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Insect Conservation and Management: A Need of the Hour

*Muzafar Riyaz, Rauf Ahmad Shah
and Soosaimanickam Maria Packiam*

Abstract

Insects play a very vital role in divergent ecosystems and have gained great economic and medical importance as pollinators, pests, predators, parasitoids, decomposers and vectors. With the large-scale practice of synthetic pesticides, the diminishing rate of beneficial and pollinator insects is increasing rapidly. Environmental pollution, climate change, global warming, urbanization, industrialization and some natural calamities like wildfires add more fuel to the acceleration of insect decline all over the world. Alternative steps should be employed to replace the toxic pesticides and implementation of integrated pest management (IPM) should be put forward to reduce the overuse of synthetic pesticides and fertilizers, which have a great impact on beneficial insects as well as birds, aquatic organisms, and also on human health. The present study aims to create awareness among the researchers and general public by providing a brief review of insect importance, decline and conservation strategies.

Keywords: Insects, Pollinators, Insecticides, Climate Change, Insect decline, Conservation

1. Introduction

The most prevailing species ever to possess earth are Insects [1]. The amplified depiction of their body is a positive component to withstand in any environmental conditions. These six-legged creatures came to occupy the earth in the Devonian period and turned into the predominant animal's earth ever witness [2]. Unexpectedly, the insects ought to be appraised as exceedingly abundant creation, in light of the fact that with such an outfitted depiction of the body makes them dominating and the level of triumph achieved by a class of life frame inside invertebrate phyla [3]. With such a significant number of roles and the most noteworthy number of species in any population influences them prevailing life to shape on the earth. Insects are vital due to their diverseness, ecological character, and impact on farming, human wellbeing, and natural resources. Insects are viewed as the dominant animals on earth with their main competitors as humans. Humans have been relying upon the insects for the pollination of crops, honey, silk, lac and many other ecological services that insects provide in different ecosystems [4]. In an ecosystem, there are countless species of insects with their distinguished roles either associated with crops or other organisms in a particular location. The relationship of an insect with a crop or any other organism does not really imply that the species is a pest of that crop or animal. Most of the crops which needed pollination for their development

are being pollinated by most of the insects, which are the prime agents of pollination among flowering plants [5]. Insects are very crucial for the appropriate functioning of many food chains and food webs. From nymphs of dragonflies as top predators of insect food-chains in aquatic ecosystems to grasshoppers, flies, butterflies and so on as primary consumers in many grassland biomes [6, 7]. Insects act as predators, parasitoids, herbivores, decomposers, sanguivores, parasites and also help in nutrient cycling. Insects play a very important role in decomposition which includes breakdown of waste, dead plant and animal matter, thus helps in remediation and recycling of our ecosystems [8]. The biological foundation for all terrestrial ecosystems is the insects with innumerable roles not limited to terrestrial ecosystems nevertheless they provide many useful services in and around the aquatic and agricultural ecosystems as well. Forensic and medical entomology involves the study and investigation of many insect species. From maggots of blowflies to larvae of mosquitoes, the advancement in the science of forensics and vector biology is only possible because of the deep investigation of these insect species which have changed the history of human intellectual. From the Devonian period to the present era of technological advancements, earth has witnessed these six-legged flying animals which dominated both the skies as well as the terrains [9]. As the over-use of synthetic pesticides, expansion of agriculture, urbanization, industrialization, environmental pollution, rising temperatures, climate changes came into existence, the insect species are becoming no longer the dominant animals on the planet and the risk of being threatened and receiving extinction is on the verge till this day [10].

The unending requirement of food for the fast-growing human population of the world has created havoc among the diversity of insects and other animals from different taxa by the manufacturing of toxic agrochemicals including pesticides sprayed on the crops for the eradication of pests [11]. The repeated use of these toxic pesticides sprayed in crop fields not only eradicate the pests, but also directly responsible for the decline of beneficial insects, which are having a great value to carry out the process of pollination and being as predators and parasitoids to check the diversity of insect pests in the natural ecosystem. Besides the damage done by the continuous application of synthetic pesticides on the insect biodiversity, there are many factors which are equally responsible for the insect decline. The fast-growing human population gave rise to the wide-spread expansion of urbanization, industrialization and assemblage of building and road network constructions which sequentially steered to the deforestation, habitat fragmentation and biodiversity loss. On contrary, climate change, rising temperatures, environmental pollutions are some of the main drivers of the global insect decline [12]. The introduction of alien and invasive plant species has also affected the insect diversity to some extent as the insects are mostly adapted to native plant and tree species. Implementation of conservation and management strategies of insects are need of the hour as the insect populations are falling at very higher proportions. The endangered and critically endangered insect species should be given top priority in terms of conservation. Additional insect surveys and field visits must be supported so that monitoring should be directed for proper analyzing and scrutinizing of endangered insect species. Comprehensive research studies, Citizen science projects could be implemented at a very large-scale, so that populations of insects and their diversity, richness and abundance can be monitored easily.

