Chapter

Potential Reasons for Insect Decline

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Abstract

Insects are the key component of world's ecosystem and act as vital force to maintain life's framework. But in present scenario, Insects are under multi-continental crisis apparent as reduction in abundance, diversity and biomass. The impact of decline is severe in areas which are highly impacted by human activities such as industrialized and agricultural landscapes. Habitat loss and degradation; intensive use of pesticides; pollution; introduction of invasive species and climate change are the most influential factors for their alarming decline and each factor is multifaceted. The accelerated decline in insect population can cause unpredictable negative consequences for the biosphere and is a matter of global concern that requires immediate and effective international collaborations. An urgent need is to identify the species at greatest threat; factors threatening their survival and finally the consequences of their loss. In order to maintain the integrity of managed and natural ecosystems, the protection of Insect diversity is critically important.

Keywords: Climate change, ecosystem, habitat loss, industrialization, invasive species

1. Introduction

Insects are cosmopolitan in distribution i.e., found in every possible environment. They have adapted to a broad range of habitats, successfully finding their own niche as these organisms feed on any substance that has nutritional value. They constitute crucial component of environment and act as key components in the functioning of world's ecosystems. Their accelerated decline in numbers and extinction due to anthropogenic activities cause unpredictable negative consequences for the biosphere. Insects dominate the entire globe and have silently witnessed the rise of vertebrates, the fall of non-avian dinosaurs, the proliferation of mammals and the rapid evolution, civilization and industrialization of humans. Insects are so diverse that their numbers are impressive even in most parochial places. The degree of success achieved by a group of organisms can be measured either as total number of individuals within the group or more commonly as the number of different species of organisms that comprise the group. On both accounts, the insects must be considered highly successful and established group. Their success depends on two interacting factors:

- The potential of the group for adapting to new environmental conditions.
- The degree to which the environmental conditions change.

Insects create the biological foundation for all terrestrial ecosystems by cycling nutrients, pollinating plants, dispersing seeds, maintaining soil structure and fertility, controlling populations of other organisms and by providing major food source for other taxa. Once the benefits of insects-provided services are realized there may be start up call for increased funding to conserve insects through legislation. Insects are certainly under represented and underfunded through legislation and increased funds could save insect species from extinction. Because insects constitute the world's most abundant and speciose animal group and provide critical services within ecosystems, cannot be ignored and prompt a decisive action to avert a catastrophic collapse of nature's ecosystem [1].

2. Insect decline: a major concern

> *"Bugs nevrer bug my head. They are amazing. It is the activities of humans which actually bug me all the time." (Munia Khan)*

Declines have been severe in areas highly impacted by human activities such as industrialized and agricultural landscapes but ongoing insect declines are not restricted to the farms or footprints of suburban sprawl. The reduction in total biomass in multi-decadal studies is similarly being reported from different parts of the globe. About 33% reduction in the abundance of butterflies was observed over a span of 21 yrs. in extensive monitoring in Ohio, USA [2]; 176 moth species decreased by 20% from 1975 to 2014 in Rothamsted insect survey in Scotland [3]; total flying insect biomass decreased by more than 70% across 63 study locations over 27 yrs. in Germany [4].

Declines have not only been observed among species with narrow habitat requirements but also among those which are broadly distributed and abundant. Anthropogenic pressure is shifting multiple insect communities towards species-poor assemblages and the affected insect groups not only include specialists that occupy particular ecological niches, but also many common and generalist species [5]. The current biodiversity losses and shifts in community composition could cause the extinction [6]. Species losses are expected to lead to a steady decay of insect mediated ecosystem services, which are likely to be provided by fewer and less specialized species [7, 8]. Five massive extinctions of life on earth have already occurred in the distant geological past, it is considered that the present day biodiversity extinction will be the largest in the history of life [9]. The extinction rate due to anthropogenic causes such as habitat destruction, overharvesting, pathogens, pesticides, addition of pollutants, urbanization, inclusion of invasive species and emission of greenhouse gases will be probably thousands times larger than the background rate [10]. Insects are not immune to this unprecedented wave of extinctions due to the reasons indicated above; they have also been neglected in relation to other more charismatic species [11, 12].

