness and diversity of butterflies in two different localities. Abundance may vary in different sites due to the presence of large amount of nectar producing plants and suitable conditions for their growth. Our findings are important with respect to monitoring butterfly and plant diversity and defining conservation strategies.

INTRODUCTION

Lepidoptera is occupying a major part in the global biodiversity and are the second largest order in the class Insecta. Lepidoptera regarded as one of the important components of biodiversity and are the second largest order among insects, approximately 1,50,000 species are so far known to the literature. Butterflies are winged insects, they are the important natural resources which provide economic and ecological benefits. Butterflies are good environmental indicators and pollinators of plants. Butterflies are broadly considered as potent ecological indicators and are sensitive to the temperature, humidity, light levels and also to the habitat disturbance. Butterflies occupy different environmental conditions in the ecosystem. Due to the harmful gases and chemicals liberated by the industries, affects the life of butterflies. Radiation from various resources also affects butterflies in the ecosystem. Very little documentation has been done on butterfly fauna in Kerala. The main causes for the decline of butterfly populations are deforestation, habitat destruction for urbanization, industrialization and agriculture causes changes in temperature, humidity and rainfall. Prevalence of unfavorable weather conditions often affect habitat suitability leading to local extinction of butterflies. Unfortunately, developmental activities and resulting habitat fragmentation create threats to the survival of butterflies worldwide. The present study mainly concentrates on butterfly abundance, habitat preference like gardens, grasslands, shrubs Ornamental plants such as bougainvillea and roses were observed in Hill palace. The migration of pollens induces genetic variation in plants species and give a better chance at survival against different disease. These insects also provide food for other organisms such as birds, reptiles, amphibians, also acts as biological pest control. Butterflies are of economic importance in nature. They are the second largest pollinators of world after bees. But the population of these insects decline rapidly due to human activities, habitat destruction, uses of pesticides and unawareness of people about the importance of butterflies. When those get reduced, the pollination also gets decreased. As a result, in future people will starve for food. Some species of butterfly help to reduce the air pollution like Monarch butterflies. These species decrease the carbon dioxide in the air. When those species get destroyed, the amount of CO₂ in the air increases. Today butterflies are facing threat due to change in climate and pollution. Butterflies are the primary consumers of food chain. So, reduction in their number will ultimately affect the other living organisms depending upon them. Human activities destroy the butterfly habitat. Global climate fluctuation also affects the butterfly habitat. Governmental policy on forestry, farming and road planning has great effect on the abundance and distribution of butterfly. So, as a Zoology student, it's our duty to study about them and to find various problems in their survival.

AIMS AND OBJECTIVE

- To study butterfly fauna in 2 different sites- Subhash park and Hill palace.
- Observation and identification of butterflies.
- To study morphological features of butterfly, their behavior and habit.
- To study different families, scientific names of butterflies.
- Importance of butterfly and their contribution to environment.
- Role of butterfly in nature and current diversity in 2 different sites.
- To study the population of butterfly families.
- To study species diversity, species richness and to know about the relative dominance of each species of butterfly.

REVIEW OF LITERATURE

Very little documentation has been done on butterfly fauna in Kerala. Some of the earlier documentation on butterfly fauna from Kerala and adjacent areas include (Mathew & Rahamathulla, 1993), who had reported 100 species of butterflies from Silent Valley National Park, (Sudheendrakumar et al., 2000), who reported 124 species of butterflies from Parambikulam Wildlife Sanctuary, (Arun, 2003), reported 75 species from Siruvani Reserved Forests (Ambrose & Raj, 2005) reported 24 species from Kalakkad-Mundanthurai Tiger reserve, (Eswaran & Pramod, 2005) reported 75 species from Anaikatty near Coimbatore, (Prasad et al., 2010) recorded 52 species from Kerala University campus, Thiruvananthapuram, while (Toms et al., 2010) reported 109 species from Mahatma Gandhi University campus, Kottayam. In the present study, an attempt has been made to document about butterfly fauna in Suvarnodhyanam biological park, Subhash park and Hill palace. Survey was conducted to know about the importance of butterfly and their contribution to environment, reasons for the reduction in number of butterflies and after effects.

In popular esteem the butterflies among the insects are the most attractive and beautiful members. They are primarily day fliers and are remarkable for the delicacy and beauty of their membranous wings, covered with myriads of tiny scales that overlap one another like the shingles on a house and show an infinite variety of hue through the coloring of the scales and arrangement upon the translucent membrane running between the wing veins. It is this characteristic structure of the wings that gives to the great order of butterflies and moths its name Lepidoptera, meaning scale-winged (Moore & Weed, 1923). Butterflies, because of their beauty and mystique, are our most visible insects. Their images appear in clothing, jewellery, advertisements, magazines, movies, books, literature and on television. In warm seasons, living butterflies attract our attention as they sip nectar from flowers, lazily fly by, or spiral together upward in the air. Entire museums and conservatories are devoted to helping us learn about their life pattern. Great museum collections house millions of butterfly specimens from all over the world, striving to record their diversity in an ever-shrinking natural landscape. Butterflies are familiar, fascinating, and admired, but few people really know them well. (Klass et al., 1992). These colorful insects frequent open, sunny wildflower gardens grasses and orchards, feeding on nectar from flowering plants. Butterflies are common throughout the world. Although they symbolize different things to different cultures, universally butterflies represent change and transformation. Some butterflies are mysterious, appearing always to be rare in the sense of being found singly at long intervals of time and space. (Austin, 2000)

Scales provide a number of functions, which include insulation, thermoregulation and aiding gliding flight, amongst others, the most important of which is the large diversity of vivid or indistinct patterns they provide which help the organism protect itself by camouflage, mimicry and to seek mates. Some of the commonly found species of butterflies in Kerala includes:

Common Pierrot- *Castalius rosimon* , Blue Mormon- *Papilio polymnestor* , Grey Pansy- *Junonia atlites*, Psyche- *Leptosia nina* ,Common Mime *Papilio clytia* ,The Blue Tiger- *Tirumala limniace* ,Common Mormon- *Papilio polytes* ,Red Pierrot- *Talicerca nyseus*

,Banded Blue Pierrot- *Discolampa ethion* ,Oriental Plains Cupid- *Chilades pandava*,Common Sailor- *Neptis hylas* ,Tailed Jay- *Graphium Agamemnon*, The Grass Demon- *Udaspes folus* ,Chestnut Bob Butterfly- *Lambrix salsala* ,The Water Snow Flat- *Tagiades litigiosa* , Indian lime blue- *Chilades lajus* . (David ,2017)

As well as being an indicator of climate change, butterflies are also sensitive to other threats such as habitat destruction. Changes in the behavior of butterflies can warn people of the future effects of habitat loss on other animals. Diversity of butterflies increases with increasing of habitat scale and vegetation structure complex. This shows that a forest habitat with more forest canopy layers and high vegetation diversity supports more insect species than a forest habitat with less forest canopy layers and less vegetation diversity.

The diversity of butterfly communities has been studied in different habitat types in different parts of the world including tropical forest of Southeast Asia. However, there have not been many studies on the diversity of butterfly communities in tropical forests within different habitat types including stream sides in the forest. Stream side habitats in the forest may play an important role in conserving a portion of tropical biodiversity, of which insects are a major part, but little data is available. The forest edge which has more exposure to the open also has the greatest diversity of butterflies.

The gaps in the forest have higher diversity of butterflies than the closed forest areas. The stream sides with more open space should therefore have a high diversity of butterflies. According to the scientists, there are estimated 28,000 species of butterflies throughout the world. The diversity of butterflies may occur some changes depending on the climate, whether it is changing or constant. According to some biologist butterfly are diversified all throughout the world, even above the Arctic Circle, but they do not occur on Antarctica. In the diversity of the butterflies, the demographic and socioeconomic may affect it. Insect diversity is highest in habitats with the most plant diversity and is lowest in shrub, grass and open areas. The human development and the resultant habitat fragmentation can be sufficient to cause the extinction of butterfly species. As well as being an indicator of climate change, butterflies are also sensitive to other threats such as habitat destruction. Changes in the behavior of butterflies can warn people of the future effects of habitat loss on other animals. As many species, of butterflies are highly specialized, individual species can be of particular benefit to science.

Scientists use the presence or absence of butterflies as a predictor of whether an ecosystem is healthy. Adult and larval forms are sensitive to pesticides. Changes in climate will impact butterflies because temperature changes and rainfall amounts may alter migration patterns and timing.

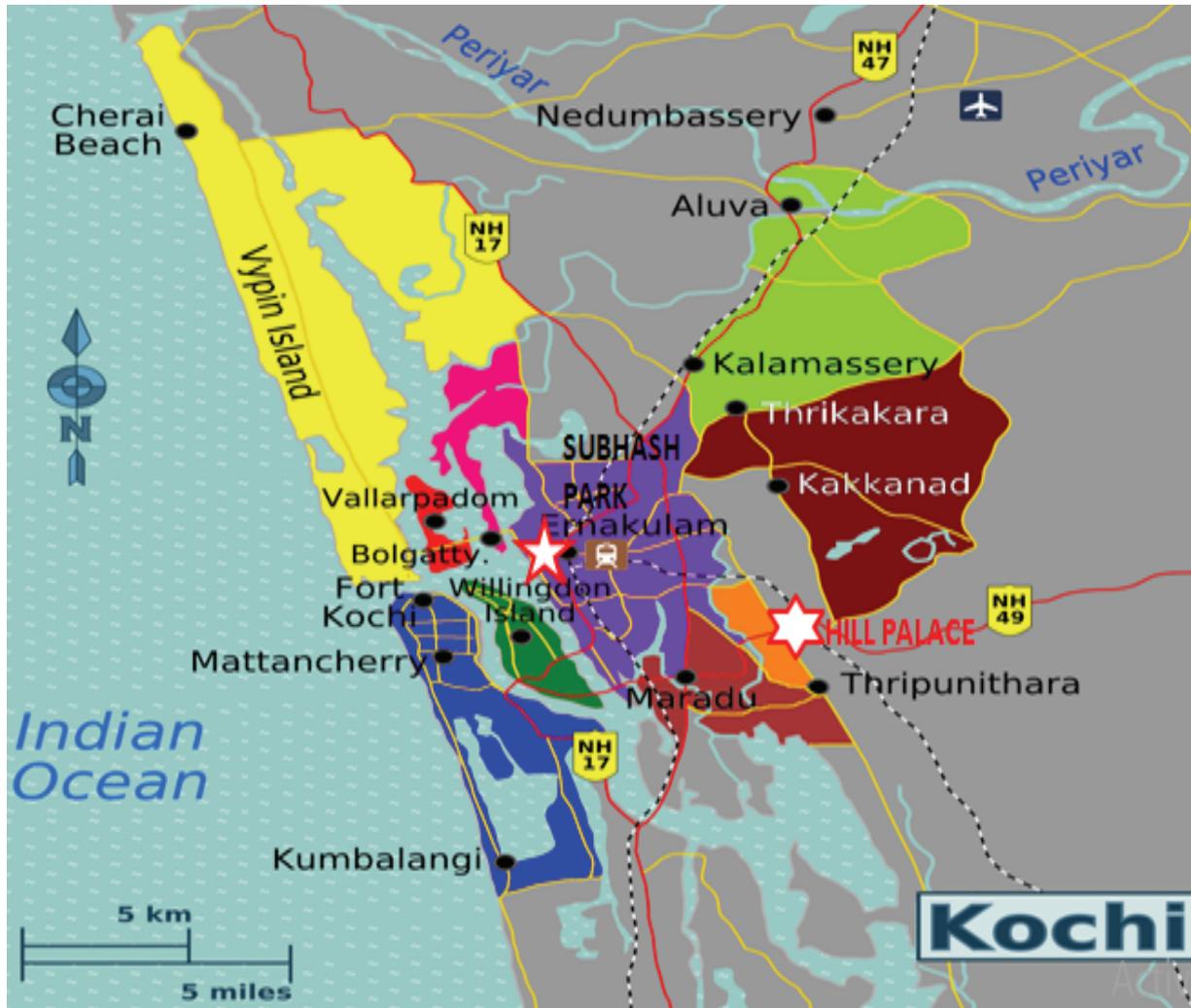
Loss or fragmentation of habitat - for example, losing chunks of cover as a result of construction or defoliation - increases predation and also affects migration. Ecologists study butterfly behavior, population numbers and migration patterns to help determine the impact of these environmental issues.

Western butterfly populations are declining at an estimated rate of 1.6% per year, according to a new report. The report looks at more than 450 butterfly species, including the western monarch, whose latest population count revealed a 99.9% decline since the 1980s. (Forister et al.,2021)

METHODOLOGY

The first step of our study was to identify the sites for study and we selected the following sites:

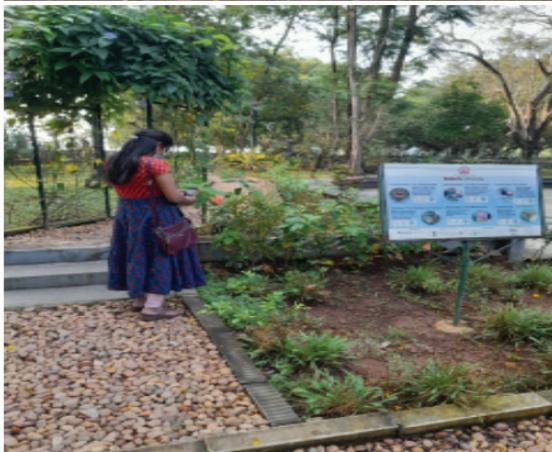
HILL PALACE, SUBHASH PARK



STUDY AREA

1. SUBHASH PARK (URBAN)

Subhash Park is a beautiful park located next to the boat jetty and opposite to Maharaja's College in the heart of Ernakulam. It's a public park which is maintained by the Corporation of Cochin and overlooks the Vembanad Lakes, backwaters and Cochin harbor. While stepping inside you will find a Breezy, Lakefront park featuring lush lawns, a children's playground & benches with water views. Recently, plants on which butterfly feeds are being planted to create a butterfly garden along with a nature interpretation centre to support the theme 'urban biodiversity'.



2.HILL PALACE MUSEUM

Located about 10 km from Kochi, the Hill Palace Museum was the official residence of the erstwhile rulers of Kochi. Built in 1865, it is now famous for being a full-fledged Ethno-Archaeological Museum and Kerala's first ever Heritage Museum. The palace complex itself comprises 49 buildings. It has over 52 acres of terraced land around it. The place is surrounded by many trees and herbs which adds greenery & hence many butterfly species wander around.



COLLECTION METHODS

The present study was carried out in Subhash park on 29th January and in Hill palace on 3rd February (evening 3.00-6.00 p.m). Ernakulam district, Kerala. The survey of butterflies was undertaken by line transect method. The butterflies were recorded using standard transect counting method, counted while walking along the selected transect route of 1 km, in each habitat. The nomenclature used in the check list of Butterflies in IUCN (2020) was followed. All the transects surveyed were segments of existing garden, shrubs and herbs, grassland and small pond areas. Typical and unique features of the wings, abdomen and pattern of coloration of all body parts were noted down.

Sketches were made accordingly using pencils and marked the pattern of color patches and print distribution. Butterflies were photographed from different angles as often as possible to obtain sufficient photographs to enable positive identification of species. Photographs were taken with an i phone, One plus 5 and Samsung galaxy A12. All the butterflies observed were recorded and identification of butterflies was done on the site itself and was confirmed with the help of Google lens and IUCN(2020) .Some rare and small butterflies which are difficult to identify were caught by using insect net (Nylon net with long handle was used for sweeping free flying butterflies) and closely observed. Then they were released to the same habitat from where they were caught.

Descriptions, photographs and drawings were compared with literature and the species were identified based on the collected data and available reference, both printed and electronic. Species identity was confirmed with the help of Google lens and IUCN.

The materials used for collection were

- hand gloves
- white cloth
- net/mesh.

Two of the simplest method is by aerial netting and handpicking. An aerial net is used to collect organism on the top of flower heads and other vegetations. It tends to catch aerial insects lots of flies particularly you font really hit the vegetation. You just very quickly sweep over it and butterfly feeding or resting on the vegetation will fly up into the net. You need to flick it.



Identification

Identification is based on morphological features of butterflies .

Data analysis

Abundance

- **Species diversity calculation**

The index used for diversity calculation is Shannon- Wiener diversity index.

$$\text{Diversity index } = H = - \sum [(P_i) \ln(P_i)]$$

Where, H= Shannon index, is used to characteristic species diversity and abundance in a community.

P_i = the proportion of individuals in the sample belonging to i th species.

$$P_i = S/N$$

S is number of individuals of one species

N is the total number of all individuals in the sample

\ln = natural logarithm

Shannon - Wiener diversity index

Shannon - Wiener diversity index showed that the total butterfly diversity.

Shannon diversity index's range of values is usually **1.5 - 3.5**. The species diversity of the three different habitats ranged from 1.898 to 2.183. The maximum diversity was reported in Hill palace and minimum diversity was found in Subhash park

- **Species richness calculation**

The index used for richness calculation is Margalef's index.

$$\text{Margalef's index} = (S-1)/\ln N$$

S is the total number of species

N is the total number of individuals in the sample

\ln is the natural logarithm

Measurement of Diversity

Relative dominance index of the species was calculated by the formula,

Relative Dominance (%)

=Number of individuals of one species(n)/ x100

Number of individuals of all species(N)

RESULT

From the collected specimens, identification was done using proper identification techniques. The results are given in table 1 to table 10 and figure 1 to figure 4.

TABLE 1: NUMBER OF BUTTERFLIES IN HILL PALACE

SPECIES	SCIENTIFIC NAME	FAMILIES	NO:OF BUTTERFLIES
Common crow	<i>Euploea core</i>	Nymphalidae	8
Glassy tiger	<i>Parantica aglea</i>	Nymphalidae	15
Lemon emigrant	<i>Catopsilia pomona</i>	Pierida	5
Indian jezebel	<i>Delias eucharis</i>	Pieridae	5
Common jay	<i>Graphium doson</i>	Papilionidae	4
Black swallow tail	<i>Papilio poiynenes</i>	Papilionidae	7
Common rose	<i>Pachliopta aristolochiae</i>	Papilionidae	5
Common albatross	<i>Appias albina</i>	Pieridae	17
Common baron	<i>Euthalia aconthea</i>	Nymphalidae	6
Plum judy	<i>Abisara echerius</i>	Riodinidae	8

TABLE 2: HOST PLANTS IN HILL PALACE

SL NO.	SPECIES	HOST PLANTS	NO:OF BUTTERFLIES
1	<i>Euploea core</i>	Hibiscus rosasinesis, <i>Nerium oleander</i> , apocynacea	8
2	<i>Parantica aglea</i>	Napier grass	15
3	<i>Catopsilia Pomona</i>	Grass, Mimosa pudica	5
4	<i>Delias eucharis</i>	<i>Mangifera indica</i> (Mango) Bougainvillea, Lantana	5
5	<i>Graphium doson</i>	Ferns	4
6	<i>Papilio poiynenes</i>	Ixora red plant	7
7	<i>Pachliopta aristolochiae</i>	Hibiscus	5
8	<i>Appias albino</i>	Grass, Tridax procumbens	17
9	<i>Euthalia aconthea</i>	Mango tree, Hibiscus rosasinesis	6
10	<i>Abisara echerius</i>	Hibiscus rosasinesis	8

TABLE 3: SPECIES DIVERSITY IN HILL PALACE

SPECIES	NO:OF BUTTERFLIES(S)	PROPORTION $p_i = S/N$	$\ln(p_i)$	$P_i \ln(p_i)$
<i>Euploea core</i>	8	0.1	2.303	0.230
<i>Parantica aglea</i>	15	0.188	1.671	0.314
<i>Catopsilia Pomona</i>	5	0.063	2.765	0.174
<i>Delias eucharis</i>	5	0.063	2.765	0.174
<i>Graphium doson</i>	4	0.05	2.996	0.150
<i>Papilio poiynenes</i>	7	0.088	2.430	0.214
<i>Pachliopta aristolochiae</i>	5	0.063	2.765	0.174
<i>Appias albino</i>	17	0.213	1.546	0.329
<i>Euthalia aconthea</i>	6	0.075	2.590	0.194
<i>Abisara echerius</i>	8	0.1	2.303	0.230

Shannon-Wiener diversity index $H = -\sum[(P_i) \ln(P_i)]$

Where $P_i = S/N$

N=80

H=2.183

TABLE 4: SPECIES RICHNESS IN HILL PALACE

SPECIES	N	SPECIES RICHNESS
<i>Euploea core</i>	8	37.991
<i>Parantica aglea</i>	15	29.172
<i>Catopsilia Pomona</i>	5	49.085
<i>Delias eucharis</i>	5	49.085
<i>Graphium doson</i>	4	56.986
<i>Papilio poiynenes</i>	7	40.598
<i>Pachliopta aristolochiae</i>	5	49.085
<i>Appias albino</i>	17	27.884
<i>Euthalia aconthea</i>	6	44.091
<i>Abisara echerius</i>	8	37.991

TABLE 5: RELATIVE DOMINANCE IN HILL PALACE

SPECIES	n	RELATIVE DOMINANCE n/N X100
<i>Euploea core</i>	8	10
<i>Parantica aglea</i>	15	18.75
<i>Catopsilia Pomona</i>	5	6.25
<i>Delias eucharis</i>	5	6.25
<i>Graphium doson</i>	4	5
<i>Papilio poiyyenes</i>	7	8.75
<i>Pachliopta aristolochiae</i>	5	6.25
<i>Appias albino</i>	17	21.25
<i>Euthalia aconthea</i>	6	7.5
<i>Abisara echerius</i>	8	10

N=80

DETAILS OF BUTTERFLIES OBSERVED IN HILL PALACE

COMMON CROW(CRAMER)

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Lepidoptera
Family	Nymphalidae
Genus	<i>Euploea</i>
Species	<i>Core</i>
Scientific name	<i>Euploea core</i>



MORPHOLOGY

- The common crow, is a common butterfly found in South Asia to Australia.
- In India it is also sometimes refers to as the common Indian crow, and in Australia as the Australian crow.
- Common crow is a glossy black butterfly with brown underside with white marks along the outer margins of the wing. The wingspan is about 8-9 cm and the body also has prominent white spots.
- This butterfly also gathers of damaged parts of plants such as crotalaria, heliotropism to forage for chemicals precursors to produce pheromones. (Muller & Tennet,1905)

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side of wings black, with rows of sub marginal and marginal white spots on both wings and forewing with a short brand in male.
- Upper side of wings black or glossy brown; fore wing 'with a sub marginal and a marginal row of white spots, posterior towards inner margin spots larger than the anterior ones

➤ **HABITS**

The butterfly is slow flying. It may be seen sailing lazily along in all types of regions or flying about shrubs and bushes for its foodstuff.

➤ **PLANTS**

- *Hibiscus rosasinesis*
- *Nerium oleander*
- *Holarrhena antidysenterica*
- *Ficus benghalensis* (Banyan)
- Apocynacea

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

GLASSY TIGER

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Nymphalidae
Genus:	<i>Parantica</i>
Species:	<i>P. aglea</i>
Scientific name	<i>Parantica aglea</i>



MORPHOLOGY

Common name: Glassy tiger

Diagnostic characters:

- Ground colour fuliginous black with subhyaline bluish-white streaks and spots
- Antennae black; head and thorax black spotted with white; abdomen blackish brown

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side: forewing—interspace 1 with two comparatively long
- Broad streaks united at base, truncate exteriorly; cell with a very broad
- Basal spots in interspaces 2 and 3
- An irregular discal series of three spots and two elongate streaks and a sub terminal series of spots
- The two series curved inwards opposite apex of wing, the latter continued along the apical half of the costa.
- Finally a terminal row in pairs in the interspaces, of much smaller spots.

➤ **HABITS**

- This is a moderately fast, casual flier which feeds on flowers of herbs and scrubs.
- Males extrude yellow colored hair pencils from the back of their abdomen to attract females.
- It is a migratory species.

➤ **PLANTS**

- Napier grass

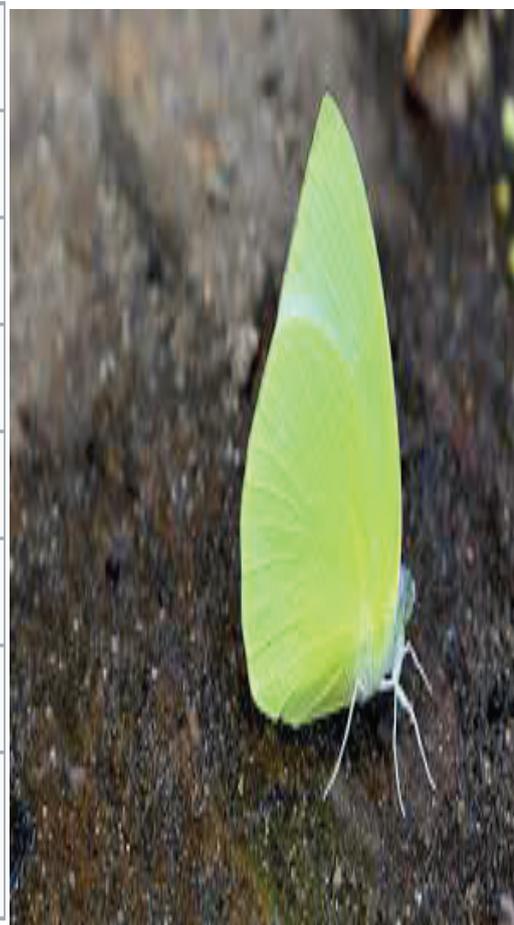
➤ **STATUS**

- Common

(Varshney et al., 2015)

LEMON EMIGRANT

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Catopsilia</i>
Species:	<i>C. pomona</i>
Scientific name	<i>Catopsilia pomona</i>



MORPHOLOGY

Common name: Common emigrant

Diagnostic characters: Upperside of wings with ground colour white and proximal areas yellow; fore wing black at apex and with a marginal narrow border macular.

➤ **MORPHOLOGICAL CHARACTERS**

- Male- upper side of both wings with ground color white and the proximal areas yellow; fore wing with costal margin black at apex
- Outer marginal narrow border
- Female- like male but upper side sulphur yellow to white
- Fore wing with costa only black for about the apical third or less
- Outer marginal black border much narrow

➤ **HABITS**

- Its flight is powerful and rapid and it proceeds in a series of upward and downward curves.
- It is fond of settling on flowers and it is found in large numbers in gardens in plains during and after rains.

➤ **PLANTS**

- Grass
- *Mimosa pudica*

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

INDIAN JEZEBEL

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Delias</i>
Species:	<i>D. eucharis</i>
Scientific name	<i>Delias eucharis</i>



MORPHOLOGY

Common name: Common Jezebel

Diagnostic character: Upperside white with black veins and hind wing underside yellow with red border

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side white both for and hind wings with a black outer discal band fore wing with black veins
- Sub marginal row of seven white spots the latter
- Underside of fore wing white and all the veins heavily marked
- Hind wing yellow with black veins and black border bearing a sub marginal row of six large red spots, each spot edged with a dusting of dull white and having a shape of a square.

➤ **HABITS**

- It is an ornament among the butterflies occurring in India
- The male emits very strong scent which is like that of sweet briar.
- They drink at moist patches on roads and in river beds in the hot weather.

➤ **PLANTS**

- *Mangifera indica* (Mango)
- Bougainvillea
- Lantana

➤ **STATUS**

- common

(Gupta & Mridula, 2012)

COMMON JAY

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Graphium</i>
Species:	<i>G. doson</i>
Scientific name:	<i>Graphium doson</i>



MORPHOLOGY

Common name: Common Jay

Diagnostic character: Pale blue semi-transparent central wing bands that are formed by large spots. There is a marginal series of smaller spots.

➤ **MORPHOLOGICAL CHARACTERS**

- Pale blue semi-transparent central wing bands that are formed by large spots.
- There is a marginal series of smaller spots.
- The underside of wings is brown with markings similar to upper side but whitish in color.
- The sexes look alike.

➤ **HABITS**

- Common jay is active throughout the day and constantly on the move; it rarely settles down.
- Its flight is swift and straight.
- When feeding from flowers, it never settles down and keeps its wings vibrating.

➤ **PLANTS**

- Ferns

➤ **STATUS**

- Common

(Moore,1905)

BLACK SWALLOW TAIL

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Papilio</i>
Species:	<i>P. polyxenes</i>
Scientific name:	<i>Papilio poiixenes</i>



MORPHOLOGY

Common name: Swallow tail

Diagnostic character: The members of this tribe all have tails on the hindwings, and therefore include species named swallowtail.

➤ **MORPHOLOGICAL CHARACTERS**

- The black swallowtail has a wingspan of 6.9–8.4 cm, and females are typically larger than males.
- The upper wing surface is black with two rows of yellow spots – these spots are large and bright in males and smaller and lighter in females.

➤ **HABITS**

- They are usually found in open areas like fields, parks, and they prefer tropical or temperature
- Exhibit sexual dimorphism
- Mimicry

➤ **PLANTS**

- Ixora plant (Red)

➤ **STATUS**

- Common

(Lederhouse et al.,1989)

COMMON ROSE(FABRICIUS)

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Pachliopta</i>
Species:	<i>Aristolochiae</i>
Scientific name	<i>Pachliopta aristolochiae</i>



MORPHOLOGY

- The Common Rose is black with grey shading between the veins on its wings.
- Its swallow-tailed hindwings (back wings) have large white patches and grayish-red crescent-shaped markings.
- Its underside is similar to its top side, but with striking red or pinkish spots. Its body is bright red.
- It is very common almost all over the plains of India, and is not threatened as a species. During and after the monsoon it is extremely abundant.

(Collins et al. ,1985)

➤ **MORPHOLOGICAL CHARACTERS**

- Mostly black and wings elongated, hind wing tailed and with elongate white spots around lower end of cell.
- Underside crimson and black.

➤ **HABITS**

- The flight of the butterfly, when not alarmed, is slow, direct and on the level.
- It visits flowers and groups sometimes in large companies.

➤ **PLANTS**

- *Hibiscus rosasinensis*

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

APPIAS ALBINA (COMMON ALBATROSS)

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Appias</i>
Species:	<i>albina</i>
Scientific name	<i>Appias albina</i>



MORPHOLOGY

Common name: Common Albatross.

Diagnostic characters:

- Upperside white.
- Fore wing with edge of basal black area slightly incurved and blackish apical and marginal markings narrow in male but broader in female.

➤ **MORPHOLOGICAL CHARACTERS**

- Male: Upper side white
- Fore wing with narrow black apical and marginal markings, basal black area with edge slightly incurved
- Hind wing with small spots at ends of veins.
- Underside of wings unmarked; fore wing with apical area and hind wing pale dull
- Female- like male but upper side of forewing with light basal black scaling

➤ **HABITS**

- It is a fast flier and is found in wooded regions. It frequently visits flowers.
- The males settle in large numbers on wet patches and damp roads but the females do not. Both sexes go to rest on the undersides of leaves during the heat of the day. It is migratory in habits.

➤ **PLANTS**

- Grass
- *Tridax procumbens*

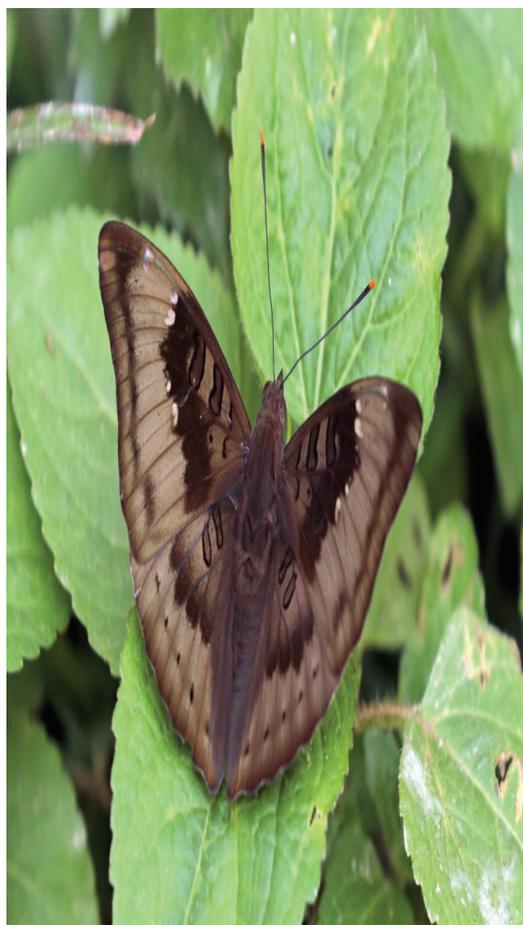
➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

COMMON BARON

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Nymphalidae
Genus:	Euthalia
Species:	E. aconthea
Scientific name	<i>Euthalia aconthea</i>



MORPHOLOGY

Common name: Common baron

Diagnostic Characters: It flies with stiff wing beats and often glides. The wing is not flapped very far below the horizontal.

➤ **MORPHOLOGICAL CHARACTERS**

- Brown with slight traces of olive.
- The forewing has two transverse short black lines at the base, a black loop across the middle, and another beyond the apex of the cell, with their centers dark brown.
- Antennae, head, thorax and abdomen dark brown

➤ **HABITS**

- This butterfly has a stiff flap glide style of flying.
- It flies at low heights and maintains a territory.

➤ **PLANTS**

- *Hibiscus rosasinesis*
- Mango tree

➤ **STATUS**

- common

(Varshney et al. ,2015)

PLUM JUDY

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Riodinidae
Genus:	<i>Abisara</i>
Species:	<i>A. echerius</i>
Scientific name	<i>Abisara echerius</i>



MORPHOLOGY

Common name: Plum judy

Diagnostic characters: Antennae black with scattered pale specks; head, thorax and abdomen maroon-brown; beneath, the palpi, thorax and abdomen paler brown

➤ **MORPHOLOGICAL CHARACTERS**

- Brown with slight traces of olive.
- The forewing has two transverse short black lines at the base, a black loop across the middle, and another beyond the apex of the cell, with their centers dark brown.
- Antennae, head, thorax and abdomen dark brown

➤ **HABITS**

- This active butterfly is usually seen at the tops of trees and amidst foliage.
- It has a habit of landing and turning around almost immediately after alighting.
- It repeats this turning movements as it moves along branches.

➤ **PLANT**

- *Hibiscus rosasinesis*

➤ **STATUS**

- Common

(Kunte, 2006)

TABLE 6: NUMBER OF BUTTERFLIES IN SUBHASH PARK

SPECIES	SCIENTIFIC NAME	FAMILIES	NO:OF BUTTERFLIES
Indian jezebel	<i>Delias eucharis</i>	Pieridae	8
Common albatross	<i>Appias albina</i>	Pieridae	8
Glassy tiger	<i>Parantica aglea</i>	Nymphalida	6
Common mormonn	<i>Papilio polytes</i>	Papilionidae	4
Southern birdwing	<i>Troides minos</i>	Papilionidae	3
Plum judy	<i>Abisara echerius</i>	Riodinidae	5
Common yellow grass	<i>Eurema hecabe</i>	Pieridae	6

TABLE 7: HOST PLANTS OF BUTTERFLIES IN SUBHASH PARK

SL NO.	SPECIES	HOST PLANTS	NO:OF BUTTERFLIES
1	<i>Delias eucharis</i>	Ixora ,Marigold	8
2	<i>Appias albina</i>	Victoria plant ,Grass, <i>Tridax procumbens</i>	8
3	<i>Parantica aglea</i>	<i>Hibiscus rosasinesis</i>	6
4	<i>Papilio polytes</i>	Globe amaranth, <i>Mangifera indica</i>	4
5	<i>Troides minos</i>	Hibiscus,Ixora	3
6	<i>Abisara echerius</i>	Grass	5
7	<i>Eurema hecabe</i>	<i>Tridax procumbens</i> ,lantana	6

TABLE 8: SPECIES DIVERSITY IN SUBHASH PARK

SPECIES	NO:OF BUTTERFLIES(S)	PROPORTION $p_i = S/N$	$\ln(p_i)$	$P_i \ln(p_i)$
<i>Delias eucharis</i>	8	0.2	1.609	0.322
<i>Appias albino</i>	8	0.2	1.609	0.322
<i>Parantica aglea</i>	6	0.15	1.897	0.285
<i>Papilio polytes</i>	4	0.1	2.303	0.230
<i>Troides minos</i>	3	0.075	2.590	0.194
<i>Abisara echerius</i>	5	0.125	2.079	0.260
<i>Eurema hecabe</i>	6	0.15	1.897	0.285

Shannon-Wiener diversity index $H = -\sum[(P_i) \ln(P_i)]$

Where $P_i = S/N$

N=40

H=1.898

TABLE 9: SPECIES RICHNESS IN SUBHASH PARK

SPECIES	N	SPECIES RICHNESS
<i>Delias eucharis</i>	8	18.755
<i>Appias albina</i>	8	18.755
<i>Parantica aglea</i>	6	21.766
<i>Papilio polytes</i>	4	28.133
<i>Troides minos</i>	3	35.499
<i>Abisara echerius</i>	5	24.232
<i>Eurema hecabe</i>	6	21.766

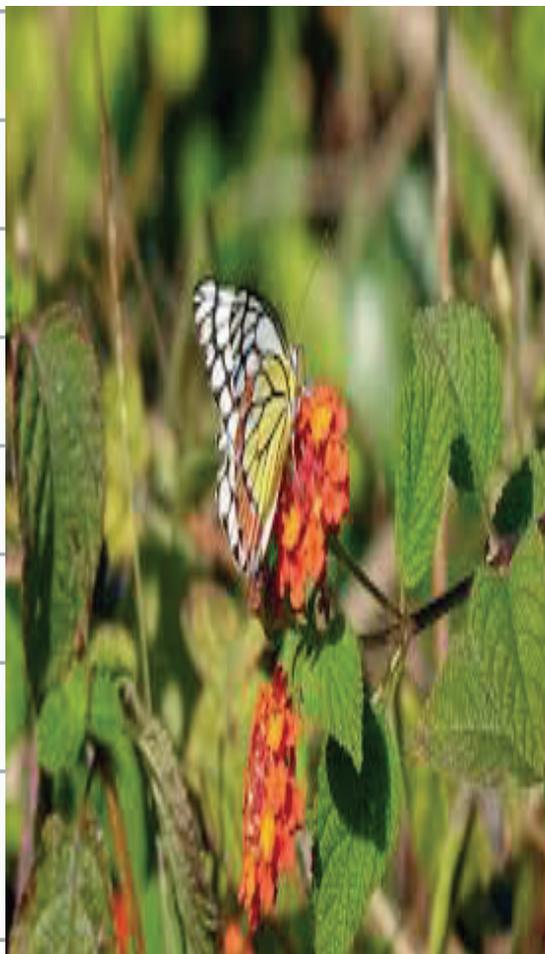
TABLE 10: RELATIVE DOMINANCE IN SUBHASH PARK

SPECIES	n	RELATIVE DOMINANCE n/N X100
<i>Delias eucharis</i>	8	20
<i>Appias albino</i>	8	20
<i>Parantica aglea</i>	6	15
<i>Papilio polytes</i>	4	10
<i>Troides minos</i>	3	7.5
<i>Abisara echerius</i>	5	12.5
<i>Eurema hecabe</i>	6	15

DETAILS OF BUTTERFLIES OBSERVED IN SUBHASH PARK

INDIAN JEZEBEL

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Delias</i>
Species:	<i>D. eucharis</i>
Scientific name	<i>Delias eucharis</i>



MORPHOLOGY

Common name: Common Jezebel

Diagnostic character: Upperside white with black veins and hind wing underside yellow with red border

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side white both fore and hind wings with a black outer discal band
fore wing with black veins
- Sub marginal row of seven white spots the latter
- Underside of forewing white and all the veins heavily marked
- Hind wing yellow with black veins and black border bearing a sub marginal row of six large red spots, each spot edged with a dusting of dull white and having a shape of a square.

➤ **HABITS**

- It is an ornament among the butterflies occurring in India
- The male emits very strong scent which is like that of sweet briar.
- They drink at moist patches on roads and in river beds in the hot weather.

➤ **PLANTS**

- Ixora
- Marigold

➤ **STATUS**

- common

(Gupta & Mridula, 2012)

APPIAS ALBINA (COMMON ALBATROSS)

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Appias</i>
Species:	<i>albina</i>
Scientific name	<i>Appias albina</i>



MORPHOLOGY

Common name: Common Albatross.

Diagnostic characters:

- Upperside white.
- Fore wing with edge of basal black area slightly incurved and blackish apical and marginal markings narrow in male but broader in female.

➤ **MORPHOLOGICAL CHARACTERS**

- Male: Upper side white
- Fore wing with narrow black apical and marginal markings, basal black area with edge slightly incurved
- Hind wing with small spots at ends of veins.
- Underside of wings unmarked; fore wing with apical area and hind wing pale dull
- Female- like male but upper side of forewing with light basal black scaling

➤ **HABITS**

- It is a fast flier and is found in wooded regions. It frequently visits flowers.
- The males settle in large numbers on wet patches and damp roads but the females do not. Both sexes go to rest on the undersides of leaves during the heat of the day. It is migratory in habits.