2. Importance of insects: a general concept

Insects are one of the dynamic groups of organisms in the kingdom animalia. The distinguished roles played by Insects in all biological systems makes them one

of the prevailing class, earth at any point saw (**Figure 1**). The potential to withstand in any climatic condition, light weight, small size, flight capability makes them significantly versatile to endure and reproduce more faster than some other living forms on the planet. Insects were the first animals to ever develop the ability to fly. Since evolution usually works with what it has; new body structures do not crop up very often. However, in case of insects, they did not use modified limbs to fly. The

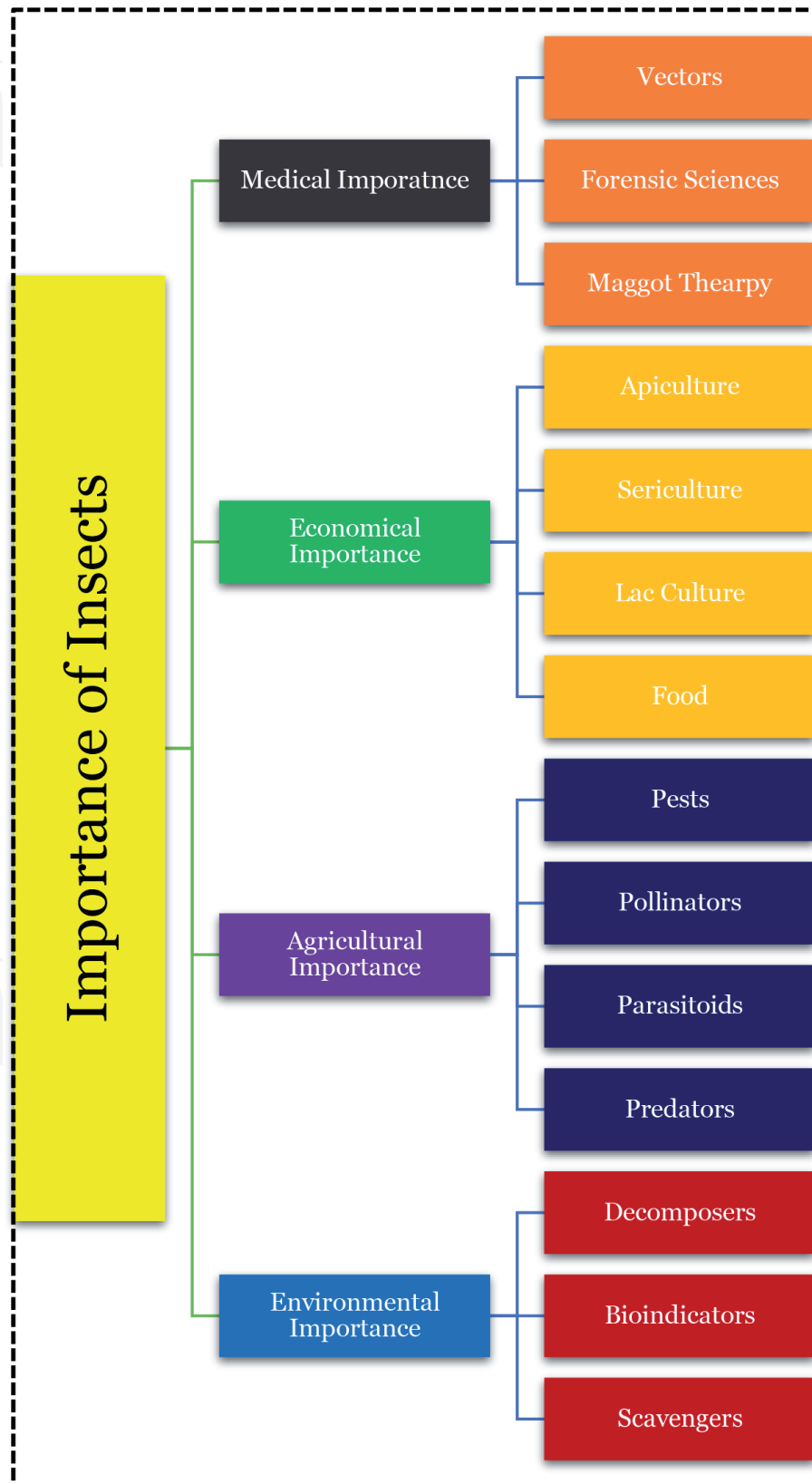


Figure 1.
A flowchart showing the importance of insects (Designed in MS PowerPoint by Muzafar Riyaz)

