International Journal of Zoology Studies
www.zoologyjournals.com
ISSN: 2455-7269
Received: 17-02-2023, Accepted: 03-03-2023, Published: 18-03-2023
Volume 8, Issue 1, 2023, Page No. 30-37

Insect pests affecting medicinal plants and vegetables in government arts college for men Nandanam, Tamil Nadu: Prevalence, impact, and control

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Abstract
Vegetables are a crucial component of staple foods in many regions around the world. They are an excellent source of vitamins, minerals, and dietary fibers. However, the growth and yield of vegetable crops are severely affected by various lepidopteron pests. This publication provides an overview of lepidopteron pests and the natural bioactive constituents present in vegetable crops. Based on a comprehensive literature review and field research, the investigation reveals that as many as 19 species of lepidopteron, 9 species of Coleopteron, 7 species of Orthopteran, 4 species of Odonata, 5 species of Hymenopteran, 10 species of Araneae and 9 species of Hemipteran pests cause substantial damage to vegetable crops. The aim of this study is to provide current information on lepidopteran pests and ecological bio-control agents in this location. The Shannon index and Simpson index were calculated in the survey. The study is based on earlier efforts to research-based agents such as parasitoids, predators, and pathogens of insect pests of vegetable crops, as revealed by the literature survey. The study will be useful in creating and developing Integrated Pest Control in this region. It highlights the importance of regulation and the use of natural bio-control agents, particularly in research work.

Keywords: vegetable crop, insect identification, Shannon index and Simpson index

Introduction
The word "mini livestock" means "six-legged livestock" and refers not only to insects but also to small organisms, which can be produced for profitability through the sale for consumption by humans or to feed animals (Raquel Guine *et al*., 2020) [32]. In 2015, Yen reported an estimation according to which nearly 92% of edible insect species were collected directly from the wild. Insects are little animals with a length ranging from under 1 mm to 20 cm.

1. Insect identification
Approximately 480 million years ago, during the Ordovician period, insects emerged around the same time as the evolution of the first land plants, according to Misof *et al*. (2014). Insects were the first animals to evolve flight and have dispersed and diversified across most continents and into most niches, from plant chewers to mammal parasites (Condamine Clapham and Kergoat 2016) [13]. The largest of these orders are Lepidoptera (butterflies and moths), Coleoptera (beetles), Hymenoptera (bees, ants, and wasps), and Araneae (spiders).
In the Linnaean method classification, insects are classified as a part of the arthropod phylum. Crabs, lobsters, spiders, mites, centipedes, and millipedes are examples of arthropods. They have an exterior hard skeleton made of the polysaccharide chitin, with jointed legs. Insect arthropods belong to the class Insecta, characterized by the presence of three distinct sections: the head, thorax, and abdomen.

2. To identify insects in the garden & agricultural fields
Taxonomists use a variety of insect traits to identify and describe insects, including wing number, wing shape and venation, antennae structure, legs or tarsi, mouthparts, and internal components such as genitalia. You will undoubtedly become "excellent" at identifying insects in your field with some practice and knowledge of accessible resources.
India is a cultivated country, with agriculture employing over 70% of the people. Plant disease causes a considerable decrease in the quality and quantity of agricultural goods (Hein 2003) [13]. There are two ways in which insect pests can destroy crops, and each one is associated with their feeding habits. In the first type, the plant is affected by being bit and chewed by the insect pest. The second type of damage was caused by draining plant sap from the phloem system (Sorensen 1995) [35].
Imam, Yusuf, and Mukhtar (2010) [18] assess the diversity of insects that eat common vegetables to rate and estimate their impact on food quality and abundance in the research area. Many moth and butterfly species, including the gypsy moth *Lymantria dispar*, the codling moth *Cydia pomonella*, and the diamondback moth *Plutella xylostella*, are known to cause considerable yield losses in a variety of crops around the world (Bradshaw *et al*., 2016: Gautam, *et al*.,2018) [4, 10]. When populations are well developed, these insects can ovipositor a great number of eggs, and the larval stages feed voraciously, causing direct defoliation, and resulting in massive losses. Wen *et al*. (2015) [39] employed a sufficient combination of shape, color, texture, and numerical data retrieved for moth description to identify species based on photographs.
Sucking bugs are one of the most important contributors to producing losses in greenhouses. When crops are cultivated in congested conditions in closed spaces, thrips, aphids, and whiteflies are known as some of the most problematic pests. Sticky traps are commonly used in greenhouses to monitor the populations of these pests. Because of their size, complex morphology, and a low-efficiency score of weary or untrained human observers,

