



Insect survey in Arikambedu and its relative abundance based on temperature and humidity

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Abstract

A preliminary study was conducted on the relative abundance of insect diversity with temperature and humidity in Arikambedu village, Thirumullaivoyal, Tamil Nadu. The study was aimed to estimate the insect population and their variation with temperature and humidity. The study was carried out from May 2021 to July 2021. A total of 7,338 insects from 6 orders were identified. Quadrat method, light trap method, sticky trap method and hand picking were adopted for the collection of insects in the present study. Various materials were used for the collection of insects such as sweep net, aquatic net, collection box, Global Positioning System (GPS), camera and data sheets. Hymenopterans were the most dominant and Odonates were the least dominant. The insect population of each insect order contributed as follows, Hymenopterans (41%), Dipterans (33%), Coleopterans (12%), Phasmids (8%), Orthopterans and Lepidopteran (2%) and Odonates (1%). The highest population of insects were recorded in July (41%) followed by May (34%) while June had the lowest population (25%). The start of monsoon could have led to increase in number during the month of July 2021. The insect population was influenced by variation in temperature and humidity. Simpson's reciprocal index diversity was low for all the orders. The diversity of insects was calculated by Shannon- Wiener Index. The values of both the indexes were 0 and 2 respectively which denotes poor diversity of insects in the study area Arikambedu.

Keywords: arikambedu, biodiversity, quadrat method, shannon wiener index, simpson's reciprocal index

Introduction

Insects are the most diverse, wide spread and the only invertebrate group with the ability to fly. Insects come under the phylum Arthropoda which comprises of various other subphyla such as Chelicerata, Crustacea, Hexapoda and Myriapoda. Insects constitute 75% of all living organisms and are the most successful group among animals. They are characterized by chitinous exoskeleton, segmented body (head, thorax and abdomen), three pairs of legs, a pair of antennae and compound eyes. Reproductive potential is higher in insects and are categorized as holometabolous and hemimetabolous in their development based on their pupal and nymphal stages.

Survey is a research method to collect wide information from large samples. Researchers can utilize the different methods based on their needs to understand the research problems. Data collection for biological survey is performed using standardized methods such as line transects, quadrants, camera traps and other trapping methods. Surveys help in accuracy, quick analysis, flexibility and it's easy to perform. But it may be a laborious process in preparation and might be time consuming too. Survey outcomes may vary based on the study and the sample size, were a set of data can be obtained. The data obtained can be used for the implementation of various policies and methodologies. Insect surveys are done to estimate the count of insects in a given area so as to determine ecosystem sustainability from the study. Since insects being a diverse group, the local diversity can also be determined by performing a survey. A survey needs to be carried out in a periodical and systematic way so as to collect data in an appropriate manner. Survey methods can be affected by the cost constraints of a study and thus an ideal and viable method may be adopted for the study. Estimating the

number of insects in a particular ecosystem is needed as insects play a major role in provisioning ecosystem. The role of insects in an ecosystem is of high importance as they help in starting the energy transfer along the trophic levels. They play a key role in pollination as many insects are pollinators and they are closely associated with plants.

Global diversity of insects

Insects are the most successful group of organisms found in almost all kinds of habitat from aquatic to land and have been able to overcome the various pressures exerted on the insect habitat. Insects are found in arid desert regions and in regions of high rainfall. A single species of insect can be found in different geographic conditions. There are more than 1 million species spread across the 30 different orders. Of the 30 orders Lepidopterans, Coleopterans, Dipterans and Hymenopterans dominate the overall insect diversity. Global diversity of insects can be 4 determined by performing global insect assessment by different governing bodies such as Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Insect diversity in India

India is one among the mega diverse nations in the world, and is a home to 18 biosphere reserves which have rich biodiversity and high level of endemism. India has a varied landscape, which ranges from high mountain peaks, deserts, tropical, temperate, evergreen and regions of heavy rainfall. Insects are found in all the geographic conditions that are present in India and have adapted and established themselves in all these geographical conditions. Current estimate indicates that there are around 63,760 species of insects found in India of which 21,166 are endemic. The Western Ghats and Andaman - Nicobar Islands show high level of endemism. (Sankarganesh, 2017) [26].

Insect diversity along the coast of Tamil Nadu

Tamil Nadu being a home to a long coastal line of approximately 1076 kilometers which accounts to 17% of the total coastal line of India, (DADF, 2014) is a home to varied landscape ranging from dry deciduous forest to evergreen forest. The climatic conditions vary from cold to hot humid condition (12°C to 40°C) and insects have established themselves in all these conditions. Tamil Nadu coast has a good number of insect diversity showing an estimate of 929 species of insects falling under various orders. (Balakrishnan and Srinivasan, 2014)^[1].