insect wings are a brand-new innovation in their physiology. The development of wings among them is so unusual that scientists are still working on, and arguing about how and when insect wings first came about. Nearly more than 1 million insect species have been discovered so far and scientists estimate that there could be million more waiting to be discovered. The faster reproductive rate, flight ability, light weight, unique body structures and major roles in different ecosystems makes them most dominant animals the earth has ever witnessed.

Insects play major roles in our environment however; insects are some of the most misunderstood and underappreciated animals on earth due to their capacity to destroy crops and carry diseases. Yet, insects are very crucial for better functioning of many ecosystems. One of the most important services that insects deliver is the pollination. Insects help in pollination of around 80% of the angiosperms across the globe [13]. Insects are very important in systematic functioning of many food chains and food webs as they provide food for many animals including birds, amphibians and reptiles. There are many significant assets that insects have been provided to Humans like Honey, Silk, Lac, Wax etc. Besides feeding on our crops and vegetables as pests, numerous insect species play crucial roles in eliminating many pest species as predators and parasitoids. Many predatory and parasitoid species of insects feed on Mosquitoes, aphids, pest caterpillars and mealybugs that destroy fruits and vegetable crops, therefore act as biological control agents in our ecosystems. Insects have been used in molecular and genetic studies, forensic sciences and many other biological studies including therapies. Many insects such as dragonflies act as biological indicators in the environment [14]. These species help in monitoring the biological quality of water as there are very sensitive to pollution. Most of the insect species help in environmental remediation as they spend most of their lives under water or inside soils. Insects play a very crucial role in the decomposition of plant and animal matter. The role of insects is so crucial that if insects and other land-dwelling arthropods were to become extinct, then it would sound death knell for all the earthlings. Majority of the birds, reptiles and mammals and amphibians would soon fizzle out to extinction. Next in line be the flowering plants, the physical structure of the forests and soon other terrestrial habitats will suffer an equatorial damage due to the disturbance in the food chains and food webs. Apart from ecosystem services, insects have been mentioned in folklores of many tribes and communities of peoples from all over the world. Many traditions across globe have considered insects as the treasures of the world. The ecosystem services delivered by insects on the planet are innumerable. However, due to some anthropogenic activities the populations of many insect species are rapidly running towards the engenderment. The large-scale utilization of synthetic pesticides has created a havoc among beneficial insect populations. Apart from synthetic pesticides, climate change, cryptic and alien plant and animal species are also responsible for the decline of insects.

3. Impact of anthropogenic activities on Insect diversity

One of the most common misconceptions about insects is the pest nature. Since, many of the species among different insect orders and families are pests however, not all of the insects are pests. A lot of this is based on the personal opinions of common people which need to be changed fundamentally by taking initiatives such as public awareness and citizen science. Global decline of insects is a very big problem that we are witnessing in the present era and a lot of people are not aware of what's happening and it's difficult to understand because the insects are seemingly everywhere. A lot of studies have revealed that the insects are disappearing at a high rate with estimates suggesting to 40% of the species in class Insecta will disappear in

the couple decades [15]. The trend is pretty clear that insects are disappearing both in species and in number as well. The decline of insect biodiversity across the globe falls on many anthropogenic activities like habitat destruction through deforestation, hunting, expansion of agriculture, industrialization and urbanization. Large-scale intensification of agricultural activities has resulted in decline of populations among the insects. The enormous utilization of synthetic pesticides is a result of the expansion of agricultural activities and adds as one of the top drivers of insect population decline (**Figure 2**). Besides the impact of synthetic pesticides on insects, many other factors are also responsible for their decline. Destruction of pond and wetland habitats, increasing temperatures, introduced species, ecological traits, pollution, wildfires are some of the key factors which are associated with the decline of insect populations across the globe (**Figure 3**). According to many reports, order Coleoptera (Beetles and weevils) is being highly affected by the habitat change followed by orders Hymenoptera (Bees and Wasps), Lepidoptera (Butterflies and Moths), Odonates (Dragonflies and Damselflies) and other terrestrial and aquatic insects. Pollution, climate change and biological traits are one of the main drivers associated with the vastly declining of insect species from the order Coleoptera followed by Hymenoptera, Lepidoptera, Odonata and other group of insects. These factors have caused a very huge damage to insect populations. As revealed by many studies across the globe, a very large of insect species such as Dung beetles followed by the bees, moths and butterflies are vulnerable and rapidly heading towards the endangerment. A decline of over <30% proportions of particular insect order can be seen among the Coccinellid beetles followed by the orthopterans, butterflies, hymenopterans and in case of aquatic insect species from the order Odonata followed by Ephemeroptera, Plecoptera and Trichoptera [16–19].