Despite the ubiquity of insects and their extensive connections to plants and other animals, declines in insect diversity and abundance are apparent in studies including faunal and biomass assessments and status reviews of key indicator groups [13].

3. Loss of abundant species

Conservation efforts have mainly focused their attention on protecting and conserving rare, charismatic and endangered species but the "Insect apocalypse" presents a different challenge. The sweeping declines of formerly abundant insects in addition to the loss of rare taxa have raised concern about ecosystem functioning [14].

The insect declines potentially have created global ecological and economic consequences. Not all insects are declining and many lineages have not changed rather increased in abundance [15, 16]. For instance: In Great Britain many species of moths have expanded in their range or population size [17]; numerous temperate insects, presumably limited by winter temperatures, have increased their abundance and range, in response to warmer global temperatures [14]; anthropophilic and human-assisted taxa, which include many pollinators, such as the western honey bee (*Apis mellifera* Linnaeus) in North America, thrive well due to their associations with humans; abundance of freshwater insects attributed to clean water legislation, in both Europe and North America [18]. In some places, native herbivores have flourished by utilizing nonnative plants as adult nectar sources or larval food plants [19], and there are even instances where introduced plants have rescued imperiled species.

4. Systematic drivers of insect decline

Despite great diversity of ecologies and life histories represented by insects in different regions and habitats, patterns are emerging that point to the primary drivers of insect declines. Most influential factors are habitat degradation and loss, excessive pesticide usage and climate change [20], although other factors include diseases, invasive species and pollution. Though Drizo *et al.* considered the insect decline due to multiplicity of factors, but they termed habitat destruction, deforestation, fragmentation, urbanization and agricultural conversion as the leading factors responsible in insect decline [21]. They captured the essence of the problem that the Insects are suffering from "death by thousand cuts" (**Figure 1**).

The potential reasons for Insect decline are as under:

- Habitat Loss
- Intensive use of pesticides and herbicides
- Pollution
- Introduction of invasive species
- Climate change

4.1 Habitat loss

Undoubtedly, the most serious cause of insect decline is their habitat loss. It takes place as natural habitats are being converted to human utilization areas such as croplands i.e., agriculture areas, urban areas and for infrastructure development (e.g. roads, industries, dams, power stations etc). The habitat loss eventually results in species extinction and loss of biodiversity. It is not an exclusively man-made phenomenon, habitat loss also occurs as a result of natural events such as floods, volcanic eruptions, earthquakes and climatic fluctuations.

Habitat loss can be broadly categorized into three major types:

a. Habitat destruction

b. Habitat degradation

c. Habitat fragmentation

Figure 1.
Death by a thousand cuts: Major drivers responsible for insect decline [21].

(a) Habitat destruction: It involves the processes by which natural habitat is destroyed or damaged as it remains no longer capable of supporting the species and ecological communities occurring naturally in that area. It results in extinction of species and ultimately loss in biodiversity at large [22]. Human activities such as clearing of land for various purposes like agriculture, mining, logging, hydroelectric projects, urbanization etc. directly destruct the habitats. It leads to species extinction but on the contrary opens up new opportunity habitats for evolution of new species, thus demonstrating the resilience of life on earth. Unfortunately, most species and communities are not able to cope with these changes as natural habitats are being destroyed at a much higher rate and spatial scale [23].

(b) Habitat degradation: The factors such as pollution, introduction of invasive species and over utilization of natural resources are causing decline in the biological conditions. This decline in biological conditions is further degrading the natural habitats. The habitat degradation reduces the quality of the environment, making it difficult for native plants and animals to thrive [24]. Habitat degradation is fueled by fast-growing human population. As the population increases, humans use more land for agriculture and for development of cities and towns which spread out over ever-widening areas. The effects of habitat degradation not only affect native species and communities but human populations as well. The degraded lands are frequently lost to erosion, desertification and nutrient depletion.