➤ **PLANTS**

- Victoria plant
- *Tridax procumbens*
- Grass

➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

GLASSY TIGER

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Nymphalidae
Genus:	<i>Parantica</i>
Species:	<i>P. aglea</i>
Scientific name	<i>Parantica aglea</i>



MORPHOLOGY

Common name: Glassy tiger

Diagnostic characters:

- Ground colour fuliginous black with subhyaline bluish-white streaks and spots
- Antennae black; head and thorax black spotted with white; abdomen blackish brown

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side: forewing—interspace 1 with two comparatively long
- Broad streaks united at base, truncate exteriorly; cell with a very broad
- Basal spots in interspaces 2 and 3
- An irregular discal series of three spots and two elongate streaks and a sub terminal series of spots
- The two series curved inwards opposite apex of wing, the latter continued along the apical half of the costa.
- Finally a terminal row in pairs in the interspaces, of much smaller spots.

➤ **HABITS**

- This is a moderately fast, casual flier which feeds on flowers of herbs and scrubs.
- Males extrude yellow colored hair pencils from the back of their abdomen to attract females.
- It is a migratory species.

➤ **PLANTS**

- Napier grass

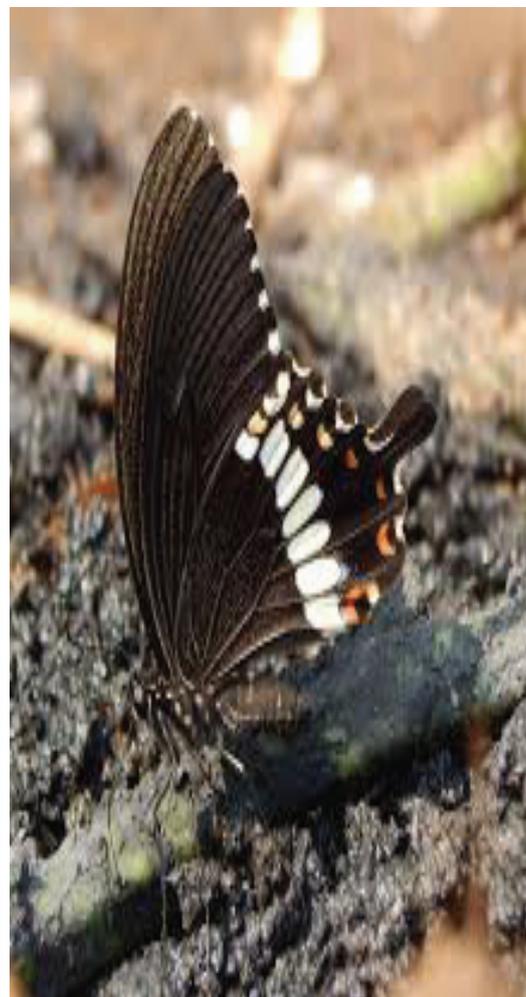
➤ **STATUS**

- Common

(Varshney et al.,2015)

COMMON MORMON

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Papilio</i>
Species:	<i>P. polytes</i>
Scientific name	<i>Papilio polytes</i>



MORPHOLOGY

Common name: Common mormon

Diagnostic characters: Tailed, Upperside black, fore wing with a marginal row of white spots, the latter decreasing in size apically and hind wing with a discal series of elongate white spots.

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side black
- Forewing with prominent marginal white spots, the latter decreasing in size towards apex
- Underside dull black
- fore wing with prominent streaks in cell and between veins
- Hind wing with series of white spots

➤ **HABIT**

- This species shows sexual dimorphism, and polymorphism in female.
- It seldom rises far from the ground. It prefers the shelter of bushes

➤ **PLANTS**

- Globe amaranth
- *Mangifera indica*

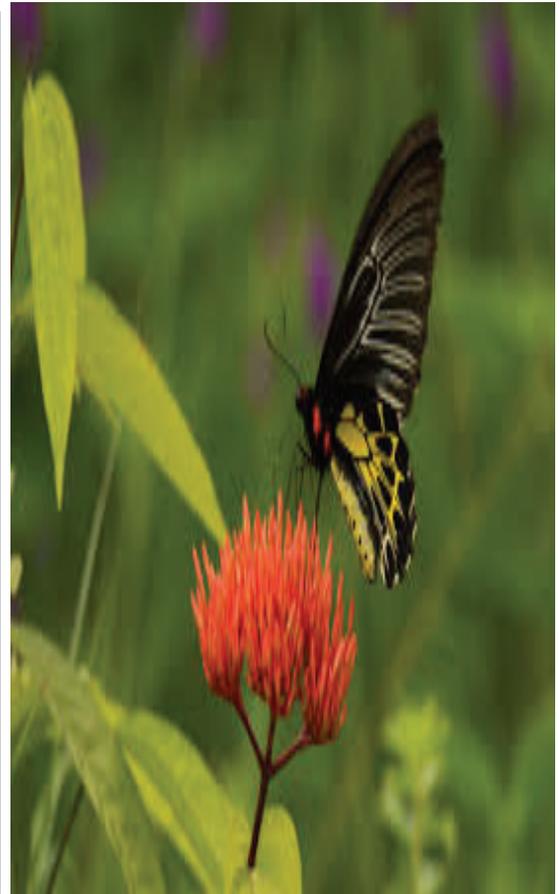
➤ **STATUS**

- Very common

(Gupta & Mridula, 2012)

SOUTHERN BIRDWING

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Papilionidae
Genus:	<i>Troides</i>
Species:	<i>T. minos</i>
Scientific name	<i>Troides minos</i>



MORPHOLOGY

Common name: Common mormon

Diagnostic Characters :Upperside fore wing of male black with a few grey white vein stripes and hind wing golden with black borders and veins , female fore wing with grey white vein stripes and hindwing with a discal row of large triangular black spots.

➤ **MORPHOLOGICAL CHARACTERS**

- Upper side of fore wing glossy black, veins 2-6 edged with white but veins 2-4 prominently white striped than others these stripes continued to cell and united ,hind wing golden with inner area black as far as the cell, veins back and a broad outer marginal black border
- Cone shaped black spots separated by yellow from the broad black border.

➤ **HABIT**

- It has a slow flight and flies high over the trees.

➤ **PLANTS**

- Hibiscus
- Ixora

➤ **STATUS**

- Not rare

(Gupta & Mridula, 2012)

PLUM JUDY

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Riodinidae
Genus:	<i>Abisara</i>
Species:	<i>A. echerius</i>
Scientific name	<i>Abisara echerius</i>



MORPHOLOGY

Common name: Plum judy

Diagnostic characters: Antennae black with scattered pale specks; head, thorax and abdomen maroon-brown; beneath, the palpi, thorax and abdomen paler brown

➤ **MORPHOLOGICAL CHARACTERS**

- Brown with slight traces of olive.
- The forewing has two transverse short black lines at the base, a black loop across the middle, and another beyond the apex of the cell, with their centers dark brown.
- Antennae, head, thorax and abdomen dark brown

➤ **HABITS**

- This active butterfly is usually seen at the tops of trees and amidst foliage.
- It has a habit of landing and turning around almost immediately after alighting.
- It repeats this turning movements as it moves along branches.

➤ **PLANT**

- Grass

➤ **STATUS**

- Common

(Kunte ,2006)

COMMON GRASS YELLOW

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Family:	Pieridae
Genus:	<i>Eurema</i>
Species:	<i>E. hecabe</i>
Scientific name	<i>Eurema hecabe</i>



MORPHOLOGY

Common name: Common grass yellow

Diagnostic characters: Upperside (dorsal surface): yellow, variable in tint from sulphur to rich lemon yellow according to season and locality.

Forewing: apex and termen deep black, this colour continued narrowly along the costal margin to base of wing, near which it often becomes diffuse.

➤ **MORPHOLOGICAL CHARACTERS**

- Forewing: two small spots or specks in basal half of cell and a reniform (kidney-shaped) spot or ring
- Hind wing: a slightly curved
- Sub basal series of three small spots
- An irregular slender ring or spot
- Antennae, head, thorax and abdomen similarly colored

➤ **HABITS**

- Females also have a reduced patch of ultraviolet-reflecting scales located in the proximate region of the dorsal forewing.
- The mechanism responsible for this coloration is the same as in males but the reflectance is less bright.

➤ **PLANT**

- *Tridax procumbens*
- Lantana

➤ **STATUS**

Common

(Swinhoe & Charles, 1905)

FIGURE 1: THE SPECIES DIVERSITY OF BUTTERFLY IN HILL PALACE & SUBHASH PARK

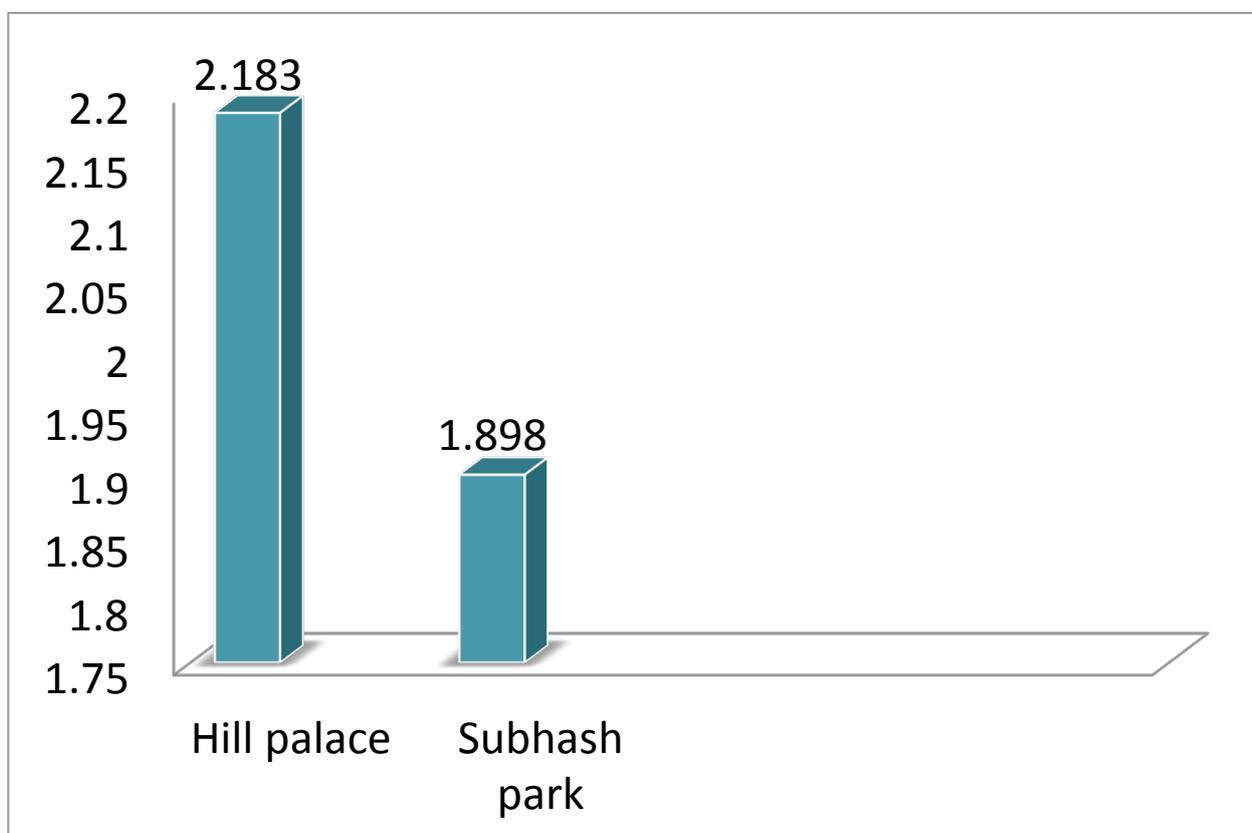


FIGURE 2: THE SPECIES DIVERSITY OF BUTTERFLY IN HILL PALACE & SUBHASH PARK

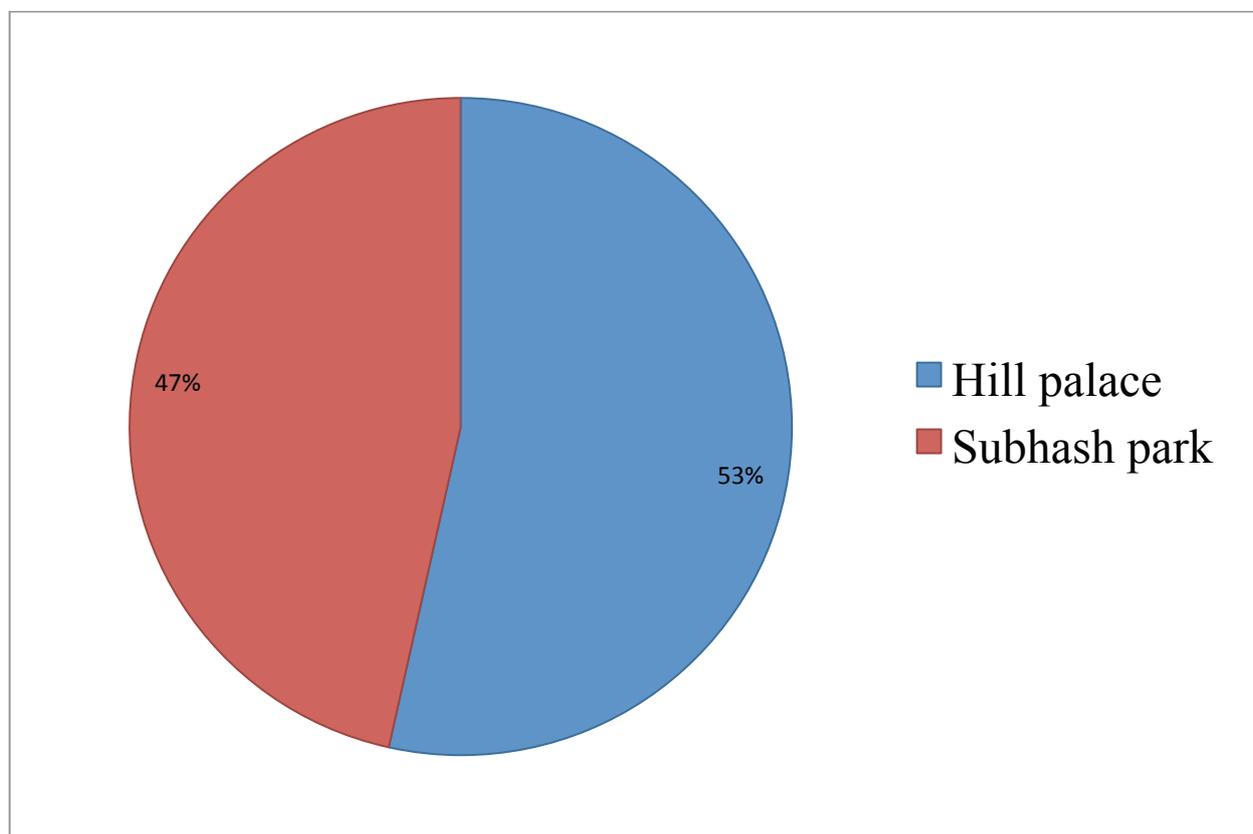


FIGURE 3: RELATIVE DOMINANCE OF BUTTERFLY SPECIES IN HILL PALACE

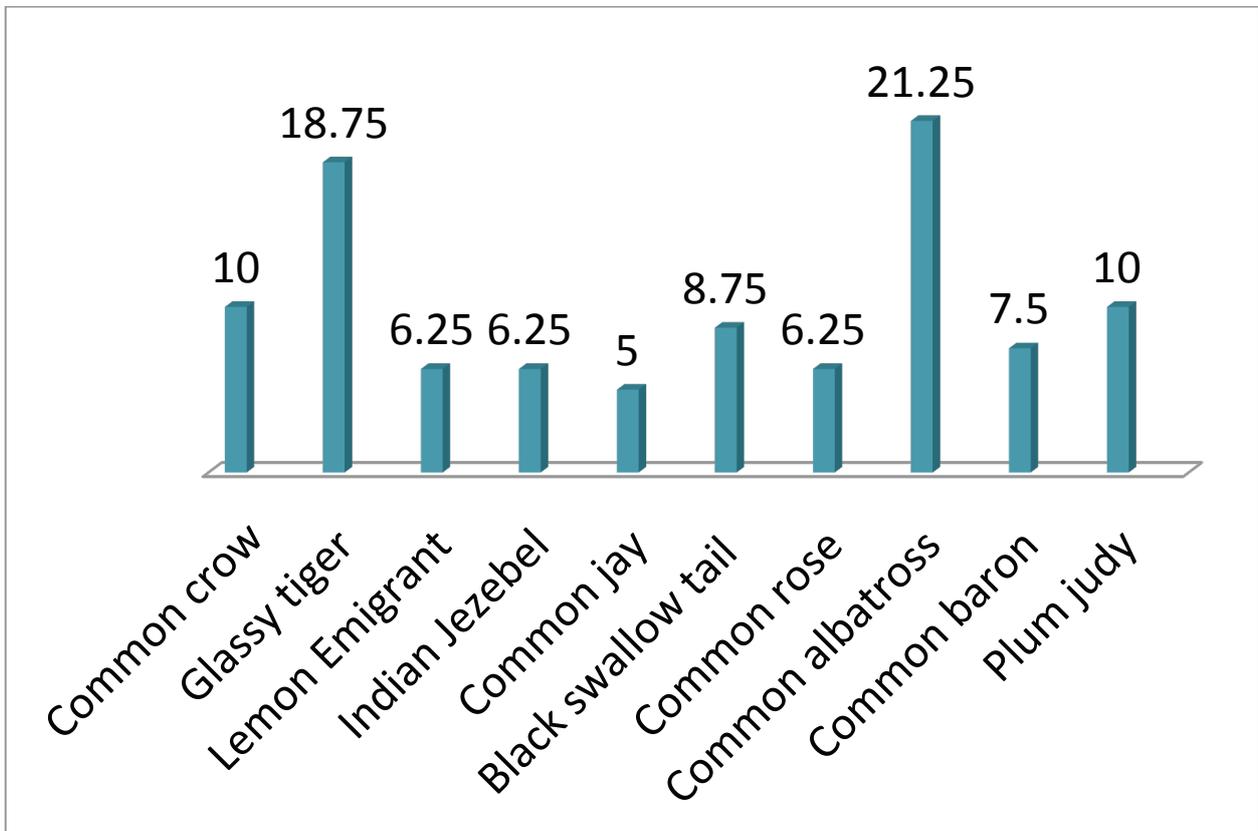
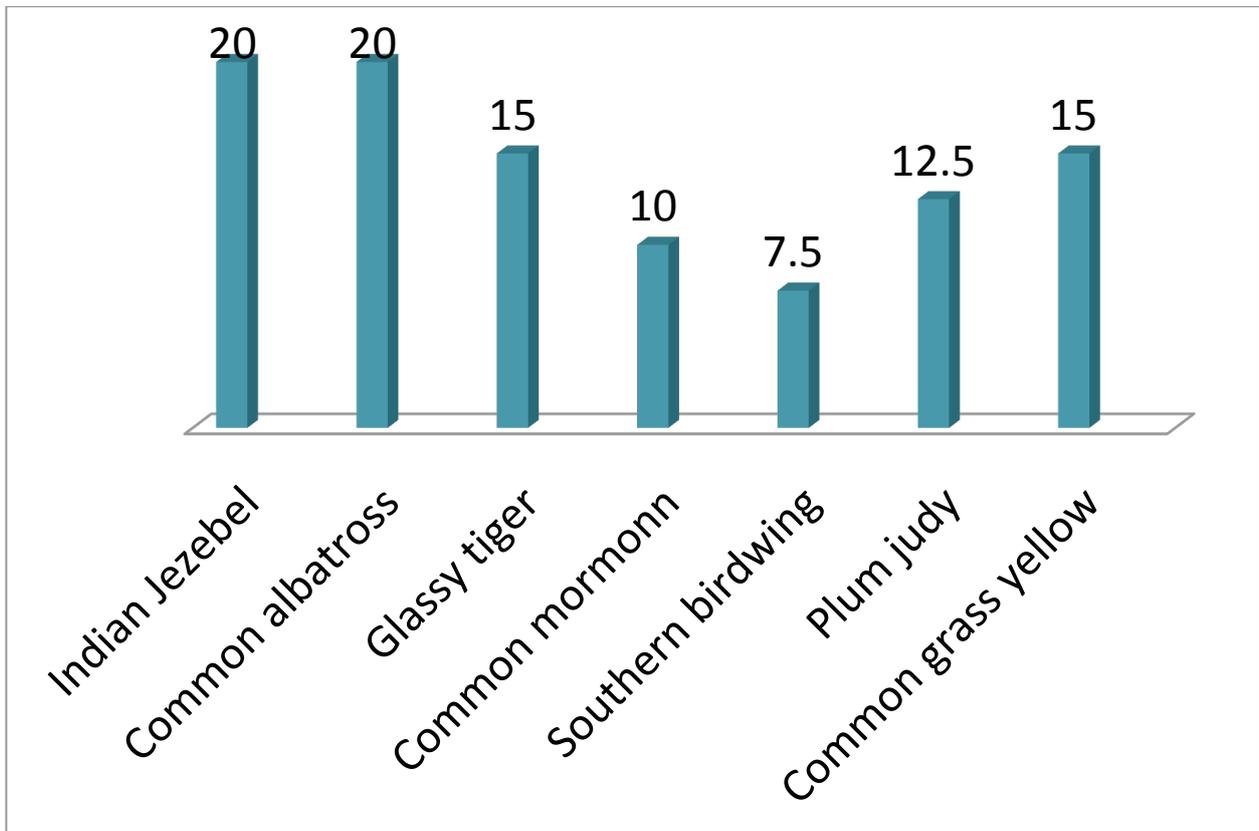


FIGURE 4: RELATIVE DOMINANCE OF BUTTERFLY SPECIES IN SUBHASH PARK



DISCUSSION

A study was conducted to find out the diversity of butterflies at two different sites in Kochi. Butterflies are one of the most conspicuous species of Earth's biodiversity. Being extremely responsive to any changes in their environment, namely temperature, humidity, light and rainfall patterns, these insects are identified as useful bio indicators. Population growth and increased pollution will also affect the occurrence of butterfly species.

Butterflies were collected from different places like Hill palace and Subhash Park on the month of January and February 2022. A total number of **40** butterflies were observed from Subhash Park and **80** from Hill palace. Of these some species were collected from these places using collecting nets and other methods. The butterflies caught were identified up to the family level with the help of Google lens. The observed butterflies falls in 4 families and 13 species. Nymphalidae, Pieridae, Rionidae, and Papilionidae are the families.

The species diversity, relative dominance and species richness were calculated from the collected data. The present study reflects the richness and diversity of butterflies in less polluted, area such as Hill palace. This was due to the presence of large amount of nectar producing plants and suitable conditions for their growth. Through the case study conducted in Subhash Park, it was observed how the increase in population may affect the diversity of butterfly species. Hill palace is less polluted and many species were also observed due to large area.

Among the two sites taken, Hill Palace had the highest diversity of species. In case of Hill Palace, mean species diversity was 2.183. More number of species were found in Hill palace than in Subhash park. Hill palace had species diversity 2.183 while in Subhash Park diversity was 1.898. During the study butterflies were recorded from two study sites and these belongs to the four families namely Pieridae, Papilionidae, Nymphalidae and Rionidae. The most abundant species recorded from the study sites was common albatross butterfly. Indian jezebel, common albatross, glassy tiger, plum judy were found in all places. Lemon emigrant found in both Hill palace and Subhash park was roaming around the grass. The butterflies collected were of different sizes. Some were brightly colored, attractive and hence easily found. Shannon-Wiener diversity index was more in Hill palace and less was observed in Subhash park. Species richness was calculated using Margalef's index.

From the above observations, even though Subhash park has butterfly garden, which is located at the centre of the city, is found to be more polluted due to the high amount of pollutants released from the vehicles and lesser number of trees compared to other areas.

Hill palace had more trees, shrubs, climbers, creepers. It comprises of many flowering plants (*Ixora coccinea*, *Saraca asoca*), citrus plants (*Citrus limon*, *Citrus grandis*) and all are beautifully maintained. Ornamental plants such as bougainvillea and roses were also observed in Hill palace. Habitat and host plants were also observed. The following plants were Ixora, marigold, grass, *Tridax procumbens*, victoria, globe amaranth, *Mangifera indica*, Hibiscus, lantana, nerium, mimosa, ferns, bougainvillea, ficus, acasia, citrus, bamboo,

Ashoka tree etc. Common albatross were found mostly surrounding the grass. Common grass yellow was mainly seen roaming around *Tridax procumbens*.

Due to pollution and radiation, number of butterflies observed were less in Subhash park as compared to Hill palace. Due to the presence of large amount of nectar producing plants and suitable conditions for the growth, more number of species were observed in Hill palace. Relative dominance were also calculated. Due to the harmful gases and chemicals liberated by the industries, affects the life of butterflies. Radiation from various resources also affects butterflies in the ecosystem. The main causes for the decline of butterfly populations are deforestation, habitat destruction for urbanization, industrialization and agriculture causes changes in temperature, humidity and rainfall. Prevalence of unfavorable weather conditions often affect habitat suitability leading to local extinction of butterflies. Unfortunately, developmental activities and resulting habitat fragmentation create threats to the survival of butterflies worldwide. The present study mainly concentrates on butterfly diversity, habitat preference like gardens, grasslands, shrubs.

Butterflies, perhaps because they are mobile exotherms, respond extremely rapidly to environmental disturbance or degradation, especially those involving temperature changes, and are well studied ecologically. The greatest threats to butterflies are habitat change and loss due to residential, commercial and agricultural development. Climate change is also threatening species of butterfly because of the unscientific developmental activities of man, the habitats of many species of butterflies have been altered, threatening to their survival. Species loss has tremendous implications on the survival of mankind in this universe. It has been estimated that there has been a loss of 50% forest cover in the past 50 years in the Western Ghats (Goanker,1996).

Due to large scale ecological disturbances, many species are facing extinction. Since the butterflies are good bio indicators of environment, they can be used to identify ecologically important landscapes for conservation purpose (Barlow et al.,2008). Butterfly gardens help in caring wild butterfly population and to maintain the biodiversity in natural ecosystems, which in turn, may increase the existence of human beings.

CONCLUSION

A total number of 40 butterflies were observed from Subhash Park and 80 from Hill palace. The observed butterflies falls in 4 families and 13 species. Nymphalidae, Pieridae, Rionidae, and Papilionidae are the families. Among the two sites taken, Hill Palace had the highest diversity of species. In case of Hill Palace, mean species diversity was 2.183. More number of species were found in Hill palace than in Subash park. Hill palace had species diversity 2.183 while in Subhash Park diversity was 1.898. Indian jezebel, common albatross, glassy tiger, plum judy were found in all places. The above observations, Subhash park which is located at the centre of the city, is found to be more polluted due to the high amount of pollutants released from the vehicles and lesser number of trees compared to other areas. Due to pollution and radiation, number of butterflies observed were less in Subhash park as compared to Hill palace. Due to the presence of large amount of nectar producing plants and suitable conditions for the growth, more number of species were observed in Hill palace. The main causes for the decline of butterfly populations are deforestation, habitat destruction for urbanization, industrialization and agriculture causes changes in temperature, humidity and rainfall. Prevalence of unfavorable weather conditions often affect habitat suitability leading to local extinction of butterflies. The present list of butterfly species is not conclusive and exhaustive therefore future exploration will be continued to update this checklist. Further studies are needed to explore more species in the study area. Furthermore, long term research and monitoring on the diversity of butterflies with special reference to ecological aspects may be taken up in the area. In addition further research is required inorder to protect species of concern.

HILL PALACE





SUBHASH PARK



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STUDY ON FISH DIVERSITY



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CERTIFICATE

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Abstract

This study focused on fish diversity in Pallippuram region of Alappuzha district and Puthuvypeen region of Ernakulam district. The study was conducted on March 2022. During the study period a total of 29 species of fishes belonging to 20 families were identified from Pallippuram region & a total of 51 species of fishes belonging to 34 families are identified from Puthuvypeen region. Comparing the diversity of finfish, crustation, and mollusc the finfishes are seen in large number then comes crustation and molluscs. In Puthuvypeen region, out of the 34 family Penaeidae dominated first with five species of fishes & in Vembanadu lake out of 20 families Cyprinidae dominated first with four species of fishes. The result of the study indicates that Pallippuram region of Vembanad lake & Puthuvypeen region is rich in fish diversity.

Introduction

As a tropical country, India boasts a rich diversity of flora and fauna and is listed among the world's mega biodiversity countries. There is growing concern about the increasing human effect that has occurred in recent years on marine biodiversity. According to marine and coastal waters of Kerala are considered as the most significant ecosystems in terms of productivity and uniqueness. With the rapid overall development of the country, the aquatic ecosystems are under constant pressure of man-induced stresses to the fishes. Though the decline of individual fish species is very often related to more than one proximate factors; Physical habitat loss due to construction of dams and weirs across the rivers, soil erosion due to deforestation and excessive utilization of waters, Chemical pollution due to industrial and municipal wastes, Over-exploitation and indiscriminate killing of juveniles and brood fishes. This study is meant to make an inventory of fishes, crustaceans and molluscs of the areas, pallipuram and puthuvypeen region with a view to act as a baseline data for future studies.

Vembanad lake is the transitional ecotone lying parallel to the Arabian Sea and encompassing mangroves, mudflats, swamps and marshes. The ecosystem provide a harsh environment, many species of fishes have found them to be an ideal place for spawning, development and growth during their early life. Rich biodiversity and ecological value made vembanad Lake to be identified as a Ramsar site in November 2002. Vembanad lake is among the most productive life-supporting coastal wetland in Kerala, having length 96km, and surface area of 1512km².

Six Rivers bring fresh water into vembanad lake and it has to permanent opening to the Arabian Sea, one at Cochin other at Azhikode.

A study on the status and Trends of back water fisheries is the key to sound policy development, better decision making and responsible fisheries management .A study on the distribution of fish diversity in Pallipuram region of vembanad lake. Henceforth in present investigation attempt has been made to identify finfish and shellfish fauna in that region.

Puthuvypeen (also called as puthuvype) upcoming major industrial area in Kochi in the Indian state Kerala. It is a western Suburb of Kochi (colonial name: Cochin) city and is a part of Vypin island which is 24 km long and 2.6 km wide. Vypin Island has a total area of 87.85 km². Island is situated on the western side of Ernakulam District with Kodungallor Strait on the North, Cochin backwaters and Cochin port on the south, River Periyar and Kochi City on the east and Arabian sea on the west. Island is connected to the city by three bridges known as Goshree"bridges. The ecology of Vypin Island is unique, endowed with Canal extending over 50 km and a network of small canal emerging therefrom. The population of Vypeen is estimated at more than 2 lakhs, with one among the highest density of population in the world(more than 2200 people per km²). Industries located to Puthuvypeen mainly related to natural gasification project and petroleum project such as LNG terminal, single buoy mooring, bunkering terminal and ship repair complex. The present study was meant to make an Inventory of fishes, crustaceans and molluscs of the area with a view to act as a baseline data for future studies. There are many studies on the fishes of Vembanad Lake study area, the whole lake or the selected section of the lake. However a limited number of studies are known to exist on diversity of fish and shellfish population specifically of Puthuvypeen area.

Review of literature

Mogalekar, et al(2015) have done a pioneering study on fish diversity of Vembanad Lake in the PanangadKumbalam region of Kochi, Kerala,India. According to this study The Vembanad Lake is second largest brackish water lake in the India. The status of fish diversity and seasonalvariation in their distribution and abundance were investigated in Vembanad Lake at Panangad- Kumbalam backwater. In total 48 samples have been analyzed which were taken throughout June 2012 to May 2013. A total 2231 individuals were encountered, comprising 39 species of finfishes belonging to 27 families, 11 orders and 31 genera. Fish abundance was high during pre-monsoon season (780 numbers), whereas low during post monsoon season (455 numbers). They estimates from these indices were indication of high fish species composition and richness.

Krishnakumar and Priyadarsanan (2008-2011) done a study on Fish and Fisheries in Vembanad Lake. According to this study the main objective of his participatory assessment is to bringto the declining status of inland fisheries in theVembanad Lake and to createa pcommon platform to consolidate attentionof all concerned, including the policy makers todiscuss conservation issues.

Asha , et al(2014) done a study on Decline in Diversity and Production of Exploited Fishery Resources in Vembanad Wetland System: Strategies for Better Management and Conservation. This paper describes the fishery catch structure of Vembanad wetland system during August 2012 to July 2013. The estimates of fishery production indicated an annual landing of 4387.31 t, in which 480.98t and 3906.33t contributed by southern and northern zone of Vembanad respectively. Eighty species of finfishes, five species of penaeid shrimps, three species of palaemonid prawns and two species of crabs were identified from the study period.

The catch per unit effort (CPUE) value was maximum for gill net (3.04 kg·h⁻¹) followed by stake net (2.43 kg·h⁻¹), Chinese dip net (2.01 kg·h⁻¹), seines (1.2 kg·h⁻¹), cast net (0.72 kg·h⁻¹) and hook and line (0.34 kg·h⁻¹). Biological integrity and fishery production of estuaries in the country are declining mainly due to various man induced activities. Thaneermukkom barrage, the salinity barrier, constructed across the Vembanad wetland system in 1976, transforming the waterbody into two distinct ecosystems, a fresh water zone on the south and a brackish water zone on the north, resulting in gross changes in physical, chemical and biological entity of the aquatic ecosystem. In the southern zone of Vembanad the marine fish species were less available with the closure of the barrage period. There are signs of decline of the Vembanad fishery resources, evident in the lesser number of species and decline of fishery production. This will lead to biodiversity loss, fish stock reduction and will ultimately affect the livelihood support of the traditional fishers to a large extent, besides affecting other ecological services. A better conservation measure must be implemented for maintaining the sustainable fishery resources in Vembanad.

Ansar, et al(2015) have done a study on Biodiversity of Decapod Crustacean in the Vembanad Lake at Panangad-Kumbalam Region of Kochi, Kerala. Vembanad Lake is a massive and vibrant coastal wetland ecosystem in India. Status of decapod crustacean diversity and seasonal variation in their distribution and abundance were investigated in the Vembanad Lake at Panangad - Kumbalam backwater. In total 730 individuals were encountered, comprising 20 species of decapod crustaceans belonging to 5 family and 10 genera. About 7 species of Penaeid shrimp belonging to 2 genera, 5 species of Palaemonid prawn belonging to 2 genera, 5 species of Portunid crab belonging to 3 genera, 2 species of Sesamid crab and one species of Ocypodi crab were identified. The species diversity was high during pre-monsoon (42%), whereas low during post monsoon (13%).

The calculated values of various diversity indices included Shannon– Wiener diversity (H') ranged from 2.18 to 2.81, Margalef's species richness (d) ranged from 1.90 to 3.12, Pielou's evenness (J') ranged from 0.86 to 0.92, Taxonomic diversity (D) ranged from 46.71 to 61.09, Average taxonomic distinctness (D^+) ranged from 53.33 to 67.32, Variation in taxonomic distinctness (Lambda^+) ranged from 227.78 to 457.46 and total phylogenetic diversity index ($s\text{Phi}^+$) ranged from 466.66 to 900. Ecological status of decapod crustacean diversity in the study area was moderate as per the estimated values of diversity index.

A study on the ichthyofauna of Aymanam panchayath in Vembanad wetland, Kerala was carried out by Narayanan et al (1980-1982). A total of 37 species of fishes belonging to 18 families and nine orders were recorded. Order Perciformes showed maximum family diversity. The highest number of species belonged to family Cyprinidae. Nine of the 34 freshwater species recorded are threatened. One exotic species *Poecilia reticulata* was also noted.

Krishnakumar et al (2011) have done a study on Unregulated aquaculture and invasive alien species: a case study of the African Catfish *Clarias gariepinus* in Vembanad Lake (Ramsar Wetland), Kerala, India. As per the report Indiscriminate and illegal farming of the African Catfish *Clarias gariepinus*, in central Kerala has now resulted in the escape and spread of the species into Vembanad Lake, a large brackish water wetland and inland fish diversity hotspot. We collected 17 individuals of *C. gariepinus* ranging in size from 200 to 750 mm from different locations in the southern sector of the lake during a field survey conducted in 2007. Samples comprised of mature specimens of both sexes indicating their reproductive potential in the study area. The possible impacts of spread of *C. gariepinus* into natural water bodies of Kerala, especially the Vembanad Lake, and options for their management are discussed.

An interesting study of Synudeen Sahib (2018) on Fish diversity in Vembanad Lake, Kerala, India. Study reports that Vembanad Lake is under increasing pressures from anthropogenic and climate factors. The study evaluated the fish diversity in Vembanad Lake in order to ascertain its health. Fish samples caught with different types of nets namely cast net and gill net were collected from September 2012 to February 2013 from local fishers at the fish landing centre. A total of 20 species belonging to 18 families and 19 genera were recorded from the study area during the present study. Diversity of fishes and threats to the fauna are discussed. The low fish species composition denotes that Vembanad Lake is threaten, that is, undergoing degradation.

A study conducted by Vijayasree and Radhakrishnan (2014) on Fish Diversity of Kuttanad's River System, Kerala State, India. As per the study India is known for its inland fishery resources and once with rich indigenous fishery resources with great biodiversity. The poor inland fishers and rural community depended for their livelihood and food security on these indigenous species. The present investigation has been conducted to identify the fishes of the Kuttanad River from January to May 2014 at weekly intervals. A total of 62 freshwater species from 17 families were found during our survey. The fishes were divided into three groups' viz., cultivable fishes, food fishes and ornamental fishes. Among cultivable fishes order Cypriniformes were dominated by 6 species, followed by Perciformes (3 species) and Siluriformes (2 species). The order Anguilliformes and Beloniformes were represented by 1 species each. A total of 11 species were identified as cultivable fishes. The number of food fishes identified were 22 species under investigation. The dominant group belongs to the family Siluridae (7 species) followed by Cyprinidae (6 species). 5 species were identified under the order Perciformes. Synbranchiformes and Beloniformes by 3 and 1 species respectively. Maximum fish species identified were ornamental fishes (28 species).

The order Cypriniformes alone represented 22 species. The identified fishes of the order Beloniformes were 3, Siluriformes by 2 and Tetraodontiformes by 1 species. The results of the present study clearly showed that the fish fauna of the River is highly diverse and proper management is essential for the conservation of the fish biodiversity.

Salu , Sasi&Ambili(2019) done a study on the diversity of fishes in Thodupuzha River, Idukki District, Kerala. It is a tributary of Muvattupuzha River, Kerala. The present study was conducted to document the diversity of fishes in Thodupuzha River, Idukki District, Kerala. It is a tributary of Muvattupuzha River, Kerala. The study period was during December 2018 to February 2019. There are about 19 species of fishes were collected and identified. Currently, the river is under severe ecological degradation due to sand mining and other anthropogenic activities. Despite this, the present study also highlights the rich diversity of fishes in this river, hence it is suggested that these river been protected to conserve for future generation.

Vijayasree, and Radhakrishnan(2014) done a study on Fish Diversity of Kuttanad's River System, Kerala State, India India is known for its inland fishery resources and once with rich indigenous fishery resources with great biodiversity. The poor inland fishers and rural community depended for their livelihood and food security on these indigenous species. The present investigation has been conducted to identify the fishes of the Kuttanad River from January to May 2014 at weekly intervals. The results of the present study clearly showed that the fish fauna of the River is highly diverse and proper management is essential for the conservation of the fish biodiversity.

Sojomon Mathew(2022) have done a study on Ichthyofauna diversity of Meenachil River, Thazhathangady Region, Kottayam, Kerala The study was conducted to understand the Ichthyofauna diversity of Meenachil River – Thazhathangady region. The Meenachil river, originating from Western Ghats is a degrading riverine ecosystem in Central Kerala of India, may be the only river inKerala which is characterized by the presence of human settlement right from the source of the river till it confluences at Vembanad lake, India’s second largest wetland ecosystem. Thazhathangady region is a place with a rich indigenous fishery resource with great biodiversity.

The present investigation has been conducted to identify the fishes in the Thazhathangady region which is a part of the Meenachil River for a period of 6 months (July 2019 to December 2019) at an interval of 15 days.A total of 44 freshwater species was found during our survey; out of this 20 species are selected for our study. It includes cultivable fishes and food fishes.