Study area

Arikambedu is situated in Thirumullaivoyal which is about 20 kms to the western side of Chennai and falls under Tiruvallur district. Thirumullaivoyal was once a home for Champaka forest in the ancient times and later cleared for urbanization. Arikambedu is a diverse village having a good faunal diversity of more than 30 species of birds and 50 species of insects. The area was selected for the present study as there was no previous research work done in Arikambedu area since it showed a good floral and faunal diversity. It is surrounded by Arikambedu lake, Kollumedu lake, Puzhal lake and various other small ponds. The habitat varies from lentic water ecosystem to open grasslands. The climatic conditions in this region vary from 24°C to 36°C, with the annual rainfall of about 1152mm. The area includes few species of flora 5 like *Lantana camara*, *Ixora coccinia*, *Mangifera indica*, *Prosopis juliflora*, *Croton glandulosus*, *Salix purpurea*, *Acalypha indica*, *Randia aculeata*, *Canthium parviflorum*, *Borassus flabellifer*, *Azadirachta indica*, *Cocos nucifera*, *Eucalyptus globulus* and other fruiting trees and shrubs. These plants are home to a number of nesting migratory birds which return to this region annually. The vast open grasslands are a good habitat to a number of insect species such as ants, ground beetles and bugs. The floral transition extends from grass to smaller plants and shrubs which host many butterflies, dragonflies and honey bees. The larger plants are a home to wasp colonies and bee hives. The fruiting plants attract many beetles and ants. The perennial water body is helpful for the reproduction of insects as the water body hosts the egg and the larval stages. The water body also harbours a number of aquatic insects. The presence of good insect density is indicated by the good number of insectivorous birds and raptors. The vegetation alters with season from completely dry vegetation during the summer to greener vegetation after monsoon.

Materials and methods

Quadrat method, light and sticky trap method were adopted for the collection of insects in the present study. Various materials were used for the collection of insects such as sweep net, aquatic net, collection box, Global Positioning System (GPS), camera and data sheets. Sweep nets were used at random places in the various plots by sweeping them across the bushes and on the ground. The insects trapped in the net were collected and were stored in the collection box. Aquatic nets were used to collect aquatic insects such as water bugs. Collection boxes were used to store insects for later identification. The plots were separated with various check points using GPS marker for further study. Data sheets were designed to collect the survey data for further analysis. The insect count was entered as tally marks against

each insect species. Data sheets were prepared with information about the temperature, humidity, date and time. Insects collected and those in the field were photographed using Mobile as well as Nikon DSLR cameras.

Quadrat method/ sweep net

Quadrat sampling (Arun *et al.*, 2017) is a classical ecological tool to study the diversity in a given area. It is a method by which organisms are directly counted in the field by dividing the area into several quadrat plots based on the size of the study area. A quadrat position is randomly selected in a plot and placed along the transect.

The present work is an inventory study of the Arikambedu area (Tamil Nadu, India) as no previous work was performed in the experimental area. The study area was divided into 12 plots. Each plot was examined regularly for 30 days. Surveys were conducted both in the mornings and in the evenings to study the activity of various insects. Insects were caught using sweep net by swaying the net at random places in the plots and the collected insects were stored in the collection box for further identification. Ground dwelling insects were collected with the help of forceps and by handpicking from logs and tapping of leaf litters. Aquatic net was used to collect aquatic insects from water. The insect count was entered in data sheets as tally marks. The collected insects were photographed using mobile camera and the insects were identified based on their morphological features. The morphological features that were taken into consideration for the identification were the elytra, wings, body segments and antennae. Entomological field guides and keys for identification were also referred to identify the insects. The predominant population and the rare population were identified and the activity of the insects in correlation with humidity and temperature were also studied.

Light trap

A light trap was set up using a 25watt LED bulb and a trough of water was placed under the light source. The insects attracted towards the light source were trapped in the water trough. Light traps were operated for 10 hours each night for a period of 15 days. The insects that were trapped in the water trough were removed regularly and identified immediately by studying its morphological features such as its size, wing pattern, structure of the elytra and its body segments. The insect count was entered in the data sheets as tally marks and later compiled using Microsoft Excel. A macro lens was used to examine the insects.

Sticky trap

A sticky trap was set up with a sheet of paper applied with oil as an adhesive. The paper was tied under a light source with the help of a thread to trap nocturnal and diurnal flying insects. The sheet with adhesive was placed on the ground with weights in the corner to prevent the movement of the paper and placed in the corners and near crevices to trap ground dwelling insects. Sticky traps were operated for 10 hours per day for 10 days. The insect count was entered in data sheets and later compiled using Microsoft Excel. The insects were identified with 17 the help of magnifying lens by studying the morphological characters such as the structure of the elytra and wings. Field guides were also referred for identification.