Global warming and climate change are equally responsible for the decline of insect populations. The insects of temperate regions across the globe are among the most affected species of insects. Insect species such as dragonflies, stoneflies and bumblebees which are adapted to cold climates and higher altitudes are being affected by the rising temperatures in temperate regions of the world. Besides, the

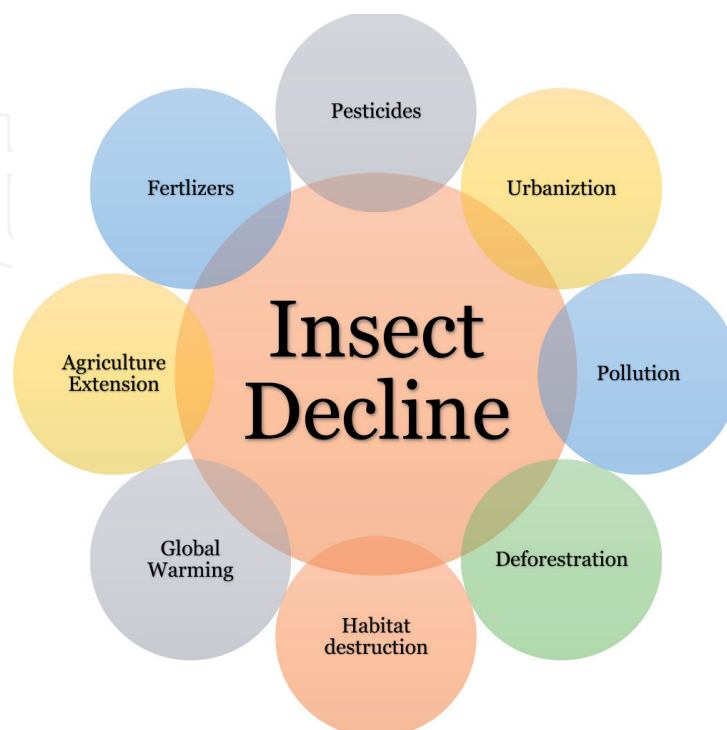


Figure 2.
Drivers of insect decline (Designed in MS PowerPoint by Muzafar Riyaz).