Methodology

Fishes have great diversity and hence can be classified in different categories. The backwater and the sea in puthuvypeen and the vembanad lake have great diversity of fish. For studying the fish diversity, visit the area that is selected for studying. The data are collected from the pallipuram region of vembanad lake and from the puthuvypeen at alternate 3 days in March 2022. The fishes are collected by the fisherman from the sea, backwater and lake, using fishing net. There are different kinds of fishes that live in different habitats so that the fishes that get from sea, lake, and backwater are different based on their habitat, and also the fishes that caught in the different nets are also different. The collected fish were identified using different methods. Fishes were identified with the help of fishermen, by taking photos, and with the help of Google lens. The fishes that are identified were grouped into a table. The table should contain the details about the fish such as its scientific name, Common name and family.

Result

Table 1.

Fish Diversity in Vembanadu lake at Pallippuram Region of Alappuzha District

Common name	Scientific name	Family	IUCN Status
Red tipped half beak	<i>Hyporhamphus xanthopterus</i>	<i>Hemiramphidae</i>	VU
Indian anchovy	<i>Stolephorus indicus</i>	<i>Engraulidae</i>	NE
Spotted scat	<i>Scatophagus argus</i>	<i>Scatophagidae</i>	LC
Small Bengal silverbidy	<i>Gerres setifer</i>	<i>Gerreidae</i>	NE
Tilapia	<i>Oreochromis mossambicus</i>	<i>Cichlidae</i>	NE
Pearl spot	<i>Etroplus suratensis</i>	<i>Cichlidea</i>	LC
Orange chromide	<i>Etroplus maculatus</i>	<i>Cichlidea</i>	LC
Stripped snakehead	<i>Channa striata</i>	<i>Channidae</i>	LC
Climbing perch	<i>Anabas testudineus</i>	<i>Anabantidae</i>	DD
Glassy perche	<i>Chanda nama</i>	<i>Ambassidae</i>	LC
Mullet	<i>Mugil cephalus</i>	<i>Mugilidae</i>	LC
Milk fish	<i>Chanos chanos</i>	<i>Channidae</i>	NE
Blue panchax	<i>Aplocheilus panchax</i>	<i>Aplocheilidae</i>	LC
Banded snake head (varaal)	<i>Channa striata</i>	<i>Channide</i>	LC

Striped panchax	<i>Aplocheilus lineatus</i>	<i>Aplocheilidae</i>	<i>LC</i>
Slender rasbora	<i>Rasbora daniconius</i>	<i>Cyprinidae</i>	<i>LC</i>
Freshwater garfish	<i>Xenentodon cancila</i>	<i>Belonidae</i>	<i>LC</i>
Short finned eel	<i>Anguilla australis</i>	<i>Anguillidae</i>	<i>NT</i>
Stinging catfish	<i>Heteropneustes fossilis</i>	<i>Heteropneustidae</i>	<i>LC</i>
Striped Dwarf Catfish	<i>Mystus vittatus</i>	<i>Bagridae</i>	<i>LC</i>
Wallago	<i>Wallago attu</i>	<i>Siluridae</i>	<i>NT</i>
Catla	<i>Catla catla</i>	<i>Cyprinidae</i>	<i>LC</i>
Rohu	<i>Labeo rohita</i>	<i>Cyprinidae</i>	<i>LC</i>
Olive barb	<i>Systemus sarana</i>	<i>Cyprinidae</i>	<i>LC</i>
Oriental sole	<i>Brachirus orientalis</i>	<i>Solidae</i>	<i>NE</i>
Zig-zag eel	<i>Mastacembelus armatus</i>	<i>Mastacembelidae</i>	<i>LC</i>

Table 2

Diversity of Crustaceans in Vembanadu lake at Pallippuram

Region of Alappuzha District.

Common name	Scientific name	Family	IUCN Status
Indian white prawn	<i>Fenneropenaeus indicus</i>	<i>Penaeidae</i>	<i>NE</i>
Giant tiger prawn	<i>Penaeus monodon</i>	<i>Penaeidae</i>	<i>NE</i>
Giant freshwater prawn	<i>Macrobrachium rosenbergii</i>	<i>Palaemonidae</i>	<i>NE</i>

Table 3.**Diversity of Backwater Fishes of Puthuvypeen Region at Ernakulam****District**

Common name	Scientific name	Family	IUCN Status
Pearl spot (karimeen)	<i>Etroplus suratensis</i>	<i>Cichlidae</i>	<i>LC</i>
Tilapia (thilopia)	<i>Oreochromis mossambicus</i>	<i>Cichlidae</i>	<i>NE</i>
Tiger Panchax (pochutti)	<i>Aplocheilus lineatus</i>	<i>Aplocheilidae</i>	<i>NE</i>
Orange chromide (pallathi)	<i>Etroplus maculatus</i>	<i>Cichlidae</i>	<i>LC</i>
Mullet (kanambu)	<i>Mugil cephalus</i>	<i>Mugilidae</i>	<i>LC</i>
Spotted scat	<i>Scatophagus argus</i>	<i>Scatophagidae</i>	<i>LC</i>
Tank goby (poolan)	<i>Glossogobius giuris</i>	<i>Gobiidae</i>	<i>LC</i>
Banded snake head (varaal)	<i>Channa striata</i>	<i>Channidae</i>	<i>LC</i>
Stinging catfish (kaari)	<i>Heteropneustes fossilis</i>	<i>Heteropneustidae</i>	<i>LC</i>
Walking catfish (muzhi)	<i>Clarias batrachus</i>	<i>Clariidae</i>	<i>LC</i>
Long whiskered catfish (vellakkoori)	<i>Sperata aor</i>	<i>Bagridae</i>	<i>LC</i>
Climbing Perch (chempally)	<i>Anabas testudineus</i>	<i>Anabantidae</i>	<i>DD</i>
Giant danio (paral)	<i>Devario aequipinnatus</i>	<i>Cyprinidae</i>	<i>LC</i>
Yellow catfish (manjakkooari)	<i>Pylodictis olivaries</i>	<i>Ictaluridae</i>	<i>NE</i>
Peninsular olive barb	<i>Puntius sarana</i>	<i>Cyprinidae</i>	<i>LC</i>

Table 4.

Diversity of Marine fishes in Puthuvypeen Region of Ernakulam District

Common name	Scientific name	Family	IUCN Status
Goldstripe sardinella(mathi)	<i>Sardinella gibbosa</i>	<i>Clupeidae</i>	<i>LC</i>
IndianOil sardine	<i>Sardinella Longiceps</i>	<i>Clupeiae</i>	<i>LC</i>
Indian mackerel	<i>Rastrelliger kanagurta</i>	<i>Scombridae</i>	<i>DD</i>
Silver pomfret	<i>Pampus argenteus</i>	<i>Stromateidae</i>	<i>VU</i>
Kawa kawa(choora)	<i>Euthynnus affinis</i>	<i>Scombridae</i>	<i>LC</i>
Fin tuna(choora)	<i>Thunnus orientalis</i>	<i>Scombridae</i>	<i>LC</i>
Pink perch(kilimeen)	<i>Nemipterus japonicus</i>	<i>Percidae</i>	<i>LC</i>
Indian anchovy(kozhuva)	<i>Stolephorus indicus</i>	<i>Engraulidae</i>	<i>NE</i>
Sole fish (maanthal)	<i>Cynoglossus semifasciatus</i>	<i>Soleoidei</i>	<i>LC</i>
Bluefin trevally	<i>Caranx melampygus</i>	<i>Carangidae</i>	<i>LC</i>
Malabar thryssa(manangu)	<i>Thryssa malabarica</i>	<i>Engraulidae</i>	<i>LC</i>
White Sardine	<i>Escualosa thoracat</i>	<i>Clupeidae</i>	<i>LC</i>

Bartail flat head	<i>Platycephalus indicus</i>	<i>Platycephalidae</i>	<i>DD</i>
Red snapper	<i>Lutjanus campechanus</i>	<i>Lutjanidae</i>	<i>VU</i>
Glass fish	<i>Parambassis ranga</i>	<i>Ambassidae</i>	<i>LC</i>
Atlantic bumper	<i>Chloroscombrus chrysurus</i>	<i>Carangidae</i>	<i>LC</i>
Golden thread fin	<i>Nemipterus virgatus</i>	<i>Nemipteridae</i>	<i>VU</i>
Spotless smooth-hound	<i>Mustelus virgatus</i>	<i>Triakidae</i>	<i>EN</i>
Yellow tail barracuda	<i>Sphyraena flavicauda</i>	<i>Sphyraenidae</i>	<i>VU</i>
Silver moony fish	<i>Monodactylus argenteus</i>	<i>Monodactylidae</i>	<i>LC</i>
Yellow goat fish	<i>Mulloidichthys martinicus</i>	<i>Mullidae</i>	<i>LC</i>
Brown-banded rockcod	<i>Cephalopholis boenak</i>	<i>Serranidae</i>	<i>LC</i>
Whipfin silver-biddy	<i>Gerres filamentous</i>	<i>Gerreidae</i>	<i>LC</i>

Table 5.

Diversity of Crustaceans in Puthuvypeen Region of Ernakulam

District

Common name	Scientific name	Family	IUCN Status
Indian white prawn	<i>Fenneropenaeus indicus</i>	<i>Penaeidae</i>	<i>NE</i>
Black tiger prawn	<i>Penaeus monodon</i>	<i>Penaeidae</i>	<i>NE</i>

Green tiger prawn	<i>Penaeus semisulcatus</i>	<i>Penaeidae</i>	<i>NE</i>
Brown shrimp	<i>M.affinis</i>	<i>Penaeidae</i>	<i>NE</i>
Mangrove crab	<i>Scylla serrata</i>	<i>Portunidae</i>	<i>NE</i>
Green mud crab	<i>S.tranquibarica</i>	<i>Portunidae</i>	<i>NE</i>
Stripped barnacle	<i>Balanus amphitrite</i> <i>Darwin</i>	<i>Palaemonidae</i>	<i>NE</i>
Three dotted crab	<i>Portunus</i> <i>sanguinolentus</i>	<i>Portunidae</i>	<i>NE</i>
Flower crab	<i>Portunus pelagicus</i>	<i>Portunidae</i>	<i>NE</i>
White shrimp	<i>Peanus indicus</i>	<i>Penaeidae</i>	<i>NE</i>

Table 6.

Diversity of Molluscs in Puthuvypeen Region of Ernakulam District

Common name	Scientific name	Family	IUCN Status
Indian fresh water mussel	<i>Lamellidens marginalis</i>	<i>Unionidae</i>	<i>LC</i>
Green mussel	<i>Perna viridis</i>	<i>Mytilidae</i>	<i>NE</i>

Discussion

Venbanad lake was very rich in diversity, A total of 29 species of fishes belonging to 20 families were identified during the study period. Among the 29 species, 26 are fin fishes and 3 are crustaceans. Out of 20 families Cyprinidae dominated first with four species of fishes. Cichlidae was secondly dominated representing three species, the next was Channidae, Aplocheilichthys and Penaeidae having two species each and the rest of the family have one species. According to IUCN status 17 species are in least concern, one is vulnerable (red tipped half beak), 2 are near threatened species, 8 of them are not evaluated & one is data deficient (climbing perch).

The Puthuvypeen region in Ernakulam district was very rich in diversity. A total of 51 species of fishes belonging to 34 families are identified during the study period. Among them 23 are backwater fishes of 17 different families. It includes different categories of fishes (12 finfish, 7 crustaceans and 1 mollusc). There are 30 species of marine fishes belonging to 22 families were identified (23 finfish, 5 crustaceans and 2 molluscs). Out of the 34 families Penaeidae dominated first with five species of fishes. Portunidae was secondarily dominated with four species and Cichlidae, Clupeidae, Scombridae coming next with three species and Cyprinidae, Engraulidae, Carangidae with two species and the rest of the family have one species each. According to IUCN status 27 are in least concern among them 11 are backwater fishes, 15 are marine fishes & 1 mollusc, 4 species are vulnerable (marine fishes), 15 of them are not evaluated among them 3 are backwater, 12 marine (1 finfish, 10 crustaceans, 1 mollusc), 3 are data deficient (among them 1 is backwater and 2 are marine finfish), 1 species is endangered (spotless smooth hound) marine fish.

Backwaters of Puthuvypeen region is rich in fish diversity than the vembanadu lake in pallipuram region. Most of the fishes found are common in both region. Large number of finfishes were identified from both regions. When compared to the puthuvypeen region diversity of fish was less in vembanadu lake because of the pollution of waterbodies. Now it become one the most polluted water in the world. Pesticide residue from the fields and nutrient discharge from urban settlements are one of the major reason for the pollution of Vembanad Lake and also it is polluted by various organic and household waste, industrial activities and anthropogenic activities like agricultural disposal and land reclamation. Houseboat tourism, sewage discharge and spread of invasive plant species play a crucial role in the decline in dissolved oxygen level, we know that the decline in the oxygen level will adversely effect the life of fishes. Many the fishes are die due to insufficient oxygen. Beside this Rapid Urban Development ,improper Sewage Disposal, oil Spills, chemical Waste Dumping, radioactive Waste Discharge, sedimentation, runoff, erosion, dissolved oxygen, Ph, temperature, detergents, litter/garbage, oil/grease, household cleaners, Population growth etc. This are also a major problem affect the quality of water. Due to this many fishes are in a thread of extinction and some fishes were already extinct. This will effect the diversity of fishes.

In puthuvypeen both marine and backwater is present .The Veeranpuzha is a lake in puthuvypeen, it is the northern extension of Vembanad Lake. From Kochi Azhi to Munambam Azhi, the Vembanad lake is popularly known as “Veeranpuzha”. Diversity of marine fishes is greater than backwater fish in puthuvypeen region. Most of fishes found in marine and backwaters are finfishes. From the family penaeidae five species were identified. The veeranpuzha is less polluted than the vembanadu lake.

Mangroves are highly productive components of the food web of coastal ecosystem. Detritus of plant material serves as the basis of food web and contributes to the good quality of mangrove habitat. Many commercial finfish and shell fish species depend on mangrove habitat for part of their life cycle. An analysis of the impact of mangrove plants on marine carbon inventories suggests that the mangroves account for more than 10% of the terrestrially derived dissolved organic carbon transported to the ocean, Mangroves function as nursery habitats for many organisms, providing protection and food sources for early developmental stages of crustaceans and fish, This is one of the reason for the great diversity of finfishes in both region.

Conclusion

The present study is meant to collect information on finfishes & shell fishes of the areas with a view to act as a base line data for future studies. In the present study a total of 29 species of fishes belonging to 20 families were identified from Pallippuram region & a total of 51 species of fishes belonging to 34 families are identified from Puthuvypeen region. Among them finfishes are great in diversity at both regions . According to IUCN Status in Pllippuram region of vembanadu lake one species is vulnarable & two of them are near threatened species. In puthuvypeen region four species are vulnerable and one is endangered . The result of the study indicate that Pallippuram region of Vembanad lake & Puthuvypeen region is rich in fish diversity.

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STUDY ON FISH DIVERSITY



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of Bachelor of science

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CERTIFICATE

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Abstract

This study focused on fish diversity in Pallippuram region of Alappuzha district and Puthuvypeen region of Ernakulam district. The study was conducted on March 2022. During the study period a total of 29 species of fishes belonging to 20 families were identified from Pallippuram region & a total of 51 species of fishes belonging to 34 families are identified from Puthuvypeen region. Comparing the diversity of finfish, crustation, and mollusc the finfishes are seen in large number then comes crustation and molluscs. In Puthuvypeen region, out of the 34 family Penaeidae dominated first with five species of fishes & in Vembanadu lake out of 20 families Cyprinidae dominated first with four species of fishes. The result of the study indicates that Pallippuram region of Vembanad lake & Puthuvypeen region is rich in fish diversity.

Introduction

As a tropical country, India boasts a rich diversity of flora and fauna and is listed among the world's mega biodiversity countries. There is growing concern about the increasing human effect that has occurred in recent years on marine biodiversity. According to marine and coastal waters of Kerala are considered as the most significant ecosystems in terms of productivity and uniqueness. With the rapid overall development of the country, the aquatic ecosystems are under constant pressure of man-induced stresses to the fishes. Though the decline of individual fish species is very often related to more than one proximate factors; Physical habitat loss due to construction of dams and weirs across the rivers, soil erosion due to deforestation and excessive utilization of waters, Chemical pollution due to industrial and municipal wastes, Over-exploitation and indiscriminate killing of juveniles and brood fishes. This study is meant to make an inventory of fishes, crustaceans and molluscs of the areas, Pallipuram and Puthuvypeen region with a view to act as a baseline data for future studies.

Vembanad lake is the transitional ecotone lying parallel to the Arabian Sea and encompassing mangroves, mudflats, swamps and marshes. The ecosystem provides a harsh environment, many species of fishes have found them to be an ideal place for spawning, development and growth during their early life. Rich biodiversity and ecological value made Vembanad Lake to be identified as a Ramsar site in November 2002. Vembanad lake is among the most productive life-supporting coastal wetland in Kerala, having length 96km, and surface area of 1512km².

Six rivers bring fresh water into Vembanad lake and it has two permanent openings to the Arabian Sea, one at Cochin other at Azhikode.

A study on the status and Trends of back water fisheries is the key to sound policy development, better decision making and responsible fisheries management .A study on the distribution of fish diversity in Pallipuram region of vembanad lake. Henceforth in present investigation attempt has been made to identify finfish and shellfish fauna in that region.

Puthuvypeen (also called as puthuvype) upcoming major industrial area in Kochi in the Indian state Kerala. It is a western Suburb of Kochi (colonial name: Cochin) city and is a part of Vypin island which is 24 km long and 2.6 km wide. Vypin Island has a total area of 87.85 km². Island is situated on the western side of Ernakulam District with Kodungallor strait on the North, Cochin backwaters and Cochin port on the south, River Periyar and Kochi City on the east and Arabian sea on the west. Island is connected to the city by three bridges known as Goshree"bridges. The ecology of Vypin Island is unique, endowed with Canal extending over 50 km and a network of small canal emerging therefrom. The population of Vypeen is estimated at more than 2 lakhs, with one among the highest density of population in the world(more than 2200 people per km²). Industries located to Puthuvypeen mainly related to natural gasification project and petroleum project such as LNG terminal, single buoy mooring, bunkering terminal and ship repair complex. The present study was meant to make an Inventory of fishes, crustaceans and molluscs of the area with a view to act as a baseline data for future studies. There are many studies on the fishes of Vembanad Lake study area, the whole lake or the selected section of the lake. However a limited number of studies are known to exist on diversity of fish and shellfish population specifically of Puthuvypeen area.

Review of literature

Mogalekar, et al(2015) have done a pioneering study on fish diversity of Vembanad Lake in the PanangadKumbalam region of Kochi, Kerala,India. According to this study The VembanadLake is second largest brackish water lake in the India. The status of fish diversity and seasonalvariation in their distribution and abundance were investigated in Vembanad Lake at Panangad- Kumbalam backwater. In total 48 samples have been analyzed which were taken throughout June2012 to May 2013. A total 2231 individuals were encountered, comprising 39 species of finfishesbelonging to 27 families, 11 orders and 31 genera. Fish abundance was high during pre-monsoon season (780 numbers), whereas low during post monsoon season (455 numbers). They estimates from these indices were indication of high fish species composition and richness.

Krishnakumar and Priyadarsanan (2008-2011) done a study on Fish and Fisheries in Vembanad Lake. According to this study the main objective of his participatory assessment is tobringto the declining status of inland fisheries in theVembanad Lake and to createa pcommon platform to consolidate attentionof all concerned, including the policy makers todiscuss conservation issues.

Asha , et al(2014) done a study on Decline in Diversity and Production of Exploited Fishery Resources in Vembanad Wetland System: Strategies for Better Management and Conservation. This paper describes the fishery catch structure of Vembanad wetland system during August 2012 to July 2013. The estimates of fishery production indicated an annual landing of 4387.31 t, in which 480.98t and 3906.33t contributed by southern and northern zone of Vembanad respectively. Eighty species of finfishes, five species of penaeid shrimps, three species of palaemonid prawns and two species of crabs were identified from the study period.

The catch per unit effort (CPUE) value was maximum for gill net (3.04 kg·h⁻¹) followed by stake net (2.43 kg·h⁻¹), Chinese dip net (2.01 kg·h⁻¹), seines (1.2 kg·h⁻¹), cast net (0.72 kg·h⁻¹) and hook and line (0.34 kg·h⁻¹). Biological integrity and fishery production of estuaries in the country are declining mainly due to various man induced activities. Thaneermukkom barrage, the salinity barrier, constructed across the Vembanad wetland system in 1976, transforming the waterbody into two distinct ecosystems, a fresh water zone on the south and a brackish water zone on the north, resulting in gross changes in physical, chemical and biological entity of the aquatic ecosystem. In the southern zone of Vembanad the marine fish species were less available with the closure of the barrage period. There are signs of decline of the Vembanad fishery resources, evident in the lesser number of species and decline of fishery production. This will lead to biodiversity loss, fish stock reduction and will ultimately affect the livelihood support of the traditional fishers to a large extent, besides affecting other ecological services. A better conservation measure must be implemented for maintaining the sustainable fishery resources in Vembanad.

Ansar, et al(2015) have done a study on Biodiversity of Decapod Crustacean in the Vembanad Lake at Panangad-Kumbalam Region of Kochi, Kerala. Vembanad Lake is a massive and vibrant coastal wetland ecosystem in India. Status of decapod crustacean diversity and seasonal variation in their distribution and abundance were investigated in the Vembanad Lake at Panangad - Kumbalam backwater. In total 730 individuals were encountered, comprising 20 species of decapod crustaceans belonging to 5 families and 10 genera. About 7 species of Penaeid shrimp belonging to 2 genera, 5 species of Palaemonid prawn belonging to 2 genera, 5 species of Portunid crab belonging to 3 genera, 2 species of Sesamid crab and one species of Ocypodid crab were identified. The species diversity was high during pre-monsoon (42%), whereas low during post monsoon (13%).

The calculated values of various diversity indices included Shannon– Wiener diversity (H') ranged from 2.18 to 2.81, Margalef's species richness (d) ranged from 1.90 to 3.12, Pielou's evenness (J') ranged from 0.86 to 0.92, Taxonomic diversity (D) ranged from 46.71 to 61.09, Average taxonomic distinctness ($D+$) ranged from 53.33 to 67.32, Variation in taxonomic distinctness ($\text{Lambda}+$) ranged from 227.78 to 457.46 and total phylogenetic diversity index ($s\text{Phi}+$) ranged from 466.66 to 900. Ecological status of decapod crustacean diversity in the study area was moderate as per the estimated values of diversity index.

A study on the ichthyofauna of Aymanam panchayath in Vembanad wetland, Kerala was carried out by Narayanan et al (1980-1982). A total of 37 species of fishes belonging to 18 families and nine orders were recorded. Order Perciformes showed maximum family diversity. The highest number of species belonged to family Cyprinidae. Nine of the 34 freshwater species recorded are threatened. One exotic species *Poecilia reticulata* was also noted.

Krishnakumar et al (2011) have done a study on Unregulated aquaculture and invasive alien species: a case study of the African Catfish *Clarias gariepinus* in Vembanad Lake (Ramsar Wetland), Kerala, India. As per the report Indiscriminate and illegal farming of the African Catfish *Clarias gariepinus*, in central Kerala has now resulted in the escape and spread of the species into Vembanad Lake, a large brackish water wetland and inland fish diversity hotspot. We collected 17 individuals of *C. gariepinus* ranging in size from 200 to 750 mm from different locations in the southern sector of the lake during a field survey conducted in 2007. Samples comprised of mature specimens of both sexes indicating their reproductive potential in the study area. The possible impacts of spread of *C. gariepinus* into natural water bodies of Kerala, especially the Vembanad Lake, and options for their management are discussed.

An interesting study of Synudeen Sahib (2018) on Fish diversity in Vembanad Lake, Kerala, India. Study reports that Vembanad Lake is under increasing pressures from anthropogenic and climate factors. The study evaluated the fish diversity in Vembanad Lake in order to ascertain its health. Fish samples caught with different types of nets namely cast net and gill net were collected from September 2012 to February 2013 from local fishers at the fish landing centre. A total of 20 species belonging to 18 families and 19 genera were recorded from the study area during the present study. Diversity of fishes and threats to the fauna are discussed. The low fish species composition denotes that Vembanad Lake is threatened, that is, undergoing degradation.

A study conducted by Vijayasree and Radhakrishnan (2014) on Fish Diversity of Kuttanad's River System, Kerala State, India. As per the study India is known for its inland fishery resources and once with rich indigenous fishery resources with great biodiversity. The poor inland fishers and rural community depended for their livelihood and food security on these indigenous species. The present investigation has been conducted to identify the fishes of the Kuttanad River from January to May 2014 at weekly intervals. A total of 62 freshwater species from 17 families were found during our survey. The fishes were divided into three groups viz., cultivable fishes, food fishes and ornamental fishes. Among cultivable fishes order Cypriniformes were dominated by 6 species, followed by Perciformes (3 species) and Siluriformes (2 species). The order Anguilliformes and Beloniformes were represented by 1 species each. A total of 11 species were identified as cultivable fishes. The number of food fishes identified were 22 species under investigation. The dominant group belongs to the family Siluridae (7 species) followed by Cyprinidae (6 species). 5 species were identified under the order Perciformes. Synbranchiformes and Beloniformes by 3 and 1 species respectively. Maximum fish species identified were ornamental fishes (28 species).

The order Cypriniformes alone represented 22 species. The identified fishes of the order Beloniformes were 3, Siluriformes by 2 and Tetraodontiformes by 1 species. The results of the present study clearly showed that the fish fauna of the River is highly diverse and proper management is essential for the conservation of the fish biodiversity.

Salu , Sasi&Ambili(2019) done a study on the diversityof fishes in Thodupuzha River, Idukki District, Kerala. It is a tributary of Muvattupuzha River, Kerala.The present study was conducted to document the diversityof fishes in Thodupuzha River, Idukki District, Kerala. It is a tributary of Muvattupuzha River, Kerala. The study period was during December 2018 to February 2019. There are about 19 species of fishes were collected and identified.Currently, the river is under severe ecological degradation due to sand mining and other anthropogenic activities. Despite this, the present study also highlights the rich diversity of fishes in thisriver, hence it is suggested that these river been protected to conserve for future generation.

Vijayasree, and Radhakrishnan(2014) done a study on Fish Diversity of Kuttanad's River System, Kerala State, India India is known for its inland fishery resources and once with rich indigenous fishery resources with great biodiversity. The poor inland fishers and rural community depended for their livelihood and food security on these indigenous species. The present investigation has been conducted to identify the fishes of the Kuttanad River from January to May 2014 at weekly intervals.The results of the present study clearly showed that the fish fauna of the River is highly diverse and proper management is essential for the conservationof the fish biodiversity.

Sojomon Mathew(2022) have done a study on Ichthyofauna diversity of Meenachil River, Thazhathangady Region, Kottayam, Kerala The study was conducted to understand the Ichthyofauna diversity of Meenachil River – Thazhathangady region. The Meenachil river, originating from Western Ghats is a degrading riverine ecosystem in Central Kerala of India, may be the only river inKerala which is characterized by the presence of human settlement right from the source of the river till it confluences at Vembanad lake, India’s second largest wetlandecosystem. Thazhathangady region is a place with a rich indigenous fishery resource with great biodiversity.

The present investigation has been conducted to identify the fishes in the Thazhathangady region which is a part of the Meenachil River for a period of 6 months (July 2019 to December 2019) at an interval of 15 days.A total of 44 freshwater species was found during our survey; out of this 20 species are selected for our study. It includes cultivable fishes and food fishes.

Methodology

Fishes have great diversity and hence can be classified in different categories. The backwater and the sea in puthuvypeen and the vembanad lake have great diversity of fish. For studying the fish diversity, visit the area that is selected for studying. The data are collected from the pallipuram region of vembanad lake and from the puthuvypeen at alternate 3 days in March 2022. The fishes are collected by the fisherman from the sea, backwater and lake, using fishing net. There are different kinds of fishes that live in different habitats so that the fishes that get from sea, lake, and backwater are different based on their habitat, and also the fishes that caught in the different nets are also different. The collected fish were identified using different methods. Fishes were identified with the help of fishermen, by taking photos, and with the help of Google lens. The fishes that are identified were grouped into a table. The table should contain the details about the fish such as its scientific name, Common name and family.

Result

Table 1.

Fish Diversity in Vembanadu lake at Pallippuram Region of Alappuzha District

Common name	Scientific name	Family	IUCN Status
Red tipped half beak	<i>Hyporhamphus xanthopterus</i>	<i>Hemiramphidae</i>	<i>VU</i>
Indian anchovy	<i>Stolephorus indicus</i>	<i>Engraulidae</i>	<i>NE</i>
Spotted scat	<i>Scatophagus argus</i>	<i>Scatophagidae</i>	<i>LC</i>
Small Bengal silverbidy	<i>Gerres setifer</i>	<i>Gerreidae</i>	<i>NE</i>
Tilapia	<i>Oreochromis mossambicus</i>	<i>Cichlidae</i>	<i>NE</i>
Pearl spot	<i>Etroplus suratensis</i>	<i>Cichlidae</i>	<i>LC</i>
Orange chromide	<i>Etroplus maculatus</i>	<i>Cichlidae</i>	<i>LC</i>
Stripped snakehead	<i>Channa striata</i>	<i>Channidae</i>	<i>LC</i>
Climbing perch	<i>Anabas testudineus</i>	<i>Anabantidae</i>	<i>DD</i>
Glassy perche	<i>Chanda nama</i>	<i>Ambassidae</i>	<i>LC</i>
Mullet	<i>Mugil cephalus</i>	<i>Mugilidae</i>	<i>LC</i>
Milk fish	<i>Chanos chanos</i>	<i>Channidae</i>	<i>NE</i>
Blue panchax	<i>Aplocheilus panchax</i>	<i>Aplocheilidae</i>	<i>LC</i>
Banded snake head (varaal)	<i>Channa striata</i>	<i>Channidae</i>	<i>LC</i>

Stripped panchax	<i>Aplocheilus lineatus</i>	<i>Aplocheilidae</i>	<i>LC</i>
Slender rasbora	<i>Rasbora daniconius</i>	<i>Cyprinidae</i>	<i>LC</i>
Freshwater garfish	<i>Xenentodon cancila</i>	<i>Belonidae</i>	<i>LC</i>
Short finned eel	<i>Anguilla australis</i>	<i>Anguillidae</i>	<i>NT</i>
Stinging catfish	<i>Heteropneustes fossilis</i>	<i>Heteropneustidae</i>	<i>LC</i>
Striped Dwarf Catfish	<i>Mystus vittatus</i>	<i>Bagridae</i>	<i>LC</i>
Wallago	<i>Wallago attu</i>	<i>Siluridae</i>	<i>NT</i>
Catla	<i>Catla catla</i>	<i>Cyprinidae</i>	<i>LC</i>
Rohu	<i>Labeo rohita</i>	<i>Cyprinidae</i>	<i>LC</i>
Olive barb	<i>Systemus sarana</i>	<i>Cyprinidae</i>	<i>LC</i>
Oriental sole	<i>Brachirus orientalis</i>	<i>Solidae</i>	<i>NE</i>
Zig-zag eel	<i>Mastacembelus armatus</i>	<i>Mastacembelidae</i>	<i>LC</i>

Table 2

Diversity of Crustaceans in Vembanadu lake at Pallippuram Region of Alappuzha District.

Common name	Scientific name	Family	IUCN Status
Indian white prawn	<i>Fenneropenaeus indicus</i>	<i>Penaeidae</i>	<i>NE</i>
Giant tiger prawn	<i>Penaeus monodon</i>	<i>Penaeidae</i>	<i>NE</i>
Giant freshwater prawn	<i>Macrobrachium rosenbergii</i>	<i>Palaemonidae</i>	<i>NE</i>

Table 3.**Diversity of Backwater Fishes of Puthuvypeen Region at Ernakulam****District**

Common name	Scientific name	Family	IUCN Status
Pearl spot (karimeen)	<i>Etroplus suratensis</i>	<i>Cichlidae</i>	<i>LC</i>
Tilapia (thilopia)	<i>Oreochromis mossambicus</i>	<i>Cichlidae</i>	<i>NE</i>
Tiger Panchax (pochutti)	<i>Aplocheilus lineatus</i>	<i>Aplocheilidae</i>	<i>NE</i>
Orange chromide (pallathi)	<i>Etroplus maculatus</i>	<i>Cichlidae</i>	<i>LC</i>
Mullet (kanambu)	<i>Mugil cephalus</i>	<i>Mugilidae</i>	<i>LC</i>
Spotted scat	<i>Scatophagus argus</i>	<i>Scatophagidae</i>	<i>LC</i>
Tank goby (poolan)	<i>Glossogobius giuris</i>	<i>Gobiidae</i>	<i>LC</i>
Banded snake head (yaraal)	<i>Channa striata</i>	<i>Channidae</i>	<i>LC</i>
Stinging catfish (kaari)	<i>Heteropneustes fossilis</i>	<i>Heteropneustidae</i>	<i>LC</i>
Walking catfish (muzhi)	<i>Clarias batrachus</i>	<i>Clariidae</i>	<i>LC</i>
Long whiskered catfish (vellakkoori)	<i>Sperata aor</i>	<i>Bagridae</i>	<i>LC</i>
Climbing Perch (chempally)	<i>Anabas testudineus</i>	<i>Anabantidae</i>	<i>DD</i>
Giant danio (paral)	<i>Devario quipinnatus</i>	<i>Cyprinidae</i>	<i>LC</i>
Yellow catfish (manjakkoori)	<i>Pylodictis olivaries</i>	<i>Ictaluridae</i>	<i>NE</i>
Peninsular olive barb	<i>Puntius sarana</i>	<i>Cyprinidae</i>	<i>LC</i>

Table 4.

Diversity of Marine fishes in Puthuvypeen Region of Ernakulam District

Common name	Scientific name	Family	IUCN Status
Goldstripe sardinella(mathi)	<i>Sardinella gibbosa</i>	<i>Clupeidae</i>	<i>LC</i>
Indian Oil sardine	<i>Sardinella Longiceps</i>	<i>Clupeidae</i>	<i>LC</i>
Indian mackerel	<i>Rastrelliger kanagurta</i>	<i>Scombridae</i>	<i>DD</i>
Silver pomfret	<i>Pampus argenteus</i>	<i>Stromateidae</i>	<i>VU</i>
Kawa kawa(choora)	<i>Euthynnus affinis</i>	<i>Scombridae</i>	<i>LC</i>
Fin tuna(choora)	<i>Thunnus orientalis</i>	<i>Scombridae</i>	<i>LC</i>
Pink perch(kilimeen)	<i>Nemipterus japonicus</i>	<i>Percidae</i>	<i>LC</i>
Indian anchovy(kozhuva)	<i>Stolephorus indicus</i>	<i>Engraulidae</i>	<i>NE</i>
Sole fish (maanthal)	<i>Cynoglossus semifasciatus</i>	<i>Soleoidei</i>	<i>LC</i>
Bluefin trevally	<i>Caranx melampygus</i>	<i>Carangidae</i>	<i>LC</i>
Malabar thryssa(manangu)	<i>Thryssa malabarica</i>	<i>Engraulidae</i>	<i>LC</i>
White Sardine	<i>Escualosa thoracat</i>	<i>Clupeidae</i>	<i>LC</i>

Bartail flat head	<i>Platycephalus indicus</i>	<i>Platycephalidae</i>	<i>DD</i>
Red snapper	<i>Lutjanus campechanus</i>	<i>Lutjanidae</i>	<i>VU</i>
Glass fish	<i>Parambassis ranga</i>	<i>Ambassidae</i>	<i>LC</i>
Atlantic bumper	<i>Chloroscombrus chrysurus</i>	<i>Carangidae</i>	<i>LC</i>
Golden thread fin	<i>Nemipterus virgatus</i>	<i>Nemipteridae</i>	<i>VU</i>
Spotless smooth-hound	<i>Mustelus virgatus</i>	<i>Triakidae</i>	<i>EN</i>
Yellow tail barracuda	<i>Sphyraena flavicauda</i>	<i>Sphyraenidae</i>	<i>VU</i>
Silver moony fish	<i>Monodactylus argenteus</i>	<i>Monodactylidae</i>	<i>LC</i>
Yellow goat fish	<i>Mulloidichthys martinicus</i>	<i>Mullidae</i>	<i>LC</i>
Brown-banded rockcod	<i>Cephalopholis boenak</i>	<i>Serranidae</i>	<i>LC</i>
Whipfin silver-biddy	<i>Gerres filamentous</i>	<i>Gerreidae</i>	<i>LC</i>

Table 5.

Diversity of Crustaceans in Puthuvypeen Region of Ernakulam

District

Common name	Scientific name	Family	IUCN Status
Indian white prawn	<i>Fenneropenaeus indicus</i>	<i>Penaeidae</i>	<i>NE</i>
Black tiger prawn	<i>Penaeus monodon</i>	<i>Penaeidae</i>	<i>NE</i>

Green tiger prawn	<i>Penaeus semisulcatus</i>	<i>Penaeidae</i>	<i>NE</i>
Brown shrimp	<i>M.affinis</i>	<i>Penaeidae</i>	<i>NE</i>
Mangrove crab	<i>Scylla serrata</i>	<i>Portunidae</i>	<i>NE</i>
Green mud crab	<i>S.tranquibarica</i>	<i>Portunidae</i>	<i>NE</i>
Stripped barnacle	<i>Balanus amphitrite</i> <i>Darwin</i>	<i>Palaemonidae</i>	<i>NE</i>
Three dotted crab	<i>Portunus</i> <i>sanguinolentus</i>	<i>Portunidae</i>	<i>NE</i>
Flower crab	<i>Portunus pelagicus</i>	<i>Portunidae</i>	<i>NE</i>
White shrimp	<i>Peanus indicus</i>	<i>Penaeidae</i>	<i>NE</i>

Table 6.

Diversity of Molluscs in Puthuvypeen Region of Ernakulam District

Common name	Scientific name	Family	IUCN Status
Indian fresh water mussel	<i>Lamellidens marginalis</i>	<i>Unionidae</i>	<i>LC</i>
Green mussel	<i>Perna viridis</i>	<i>Mytilidae</i>	<i>NE</i>

Discussion

Venbanad lake was very rich in diversity, A total of 29 species of fishes belonging to 20 families were identified during the study period. Among the 29 species, 26 are fin fishes and 3 are crustaceans. Out of 20 families Cyprinidae dominated first with four species of fishes. Cichlidae was secondly dominated representing three species, the next was Channidae, Aplocheilichthysidae and Penaeidae having two species each and the rest of the families have one species. According to IUCN status 17 species are in least concern, one is vulnerable (red tipped half beak), 2 are near threatened species, 8 of them are not evaluated & one is data deficient (climbing perch).

The Puthuvypeen region in Ernakulam district was very rich in diversity. A total of 51 species of fishes belonging to 34 families are identified during the study period. Among them 23 are backwater fishes of 17 different families. It includes different categories of fishes (12 finfish, 7 crustaceans and 1 mollusc). There are 30 species of marine fishes belonging to 22 families were identified (23 finfish, 5 crustaceans and 2 molluscs). Out of the 34 families Penaeidae dominated first with five species of fishes. Portunidae was secondarily dominated with four species and Cichlidae, Clupeidae, Scombridae coming next with three species and Cyprinidae, Engraulidae, Carangidae with two species and the rest of the families have one species each. According to IUCN status 27 are in least concern among them 11 are backwater fishes, 15 are marine fishes & 1 mollusc, 4 species are vulnerable (marine fishes), 15 of them are not evaluated among them 3 are backwater, 12 marine (1 finfish, 10 crustaceans, 1 mollusc), 3 are data deficient (among them 1 is backwater and 2 are marine finfish), 1 species is endangered (spotless smooth hound) marine fish.

Backwaters of Puthuvypeen region is rich in fish diversity than the vembanadu lake in pallipuram region. Most of the fishes found are common in both region. Large number of finfishes were identified from both regions. When compared to the puthuvypeen region diversity of fish was less in vembanadu lake because of the pollution of waterbodies. Now it become one the most polluted water in the world. Pesticide residue from the fields and nutrient discharge from urban settlements are one of the major reason for the pollution of Vembanad Lake and also it is polluted by various organic and household waste, industrial activities and anthropogenic activities like agricultural disposal and land reclamation. Houseboat tourism, sewage discharge and spread of invasive plant species play a crucial role in the decline in dissolved oxygen level, we know that the decline in the oxygen level will adversely effect the life of fishes. Many the fishes are die due to insufficient oxygen. Beside this Rapid Urban Development, improper Sewage Disposal, oil Spills, chemical Waste Dumping, radioactive Waste Discharge, sedimentation, runoff, erosion, dissolved oxygen, Ph, temperature, detergents, litter/garbage, oil/grease, household cleaners, Population growth etc. This are also a major problem affect the quality of water. Due to this many fishes are in a thread of extinction and some fishes were already extinct. This will effect the diversity of fishes.

In puthuvypeen both marine and backwater is present. The Veeranpuzha is a lake in puthuvypeen, it is the northern extension of Vembanad Lake. From Kochi Azhi to Munambam Azhi, the Vembanad lake is popularly known as "Veeranpuzha". Diversity of marine fishes is greater than backwater fish in puthuvypeen region. Most of fishes found in marine and backwaters are finfishes. From the family penaeidae five species were identified. The veeranpuzha is less polluted than the vembanadu lake.