Handpicking

Insects were collected by hand with the help of forceps to transfer them to collection boxes. The insects that were collected were later examined and identified. They were killed using chemical agents. (Nandhini *et al.*, 2014).

Results

Insect survey was carried out for ten days every month over a period of three months in (May – June'21) Arikamedu. Arikamedu was formerly dominated by Champakka forest but at present is a home to open grasslands, ponds, lakes and scrub areas. These varied topographies sustain various flora and fauna. The insect population of Arikamedu predominantly belonged to Hymenoptera, Coleoptera and Diptera. A total of 7,338 individuals were counted and recorded. Of the total reported insects Hymenopterans were 41% followed by Dipterans 33%, Coleopterans 12%, Phasmida 8%, Orthopterans and Lepidopterans 2% and Odonata 1%.

Evaluation of insect population in Arikamedu against temperature

Temperature had an effect on the insect population of Arikamedu. Insect activity was based on the temperature as they were cold blooded organisms and hence the external temperature tends to affect their activity (Kenneth, 1939). Insect population was found to be high during the month of July and low during the month of June. During the month of June water sources had dried up in the region which might have had an effect on the insect population. With the start of rains in July the insect population had a slight increase in number. Temperatures below 26°C were more conducive for insects and temperatures between 32°C - 35°C were not conducive for insect activity. Insect population was found to be the highest during the month of July'21 (41%) followed by May'21 (34%) and with the least population in the month of June'21 (25%). Insect activity was high during the morning hours with temperatures below 26°C. Insect counts were considerably higher during morning surveys compared to the surveys in the evening. Insect activity was high at temperatures about 26°C and dropped as the temperature increased and again the activity increased at 35°C.

Evaluation of insect population in Arikamedu against humidity

Insect activity increased with high atmospheric humidity and decreased with a lower atmospheric humidity since humidity tends to affect the rate of metabolism of the insects (Kenneth, 1936). Humidity levels more than 75% had lower insect activity and less than 75% had the highest insect activity. Humidity was within an average range of 60% to 87%. Since humidity during the three months was similar the activity of the insects throughout the study period was almost alike. During the study period of three months from May - June'21 insects grouped under three major insect orders Hymenoptera, Diptera and Coleoptera were recorded. Dipterans were found to be the highest accounting to 48% followed by Hymenopterans 35% and the lowest were Coleopterans accounting 10% and other orders such as Phasmida, Orthoptera, Coleoptera and Lepidoptera accounted for the remaining 7%.

Evaluation of insect population in Arikamedu using light trap

Light trap attracted insects such as moths, grasshoppers and flies, classified under the orders Diptera, Lepidoptera and Orthoptera. Flies accounted for 55% of the total population followed by 40% of moths and grasshoppers accounted for 5%. The temperature and humidity of the day had an effect on the insect population of the night. Hot and humid days supported more insects and cooler days had lower insect activity during nights (Harding, 1966) [10]. Moths being nocturnal in nature were found to be more active at night and hence were found in more numbers during night than in day surveys. Flies due to their phototrophic nature were attracted towards light and hence were trapped in the light traps.

Evaluation of insect population in Arikamedu using sticky trap

Insects such as grasshoppers, moths and flies were trapped using sticky traps. Moths were trapped in aerial sticky trap and grasshoppers were trapped in ground sticky traps. Moths accounted for 50% followed by flies 45% and grasshoppers 5%, grouped under the orders Diptera, Lepidoptera and Orthoptera respectively. Moths were trapped in the sticky trap attracted towards the light source placed near the trap. Sticky traps were less effective may be due to change in the course of the wind which could have made insects drift away and as a result the entire diversity may not be studied thoroughly (Johnson, 1950) [14].

Insect species diversity in Arikamedu using simpson's diversity index

Simpson's diversity index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increases, so does the diversity (Risser, 1971) [25]. To calculate Simpson's Index for insect diversity, the study area was sampled using quadrats placed randomly or systematically. The 21 number of insect species within each quadrat, as well as the number of individuals of each species was noted. The formula to calculate Simpson's diversity index

$$D = 1/\sum(P_i^2)$$

Where, $P_i = S / N$; S = Number of species; N = Total number of individuals

The Simpson's diversity index is measured in a scale of 0 - 1, where 0 denotes zero diversity and 1 denotes infinite diversity. The Simpson's index of Arikamedu was found to be 0.09 which denotes a very low level of diversity. The abundance of each species was found to be low and certain species dominated the entire population.

