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Chapter [18]

Insect's diversification and their conservation strategies

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Abstract

In planet Earth, insects are the most dominant diverse and important group. The terrestrial diversity of insect is large as compare to insect live in other habitat. Insects possess an amazing diversity in morphological characters as well as in genetic diversity that's helps in survival in different environmental conditions. The great insect diversity is indeed an intrinsic part of the Earth's ecosystem and they are what make the ecosystem. Thus, the diversity and ecological importance of insects make them very valuable for studies of biodiversity. Similarly, Insects have great potential for understanding ecosystem and to measure the ecosystem health but the limited knowledge and resources increase the difficulty of work on insect biodiversity The conservation of insect biodiversity is very important for the investigation of relation between climatic factors and insect diversity with respect to impact of human as well as increasing globalization. The limited research study on global insect diversity is harmful in advance study and research field with respect to advance evolutionary insect ecology. This book chapter explores the conservation of various species with their diversity. It includes assessments of insect's population as compare to bio-ecology changes.

Keywords Conservation, Community ecology, Evolution, Insect, Species abundance

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Introduction

Insects are the most dominant creatures of earth and they help in pollination, seed dispersal, maintain soil fertility, control population of other organisms and play an important role in foundation of ecosystem. Some insects are beneficial and some are referred as pests, others are beneficial to human being. About 80 to 95% of insect species were identified and approximate 30 million insect species found in tropical region (Stork, 2007). Insects are evolved at the time of Devonian period (200 million years ago) and it is the largest class in animal kingdom consist 29 orders. First they appeared in the Ordovician period, approximately 480 million years ago (Singh and Sidhu, 2015). However, most of the species of insects are unknown about their behaviour that causes the insect diversity i.e. faced with habitat degradation, species extinction and a decline in the natural enemies of harmful pests and these problems are due to the expansion of agriculture, urbanization, industrialization, pollution, mining, tourism, introduced species, hunting and the illegal trade in endangered species. The great insect diversity is indeed an intrinsic part of the Earth's ecosystem and they are what make the ecosystem (Samways, 1994). Thus, the diversity and ecological importance of insects make them very valuable for studies of biodiversity. Similarly, Insects have great potential for understanding ecosystem and to measure the ecosystem health but the limited knowledge and resources increase the difficulty of work on insect biodiversity (Danks, 1996). The functional significance of insects are enormous, owing to the large number of individuals and great intra-and interspecific variety as well as insects play a key role in providing numerous irreplaceable services, many of which are critical to human survival and wellbeing. Yet, most insects are non-charismatic at best and perceived as pests at worst. As such, they receive little attention, attracting few resources for monitoring and conservation (Krause and Robinson, 2017). Lack of human appreciation coupled with the general disregard and dislike of insects, is an enormous perception impediment to their conservation. This impediment coupled with the taxonomic impediment, must be overcome for realistic biodiversity conservation. As it is not possible to know all the species relative to the rate at which they are becoming extinct, it is essential to conserve many biotopes and landscapes as possible. These would be for typical species and communities, as well as for endemic sinks. Currently insect conservation has a foothold in six interconnected themes such as philosophy, research, psychology, practice, validation and policy, the latter of which makes the framework for action (Samways, 2018). A common challenge in insect species conservation and management is to manage species belonging to various orders particularly in relation to life-cycle interventions. Only about 7700 species having been evaluated for the Red List and only 1% of insect species were described (Cardoso *et al*., 2011; Foottit and Adler, 2017).

Nevertheless, species management may be a tool to be explored further in insect conservation. It is also essential to preserve species dynamo areas as insurance for future biodiversity of insect. The preserved areas of insects must also be linked by movement and gene-flow corridors as much as possible. However, insect biodiversity faces the same ecological threats as all other biodiversity (Hook, 1997). Insects are covered under many international conventions, including the pivotal Convention on Biological Diversity. Insects are also being included in many National Biodiversity Action Plans and

Agri-Environment Schemes. This goes hand in hand with raising public awareness of the plight of insects (Samways, 1994). Ecological restoration involves so many biotic and abiotic interactions in even the simplest of communities, that productiveness under all potential conditions is virtually unattainable. Instead, there should be strong focus on the preservation and conservation of as many and as large as possible, pristine and near-pristine unique and typical landscapes as soon as possible.