Mangroves are highly productive components of the food web of coastal ecosystem.

Detritus of plant material serves as the basis of food web and contributes to the good quality of mangrove habitat. Many commercial finfish and shell fish species depend on mangrove habitat for part of their life cycle. An analysis of the impact of mangrove plants on marine carbon inventories suggests that the mangroves account for more than 10% of the terrestrially derived dissolved organic carbon transported to the ocean, Mangroves function as nursery habitats for many organisms, providing protection and food sources for early developmental stages of crustaceans and fish, This is one of the reason for the great diversity of finfishes in both region.

Conclusion

The present study is meant to collect information on finfishes & shell fishes of the areas with a view to act as a base line data for future studies. In the present study a total of 29 species of fishes belonging to 20 families were identified from Pallippuram region & a total of 51 species of fishes belonging to 34 families are identified from Puthuvypeen region. Among them finfishes are great in diversity at both regions . According to IUCN Status in Pllippuram region of vembanadu lake one species is vulnarable & two of them are near threatened species. In puthuvypeen region four species are vulnerable and one is endangered . The result of the study indicate that Pallippuram region of Vembanad lake & Puthuvypeen region is rich in fish diversity.

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STUDY ON BUTTERFLY DIVERSITY IN
SUARNODHYANAM BIODIVERSITY
PARK NEDUMBASSERY

DONE BY: ATHIRA S KUMAR
AB19ZOO006

ABSTRACT

- Butterflies are the winged Insect belonging to Phylum Arthropoda.
- The present study was done in Suvarnodhyanam Biodiversity Park, Nedumbassery.
- The study was conducted on the month of January 2022.
- The observed butterflies belongs to Nymphalidae, Pieridae, and Papilionidae families.
- Butterflies are important part of ecosystem. To conserve the butterfly population, we must conserve the natural habitat

INTRODUCTION

- The term “Biodiversity” is used to describe the number, variety, and variability of living organisms.
- Butterfly belongs to the phylum Arthropods.
- The Butterfly and Moths belongs to the order Lepidoptera.
- Its body is metameric with jointed appendages.
- During its lifespan, a Butterfly undergoes complete metamorphosis, consisting of four distinct stages; Egg, Caterpillar larva, Pupa and Adult.

AIMS AND OBJECTIVE

- To study butterfly fauna in Suvarnodhyanam biological park.
- Observation and identification of butterflies.
- To study morphological features of butterfly, their behavior and habit.
- To study different families, scientific names of butterflies.
- Importance of butterfly and their contribution to environment.
- Role of butterfly in nature and current diversity in Suvarnodhyanam.

REVIEW OF LITERATURE

- Very little documentation has been done on butterfly fauna in Kerala.
- Some of the earlier documentation on butterfly fauna from Kerala and adjacent areas include (Mathew & Rahamathulla ,1993), who had reported 100 species of butterflies from Silent Valley National Park.
- In popular esteem the butterflies among the insects are the most attractive and beautiful members.
- Some of the commonly found species of butterflies in Kerala includes: 6
Common Pierrot- *Castalius rosimon* , Blue Mormon- *Papilio polymnestor* , Grey Pansy- *Junonia atlites*.
- As well as being an indicator of climate change, butterflies are also sensitive to other threats such as habitat destruction.

METHODOLOGY

- 1.SUARNODHYANAM BIOLOGICAL PARK

- The study area in Suvarnodhyanam Biodiversity Park is near the Cochin International Airport Nedumbassery Panchayath, Aluva taluk at Ernakulum district, India.
- Suvarnodhyanam is newly proposed biodiversity park.
- This is located within the 10 acres land of Thattekkad forest department in the western periphery of cochin international airport.
- This park has a rich fauna and flora including butterflies.
- The richness is due to less pollution, presence of paddy field and diversity of plants.The diversity of butterflies in this area can be enhanced by planting more trees and shrubs.

COLLECTION METHODS

- The present study carried out on 29 January from Suvarnodhyanam. Ernakulam district, Kerala.
- The survey of butterflies was undertaken by line transect method.
- All the transects surveyed were segments of existing garden, shrubs and herbs, grassland and small pond areas.
- Typical and unique features of the wings, abdomen and pattern of coloration of all body parts were noted down.
- The materials used for collection were
 - hand gloves
 - white cloth
 - net/mesh.

IDENTIFICATION

- Identification is based on morphological features of butterflies.



RESULT

- From the collected specimens, identification was done using proper identification techniques.

COMMON CROW(CRAMER)

- MORPHOLOGY

- The common crow, is a common butterfly found in South Asia to Australia.
- In India it is also sometimes refers to as the common Indian crow, and in Australia as the Australian crow.
- This butterfly also gathers of damaged parts of plants such as crotalaria, heliotropism to forage for chemicals precursors to produce pheromones.



DARK BLUE TIGER (BUTLER)

- MORPHOLOGY

- Also called butler

- DIAGNOSTIC CHARACTERS

- Tailless

- Upperside black or very dark brown, with narrower pale wing markings.



COMMON ROSE (FABRICIUS)

- MORPHOLOGY

- The Common Rose is black with grey shading between the veins on its wings.
- Its swallow-tailed hindwings (back wings) have large white patches and greyish-red crescent-shaped markings.
- Its underside is similar to its top side, but with striking red or pinkish spots. Its body is bright red.
- It is very common almost all over the plains of India, and is not threatened as a species. During and after the monsoon it is extremely abundant.



PAPILIO POLYMNESTOR(BLUE MORMON)

- MORPHOLOGY
- Blue Mormon is a large swallowtail butterfly found in south India.
- It is the "state butterfly" of the Indian state of Maharashtra.
- With a wingspan of 120–150 mm, it is the fourth largest butterfly of India.



MYCALESIS PERSEUS(DINGY BUSHBROWN)

- MORPHOLOGY
- *Mycalesis perseus*, the dingy bushbrown or common bushbrown.
- Species found in south Asia and southeast Asia.
- Brown colour usually found in flying in between bamboo stem and coconut trees.
- It camouflages with dry leaves and trees.



APPIAS ALBINA (COMMON ALBATROSS)

- MORPHOLOGY

- Upperside white.
- Fore wing with edge of basal black area slightly incurved and blackish apical and marginal markings narrow in male but broader in female.



GLASSY TIGER

- MORPHOLOGY
- Ground colour fuliginous black with subhyaline bluishwhite streaks and spots.
- Antennae black; head and thorax black spotted with white; abdomen blackish brown.



LEMON EMIGRANT

- MORPHOLOGY
- Common name: Common emigrant
- Diagnostic characters: Upperside of wings with ground colour white and proximal areas yellow; fore wing black at apex and with a marginal narrow border macular.



DISCUSSION

- A study was conducted to find out the diversity of butterflies at Suvarnodhyanam .Butterflies are one of the most conspicuous species of Earth's biodiversity.
- Suvarnodhyanam is less polluted and many species were also observed due to large area.
- The most abundant species recorded from the study sites was common albatross butterfly.
- Butterflies, perhaps because they are mobile exotherms, respond extremely rapidly to environmental disturbance or degradation, especially those involving temperature changes, and are well studied ecologically.
- Suvarnodhyanam Biodiversity Park has a rich fauna and flora including butterflies. The richness was due to the good habitat that surrounds the area.

CONCLUSION

- The destruction of host plant in crop area habitat, use of synthetic pesticides, human disturbance, pollution has lead to decline of butterfly diversity.
- Both habitat destruction and anthropogenic lighting at night are altering the natural light conditions in which butterflies have evolved specific biological functions for millions of years.
- The butterfly species found in Suvarnadhyanam Biodiversity Park includes:-
Common Crow, Dark Blue Tiger, Common Rose, Blue Mormon, Dingy Bushbrown, Common Albatross, Glassy Tiger, Common `Emigrant
- The present study concludes that Suvarnodyanam Biodiversity Park has a rich diversity of butterflies.

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THANK YOU!

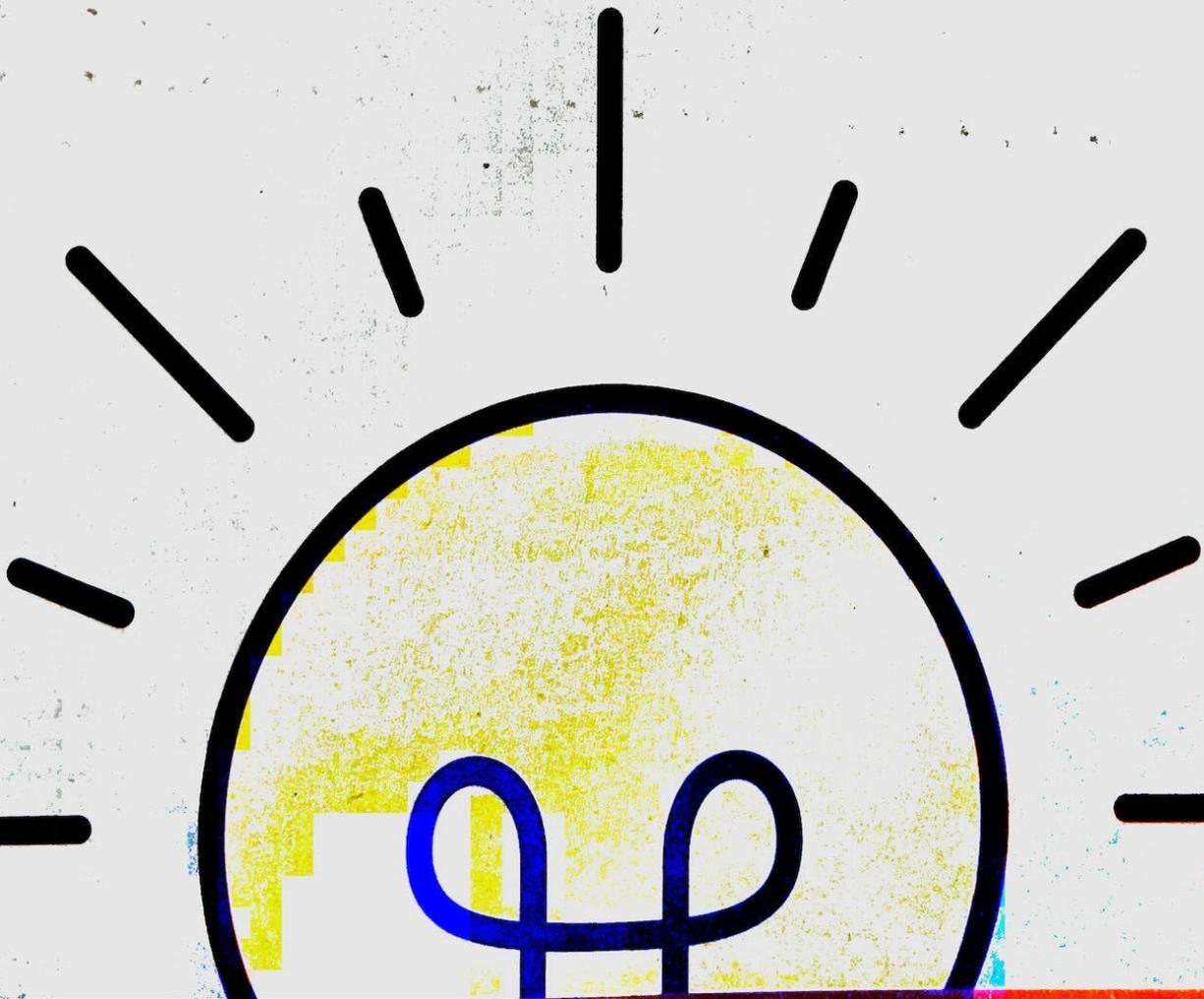




IDEAS INCARNATED

Stories of Keralites who forged their
own path, from vision to action

The Commerce Society
Department of Commerce (SF)
St. Teresa's College (Autonomous) Ernakulam



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Rev. Sr. Emeline CSST
Director

“When learning is purposeful, creativity blossoms. When creativity blossoms, thinking emanates. When thinking emanates, knowledge is fully lit. When knowledge is lit, economy flourishes.” —A.P.J. Abdul Kalam

St. Teresa’s College has established itself as one of the leading colleges in Kerala, primarily due to the large significance that the college puts on building an ever-growing value-based community.

I heartily appreciate the Commerce Society for their new initiative in the form of *Ideas Incarnated*. The interviews presented in this book will inspire budding entrepreneurs to take up their own ventures and contribute to a vibrant startup ecosystem.

The release of this book in the midst of a pandemic is the result of the students’ dedication, creativity and innovation. I once again congratulate the Department of Commerce SF and whole team of the Commerce Society, and am sure that this will prove to be a milestone in the journey of the ComSoc towards unlocking curiosity.

God Bless you all!



Rev. Dr. Sr. Vinitha CSST Provincial Superior & Manager

As Nelson Mandela once said, "Education is the most powerful weapon which you can use to change the world". St Teresa's College (Autonomous), Ernakulam has been contributing to changing the world for the better over the past 97 years, being ranked among the premier educational institutions in Kerala. The students of this institution have also excelled in co-curricular activities and kept the flag flying high. It owes its success to the devoted efforts of the management, teaching and non-teaching staff as well as the students.

Ideas Incarnated is yet another example of the college's quest for multi-dimensional excellence through the Department of Commerce (SF). Whilst serving as a platform for nurturing the aptitude and creative talents of the students, it has enabled them to undertake initiatives that will help them as well as their peers. This is exactly the environment that our college aims to offer its students. I am sure this book will provide new perspectives on the various aspects of entrepreneurship with first-hand accounts of the entrepreneurs, business facts and thought-provoking journeys.

I proudly applaud the efforts of all the dedicated students who have made their brilliant contributions to this excellent book.

God bless each one of us.



Dr. Lizzy Mathew
Principal

"Tell me and I forget, teach me and I may remember, involve me and I learn." The Chinese proverb perfectly encapsulates how we have always perceived learning at St. Teresa's College. Innovation has always been at the core of our academics and over the past years, several young Teresians have ventured out and claimed their places in the field of entrepreneurship.

I take this opportunity to convey my heartfelt appreciation for the teachers of the Department of Commerce (SF) who motivated the students to take up a book project, and the members of the Commerce Society who committed themselves to bring out *Ideas Incarnated* - interviewing the entrepreneurs, writing, editing and designing, all by themselves.

The college is delighted to be a launchpad for their first publishing journey and many more such projects in the future, for the holistic development of all the students of the community.

Best Wishes.



Smt. Jini Justin D'Costa
HoD, Department of Commerce (SF)

"High expectations are the key to everything"
- Sam Watson

The world is a better place thanks to people who want to develop and lead others. What makes it even better are people who find their time to motivate future leaders. Thank you everyone who strives to grow and help others grow.

Having an idea and turning it into a book is as hard as it sounds. I am immensely grateful to the Commerce Society which has allowed me to use the group as my personal learning laboratory. It's a great pleasure to interact with students who are genuinely interested in ideas, who are always eager to test new ideas and new ways of thinking.

I take this opportunity to acknowledge the entire team of ComSoc for their tireless efforts in materializing *Ideas Incarnated*. I will always welcome the chance to represent my students and I wish them all great success.



Smt. Ottina Treasa Mendez
Faculty Co-ordinator, ComSoc

Learning never exhausts the mind . The learning process is different for each individual

- Leonardo da Vinci

When the pandemic struck, life as we knew it changed drastically. Colleges, schools and offices were shut. Bazaars, malls and theatres were closed, roads were deserted, but this didn't stop our enthusiastic young minds who had always set their standards high.

The Commerce Society was started exclusively for the students of our department to learn, explore and help each other expand their horizons of knowledge. *Ideas incarnated* was a project taken up, which included life-changing stories and challenges faced by young, innovative, outstanding, social entrepreneurs whose prime motivation was to build their community and put others first.

The hard work and dedication put in by each member of the ComSoc team has left me amazed and I wish them all success in their future endeavors.

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STUDY ON BEHAVIORAL PATTERN OF ANT (*Camponotus herculeus*, *Monomorium pharaonis*, *Monomorium minimum*, *Camponotus parius*) AND SPIDER (*Tigeneria agustis*, *Eratigena duellia*, *Plexipus paykulli*, *Pholcidae*, *Menemerus bivittatus*)

MINI PROJECT – SEM I

**SUBMITTED TO ST. TERESA'S COLLEGE (AUTONOMOUS),
ERNAKULAM**



SUBMITTED BY,

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REG. NO: SM20ZOO002

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2020-2022

CERTIFICATE

This is to certify that the Mini project entitled “**Study on behavioral pattern of ANT** (*Camponotus herculeus*, *Monomorium pharaonis*, *Monomorium minimum*, *Camponotus parius*) **AND SPIDER** (*Tigeneria agustis*, *Eratigena duellia*, *Plexipus paykulli*, *Pholcidae*, *Menemerus bivittatus*)” is an authentic work carried out by **FIDHA LATHEEF** (Reg. No: SM20ZOO002), during the Academic year **2020-2022**, under my guidance from St. Teresa’s College (Autonomous), Ernakulam.

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DECLARATION

I hereby declare that the Mini project entitled “**Study on behavioral pattern of ANT (*Camponotus herculeus*, *Monomorium pharaonis*, *Monomorium minimum*, *Camponotus parius*) AND SPIDER (*Tigeneria agustis*, *Eratigena duellia*, *Plexipus paykulli*, *Pholcidae*, *Menemerus bivittatus*)**” submitted to St. Teresa’s College (Autonomous), is an original work done by me under the supervision and guidance of Ms. Tiya K. J, Assistant professor, Department of Zoology, St. Teresa’s College (Autonomous), Ernakulam and to the best of my knowledge and belief , this project contains no material previously published or written by another person, except where due reference is made.

FIDHA LATHEEF

ACKNOWLEDGMENT

I hereby express my deepest gratitude to God Almighty for blessing me in successfully completing this Mini project. I am indebted to my parents with respect, without their blessing and support I could not have been able to complete this work.

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FIDHA LATHEEF

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ABSTRACT

The behaviour of animals is fundamental to whether individuals will survive and reproduce and studying their behaviour is therefore essential to fully understand evolution.

Ethology deals with two types of causal explanations to behaviour; one that deals with motivational mechanisms and the experience of animals as causing the behaviour (proximate explanations) and one that deals with selection pressures and phylogenetic factors that cause the evolution of behaviour (ultimate explanations).

Ant colonies are very interesting entities because of their capacities to collectively achieve complex decisions and patterns through self-organization processes based on simple behavioural rules and the use of local information and indirect communication. Some spiders are active hunters that chase and overpower their prey. They typically have a well-developed sense of touch or sight. Other spiders instead weave silk, snares, or webs, to capture prey. Webs are instinctively constructed and effectively trap flying insects.

The present study on ANT and SPIDER Behaviour was carried out in my native place Kanjikuzhi, Kottayam. I examined the behaviours of ants and spiders during three months from March 22 to June first week 2021. I employed several experimental setups by doing test with honey, sugar, coffee drops and also checked some stimulus response to observe the behaviours of Ant. They have shown fascinating behaviours like Grooming, foraging, feeding, sociability, and necrophoresis. In spider, checked sensitiveness, light response, tactile response and observed in their natural behaviour. They have shown Grooming, visual Perception, webbing, feeding, and foraging.

INTRODUCTION

There are more than 10,000 known species of ants living throughout the world. Ants can be identified by the constriction between the abdomen and thorax that looks like a narrow waist. Their bodies are covered with hard armour called the exoskeleton. Ants have large heads with compound eyes, elbowed eyes, elbowed antennae, and powerful jaws. Many ant species communicate using chemical scents called pheromones.

Ant colonies are very interesting entities because of their capacities to collectively achieve complex decisions and patterns through self-organization processes based on simple behavioural rules and the use of local information and indirect communication.

The decisions of the ants are controlled by the laying/ following of trails of a chemical substance, called pheromone. When given the choice among several alternative paths, ants choose a path in a probabilistic way, based on the pheromone concentration over the possible paths. This mechanism allows the selection of the shortest path among several ones. Shorter paths are completed earlier than longer ones. Hence, the pheromone concentration on those paths increases more rapidly and they attract more ants. This process of indirect communication relies on a positive feedback mechanism and depends on the environmental characteristics (Karla Vittori *et al.*, 2004).

Ant colonies are widely recognized as an experimental model for dynamic non-linear systems, because they are self-organized adaptive societies whose macroscopic colony-level) properties originate from interactions at the microscopic level among the individuals and the environment. Furthermore, ants are, by any measure, extremely successful. For example, it is estimated that the biomass of ants equals the biomass of humans (Kim Christenson *et al.*, 2014)

Ant foraging is a collective process composed of the activities of individuals as well as behaviourally integrated groups. Therefore, a great challenge in the socioecology of foraging is to explain how the behaviour of such a potentially large and complex system as an ant colony emerges as a function of the properties of its individual components. A forager leaves the nest entrance in either a random or a consistent direction. A travel phase ensues, during which the worker maintains a constant compass bearing and moves directly away from the nest. At some point during the travel phase the forager shows a high frequency of turning, marking the beginning of search. During search, food resources are

encountered and selected based upon a forager's physical caste, age, and prior experience, the trip distance, thermal stress, resource quality, and the colony's current nutritional status. Depending on the ant species and the size, density, or quality of the food, the forager may communicate information to nest mates about its location and recruit additional foragers (James F. A, 2012).

Necrophoresis (removal of nest-mate corpses) was studied in two Indian ant species, *Camponotus compressus* (fam. Formicinae) and *Diacamma vagans* (fam. Ponerinae) were collected (B. Sarmistha *et al.*, 2010), the division of labours plays a major role in the success of social insects. For instance, through social prophylaxis, the spread of pathogens within the colony can be reduced if corpse removal is the concern of a special group of ants. Corpse carriers limited cross-contamination by remaining mostly outside the nest and congregating near the entrance when resting inside.

Spiders covers a large variety of morphological forms (Bristowe 1958, Comstock 1948, Foelix 1996) ranging from the huge, hairy mygalomorphs to pin-size, bald oonopids, from eight-eyed to two-eyed, from using lung to using trachea (or both or neither) to breathe, from having very long to very short legs. A spider's morphology (Bristowe 1958), anatomy (Snodgrass 1952), and nervous system (Barth 1985, 2002) typically reflects its general ecology (Main 1976, Nentwig 1986, Wise 1993) and behaviour (Robinson 1975, Vollrath 1992).

Most importantly, all spiders make and use silk throughout their lives, however diverse their morphology, ecology, and behaviour (Fritz Vollrath *et al.*, 2007). Spiders are useful models for testing different hypotheses and methodologies relating to animal personality and behavioural syndromes because they show a range of behavioural types and unique physiological traits (e.g., Silk and Venom) that are not observed in many other animals (H. D Linda *et al.*, 2021).

Salticids, the largest family of spiders, have unique eyes, acute vision, and elaborate vision mediated predatory behaviour, which is more pronounced than in any other spider group. Diverse predatory strategies have evolved, including araneophagy, aggressive mimicry, myrmecophagy, and prey-specific prey- catching behaviour (RR Jackson *et al.*, 1996). A first case of subsociality is reported for the genus *Latrodectus*. Individuals were found sharing the same web and feeding together. In captivity they showed mutual tolerance and communal feeding (B. Rogerio *et al.*, 2008).

All spiders are predators, feeding almost entirely on other arthropods, especially insects. Some spiders are active hunters that chase and overpower their prey. These typically have a well-developed sense of touch or sight. Other spiders instead weave silk snares, or webs, to capture prey. Webs are instinctively constructed and effectively trap flying insects. Many spiders inject venom into their prey to kill it quickly, whereas others first use silk wrappings to immobilize their victims.

The present study examined the behaviours of ants and spiders in the area Kanjikuzhi, Kottayam, carried out during three months from March 22, 2021 to June first week 2021. I employed several experimental setups by doing test with honey, sugar, coffee drops and also checked some stimulus response to observe the behaviours of Ant. They have shown fascinating behaviours like Grooming, foraging, feeding, sociability, and necrophoresis. In spider, checked sensitiveness, light response, tactile response and observed in their natural behaviour. They have shown Grooming, visual Perception, webbing, feeding, and foraging.

REVIEW OF LITERATURE

The study of Modelling Ant behaviour under a Variable Environment carried out during September 2004 shows the Mathematical model of path following by attracting trail pheromone. They study the behaviour of ants when moving in an artificial network composed of several interconnected paths linking their nest to a food source. The ant responses when temporarily blocking the access to some branches of the maze were observed in order to study which factors influenced their local decisions about the paths to follow. They present a mathematical model based on experimental observations that simulates the motion of ants through the network. In this model, ants communicate through the deposition of a trail pheromone that attracts other ants. In addition to the trail laying/following process, several other aspects of ant behaviour were modelled. The paths selected by ants in the simulations were compared to those selected by ants in the experiments. The results of the model were encouraging, indicating that the same behavioural rules can lead ants to find the shortest paths under different environmental conditions (Karla Vittori *et al.*, 2004).

According to the study conducted by IIT Kanpur 2012, a Study of Ant Foraging Behaviour, they tried to replicate a very famous experiment where ants are constrained to follow a binary bridge from their nest to the food source and see over time that they converge to one path. They successfully replicated the experiment on various bridges and observed the convergence mostly in a shorter path. In addition, they implemented a new computational model of ant foraging that was proposed by Theraulaz *et., al.* This new model characterizes the “choice-function” of the individual ant as a linear function as opposed to nonlinear functions that were previously proposed (Aditya Tandon, 2012).

The study of Universality in Ant Behaviour carried out during 2015, they shows that in ant societies individual average speed is higher when event duration is longer. Expressed as a single scaling function, this relationship is universal because for any event duration an ant, on average, moves at the corresponding average speed except for a short acceleration and deceleration at the beginning and end. This establishes cause and effect within a social system and may inform engineering and control of artificial ones (Kim Christenson *et al.*, 2015).

The study examined Pyrokinin β -Neuropeptide Affects Necrophoretic Behavior in Fire Ants (*S. invicta*), and Expression of β -NP in a Mycoinsecticide increases its virulence in the year 2014, presented a means of increasing the virulence of the fungal agent by expressing a fire ant neuropeptide. They show that Expression of the fire ant (*Solenopsis invicta*) pyrokinin β -neuropeptide (β -NP) by *B. bassiana* increased fungal virulence six-fold towards fire ants, decreased the LT_{50} , but did not affect virulence towards the lepidopteran, *Galleria mellonella*. Intriguingly, ants killed by the β -NP expressing fungus were disrupted in the removal of dead colony members, i.e. necrophoretic behavior. Furthermore, synthetic C-terminal amidated β -NP but not the non-amidated peptide had a dramatic effect on necrophoretic behavior. These data link chemical sensing of a specific peptide to a complex social behavior. Their results also confirm a new approach to insect control in which expression of host molecules in an insect pathogen can be exploited for target specific augmentation of virulence (Yanhua Fan *et al.*, 2014).

The Research on Communication in Ants in the year 2006, shows that ants, and also honeybees and other species of social insects, use several pheromones or other signals in organizing their foraging system. Two important and connected questions, therefore, are to determine why multiple signals are needed and how they work together. The short-lived attractive and repellent trail pheromones used by Pharaoh's ants can direct foragers to the rewarding branch at a trail bifurcation but a single one of these pheromones can only direct about 75% to the rewarding branch. Perhaps the presence of two pheromones can increase this to 90%. The solid substrate upon which ants walk from nest to food is suitable for depositing trail pheromones to guide nest mates. The use of a trail pheromone means channels of communication may be continuously open for ants, because they are capable of a continual, reactive exchange of information with nest mates whilst foraging (E J Duncan *et al.*, 2006).

According to the study of The Role of Behaviour in the Evolution of Spiders, Silks, and Webs in the year 2007, the Spiders' silks and webs have made it possible for this diverse taxon to occupy a unique niche as the main predator for another, even more diverse taxon, the insects. Indeed, it might well be that the spiders, which are older, were a major force driving the insects into their diversity in a coevolutionary arms race. The spiders' weapons were their silks and here they explore the evidence for the evolution of silk production and web building as traits in spider phylogeny (Fritz Vollrath *et al.*, 2007).

The study, 'Do stabilimenta in orb webs attract prey or defend spiders' during the year 1999, they examined the impact of including stabilimenta, designs of bright-white noncapture silk, at the center of orb webs for foraging and defence in *Argiope aurantia*. Their findings suggest that stabilimentum building is a defensive behaviour, supporting the "web advertisement" hypothesis that the high visibility of stabilimenta can prevent birds from flying through webs. Yet, spiders often do not include stabilimenta in their webs, indicating that a serious cost is associated with them. They also show that through comparison of paired webs with and without stabilimenta, that stabilimenta reduce the prey capture success of spiders by almost 30%. This demonstrates the potential impact that defensive behaviours of spiders can have on their foraging success and suggests that much of the variation in stabilimenta may be accounted for by a cost-benefit trade-off made when including stabilimenta in webs (A B Todd *et al.*, 1999).

The study of the Evolution of Sociality in Spiders in the year 2007, discusses the occurrence of group living in spiders. Group living has arisen in spiders in basically two different forms. Cooperative or non territorial and permanent social species. The form of group living in spiders has been termed "colonial" or "communal-territorial." Colonial species have been likened to foraging flocks of birds and are described as foraging societies. They illustrate that, as this terminology is also somewhat unwieldy, for convenience it reverts to the commonly used shorthand designations of social and subsocial, for nonterritorial permanent social and territorial periodic social, respectively (Yael Lubin *et al.*, 2007).

According to the study Grooming behaviours and fouling of the spider crab, *Libinia dubia* (Decapoda: Epialtidae) conducted during the year 2019, show that body fouling has been reduced by grooming behaviours. In decapods, grooming has been focused on gills, sensory structures, and jointed appendages. In this study, grooming behaviours of the spider crab, *Libinia dubia* H. Milne-Edwards, 1834, were examined; this brachyuran crab decorates and camouflages body regions by attaching materials onto hooked setae. The relationship between grooming and these camouflaged body regions was unknown. Six observational and experimental studies examined the grooming frequency, duration of grooming behaviours, body regions groomed, variance of these behaviours in the presence of another individual, and the efficiency of these grooming behaviours at removing gill fouling. Reasons for not grooming body regions with hooked setae were discussed. Spider crabs had a lower time

budget for grooming compared to most decapods, but similar to another brachyuran (L W Jenet *et al.*, 2019).

The study Vibratory courtship in a web-building spider: Signalling quality or stimulating the female, conducted during the year 2003 show that Male vibration behaviour on the old abandoned webs resembled that on the webs of mated females and of females with eggsacs. They suggest that once females become unreceptive after mating, they cease to produce sex pheromone, which results in a reduction of male vibratory courtship. In conclusion, they found no evidence that premating vibrations produced by *S. lineatus* males provide an opportunity for sexual selection via female choice. The data also contradict the hypotheses that vibrations are species- or sex-specific recognition signals. They suggest that the primary function of this behaviour is to stimulate receptive (virgin) females to assume the mating position and copulate. Male vibrating behaviour does not stimulate non receptive females (Alexi A. M. *et al.*, 2003)

METHODOLOGY

STUDY AREA

The present study on ANT and SPIDER Behaviour was carried out in my native place Kanjikuzhi, Kottayam.



Figure 1: Map showing Kanjikuzhi, Devalokam Road, Kottayam

The current study was conducted in and around my home, used different food materials and observed different behaviour in their natural condition and response to various stimulus.

MATERIALS USED

Honey, Sugar, Hot water, light, Coffee cup, lemon

EXPERIMENTAL PROTOCOL

Employed experimental set up by testing with honey drops near the colony of ant to observe the Foraging, interaction and social nature of ants, tested with sugar crystals in a closed tin and put a pair of ants to observe their feeding and defence behaviour. Found out heat response by using hot water. Light sensitiveness was noted by flash light. In spider, rubbed a lemon near the way of hobo spider to observe their response, Different stimulus response was checked by tapping, lighting to know the response of jumping spider.

OBSERVATION AND RESULT

ORGANISM NO.1: ANT

SL.N O	DATE	TIME	ORGANISM	OBSERVATION
1	22/3/21 (3 day exp)	4.30PM	<i>Camponotus herculeus</i>	<p>Put a pair of ants from the tree bark in a transparent closed small plastic tin, gave them sugar and observed, they show defence behaviour during they ate sugar crystal by covering the crystals by one of the ants (inference: they are of two ants from two colonies).</p> <p>After an hour, they <i>sense</i> using their antennae for a way out.</p> <p>They show communication behaviour by touching the antennae together.</p> <p>For a day, they weren't exhausted.</p> <p>Due to the lack of oxygen after one and half days they died.</p> <p>Inference: ants can be active for a day without oxygen and food.</p>
2		Full day		
3	23/3/21 24/3/21	Till afternoon		
4	26/3/21	1:17 pm- 1:47 pm	<i>Monomorium pharaonis</i>	<p>Communication using antennae is observed on a trail.</p> <p>These ants were moved by leaving scent trails to aid other ants.</p> <p>Noticed that they often touch each other with their antennae when they meet.</p>
5	27/3/21	3.00 pm	-----	No observation

6	28/3/21	2.15 pm- 2.30 pm	<i>Monomorium pharaonis</i>	Observed that Ants forms groups during their trail when they encounter with a spider. This is because they secrete aggregation pheromone (group together)/ alarm pheromone (warning behaviour).
7	29/3/21	12.30 pm	<i>Monomorium minimum</i>	Foraging behaviour of little black ant is observed, When I dropped a honey, one of the ant found out, the foraging ant fill up its social stomach which as much food as it can. Once it is full, the ant scurries back to its nest leaves a continuous line of scent along the way and then other ants followed the traced sent back to the food source.
8	2/4/21	2.00 pm	-----	No observation
9	4/4/21	4.30-4.40 pm	<i>M.minimum</i>	Sensitiveness of ants towards hot water is observed (sensing mechanism), when one of this ants touched a drop of hot coffee, it suddenly took off the antennae. Sudden reflex reaction is observed.
10	5/4/21	3.00 pm	-----	No observation
11	6/4/21	1.20 pm- 1.30 pm	<i>M. pharaonis</i>	Communication behaviour is observed- touching each other with their antennae on trail.
12	7/4/21	12.59 pm – 1.30 pm	<i>M. minimum</i>	During foraging, when one of this ant fill up its stomach and once it is full, this ant shared its food with another member of its colony through its

				social stomach through <i>oral transfer</i> .
13	8/4/21	3.00 pm- 4.00 pm	-----	No observation
14	9/4/21	11.30 am- 11.45 am	<i>M. pharaonis</i>	Foraging and sociability is observed.
15	11/4/21	7.30 am- 7.40 am	<i>M. minimum</i>	Necrophoresis is observed, it is a behaviour found in social insects, and two of the black ants carry their dead in order to protect themselves and their queen from contamination (communication via chemical - oleic acid).
16	12/4/21	7.33am-7.45 am	<i>M. pharaonis</i>	Observed that they moved in a line by the pheromone, the tips of their antennae translate the chemical words, thereby guiding the ants in a line to or from the derived destination.
17	14/4/21	4.31 pm – 4-35 pm	<i>M. pharaonis</i>	Pair of ants carrying food crumbs on their jaws to the colony is observed.
18	15/4/21	9.15 am- 9.30 am	<i>M. minimum</i>	Sociability and foraging are observed: carrying a long piece of bone by a group of little black ants to its nest, since it cannot break into small pieces, the group together carry it as a whole to the nest.
19	16/4/21	2.00 pm	-----	No observation
20	17/4/21	4.00 pm	-----	No observation
21	18/4/21	9.20 am – 9.40 am	<i>Camponotus</i> (carpenter ant)	Grooming behaviour is observed, carpenter ant used its specialized structure on the foreleg- the Basi tarsal brush grooms the ipsilateral antennae, and then basi-lateral brush is orally groomed.

22	19/4/21	3.00 pm	-----	No observation
23	21/4/21	5.13 pm – 5.20 pm	<i>Carpenter ant</i>	Feeding on a dead insect is observed
24	23/4/21	10.15 am- 10.25 am	<i>M. pharaonis</i>	Observed that a group of these ants carry dead mosquitoes and its parts.
25	24/4/21	12.00pm	-----	No observation
26	25/4/21	11.30- 11.35 am	Thin black ants	<i>Necrophoresis</i> is observed (carry dead ants from their colony).
27	26/4/21	12.5- 12.15 pm	<i>M. pharaoanis</i>	Communication and foraging is observed.
28	27/4/21	5.00 pm	-----	No observation
29	28/4/21	12.20- 12.40pm	Pharoa ant	Observed that grouping together around a drop of honey and they <i>defend</i> when a <i>M. minimus</i> came near by the food, they didn't allow that ant to feed.
30	29/4/21	3.00pm	-----	No observation
31	30/4/21	8.50 -9.00 am	Winged carpenter ant	Winged carpenter ant with elbowed antennae is observed, they become winged during mating or breeding time.
32	1/5/21	9.00 am	-----	No observation
33	2/5/21	5.40- 5.45 pm	Carpenter ant	Grooming behaviour is observed.
34	3/5/21	4.30- 4.40 pm	Black ant	Test whether they are sensitive or attracted to the flash light (during feeding when the flash light is on, a sudden reaction occurs and they scattered and run)
35	4/5/21	7.30 -7-45 am	<i>M. pharaoanis</i>	Foraging of ants' trail in a curve line is observed (chemoreceptors enable them to follow in curved trail, more often they may see as straight trails, or even

				zigzags.
35	5/5/21	11.00am	-----	No observation
36	6/5/21	2.00 pm	-----	No observation
37	7/5/21	12.30- 12.40 pm	Camponotous	<i>Foraging-Sniffing</i> out using the antennae by the trail is observed.
38	9/5/21	4.30 – 4.45 pm	Carpenter ant	They are not aggressive towards any other insects, if they aren't felt threatened or get disturbed. Because, when I observed that a bug which came near to Camponotous, it didn't attack the bug for a long time, as the bug is not tried to disturb the Camponotous either.
39	11/5/21	12.30 – 12. 35 pm	Tiny black ant	<i>Sensing behaviour</i> is observed, suddenly appear around an opened coffee mug as a group, using their chemoreceptors even if there is low concentration, they have the ability to detect the chemical substance in their environment.
40	12/5/21	3.00 pm	-----	No observation
41	14/5/21	4.30 – 4.40 pm	Pharoa ant	Food particles which they divided and carried each small crumbs by individual to their nest is observed.
42	16/5/21	11.23 – 11.33 am	Tiny black ant	Necrophoresis is observed (carry the dead ant by a Monomorium ant is observed)
43	17/5/21	1.25 pm – 1.30 pm	Camponotous	Grooming and sniffing around is observed.
44	18/5/21	11.30 – 11.40 pm	Tiny black ant	Observed sensing and sociability behaviour that an ant that got injured and shows difficulty in walking,

				carries back to the nest by a tiny black ant.
45	19/5/21	9.30 – 9.37 am	M. minimus	Response to temperature is observed, when these ants falls on a normal water they tried to escape and stay alive for half minutes, but when they falls on boiled water within 5 seconds they become dead.
46	21/5/21	10.30 am	-----	No observation
47	22/5/21	11.00 – 11.30 am	Black ant	Tested the sensing and attraction towards different food materials- placed a coffee mug, spicy food remains, and hot tea. The ants sniff around within five minutes and came near to the coffee mug first than other two food particles. Ants always prefer sugar, fluids, and protein, since they need quick energy for their work and survival.
48	23/5/21	1.00 – 1.15 pm	Camponotous	Observed Foraging behaviour - Sniffing out using the antennae by the trail is observed.
49	24/5/21	3.00 – 3.10 pm	Pharoa ant	Feeding and sociability is observed, Food particles which they divided and carried each small crumps by individual to their nest is observed.
50	26/5/21	2.00 pm	-----	No observation
51	28/5/21	4.00 pm	Carpenter ant	Grooming behaviour is observed.
52	31/5/21	8.00 am- 8.10 am	M.pharoanis	Communication using antennae is observed on a trail. These ants were moved by leaving scent trails to aid other ants.

				Noticed that they often touch each other with their antennae when they meet.
53	1/6/21	3.00 pm	Thin black ants	<i>Necrophoresis</i> is observed (carry dead ants from their colony).