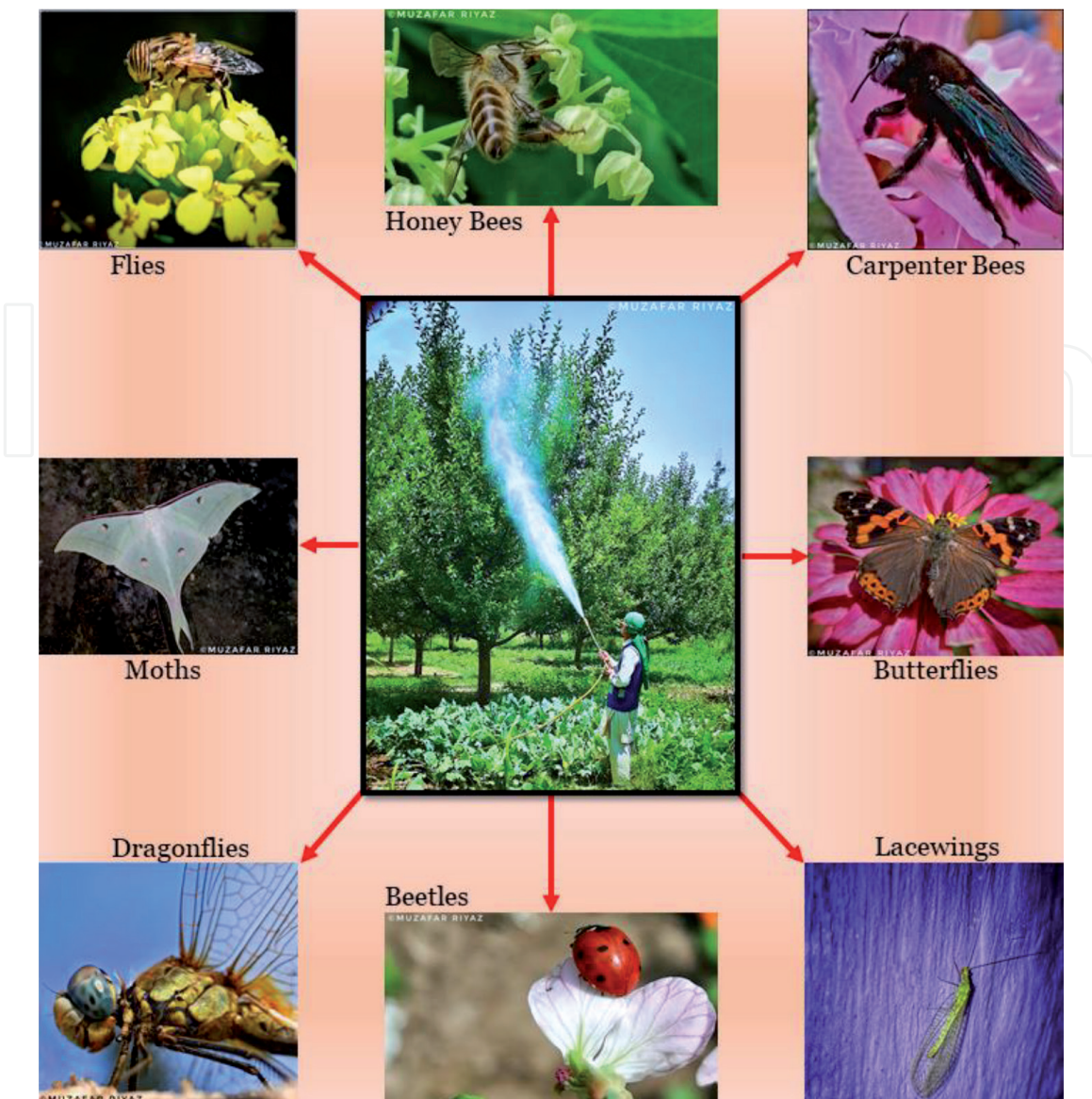


Figure 3.
Impact of synthetic agrochemicals on different species of insects. (Photos by Muzafar Riyaz).

insects from the rainforests of Caribbean islands have been drastically affected by the climate change. Almost half of the insect populations across the globe are affected by the global warming and climate change trends [20]. Other factors that are equally responsible for the insect decline are persistent halogenated hydrocarbons, metal pollution, heavy metals. These pollutants often discharged into rivers, lakes and ponds which lead to an innumerable impact to the aquatic insect fauna. Industrial spills which are very toxic not only affect the aquatic insect fauna but also other forms of life residing in both fresh and salt waters. On contrary, natural calamities such as wildfires, cyclones and so on have also made a huge impact on the reduction of insect populations. Many endemic insect species are believed to face extinction due to the recent wildfires in Australia.

4. Conservation and management of insects

Insect decline is very complicated as it is been driven by many anthropogenic and natural activities. Th populations of insects are disappearing at an alarming rate and the total mass of insects is falling by a staggering 2.5% a year [21]. Insect species such as beetles, ants, bees are disappearing eight times faster than mammals, birds

or reptiles. The population of monarch butterflies in the United States reduced by 90% in the last 20 years [22]. Insects outweigh every other animal and make up around 70% of all animal species on the planet, however there are reports of widespread decline of insect species from every corner of the world. Since, the humans have been worried about the bees for a while however, the concern for overall insect decline is much bigger than just the bees.

Insect decline is indeed problematic that we need to tackle as these animal species are very important for proper functioning of our ecosystems. The implementation of conservation and management strategies is a need of the hour. The following steps need to be implemented for conservation of the insect species (**Figure 4**):

- a. Native plant species should be given the importance as compared to invasive plant species, since most of the insects rely on the friendly plantations around them.
- b. The rapidly growing urbanization and industrialization must be designed in eco-friendly ways.
- c. Alien and cryptic plant and tree species should be removed as most of the insect species are poorly adapted to these plant species.