this method can be regarded as a difficult assignment for non-specialized specialists (Xia, *et al*., 2015) [40].
The present investigation to analyses the various insect larva, bugs, and beetle infestations against vegetable crops and medicinal plants. In addition to learning more information and the biological activities of larvae, bugs, and beetles.

Material and methods

From June 2020 to June 2021, field surveys were conducted based on random sampling in our college to establish which insect pests caused harm to crops. Immature forms of eggs, larvae, pupae, and adults were collected and delivered to the laboratory from a vegetable crop garden.

Fig 1: Schematic representative of insect identification

1. Tools to aid in identification

Hand lens: assists in the identification of small insects and arthropods such as thrips, bugs, and mites.

Hand net: assists in identifying small arthropods such as butterflies and dragonflies.

Microscope: useful for clear identification of minute insects

Reference book: To learn about the insect in detail for further research.

Digital camera: to photograph and record

Small alcohol jars: to preserve specimens before taking them off for identification.

2. Study area

A survey was conducted in our college's vegetable and medicinal plant garden during the period from June 2020 - June 2021. This field survey accompanied to notice of several major insect pests damaging various vegetable crops in Government Arts College for men's, Nandanam - Tamil Nadu.13.0305Nº, 80.2393Eº-3500Sqfeet. In the above-mentioned study medicinal garden, vegetable gardens, and kitchen gardens were surveyed. Three fields were chosen at random from the site, and the sampling approach followed established sampling techniques. In a field record, data on lepidopteron, Coleoptera, Hemiptera, Hymenoptera, Orthoptera, Odonata, and Araneae pests, their host plant, nature and amount of damage, predators (natural enemies) hunting on pest larvae, were collected.