Table 1: showing behavioural observation of Ant

ORGANISM NO: 2- SPIDER

SL.N O	DATE	TIME	ORGANISM	OBSERVATION
1	22/3/21	1.15 – 1.20 pm	Hobo spider (<i>Eratigena agrestis</i>)	Seen near to the ant group, when disturbed by tapping sound, they jump and run faster.
2	24/3/21	2.23 – 2.40 pm	The giant house spider and hobo spider	Observed the fighting between giant spider and hobo spider (since it is almost similar in morphology, thought to be deterrent to hobo spider and compete with them for resource).
3	25/3/21	3.00 pm	-----	No observation
4	28/3/21	1.23- 1.30 pm	Jumping spider	Waving their pedipalps- leg like structures at the front of their head is observed. It contains sensory organs, so they move these around to contact substances and sensing.
5	29/3/21	7.35 – 7.40 am	Plexipus paykulli (jumping spider)	When watching this jumping spider for some minutes and took pictures, it looked back and flip or wave it's pedipalps for a long time (it is said that when you look at a jumping spider, they will look back at you, they have a <i>keen vision</i> having large fixed

				lens and tiny boomerang shaped retina that provides high resolution images and sees in colour and uv).
6	30/3/21	9.00 am	Jumping spider	Gregarious nature and a seemingly insatiable curiosity about humans and anything that approaching them is observed.
7	1/4/21	7.45 am-7.55 am	Daddy long legs	Spinning on the web in a circular motion, a defensive and protection behaviour is observed (it is said that, when these spiders threatened, <i>vibrate their legs</i> and bodies so rapidly so as to become invisible. Hence it is also known as <i>vibrating spiders</i>
8	2/4/21	9.45 am	-----	No characteristic observation
9	3/4/21	7.39 – 7.59 am	Social/communal spider	Sociability is observed, they are seen in a group which they web together and lay eggs together in the web, they together build, maintain and clean their web.
10	4/4/21	5.00 pm	-----	No observation
11	6/4/21	8.00 – 8.10 am	Cellar spider	Observed that they slept by hanging upside down (the spiders which that wait their head down for their prey, gravity also helps spiders as they run down the web.
12	7/4/21	2.20 – 2.30 pm	Grey wall jumper	Ate ant's fluid shows the feeding behaviour, they are day hunters and do not create web, so they hunt and eat rather than trapping in the web.
13	9/4/21	7.45 – 7.55 am	Cellar spider	Observed that they feed on an insect which it trapped in the web and covered the prey in the silk (the main

				reason of spider spins the web is to catch the prey easier and since some spiders do not have great eyesight, they usually use the vibration of the web strands to locate prey and wrap their victims in silk also they can also save the food for later use.
14	10/4/21	4.00 pm	-----	No observation
15	12/4/21	3.25- 3.30 pm	Hobo spider	Test whether spiders are attracted to citrus: rubbed a lemon near the way of hobo, since it is hated (sensitive) citrus it turned back and run away.
16	13/4/21	8.30 – 8.40 am	Cellar spider	Feed on ants which it trapped on the web.
17	14/4/21	11.00 am	-----	No observation
18	16/4/21	11.5 -11.10 am	Jumping spider	Test whether they are sensitive to light by using flash light: observed that when the lights are on, they looked into it with more concentration shows that they aren't sensitive to lights.
19	17/4/21	12.30pm	-----	No observation
20	21/4/21	9.30 – 9.40 am	Huntsman spider	Observed in rock bridge during day time, and when they got disturbed by a sound, they hide inside the rocks (since they are nocturnal, they are rarely seen in day time).
21	23/4/21	9.30 am	Yellow garden spider	Web of yellow garden spider with zigzag web, called stabilimentum is observed.
22	24/4/21	11.30 am	-----	No observation
23	25/4/21	2.30 – 2.35 pm	Jumping spider	Waving of pedipalps and staring is observed when I got near to the species.

24	26/4/21	3.00 pm	-----	No observation
25	28/4/21	1.45- 1.55 pm	Jumping spider	Sniffing around the table and wall for food by flipping the pedipalps for <i>sensing</i> is observed.
26	30/4/21	11.50 -11.55 am	Jumping spider	When I shake a chair leg this spider on a chair shows sudden reaction by jumped to nearby place(sudden change in haemolymph pressure to propels itself by contracting muscles) .
27	1/5/21	4.00 – 4.10 pm	Home spider	Watched that they are sleeping in the web upside down (it allows them to have plenty of energy for their main purposes in life: eating and breeding, in that sense, spiders are a lot like every other animal in that they know they need to be rested to eat or mate).
28	2/5/21	3.30 pm	-----	No observation
29	3/5/21	3.35 – 3.50 pm	Daddy long legs	The females which protect their eggs, by making a silk ‘bed’ and then covering them with a silk blanket is observed (she then wraps them in more silk to make the egg sac. She hangs safe and guard until the babies’ hatch).
30	4/5/21	4.00 pm	-----	No observation
31	5/5/21	2.30 pm	-----	No characteristic observation
32	7/5/21	8.15 – 8.20 am	Cellar spider	<i>Feeding behaviour</i> shown by trapping of an insect in the web is observed, when the insect is trapped it get paralysed and wrapped in silk by the spider.
33	8/5/21	4.00 – 4.10 pm	Cellar spider	<i>Sociability</i> is observed, which they webbed together and they lived in a

				group by sharing food, shelter etc.
34	11/5/21	2.00 pm	-----	No observation
35	13/5/21	8.05- 8.15 am	Jumping spider	Grooming is observed: they groom by drawing the legs one at a time through moistened chelicerae and combing them with the fangs and palps. The first and fourth pairs of legs are then used to groom other parts of the body.
36	16/5/21	2.15 – 2.45pm	Jumping spider	Visual perception , observed that a jumping spider which wave their palps by sitting in a stair case and when it disturbed by the sound that I made in staircase, they suddenly hide into a dark area (movement can be detected by the spider and they can distinguish light and dark areas, that is why it moved into dark area when it disturbed).
37	18/5/21	3.20 – 3.30 pm	Hobo spider	Female with several egg sacs in a web is observed (commonly when the male finds a mate, the female will produce several egg sacs and suspend them in her web).
38	19/5/21	2.00 pm	-----	No observation
39	21/5/21	8.05 – 8. 10 am	Jumping spider	Foraging of jumping spider near the wall is observed.
40	22/5/21	4.02- 4.05 pm	Cellar spider	Trapping and feeding of an insect in its web are observed.
41	23/5/21	3.00 pm	Jumping spider	Sniffing around the house using pedipalps shows the sensing and foraging behaviour
42	25/5/21	2.30 pm	Cellar spider	Sociability is observed
43	26/5/21	10.00 am	-----	No observation

44	27/5/21	11.30- 11.55 am	Jumping spider	Grooming is observed: they groom by drawing the legs one at a time through moistened chelicerae
45	28/5/21	1.00 pm	Jumping spider	Visual perception is observed

46	29/5/21	1.30 – 1.35 pm	-----	No observation
47	30/5/21	4.00 pm	Home spider	Hanging upside down in the web with their group is observed
48	1/6/21	4.30 pm	Cellar spider	Spinning on the web is observed
49	2/6/21	6.00 pm	-----	No observation
50	3/6/21	7.00 am	Home spider	Observed that insect was trapped on the sticky web in an arranged manner, and they are wrapped inside the silk. So that they can use it later.

Table 2: showing behavioural observation of Spider

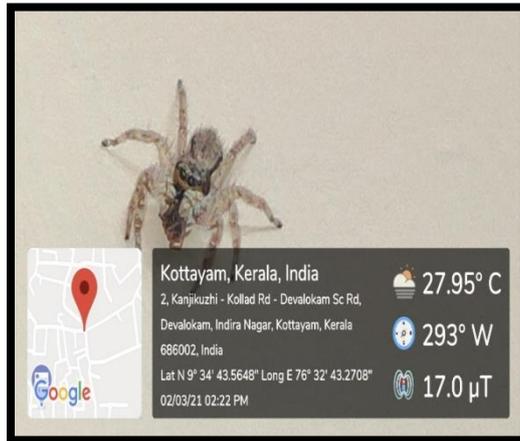


Figure 1: showing Trap and feed insect

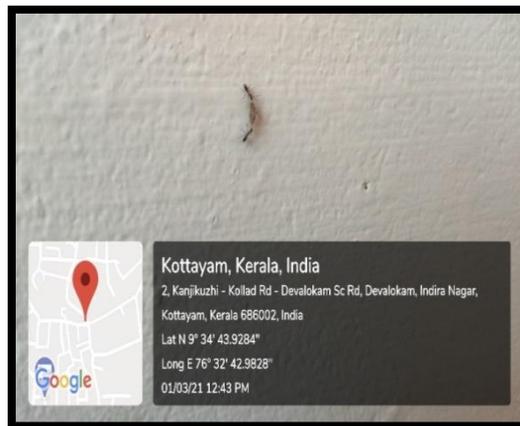


Figure 2: showing sociability and foraging



Figure 3: Trap in web and wrapped by silk

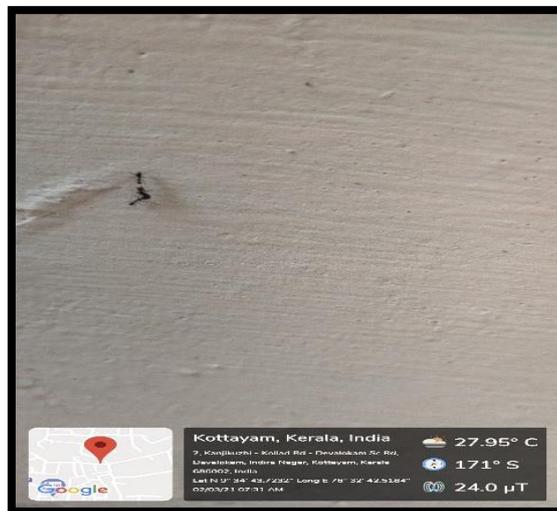


Figure 4: Necrophoresis



Figure 5: Communication and feeding



Figure 6: Strabilimentum (webbing of garden spider)



Figure 7: Oral transfer (Trophallaxis)



Figure 8 Grooming of *camponotus*

RESULT

Studying the social behaviour of ants and other insects for decades, searching for chemical cues and other signals that the insects use to coordinate behaviour. Ants, as eusocial insects, exhibit some of the most fascinating and complex programs of social behaviour in animals, where-in physiologically-distinct individuals use cooperative behaviours such as nursing, foraging, nest maintenance, defence, and policing to sustain colony homeostasis.

In the current study different conditions and materials are used to check the response. *Communication* using antennae is observed, an ant's antennae are highly sensitive and contain both touch and smell organs. Each ant colony has a unique smell, so members are able to recognize each other and sniff out intruders. Ants form groups in a suitable habitat by secreting aggregation pheromone or secrete alarm pheromone to warn the group of danger when they encounter with a predator species.

During *foraging* when a *Monomorium* species found out the food, it fills up its social stomach and the ant scurries back to its nest leaving a continuous line of scent along the way, also shows an *oral transfer* mechanism (trophallaxis), by sharing food with another member of its colony through its social stomach.

Another interesting behaviour that I observed was *Necrophoresis*, in order to protect themselves and their queen from contamination, they carry their dead. This behaviour has to do with the way ants communicate with each other via chemicals- when an ant dies, its body releases a chemical called oleic acid, it translates to dumpster material for ants and other ants were responding to its call. Show sensitive response towards flash light by black ants during foraging.

Some spiders are active hunters that chase and overpower their prey. They typically have a well-developed sense of touch or sight. Other spiders instead weave silk, snares, or webs, to capture prey. Webs are instinctively constructed and effectively trap flying insects. In current study I observed some of the interesting behaviours of spiders, one of which I observed was the *visual perception* of jumping spider, it is said that when you look at a jumping spider, they will look back at you and wave the pedipalps, they have a keen vision having large fixed lens and a tiny boomerang shaped retina that provides high resolution images. Spinning on the web in a circular motion is observed, it is said that, the daddy long legs when threatened,

vibrate their legs and bodies so rapidly so as to become invisible. Hence it is also known as *vibrating spider*.

Hobo spider show sensitive response towards citrus. Zigzag web called *stabilimentum* of yellow garden spider is observed. Home spiders are usually slept in the web hanging upside down to have plenty of energy. Sociability of cellar spider is another interesting behaviour, that they webbed together and lived in a group which they share food and protect each other.

DISCUSSION

The present study examined the behaviours of ants and spiders in the area Kanjikuzhi, Kottayam, carried out during three months from March 22 2021 to June first week 2021. I employed several experimental setups by doing test with honey, sugar, coffee drops and also checked some stimulus response to observe the behaviours of Ant. They have shown fascinating behaviours like Grooming, foraging, feeding, sociability, and necrophoresis. In spider, checked sensitiveness, light response, tactile response and observed in their natural behaviour. They have shown Grooming, visual Perception, webbing, feeding, and foraging.

Ants, as eusocial insects, exhibit some of the most fascinating and complex programs of social behaviour in animals, where-in physiologically-distinct individuals use cooperative behaviours such as nursing, foraging, nest maintenance, defence, and policing to sustain colony homeostasis.

Ant colonies are very interesting entities because of their capacities to collectively achieve complex decisions and patterns through self-organization processes based on simple behavioural rules and the use of local information and indirect communication.

In my current study the species *Camponotus herculeus* show defence towards ants from other colonies when they are put together. *M. pharoanis* grouped together around a drop of honey and they defend when a *M. minimum* ant came near by the food, they didn't allow that ant to feed, similarly the work conducted in 2001 show that, A colony of social insects is an excellent model for investigating the organization of responses of subunits (i.e. colony members) with limited skills into sophisticated collective behaviour. The defence system of *Lasius niger* ant colonies is well organized in a context-dependent way. The proportion of fighting ants to fleeing ants changes gradually according to the importance of the area being defended, and was higher where ants tended honeydew-rich aphids and on trails for foraging with heavy traffic, than where ants were walking alone or on trails with light traffic. Although there were intrinsic differences in aggressiveness between individual ants, the differences in aggressive responses between defended areas was not due to the presence of highly aggressive or timid individuals in each area (Hiroshi Sakata *et al.*, 2001).

In my observation, I have noted that during foraging when a Monomorium species found out the food, it fills up its social stomach and the ant scurries back to its nest leaving a continuous line of scent along the way, also shows an oral transfer mechanism (trophallaxis), Social insects frequently engage in oral fluid exchange – trophallaxis – between adults, and between

adults and larvae. Although trophallaxis is widely considered a food-sharing mechanism by sharing food with another member of its colony through its social stomach. Similarly according to the study conducted by Adria and her companion in 2006, they have hypothesized that endogenous components of this fluid might underlie a novel means of chemical communication between colony members. Through protein and small-molecule mass spectrometry and RNA sequencing, also they have found that trophallactic fluid in the ant *Camponotus floridanus* contains a set of specific digestion- and non-digestion related proteins, as well as hydrocarbons, microRNAs, and a key developmental regulator, juvenile hormone. When *C. floridanus* workers' food was supplemented with this hormone, the larvae they reared via trophallaxis were twice as likely to complete metamorphosis and became larger workers (C L Adria, *et al.*, 2006).

Another interesting behaviour that I observed was Necrophoresis, in order to protect themselves and their queen from contamination, they carry their dead. This behaviour has to do with the way ants communicate with each other via chemicals- when an ant dies, its body releases a chemical called oleic acid, it translates to dumpster material for ants and other ants were responding to its call. In the study of *chemical releasers of Necrophoric behaviour in ants* during the year 1958, they presented the preliminary response in the myrmicine ants *Pogonomyrmex badius* (Latreille) and *Solenopsis saevissima* (Fr. Smith), in which special attention has been paid to the releasing stimuli (E.O Wilson *et al.*, 1958). During foraging when a Monomorium species found out the food, it fills up its social stomach and the ant scurries back to its nest leaving a continuous line of scent along the way, also shows an oral transfer mechanism (trophallaxis), by sharing food with another member of its colony through its social stomach. Also, once it is full, the ant scurries back to nest leaving a continuous line of scent along the way and then other ants followed the traced scent back to the food source; sometimes curved trails are also seen. In the overview of ant foraging strategy as an individual and social process by Department of biology in Boston University conducted in 2012 said that ant foraging is a collective process composed of the activities of individuals as well as behaviourally integrated groups. Therefore, a great challenge in the socioecology of foraging is to explain how the behaviour of such a potentially large and complex system as an ant colony emerges as a function of the properties of its individual components, the principal ecological determinants of ant foraging strategy are the distribution of food resources in size, time space, and quality; competition with sympatric ant species; and predation..

Some spiders are active hunters that chase and overpower their prey. They typically have a well-developed sense of touch or sight. Other spiders instead weave silk, snares, or webs, to capture prey. Webs are instinctively constructed and effectively trap flying insects. Most importantly, all spiders make and use silk throughout their lives, however diverse their morphology, ecology, and behaviour (Fritz Vollarth *et al.*, 2007).

When I observe the feeding behaviour I had seen two different feeding behaviour in two species of spider, the jumping spiders are hunt and eat rather than trapping in the web, at the same time the cellar spider feed on insects which it trapped in the web and cover the prey using silk and so that it can use it later too. It can be proven by the study conducted during 1992 that they explained Spiders use many methods to capture prey: from active pursuit to cautious stocking and sit-and-wait ambush, sometimes even prey attraction and aggressive mimicry spiders rely primarily on tactile and vibratory cues (W.U George, 1992).

In my observation I have noted that Cellar spiders webbed together and lived in group show sociability behaviour, they share food, and protect each other. In a study conducted in 2007, they have shown that Group living has arisen in spiders in basically two different forms. The form of group living in spiders has been termed “colonial” or “communal-territorial.” Colonial species have been likened to foraging flocks of birds and are described as foraging societies. They illustrate that, as this terminology is also somewhat unwieldy, for convenience it reverts to the commonly used shorthand designations of social and sub social, for non-territorial permanent-social and territorial periodic-social, respectively (Yael Lubin *et al.*, 2007).

CONCLUSION

The present study on ANT and SPIDER Behaviour was carried out in my native place Kanjikuzhi, Kottayam. I examined the behaviours of ants and spiders during three months from March 22 to June first week 2021. I employed several experimental setups by doing test with honey, sugar, coffee drops and also checked some stimulus response to observe the behaviours of Ant. They have shown fascinating behaviours like Grooming, foraging, feeding, sociability, and necrophoresis. In spider, checked sensitiveness, light response, tactile response and observed in their natural behaviour. They have shown Grooming, visual Perception, webbing, feeding, and foraging. Ant colonies are very interesting entities because of their capacities to collectively achieve complex decisions and patterns through self-organization processes based on simple behavioural rules and the use of local information and indirect communication. Some spiders are active hunters that chase and overpower their prey. They typically have a well-developed sense of touch or sight. Other spiders instead weave silk, snares, or webs, to capture prey. Webs are instinctively constructed and effectively trap flying insects.

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**STUDY ON BEHAVIORAL PATTERN OF *CALOTES VERSICOLOR* AND
*SCYLLA OLIVACEA***

MINI PROJECT – SEM I

**SUBMITTED TO ST. TERESA'S COLLEGE (AUTONOMOUS),
ERNAKULAM**



SUBMITTED BY,

GRACY ANU K. F.

REG. NO: SM20ZOO003

DEPARTMENT OF ZOOLOGY

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

KERALA, 682011

2020-2022

CERTIFICATE

This is to certify that the Mini project entitled “**Study on behavioral pattern of *Calotes versicolor* and *Scylla olivacea***” is an authentic work carried out by **GRACY ANU K. F.** (Reg. No: SM20ZOO003), during the Academic year **2020-2022**, under my guidance from St. Teresa’s College (Autonomous), Ernakulam.

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1.

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DECLARATION

I hereby declare that the Mini project entitled “**Study on behavioral pattern of *Calotes versicolor* and *Scylla olivacea***” submitted to St. Teresa’s College (Autonomous), is an original work done by me under the supervision and guidance of Ms. Tiya K. J, Assistant professor, Department of Zoology, St. Teresa’s College (Autonomous), Ernakulam and to the best of my knowledge and belief, this project contains no material previously published or written by another person, except where due reference is made.

GRACY ANU K. F.

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GRACY ANU K. F.

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ABSTRACT

Although, the common oriental lizard, *Calotes versicolor* and *Scylla olivacea*, the orange mud crab is familiar and found everywhere in our country, information on its ethological behavior is remain scarce. In order for the better understanding of the daily behavioral characters of the two organisms, observations have been made by day-to-day monitoring the two organisms, *Scylla olivacea* and the agamid lizard, *Calotes versicolor*. Agamids typically have scaly bodies, well-developed legs, and a moderately long tail. *Calotes*, genus of arboreal (tree-dwelling) lizards of the family Agamidae, remarkable for their colour changes when excited. It is found in gardens and forests of India, Sri Lanka, Southeast Asia, and some Pacific islands. *C. versicolor* turn red when the lizard is victorious in combat or when he is in courtship, which is the reason they are commonly called “bloodsuckers.” They are also known locally as garden lizards.

Scylla olivacea, commonly known as the orange mud crab, is a commercially important species of mangrove crab in the genus *Scylla*. It is one of several crabs known as the mud crab and is found in mangrove areas. Along with other species in the genus *Scylla*, it is widely farmed in aquaculture. The study was conducted for three months duration. Observations were made on the different behavioral changes and various behavioral exhibition of the two animals by keen inspection made on each day within the three months of the study. Results of the study is drawn based on monitoring the animals daily at the morning, afternoon, evening and also at the time of feeding and various other daily activities.

From the current behavioural study conducted, many ethological characters were observed among the two organisms. *S. olivacea* was captured and behaviour was monitored on daily basis. Aggression was the major character observed with ticking the appendages and moving around the medium in which the crab was been kept. The crab showed significant movements and aggressive characters in the morning hours bubbling and foraging behaviour was observed at evening time. The activity patterns of *C. versicolor* involved basking in the sunny days and resting at early morning period. Once they attained optimum body temperature at peak period, activities such as moving around, hiding under leaves and twigs, foraging were performed. Detection of the prey-body by using the chemical cues has been seen as tongue flicking behaviour. In late afternoon, almost all the activities were decreased and again remain at resting position.

INTRODUCTION

The oriental garden lizard, eastern garden lizard, Indian garden lizard, common garden lizard, bloodsucker, or changeable lizard (*Calotes versicolor*) is an agamid lizard commonly found lizard and widely distributed in eastern Iran, across the Indian Subcontinent, to Indo-China and Indo-Malaya, with several naturalized populations in both the New and Old Worlds, It has also been introduced in many other parts of the world (Indraneil *et al.*, 2008).

Kingdom: Animalia

Phylum: Chordata

Class: Reptilia

Order: Squamata

Family: Agamidae

Genus: *Calotes*

Species: *C. versicolor*

The lizard is an insectivore and the male gets a bright red throat in the breeding season. It has an elongated body which is compressed laterally to a slight extent. The body is distinguished into head, neck, trunk and tail. It is covered all over the body with scales which overlap each other in the posterior direction. the eyes are each protected by a pair of movable eyelids and a small nictitating membrane. The lateral location of the eyes makes the vision of the monocular type. Just above the eyes are a pair of folds called the supraciliary ridges. The trunk is somewhat cylindrical in form and slightly compressed laterally. Posterior end of the trunk is marked by the presence of a transverse slit or cloaca on the ventral side. The cloacal slit is bounded by a pair of anterior and posterior lip. The tail of an adult *C. versicolor* is usually more than twice the length of the trunk region. Regarding the body coloration, the lizard is greyish dorsally and ash coloured ventrally. During breeding season, the male turns pinkish red particularly on the ventral side. The female is more or less sombre (Paranjape, 1966).

It is an oviparous by nature. Exhibits temperature-dependent sex determination. The female lays from five to sixteen soft oval eggs, about 5/8 of an inch long, in hollows of trees, or in holes in the soil which they have burrowed, afterward covering them up. The young appear in about eight or nine weeks. In a hot sunny day, a solitary Bloodsucker may be seen on a twig or on a wall, basking in the sun, with mouth wide open. After a shower of rain numbers of them are seen to come down on the ground and pick up the larva and small insects which fall from the trees during the showers. Changeable lizards escape danger by darting to the nearest tree. If the predator comes even closer, they will scale to the side of the tree facing away from the predator and very swiftly dart up the tree. The predator looks behind the tree only to see that the lizard is up in the branches (Pandey *et al.*, 2017).

Changeable Lizards are related to iguanas (which are found only in the New World). Unlike other lizards, they do not drop their tails (autotomy), and their tails can be very long, stiff and pointy. Like other reptiles, they shed their skins. Like chameleons, Changeable Lizards can move each of their eyes in different directions (Günther, 1864).

Calotes versicolor belongs to the family Agamidae of the suborder Lacertilia included under the order Squamata of the class Reptalia. The crested tree lizard, *Calotes versicolor* is a strong candidate for the status of most widespread non-Gekkonid lizard in the world. With growing evidence that *C. versicolor* is an invasive species with potentially harmful ecological impacts in the areas where it is introduced, largely because of its omnivorous feeding habits. Among the various common English names used for this species (garden lizard, bloodsucker, etc.) “crested tree lizard” is felt to be the most appropriate in the to avoid confusion with other species found in gardens (Matyot, 2004).

Being a semi-arboreal, sun-loving lizard that spends a lot of time on tree- trunks and rocks, *C. versicolor* has a predilection for open scrubland, wasteland, gardens, parks and other “man-made habitats” in Asia reports that it is found on low vegetation in open forest or disturbed areas near human habitation (Stuart, 1999).

It has a sit-and-wait hunting strategy, usually watching for prey from a vantage point on a tree-trunk, but moving into the shade, including among high grasses, when it gets too hot; adult males stay in the open more often to exercise territoriality, while adult non-breeding females and, especially, juveniles tend to forage on the ground in grassy and shrubby vegetation (Diong *et al.*, 1994).

Scylla olivacea, the mud crabs belong to genus *Scylla*, a fast growing species that attains larger size among portunids and is widely distributed throughout the coastal zones of the Indo-Pacific region (Fratini *et al.*, 2008).

Kingdom:	Animalia
Phylum:	Arthropoda
Subphylum:	Crustacea
Class:	Malacostraca
Order:	Decapoda
Family:	Portunidae
Genus:	<i>Scylla</i>
Species:	<i>S. olivacea</i>

They represent a valuable component of traditional, small scale coastal fisheries in several tropical and subtropical Southeast Asian countries which stands as a significant commodity that fetches a high price in the international seafood market, Mud crabs form the ‘candidate species for aquaculture’ owing to its winsome qualities such as faster growth, larger size, high reproductive capacity (fecundity), disease resistance, marketability, adaptability to farming systems etc. Over the last three decades, exploitation of mud crab populations has increased tremendously in many countries in South East Asia (Chandrasekaran *et al.*, 1994).

Carpus of chelipeds without two obvious spines on distal half of outer margin; palm of cheliped usually with a pair of blunt prominences on dorsal margin behind insertion of the dactyl, inner larger than outer; may be spinous in juveniles and young adults. Frontal lobe spines low (mean height c. 0.03 times frontal width measured between medial orbital sutures), rounded with shallow interspaces. Chelipeds, legs and abdomen all without obvious polygonal patterning for both sexes. (Keenan C. P, 1999).

The mud crabs belong to genus *Scylla* is one of the largest portunids and is widely distributed throughout the costal Indo- Pacific region. These mud crabs are esteemed palatable seafood item which stands as significant commodity in the international seafood market. They represent a valuable component of small-scale coastal fisheries in tropical and subtropical Asia. Unlike

the other portunids, *Scylla* has the ability to withstand fluctuations in salinity and low oxygen levels as well as being able to survive out of water, thus simplifying the transportation needed, particularly during exportation. The species identification of mud crab has been controversial for many years. A precise and sound taxonomic identification of species in genus *Scylla* is a prerequisite for hatchery rising of mud crab seeds for aquaculture and also for stock enhancement of mud crab fishery (Bopb, 1991).

Frontal lobe spines low (mean height c. 0.03 times frontal width measured between medial orbital sutures), rounded with shallow interspaces. Palm of cheliped usually with a pair of blunt prominences on dorsal margin behind insertion of the dactyl, inner larger than outer; may be spinous in juveniles and young adults. Chelipeds, legs and abdomen all without obvious polygonal patterning for both sexes. Colour varies from red through brown to brownish/black depending on habitat (Keenan *et al.*, 1998).

Most common species of *Scylla* in markets in Sundaic Southeast Asia and Thailand. Intertidal to subtidal, estuarine, found on mangroves. Members of the order Decapoda are mostly gonochoric. Mating behavior: Precopulatory courtship ritual is common (through olfactory and tactile cues); usually indirect sperm transfer (Herbst, 1796).

Crabs are highly potential to be exploited in the country. Moreover, the country has numerous mangrove forests as the habitats. It is stated that crabs live well in healthy mangrove forests. They need mangroves to provide them with litters and benthos as their food sources. In addition to be the habitats for adult crabs, the mangrove ecosystems also serve as crabs spawning, nursery, and feeding grounds (Pane *et al.*, 2020).

REVIEW OF LITERATURE

Calotes versicolor is native to large parts of south and southeast Asia, with introduced populations elsewhere (Uetz et al. [eds.] 2019). It feeds on a wide range of invertebrates and vertebrates including annelids, molluscs, insects, myriapods, arachnids, crustaceans, amphibians, reptiles, birds, and mammals, as well as plant matter (Sudasinghe, *et al.*, 2015).

The Oriental Garden lizard (*Calotes versicolor*) belongs to the family Agamidae, of which there are at least 82 species present in Australia (Cogger, 2014).

The colouration is varied but is often described as olive green or greyish above and whitish below (Das 2015). The lizard exhibits obvious geographic variation in coloration, scalation, and size across its. The average snout-vent length (SVL) is 100 mm, with a total body length (including tail) between 250–400 mm. Neonates in India typically measure 25–28 mm SVL (Radder *et al.*, 2001).

The Oriental Garden lizard is distinguished from other *Calotes* by having lateral body scales that point backwards and upwards, two separated spines above the tympanum, and 35–52 scales around the body. The five fingers have long sharp pointed claws and the five toes have curved pointed claws (Bomford, 2008).

Oriental garden lizard is semi-arboreal and individuals are often found clinging to rocks, tree trunks, vines and low vegetation up to 9 m. They typically live among leafy undergrowth and grass, particularly in open habitats. Males often display from fences and other conspicuous perches (Hasen, 1993).

Juveniles forage and bask mostly on the ground, whereas sub-adults and adults spend much of their time on tree trunks, frequently in a head-down posture surveying for prey. Adults roosting at night have been collected from May through October (summer to early autumn) in Florida (Enge *et al.*, 2004).

Oriental garden lizard is semi-arboreal and individuals are often found clinging to rocks, tree trunks, vines and low vegetation up to 9 m. They typically live among leafy undergrowth and grass, particularly in open habitats. Males often display from fences and other conspicuous perches (Cox *et al.*, 1998).

The lizard seeks prey using a sit-and-wait strategy from a vantage point, such as tree trunks and fences. Females and juveniles typically seek prey from the ground. Although predominately an insectivore, the lizard is opportunistically omnivorous, consuming a wide

range of prey. In its native range, diet includes annelids, molluscs, insects, myriapods, arachnids, crustaceans, amphibians, reptiles, small birds and mammals as well as plant matter. Adults occasionally prey on their own young. Predators of the oriental garden lizard are mammals and birds. The lizard seeks prey using a sit-and-wait strategy from a vantage point, such as tree trunks and fences. Females and juveniles typically seek prey from the ground (Diong *et al.*, 1994).

There are four species of mud (or mangrove) crabs in the genus *Scylla*, *S. serrata*, *S. olivacea*, *S. tranquebarica* and *S. paramamosain*, all of which support capture fisheries and aquaculture. In most countries where mud crabs are fished or farmed, they are an important source of income from both export and local sales, and are utilized by recreational fishers (Sharma, 1991).

Mud crabs are a common component of the fauna of mangrove forests, usually burrowing in mud or sandy-muds. They have a diverse diet and are omnivorous in nature, feeding on a wide range of animal and plant resources (Hill, 1976).

The distribution of mud crabs extends from South Africa, along the southern coasts of middle-eastern countries, across the Indian Ocean and northerly to the southern tip of Japan, east as far as Micronesia and south to the east coast of Australia. *Scylla serrata* is the most widely distributed species, whilst Indonesia appears to be the centre of diversity for the genus, where all four species of *Scylla* are found. (Keenan *et al.*, 1998).

All mud crabs commonly display 6 larval stages; 5 zoeal stages, followed by a megalops larval stage which precedes the first crab stage. Mud crabs typically undergo 14–16 moults prior to reaching their maximum size. Reported daily weight gain for mud crabs varies from 1–4 g per day and varies with species, and sex, with males reportedly growing faster than females (Macintosh *et al.*, 2004).

All mud crabs can mature within their first year of life, with *S. paramamosain* maturing at a size of 102 mm carapace width at around 160 days from settlement, whilst *S. serrata* have reportedly grown to 750 g within 145 days and shown signs of maturity at day 147 (Karthik P *et al.*, 1976).

They are highly fecund with individual females carrying over 3 million eggs. Apart from spawning migrations where females may travel considerable distances offshore most crabs appear to move little within their local habitat, which is typically mangrove. Mud crabs of

different sizes occupy different niches within mangrove forests and the adjacent sub-tidal zone. Crabs which have recently moulted and have not fully grown to fill their new shells are commonly referred to as “empty” crabs. Such crabs may be put into fattening pens, ponds or enclosures and fed until they are “full” and ready for market. Other crabs of varying sizes will be caught and put into soft shell shedding facilities. Such crabs are commonly placed in individual containers and monitored until they moult. On moulting the crabs will either be chilled and put on ice, or frozen for the soft-shell crab market, where all parts of the crab can be consumed as the shell has not been allowed to harden after moulting. Mud crabs born in captivity have been successfully mated with both wild and other captive stock so that some organizations and companies now use domesticated stock. Almost all hard shell, mature females collected from the wild will have been impregnated and will spawn if held under appropriate conditions. Each mature female will usually be able to spawn 2 or 3 batches of larvae when held under satisfactory conditions following a single copulation. (Walton *et al.*, 2006).

Mud crabs are top benthic predators and feed on sessile or slow-moving benthic macroinvertebrates, mainly gastropods, crustaceans, and molluscs, as shown by foregut content analyses conducted on populations in Australia, Africa, and India. Small mud crabs are omnivorous, feeding opportunistically on smaller crabs and plants, whereas medium- and large-sized crabs are carnivorous, feeding on benthic invertebrates or being opportunistic scavengers (Thimdee *et al.*, 2001).

Mud crabs are well adapted to warm temperatures (20–30°C) in the tropical and subtropical regions, but become inactive at low temperatures. Fishermen in Australia have recognized drastic decreases in catch rates, when water temperatures drop to 20°C or exceed 35°. The majority of crabs showed decreased movement and general activity with decreasing temperatures (below 16°C), indicating that mud crabs stay inactive during the colder seasons in subtropical regions. An attempt of acclimating mud crabs to water temperatures of 10°C failed with most crabs dying (Meynecke *et al.*, 2010).

Nevertheless, in recent research, different sizes at maturity were observed for *S. serrate* at different locations. In both males and females, a distinction between physiological, morphological, and functional maturities can be made. Physiological maturity in males is characterized when spermatophores develop in the vas deferens after the pubertal molt, but the

external appearance of the crab might still be the one of an adolescent/juvenile crab (Robertson *et al.*, 1994).

In contrast to males, the functional maturity is often reached at the same time as physiological maturity, since successful mating can already occur during the last pubertal molt when the female is soft-shelled. Morphological maturity is characterized by the development of a mature abdominal flap (wider and more rounded than in adolescent females) and sometimes by the ability of extruding eggs (Hill, 1976).

Mating occurs when the mature (or maturing) female is in the verge of molting. The male uses its walking legs to gently grab the female by its carapace and keeps hold to her until she molts and is soft-shelled. Then he turns her around, both open their ventral flap, and the male inseminates the female by depositing the spermatophore into the female's spermathecae by inserting his gonopodia into the female's genital openings (Edwards. C, 1972).

The current investigation was made by monitoring the two organisms, *Calotes versicolor* and *Scylla olivacea* on a daily basis. The study was conducted on typically common and regionally oriented species from Kochi, Kerala. Kochi's climate is generally tropical, with no harsh extremities. Under Köppen's climate classification, the city features a tropical monsoon climate. Surface temperatures range between 20–35 °C (68–95 °F). The current record high temperature is 38 °C; the lowest is 17 °C. According to the Holdridge life zones system of bioclimatic classification, Kochi is situated in or near the cool temperate wet forest biome.

C. versicolor was captured from a small local dry forest in Willingdon Island, Kochi, Kerala. *S. olivacea* was apprehended from a local fisherman at Kumbalangi, Kerala.

In order to augment the accuracy of the study on the behaviour of the animals, these organisms were given an environment which is moderately similar to the natural habitats of these organisms.

METHODOLOGY

STUDY AREA -KOCHI

Kochi is located on the southwest coast of India, in the southern state of Kerala. The city lies at the sea mouth of seven major rivers which start from the Western Ghats and travel through Kerala's midlands, lowlands and coastal areas, to drain out into the Arabian Sea. Kochi lies at the northern end of a narrow neck of land, about 19 km long and less than 1.6 km wide in many places, and is separated from the mainland by inlets from the Arabian sea and by the estuaries of rivers draining from the Western Ghats. As a result, Kochi is a natural harbour.

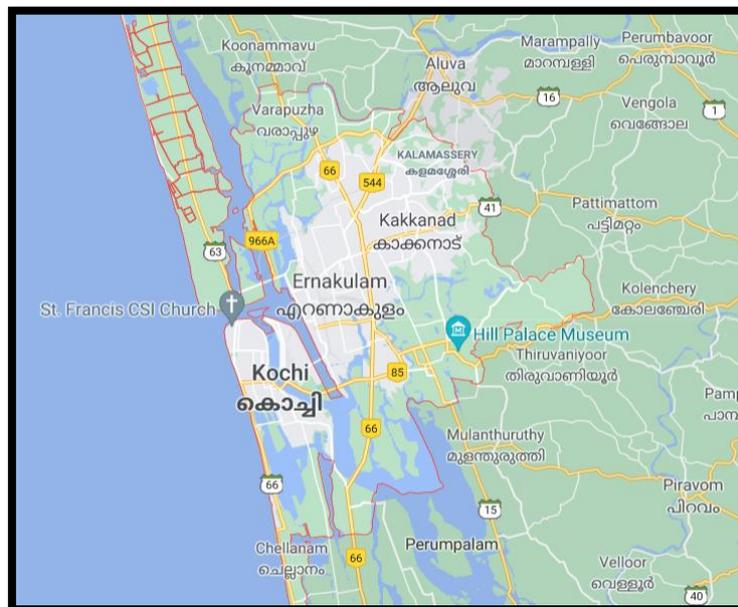


Fig.1: Map showing the Study Area

Kochi, one of the populous cities of Kerala, located in the south western coasts of India. Presently the islands include Mattancherry, Willingdon Island, Fort Kochi, Kumbalangi, Ernakulam and other outlying islands. Kochi is one of the few cities in the country that is loaded with every natural resource and physical features. From rivers, beaches, lagoons to hills and forests – the quaint city has it all. And this also makes Kochi was one of the favourite tourist locales both for national and international travellers. Kochi has a tropical monsoon climate with temperatures ranging between 20°C and 35°C. Maximum temperature recorded in summers is about 38°C and minimum in winters is 17°C. The South - west monsoons are from

June to September where Kochi experiences heavy rainfall and light showers from October to December due to north – west monsoon. The average annual rainfall is about 350 cm with approximate 132 days of Average rainfall: 3,228.3 mm. The total Geographical area is 87.5 square kilometres. Kochi has the latitude 9.9700°N and Longitude of 76.2800°.

Much of Kochi lies at the sea level, and the city along with the suburbs span an area of around 440 km². The city has a seacoast of about 30 miles. Willingdon Island is a large artificial island, created by dredging the Vembanad Lake under the direction of Lord Willingdon. The city has a rich network of backwaters, which has been declared as National Waterways by the Central Government.

Mangrove formations are also common. The soil consists mainly of recent sediments (Alluvium, Teri's, Brown sands etc.). Hydromorphic saline soils are also found in the areas surrounding the backwaters. The major rock types are Archaean-basic dykes, Charnockites and Gneisses. Kochi includes an archipelago of various islands, from large to very small. One of the major Island is Willingdon Island.

At Kumbalangi, the backwater is in an enclosed condition with a rather narrow opening into the main lake. The water temperature ranged between 24.8°C and 27.8°C, while the salinity had a range between 2.0‰ and 10.5‰. The dissolved oxygen ranged from 1.060 ml/l to 5.225ml/l. The mean water temperature in the Kumbalangi waters (infested area) was 27.8°C which was the highest when compared to the other places and salinity registered a value of 3.0‰ and the dissolved oxygen content was 4.089 ml/l. While the pH of is slightly acidic (6.72). The salinity of the mud showed a range between 0.26 and 4.08 ppt (K.J. Mathew *et al.*, 1994).

SPECIMEN COLLECTION

The current experiment was performed by collecting the sample specimens, keeping them protected by providing an environment which nearly exhibits the original habitat of the organism. Further, feeding and bedding facilities were rendered for the acquire the validation of this investigation.