(c) Habitat or Landscape fragmentation: It involves the breakage up of a habitat or vegetation type into smaller, disconnected patches. The major consequence of land use involving agriculture activities, construction of roads, housing projects etc. are resulting in the fragmentation of existing habitats. This process involves three major steps i.e. Landscape dissection; Landscape perforation and Landscape attrition. Fragmentation reduces animal ranges and restricts their movement. It poses higher risks of extinction and decreases genetic diversity among them. It results in reduction of habitat area which automatically leads to:

- Increased Isolation i.e., habitat patches are no longer connected to each other which results in loss of biodiversity. Some species temporarily disappear and the net result is lower number of species.

- Smaller habitat patches

- Negative and positive edge effects

It is generally accepted among conservation biologists that the ongoing fragmentation and reduction in area of natural habitats is causing species extinctions at local, regional and global levels. The remaining areas of more-or-less natural habitats are increasingly becoming mere pockets with in a sea of habitats or in other words as habitat islands.

Several butterflies breed in the canopy (feeding on deciduous trees) but other in open spaces like clearings, glades, shrubs, hedges etc. The open spaces are also declining due to lack of management or re-plantation of coniferous trees which cast shade. Certain species namely *Boloria euphrosyne* (Linnaeus) and *Boloria selene* (Denis & Schiffermüller) have drastically declined in number. The populations breeding in fragmented habitats are likely to become extinct, through normal stochastic processes or by inbreeding depression. Hanski discussed about the butterflies which have been reported to occur frequently as meta-populations spanning in small patches of habitat [25]. The species depending on particular resources such as specific food plants for larval development or specific microhabitats are mainly affected by deteriorating habitat quality. However, sedentary species suffer more severely under the driver of increasing habitat isolation [26]. More extinctions are sure to occur if the loss of natural habitat around the globe does not slow or pace down [27].

4.2 Intensive use of pesticides and herbicides

The excessive use of fertilizers and synthetic pesticides in agricultural practices constitutes the second major driver of insect decline. The pesticide pollution is reported in 13% of cases, followed by fertilizer inputs (10%) and to a lesser extent by urban and industrial pollutants (3%).The systematic and widespread use of pesticides for controlling crop pests (insecticides), competing weeds (herbicides) and fungal infections (fungicides) forms the basis of modern intensive agriculture [28]. Insecticides are most toxic to insect life and other arthropods, followed by fungicides and then herbicides in terms of toxicity [29]. The herbicide application to croplands have more negative impact on both terrestrial and aquatic plants and insect diversity than any other agricultural practice [30]. The herbicides reduce the vegetation diversity within the crops and runoff, thus impacting indirectly on the arthropod species which are dependent on wild plants. This reduction results in either complete disappearance or significant decline in their numbers [31].

Insecticides such as pyrethroids, neonicotinoids and fipronils have devastating impact on aquatic insects and crustaceans due to their high acute and chemical toxicity [32], thus reducing their abundance significantly in water bodies. Neonicotinoids are known to kill monarch butterflies in the laboratory conditions and their lethal quantities are found in host plants of these butterflies in the fields [33]. These pesticides are persistent and leach into the soil and water courses as well as into field margins where certain butterfly species breed or forage. Neonicotinoids also play a major role in the decline of bees [34]. The exposures to even low doses of pesticides have complex and unpredictable sub-lethal impact on insect behavior. Bees when exposed to these pesticides get confused and are unable to find their way back to the hive. Even minute amount of neonicotinoids i.e., 1 part per billion in food impairs their immune system thus making them susceptible to diseases like deformed wing virus etc. Nakanishi *et al.* discussed about neonicotinoids as one of the major drivers of dragonfly decline in Japan [35]. The pesticides caused the decline in moth numbers in the rural areas of U.K [36] and pollinators in Italy [37]. Lundgren *et al*. concluded that the broad spectrum insecticides reduce the abundance and diversity of beneficial, ground dwelling and foliage foraging insects [30]. The systemic insecticides reduce population of ladybirds and butterflies in gardens and nurseries [38] and inflict multiple lethal and sub-lethal effects on bees and other arthropods. The residues of pesticides namely fipronil in sediments inhibit the emergence of dragonflies [39] and the development of chironomids and other insect larvae thereby having cascading effects on fish survival [40]. Hallamann *et al.* [41] demonstrated that 80% of the flying insect biomass losses in Germany were not caused by increase in agricultural land, deforestation or climate change but occurred due to intensive use of pesticides.