The book chapter explores the wide variety in types, number of insect species and their evolutionary relationships. Insect's biodiversity help to meet the needs of rapidly expanding human population and also examine the consequences that increased loss of insect species in the world.

Insects and their importance for ecosystem

Insects and related arthropods structure is quite 50 percent of the known animal diversity. Over the last 400 million years, the amounts of insect families have been steadily rising. There are 1.4 millions species of insects described in the scientific literature which is 80% of life currently recorded on earth. The estimation indicates that there may be as many as 30-50 million species of insects. This perceives terrestrial orthopaedical groups which is 97% of global diversity (Erwin, 1982; Kulshrestha and Jain, 2016). The world of insects is amazing and diverse. No other group of animals has developed such an enormous array of species. We encounter them within the widest range of shapes and sizes. They may be as big as your hand or microscopically small. All of them have three pairs of legs. Hence the scientific name "Hexapod" or "six feet", the zoological subphylum that covers insects along with a few other, less-common creatures. The description of insects and their colourful body patterns have initiated prominent contributions to our art, literature, culture and offer great educational tools (Pyle and Opler, 1981). Insects are often confused with other creepy-crawlies, such as mites, ticks and woodlice. The same is true of centipedes and millipedes, although their names ("hundred" or "thousand feet") indicate that they cannot possibly be insects. Spiders are also sometimes lumped together with insects though they neither have eight legs nor are crabs, which have ten legs (including a pair of pincers), counted as hexapods. Apart from all having six legs, insects have various other features in common. Their bodies consist of three segments are the head with the mouth parts and thousands of individual lenses clustered into compound eyes, the thorax that bears three pairs of legs and in flying insects, the wings and the abdomen, which houses the digestive and they have reproductive parts on their abdomens (Snodgrass, 1935; Gullan and Cranston, 2020). Insects have no skeleton and their bodies are encased within a thin, horny layer of chitin that protect them from water and give their body stability along with flexibility. Insects don't have lungs, they breathe via a system of tubes and sacs referred to as trachea that run throughout the entire body (Snodgrass, 1935; Gullan and Cranston, 2020). Insects pass through several stages of development, some of which may make completely different demands on their habitat – both in terms of their structure, features, and interrelationship and in their food sources. Most insects lay eggs that hatch and pass through several larval stages, perhaps along with a pupal stage (Snodgrass, 1935).

Some types of insects including dragonflies, crickets and bugs do not undergo a pupal stages such as bumblebees, butterflies and beetles must pupate to produce an adult (Snodgrass, 1935).Within this general plan there's an outsized amount of variation and that they are inter alia, predators, herbivores, decomposers, and parasites representing a wider range of life histories than the vertebrates.

Insects pollinate flowers and they help in reproduction in majority of plants such as *Apis meliffera* L. (European honey bee) is liable for the pollination services in majority of crops (Getanjaly *et al*., 2015). Non-Apis bees are also important pollinators of crops, examples of managed non-Apis species include bumble bees, *Bombus impatiens Cresson* (Hymenoptera: Apidae) managed for cranberry (*Vaccinium* spp.) and greenhouse tomato (*Solanum lycopersicum* L.). Bees are considered the foremost effective insect-pollinator of most plant species but other insects are recognized for his or her contribution to pollination such as flower visiting flies (Diptera) are pollinators of several crops including carrot (*Dacus carota* L.), mustard (*Brassica* spp.), leek, (*Allium ampeloprasum* L.), almond (*Prunis dulcis*) and weevil *Elaeidobius kamerunicus* (Coleoptera: Curculionidae) play great role in pollination of Oil palm (Getanjaly *et al*., 2015). in temperate region about two third of all the plant species depend on insects for pollination and the most important pollinators are bees, beetles, butterflies and flies. There are many insects found on agriculture land which are not threat to the crop production but beneficial to the farmers in different aspects as natural enemies, pollinators, productive insects, scavengers, weed killer and soil builders (Schoonhoven *et al*, (2005). Beneficial insects provide regulating ecosystem services to agriculture like pollination and therefore the natural regulation of plant pests (Getanjaly *et al*., 2015). Similarly, insects in terrestrial ecosystem plays specific role such as nutrient cycling, seed dispersal, bioturbation, pollination and pest control (Jankielsohn, 2018).