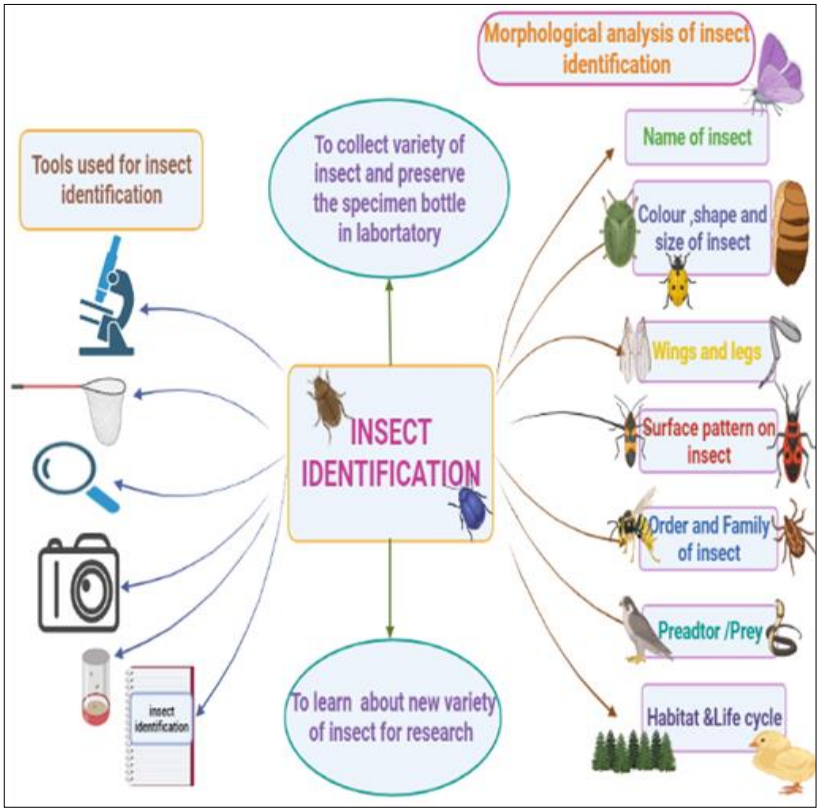

Fig 2: Tools of insect identification

Results

During the study of investigation, more than 63 insect pest species, distributed over seven insect orders(Lepidoptera, Coleoptera, Hemiptera, Orthoptera, Odonata, Araneae, and Hymenoptera)belonging to 32 families(Acrididae, Aeshnidae, Arctiidae, Attelabidae, Apidae, Chrysomelidae, Coccinellidae, Coenagrionidae, Crambidae, Curculionidae, Erebidae, Geometridae, Gryllidae, Ichneumonidae, Libellulidae, Membracidae, Nymphalidae, Noctuidae, Notodontidae, Oxyopidae, Papilionidae, Pentatomidae, Pholcidae, Plutellidae, Pseudococcidae, Reduviidae, Salticidae, Scarabaeidae, Scutelleridae, Tenthredinidae, Tettigoniidae, and Vespidae) found to attack host vegetable crops.