Insect species diversity in Arikamedu using shannon-wiener diversity index

Shannon-wiener diversity index is a measure of diversity (Strong, 2016) on scale of 1-10, lower values denote low diversity and higher values denote higher diversity. The species evenness and richness can be identified for a given area. The formula to calculate Shannon- Wiener Diversity index.

$$H = - \sum P_i \ln(P_i)$$

Where, $P_i = S / N$; S = number of species; N = total number of individuals;

ln = logarithm to base

The Shannon- Wiener diversity index of Arikamedu was found to be 2.67 which denotes low diversity and the species evenness was found to be 0.839.

Table 1: Diversity indexes for insect orders collected in Arikamedu - May'21- July'21

S.No.	Order	No. of species	No. of individuals	Simpson's index	Shannon-wiener index
1.	Hymenoptera	6	2393	1	0
2.	Diptera	7	1939	1	0
3.	Lepidoptera	2	147	1	0
4.	Coleoptera	3	721	1	0
5.	Orthoptera	1	156	1	0
6.	Phasmida	2	433	1	0
7.	Odonata	1	7	1	0

Table 2: List of insect fauna collected in Arikamedu - May'21- July'21

S. No	Insects	Collection Method	MAY'21	JUNE'21	JULY'21
1.	Black ant	HC	299	406	317
2.	Red ant	HC	216	148	184
3.	Little black ant	HC	326	11	243
4.	House fly	SN	61	52	59
5.	Blue bottle fly	SN	27	20	18
6.	Dragon fly	SN	22	148	31
7.	Damsel fly	SN	129	11	92
8.	Aphid	SN	69	0	41
9.	Honey bee	SN	94	46	81
10.	Wasp	SN	41	31	38
11.	Leaf hopper	SN	310	0	252
12.	Lispe	HC	387	0	371
13.	Termite	HC	347	218	318
14.	Butterfly	SN	44	57	41
15.	Carpenter bee	SN	9	5	8
16.	Mosquito	SN	15	5	17
17.	Darkling beetle	HC	258	10	221
18.	Mealworm beetle	HC	122	20	85
19.	Jewel bug	HC	5	7	3
20.	Grasshopper	SN/ST/LT	80	0	69
21.	Sick insect	HC	3	7	3
22.	Moth	ST/LT	0	1	5
23.	Six spotted ground beetle	HC	0	0	20
24.	Micronecta	HC	0	0	105