In order to perform the study, mud crab has been collected alive from a local fisherman from Kumbalangi, Kerala right after the catch. The crab was kept in a transparent glass tank where

light can pass through. As the crab need saline water for their optimum living condition, the tank was filled one - fourth amount saline water of 10 ppt. Saline water has been prepared by diluting about 10 grams of common salt to normal water and made up to 1,000 grams. This saline water is used to keep the crab bedding and feeds were also provided. The feedings include bits and pieces of fish meat, trash fish etc. A minimum amount of feed was given daily by checking the remaining bits of meat left in the medium or not. As crabs do not more food also if the feed is already remaining, no new feedings were added.

Regular checking the medium is a major task, since the excreta or the faecal particles of the crab should be removed regularly. If not, it can cause a major impact to the life of the organism, as it can pollute the medium, thus affecting the crab. This can be prevented either by solely picking up and eliminating the faecal particle in the medium or by completely displacing the water surrounding the crab. Either way, the water in the medium should be cleaned which makes up the factor that help the crab to live longer.

The second sample specimen for this behavioural study was *Calotes versicolor*, the oriental garden lizard. For the purpose of the experiment, *C. versicolor* was captured using a thin twine thread into a bottle from a small local dry forest in Willingdon Island, Kochi. It was then later shifted in to a medium which a bigger glass jar along with some plants, leaves and twigs to appear as a living environment. Bottom of the glass jar was lined with sand and water has been kept at one side of the medium with all the necessary requirement of the lizard. Feeding *C. versicolor* was a compelling obligate task, which involve catching of prey for the lizard which includes live flies, ticks, ants and grasshoppers. The live feedings were captured every day and then must be provided carefully, to the medium where the lizard is kept. No extra space to be given while opening the jar, that might help the lizard escape from the jar.

The current study was carried out by regularly checking on the animal, cleaning the medium where the organisms are kept protected, providing them enough feedings and recording the observation of the behaviour that has been shown by the animal each day until three months. The investigation was conducted from 22nd March, 2021 till 22nd June, 2021.

OBSERVATION AND RESULT

Current behavioural study was carried out to a duration of three months starting from 22nd March, 2021 until 22nd June 2021. Observation has been recorder daily with respect to the characteristic behavioural exhibited by each of the organisms. Following are the behaviours shown by the organisms and recorded the observations of each of the organisms separately.

Scylla olivacea, the orange mud crab

SL NO:	DATE	TIME	OBSERVATION
1	22-03-21	11:30 AM	Aggression was seen. Showed aggressive behaviour by exhibiting restlessness always in mobile. Running into the sides is seen.
2	23-03-21	10:00 AM	Restlessness is seen with disturbing behaviour.
3	24-03-21	9:30 AM	No characteristic behaviour is shown.
4	25-03-21	11:00 AM	Feeding behaviour is seen today. Fed with trash fish. Blood from the fish act as attractant for the crab as it relays heavily on chemoreception that detects the changes in the surroundings.
5	26-03-21	9:00AM	No characteristic behaviour is shown.
6	27-03-21	12:30 PM	Always moving nature and took every chance to move out of the jar. No other behaviour is seen.
7	28-03-21	11:30 AM	No characteristic behaviour is shown.
8	29-03-21	10:00 AM	No characteristics behaviour is shown.
9	30-03-21	9:30 AM	Exploration behaviour is seen.
10	31-03-21	11:00 AM	Using chiloped and also with the locomotory appendages (pereopods) while it moved.
11	01-04-21	9:00AM	Showing aggressive behaviour to its new environment.
12	02-04-21	12:30 PM	Always making noises with the pincers ticking.
13	03-04-21	02:00PM	Faecal particles were noticed in the medium. Water was then replaced.

14	04-04-21	01:15PM	Aggressive behaviour.
15	05-04-21	08:00AM	A standard foraging behaviour is seen. Crab uses its chiloped to scratch the area, where the food or the feedings were placed.
17	06-04-21	9:00AM	Took the feed, broke the large piece into small bits using pincers took into its oral part.
18	07-04-21	12:30 PM	No characteristics behaviour is shown.
19	08-04-21	11:30 AM	Bubbling behaviour is seen today.
20	09-04-21	10:00 AM	No characteristics behaviour is shown.
21	10-04-21	9:30 AM	No characteristics behaviour is shown.
22	11-04-21	11:00 AM	Sideway walking behaviour is seen.
23	12-04-21	05:00PM	Walking around can be seen.
24	13-04-21	03:00 PM	Movement of the eye stalk is seen. If anything, moving near the eye of the crab, it suddenly (eye) move to inside area of the carapace.
25	14-04-21	9:00 AM	Feeding behaviour is seen.
26	15-04-21	10:30AM	No characteristics behaviour is shown.
27	16-04-21	11:30 AM	Occasional bubbling is seen.
28	17-04-21	10:00 AM	Restlessness and aggressive behaviour.
29	18-04-21	9:30 AM	No characteristics behaviour is shown.
30	19-04-21	11:00 AM	Feeding is seen today.
31	20-04-21	9:00AM	No characteristics behaviour is shown.
32	21-04-21	12:30 PM	Rhythmic movement of alternate pincers while feeding is clearly visible.
33	22-04-21	11:30 AM	foraging behaviour is seen.
34	23-04-21	10:00 AM	No characteristics behaviour is shown.
35	24-04-21	9:30 AM	Excreta was seen in the water.
36	25-04-21	11:00 AM	Shows aggression by ticking the pincers and also vigorously moving all the appendages.
37	26-04-21	9:00AM	No characteristics behaviour is shown.
38	27-04-21	12:30 PM	No characteristics behaviour is shown.
39	28-04-21	02:00PM	Was in motionless posture.
40	29-04-21	01:15PM	Feeding is seen.

41	30-04-21	08:00AM	No characteristics behaviour is shown.
42	01-05-21	9:00AM	Feeding is seen.
43	02-05-31	12:30 PM	Whole killed prawn was given as feed, the crab itself went near to the feed and used its pincers to break he prawn into very small pieces.
44	03-05-21	11:30 AM	No characteristics behaviour is shown.
45	04-05-21	10:00 AM	Bubbling was seen.
46	05-05-21	9:30 AM	No characteristics behaviour is shown.
47	06-05-21	11:00 AM	Waving the pincers in the air is seen. It might be a sign of aggression.
48	07-05-21	05:00PM	Feeding is seen.
49	08-05-21	03:00 PM	No characteristics behaviour is shown.
50	09-05-21	9:00 AM	Sideway walking is seen.
51	10-05-21	10:30AM	Movement of all the appendages was seen.
52	11-05-21	11:30 AM	Feeding behaviour is seen.
53	12-05-21	10:00 AM	When very small bits of feeding were introduced into the tank, the crab grabbed it and consumed the pieces without any manipulation of the pieces.
54	13-05q-21	9:30 AM	Drumming behaviour was seen.
55	14-0521	11:00 AM	No characteristics behaviour is shown.
56	15-05-21	9:00AM	Making noises by beating the floor of the tank with the chiloped is observed.
57	16-05-21	12:30 PM	No characteristics behaviour is shown.
58	17-05-21	11:30 AM	Grooming behaviour is seen.
59	18-05-21	10:00 AM	Dissolving the dirt of the body into the water can be seen.
59	19-05-21	9:30 AM	Waving and moving the appendages.
60	20-05-21	11:00 AM	No characteristics behaviour is shown.
61	21-05-21	9:00AM	No characteristics behaviour is shown.
62	22-05-21	12:30 PM	Feeding is seen.
63	23-05-21	02:00PM	Stationary posture.
64	24-05-21	01:15PM	Sideway walking can be seen.

65	25-05-21	08:00AM	A conspecific individual has been introduced to the tank today. The second crab is too tiny. The main crab is disturbed and going away after seeing this new crab.
66	26-05-21	9:00AM	Bubbling behaviour is seen.
67	27-05-21	12:30 PM	Feeding behaviour is seen. This time without using the pincers, the crab is feeding by flexing body dorsoventrally, scratching the food, braking into small pieces and then consuming it directly using the oral appendage.
68	28-05-21	11:30 AM	No characteristics behaviour is shown.
69	29-05-21	10:00 AM	The big crab seems to disturb the tiny one, it may occur because of the minor size and a low strength. Feeding character is seen.
70	30-05-21	9:30 AM	Aggression is exhibited when an external disturbance is noticed is given to stimulate the crab.
71	31-05-21	11:00 AM	No characteristics behaviour is shown.
72	01-06-21	05:00PM	Showed defending characters like waving its pincers.
73	02-06-21	03:00 PM	No characteristics behaviour is shown.
74	03-06-21	9:00 AM	Stridulatory behaviour is seen. It is the act of producing sound or noise by rubbing the body parts and appendages and the claws together.
75	04-06-21	10:30AM	No characteristics behaviour is shown.
76	05-06-21	11:30 AM	Bubbling is seen.
77	06-06-21	10:00 AM	Sedentary posture is observed.
78	07-06-21	9:30 AM	Feeding is seen.
79	08-06-21	11:00 AM	No characteristics behaviour is shown.
80	09-06-21	9:00AM	Bubbling is seen.
81	10-06-21	12:30 PM	Aggression is seen with rapid scaphognathite beating character was seen. It may be shown as the aggressive nature of the crab.

82	11-06-21	11:30 AM	Cannibalistic behaviour was observed today. The tiny crab was been eaten by the crab, may be at the dark. Only small pieces and bits of the small crab had remained. The medium was cleaned later with clean water.
83	12-06-21	10:00 AM	One of the pincers was lost. The damage resulted in the less activeness and showed low energy of the crab. Remained in immobile posture all the day.
84	13-06-21	9:30 AM	Faecal particle was seen on the water in the medium.
85	14-06-21	11:00 AM	No characteristics behaviour is shown.
86	15-06-21	9:00AM	Sideways walking can be seen.
97	16-06-21	12:30 PM	Restlessness is seen.
88	17-06-21	02:00PM	Aggression with always ticking the claws to the floor of the tank can be seen.
89	18-06-21	01:15PM	Less active during the day. Retrieval was seen when feeds were introduced into the medium.
90	19-06-21	08:00AM	Bubbling was seen. Going around, swimming in the water using the swimming paddles was seen.
91	20-06-21	9:00AM	Both the appendages of chiloped (pincers) were seen lost now. The crab is severely injured. Now it uses the oral appendage to feed.
92	21-06-21	12:30 PM	Sideways movement is seen.
93	22-06-21	11:30 AM	Swimming and flapping the appendages in the water is seen. No other characteristics behaviour is shown.

Table 1: Showing observation of *Scylla olivacea*.

***Calotes versicolor*- the oriental garden lizard**

SL NO:	DATE	TIME	OBSERVATION
1	22-03-21	11:30 AM	Aggression was seen as a result of change in the natural environment. Restlessness and denying food is seen.
2	23-03-21	10:00 AM	Unsettling is observed. At times, the lizard seemed to be at resting position without moving any body parts but again running around after some time.
3	24-03-21	9:30 AM	Running around the medium was observed.
4	25-03-21	11:00 AM	Starting feeding and drinking water. Fed on live insects.
5	26-03-21	9:00AM	No characteristic behaviour is shown.
6	27-03-21	12:30 PM	Feeding is seen today.
7	28-03-21	11:30 AM	Uneasiness in staying calm, always in motion.
8	29-03-21	10:00 AM	Hiding behaviour is seen. Runs around and hides behind the leaves which act as shelter.
9	30-03-21	9:30 AM	Excreta was noticed in the jar.
10	31-03-21	11:00 AM	Feeding is seen.
11	01-04-21	9:00AM	No characteristic behaviour is shown.
12	02-04-21	12:30 PM	Push up behaviour is seen today. It may be as a sign of aggression.
13	03-04-21	02:00PM	Motionless posture all day.
14	04-04-21	01:15PM	No characteristic behaviour is shown.
15	05-04-21	08:00AM	Stand in high position is seen with stiff pose and no movement was observed for a long time.
17	06-04-21	9:00AM	<i>Calotes</i> did not turn when dead prey has been given. It will feed only when the prey is alive.
18	07-04-21	12:30 PM	Aggression with running around the medium is observed today.
19	08-04-21	11:30 AM	Basking behaviour is seen today, when the medium was lifted to a sunny spot.

20	09-04-21	10:00 AM	Always seems to be alert and cautious, observing the surrounding environment against intruders or enemies.
21	10-04-21	9:30 AM	Exploration and foraging behaviour is seen.
22	11-04-21	11:00 AM	No characteristics behaviour is shown.
23	12-04-21	05:00PM	No characteristics behaviour is shown.
24	13-04-21	03:00 PM	Perching is considerably visible with immobile posture and always sensing the environment.
25	14-04-21	9:00 AM	Feeding behaviour is see. Fed on flies, ants and other insects. No other characteristic behaviour is observed.
26	15-04-21	10:30AM	Drinking water from the medium is seen; although, most lizard rarely drink water regularly.
27	16-04-21	11:30 AM	No characteristics behaviour is shown.
28	17-04-21	10:00 AM	Baking is observed in the morning hours. The lizard is active and exploring behaviour is exhibited at the morning time before noon time.
29	18-04-21	9:30 AM	Feeding and drinking water is seen after basking for some time.
30	19-04-21	11:00 AM	No characteristics behaviour is shown.
31	20-04-21	9:00AM	Alternate and irregular restlessness followed by running around is seen.
32	21-04-21	12:30 PM	Foraging behaviour is seen within the medium. Hiding is one of the main activities of the lizard now.
33	22-04-21	11:30 AM	Uses shelters for hiding. Green leaves and stems act as shelters. Maybe to save from intruders.
34	23-04-21	10:00 AM	Sleeping behaviour is observes today. It “slept” with the head at the position into the angle of cervices, seemed as a pattern of alertness.
35	24-04-21	9:30 AM	Grooming behaviour is seen. Sliding the tongue all over the body is observed.
36	25-04-21	11:00 AM	No characteristics behaviour is shown.

37	26-04-21	9:00AM	Basking and perching has been visible throughout the day time. Accumulation of excreta is seen in the medium, which was later carefully got ridden from the medium.
38	27-04-21	12:30 PM	No characteristics behaviour is shown.
39	28-04-21	02:00PM	Running around is seen.
40	29-04-21	01:15PM	Tongue flicking behaviour is seen. It may help the lizard to detect the chemical detection of the live prey inside the medium.
41	30-04-21	08:00AM	Sensing the environment is observed.
42	01-05-21	9:00AM	Alertness is seen. Responding to every minute external changes results in restlessness of the animal.
43	02-05-31	12:30 PM	No characteristics behaviour is shown.
44	03-05-21	11:30 AM	Basking is seen in the morning.
45	04-05-21	10:00 AM	No characteristics behaviour is shown.
46	05-05-21	9:30 AM	Foraging behaviour is seen. It includes sit and wait process where the lizard notices a moving prey and at first it waits till the prey reaches close to the lizard and then suddenly it ticks the tongue and swallow the insect.
47	06-05-21	11:00 AM	Screen walking is seen today. It may occur when the lizard notices the outside environment, wanting to go out.
48	07-05-21	05:00PM	Tongue flicking is considerably observed throughout the day.
49	08-05-21	03:00 PM	Feeding live animals and drinking water is seen.
50	09-05-21	9:00 AM	Have high visual capacity. Responds to every slight change in the environment. Suddenly move if any unusual changes notices in the outside the glass jar.
51	10-05-21	10:30AM	No characteristics behaviour is shown.
52	11-05-21	11:30 AM	The lizard shoe no preference to any dead animal in the medium, so live pray to be captured and given to the lizard to feed on.

53	12-05-21	10:00 AM	Sudden movement of eyes in all directions is seen and the typical head movement showed alertness to the surroundings,
54	13-05-21	9:30 AM	When dead insects were introduced into the jar, the lizard does the flicking of the tongue and never went near the insects. But when live feedings were provided. It ate those considerably.
55	14-05-21	11:00 AM	No characteristics behaviour is shown.
56	15-05-21	9:00AM	Sleeping behaviour is seen today in the evening.
57	16-05-21	12:30 PM	Screen walking is seen.
58	17-05-21	11:30 AM	Foraging behaviour is seen. It is visible by scratching the floor of the medium and always stayed in mobile condition.
59	18-05-21	10:00 AM	No characteristics behaviour is shown.
59	19-05-21	9:30 AM	Feeding is seen.
60	20-05-21	11:00 AM	Faecal particles is noticed in the medium.
61	21-05-21	9:00AM	Remaining in resting position is seen. Standing only on hind legs is observed. No other characteristics behaviour is shown.
62	22-05-21	12:30 PM	No characteristics behaviour is shown.
63	23-05-21	02:00PM	Most of the time during feeding behaviour grabbing the food using its long slender tongue chewing the insect and then swallowing the insect was seen.
64	24-05-21	01:15PM	Continuous restlessness and wiggling of the tail is seen.
65	25-05-21	08:00AM	The warming up behaviour or basking is seen with keen observation and scanning the surrounding environment.
66	26-05-21	9:00AM	No characteristics behaviour is shown.
67	27-05-21	12:30 PM	Feeding and drinking water is seen. No other characteristics behaviour is shown.

68	28-05-21	11:30 AM	Feeding on the leaf pieces and as well as on the soil matter is seen. May be looking for some nutrients from them.
69	29-05-21	10:00 AM	No characteristics behaviour is shown.
70	30-05-21	9:30 AM	Tongue flicking is seen
71	31-05-21	11:00 AM	Observing the surroundings is observed.
72	01-06-21	05:00PM	No characteristics behaviour is shown.
73	21-06-21	03:00 PM	Excreta is mixed up with the soil matter in the medium. Restlessness and moving around is seen.
74	03-06-21	9:00 AM	Tail moving vigorously in quick motion is seen.
75	04-06-21	10:30AM	Eyes of the lizard did not look good or the sunken eye is observed. It may happen as a result in some minute change in the environment.
76	05-06-21	11:30 AM	Respiration with the mouth open is observed as a change in the normal behaviour of the lizard. Heavy breathing is also observed.
77	06-06-21	10:00 AM	Movement of the middle region of the abdomen of the body of the lizard can be observed while respiration can be easily observed.
78	07-06-21	9:30 AM	No characteristics behaviour is shown.
79	08-06-21	11:00 AM	Movement of the head also known as head bob is observed today.
80	09-06-21	9:00AM	No characteristics behaviour is shown.
81	10-06-21	12:30 PM	No characteristics behaviour is shown.
82	11-06-21	11:30 AM	Sleeping was seen with eye lid closed and feeding behaviour is observed.
83	12-06-21	10:00 AM	Due to open mouth breathing practice of the lizard, the mouth and teeth is clearly visible.
84	13-06-21	9:30 AM	Immovable posture and sitting at only one location is seen throughout the day.
85	14-06-21	11:00 AM	No characteristics behaviour is shown.
86	15-06-21	9:00AM	Crawling in the ground and feeding as well as drinking water is observed.

97	16-06-21	12:30 PM	Screen walking is seen.
88	17-06-21	02:00PM	Gapping behaviour was observed today.
89	18-06-21	01:15PM	Occasional tongue flicking along with feeding is observed.
90	19-06-21	08:00AM	No characteristics behaviour is shown.
91	20-06-21	9:00AM	Noticeable movement of muscles contraction is seen in the middle part of the body. It occurs due to abnormal respiration rate.
92	21-06-21	12:30 PM	Basking and relative perching behaviour is seen today. Hiding under the shelter most of the time along with feeding live insects.
93	22-06-21	11:30 AM	Standing in the hind legs and maintain this stationary posture for a long time without any movement. No other characteristics behaviour is shown.

Table 2: Showing observation of *Calotes versicolor*.

RESULTS FROM THE BEHAVIOURAL STUDY OF *Scylla olivacea*.

Aggression is major behavioural character shown by the crab. when its natural environment has been changed, aggression is shown by the organism considerably.



Fig 2: Showing aggressive behaviour and denying feed of *Scylla olivacea*.

Bubbling behaviour is exhibited by the crab is a character to release bubbliies in the water. The term for that is, "airing out". It's a method to keep their gills moist and to balance the salt concentration within their body. If you want the poor thing to have less bubbles, just put it in fresh water with salt, so it can resemble the sea.



Fig 3: Showing bubbling behaviour of *S. olivacea*.



Fig 4: Showing close-up image of bubbling.

Feeding behaviour of crab is seen by having the feedings which includes trash fish, small prawn, other small molluscs etc.



Fig 5: Showing feeding behaviour. Consuming by using cheliped, the pincers.



Fig 6: Showing feeding behaviour *S. olivacea* with trash fish.

Cannibalistic behaviour has been exhibited someday after another crab was introduced to the medium. habitat type and predator size indicating changes in foraging efficiency in different habitats.



Fig 7: Another very small conspecific was into the medium.



Fug 8: Showing cannibalistic behaviour. After some days, *S. olivacea* consumed the minor.

Elevation of eyestalk and stimulation of antennae is an important behaviour where the crab is stimulated and responds to the changes in the external surroundings. Eyestalk ablation has been known as a methodology for stimulating ovarian maturation and spawning in crustaceans.



Fig 9: Movable Eyestalk and Antennae stimulating, identifying chemical cues.



Fig 10: Showing antennae stimulation when water is changed.

Some of the appendages were lost during the course of time, that had made the crab vulnerable and affected its daily activities. But it hadn't affected the life of the crab. Depending upon the time in the moult cycle of autotomy, limb loss, particularly when severe, appeared initially to inhibit moulting, or to stimulate ecdysis.



Fig 11: Lost pincers which was *Scylla*'s strongest armour.



Fig 12: Lost some of the appendages after some days, still feeds using oral appendages.



Fig 13: Showing pattern of lateral soft spines of *Scylla olivacea*.

RESULTS FROM THE BEHAVIOURAL STUDY OF *Calotes versicolor*.

Perching behaviour and related foraging activities were observed. The lizard showed a unimodal activity pattern, peak activity period was observed at late morning (11.00-12.30 h) and afternoon (13.00-15.45 h). The activity patterns of lizards involved basking and resting at early morning period. Once they attained optimum body temperature at peak period activities such as moving, foraging was performed.



Fig 14: Showing basking and perching behaviour of *Calotes*.

Aggression was observed as a result of change in the natural environment. Like most animals, **lizards** puff their bodies up to make them look much larger than they are. Most lizards are found to puff their throat out to appear larger and thus discouraging the predator from eating them. Therefore, it can be concluded that the **lizard actively changed its colour as a response to the predator attack**. These lizards can be very aggressive towards snakes since they are relatively large agamids themselves.



Fig 15: Showing aggression with Gaping behaviour.



Fig 16: Maintaining an immobile position.

Hiding behind the leaves and twigs is another behaviour. It occurs so as to protect themselves from intruders. Another important behaviour of *C. versicolor* was that, it sometimes perched on the ground soil in the tank. It does so maybe to attain some of the micronutrients present in the soil.



Fig 17: Hiding behind leaves which acts as shelter.



Fig 18: Showing *C. versicolor* foraging on the soil.

Screen walking or walking on the surface of the medium is another behaviour character exhibited by the lizard. It is mainly done to escape from the medium and go out to its natural environment.



Fig 19: Showing screen walking.



Fig 20: Screen walking.

Tongue flicking is a major character shown to detect the chemical cues of the prey. Gapping is the behaviour shown as a result of respiration by the mouth. It is the open mouth breathing of the lizard. During which the long slender tongue and the conical blade-like teeth are visible.

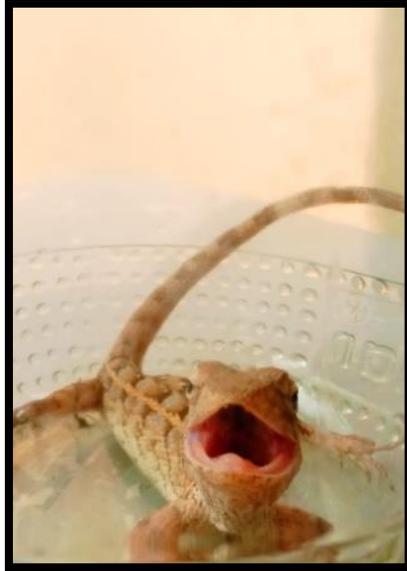


Fig 21: Gaping behaviour.

DISCUSSION

In the present study of the oriental lizard, when the prey was introduced to the medium, a behaviour of sit-and-wait has been shown by the organism. Once the live prey has been noticed by the animal, it first waits till the prey gets near to the lizard and then when it is near, suddenly the lizard opens its mouth and swallows the prey quickly. According to the study of R. Meek *et al.*, 2005 operative models were employed to determine the consequences for behaviour and body temperatures in the lizard *Calotes versicolor* in two habitats at different altitudes. *C. versicolor* operates largely as an arboreal sit-and-wait predator with a limited home territory. This makes *C. versicolor* an ideal subject for thermoregulation studies.

The current investigation of the oriental garden lizard shows the presence of scales all over the body. The lizard like the common chameleon changes its colour when excited or vulnerable to any predator around. An Oriental Garden Lizard can change its colours to suit a situation, mostly as a camouflaging mechanism. It assumes the colour of the surface it is on. This trait gives it its scientific name *Calotes versicolor*, where 'versicolor' has been derived from the Latin words *verso* ("turn") and *colour* ("colour"). A study conducted by Michelle T. Christy, *et al.*, in the year 2008, showed that, the oriental garden lizard is distinguished from other *Calotes* species by having lateral body scales that point backwards and upwards, two separated spines above the tympanum, and 35–52 scales around the body. The five fingers have long sharp pointed claws and the five toes have curved pointed claws.

The current investigation of the behavioural study of *C. versicolor* shows many distinctive characters such as aggression, head movement, stand in high position etc., Similar study on ethogram of *C. versicolor* was been conducted by Bhagyarekha N. Pandav *et al.*, in the year 2007. According to the study, it indicates aggression which is an agonistic or dominating actions performed by the animal. Push-up is the rapid raising and lowering of the body on all four legs. Head bob or shaking of the head is raising and lowering of the head above and below the axis with no movement of the legs. Stationary is the immovable position where the organism doesn't make any move but scanning the surrounding environment. Throat inflation is the puffing up of the throat and inflating it.

According to a study conducted by Enge *et al.*, in the year 2004, oriental garden lizard is known to arrive in new locations via the transportation network. For example, in the 1980s the species was introduced to Reunion Island as a stowaway in sugarcane cuttings from Java, where it

rapidly established populations. Once a breeding population establishes, there is no evidence to suggest whether or not it is possible to remove individuals at a rate faster than population growth.

In the present study of *Scylla olivacea*, it was observed that the crab fed on trash fish and also small crustaceans. According to study conducted by Hilke Alberts *et al.*, in the year 2016, mud crabs are top benthic predators and feed on sessile or slow-moving benthic macroinvertebrates, mainly gastropods, crustaceans, and molluscs.

The present behavioural study noticed one important constant behaviour of the crab that is making noises with the pincers. By ticking the pincers and rubbing the appendages together they make noises. A similar study conducted by Crane. J in the year 2015, shows that Some species of semi-terrestrial crabs also use stridulation to produce sound. Sounds produced by the crabs are transmitted through the air and the substrate. Fiddler and mangrove crabs produce stridulatory sounds within their burrows. Multiple anatomical structures on the claws, walking legs, and carapace of fiddler crabs are used for stridulation. The crabs rub their enlarged claw against any of these other structures to produce sound. Mangrove crabs also produce stridulatory sounds. These crabs have hard ridges, or tubercle and rows of bristles, called setae, on the dorsal side of their enlarged claws. When one claw rubs against the other, a rasping sound is created. The crabs may also place one claw on the substrate and move the other claw up and down against the stationary claw, producing sound. With one claw in contact with the substrate, vibrations may be transmitted through the ground.

In the present study it indicates that the cannibalistic behaviour and most of the feeding activity of the crab was carried out at night. Occurrence of cannibalism have also been reported during a study conducted by Paul in the year 1981. According to the investigation, cannibalistic behaviour is shown for several other crab species like the Pacific Dungeness crab, Cancer, the Japanese mud crab, *Helice tridens* and the Australian Portunid, *Ovalipes catharus* as well as other *Callinectes* species.

The behaviour and ecology of mud crab larvae have been studied using hatchery-reared larvae by Webley *et al.*, in the year 2009 showed that laboratory-reared megalopa did not select between different habitats (mud, sand, seagrass), whereas early juveniles expressed strong preferences for seagrass. This suggests that megalopae do not benefit from preferring one of the habitats or do not depend on encountering these, whereas they seem to benefit from inhabiting seagrass as early juveniles. This result can be seen as an indicator for post-settlement

behaviour, but this aspect should be further investigated, since the preference for seagrass could also be an indicator for preferences for structured or sheltered habitats in general.

According to a study conducted by Hyland et al., in the year 1984 showed that the movement of mud crabs seems to be closely related to the kind of habitat they live in. In general, crabs (>100 mm CW) that live in enclosed habitats such as narrow mangrove-fringed creeks, normally do not move more than 1 km.

However, few studies have focused specifically on the cannibalistic behaviour of the mangrove mud crabs behaviour so only a little information is known about the cannibalistic character of the mud crab. The effect of cannibalism on mud crab population dynamics and the interaction with other environmental characteristics such as habitat refuge, food abundance, population density, etc., are unknown. In a similar study done by Thimdee et al., in the year 2001, it was found that, small mud crabs are omnivorous, feeding opportunistically on smaller crabs and plants, whereas medium- and large-sized crabs are carnivorous, feeding on benthic invertebrates or being opportunistic scavengers.

Quinn *et al.*, in the year 1987, suggested that the maturity of *S. serrata* starts at different sizes in different geographic regions. suggested that the different maturation sizes depend on the latitudinal distribution of the crabs, resulting in a faster maturation in tropical regions. However, these conclusions might actually derive from the different size classes of the various *Scylla* species, since these assumptions were made before the revision of the species.

In case of the cannibalistic behaviour of the crab, a study conducted by Christopher A. Peery in 1989, says that cannibalism by small predators was related to prey size, suggesting an inability to consume the larger prey. So, larger crabs fed on smaller sized crabs, maybe to capture the essential nutrients from the body.

CONCLUSION

The behavioural study was conducted on two organisms, the agamid oriental garden lizard, *Calotes versicolor* and the mangrove mud crab, *Scylla olivacea*. Mud crabs are a common component of the fauna of mangrove forests, usually burrowing in mud or sandy-muds. They have a diverse diet and are omnivorous in nature, feeding on a wide range of animal and plant resources.

Lizard, being a semi-arboreal, sun-loving lizard that spends a lot of time on tree trunks and rocks, *C. versicolor* has a predilection for open scrubland, wasteland, gardens, parks and other “man-made habitats” in Asia. According to study conducted by Radder *et al.*, in the year 1998, the lizard has a high likelihood of establishment for a number of reasons like ability to adapt to new environments, Capacity to thrive in highly urbanised areas and the Prolific breeding biology with an ability to store sperm and retain viable eggs.

The current investigation was conducted by monitoring the two organisms on daily basis and recording the characteristic behaviour shown by the two animals each day. The study was conducted at Willingdon Island, Kochi from 22nd March, 2021 till 22nd June, 2021.

Important behaviours shown by the mud crab includes, bubbling or the airing put behaviour, pincer ticking thereby making noise behaviour, feeding behaviours, swimming around the medium and also the cannibalistic behaviour is exhibited.

The behaviour shown by the oriental garden lizard, *Calotes versicolor* includes, hiding behind the leaves thereby exhibiting camouflage, screen walking, running around the medium, preferring only live prey is an important characteristic behaviour of the lizard, gapping and foraging is seen by exploring the area of living. Basking at the morning sun is an important characteristic shown, which is exhibited in order to attain enough optimum body temperature for it daily bodily activities. Extracting nutrients from the soil matter is an important was of attaining maximum micronutrients for its body.

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**STUDY ON BEHAVIORAL PATTERN OF *Capra aegagrus hircus* and
*Corvus splendens***

MINI PROJECT – SEM I

**SUBMITTED TO ST. TERESA'S COLLEGE (AUTONOMOUS),
ERNAKULAM**



SUBMITTED BY,

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2020-2022

CERTIFICATE

This is to certify that the Mini project entitled “**Study on behavioral pattern of *Capra aegagrus hircus* and *Corvus splendens***” is an authentic work carried out by **JOYS MARY** (Reg. No: SM20ZOO004), during the Academic year **2020-2022**, under my guidance from St. Teresa’s College (Autonomous), Ernakulam.

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DECLARATION

I hereby declare that the Mini project entitled “**Study on behavioral pattern of *Capra aegagrus hircus* and *Corvus splendens***” submitted to St. Teresa’s College (Autonomous), is a original work done by me under the supervision and guidance of Ms. Tiya K. J, Assistant professor, Department of Zoology, St. Teresa’s College (Autonomous), Ernakulam and to the best of my knowledge and belief , this project contains no material previously published or written by another person, except where due reference is made.

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ABSTRACT

The present project “study on behavioural pattern of *Capra aegagrus hircus* and *Corvus splendens*” was focused to find the behavioral responses of domestic goat and house crow in their habitat to grow and reproduce. Animal behavior includes all the ways animals interact with other organisms and the physical environment. Animals have behaviors for almost every imaginable aspect of life, from finding food to wooing mates; from fighting off rivals to raising offspring. The goat is a member of the animal family Bovidae and the subfamily Caprinae, meaning it is closely related to the sheep. Goats have been used for milk, meat, fur and skins across the world. Different modes of behaviour present in goats are grazing and watering behaviour, modes of social behaviour in goats, sexual behaviour, parturition and maternal behaviour etc. Crows, especially the Indian common crow or the house crow (*Corvus splendens*) is an indigenous species of the Indian sub-continent. It is usually seen in urban cities and it is one of the commonest birds encountered by people in most parts of India. They are well adapted and highly intellectual birds suiting the urban ecosystem. They are considered to be a global pest as they are very notorious and cause serious trouble to other fauna, flora and humans. Although considered as a pest around the globe they play different ecological roles viz., predators, scavengers and omnivore. They were introduced in many countries just to feed on the garbage; leftovers were lack of cleaning was ignored. They are essential organisms in the food chain. So these two organisms have different modes of behaviour to feed, drink , foraging food, to find mate and reproduce, etc. Certain types of behaviours are present only in that group of species and that makes the species unique.

INTRODUCTION

Living organisms live in harmony with their environment. Organisms' reaction to the Changes around them, and the behaviors exhibited when living organisms encounter each other are subjects that should be studied. Behaviour is the whole of activities which the organism brings about in response to stimuli received from the internal and external environment. Behaviour helps the living organism find a mate, water, food, and shelter or avoid unfavorable environmental conditions (enemies, scarcity, fire, flood, etc.). Factors that influence animal behaviour are genetics, environment, social groupings, domestication, etc.

The domestic goat or simply goat (*Capra aegagrus hircus*) is a subspecies of *C. aegagrus* domesticated from the wild goat of Southwest Asia and Eastern Europe. The goat is a member of the animal family Bovidae and the subfamily Caprinae, meaning it is closely related to the sheep. There are over 300 distinct breeds of goat. It is one of the oldest domesticated species of animal, according to archaeological evidence that its earliest domestication occurred in Iran at 10,000 calibrated calendar years ago.

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Artiodactyla
Family: Bovidae
Subfamily: Caprinae
Genus: Capra
Species: *C. aegagrus*
Subspecies: *C. a. hircus*

Different modes of behaviour present in goats are grazing and watering behaviour, modes of social behaviour in goats, sexual behaviour, parturition and maternal behaviour etc. Daily feed ingestion activities in goats comprise 1/3 of all activities. Although goats ingest feed more rapidly than sheep, their grazing period takes longer than sheep. The reason for this is that they are excessively selective and mobile while grazing (Ngwa et al., 2000).

Goats conduct their watering behaviour in the form of sucking. As is the case in all animals, water requirement in goats varies according to the variety and condition of feed, and lactation and pregnancy status. Water intake in goats increased at increased environmental temperature and during periods such as during pregnancy and lactation (Haenleinet et al., 1992).

Goats display selective behaviour toward their favorite plants while grazing at the pasture. The taste and smell of plants plays an important role in their selection. Another factor which is influential in the selection of feeds at pasture is the nutrient and toxic content of plants. During studies, goats have been observed to have a higher preference for plants with high nutritious content. Physiological conditions such as lactation and pregnancy are also influential in goats' feed preferences (Wittenberger, 1981; Hoste et al., 2001). Pregnancy and lactation have been reported to increase the total daily time of feeding, the frequency of feeding, the total daily time of rumination, and the frequency of rumination (Wittenberger, 1981).

Agonistic behaviour in goats is behaviours such as attacking, escape, threatening, and defense. The reason for these behaviours in goats is the instinct to protect both themselves and their food sources (Mc Glone,1986). Agonistic behaviour is observed to be 50% higher in males. The most important cause of this is the fact that females have no horns or weak horns (Unal and Akcapinar, 1994).

Sexual behaviour in goats can be listed as courting, estrus, mating, and pregnancy-related behaviour. Factors such as sex, race, feeding, and day length are important in terms of behavioural differences. For instance in bucks this activity emerges most during periods when day length shortens (Hafez and Hafez, 2000; Imwalle and Katz 2004). Postnatal behaviour and the relationship between the mother goat and kid are behaviours that begin immediately after birth. Maternal bonding begin with birth and end with the weaning period. Age, number of births, the kid's need for nutrition, race, birth type, and stimulus by the kid (warmth, sucking, moving) are influential on mothering behaviour. The mother goat immediately beginning to lick her kid and allowing the kid to suckle herself are the first indications of mothering behaviour (Unal and Akcapinar,1994; Kaymakci, 2002).

Crows, especially the Indian common crow or the house crow (*Corvus splendens*) is an indigenous species of the Indian sub-continent including parts of Afghanistan and Thailand and is usually seen in urban cities and it is one of the commonest birds encountered by people in most parts of India. They are well adapted and highly intellectual birds suiting the urban ecosystem.

Kingdom: Animalia
Phylum: Chordata
Class: Aves
Order : Passeriformes
Family : Corvidae
Genus: Corvus
Species: C. splendens

The house crow has a dusky gray nape, neck, upper breast and upper back, being glossy black over the rest of the body. The jungle crow is distinguished from the house crow by the absence of any grey on the hind neck and breast. Sexes are alike, with males being slightly larger (Rasmussen and Anderton 2005). Crows are successful in establishing their population by overlap breeding method. Most of the birds in the Corvidae family are intelligent and it's due to the large brain to body ratio compared to other birds and equal to great apes and a bit lesser compared to humans (www.birding.in). The young ones live with the parents for a long time during which they learn all the skills necessary to survive and since they are co-operative brooders they will learn the skills from any members of the group (Clayton et al., 2005).

Feeding: Crows are extremely skilled in feeding; they feed on everything and anything that is edible whether alive or dead. The house crows are omnivorous in nature and hence their diet includes fruits, grains, insects, small reptiles, mammals and left over's thrown by humans (garbage). This is the major reason for their establishment in the urban areas.

The breeding/nesting season is from April to June. Nests are located 4m or higher up in trees and dense foliage is preferred. Communal nesting sites are not usual but it appears the house crow is adaptable (depending on locations and conditions). The bird usually lays 4-5 eggs which are pale blue green in colour with brown colour speckles on it. Parental care is observed in both the sexes.

The Indian Koel (*Eudynamys scolopacea*) is a brood parasite of the house crow. Crows usually build their nest in the trees, buildings or any artificial structures with sticks, wire, nail and coir or any fiber materials. The House crows usually roost with other birds like the Jungle crow and Myna. They are usually benefited as they are protected from predators. Crows are very good at Mobbing (Gadgil, 2001). They are known to attack dogs, cats and birds of prey. They usually mob the predators in groups. They distract the enemy and steal their food. (S. Ramakrishna et al., 2014)

The house crow has established itself in at least 25 countries. The House crow occurs in agricultural areas, coastland, desert, estuarine habitats, natural forests, planted forests, range/grasslands, riparian zones, ruderal/disturbed, scrub/scrublands, urban areas, wetlands. The two most commonly found species in the urban areas are the house crow and the jungle crow. (S. Ramakrishna et al., 2014).

They are considered to be a global pest as they are very notorious and cause serious trouble to other fauna, flora and humans. According to GSID (2010) the House crows are considered to be the world's most invasive bird species. The house crow's dispersal is associated with accidental introductions through ships and deliberate introductions (Brook et al., 2003; Wells. 2007). The house crows were deliberately introduced into other countries mainly to aid in cleaning the environments especially the garbage (Feare and Mungroo 1990).

The house crow has successfully invaded tropical and subtropical regions well beyond its native range, reaching pest proportions in many areas (Brook et al. 2003). In some countries they are considered to be a vector carrying major disease causing agents in their intestine, such as *Salmonella* sp., *Plesiomonas*, enteropathic *Escherichia coli*, *Shigella* and *Aeromonas hydrophila* (Ryall 1992). The birds in the introduced range are a threat to the biodiversity of that place as they become a competitor to the avifauna of that place and also cause decline in the population of the native species due to their rapid population build up (Ryall, 1992). They also cause a nuisance to tourists and local people with their loud calls and arduous defecation and steel food.