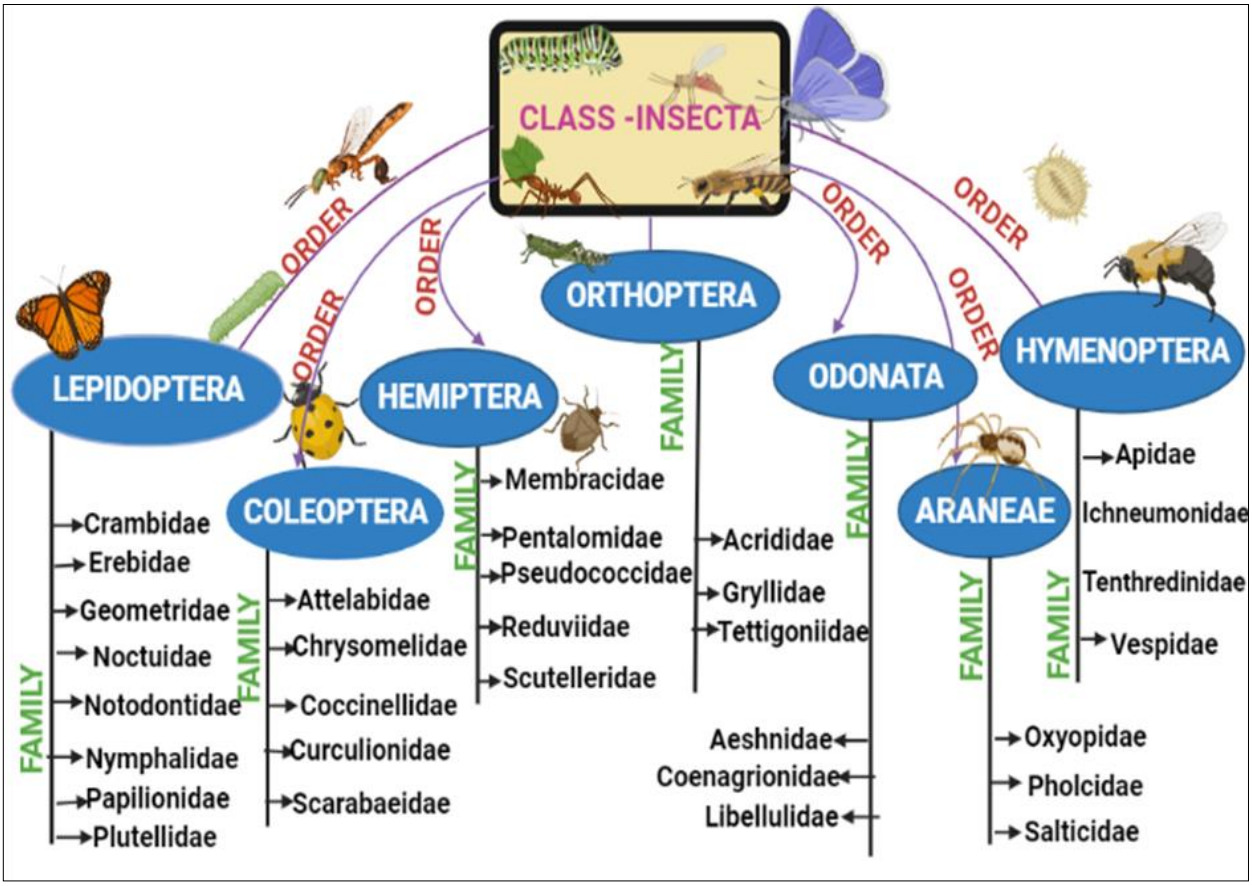

Fig 3: Illustrare the orders and families of insects

Biodiversity index

The biodiversity index describes the species diversity in a given area. Calculating a basic biodiversity index is done as follows:

$$= \frac{\text{Number of species in the area}}{\text{Total of individuals present in the area}}$$

$$= \frac{63}{1000 \text{ Approx.}} \quad = 0.063$$

Shannon index and Simpson index

Simpson's index Ds and Shannon's index H' are two regularly used indexes to measure biodiversity. The similarity index in Simpson's index DS (the higher the value the lower in diversity). While the Shannon index places less emphasis on dominating species and instead combines evenness and richness.

In the ecological literature, the Shannon index also referred to as Shannon's diversity index, Shannon-Wiener index, Shannon-Weaver index, and Shannon entropy has been a well-liked diversity index. The concept of the measure was first put forth by Claude Shannon to quantify the entropy (uncertainty or information content) in text strings (Primack). The Shannon entropy calculates the amount of entropy or surprise connected to this forecast. It is frequently determined as shown below (Hill *et al*., 2005) [14]. The Simpson index is a dominance measure since it favors common or dominant species. In this instance, a few rare species with a small number of representatives won't have an impact on the diversity.

$$\text{Shannon Index (H)} = -\sum_{i=0}^{s} P_i \ln P_i$$

In the Shannon index, P is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), The terms ln and s stand for the natural log, computation sum, and number of species, respectively.

$$\text{Simpson Index (D)} = \frac{1}{\sum_{i=0}^{s} P_i^2}$$

In the Simpson index, P is the sum of the calculations, is still the number of calculations, and s is the number of species. P is the proportion (n/N) of individuals of one specific species identified (n) divided by the total amount of individuals found (N).

Table 1: Survey total number of species collected in Government Arts College, Nandanam, and Chennai

Orders	Number of Individuals	n/N	P	P**2	Ln P	PLnP
Lepidoptera	19	19/63	0.301587	0.090955	-1.1987	-0.36151
Coleoptera	9	9/63	0.142857	0.020408	-1.9459	-0.27799
Hemiptera	9	9/63	0.142857	0.020408	-1.9459	-0.27799
Orthoptera	10	10/63	0.15873	0.025195	-1.8405	-0.29214
Odonata	7	7/63	0.111111	0.012346	-2.1972	-0.24413
Araneae	4	4/63	0.063492	0.004031	-2.7568	-0.17503
Hymenoptera	5	5/63	0.079365	0.006299	-2.5337	-0.20109
Total	63		1	0.179642	-14.4187	-1.82988

s (number of species) =	63
N (total number of individuals) =	7
Σ (sum) of pi ^2 (n/N)^2=	0.179642
Σ (sum) of pi ln pi =	-1.82988
Shannon index(H)=	1.82988
Simpson index(D)=	158.76