HC- Hand collection, SN- Sweep net, ST- Sticky trap, LT- Light trap

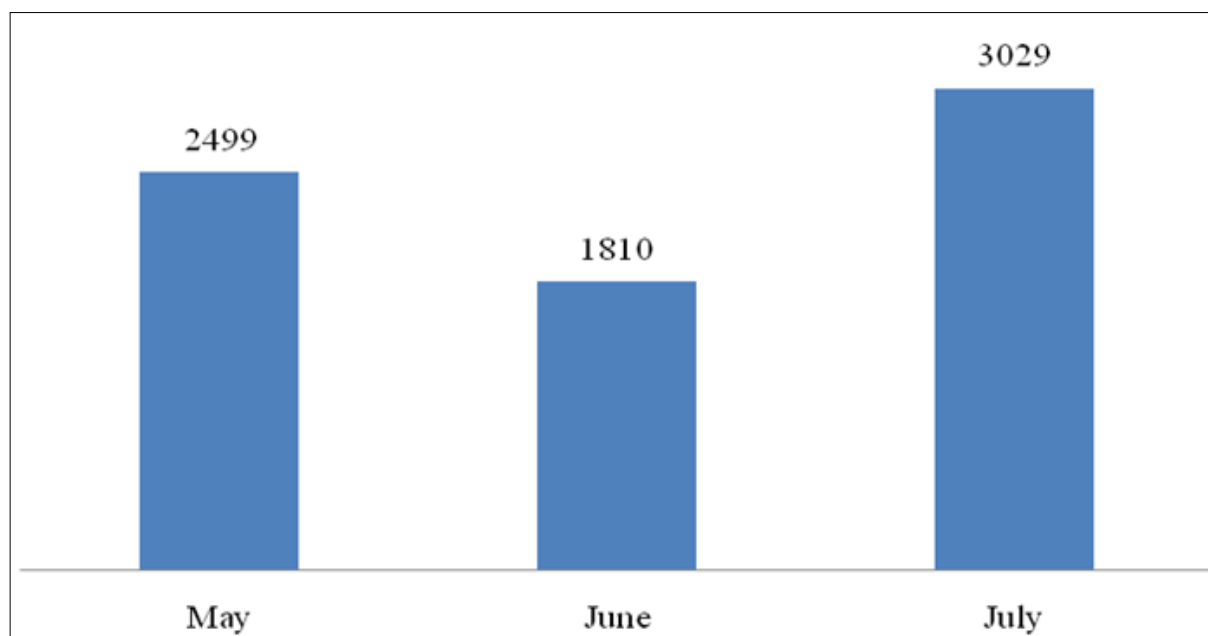


Fig 1: Total number of insects recorded each month during the study period

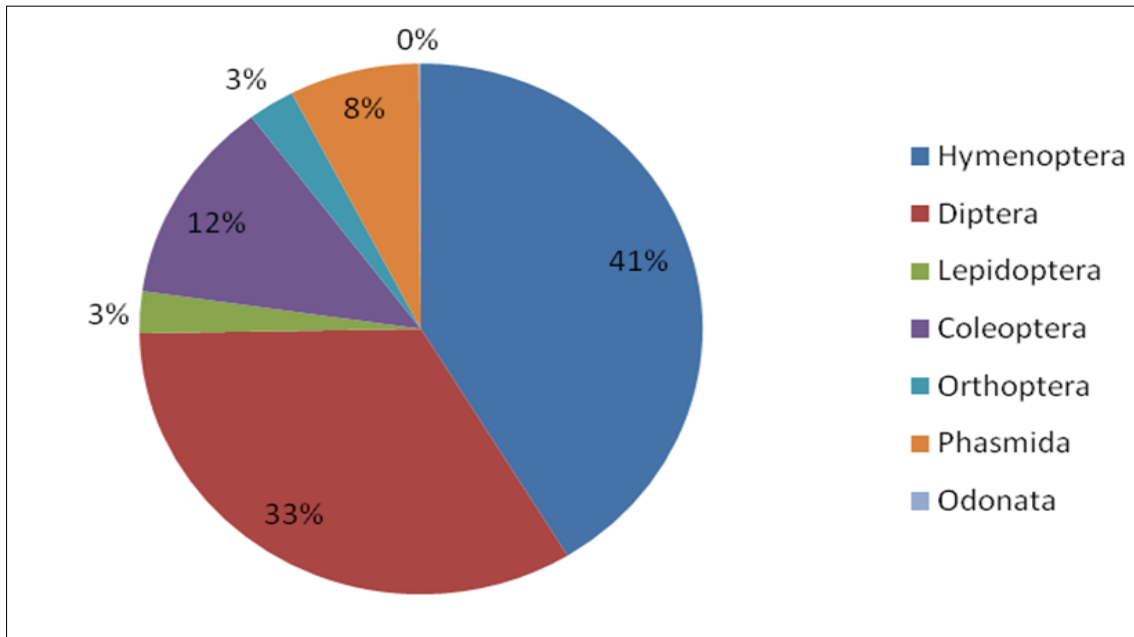


Fig 2: Contribution of insect orders in the total population.