In the insect orders Odonata (dragon flies) and Neuroptera (lacewings and ant lions) all the insect species are predators while an outsized percentage of species within the orders Hemiptera (bugs), Coleoptera (beetles), Diptera (flies) and Hymenoptera (wasps, bees and ants) are predators, either as larvae or in both larval and adult stages (Table 1). The biodiversity of insects found in natural ecosystem plays an important role in sustainable agricultural production and food security (Jankielsohn, 2018).There are various parisitoids in the order Hymenoptera that parasitizes adults, larvae or eggs of other insects. For instance, *Aphytis lingnanensis* parasitizes scale insects, *Aphelinus asychis*, *Aphelinus varipes*, *Diaeretiella rapae*, *Aphidius colemani*, *Aphidius matricariae* and *Aphidius ervi* parasitizes cereal aphids and Trichogramma parasitic wasps attack Lepidopteran eggs (Getanjaly *et al*., 2015). Herbivorous insects with the potential of becoming pests are under natural control by insect predators and parasitoids (Van-Lenteren, 2012; Jankielsohn, 2018). Biotic communities are vital for providing ecological functions and ecosystem services (Naeem *et al*., 2012). As a dominant sort of animal biomass and life on earth, insects represent many various tropic niches and a good range of ecological functions in their natural ecosystem including herbivores, carnivores and detritus feeding.

Table 1. List of Beneficial insect or invertebrate (Getanjaly *et al*., 2015)

Group	Beneficial insect or invertebrate	Pest attacked
Beetles	Red and Blue beetles (*Dicranolaius bellulus*) Green carab beetles (*Calosoma schayeri*) Green soldier beetles (*Chauliognathus pulchellus*)	Aphids, mites, thrips, mealy bugs, moth eggs including *Heliothis* spp. and larvae.
Bugs	Bigeyed bugs (*Geocoris lubra*) Brown smudge bugs (*Deraeocoris signatus*) Damsel bugs (*Nabis kingbergii*), Glossy shield bug (*Cermatulus nasalis*) Pirate bug (*Orius spp.*) Apple dimple bug (*Campylomma liebknectic*) Spined predatory shield bug (*Oechalia*) Broken backed bug (*Taylorilygus pallidulus*)	Aphids, Diamondblack moth, eggs of and larvae of *Heliothis* spp., cut-worms (*Spodoptera litura*), false loopers
Lacewings	Green Lacewings (*Mallada signatus*) Brown Lacewings (*Micromus tasmaniae*)	Aphids, moth larvae and eggs, whitefly, thrips, mites and mealy-bugs.
Caterpillar (Parasitoids)	Banded caterpillar parasite (*Ichneumon promissorius*) Two-toned caterpillar parasite (*Heteropelma scaposum*) Sorghum midge parasites (*Eupelmus australiensis*)	Heliothis and other moth larvae Sorghum midge Heliothis, looper, armyworm, grasshopper and other larvae
Helicoverpa Egg Parasitoids	*Trichogramma chilonis*	Helicoverpa and Lepidoptera
Whitefly Parasitoids	*Encarsia formosa*	Whitefly
GVB (Green Vegie Bug) egg Parasitoids	*Trissolcus basalis*	Green vegetable bug