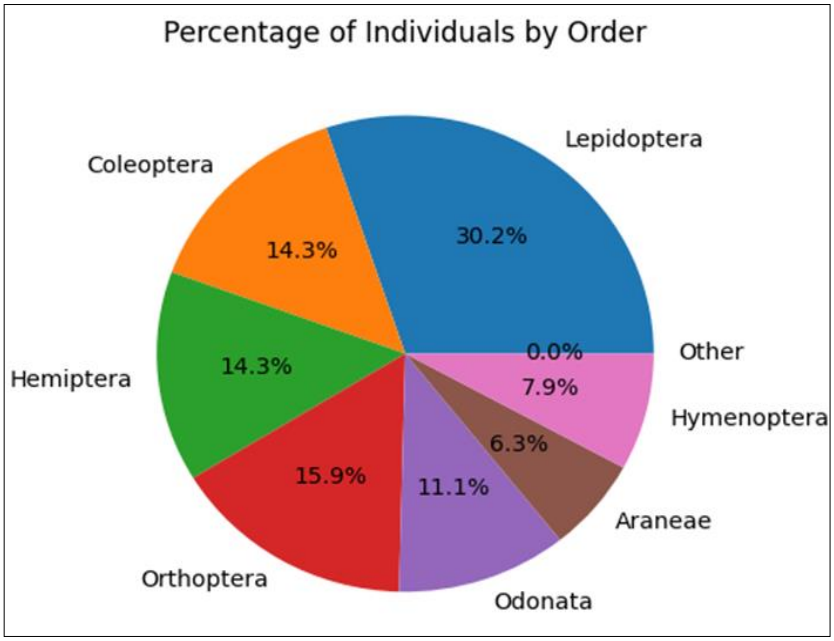

Fig 4: Survey total number of species collected in Government Arts College, Nandanam, and Chennai

Order I-Lepidopter

The word Lepidoptera is derived from the Greek term, wings, and scales. It is considered a sign of beauty and grace in nature. (Boggs *et al*., 2003) [3]. It is the second-largest and most diversified order of insects in the phylum Arthropoda. There are 126 families and 46 superfamilies. They can be distinguished based on morphological, anatomical, behavioral, and ecological traits (Miller and Hammond 2003) [24]. Additionally, 500 Lepidoptera species are described, with 70,820 butterfly species (Sutton & Sutton, 1999) and 3700 skipper species worldwide. Lepidopterans are excellent for educating people about environmental issues and raising awareness.

Table 2. Represented the lepidopteron species

Scientific name	Common name	Flight season	Natural foe	References
Anadevidiapeponis (Fabricius, 1775)	Cucumber looper	June to December	Parasite- *Brachymeria lasus*; Pathogen-*Gibberella fujikuroi*	Muddasar and Singhamahapatra 2022
Leucinodes orbonalis (Guenee, 1854)	Eggplant fruit borer	mid-September	Pathogen-*Baculo virus, Bacillus thuringiensis kurstaki*	Onekutu *et al*.,2013
Orgyia leucostigma (J.E. Smith, 1797)	White marked tussock moth	April to June	Parasite-*Royas lymantriae,* Pathogen- *Entomophaga aulicae*	Foltz. 2006
Plutella xylostella (Linnaeus 1758)	Diamondback moth	April to August	Parasite-*Cotesia plutellae*; Pathogen-*Beauveria brongniarti*	Philips *et al*., 2014,
Spodoptera litura (Fabricius 1775)	Tobacco cutworms	June to August	Parasite -*Zele chloraphthalama*	Meagher *et al*., 2008

Order II & III –Coleoptera

The name Coleoptera describes the protective covers of the membranous hind wings and is derived from Greek. With over 350,000 known species in 115 families, it is the largest order of insects. There are about 30,000 identified species of beetles in the United States (Arnett 1968). Many beetles are predators. Numerous beetles are thought to be significant pests of agricultural plants and stored goods. Scavengers and wood-boring beetles are helpful as organic nutrient recyclers and decomposer.