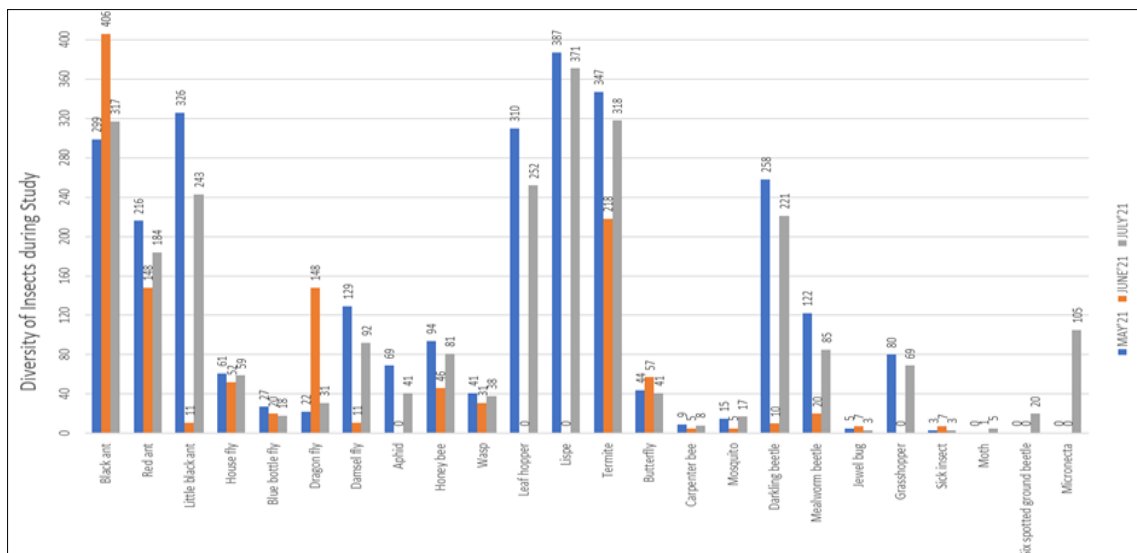


Fig 3: Diversity of insects during Study – May '21 – July '21

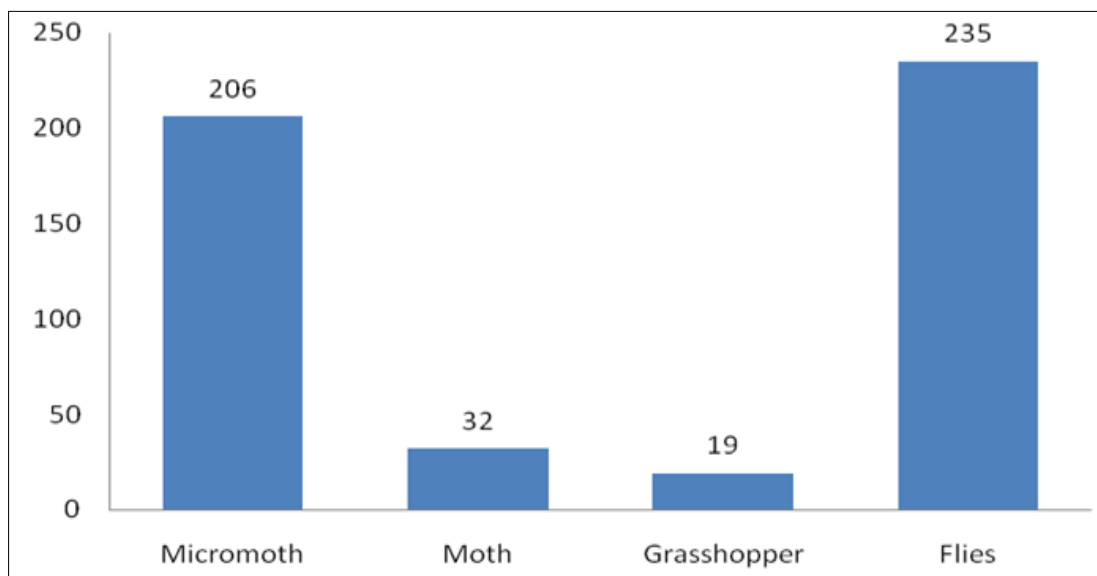


Fig 4: Insect Diversity using light trap

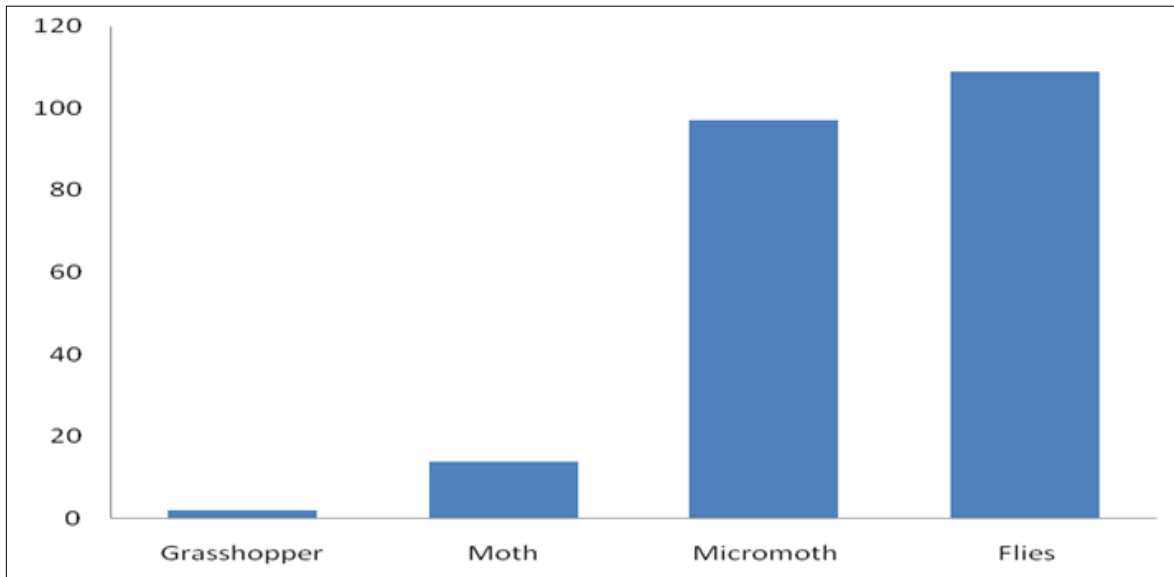


Fig 5: Insects collected through sticky trap

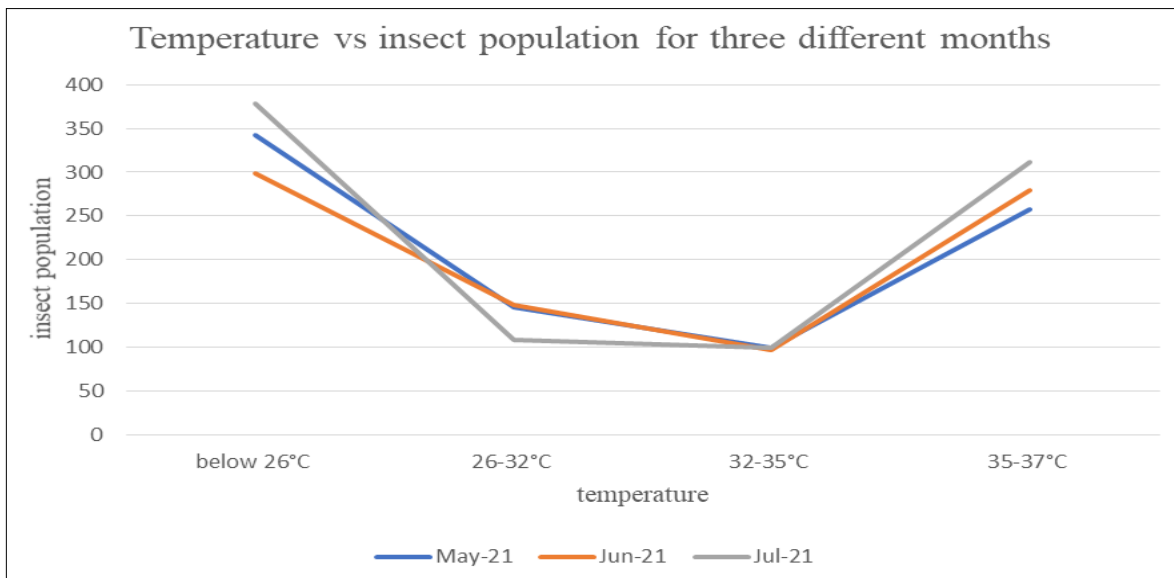


Fig 6: Temperature vs insect population for May '21– July '21

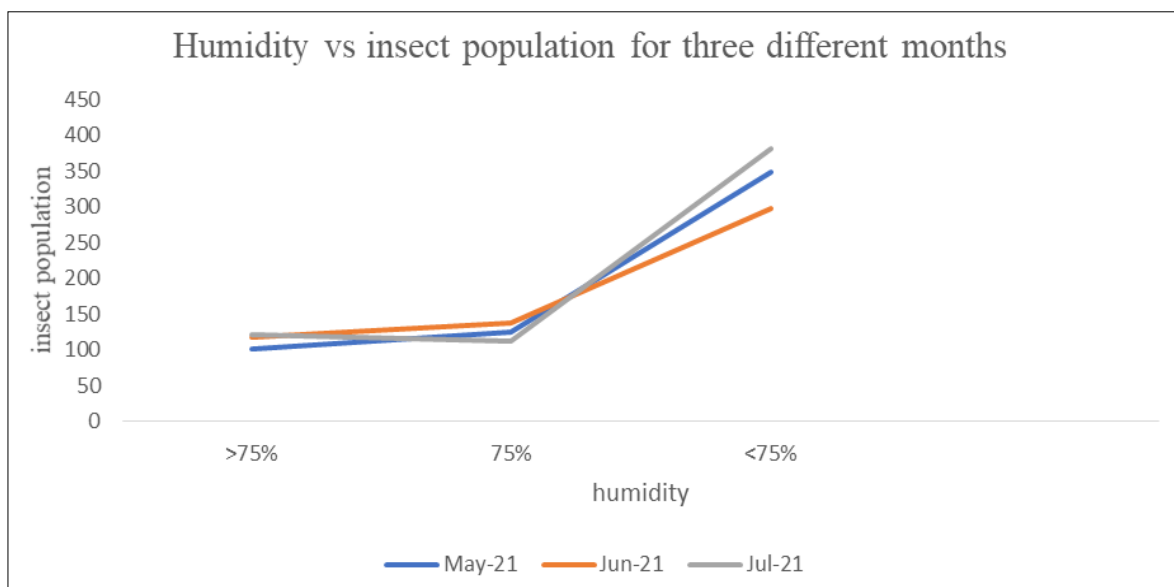


Fig 7: Humidity vs insect population for May '21– July

Discussion

Insect survey was conducted over a three-month period in Arikambedu. An increase in insect population was noted during the month of July'21 and the lowest was during the month of June'21. Hymenoptera, Coleoptera, and Diptera made up the majority of the insect population. There were a total of 7,338 insects (Table 2) counted. Hymenopterans were 41% followed by Diptera 33%, Coleoptera 12%, Phasmida 8%, Orthoptera and Lepidoptera 2% and Odonata 1% (Fig.3). The highest population of insects were recorded in July'21 (41%) followed by May'21 (34%), while June'21 had the lowest population (25%) (Fig.2). The start of monsoon could have lead to increase in number during the month of July'21. The insect population was influenced by the variations in temperature and humidity. Hymenopterans had the largest percentage of 48%, followed by Dipterans with 35%, and Coleopterans with 17%. Lepidopterans and Odonates were found to be in low numbers due to lack of flowering plants as Arikambedu was predominantly covered by non-flowering thorny bushes. The open moist grasslands supported the ants and termite mounds in Arikambedu.

Black carpenter ants were detected to be more in number during May'21 (Fig.4), followed by the red and the small ants, aphids, house flies, blue bottle flies, dragon flies and damselflies, of which the aphids represented 5-15% of the overall population. Mosquitoes were in very low numbers, stick insects, jewel beetles, aphids and honeybees were quite uncommon. The percentage of black carpenter ants were more in June'21 (Fig.4), followed by the red ants, little black ants, and