Insects are most abundant in terrestrial ecosystem and display a good variation among species in almost any aspect of their biology (Gullan and Cranston, 2020). Due to the massive number of insects and great intra-and interspecific variety, the functional significance of insects is giganticand plays an important role as a key component in diverse ecosystem (Samways, 1993; Kim, 1993). Since insects are mostly perceived as pests or potential pests. This ecological importance of insects often goes unnoticed. The main ecological functions of insects in ecosystem are ecosystem cycling, pollination, predation/ parasitism, and decomposition. Insect herbivores change the quality, quantity, timing of plant, detritus inputs and may potentially have large effects on ecosystem cycling. However, insect herbivory increased plant abundance due to greater availability (Mattson and Addy, 1975; Belovsky and Slade, 2000). Insect herbivores are therefore important drivers of ecosystem process by transforming living plant biomass into grass, green fall, and through fall should drive a big fraction of above-ground to below ground nitrogen and phosphorus fluxes across entire ecosystems (Hunter, 2001; Metcalfe *et al*., 2013). Ground beetles are also commonly used as bio-indicators for changes in environmental conditions. Thanks to their sensitivity to habitat change and since carabid studies are being highly cost-efficient (Rainio and Niemela, 2003). Hymenopteran and Coleopteran predators and parasitoids can help in pest control by feeding on pest species such as caterpillars or Hemiptera. Soil insects such as dung beetles and termites assist in soil fertility by their transformation, bio-turbation decomposition and by assisting nutrient cycling (Huffaker, 1959; Stork and Eggleton, 1992; Griffiths *et al*., 2019; Ulyshen, 2015) (Table 2). Termites in the tropic have a role somewhat analogous to temperate earthworms and have a similarly high biomass especially on wet acid soils and their contribution to ecosystem services have been valued at47 billion dollar a year (Jouquet *et al*., 2011; Losey and Vaughan 2006). Wilson (1987) has mentioned invertebrates generally with some justification, because the "little things that run the world".

Global biodiversity and species richness of insects

Insects are an immensely successful biological group, with possibly two to ten species on Earth today. Less than 10% of these have scientific names. Although insects at the family level have survived various major impacts over the last 100 million years, it's the specialists that died out during the mass extinction event at the end of the Cretaceous. Great insect diversity is indeed an

Table 2. List of ecosystem services provided by insects (Eggleton, 2020).

Order	Ecosystem service	Feeding Guild	Examples
Hymenoptera	Biological control	Predators	Formicidae (ants) and Vespidae (wasps)
Hymenoptera	Biological control	Parasitoids	Ichnemonidae, Braconidae, Chalcidoidea
Hymenoptera	Pollination	Herbivores	Mostly Apidae (bees)
Hymenoptera	Seed dispersal	Scavengers	Formicidae (ants)
Hymenoptera	Bio-turbation	scavengers	Formicidae (ants)
Coleoptera	Biological control	Predators	Carabidae (ground beetles) and Coccinellidae (ladybugs)
Lepidoptera	Pollination	Herbivores	Moths
Diptera	Animal decomposi-tion	Scavengers	Many families
Blattodea	Plant decomposition	Decomposers	Termites, dung beetles and weevils
Blattodea	Bio-turbation	Decomposers	Termite constructions

intrinsic part of the Earth's ecosystem (Samways, 1994).Although evidence suggests that a lot of insect specialists died out at the top of the Cretaceous, most have survived up to many geological events over the previous couple of many years. This is now changing with the human impact estimated to be threatening the survival of one fourth of all insect species. Insects appeared first in the Ordovician, approximately 480 million years ago at approximately the same time when the first land plants evolved and insects were the first animals to evolve flight as well as they are dispersed and diversified across most of the continents (Condamine *et al*., 2016). However, evidence for the earliest case of terrestrial arthropod like termite from the early Cretaceous (Lacasa-Ruiz and Martinez-Delclos, 1986). Moreover, some cycads belong to Mesozoic era (Norstog, 1987) and the several groups of blood-sucking insects from order Diptera occur during the period of Jurassic Cretaceous and Paleozoic (Kalugina and Kovalev, 1985; Boudreaux, 1987) (Table 3). Their evolution of a plant feeding habit led their massive diversification (Snodgrass, 1935; Mitter *et al*., 1988). They are defined as a category of class Insecta and splits into some 29 orders. These orders can split into three groups based on their development pattern. Some are holometabolous with complete metamorphosis i.e. egg, larva, pupa, adult and others are hemimetabolous with incomplete metamorphosis i.e. nymphs and adults. There are some wingless insects that are ametabolous i.e. no distinction between larvae and adult, no nymphs