Table 3: Represented the Coleoptera species

Scientific name	Common name	Flight season	Mode of saturation	References
Apoderus longicollis(Jekel, 1860)	Leaf rolling weevil	May- to June	Suck the sap from the plants.	Myers *et al*., 2022
Aulacophora fermoralis (Chevrolat 1860)	Red melon beetle	January-February	feed on the foliage and flowers of the plants	Muhammad Aamir Rashid *et al*., 2014
Epilachna varivestis (Mulsnat 1850)	Mexican bean beetle	October-November	Feed on the parenchyma of the leaves	Hontiveros 2012
Zygogramma bicolorata (Pallister 1953)	Parthenium beetle	November-December	External feeding and suck the plant	Gupta, *et al*., 2004

Order II & III –Coleoptera

The term Hemiptera indicates "half wings." With over 82.000 known species, it is the sixth biggest category of insects (Grimaldi and Engel 2005; Cameron *et al*. 2006) and the most varied group of non-endopterygote insects (Arnett 2000) [1]. Many of them are significant crop pest species, some of which include significant disease vectors for humans. Hemiptera has a rostrum that resembles a beak that aids sucking and piercing. Some species can recognize changes in water quality and destroy mosquito larvae in ponds and rivers.

One of the well-built orders in the class of arthropods is the Araneae. According to the 2017 World Spider Catalog, there are around 46,879 species of spiders over 3967 genera and 114 families, and approximately 1686 species of spiders from India, distributed throughout 438 genera and 60 families (Keswani *et al*., 2012).

Table 4: Represented the Hemiptera and Araneae species

Scientific name	Common name	Flight season	Natural foe	References
Chrysocoris stollii (Wolff 1801)	Green jewel bug	March-May	*Trichopoda pennipes*	Parveen and Gaur 2015.
Eysarcoris guttiger (Hahn 1834)	Two spots sesame bug	July -August	Parasite-*Telenomus triptur*	Berhe *et al*., 2008.
Publilia concave (Rafinesque 1815)	Aster tree hopper	May-June	Parasite-*Tricho grammatidae*; Predator-ant	Laura Alexandra Laiton Jimenez *et al*., 2020
Araneae species				
Oxyopes salticus (Hentz 1845)	striped lynx spider	June- August	Parasite-*Podisus maculiventris*,	Nyffeler *et al*., 1987;
Phidippus arizonensis (Peckham &Peckham 1883)	Jumping spider	April-July	Parasite-*Corcyra cephalonica*, and *Nezara viridula*	Edwards 2004
Plexippus paykulli (Audouin 1826)	Pan tropical jumping spiders	Winter seasons	*Corcyra cephalonica*, *Recilia dorsalis* and *Pyrilla perpusilla*	Chaubey, and Yadav 2017

Order V, VI, VIII- Orthoptera, Odonata& Hymenoptera

The grasshoppers, katydids, and crickets are all Orthoptera. The word of the order denotes straight (ortho) wings (ptera). One of the largest orders of insects, Orthoptera, is known to have 22,500 species globally.

One of the oldest amphibious insect orders is Odonata, which includes damselflies and dragonflies, about 250 million centuries. Around the world, 6338 species and 693 genera of odonates have been observed (Schorr and Paulson 2020), of which 496 species, 27 subspecies, 154 genera, and 18 families were identified to be originating from India (Subramanian and Babu 2020; Bedjani *et al*., 2020; Payra *et al*., 2020) [2, 36].