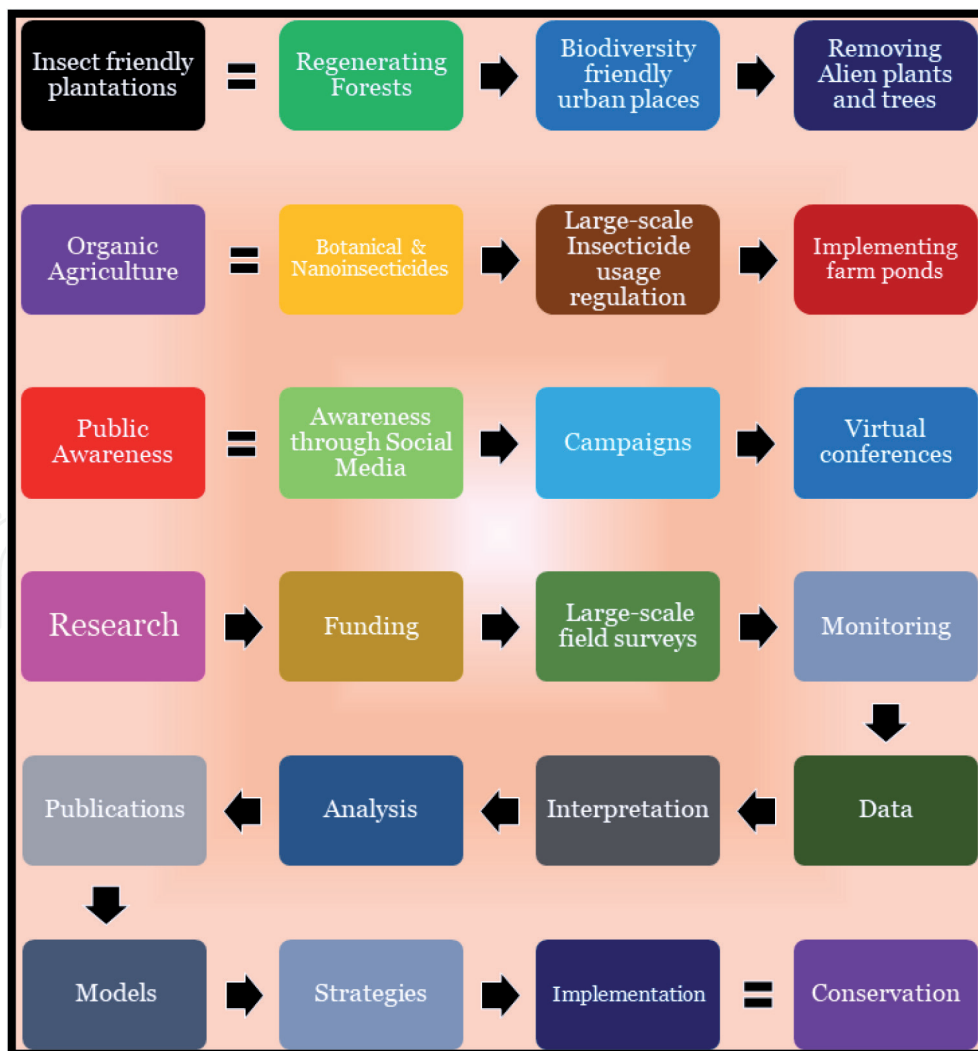


Figure 4.
 An overview of conservational and management strategies of insects. (Designed in MS PowerPoint by Muzafar Riyaz).

- d. Deforestation is one of the major issues in terms of the biodiversity loss and insect decline. Regeneration of the forests is a need of the hour, since forests are the common home to all wild fauna including the insects.
- e. The large-scale extension of agricultural activities must be regulated and managed in a proper channel. Organic farming should be implemented in way which support crop yield as well the biodiversity around.
- f. With the use of botanical pesticides, the extensive utilization of synthetic pesticides can be controlled to some extent.
- g. With nanotechnological approaches like use of nanopesticides and nanofertilizers will help in reducing the wide-spread utilization of insecticide pollution.
- h. Use of synthetic pesticides which not only affects the life from different taxa but costs the human health as well [23]. Alternative to these synthetic pesticides are the biological control agents such as insect predators and parasitoids which are also the core component of ecological intensification in Integrated Pest Management (IPM) [24, 25].
- i. Implementing small farm ponds in the agricultural fields will aid in restoration of aquatic insect taxa like dragonflies and stoneflies.
- j. Public awareness is one of the key factors in conserving and managing the insect decline. In these times of technology and fast-growing civilizations, people are ignoring the ecological services of nature and natural ecosystems. People should be made aware of the importance of insect diversity and our biodiversity wealth and their conservation and management.
- k. Public awareness should be made through campaigns, seminars, conferences about the insect diversity and conservation.
- l. Rather than sharing memes on the social media, general people must be trained for sharing the benefits of insects and their conservation aspects.
- m. Citizen science aims at increasing scientific knowledge through collaboration and public participation in scientific research. With this initiative, people from different parts of the world take part in such activities and share and contribute to data monitoring and collection programmes. Citizen science allows people to enhance their scientific temperament in the fields and empowers communities to observe nature and with the collective efforts to conserve as well. Across the globe, majority of people are been taking part in such activities and people are very enthusiastic about sharing and collaborating to scientific research. More citizen science projects must be initiated in the future as well so that more discoveries of species can be made and together with the public, scientists and researchers will be able to solve the insect decline problems.
- n. Diversity studies of the most of the insect orders have been ignored in case of Collembola, Ephemeroptera, Neuroptera, Plecoptera which are having many ecological roles and services.