Table 3. Fossil history of major insect orders (Boudreaux, 1987; Gullan and Cranston, 1996)

Order	Earliest fossils	Million years ago
Archaeognatha	Devonian	390
Thysanura	Carboniferous	300
Odonata	Permian	260
Ephemeroptera	Carboniferous	300
Plecoptera	Permian	280
Phasmatodea	Triassic	240
Dermaptera	Jurassic	160
Isoptera	Cretaceous	140
Mantodea	Eocene	50
Blattodea	Carboniferous	295
Thysanoptera	Permian	260
Hemiptera	Permian	275
Orthoptera	Carboniferous	300
Coleoptera	Permian	275
Strepsiptera	Cretaceous	125
Hymenoptera	Triassic	240
Neuroptera	Permian	270
Siphonaptera	Cretaceous	130
Diptera	Permian	260
Trichoptera	Triassic	240
Lepidoptera	Jurassic	200

Table 3. Fossil history of major insect orders (Boudreaux, 1987; Gullan and Cranston, 1996)

Order	Common name	Feeding habit	Numbers of species
Blattodea	Cockroaches, termites	Detritivores	5,710
Coleoptera	Beetles	Various	392,415
Dermaptera	Earwigs	Detritivores	1,982
Diptera	True flies	Various	160,591
Ephemeroptera	Mayflies	Aquatic predators	3,281
Hemiptera	Bugs	Herbivores/predators	104,165
Hymenoptera	Bees, ants, wasps	Predators/herbivores	152,677
Lepidoptera	Butterflies, moths	Herbivores	158,570
Mantodea	Mantises	Predatorsc	2,447
Neuroptera	Net-winged insects	Predators	5,937
Odonata	Dragonflies, damselflies	(Aquatic) predators	6,650
Orthoptera	Grasshoppers, crickets	Herbivores	24,481
Phasmida	Stick insects	Herbivores	3,270
Plecoptera	Stoneflies	Aquatic herbivores	3,930
Psocodea	Booklice, true lice	Parasites/detritivores	10,746
Siphonaptera	Fleas	Parasites	2,086
Thysanoptera	Thrips	Herbivores	6,157
Trichoptera	Caddisflies	Aquatic predators	15,233

with secondarily wingless insects and not ametabolous (Snodgrass, 1935). The largest of those orders are all holometabolous: Lepidoptera (butterflies and moths), Coleoptera (beetles), Hymenoptera (bees, ants, and wasps), and Diptera (true flies) (Eggleton, 2020) (Table 4).

Class Insecta are extremely large groups having more than a millions of species. At present the total number of living species of insects is 5.5 million and they are the most taxonomically intractable of animal classes and there are many an identified species (Stork, 2018; Gaston, 1994). Similarly, order coleoptera has the largest number of described species (Roskov *et al*., 2020). However, insects are within the largest group of arthropods and leave every other group seeming relatively small but they showed large proportion of global diversity across the entire world's biota. Biological diversity is one of the most fascinating evolutions by natural selection producing different varieties of species (Kulshrestha and Jain, 2016). However, the success of insects have been due to their versatile methods of feeding, their ability to fly and locate their food sources, sometimes over many kilometres. Insects are extremely diverse and they have great potential for understanding ecosystem but the limited knowledge and resources about incest increase the difficulty of working on insect biodiversity (Danks, 1996; Finnamore, 1996; Spellerberg and Fedor, 2003). Species richness in trees of insects may serve as the best proxy for overall biodiversity in tropical forests. Crucial suppositions they made were that each of the 50,000 tree species of insects are in the world and out of them beetles represent 40% of all insect species. The canopy is rich in insect species as the ground species (Novotny, 2002).The other estimation showed dramatic losses of insects in the tropical rain forests which are home to at least half of all insect species that are found (Pennington *et al*., 2015). There is much estimation of extinction rates such as 11, 200 species of insects have gone extinct since 1600 and that possibly half a million insect species will go extinct in the next three centuries (Samway, 1994).

