Decline of Entomofauna- An Overview

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Introduction

Insects are hexapod invertebrates and the largest group within the phylum Arthropoda belongs to class Insecta. Insects excel all other animals in both diversity and magnitude and it would be impossible to come across in any other group of animals the type of intimate relations the insects exhibit with men and his belongings. Globally, an average estimate suggested that, there are around 5.5 million insect species, of which about 1 million insect species were found and described. Hence, over 50 per cent of all described eukaryotes are insects. Now a day's various factors and human interventions lead to continuous reduction or defaunation of vertebrate and invertebrate species which ultimately ends in global, local or functional extinction of animal populations or species from ecological communities. In 2017, atleast 66 insect species extinctions had been recorded in the previous 500 years, which generally occurred on oceanic islands. According to Bayoa and Wyckhuys (2019), huge rates of decline may lead to the extinction of 40 per cent of the world's insect species over the next few decades. Noteworthy, biomass losses occurred between 98% and 78% for ground-foraging and canopy-dwelling arthropods over a 36 year period, with respective annual losses between 2.7% and 2.2% in rainforest (Listera and Garcia, 2018). Among the Holometabola insects, several economically important orders such as Lepidoptera, Hymenoptera and Coleopteran already lost a gradual proportion of species in terrestrial ecosystems. Among the insects, hymenopterans are considered as the largest and diversified beneficial insects with nearly 2.5 lakh described species and important group of pollinating insects. Hallmann *et al*. (2017), estimated a seasonal decline of 76% and mid-summer decline of 82% in flying insect biomass over the past 27 years. Reason behind that decline as apparent regardless of habitat type, while changes in weather, land use, and habitat characteristics.

Pollinators decline

Pollinators play an important role in maintaining plant diversity by transferring pollen from the anthers to the stigma of the flower, enabling the flower to set seeds and fruits. Though this process is carried out by a variety of animals, insects like bees, flies, butterflies, moths, wasps, beetles and some other insect orders encompass the majority of pollinating species. It is estimated that worldwide, 35 per cent of crop production is mainly dependent on insect pollination. Further it has also been reported that about 15 per cent of the hundred principal crops are pollinated by domestic bees, while at least 80 per cent by the wild bees. A dramatic decline of upto 50 per cent of bee colonies have been suffered worldwide. According to Gallai *et al*. (2009), more than 40 % of honey bees have been disappeared

during the last 25 years in India. However, this is only reliable data on decline of honey bees in India. In United Kingdom (UK) and Netherlands, 71 per cent of butterfly species have decreased and 3.4 per cent wild flowering plants became extinct over the past 20 years. The highest net loss compared to native flowering plants (28% decrease in 40 years) and birds (54% decrease over 20 years) (Pannure, 2016).

Defaunation

Change in habitat is the main and large proportion factor for insect declination (49.7%) followed by pollution (25.8%), biological factors (17.6%) and climate change (6.9%) triggering the losses for insect declination (Bayoa and Wyckhuys, 2019).

Habitat change

Habitat change is an immediate consequence of human activities. In the past and recent centuries increasing amounts of land is being transformed to provide dwellings, facilitate transportation, urbanization (11%), agricultural conversion (24%) and deforestation (9%) at the expense of various natural habitats. However, majority of insect declines occurred, when agricultural practices were moved from traditional to intensive and industrial scale production brought about by the Green Revolution during 1960s. Agricultural intensification includes stream channel, draining of wetlands, modification of floodplains and removal of riparian canopy, resulting in homogenization of water stream microhabitats and alteration of aquatic insect communities. In recent decades, urbanization has taken over agricultural land across the globe, causing the disappearance of natural vegetation or biodiversity with the replacement of artificial habitats.

Pollution

Pollution is the second major factor of arthropod declines. Sources of pollution include fertilizers (10%) and synthetic pesticides (13%) used in agricultural production, sewage and landfill leachates from urbanized areas and industrial chemicals. In terms of toxicity, pesticides are considered as the most toxic to all insects and herbicides reduce the biodiversity of vegetation within the crops and in surrounding areas through drift effects that indirectly affects the arthropod species. Apart from pesticides, the introduction of synthetic fertilizers also plays a major role of pollinator losses. Aquatic species such as dragonflies have also been affected by the eutrophication of surface waters, caused by excessive fertilizer use in rural areas. The impact of industrial chemicals (*e.g.*, heavy metals, persistent halogenated hydrocarbons) lead to global declination of stoneflies, mayflies and caddisflies which can be imputed to man-made pollutants discharged into streams and rivers

Biological factors

Parasites and pathogens are involved in the collapse of honeybee colonies. The global spread of mite (*Varroa destructor*) and the small hive beetle (*Aethina tumida*) pose a threat for the apicultural industry because they can also transmit viral diseases. The human-assisted introduction of exotic species for biological control can also contribute to a decline of endemic insects through processes such as competitive displacement. The introduction of invasive plants had negative effects leading to a reduction in the overall abundance, diversity and fitness of different organisms, including insects.

Climate change

Global warming is one of the important causes for insects and bees decline, sometimes it has a positive impact on tropical and subtropical insects as they can be easily adopted and develop in temperate regions by changing their favorable habitats. In contrast, insects of tropical regions have more narrow thermoregulatory adaptations and get acclimatized to increased temperature. Hence, global warming has increased the population of certain butterflies in northern Europe (Bayoa and Wyckhuys, 2019). Global warming has certainly reduced the range of some dragonflies, stoneflies, bumblebees and some pollinators.

Impacts on ecosystem

***Pollination*:** Insect pollination is needed for 75 per cent of all the world's food crops which nearly contributed to 10 per cent of the economic value of the world's entire food supply. In the last 30 years, the abundance of pollinators appears to be strongly declining globally. Therefore, reduced pollination further reduces seed production and population regeneration.

Economic impact*:* The losses of pollinators were found to vary widely across crop categories. Globally, vulnerability was high for fruits (23%), vegetables (12%), nuts (31%), edible oil crops (16%) and beverages and narcotic crops (39%), lower for pulses (4%), spices (3%) and nil for cereals, tuber and sugar crops (Gallai *et al*., 2009).

Nutrient cycling: The diversity of invertebrate communities, have higher impacts on decomposition rates and nutrient cycling water quality**.** Defaunation has its impact on global declines in amphibian populations with increased algae and detritus biomass which reduced the nitrogen uptake and whole stream respiration.

Human Health: Defaunation will affect human health in many other ways, *via* reductions in ecosystem goods and services including pharmaceutical compounds, livestock species, biocontrol agents, food resources and disease regulation.

Conclusion

Pollution and habitat change are the important factors of arthropod declines. In particular, the crop production practices such as synthetic pesticides are a major factor of insect losses in recent times. Unless a change in our ways of crop production practices and using inputs, insects will reach a phase of extinction in a few decades. Habitat restoration is the only way of mitigation and limit reduction of entomofauna. Some of the tactics like 'ecological engineering' used to maintain and conserve pollinators and insects with their natural enemies. Hence, in cultivation practices, using biological control agents instead of pesticides management, we can avoid the decline of non-targeted species and at the same time cost effective management can also be attained. On reducing the contamination by limiting the use of toxic chemicals we can maintain aquatic insect biodiversity. There is still a gap between insect species abundance and diversity of basic information. Unless this gap is bridged, the clear-cut results regarding the disappearance of insects and nontarget species could not be predicted in India.

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