The name "Hymenoptera" comes from the Greek words "hymen," which means membrane, and "petra," which means wings. Hymenoptera is one of the four major insect orders of more than 100,000 species worldwide (Huber 1993). The number of described species in the Hymenoptera order is roughly 115,000, and authors have calculated that there are likely up to 1,000,000 species of Hymenoptera.

Table 5: Represented the Orthoptera, Odonata, and Hymenoptera species.

Scientific name	Common name	Flight season	Natural foe	References
Abracris flavolineata(De Geer 1773) [22]	Short-horned grasshopper	May-August	*Elephantopus mollis*	Mariana Bozina Pine *etal*., 2017
Dichromorpha viridis (Scudder 1863)	Short-winged green grasshopper	July-September	Not known	Hojun Song *et al*., 2018
Odonata				
Ischnura heterosticta (Burmeister 1872)	Blue-tailed damselfly	October-March	*Cricotopus bicinctus*	Karin and Marcel 2016
Tramea lacerata (Hagen 1861	Black saddle bags	July-early October	*Ctenopharyngodon idella*	Logan 1967
Hymenoptera				
Ropalidia fasciata (Fabricius 1804)	Paper wasp	April - November	Parasite-*Arthula formosana*	Yosiaki and Eiiti kasuya.2005
Xylocopa virginica (Linnaeus 1771*)*	Carpenter bee	July- August	*Xenox tigrinus* and *Dysmicoccus brevipes*	Warriner, Michael. 2010

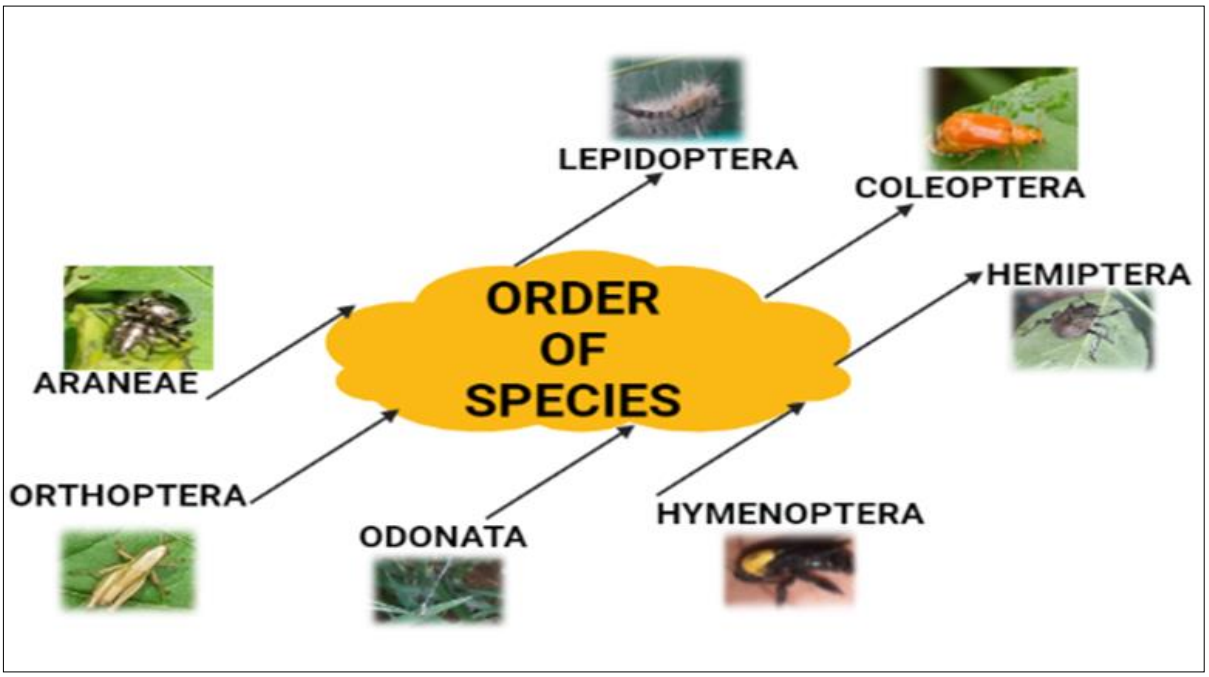

Fig 5: Shows various orders of species.