Conservation and their management for insect's diversity

The conservation of biodiversity has become one of the most important challenges on our planet. According to the beneficial components of insects as biological resources with effective control, many national strategies, legal actions and capacity-building activities have been developed or implemented (Danks, 1996). These efforts work towards the goal of insect diversity conservation and understanding the extent of insect diversity that is one of the major challenges in modern ecology. Insects have important economic roles, supporting and providing livelihoods for numerous people from the silk trade to beekeeping and the pollination of most of our fruit and a range of other agricultural produce. However, concern for declining insect population has been voiced since the first half of the 19th century and the historical aspects of insect conservation have been reviewed elsewhere (Pyle and Opler, 1981). The present momentum began in the 1960's, legislative measures were taken in the 1970's and being strengthened in the 1980's and1990's.The insects are responsible for many processes in the ecosystem and its loss can have negative effects on entire community. It is suggested that conservation of natural resources and biodiversity have become an urgent issue in recent years for attaining an environmentally sustainable future. While a lack of data has historically excluded the use of many taxa as possible indicators (Choudhary and Ahi, 2015; Samways, 1994).Insect conservation in the twenty-first century can be seen against six inter-related themes which are as follows:-

- Philosophy (establishing the ethical foundation)
- Research (the finding out),
- Policy (the framework for action),
- Psychology (understanding how human engage in insect conservation action)
- Practice (implementation of action)
- Validation (establishing how well we are doing at conserving insects).

We will now interrogate these themes in more detail. We do this against a background of species, landscape, national and global operational levels so as to move quickly to save the current insect diversity on Earth (Samways *et al*., 2020). For insect's conservation, this research is about finding new and effective ways for maintaining insect's diversity, insect species, and insects population. As insects are embedded in the ecological fabric around them, we need to understand it if we have to provide realistic insect conservation solutions. We research the optimal environmental conditions that enable insect's survival. These environmental conditions may be abiotic, such as temperature regimes, fire frequencies and intensity, rainfall patterns and intensity, insolation, elevation, rockiness, water, pH, dissolved oxygen as well as contaminants, pollutants, pesticides, and many others. Insect's community conservation and restoration have been identified as important yet difficult tasks (Arenz and Joern, 1996). International agreement is combined in the Convention on International Trade in Endangered Species of World Fauna and Flora (CITES), which controls and monitors import and export of listed species. By virtue of their huge abundance and great variety, insects are major player's in many ecosystem processes with keystone roles and largely maintain terrestrial ecosystem. However, the highest density of biodiversity research occurs in temperate climates, markedly in Western Europe (Titley *et al*., 2017). Similarly, 85% of insect species are found in the tropics and south temperate regions (Stork, 2018). Global monitoring programs are not implemented and unbiased data are not available. Land management and land protection are recognised as the most relevant conservation measures for the global preservation of insects across regions and taxa. Taking a landscape perspective to protection and management of insect biotopes is in fact one of the most effective ways to protect countless taxa, their unique ways of life, evolutionary history and complex networks (Samways *et al*., 2020). International Union for the Conservation of Nature (IUCN) species assessments, particularly regarding insects, almost invariably depend on expert scientific judgments as one of the sources of information that is used to measure our progress towards global biodiversity conservation goals. However, National parks and reserves must be adequately protected and must not be eroded by financial interests even during times of recession. The globally recognized list provides just not only an inventory of the world's species and their threat status, but also gives suggestions for conservation action. It does this through the activities of a network of specialists on various taxonomic groups. The concept based on marine animals like whale or weasel is raised considerably automatically (Cardoso *et al.,* 2011). However, for insect species- Red listing is that group which is so precious. Today, about 7700 species having been evaluated and probably less than 0.2% of the millions that exist are the main cause of the downfall of number of insect species under the Endangered Species Act. It is due to lack of qualified entomologist (Lugo, 2006). According to Convention on Biological Diversity (CBD), insects are a component of biodiversity and they provide essential ecosystem services. However, the Endangered Species Act (ESA) has the potential to eliminate the impact of habitat change on insect species (Lugo, 2006). In 2006, the IUCN approach to conserving insects is at the same time, three major insect groups i.e. butterflies, dragonflies and dung beetles were selected for IUCN Sampled Red List index. (Spector, 2008; Samways, 2007; Nichols *et al*., 2007). 1,255 insect species are evaluated for inclusion within the International Union for Conservation of Nature (IUCN) and Red List of Threatened Species (Nichols *et al*., 2007). Moreover, it is difficult to calibrate truth proportion of insects which may be threatened on a worldwide scale.