Although considered as a pest around the globe they play different ecological roles viz., predators, scavengers and omnivore. They were introduced in many countries just to feed on the

garbage; leftovers were lack of cleaning was ignored. They are essential organisms in the food chain. Usually in India a common sighting is the road kills or human killed rat corpses are thrown out on the streets and those corpses are fed by these crows. Thus in a way they keep the surrounding clean. They are very much necessary for our urban ecosystem as they clean the waste which we dump in our streets. In a way they have learnt to survive in the urban ecosystem and are dependent on humans. (S. Ramakrishna et al.,2014)

This species presents great ecological flexibility, as well as an obligate association with human presence, to the extent that no populations are known to live independently of man (Nyári et al., 2006). In India crows are being characterized in the general literature and folktales. In Hindu mythology crows are considered as human ancestors, usually during a death anniversary they feed the crows. The origin of river Kaveri is also based on a myth that lord Ganesh transformed into a crow and poured the water from a kamandal of Agastya. (S. Ramakrishna et al.,2014).

From human perspective anything which causes damage or loss are considered as pest. The ubiquitous distribution of the species mirrors its potential to adapt and flourish in different ecosystems. In conclusion, crows are integral part of the ecosystem and they play a critical role in the ecosystem as a predator, scavenger. Hence, it should be allowed to perpetuate like other species each with specific niches in the ecosystem.

Here, we will study about this amazing behavioural pattern of both goat and house crow. Also, we will delve into the details of these animals, studying many such amazing facts about it.

REVIEW OF LITERATURE

Ethology is the branch of science which studies the behaviour of living organisms in their natural environments. Stimulus is the physical, chemical, and biological changes that occur in the internal or external environment and can cause a reaction in the living organism. Reaction is the response given by effector organs to stimuli. Behaviour is a result of stimuli and reactions. Behaviour can be studied in three groups which are inherent behaviour, learned behaviour, and social behaviour.

Factors that influence animal behaviour are genetics, environment, social groupings, domestication, etc. Genetics plays an important role in animal behaviour. Many behaviours of animals of genetically similar species are similar. Some environmental factors which influence animal behaviour are periods of high and low environmental temperature, day length (photoperiod) is influential in the goat entering the mating season, the availability of feed - the amount and type of available coarse feed influences grazing models. Social grouping influences behaviour by the size of the social group, the age of its members and the sex of animals. (S. Ramakrishna et al., 2014)

Domestication is the selection of brood animals with economically significant characteristics for the sake of profitable production has caused these species to exhibit different behaviour than their ancestors. Today, most farm animals live in more comfortable environmental conditions that are controlled by humans. Physiology comprises the nervous and endocrine systems play an important role in animal behaviour. The nervous system receives, processes, and stores information received from external stimuli. The endocrine system creates important influences on behaviour via hormones. Sensory systems: Animals receive information created by the stimuli received via their visual, auditory, olfactory, taste, and tactile senses. The capacities of these systems for receiving and processing information vary among species. Generally, information received from multiple sensory systems are used to generate an appropriate response (S. Seçkin tuncer et al., 2016).

Domestication of goats occurred approximately 10,000 yr ago in the Middle East (Zeder and Hesse, 2000); the success of goats at coexisting with humans can be attributed to their ability to sustain themselves in harsh topography, meaning they were useful sources of milk, fibre and meat to humans, particularly when resources were limited.

Since front incisors in goats have a higher outward inclination, they can gnaw tree barks and trunks. They detach grass with the aid of their tongues and front incisors, and complete their grazing behaviour by shredding them between their teeth (Yakan et al, 2007).

Goats mostly graze at lower and flat places, but they also like to roam and graze at steep hillsides and rocky inclines. They are also capable of treading 14-15 km a day at the pasture. Goats can take advantage of low quality pastures, maquis and bushes. They can stand on their rear legs and eat the sprouts, buds, and leaves on the branches of leaves (Schwartz, 1981). There are many factors which influence the grazing period. These are respectively: climate conditions, the quality of the pasture where the animals graze, live weight, race, size of herd, age, health condition, the condition of the goat's hair cover and the parasite status, and many other factors. During periods where air temperatures increase, goats deliberately decrease their intake of feed to compensate for heat stress. They tend to graze more during early morning and late evening during warm seasons (Yakan et al., 2007).

Furthermore, the central and peripheral nervous systems as well as hormones are also known to have an influence on the grazing behaviour of goats (Hafez and Hafez, 2000). Since adult goats are better able to distinguish the weeds to which they are accustomed, and that are nourishing they can obtain them in a shorter period of time than young goats. There are also variations between races with respect to grazing period. For instance, goats that are bred for angora yields graze for longer periods as compared to milk goats (Quick and Dehority, 1986; Hoste et al., 2001).

Agonistic behaviour modes in goats are observed mostly in the form of attacking, threatening, and submission. Knowledge of these behaviours is important for breeding and handling of animals (Shackleton and Shank, 1984; Barroso et al., 2000; Yakan et al., 2007). Threatening behaviour is present as the number of living creatures in a population rises, competition for

food, living space, and mate increases. Competition leads to the emergence of social hierarchy among animals which make up the group. The individual which proves its superiority has the chance to meet its vital needs before others. These individuals exhibit symbolic threatening behaviour. Animals which are dominant within the herd try to have their superiority recognized by other animals through certain sounds and motions to express their intent to the other animal. Attacking behaviour is perhaps the most important of agonistic behaviors. Environmental factors have a fairly high influence in the emergence of these behaviours. We could list herd size and physical amenities (shelter, feed, area for water etc.) among these factors. For instance increased herd size can increase attacking behaviour since it will limit food, water, and shelter areas (Unal and Akcapinar, 1994; Yakan et al., 2007). Attacking behaviour also increase with sexual maturity. These behaviours mostly manifest in the form of head-butting (Craig, 1986; Barroso et al., 2000; Yakan et al., 2007).

A detailed description of the external morphology of crows as entailed by Gadgil (2001) is as follows, crows are predominantly black, medium sized birds with tails shorter than the wing and graduated or rounded at the back. Their bills are stout with stiff, straight bristles that reach almost to the middle. This scavenging bird can be found in cities drinking freshwater from swimming pools and artificial ponds. These birds can be seen near marketplaces and garbage dumps, foraging for scraps. They also feed on carcass (Anil Kumar, 2004). Adult birds regularly travel up to 20 km per day to known feeding areas and needs about 300g of food daily (Sen, 2011).

Sirsat and Patil (2013) studied the communal roosting behaviour of birds in Vaijapur. They reported that the crows roosted along with the Mynas. Gadgil (2001) recorded the communal roosting behaviour of the *C. Splendens* with the Jungle crow and Myna, were the House crows and Jungle crows shifted their roosting site from the Mynas and within four days the Mynas joined them.

The House Crow (*C. splendens*), is a common bird of Asian origin but found in many parts of the world. They are closely bound to human settlements and hence are perfectly adapted to urban ecosystem (Goodwin 1976; Feare and Mungroo 1990). Five subspecies have been reported: *C. splendens splendens*, *C. splendens zugmayeri* (southern Jammu and Kashmir, Punjab and

western Rajasthan), *C. splendens protegatus* (coastal areas, Kerala, the Maldives, Sri Lanka and nearby islets), *C. splendens maledivicus* (the Maldives) and *C. splendens insolens*. *C. splendens zugmayeri* is also found in the dry parts of South Asia and Iran (Csurhes, 2010).

In Australia a risk prediction model has been developed to identify the suitable habitats of *C. splendens* (Csurhes, 2010). The spread of the house crow has resulted from both inadvertent introductions associated with increased global sea traffic and trade and deliberate introductions (Brook et al. 2003). The distributional potential of the house crow may be in the process of shifting, given the current global climate shift, which could broaden the species' distributional potential at the poleward limits (Nyári et al., 2006).

In Japan, crows are considered to be a pest as they rip open garbage bags and take wire coat hangers for their nests. In Himachal Pradesh they were a serious pest on almond crops (Bhardwaj 1991). They prey on the many indigenous species in other countries. The introduced birds are often considered to be a serious problem to that ecosystem by causing ecological damage and pose as a threat to humans and wildlife (Feare and Mungroo 1990). They prey on indigenous birds by attacking and feeding on their chick and eggs. They are a serious agricultural pest as they raid on crops such as Maize and Sorghum (Lim et al., 2003).

Due to the nest raiding habit in its native range these species enter the species conserved area and pose a threat to them. The Indian Bustard is one such species affected due to the nest raiding habit of the house crow (Ali and Rahmani, 1982-1983). The generic specific name, 'splendens' is latin translates to brilliant - a difficult adjective to use when talking about crows as they are considered nuisance by many. Indian house crows are suspected carriers of paramyxoviruses such as PMV 1, which can cause Newcastle disease (Roy et al. 1998). Outbreaks of Newcastle disease experienced in India were often preceded by mortality in Indian house crows (Blount 1949). They also carry *Cryptococcus neoformans*, bacteria that can cause cryptococcosis in humans (Gokulshankar et al. 2004). Despite their scavenger niche, over population of these species can cause serious nuisance. In addition to the ecological damage, the house crow also inflict economic damage by predated chicks and eggs (making free-ranging poultry impossible) and eating crops such as maize (*Zea mays*) and sorghum (*Sorghum vulgare*) (Lim et al. 2003).

METHODOLOGY

Study Area – Karuvarakundu, Nilambur

Nilambur is a major town, a municipality and a Taluk in the Malappuram district of the Indian state of Kerala. It is located close to the Nilgiris range of the Western Ghats on the banks of the Chaliyar River. This place is also known as 'Teak Town' because of the abundance of Nilambur teaks in this area; which is a variety of a large, deciduous tree that occurs in mixed hardwood forests. Unlike many Municipalities of India; Nilambur is covered with large amounts of vegetation making it close to nature and hence make it very scenic and inspiring.

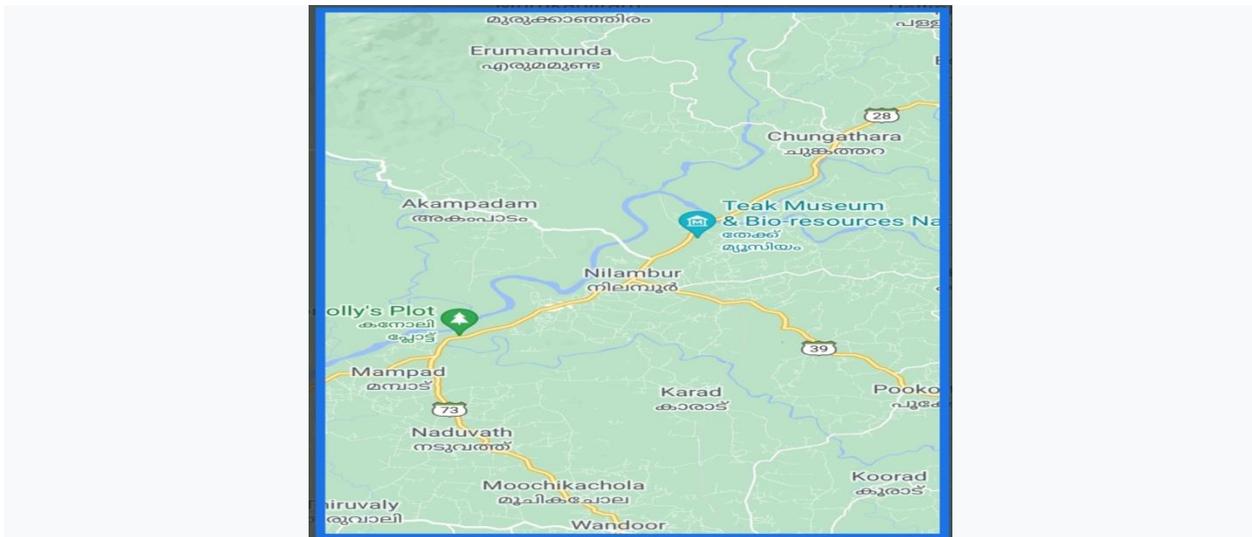


Fig.1: Map showing the study Area

In the British records, Nilambur and its surroundings are collectively described as *Nilambur Valley*. The bank of river Chaliyar at Nilambur region is also known for natural Gold fields. Explorations done at the valley of the river Chaliyar in Nilambur has shown reserves of the order of 2.5 million cubic meters of placers with 0.1 gram per cubic meter of gold. The hilly forested area of Nilambur Taluk forms a portion of the Nilgiri Biosphere Reserve of rich biodiversity. Nilambur is located about 90 km (56 mi) west of Ooty and 48 km

(30 mi) southwest of Gudalur town, and 27 km (17 mi) northeast of Manjeri, on Ooty-Gudalur-
Nilambur-Calicut road.

The 2,554 m (8,379 ft) m high Mukurthi peak, which is situated in the border of Nilambur Taluk and Ooty Taluk, and is also the fifth-highest peak in South India as well as the third-highest in Kerala after Anamudi (2,696 m [8,845 ft]) and Meesapulimala (2,651 m [8,698 ft]), is the highest point of elevation in Malappuram district. It is also the highest peak in Kerala outside the Idukki district. The 2,383 m (7,818 ft) high Anginda peak, which is located closer to Malappuram-Palakkad-Nilgiris district border is the second-highest peak. Vavul Mala, a 2,339 m [7,674 ft] high peak situated on the trijunction of Nilambur Taluk of Malappuram, Wayanad, and Thamarassery Taluk of Kozhikode districts, is the third-highest point of elevation in the district. The Nilambur Taluk has several small and medium-sized tributaries of Chaliyar river. The teaks for the construction of *Uru*, a kind of ships those were used for maritime trade through Beypore port, were usually taken from Nilambur Teak Forests. The oldest teak plantation of the world in the Conolly's plot is just two km (1.2 mi) from the town. The oldest Teak plantation of the world is at Conolly's plot. Teak Museum at Nilambur is maintained by the Kerala Forest Research Institute which was established for the memory of the oldest known Teak plantation in the world. The Nilambur–Shoranur line is among the shortest as well as picturesque broad gauge railway lines in India. It was laid by the British in colonial era for the transportation of *Nilambur Teak* logs into United Kingdom through Kozhikode. Silent Valley National Park is located near Karuvarakundu in Nilambur Taluk. It is located in the rich biodiversity of Nilgiri Biosphere Reserve. Karimpuzha Wildlife Sanctuary, New Amarambalam Reserved Forest, and Nedumkayam Rainforest in Nilambur Taluk of Malappuram district, Attappadi Reserved Forest in Mannarkkad Taluk of Palakkad district, and Mukurthi National Park of Nilgiris district, are located around Silent Valley National Park. Mukurthi peak, the fifth-highest peak in South India, and Anginda peak are also located in its vicinity. Several waterfalls and hillstations are located in the Gram panchayats around Vavul Mala (Urangattiri, Edavanna etc.)

Nilambur Taluk, also known as Eastern Eranad Taluk, comes under Perinthalmanna revenue division in Malappuram district of Kerala, India. Nilambur Taluk is the largest Taluk in Kerala. It is composed of 21 villages. Nilambur Taluk is bounded by Silent Valley National Park to south, Nilgiri mountain ranges and Pandalur, Gudalur, Ooty, and Kundah Taluks of Nilgiris

district to east, Wayanad district and Thamarassery Taluk of Kozhikode district to north, and Eranad and Perinthalmanna Taluks to west.

SPECIMEN COLLECTION

The behavioural study of goat was conducted by placing them in a cage and domesticated. The study was carried out in three domestic goats consist one mother and its two kids (1 female and 1 male), which were fully habituated to human presence during the time period from March to June, 2021. They were comes under the breed Malabari. The age of the adult female was 3 years old and the age of kids was about 4 months. The weight of the mother is measured as 25 kg and that of kids is 8-10 kg. They were white in colour or white with patches of tan on the neck and head. They have males with horns present and females without horns. Adult female have long flat dropping ears about 25 cm long is present.

The goats had been housed in good conditions with space to move and soft bedding for lying. Provision of simple shed with low cost housing materials is enough for goat for its optimum production efficiency. All goats at our study site are released into a large field during the day. At night, they are kept indoors with wooden bedding. The shed should be constructed in an elevated area to prevent water stagnation. Fodder trees can be grown around the shed, which acts as a source of feed for the growing goats. . Sheds should be constructed with proper ventilation. Floors of the shed should be firm and should have the capacity to absorb water. The floors should be constructed in such a way, so that it should be easily cleaned. The covered area is used for shelter of animals during night and adverse climatic conditions. Open type housing with a covered area and run space is generally enough. Thatched roof is best suited one due to cheaper cost and durability.

Separate feeders and water troughs should be placed for concentrate feeds, green fodders and water. Routine care of the animals is done by providing good food, cleaning their houses by removing their food waste and excreta and bathing them in alternate days. Goats have ad libitum access to hay, grass (during the day) and water, and are also fed with a commercial concentrate in quantities according to their state and age. Clean drinking water should be available for goats.

Every stable is cleaned on a daily basis. All goats are inspected each day by their caretakers and are checked regularly by a vet and given medication when appropriate.

Semi-intensive system of goat production is practiced. It is an intermediate compromise between extensive and intensive system followed in some flocks having limited grazing. It involves extensive management but usually with controlled grazing of fenced pasture. It consists of provision of stall feeding, shelter at night under shed and 3 to 5 hour daily grazing and browsing on pasture and range. In this method, the feed cost is somewhat increased. This system has the advantage of meeting the nutrient requirement both from grazing and stall feeding and making a profitable gain due to less labour input. In the wooden floor sheds, in a distance of 3m from the floor, the animals are reared. This requires less labour and more irrigation land for the fodder production.

Shelter for goats does not need to be expensive but must provide adequate protection from wind and precipitation. Goats are feared about cold and water. So take extra care in rainy and winter season. Otherwise they may be caught by Pneumonia. Water and feed should not be contaminated by accumulated manure. Goat manure is produced in pelleted form and contains nitrogen, phosphorus and potassium. Goat manure makes a wonderful addition to a home compost pile or garden. Always keep the house free from being damped. Because damping condition is responsible for various diseases. Never let the rain water enter inside the house.

Healthy livestock's can be produced by ensuring proper quantity and balanced feeding. They were protected by providing an environment which nearly exhibits the original habitat of the organism.

The study of the crow was little bit tough because they were unable to capture and rear them in cages. So the study was conducted by providing grains to them in the morning. During this time many house crows living around came to take the grains. Usually they came as groups and take the food. Crows were also found around goats present in this place. They came and sat on the body of goats.

OBSERVATION AND RESULT

Current behavioural study was carried out to a duration of three months starting from 22nd March, 2021 until 22nd June 2021. Observation has been recorder daily with respect to the characteristic behavioural exhibited by each of the organisms. Following are the behaviours shown by the organisms and recorded the observations of each of the organisms separately.

Capra aegagrus hircus - Goat

SL NO:	DATE	TIME	OBSERVATION
1	22-03-21	11:30 AM	Grazing and watering behaviour. They are excessively selective and mobile while grazing.
2	23-03-21	10:00 AM	Selective feeding.
3	24-03-21	9:30 AM	No characteristic behaviour is shown.
4	25-03-21	11:00 AM	They can graze on very short grass and browse on foliage like jackfruit leaves.
5	26-03-21	9:00AM	No characteristic behaviour is shown.
6	27-03-21	12:30 PM	Browsing using mobile lips and very prehensile tongue.
7	28-03-21	11:30 AM	No characteristic behaviour is shown.
8	29-03-21	10:00 AM	No characteristics behaviour is shown.
9	30-03-21	9:30 AM	Exploration behaviour is seen.
10	31-03-21	11:00 AM	They are capable of treading 14-15 km a day at the pasture.
11	01-04-21	9:00AM	Goats ingest feed more rapidly, but their grazing period takes long.
12	02-04-21	12:30 PM	Fastidious eating habits.
13	03-04-21	02:00PM	Goat conducts their watering behaviour in the form of sucking.
14	04-04-21	01:15PM	Aggressive behaviour.

15	05-04-21	08:00AM	Since the front incisors in goats have a higher outward inclination, they can gnaw tree barks and trunks.
17	06-04-21	9:00AM	They detach grass with the aid of their tongues and front incisors and complete their grazing behaviour by shredding them between their teeth.
18	07-04-21	12:30 PM	No characteristics behaviour is shown.
19	08-04-21	11:30 AM	Adult female requires about 5 liters of water daily.
20	09-04-21	10:00 AM	No characteristics behaviour is shown.
21	10-04-21	9:30 AM	No characteristics behaviour is shown.
22	11-04-21	11:00 AM	Kids require about 1-2 liters of water daily along with their mother's milk.
23	12-04-21	05:00PM	Walking around can be seen.
24	13-04-21	03:00 PM	Water intake in goats increased at increased environmental temperature and it also increases during the periods of lactation.
25	14-04-21	9:00 AM	Feeding behaviour is seen.
26	15-04-21	10:30AM	No characteristics behaviour is shown.
27	16-04-21	11:30 AM	They mostly graze at lower and flat places.
28	17-04-21	10:00 AM	Goats urinate frequently and it produces a particular smell.
29	18-04-21	9:30 AM	No characteristics behaviour is shown.
30	19-04-21	11:00 AM	Feeding is seen today.
31	20-04-21	9:00AM	No characteristics behaviour is shown.
32	21-04-21	12:30 PM	They can stand on their rear legs and eat the sprouts, buds and leaves on the branches of leaves.
33	22-04-21	11:30 AM	Foraging behaviour is seen.
34	23-04-21	10:00 AM	No characteristics behaviour is shown.
35	24-04-21	9:30 AM	Grooming behaviour is seen.
36	25-04-21	11:00 AM	The poop of an adult healthy goat is hard and oval

			shaped pellets. It has a dark brown colour.
37	26-04-21	9:00AM	These pellets stay separated which is something that is unique to goats.
38	27-04-21	12:30 PM	No characteristics behaviour is shown.
39	28-04-21	02:00PM	During periods where air temperatures increase, goats deliberately decrease their intake of feed to compensate for heat stress.
40	29-04-21	01:15PM	Feeding is seen.
41	30-04-21	08:00AM	No characteristics behaviour is shown.
42	01-05-21	9:00AM	Feeding is seen.
43	02-05-21	12:30 PM	At sometimes, they are stubborn and misbehaved. They can easily cause damage to property and people using their pointy horns.
44	03-05-21	11:30 AM	No characteristics behaviour is shown.
45	04-05-21	10:00 AM	At sometimes they won't stop head butting.
46	05-05-21	9:30 AM	No characteristics behaviour is shown.
47	06-05-21	11:00 AM	They stubbornly disobeying and showing no respect to owners.
48	07-05-21	05:00PM	Feeding is seen.
49	08-05-21	03:00 PM	No characteristics behaviour is shown.
50	09-05-21	9:00 AM	Biting, kicking and pushing things around with their sharp little horns.
51	10-05-21	10:30AM	Kids became aggressive as they age
52	11-05-21	11:30 AM	Feeding behaviour is seen.
53	12-05-21	10:00 AM	They try to harm humans, children and other objects using their horns.
54	13-05q-21	9:30 AM	New food is investigated by sniffing it. So they have a well developed sense of smell.
55	14-0521	11:00 AM	No characteristics behaviour is shown.
56	15-05-21	9:00AM	Alarm behaviour is highly developed. The female

			stands rigid in a typical nursing posture with ears towards the source of alarm. This stimulates young ones to run to the female.
57	16-05-21	12:30 PM	No characteristics behaviour is shown.
58	17-05-21	11:30 AM	Grooming behaviour is seen.
59	18-05-21	10:00 AM	Sometimes goats are staring at humans for help. It shows they are in danger or trapped.
59	19-05-21	9:30 AM	They were quite attached to humans by spending time with them is really relaxing.
60	20-05-21	11:00 AM	No characteristics behaviour is shown.
61	21-05-21	9:00AM	No characteristics behaviour is shown.
62	22-05-21	12:30 PM	Feeding is seen.
63	23-05-21	02:00PM	Shows contact agonistic encounters by pushing the forehead against another goat.
64	24-05-21	01:15PM	They have a range of noises for bleating, snorting and sneezing.
65	25-05-21	08:00AM	They groom themselves by scratching the neck and head with the rear feet, and by licking other parts of their body.
66	26-05-21	9:00AM	Attacking behaviour can be seen and it increases with sexual maturity.
67	27-05-21	12:30 PM	Attacking behaviour mostly in the form of head-butting.
68	28-05-21	11:30 AM	No characteristics behaviour is shown.
69	29-05-21	10:00 AM	Increase in size can increase attacking behaviour since it will limit food and water.
70	30-05-21	9:30 AM	They show selective behaviour towards their favourite plants like jackfruit leaves.
71	31-05-21	11:00 AM	No characteristics behaviour is shown.
72	01-06-21	05:00PM	They tend to graze more during early morning and

			late evening during warm seasons.
73	02-06-21	03:00 PM	No characteristics behaviour is shown.
74	03-06-21	9:00 AM	In the morning they like to eat grasses and bushes in the evening.
75	04-06-21	10:30AM	No characteristics behaviour is shown.
76	05-06-21	11:30 AM	Training the goats to change the misbehaviours and stubborn characters using wear pool noodles.
77	06-06-21	10:00 AM	No characteristics behaviour is shown.
78	07-06-21	9:30 AM	Feeding is seen.
79	08-06-21	11:00 AM	No characteristics behaviour is shown.
80	09-06-21	9:00AM	Goats eat nothing that is dirty or foul smelling. Feeds given must be clean and fresh.
81	10-06-21	12:30 PM	Goats dislike wet or trampled fodder.
82	11-06-21	11:30 AM	Feed them in hay-racks or hang the feed in bundles from a peg in a wall or from a branch of a tree.
83	12-06-21	10:00 AM	They are ruminants. So they can chew their cud.
84	13-06-21	9:30 AM	The eyes of goat have horizontal slit shaped pupils.
85	14-06-21	11:00 AM	No characteristics behaviour is shown.
86	15-06-21	9:00AM	The females have an udder consist of two teats.
97	16-06-21	12:30 PM	Goats display dominance by lowering the head and pointing the horns at the subordinate animal.
88	17-06-21	02:00PM	It is almost impossible to drive goats. When danger approaches, goats scatter and face the enemy.
89	18-06-21	01:15PM	Shows some agonistic behaviours like attacking, threatening, defensive to protect themselves and their food sources.
90	19-06-21	08:00AM	No characteristics behaviour is shown.
91	20-06-21	9:00AM	They groom themselves by scratching the neck and head with the rear feet, and by licking other parts of their body.

92	21-06-21	12:30 PM	Biting, kicking and pushing things around with their sharp little horns.
93	22-06-21	11:30 AM	New food is investigated by sniffing it. So they have a well developed sense of smell.

Table 1: Showing observation of *Capra aegagrus hircus*

Corvus splendens – House crow

SL NO:	DATE	TIME	OBSERVATION
1	22-03-21	11:30 AM	They feed largely on refuse around human habitations, small reptiles and mammals.
2	23-03-21	10:00 AM	They are occasionally nest on telephone and towers.
3	24-03-21	9:30 AM	No characteristics behaviour is shown.
4	25-03-21	11:00 AM	Feeding and drinking water. Fed on live insects.
5	26-03-21	9:00AM	No characteristics behaviour is shown.
6	27-03-21	12:30 PM	Feeding is seen today.
7	28-03-21	11:30 AM	It lays 3-5 eggs in a typical nest.
8	29-03-21	10:00 AM	There are several nest can be seen in the same tree.
9	30-03-21	9:30 AM	The voice of the crow is a harsh 'Kaaw-kaaw'.
10	31-03-21	11:00 AM	Feeding is seen.
11	01-04-21	9:00AM	No characteristics behaviour is shown.
12	02-04-21	12:30 PM	Congregation of large number of birds into a single group to sleep together called Roosts can be seen.
13	03-04-21	02:00PM	They roost communally near human habitations and often over bust street.
14	04-04-21	01:15PM	No characteristics behaviour is shown.
15	05-04-21	08:00AM	Mopping behaviour can be seen. when one crow dies, a group of crow called a murder will surround

			the deceased.
17	06-04-21	9:00AM	The crows gather together to find out what killed their member.
18	07-04-21	12:30 PM	Some crows will travel to warmer areas of their territory, when needed.
19	08-04-21	11:30 AM	They can swoop down from the air and snatching baby squirrels.
20	09-04-21	10:00 AM	Always seems to be alert and cautious, observing the surrounding environment against intruders or enemies.
21	10-04-21	9:30 AM	Exploration and foraging behaviour is seen.
22	11-04-21	11:00 AM	No characteristics behaviour is shown.
23	12-04-21	05:00PM	No characteristics behaviour is shown.
24	13-04-21	03:00 PM	Most food is taken from the ground.
25	14-04-21	9:00 AM	Feeding behaviour is seen. Fed on flies, ants and othe insects. No other characterstic behaviour is observed.
26	15-04-21	10:30AM	Crow don't forget a face.
27	16-04-21	11:30 AM	No characteristics behaviour is shown.
28	17-04-21	10:00 AM	They will often forage in groups.
29	18-04-21	9:30 AM	Feeding and drinking water is seen after basking for some time.
30	19-04-21	11:00 AM	No characteristics behaviour is shown.
31	20-04-21	9:00AM	Alternate and irregular restlessness followed by flying around is seen.
32	21-04-21	12:30 PM	Foraging behaviour is seen.
33	22-04-21	11:30 AM	They are excellent tool makers.
34	23-04-21	10:00 AM	They utilize stems and leaves from plants and by biting and tearing with their beaks, they create sticks and other tools.

35	24-04-21	9:30 AM	Grooming behaviour is seen using their beak.
36	25-04-21	11:00 AM	No characteristics behaviour is shown.
37	26-04-21	9:00AM	Crows can recognize human faces and other physical attributes has been a staple of our experiences with them for years.
38	27-04-21	12:30 PM	No characteristics behaviour is shown.
39	28-04-21	02:00PM	Flying around is seen.
40	29-04-21	01:15PM	They can store food in caches.
41	30-04-21	08:00AM	Sensing the environment is observed.
42	01-05-21	9:00AM	Alertness is seen. Responding to every minute external changes results in restlessness of the animal.
43	02-05-31	12:30 PM	No characteristics behaviour is shown.
44	03-05-21	11:30 AM	They store food for a short term in toes.
45	04-05-21	10:00 AM	No characteristics behaviour is shown.
46	05-05-21	9:30 AM	Foraging behaviour is seen.
47	06-05-21	11:00 AM	When it is time to have offspring, a mating pair will build a nest 15- 60 feet above the ground using branches, twigs, twine, bark, etc.
48	07-05-21	05:00PM	Nests are 1.5 to 2 feet in diameter.
49	08-05-21	03:00 PM	Feeding live animals and drinking water is seen.
50	09-05-21	9:00 AM	Have high visual capacity. Responds to every slight change in the environment. Suddenly move if any unusual changes notice.
51	10-05-21	10:30AM	No characteristics behaviour is shown.
52	11-05-21	11:30 AM	The female lays 4-5eggs and incubates them for 18 days.
53	12-05-21	10:00 AM	They form roosts to protect them from predators.
54	13-05-21	9:30 AM	They are afraid of large owls.
55	14-05-21	11:00 AM	No characteristics behaviour is shown.

56	15-05-21	9:00AM	Upon seeing a would-be attacker, crows are known to gather, with some group consisting of a dozen of birds or more.
57	16-05-21	12:30 PM	Cawing sound of crows can be used as a temporal warning.
58	17-05-21	11:30 AM	Foraging behaviour is seen.
59	18-05-21	10:00 AM	No characteristics behaviour is shown.
59	19-05-21	9:30 AM	Feeding is seen.
60	20-05-21	11:00 AM	Cawing sound also used to signal their location to relatives.
61	21-05-21	9:00AM	They sing softly during courtship with a rich mix of soft cooing, growls, bowing movements and mutual nuzzling.
62	22-05-21	12:30 PM	No characteristics behaviour is shown.
63	23-05-21	02:00PM	Male and female sit side by side on a wire or branch, often near their nest tree.
64	24-05-21	01:15PM	Grooming behaviour is seen. One stretches out its neck, inviting the other to groom its feathers.
65	25-05-21	08:00AM	The groomer/ preener twirls individual feathers in its beak, often starting at the back of the head and working around to the front.
66	26-05-21	9:00AM	No characteristics behaviour is shown.
67	27-05-21	12:30 PM	Feeding and drinking water is seen. No other characteristics behaviour is shown.
68	28-05-21	11:30 AM	They often forage in groups.
69	29-05-21	10:00 AM	No characteristics behaviour is shown.
70	30-05-21	9:30 AM	Grooming behaviour of crow is observed between two crows.
71	31-05-21	11:00 AM	Observing the surroundings is observed.
72	01-06-21	05:00PM	No characteristics behaviour is shown.

73	21-06-21	03:00 PM	If an enemy crow comes too close to a nest, we will see intense chasing behaviour accompanied by loud scolding vocalizations as they chase invaders across the sky.
74	03-06-21	9:00 AM	Grooming behaviour is seen.
75	04-06-21	10:30AM	In their home territory, they're always on the alert for threats and quick to share information with the rest of the group.
76	05-06-21	11:30 AM	Feeding on insects, cereals, fruits etc
77	06-06-21	10:00 AM	They start foraging early in the morning, usually comes as a group.
78	07-06-21	9:30 AM	No characteristics behaviour is shown.
79	08-06-21	11:00 AM	Grooming behaviour can be seen in the morning.
80	09-06-21	9:00AM	No characteristics behaviour is shown.
81	10-06-21	12:30 PM	No characteristics behaviour is shown.
82	11-06-21	11:30 AM	Cawing sound also used to signal their location to relatives.
83	12-06-21	10:00 AM	They form roosts to protect them from predators.
84	13-06-21	9:30 AM	Feeding and drinking water is seen.
85	14-06-21	11:00 AM	No characteristics behaviour is shown.
86	15-06-21	9:00AM	Flying around is seen.
97	16-06-21	12:30 PM	No characteristics behaviour is shown.
88	17-06-21	02:00PM	Cawing sound also used to signal their location to relatives.
89	18-06-21	01:15PM	Feeding live animals and drinking water is seen.
90	19-06-21	08:00AM	No characteristics behaviour is shown.
91	20-06-21	9:00AM	Male and female sit side by side on a branch, often near their nest tree.
92	21-06-21	12:30 PM	Grooming behaviour is seen. One stretches out its neck, inviting the other to groom its feathers.

93	22-06-21	11:30 AM	Exploration and foraging behaviour is seen.
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Table 2: Showing observation of *Corvus splendens*

RESULTS FROM THE BEHAVIOURAL STUDY OF *Capra aegagrus hircus*

- They are excessively selective and mobile while grazing. They have selective feeding habits. Feeds given must be clean and fresh. Since goats eat nothing that is dirty or foul smelling.
- They can graze on very short grass and browse on foliage. Browsing is done by using mobile lips and very prehensile tongue. Since the front incisors in goats have a higher outward inclination, they can gnaw tree barks and trunks. They detach grass with the aid their tongues and front incisors and complete the grazing behaviour by shredding them between their teeth.
- Goats ingest feed more rapidly, but their grazing period takes longer. They are also capable of treading 14-15 km a day at the pasture.
- They have a well developed sense of smell. New food is investigated by sniffing it.
- During periods where air temperatures increase, goats deliberately decrease their intake of food to compensate for heat stress.
- Goats conduct their watering behaviour in the form of sucking. Water requirement in goats varies according to the condition to feed and pregnancy status. Adult female requires about 5 liters of water daily. Lambs require about 1-2 liters of water daily along with their mother's milk. Water intake in goats increased at increased environmental temperature. And it also increases during the periods of pregnancy.
- Goats urinate frequently and it produces a particular smell. This smell is one of the main signals of individual identity, especially in relation to reproductive status.
- Goat manure is beneficial for the soil. This manure contains adequate amount of nutrients that plant need for optimal growth.
- Alarm behaviour is highly developed.

- At sometimes, they are stubborn and misbehaved. Their pointy horns are not necessarily friendly to anyone nearby. Sometimes they won't stop head butting and showing no respect to owners.
- Goats can become aggressive as they age. They started to kicking, biting and head-butting.
- Goats are quite attached to humans by spending time with them is really relaxing. Sometimes goat is staring at humans for help when they are in danger or trapped.

RESULTS FROM THE BEHAVIOURAL STUDY OF *Corvus splendens*

- They feed largely on refuse around human habitations, small reptiles, mammals, other reptiles such as insects, other small invertebrates, eggs, nestlings, grains and fruits (Omnivorous diet).
- As foragers, they also clean up dead animals and garbage. But crows are often blamed for overturning garbage cans.
- They form congregation of large number of birds into a single group to sleep together called Roosts. They prefer roost sites with a lot of human activity, close to food sources.
- A group of crows is called a Murder. When one crow dies, the murder will surround the deceased. This funeral is not just to mourn the dead though. The crows gather together to find out what killed their member. Then, the murder of crows will band together and chase predators in a behaviour called mopping.
- Crows don't forget a face. When a crow encounters a human, it will teach other crows how to identify the human. They are extremely intelligent birds.
- They are excellent tool makers. They utilize stems and leaves from plants and by biting and teasing with their beaks, they create sticks and other tools. That is used to dig and scrape insects from holes in logs and branches.



Fig.2.a. Aggressive behaviour



Fig.2.b. Mating behaviour



Fig.2.c. Watering behaviour



Fig.2.d. Head-butting



Fig.2.e. Resting and cleaning the body with the help of crow.



Fig.2.f. Mating signs



Fig.2.g. Feeding behaviour



Fig.2.h. Ruminant/chews the cud



Fig.2.i. Head-butting



Fig.2.j. Grooming behaviour



Fig.2.k. maternal behaviour



Fig.2.l. Feeding behaviour

Fig.2. Showing Modes of behaviour in *Capra aegagrus hircus*



Fig.3.a. For picking small parasites in the goat body/for resting.



Fig.3.b. Feeding on mango



Fig.3.c. Observing behaviour



Fig.3.d. Grooming each other



Fig.3.e. Social groups for feeding



Fig.3.f. Flying at a height

Fig.3. showing modes of behaviour in *Corvus splendens*

DISCUSSION

In the present study of goat we have seen that goats ingest feed more rapidly, but their grazing period takes longer. A similar result is obtained for Ngwa et al., 2000. Daily feed ingestion activities in goats comprise 1/3 of all activities. Although goats ingest feed more rapidly than sheep, their grazing period takes longer than sheep. The reason for this is that they are excessively selective and mobile while grazing. We have learned that there is an increase in the intake of water during increased temperature conditions and lactation period. Likewise the study done by Haenleinet et al., 1992 shows that as is the case in all animals, water requirement in goats varies according to the variety and condition of feed, and lactation and pregnancy status. Water intake in goats increased at increased environmental temperature and during periods such as during pregnancy and lactation. Pregnancy and lactation have been reported to increase the total daily time of feeding, the frequency of feeding, the total daily time of rumination, and the frequency of rumination (Wittenberger, 1981). Physiological conditions such as lactation and pregnancy are also influential in goats' feed preferences (Wittenberger, 1981; Hoste et al., 2001). In this study we have seen that agonistic behaviour is observed more in males than females because of the presence of horns. Similar study was done by Unal and Akcapinar., 1994 shows that agonistic behaviour is observed to be 50% higher in males. The most important cause of this is the fact that females have no horns or weak horns. Agonistic behaviour in goats are behaviours such as attacking, escape, threatening, and defense. The reason for these behaviours in goats is the instinct to protect both themselves and their food sources (Mc Glone, 1986).

From the study of house crow, we have seen that crows are cooperate breeders, which means they often stay close to the place where they born and help, raise and defend the area's young chicks. Similar study can be seen from Clayton et al., 2005. The young ones live with the parents for a long time during which they learn all the skills necessary to survive and since they are cooperative brooders they will learn the skills from any members of the group. From this study we have observed as foragers, they also clean up dead animals and garbage. But crows are often blamed for overturning garbage cans. The study conducted by Anil Kumar, 2004 shows that, these birds can be seen near marketplaces and garbage dumps, foraging for scraps. They also feed on carcass materials. We have learned that house crow forms roosts to protect them from predators, to gather food etc. Similar studies show that, the House crows usually roost with other

birds like the Jungle crow and Myna. They are usually benefited as they are protected from predators. Sirsat and Patil (2013) studied the communal roosting behaviour of birds in Vaijapur. They reported that the crows roosted along with the Mynas. Gadgil, 2001 recorded the communal roosting behaviour of the *C. Splendens* with the Jungle crow and Myna, were the House crows and Jungle crows shifted their roosting site from the Mynas and within four days the Mynas joined them.

CONCLUSION

The behavioural study was conducted on two organisms, *Capra aegagrus hircus*, domestic goat and *Corvus splendens*, the House crow. Goats is one of the species widespread raised among the domestic animals. Goats are raised in many different environments almost everywhere in the world. In much of the developing world, goats are essential for survival and are highly valued for their meat and milk. We have highlighted the ability of goats to cope with choice and complexity in their physical, feeding, and social environments, which is facilitated by their cognitive abilities.