- o. Monitoring should be carried out for each and every insect species, so that data should be utilized in the conservational strategies.
- p. Research is one of the main aspects for monitoring both the insect decline and cause of the decline. Researcher's and Scientists across the globe should be invigorated to study some of the major aspects of insect decline which have not been adequately studied. These include, impact of industrial chemicals on insects, heavy metals, thermal biology etc.
- q. Funding is a very core aspect in surveying, monitoring, data analysis and laboratory studies. A lot of funding agencies across the globe play an important role in conservation and management of the animals. Focus should be also given to insects which are heading towards the apocalypse.
- r. Journals and publishers must process faster in reviewing the articles, papers, chapters concerning the insect conservation and management and should be made freely accessible to all.

5. Discussion and conclusion

Insects perform all sorts of important ecological roles without which ecosystems could not function. The biodiversity crisis in the present era has resulted in the loss of species from our planet faster than has happened for 65 million years, since the dinosaurs were wiped out by a meteor. The perception about the conservation for most of the people is that it's about large animals like tigers, pandas, polar bears and so on and that's what where most of the attention goes and trying to prevent those creatures from going extinct. However, while focusing on the mammalian and other species conservation we have missed the bigger picture that is been going on in our environment which is the quite disappearance of the insects. The disappearance of the insect species has been going on for a long time. Insect biodiversity needs to be preserved in order to preserve both the flora and fauna of the earth. Biodiversity has been very important to human history and culture as humans are totally depend on both plants and animals which live around them for food as well as for cultural value and they make our ecosystems healthy in which humans take shelter and yet so much of it is under threat. Nature has a lot of value and biodiversity is the basis of life. One of the biggest consequences of a more developed and more technological world is that people flock to cities which resulted in making humans more gentrified and more separate from the nature. As we are aware of the fact that insect biodiversity is declining dramatically all across the globe. It is very important that we have information management systems to know what's happening and what drivers are causing the insect decline, so that management strategies should be implemented for the conservation of the entomofauna. The importance of the insect fauna cannot be over-emphasized as it is very important for proper balancing of our ecosystems and ecosystems services they provide. Insects are fueling a wide range of ecosystems services that we essentially need as humans to survive. However, it is very important that even before we can save them, we need to get to know about them. The better and advanced decisions are needed in these times of insect biodiversity loss and much care is needed of all the insect fauna that are in threat to become endangered or extinct. The knowledge about these species is very important for their conservation and management. The above-mentioned steps need to be implemented as far

as we can, so that our future generations will get to see the natural heritage of our planet. Ultimately biodiversity will become important once it means something to each and every individual.

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Conflict of interest

The authors declare no conflict of interest.

Author details

Muzafar Riyaz, Rauf Ahmad Shah and Soosaimanickam Maria Packiam*
Entomology Research Institute, Loyola College, Chennai, Tamil Nadu, India