Conservation of insect biodiversity in 21 century

Insects are a major component of ecosystem but due main factors such as Global environmental change, land transformation and contamination causes loss of insect diversity. Insect conservationists need better decision makers, stakeholders, and land manager which illustrate the multiple strategies for saving insects at local levels. Although economics is important for funding of research strategy and implement insect conservation based on value. First we need specific strategies for insect conservation which aims to understand and promote human care for insects and also promoting human and insect's well-being (Simaika and Samways, 2018). However, according to an effective strategy conveys the message for conservation of insects which is essential for our future survival (Kritsky and Smith, 2018; Samwaysa *et al*., 2020; Spector, 2008) and the various key factors for insect conservations are

- Maintain tropical forest for insect diversity particularly in high-endemism areas.
- Military training areas, golf courses, wind turbine sites, airports, and railway embankments also provide refuge for many insect species.
- Harmful pesticides must be avoided in the conservation area.
- Instigating agro-ecological approaches improve the production of landscape away from that of conventional agriculture towards protected areas which help in conservation of insects.
- Organic farming increases up to 30% in species richness of insect.
- Landscape which considers crop field increase insect species diversity.
- Red List assessments are the starting point for conservation and contribution to raising the profile of the threats facing insects.
- The global insect assessments uses standardized methods of transect counts to assess global trends.
- Citizen scientists are involved in the data gathering, leading to an estimate of how this insect group is changing with time across the globe.
- Rapid assessment programmes have discovered many new insect species, especially in biodiversity-rich areas of the world. Insect assessment projects shedding light on the status of insect species.
- New bioinformatics and cyber taxonomy tools are helpful for delivering urgently needed information on the taxonomy, distribution, and conservation status of insect species.
- Taxon-focus databases are helpful for generating or providing taxonomic information, natural history, images and distribution data on major insect orders
- Geographically, focused databases such as Nature Serve and Info Natura along with globally federated data bases such as the Global Biodiversity Information Facility helps in monitoring of insect species.
- Mapping is valuable for assessing where species occur across a designated area and used for species predictive distribution modelling, which aids in discovery of new species in an area.
- Timing of monitoring is crucial for insects especially for rare species and might not be easily detectable.
- Environmental DNA (eDNA) is the sampling of genetic materials hed from living organisms which obtained directly from environmental samples and also determine the historic data of insect species.
- Another approach is to use higher insect taxonomic groups as a surrogate.
- An important feature of maintaining insect diversity is that specific strategies using selected,

effective surrogates and indicators. However, other interventions are required as a result of strategic monitoring.

Conclusion

Insects can be found in many places and insect biodiversity conservation generates information on the status, biology and needs of insect species. Insects are covered under many international conventions such as Convention on Biological Diversity, Biodiversity Action Plans and Agri-environment schemes. The trainings on insect research give public awareness about relation between insect with ecosystem. However, the National, International and Multilateral Institutions are finally receptive to the protection of insect biodiversity. As a result, entomologists' potential for having a positive impact and contributing to a sustainable future has never been greater. The challenge is to engage more fully with the thousands of entomological researchers and collectively bring them their vast energy and expertise in the conservation playing field at last.

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