Crows are glossy blackbirds that are found majorly in all parts of the world. The majority of the *Corvus* species are known as crows. Crows feed on the ground itself where they walk around purposefully. Crows are omnivorous animals who hunt on young and weak animals. Crows live in large and close-knitted families. They are very much social in nature, who hunt, forage together, and defend their territories together. They also care for their younger ones. Most of the crow species do not normally nest in colonies. Each of the mating pairs has its own nest which is made up of sticks and twigs, which are generally situated high up in a tree. These species exhibit great curiosity, they have a reputation as inventive pranksters and they are also popularly known as thieves.

The study was conducted at karuvarakundu, Nilambur from 22nd March, 2021 till 22nd June, 2021. Important behaviours shown by the goat includes feeding behaviour both grazing and browsing behaviour, watering behaviour, aggressive behaviour, threatening and attacking behaviour, Parturition and maternal behaviour, estrus behaviour etc is exhibited. The behaviour shown by the House crow includes Mopping behaviour, Roosting behaviour, Foraging behaviour, Feeding behaviour, etc. The intelligence of this bird is highly observed in making tools for foraging, identifying human face and never forget a face once it is identified. These birds are well known for their intelligence, skill, and their high adaptability feature.

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**STUDY ON BEHAVIORAL PATTERN OF *ANAS PLATYRHYNCHOS* AND
*ORYCTOLAGUS CUNICULUS***

MINI PROJECT – SEM I

**SUBMITTED TO ST. TERESA'S COLLEGE (AUTONOMOUS),
ERNAKULAM**



SUBMITTED BY,

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REG. NO: SM20ZOO005

DEPARTMENT OF ZOOLOGY

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2020-2022

CERTIFICATE

This is to certify that the Mini project entitled “**study on behavioral pattern of *Anas platyrhynchos* and *Oryctolagus cuniculus***” is an authentic work carried out by **Sr. MARY SHELLY**. (Reg. No: SM20ZOO005), during the Academic year **2020-2022**, under my guidance from St. Teresa’s College (Autonomous), Ernakulam.

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DECLARATION

I hereby declare that the Mini project entitled “**study on behavioral pattern of *Anas platyrhynchos* and *Oryctolagus cuniculus***” submitted to St. Teresa’s College (Autonomous), is a original work done by me under the supervision and guidance of Ms. Tiya K. J, Assistant professor, Department of Zoology, St. Teresa’s College (Autonomous), Ernakulum and to the best of my knowledge and belief , this project contains no material previously published or written by another person, except where due reference is made.

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Sr. MARY SHELLY

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ABSTRACT

In the open water source *Anas platyrhynchos* are able to preen effectively, their various social behaviours also been observed in the waterline. *Oryctolagus cuniculus* those are well socialized at an early age and able to cope with most new situations and people confidently. In order to investigate the animal behaviours I have selected a pair of rabbit and four ducks. They were observed twice a day for three months continuously. Some of the fascinating and surprising behaviors of ducks are their social and preening behaviours associated with water lines. Rabbits show more comfortable with human if they had numerous positive interactions with human and female responds during mating.

All the ducks performed most of the active behaviours in water lines than they kept in cage. Ducks are much more likely to move in groups rather than individual, they usually love to spend time in smaller flocks, instead of living isolated. Ducks dip their tiny heads in the water, forcing them to blow bubbles in the water. This is their method of washing their nostrils from all the dirt stuck into them. After each bathing they preen themselves to achieve effective insulation, ducks spread preen oil from their uropygial glands. Ducks are fun to have around and are great to have in the garden. They can act as weed control for the garden as they feed on grass.

Rabbits show more comfortable with human if they had numerous positive interactions with them. Rabbits most of their time spent for grooming and even they groom each other (auto grooming and all grooming). During their mating the buck (male) follows the doe (female) around, softly humming while sniffing and licking her for few seconds. The receptive female will hop around in circles or flatten to the floor while the pressure is applied to her back. The present study on the behavior of ducks and rabbit showed that they are more active when they are out of their cage. The study conducted in south Kumbalam from month of May to July 2021.

INTRODUCTION

Almost all varieties of domestic duck apart from the Muscovy duck (*Cairinamoschata*) are descended from the mallard (*Anas platyrhynchos*). Domestic ducks have lost the mallard's territorial behaviour, and are less aggressive than mallards. Duck is the common name for numerous species of waterfowl in the family Anatidae. Ducks are generally smaller and shorter-necked than swans and geese, which are also members of the same family. Ducks are mostly aquatic birds, mostly smaller than the swans and geese, and may be found in both fresh water and sea water. The overall body plan of ducks is elongated and broad, and they are also relatively long-necked, albeit not as long-necked as the geese and swans. The body shape of diving ducks varies somewhat from this in being more rounded. The bill is usually broad and contains serrated pectens, which are particularly well defined in the filter-feeding species. In the case of some fishing species the bill is long and strongly serrated. The scaled legs are strong and well developed, and generally set far back on the body, more so in the highly aquatic species. Ducks eat a variety of food sources such as grasses, aquatic plants, fish, insects, small amphibians, worms, and small molluscs. At the edge of the beak, there is a comb-like structure called a pecten. This strains the water squirting from the side of the beak and traps any food. The pecten is also used to preen feathers and to hold slippery food items.

Kingdom: Animalia

Class: Aves

Family: Anatidae

Genus: Anas

Duck's, dabbling, drinking, and preening behaviours are some behaviours which ensure safety from predators, and these same social behaviours have also been described in commercial ducks. Preening is the process of cleaning and spreading protective oils across the body and feathers, occurs in both wet and dry conditions. The lack of an open water source ducks are not able to preen effectively. If ducks do not have access to water in which they can at least dip their heads and spread water over their feathers. However maintaining hygiene and environmental standards is difficult with open water in which ducks can immerse themselves

Keeping the plumage waterproof occupies much of the time not spent feeding or sleeping. The bill is used both to stimulate the oil gland (situated above the tail) and to spread the oil.

Rubbing the chin and throat on oiled areas also helps the process. Preening occurs at the same time, the fine structure of the feathers being nibbled into the interlocking position necessary to prevent the entry of water. Rearrangement of the feathers involves preening, scratching with the feet, and a general body shake produced by a muscular contraction sweeping from tail to neck. Various wing-stretching movements settle the flight feathers. Bathing movements include dipping the head, beating the wings on the surface and, at high intensity, actual diving or somersaulting through the water. Sleep often follows such maintenance activities, the bill being turned and placed under the scapular (shoulder) feathers. Bathing is often a communal activity, and mutual preening is seen in several species. Once a diving duck is underwater, the legs are sculled together; the wings are opened and used as steering rather than as propelling devices.

Domestic rabbits as well as wild rabbits belong to the species *Oryctolagus cuniculus* (European rabbit), which is the only domesticated mammal of western European origin. Rabbits have several specific behavioral needs that can make them a complex pet to keep. These needs relate to rabbits being prey animals and easily frightened. Fear is a response that enables an animal to avoid dangerous situations. However, animals that are put in situations where they are constantly fearful become much stressed. This will affect their health and welfare. Rabbits that are well 'socialized' at an early age will be able to cope with most new situations and people confidently. If any negative experiences get from the human who makes them to show aggressiveness in different ways .once they are confident with the human shows excessive grooming and hopping around the keeper .They often run rapidly from place to place with no apparent purpose. This is great exercise, and though it doesn't make much sense, it's fun to watch.

Kingdom: Animalia

Order: Lagomorpha

Family: Leporidae

Species: *O. cuniculus*

When does become receptive to mating, they will usually show signs of being in heat. They may act restless, rub their chins on feed and water containers or other equipment, and show a desire to join other rabbits. The doe may also present herself, and lie on her stomach or lift her tail when touched, if she is in heat. Before any mating attempts, examine both the buck and doe to be sure they are in good condition. Very Often doe refused to mate with buck the buck chases the doe until she stops.

Caging system is one of the reasons for aggressiveness in rabbits. Female rabbit constantly groom male partner. When the female is removed for few hours and introduce again male shows the copulation behavior. Rabbits become fearful if had painful or frightening experience with human

Ducks tilting their head to one side. They look very curious when they do this, and that is because they are curious – literally. Ducks walk in a line for safety reasons. Because of their eye placement, they cannot look forward and maintain good peripheral vision. Therefore, the lead duck focuses on where they are going; guiding everyone behind him or her while the ducks that are following scan the sides for any sign of danger. When they sleep, one half of the brain is wide awake keeping watch for danger, while the other half is sound asleep. The two halves of the brain are also active when ducks are walking in a line to keep watch of both sides. Ducks wag their tails when they get out of the water, or when they expect or receive a very tasty treat. This behavior indicates pleasure and enjoyment.

Ducks love to dig down deep into mud puddles with their bills. They are not playing games in the mud. They are actually foraging for food. This is because insects tend to move toward air after the rain, making for an easy meal for the ducks. Ducks preen after swimming by rubbing their heads all over their bodies. If watch closely, see that they seem to rub under their tail more than anywhere else. This is because they have a preening gland under their tails that secretes natural oil which they are spreading over their bodies while preening. This oil is what makes their feathers waterproof, enabling them to stay reasonably dry and warm.

REVIEW OF LITERATURE

Zsolt Gerencsér and companions study on the Aggressiveness, 'Mating Behaviour and Lifespan of Group Housed Rabbit Does', proved that Aggressiveness is one of the main problems in group housing of rabbit does. Aggressiveness is a well-known trait in different animal species, including the European wild and domesticated rabbit. It is one of the main problems in group housing of rabbit does. The aim of the experiment was to investigate the frequency of aggressiveness and mating behaviour as well as the lifespan of does depending on their rank order (Zsolt Gerencsér *et al.*, 2019).

The European Union have been the focus of most of these studies, they set out to characterize commercial Pekin duck social and preening behaviours associated with water lines (pin-metered water systems). They also determined if these behaviours differed with ducks housed. These recordings were analyzed for group interactions under water lines as well as preening behaviours and then compared between flooring types. They found that ducks are much more likely to drink in groups rather than individually. Significantly fewer ducks were observed drinking alone in barns with raised flooring compared with pine litter at all ages (M. Rice *et al.*, 2014).

Geese study was observed to live in harmony within each other and with other animals too. Their temperament was not aggressive and showed good acquaintance with the farmer's family members including children. Their faithfulness and intelligence, as reported by the farmers, brings them back to their respective farmer's home on their own, even after months of staying in the waters. Such behaviour has also been mention by various authors like (Wurtz, 1995).

A study on geese behaviour observed preening, rubbing and brushing their bodies with their flexible neck and claws. The study has provided an insight in to understanding of the behavioural needs of domestic geese which would aid in standardizing the rearing practice on scientific lines and also the production performance of the species taking into consideration ethics and welfare of the species. (H. Hamadani *et al.*, 2016).

Watching the ducks while bathing can be quite delightful, as they splash water joyfully. They usually love to spend time in smaller flocks, instead of living isolated. Ducks are active creatures and love to move freely all-time long, Ducks are quite shy and fearful, so don't try to jump into their gatherings, otherwise, they may quack very loud (Mary M Louise, 2012).

Preening, which is the process of cleaning and spreading protective oils across the body and feathers, has been described in both wet and dry conditions. Pekinduck behavior is adversely

affected by the lack of an open water source and that ducks are not able to preen effectively when housed commercially. Spread preen oil from their uropygial glands, also known as preen oil glands, all over their plumage. Waterproof their feathers by the process of preening (Kolattukudy *et al.*, 1985).

To achieve effective insulation, birds spread preen oil from their uropygial glands, also known as preen oil glands, all over their plumage. Ducks run away from you when you are around, this is their way of dealing with an uncertain, stressful situation. It could be that they are not used to interactions with humans, or that they have had a bad experience with humans. Ducks often shiver when they are excited. This often accompanies a showing of affection. Ducks stick their heads in the water, tilting their bottoms up to search for fish, bugs, and plants in the water to eat. (Di-Anne Seebregts). It is worth noting that contrary to common observations, vigilance did not increase. However, ducks are known to be vigilant while sleeping. This complex behavioral adjustment therefore seems to be optimal as it may allow ducks to reduce their predation risk (Cédric Zimmer, 2011).

No female displays of any kind and suspect that the female's role is essentially a passive one of observing and presumably visually stimulating the male by her presence alone. As the bird moved forward in the water he lowered his head and neck toward the surface, the body and tail were held in a straight axis, and, with a strong kick, water was splashed to the rear and upward a distance of up to six or eight feet (Paul A. Johnsgard., 1965).

Rabbits are clean pets. A hutch will start to smell a little after a few days, but not your rabbit. This is because rabbits spend significant parts of their day grooming. This could be a self-clean, they could groom another rabbit, or they may even groom you. It's all equally important to a rabbit. Rabbits are social animals and need contact with other individuals to express all forms of behavior (Gunn and Mortonet *al.*, 1995).

Males conduct promiscuous relationships with any females they manage to attract, and thus natural selection has favored the evolution of elaborate displays having considerable "attraction value," as well as promoting sexual dimorphism in body size and strength. Wild rabbits live in groups comprised of one to three males and one to five females. Previous studies have compared wild and domestic rabbits, and have shown that domestic rabbits in semi-natural conditions exhibit territoriality, dominance and social behaviors that are similar to wild rabbits (Stodart *et al.*, 1964).

Social stimulation is very important in rabbits owing to their social nature. Studies in semi-natural systems indicate the occurrence of a hierarchy between rabbits and behaviors such as allogrooming, lying and eating in the company of another individual (Held *et al.*, 1995).

METHODOLOGY

The observation took place in month of April to July at (south) Kumbalam in Ernakulum district. Kumbalam is a picturesque region in Kochi, in the state of Kerala, India. A water-bound countryside, bound by the Vembanad Lake, as well as the fast encroaching city of Kochi, it is situated around 9 km from Vytilla Junction.



Fig.1 Map showing the study area

To understand the behavioural patterns of the duck I had arranged a small pond in the garden that is actually for the cultivation of fish. Every evening that was opened for the ducks and other times it is covered with a net. Usually ducks are in the closed cage and the water is given in the tub for their need. For few days I had directed them to the water body and the following days they themselves go to the garden and spent most of the time in water.

To study the behaviour of animals I had selected a pair of rabbits (male & female) and four ducks (female). Rabbits behaviours observed inside the cage, they are provided with food and water in the cage itself in between separated female rabbits from the male and introduces it after half an hour that caused for mating behaviour. They were also negatively approached to the stranger and the loud noises. Rabbits have several specific behavioural needs that can make them a complex pet to keep. I kept both the rabbits in their nest and irritated with strange voice and holding on their ears hardly for few days that developed aggressiveness (they run away) also found that they were very closed and comfortable with who have provided positive experiences (like soft touching and back scratch around the shoulders). I also recorded various responds of the female and male rabbits before and during mating. Most of the time female hesitated and run away, but in twice I could observed that before mating female started to lick on the food plate, gentle run then it made a flattened body

posture for mating. At the same time the behaviour observed in 4 female ducks was social and preening behaviour associated with water line. They most like to be in the water once the cage is opened without any guidance they directly move to water body, the movement is always in line by line, Shunning. They together get into the water and showed various postures such as Going Bottoms-Up in Water, excessive Preening, Preening After Swimming, Swimming in A Line, Blowing Bubbles in the Water, stretching of wings, head bobbing and excited quacking. They get in and out of the water together. After swimming shiver the body and with beak preen the body by themselves.

OBSERVATION & RESUL

Sl.No.	Date	Time	Observation
1	23/04/21'	1:30pm/5pm	Aggressive in cage ,when a stranger observe them /Moving in line ,while they move in to the water body
2	24/04/21'	5pm/5:30pm	Bathing in water/preening while swimming in water
3	25/04/21'	4:15pm/5:45pm	Moving in garden ,while returning to their cage/preening in water during swimming
4	26/04/21'	1:06pm/1:14pm	Resting, after feeding /stretching feather and preening during in water
5	27/04/21'	10am /6pm	Bubbling in the water while swimming in water/bathing in water
6	28/04/21'	4pm /5:30pm	Swimming in water body /preening after bathing
7	29/04/21'	4:10pm/5pm	Swimming in water /sinking while preening
8	30/04/21'	4pm/5pm	Bathing in water while swimming
9	31/04/21'	1:25pm/4pm	Loud quacking while seeing dog/moving together after coming out of water

Table 1: behavioural observation of *Anas platyrhynchos* on month of April

Sl.No.	Date	Time	Observation
10	01/05/21'	5pm/5:30pm	Flying in water during swimming/swimming in water
11	02/05/21'	4:30pm/5pm	Roaming in garden after swimming in water /preening while swimming
12	03/05/21'	3:30pm/4pm	Moving to water body/swimming in water
13	04/05/21'	4pm/5:15pm	Going down to water while swimming /floating together while swimming
14	05/05/21'	4:30pm/5pm	Moving in line to water line/preening after swimming in water
15	06/05/21'	3:45pm/6pm	Loud quacking when they see the stranger/eating while they are allowed to move in the garden
16	07/05/21'	5pm/5:30pm	Swimming in water /moving together to the cage
17	08/05/21'	1:45pm/6pm	Quacking while they move to the water /moving in line when they returned the cage
18	09/05/21'	2pm/4pm	Resting after their feeding /moving in line while moving to the water body
19	10/05/21'	1:30pm/4:50pm	Standing together when food is provided in the cage/feeding while swimming
20	11/05/21'	9:40am/1:45pm	Preening in the cage when water supplied through hose /loud quacking sound when they do not have water in the tub
21	12/05/21'	4:15pm/5pm	Standing together after bathing in water/ Moving in line while they returned to their cage
22	13/05/21'	5pm/5:30pm	Feeding while swimming /quacking when they are in the closed cage
23	14/05/21'	4:15pm/5:45pm	Preening during swimming/moving in line after return to the cage
24	15/05/21'	4pm/5:15pm	Swimming when they are in water line/scared of barking
25	16/05/21'	5pm/5:30pm	Preening in water/flying in water

26	17/05/21'	4:15pm/5:45pm	Standing together while providing food in the cage /preening after swimming in water
27	18/05/21'	3:45pm/6pm	Resting in the cage after feeding/loud quacking when they are closed in cage
28	19/05/21'	4pm/5pm	Feeding in the garden between swimming
29	20/05/21'	4:30pm/5pm	Going down to water while swimming
30	21/05/21'	1:45pm/6:15pm	Standing together when they provided food in the cage
31	22/05/21'	4:30pm/5pm	Quacking before they released from the cage / floating together in the water line
32	23/05/21'	3:45pm/5pm	Resting after feeding /moving in line while going to water body
33	24/05/21'	1:45pm/4:40pm	Loud quacking when there was no enough water in the tub while they are closed in the cage/feeding while swimming
34	25/05/21'	4:50pm/6pm	Moving in line to water body /preening after coming out of water
35	26/05/21'	1:45pm/6pm	Aggressive in cage, when they see the dog /Moving in line
36	27/05/21'	4:30pm/6pm	blow bubbles in the water/preening during swimming
37	28/05/21'	4:15pm/5:45pm	Dipping head in the water/flying while they are in water
38	29/05/21'	4:30pm/5pm	Spreading oil on the feathers after getting out from the water /preening during swiming
39	30/05/21'	5pm/5:30pm	Swimming in water/preening after bathing

Table 2: behavioural observation of *Anas platyrhynchos* on month of May

Sl.No.	Date	Time	Observation
40	01/06/21'	4:10pm/5:15pm	Drinking from the tub while they were in the cage / flying in water
41	02/06/21'	5:15pm/5:30pm	Feeding in the water body/running when the cage opened
42	03/06/21'	4:15pm/5:45pm	Swimming in water /preening after getting out of the water
43	04/06/21'	4:35pm/5pm	Flying in water/sinking while swimming
44	05/06/21'	5pm/5:50pm	Preening while swimming/feeding when they closed in the cage
45	06/06/21'	4:15pm/4:45pm	Dipping head in the water during swimming in water
46	07/06/21'	1:45pm/5:15pm	Running from the stranger/swimming together
47	08/06/21'	1:45pm/4:15pm	Resting after feeding /removing dirt from the feathers
48	09/06/21'	3:45pm/5pm	Loud quacking when there was no water in the tub in the closed cage /sinking during swimming in water
49	10/06/21'	4pm/5pm	Moving to water body when opened the cage / swimming
50	11/06/21'	4:40pm/5pm	Swimming in water /Excited Quacking while seeing chicks
51	12/06/21'	1:45pm/4:15pm	Feeding in the cage /Sideways Head Bobbing while moving to water body
52	13/06/21'	1:45pm/4:45pm	Standing together when provided food /Blowing Bubbles in the Water
53	14/06/21'	1:15pm/5:15pm	Feeding when they were in the cage/Head Tilting while returning to the cage
54	15/06/21'	4:30pm/5pm	Walk to the water body / Swimming in a Line in water body
55	16/06/21'	3:35pm/5pm	Tail Wagging while swimming /preening after water bath
56	17/06/21'	1:45pm/3:40pm	Resting after feeding in the cage /Digging Holes in Puddles in the water log
57	18/06/21'	1:45pm/4:15pm	Resting after feeding/ Preening After Swimming
58	19/06/21'	5pm/5:30pm	Excessive Preening while swimming/Aggression when they are in the closed cage
59	20/06/21'	4:30pm/5pm	Running Away when the cage opened/Shivering after getting out of the water body
60	21/06/21'	3:30pm/4:10pm	Blow bubbles in the water/running when opened cage
61	22/06/21'	4pm/5:15pm	Moving in line to the water body /swimming in water
62	23/06/21'	5pm/5:30pm	Going Bottoms-Up in Water/flying while they are in water

63	24/06/21'	4:30pm/5:45pm	Head Tilting while moving to the water / preening after swimming
64	25/06/21'	4:15pm/5pm	Feeding while swimming/ swimming in water
65	26/06/21'	3:45pm/4:30pm	Quacking when they are opened cage /moving to the water body
66	27/06/21'	4pm/5pm	Preening in water/flying in water
67	28/06/21'	4:30pm/5:30pm	Going down while swimming /feeding when they are in the cage.
68	29/06/21'	1:45pm/6pm	Aggressive in cage/moving together to the cage
69	30/06/21'	4:30pm/6:10pm	Blowing bubbles in water /swimming in water

Table 3: behavioural observation of *Anas platyrhynchos* on month of June

Sl.No.	Date	Time	Observation
70	01/07/21'	4:15pm/5:45pm	Moving in line to water body /preening after swimming
71	02/07/21'	4:35pm/5pm	Aggressive in cage /Moving in line to the cage
72	03/07/21'	5pm/5:50pm	blow bubbles in the water/preening after getting out of the water body
73	04/07/21'	4:40pm/5pm	Moving in garden while going to the water body /preening in water
74	05/07/21'	1:45pm/4:15pm	Resting after feeding /stretching feather and preening
75	06/07/21'	4:15pm/5:45pm	Bubbling in the water/bathing in water body
76	07/07/21'	4:35pm/5pm	Swimming in water body /preening after bathing
77	08/07/21'	5pm/5:50pm	Resting after swimming /Digging Holes in Puddles
78	09/07/21'	4:30pm/6pm	Feeding while swimming/Preening After Swimming
79	10/07/21'	4:15pm/5:45pm	Excessive Preening while swimming /Aggression when they returned to the cage
80	11/07/21'	5pm/5:30pm	Tail Wagging while swimming /preening after swimming in water
81	12/07/21'	4:15pm/5:45pm	Resting when they were in the cage /Digging Holes in Puddles when they see the waterlog
82	13/07/21'	3:45pm/6pm	Moving in line to water body /preening after swimming in water

83	14/07/21'	4pm/5pm	Aggressive in cage /Moving in line to water body
84	15/07/21'	4:30pm/5pm	blow bubbles in the water/preening while swimming
85	16/07/21'	4:15pm/5:45pm	Swimming when they are in water /Excited Quacking when they see the chicks
86	17/07/21'	3:45pm/6pm	Loud quacking before releasing from the cage /sinking while swimming
87	18/07/21'	4pm/5pm	Moving in garden while going to the water body /preening in water
88	19/07/21'	4:30pm/5pm	Resting before releasing to the water body /stretching feather and preening while swimming
89	20/07/21'	4:15pm/5:45pm	Bubbling in the water/bathing while swimming
90	21/07/21'	4:15pm/5:45pm	Swimming in water /preening after bathing
91	22/07/21'	4:35pm/5pm	Moving in line to the water body/preening during swimming in water
92	23/07/21'	5pm/5:50pm	Aggressive in cage /Moving in line to the cage

Table 4: behavioural observation of *Anas platyrhynchos* on month of July

Sl.No	Date	Time	Observation
1	23/04/21'	1:45pm/4:30pm	Running when they see the stranger /scratching on the floor when one of the rabbit removed from the cage
2	24/04/21'	5pm/5:30pm	Grooming when female rabbit is introduced /feeding when food is provided in the cage
3	25/04/21'	4pm/5:30pm	Grooming when they released from the cage /hopping in the cage when they closed in the cage
4	26/04/21'	1:30pm/1:40pm	Grooming each other after feeding /moving around while seeing the stranger
5	27/04/21'	10:30am /5:30pm	Running around when they released /licking while resting
6	28/04/21'	4:30pm /5pm	Feeding when the food is provided in the cage /mating when female is introduced
7	29/04/21'	4pm/5pm	Resting after feeding /hopping when they see the familiar person

8	30/04/21'	3:45pm/4:45pm	Grooming themselves before feeding /nose jerking when they are pampered by the familiar person
9	31/04/21'	2pm/4:30pm	Resting after feeding /running around they heard loud noise

Table 5: behavioural observation of *Oryctolagus cuniculus* on month of April

Sl.No.	Date	Time	Observation
10	01/05/21'	5:20pm/5:45pm	Grooming when they are introduced in the cage /feeding when food provided in the cage
11	02/05/21'	4pm/5:15pm	Licking female before mating /smelling when they are returned to the cage
12	03/05/21'	3pm/4:30pm	Resting after feeding/mating when female is introduced
13	04/05/21'	4:30pm/5pm	Aggressive when they see the who has given a negative impulse in the previous days /running around when the stranger
14	05/05/21'	4:45pm/5:15pm	Grooming after feeding /licking to show the affection to the familiar person
15	06/05/21'	3:30pm/5:45pm	Hopping when introduced in the cage /scratching after resting
16	07/05/21'	4:30pm/5:15pm	Allogrooming when they introduced in the cage /resting after feeding
17	08/05/21'	2pm/5pm	Jumping before providing feeding /grooming when they are introduced in the cage
18	09/05/21'	2:15pm/4:30pm	Resting after feeding /feeding when food is provided in the cage
19	10/05/21'	2pm/5:15pm	Grooming while they take rest/feeding when food is provided in the cage
20	11/05/21'	10am/2pm	Running when see the stranger/resting after feeding
21	12/05/21'	4:15pm/5:15pm	Aggressive when see the person who gave a negative impulse /licking before mating.
22	13/05/21'	5:15pm/5pm	Grooming after introducing the female /female running

			before mating
23	14/05/21'	4pm/5:15pm	Auto grooming after feeding/smelling after introducing the female
24	15/05/21'	4:30pm/5pm	Licking lid before eating/grooming after feeding
25	16/05/21'	5:15pm/5:20pm	Resting after feeding/feeding after rest
26	17/05/21'	4pm/5pm	Running when hear the loud noise/licking while resting
27	18/05/21'	4pm/5:15pm	Feeding when food is provided in the cage /mating after running
28	19/05/21'	4:30pm/5:15pm	Resting after feeding /hopping when started to catch the female
29	20/05/21'	4:15pm/5pm	Auto grooming before feeding/smelling after introducing the female
30	21/05/21'	1:10pm/5:30pm	Aggressive before mating/licking before mating
31	22/05/21'	4pm/5:30pm	Grooming after feeding/running when see the dog
32	23/05/21'	4pm/5:30pm	Running around when they released /licking while resting
33	24/05/21'	2:30pm/4:30pm	Feeding when the food is provided in the cage /mating when female is introduced
34	25/05/21'	5:15pm/5:30pm	Resting after feeding /hopping when they see the familiar person
35	26/05/21'	1:30pm/5:30pm	Resting after feeding/feeding after rest
36	27/05/21'	4:15pm/5:20pm	Running when hear the loud noise/licking while resting
37	28/05/21'	4:15pm/5:30pm	Grooming while they take rest/feeding when food is provided in the cage
38	29/05/21'	4:15pm/5pm	Grooming/running
39	30/05/21'	4:15pm/5pm	Grooming/resting

Table 6: behavioural observation of *Oryctolagus cuniculus* on month of May

Sl.No.	Date	Time	Observation
40	01/06/21'	4:15pm/5:45pm	Licking/feeding
41	02/06/21'	5:15pm/5:30pm	Grooming when they released from the cage /hopping in the cage when they closed in the cage
42	03/06/21'	4:15pm/5:45pm	Grooming each other after feeding /moving around

			while seeing the stranger
43	04/06/21'	4:15pm/5:30pm	Resting when they were in the cage /Digging Holes in Puddles when they see the waterlog
44	05/06/21'	4:15pm/5:45pm	Moving in line to water body /preening after swimming in water
45	06/06/21'	4:30pm/4:15pm	Aggressive in cage /Moving in line to water body
46	07/06/21'	2:45pm/5:15pm	Grooming seeing familiar person /nose jerking when the new lid given for feeding
47	08/06/21'	2pm/5pm	Resting after feeding /running around when male is alone in the cage
48	09/06/21'	3:30pm/5pm	grooming when they are introduced in the cage / mating
49	10/06/21'	4:pm/5:15pm	nose jerking while holding in the hand /hopping after releasing
50	11/06/21'	5:10pm/5:20pm	Running around when they released /licking while resting
51	12/06/21'	2pm/4pm	Feeding when the food is provided in the cage /mating when female is introduced
52	13/06/21'	1:30pm/5pm	Jumping before providing feeding /grooming when they are introduced in the cage
53	14/06/21'	1:45pm/5pm	Resting after feeding /feeding when food is provided in the cage
54	15/06/21'	4:45pm/5:30pm	Grooming while they take rest/feeding when food is provided in the cage
55	16/06/21'	4pm/5:30pm	Grooming when they released from the cage /hopping in the cage when they closed in the cage
56	17/06/21'	2pm/4pm	Grooming while resting/nose jerking while holding in the hand
57	18/06/21'	2pm/4pm	Resting/running around when female separated
58	19/06/21'	4:45pm/5:15pm	Feeding /mating when both are put together in the cage
59	20/06/21'	4pm/5:30pm	Resting/hopping when introduced to the cage
60	21/06/21'	4pm/4:30pm	Feeding when food is provided in the cage /mating

			after running
61	22/06/21'	4:15pm/5pm	Resting after feeding /hopping when started to catch the female
62	23/06/21'	5:15pm/5:45pm	Feeding when food is provided in the cage /mating after running
63	24/06/21'	4:45pm/5:30pm	Resting after feeding /hopping when started to catch the female
64	25/06/21'	4:30pm/5:15pm	Licking lid/grooming after feeding
65	26/06/21'	4pm/4:45pm	Resting before feeding/feeding
66	27/06/21'	4:45pm/5:15pm	Running when see the cat /licking after feeding
67	28/06/21'	4pm/5pm	Grooming when they released from the cage /hopping in the cage when they closed in the cage
68	29/06/21'	2pm/5:45pm	Grooming each other after feeding /moving around while seeing the stranger
69	30/06/21'	4pm/5:45pm	Running around when they released /licking while resting

Table 7: behavioural observation of *Oryctolagus cuniculus* on month of June

Sl.No.	Date	Time	Observation
70	01/07/21'	4pm/5:30pm	Running around when they released /licking while resting
71	02/07/21'	4:45pm/5:15pm	smelling the lid before eating /Autogrooming after food
72	03/07/21'	5:30pm/6pm	Licking lid/grooming while resting
73	04/07/21'	4:30pm/5:15pm	Grooming when they released from the cage /hopping in the cage when they closed in the cage
74	05/07/21'	2pm/4pm	Running/ Moving around when they see the ducks
75	06/07/21'	4:45pm/5:30pm	Grooming each other after feeding /moving around while seeing the stranger
76	07/07/21'	4:40pm/5:15pm	Running around when they released /licking while resting
77	08/07/21'	5:15pm/5:30pm	Running around when they released /licking while resting
78	09/07/21'	4:15pm/5:45pm	Grooming after feeding /nose jerking when hold on hand
79	10/07/21'	4pm/5:30pm	Grooming each other after feeding /moving around while

			seeing the stranger
80	11/07/21'	4:40pm/5:15pm	Moving around when they see the ducks /resting after feeding
81	12/07/21'	4:30pm/5:30pm	Autogrooming after food /smelling the lid before eating
82	13/07/21'	4pm/5:45pm	Licking lid before feeding/grooming while resting
83	14/07/21'	4:50pm/5:15pm	Resting after feeding/feeding
84	15/07/21'	4pm/4:45pm	Running in the cage when see the stranger /licking before mating
85	16/07/21'	4pm/5:30pm	Running around when they released /licking while resting
86	17/07/21'	4pm/5:45pm	Grooming after feeding /nose jerking when hold on hand
87	18/07/21'	4:30pm/5:40pm	Grooming when they released from the cage /hopping in the cage when they closed in the cage
88	19/07/21'	4:15pm/5:30pm	Feeding/mating after introducing male and female in the cage
89	20/07/21'	4pm/5:15pm	Grooming each other after feeding /moving around while seeing the stranger
90	21/07/21'	4:25pm/5:50pm	Feeding /grooming after feeding
91	22/07/21'	4:30pm/4:40pm	Resting after feeding/hopping after rest
92	23/07/21'	5:15pm/5:30pm	Running when hear the loud noise/licking while resting

Table 8: behavioural observation of *Oryctolagus cuniculus* on month of July



Fig. 2: Stretching feathers after swimming



Fig. 3: flying while swimming



Fig. 4: Head sinking and feeding



Fig.5: Preening during swimming

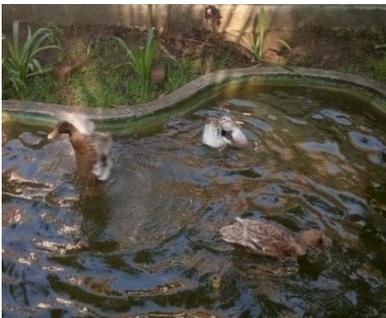


Fig. 6: Stretching feathers during swimming



Fig. 7: swimming together



Fig. 8: Aggressive and running before mating



Fig. 9: Licking



Fig. 10: Running



Fig. 11: Quacking, Bubbling and sinking



Fig. 12: grooming



Fig. 13: Scared of stranger & sound



Fig. 14: Licking before mating



Fig. 15: mating

The results on the observation of *Anas platyrhynchos* and *Oryctolagus cuniculus* showed that, the behaviours arises out of social attachment. It makes them stay together. In wild they live in large flocks and forage together. Ducks gather in flocks mainly because it offers mutual protection from predators and easy exploitation of foods. Feeding together in flocks provides some safety from predators. They most like to be in the water once the cage is opened without any guidance they directly move to water body ,the movement is always in line by line .They communicate with each other by using voice and various types of actions. A healthy rabbit shows groom it thoroughly several times a day. Before mating female starts to lick on the food plate, gentle run then it made a flattened body posture for mating. They were very closed and comfortable with whom that provides positive experiences. In most of the time ducks were more active in the evening in water line.

DISCUSSION

The observation of animal behaviour were carried out from April to July almost 90 days of observation and recording conducted in 2 rabbits and 4 ducks (Table 1- 8). Noon (In cage) and evening time were selected to collect the information. In most of the time ducks were more active in evening, in water line. The various behaviours that I had observed in water line were preening in different dimensions, they move together, roaming in garden, bowing head (Figure 11) in the water (Figure 7). These type of social (Figure 10) and preening behaviours in water line was more interesting because they used to create an irritated quacking in the cage. Rabbits show more allogrooming (Figure 13) and auto grooming in the nest when they are more comfortable or have positive experience with owner. Observation also was interested to collect the various behaviours that the male and female rabbit show before and during mating such as licking (Figure 9, 14), mounting, flat lying, running (Figure 10)

Pekin duck social and preening behaviours associated with water lines. M. Rice and co-workers of Biology Department, Hope College, Holland, MI South Crossing Veterinary Centre, Caledonia, and MI. They have conducted a study on it, to accomplish that they used video surveillance systems to observe flocks at ages of 7, 21, and 31. These recordings were analyzed for group interactions under water lines as well as preening behaviours and then compared between flooring types. They found that ducks are much more likely to drink, swim and move in groups rather than individually (M. Rice, 2014)

Rabbits will also groom each other when they live in groups and bonded pairs. This is commonly a sign of affection between rabbits. It is a way for one rabbit to show another that they care about their cleanliness and wellbeing, so find bonded rabbits licking each other on the head. Nikolaos Kostomitsopoulos (Biomedical Research Foundation Centre of Experimental Surgery DVM, PhD) to monitor and analyze the behaviour of juvenile and young adult rabbits in order to establish whether there are any age-dependent differences in grooming. 12 NZW rabbits were divided into two groups: group A consisted of six 6-month-old rabbits (young adults) and group B consisted of six 2-month-old rabbits (juvenile). All animals were already housed for more than twenty days under the same conditions in the animal facility. Both groups of rabbits were video-recorded between 06:00h - 18:00h for four consecutive days. The frequency of each behaviour was determined and compared in the two groups of rabbits from the video recordings. They suggested that the frequencies of grooming in the young rabbits were significantly greater than those in the older rabbits. (Nikolaos Kostomitsopoulos 2017)

Jiandui Mi and his companions conducted a research on ducks rely on access to water to facilitate feeding behaviours. Further, wet preening behaviour in ducks relies on access to water and is a key behaviour for duck welfare. The preen gland secretes oil which is crucial for maintaining plumage conditions. A total of one hundred twenty 1-day-old Sanshui White ducks (SSWD) were randomly divided into 2 groups and fed for 6 wk with access to a water pool (WP) or without access to a water pool and provided drinking water only (LWP). The live body weights of ducks from the WP group were significantly increased compared with those of ducks in the LWP group starting from 3 wks of age . Feed intake was increased in the WP group at 2 wk of age and from 4 to 6 wk of age. The feed conversion ratio (FCR) was significantly different only at 4 and 5 wks of age, when the FCR was increased by 5.7% and 9.5%, respectively, in the LWP group compared with the WP group. Lack of access to an open water pool significantly inhibited the growth of the preen gland based on its weight, size, and quantity of oil secretions. In addition, the proportion of ducks exhibiting wet preening behaviour was significantly reduced in the LWP group compared with the WP group This study indicated that a lack of access to an open water source had negative impacts on the development of the preen gland and on the preening behaviour of SSWD. (Jiandui Mi et al., 2020)

Rabbits show more comfortable with human if they had numerous positive interactions with them. Rabbits most of their time spent for grooming and even they groom each other (auto grooming and (allogrooming) during their mating the buck (male) follows the doe (female) around, softly humming while sniffing and licking her for few seconds the receptive female will hop around in circles or flatten to the floor while the pressure is applied to her back

From ninety days of my observation only three times were the mating took place, most of the time female showed aggressiveness, running away from male rabbit, I could say that mating not always possible and successful. Faculty of Agricultural and Environmental Sciences, Kaposvár University, Hungary submitted a paper for that, the experiment conducted with European wild and domesticated rabbit. The aim of the experiment was to investigate the frequency of mating behaviour as well as the lifespan of does depending on their rank order. In most cases the primary position in the rank order was clear. Mating activity was very high after assembling the groups. In addition to male–female mating, some female-female and female-male mounting was also observed, which could lead to pseudo-pregnancy. A second small peak of sexual activity was observed at the end of the hypothetical pseudo-pregnancy. (Zsolt Gerencsér, 2019). From this experiment he proved that natural mating is not effective in group housing system.

CONCLUSION

The three months observation on the behaviours of *Anas platyrhynchos* and *Oryctolagus cuniculus* proved that, ducks are natural water lovers. Ducks need water for swimming to bred and grow well. Ducks can be found to enjoy spending a lot of time on the water in the entire climate. Ducks are social type of bird. Like all other wild ducks the domestic ducks are also gregarious in nature. This behaviour arises out of social attachment. It makes them stay together. In wild they live in large flocks and forage together. Ducks gather in flocks mainly because it offers mutual protection from predators and easy exploitation of foods. Feeding together in flocks provides some safety from predators. They communicate with each other by using voice and various types of actions.

A healthy rabbit shows groom it thoroughly several times a day. Bonded rabbits also often groom each other as a sign of affection and rabbit even "groom" me by licking hands or face. Males chase females as part of "courting", a buck (male) and a doe (female), perform a sort of dance in which the buck chases the doe until she stops, faces the buck and boxes him with her front paws. This goes on until one of the pair leaps straight into the air. The second rabbit also leaps into the air, completing the ritual and signalling that mating can take place.

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