house flies. The numbers of blue bottle flies and dragonflies were found to be minimal. Dipteran diversity was predominantly high due to the presence of good water source and puddles which aid their reproduction that were commonly sighted in Arikambedu. During the study period, July'21 (Fig.4) was the most varied month. The black carpenter ants accounted for 13% of the population, while red ants, little black ants, houseflies, blue bottle flies, and dragon flies made up the remaining 1-7%. Stick insects and gem beetles, on the other hand, were not to be sighted. The majority of the flies were found during night (Fig.7) and made upto 48% of the entire population. Moths and grasshoppers accounted for 42% of the overall population. The flies and moths produced roughly 80% of the insect data from sticky traps (Fig.8) were as moths contributed 15% and grasshoppers contributed 5% of the total count.

Insect activity was highest in the mornings with temperatures below 26°C (Fig.9), according to the three-month temperature data (Williams, 1960) [30]. William studied and identified that insects being cold blooded their metabolic rate was affected by the external temperature and hence warmer temperatures had more insect activity. Morning surveys had significantly greater insect count than evening surveys. There was a drop in the insect activity between 28°C and 35°C, but at about 35°C insect activity began to increase. Humidity levels (Fig.12) more than 75% had lower insect activity and less than 75% had the highest insect activity. Humidity was within an average range of 60% to 87% (Jaworski, 2013) [12]. Jaworski's study revealed that insect activity increased with humidity which was similar to the insect activity in Arikambedu.

The Simpson's and Shannon Diversity index (Table 1) both produced that the insect diversity of Arikambedu was very low. The values of both indexes were 0 and 2 respectively which denotes poor diversity of insects in the study area