*Address all correspondence to: eripub@loyolacollege.edu

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References

- [1] Glenner H, Thomsen PF, Hebsgaard MB, Sørensen MV, Willerslev E. The origin of insects. *Science*. 2006 Dec 22;314(5807):1883-1884.
- [2] Carpenter FM. The geological history and evolution of insects. *American Scientist*. 1953 Apr 1;41(2):256-270.
- [3] White TC. Insects. In: *The Inadequate Environment*, White, T.C. (Ed.). 1993 (pp. 31-107). Springer, Berlin, Heidelberg.
- [4] Rosenberg DM, Danks HV, Lehmkuhl DM. Importance of insects in environmental impact assessment. *Environmental management*. 1986 Nov;10(6):773-783.
- [5] Riyaz M, Mathew P, Paulraj G, Ignacimuthu S. Entomophily of Apple ecosystem in Kashmir valley, India: A review. *International Journal Scientific Research in Biological Sciences*. 2018; 5(5): 146-154.
- [6] Pimm SL. Properties of food webs. *Ecology*. 1980 Apr;61(2):219-225.
- [7] Pimm SL, Lawton JH. Are food webs divided into compartments? *The Journal of Animal Ecology*. 1980 Oct 1:879-898.
- [8] Simmons T, Cross PA, Adlam RE, Moffatt C. The influence of insects on decomposition rate in buried and surface remains. *Journal of Forensic Sciences*. 2010 Jul;55(4):889-892. <https://doi.org/10.1111/j.1556-4029.2010.01402.x>
- [9] Wigglesworth VB. Evolution of insect wings and flight. *Nature*. 1973 Nov;246(5429):127-129. <https://doi.org/10.1038/246127a0>
- [10] Leather SR. "Ecological Armageddon"-more evidence for the drastic decline in insect numbers. *Annals of Applied Biology*. 2017 Dec 20;172(1):1-3. <https://doi.org/10.1111/aab.12410>
- [11] Williams CM. Third-generation pesticides. *Scientific American*. 1967 Jul 1;217(1):13-17.
- [12] Wilson RJ, Maclean IM. Recent evidence for the climate change threat to Lepidoptera and other insects. *Journal of Insect Conservation*. 2011 Apr;15(1):259-268. <https://doi.org/10.1016/j.foreco.2014.05.027>
- [13] Faheem M, Aslam M, Razaq M. Pollination ecology with special reference to insects a review. *J Res Sci*. 2004;4(1):395-409.
- [14] Riyaz M. Dragonflies: The Apex Predators of the Insect World. *Academia Letters*. 2021:1-4. Article 1365. <https://doi.org/10.20935/AL1365>.
- [15] Wagner DL, Grames EM, Forister ML, Berenbaum MR, Stopak D. Insect decline in the Anthropocene: Death by a thousand cuts. *Proceedings of the National Academy of Sciences*. 2021 Jan 12;118(2). <https://doi.org/10.1073/pnas.2023989118>
- [16] Sánchez-Bayo F, Wyckhuys KA. Worldwide decline of the entomofauna: A review of its drivers. *Biological conservation*. 2019 Apr 1;232: 8-27. <https://doi.org/10.1016/j.biocon.2019.01.020>
- [17] van der Sluijs JP. Insect decline, an emerging global environmental risk. *Current Opinion in Environmental Sustainability*. 2020 Oct 24. <https://doi.org/10.1016/j.cosust.2020.08.012>
- [18] Goulson D. The insect apocalypse, and why it matters. *Current Biology*. 2019 Oct 7;29(19): R967-R971. <https://doi.org/10.1016/j.cub.2019.06.069>
- [19] Saunders ME. Ups and downs of insect populations. *Nature ecology &*

evolution. 2019 Dec;3(12):1616-1617.
<https://doi.org/10.1038/s41559-019-1038-4>

[20] Halsch CA, Shapiro AM, Fordyce JA, Nice CC, Thorne JH, Waetjen DP, Forister ML. Insects and recent climate change. *Proceedings of the national academy of sciences*. 2021 Jan 12;118(2).
<https://doi.org/10.1073/pnas.2002543117>

[21] Montgomery GA, Dunn RR, Fox R, Jongejans E, Leather SR, Saunders ME, Shortall CR, Tingley MW, Wagner DL. Is the insect apocalypse upon us? How to find out. *Biological Conservation*. 2020 Jan 1;241:108327. <https://doi.org/10.1016/j.biocon.2019.108327>

[22] Wepprich T, Adrion JR, Ries L, Wiedmann J, Haddad NM. Butterfly abundance declines over 20 years of systematic monitoring in Ohio, USA. *PLoS One*. 2019 Jul 9;14(7):e0216270.
<https://doi.org/10.1371/journal.pone.0216270>

[23] Riyaz M, Shah RA, Sivasankaran K. Pesticide Residues: Impacts on Fauna and the Environment. In: *Biodegradation, Mendes, K. F. (Ed.)*. 2021. (pp. 1-13). IntechOpen. <http://dx.doi.org/10.5772/intechopen.98379>

[24] El-Shafie HA. Integrated Insect Pest Management. In: *Pests Control and Acarology, Haouas, D and Hufnagel, L. (Eds.)*. 2018 Dec 31. (pp. 1-15). IntechOpen. <https://doi.org/10.5772/intechopen.81827>

[25] El-Shafie HA. Insect pest management in organic farming system. In: *Multifunctionality and Impacts of Organic and Conventional Agriculture, Moudrý, J., Bernas, J., and Mendes, K. F. (Eds.)*. 2019 Mar 15. (pp. 1-13). IntechOpen. <https://doi.org/10.5772/intechopen.84483>