Discussion

Arthropods have withstood the Permian and Cretaceous major extinctions that have been around for upwards of 400 million years (Kim, 1993). Insects have excelled in terms of species richness and abundance, and terrestrial arthropods and insects are regarded to be the primary forces behind species richness (Stork *et al*., 2015, Samways, 1993).

Insects represent several diverse trophic niches as well as a broad range of ecological activities in their natural habitats, notably herbivory, carnivory, and detritus eating. They are the primary form of animal biomass and life on Earth. The functional significance of insects is tremendous, and the ecological systems they provide are crucial, due to their abundance and wide intra- and interspecific variation. They are effective participant in various ecosystems (Samways, 1993). Since most people view insects as pests or potential pests, their ecological significance are frequently overlooked. Insects play a key role in ecosystem via ecosystem cycle, pollination, predation/parasitism, and decomposition.

Insects play a crucial function in the environment. Insect domination in the ecosphere establishes the ecological framework for all terrestrial ecosystems. They maintain soil structure and fertility, pollinate plants, spread seeds, cycle nutrients, regulate the densities of other species, and provide a significant food source for other taxa (Foottit and Adler, 2017).

The methodology and scientific state of the art of using sensors for autonomous detection and monitoring of insect pests were examined by Matheus Cardim Ferreira Lima et *al*. (2020). The study focuses on infrared sensors, audio sensors, and image-based classification algorithms for pest identification, presenting the many systems available, examples of applications, and new advances, such as machine learning and the Internet of things. Automatic traps and decision assistance systems' future trends are also highlighted. This article discusses the current state of insects, including their taxonomic status, worth, and dangers to their survival.

Recent studies have revealed an alarming loss in insect species, flying insects to be more specific, in the northern temperate zone, which has sparked widespread media coverage. Agricultural intensification, urbanization, pesticide abuse, and global climate change have contributed to some reduction. A reduction would have a significant impact on the ecosystem services provided by insects. However, there is insufficient evidence to believe that all insects are disappearing globally. In the context of a changing world, more basic study on insect diversity is urgently needed (Paul Eggleton 2020).

Deen Mohamad Bhat, Bhagat, and Ajaz Qureshi (2011) conducted a five-year survey for the vegetable crop in Kashmir valley. The survey revealed that many vegetable crops in the three districts are infected by variety of insects in the Kashmir valley.

These investigations have highlighted the fact that insects have a considerable impact on plant investment in bioactive molecules and architecture, as well as on the kinetics of mineralization and the availability of phosphate and nitrogen, even when their abundances are modest. It has been demonstrated that insect herbivory boosts plant yield and nutrient cycling in grasslands (Belovsky and Slade, 2000).

These findings collectively imply that the indirect effects of insects on ecosystems are more significant; for instance, selective herbivory, and pollination can significantly change the composition of vegetation types. Insects play a major role in pollination. Insects pollinate 84 percent of the world's food crops, accounting for one-third of the world's food output (Allsopp *et al*., 2008).

Conclusion

In conclusion, in this survey new varieties of host insects, their life cycle, and their mode of nutrition have been observed and analysed for 365 days. This survey helps to learn more about the various insects around us in our environment. Numerous studies have revealed that insect standing crop is rather small concerning plant and vertebrate biomass and that they account for less than 10%

of net primary productivity in most ecosystems, notably forests.

Acknowledgement
The authors are highly thankful for Research supervisor and Head of the Department of Zoology for providing the necessary laboratory facilities during the course of this work.

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