Arikambedu. Poor insect diversity could be due to lack of fruiting and flowering vegetation. The open grasslands and water bodies supported Coleopterans, Dipterans and Hymenopterans but Lepidopterans and Orthopterans were less sighted. Lower population of Orthopterans may be due to lack of host plants in Arikambedu as grasshoppers tend to feed on specific host plants. A few species of grasshoppers are polyphagous but certain grasshoppers feed on specific host plants. The non – availability of flowering shrubs could have resulted in rare sighting of honey bees and butterflies. The grasslands supported the ant colonies and other hymenopterans. The presence of more flowering plants and more diverse plant vegetation could have supported more insect diversity and increased the abundance of insect orders such as Lepidoptera, Odonata and Phasmida.

Conclusion

Insect surveys are conducted to measure the number of insects in Arikambedu in order to establish the ecosystem sustainability. As insects are a diverse group, a survey can also be used to determine local diversity. Survey was done using quadrats, light traps, sticky traps, tapping the ground, picking logs and checking leaf litters. A total of 7,338 individuals were counted and recorded. Of the total reported insects, 48% were Dipterans followed by Hymenopterans (35%) and Coleopterans (17%). Black carpenter ants, red ants, little black ants, house flies, blue bottle flies, dragonflies, damselflies, aphids, honeybees, wasps, leafhoppers, lisse, termites, butterflies, carpenter bees, mosquitoes, darkling beetles, meal worm beetles, jewel beetles, grasshoppers, stick insects were commonly found according to the three-month temperature data. Insect activity is highest in the mornings when temperatures are below 26°C. Insect activity was lower at humidity levels greater than 75% and higher at humidity levels less than 75%. The Simpson's diversity index and Shannon-Wiener Index were 0.09 and 2.67 respectively which indicates a very low insect diversity. The species evenness was found to be 0.839. The overall insect diversity of Arikambedu was found to be low during May'21 - July'21.

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