4.3 Pollution

Pollution covers a wide variety of substances that adversely influence insect fauna and their habitats.

The aerial nitrogen deposition is a harmful pollutant affecting butterflies. The ammonia produced by intensive livestock rearing and the emission of nitrogen oxides from vehicles are the chief sources of nitrogen pollution. It either changes the microclimate [42] or the nature of the vegetation where the butterflies breed. Nitrogen deposition encourages vegetation growth and reduces the amount of bare ground where *Lasiommata megera* (Linnaeus) commonly known as the wall or wall brown butterflies breed in Netherlands [43]. Nitrogen accumulation also leads to replacement of flowering herbs by grasses [44]. It reduces the availability for flower visiting insects and specifically larval food plants for many phytophagous species. Pollinators are adversely affected by the decline in flowering herbs [45]. Nitrogen deposition also results in cooling off warm microclimates resulting in the decline of butterfly species which overwinter as eggs or caterpillars rather than as adults or chrysalids [42]. This cooling off reduces the growth rate and chances of survival of such insects.

Light pollution also acts as driver of insect decline in suburban and urban locations. It has a significant impact on nocturnal insects such as moths [46]. The adoption of artificial lighting at night (ALAN) is a growing threat to biodiversity in general and particularly to nocturnally active insects. The ALAN have impact on vital behaviors of nocturnally active insects, including feeding, migration and dispersal, predator avoidance and reproduction, potentially with cascading effects on the diversity of insects and the ecosystem services that they provide. Brehm *et al.* [47] tested free flying individuals of 95 moth species with a choice of specific light wavelengths under controlled conditions. They observed that attractiveness increased with both light intensity and the shorter wavelengths. The insects that produce their own light i.e., bioluminescent insects of family Lampyridae referable to order Coleoptera variously known as fireflies, glow worms or lightening bugs for signaling are severely affected by ALAN. It distracts or disorientates either the courtship partners or simply reduces the efficacy of communication by flooding the background with illumination thereby decreasing the signal to noise ratio. Deichmann *et al.* [48] suggested that switching to lights of longer wavelength in order to minimize the adverse effects on majority of insects in turn attract bioluminescent insects thereby posing threat to their survival. Langevelde *et al.* [49] studied the effect of artificial light on feeding behavior of moths. They observed that the moths subjected to artificial night lighting spend less time in feeding than in darkness, with shortest time under light conditions rich in short wavelength. Boyes *et al.* [50] suggested that the diurnal adult stages of Lepidoptera are indirectly affected by the impacts of ALAN on their nocturnal feeding caterpillars. Therefore, restoration and maintenance of darkness in illuminated areas is essential for reversing decline in moth populations. Kalinkat *et al.* [51] highlighted the scarcity of evidence that ALAN has made any significant contribution to decline in insects.

The biggest future challenge is the assessment and documentation of impacts of ALAN on individual insects and their detectable effects over long time scale on the dynamics of populations, communities and ecosystems.

4.4 Introduction of invasive species

Invasive species are among the largest threats to biodiversity in the world. According to International Union for Conservation of Nature (IUCN) an invasive species is an alien species which becomes established in natural or semi-natural ecosystems or habitats. It is an agent of change and threatens native biological diversity. Invasive species possess specific traits or combination of traits that allow them to outcome native species. These species tend to have the following traits [52]:

- Fast growth
- Rapid reproduction
- High dispersal ability
- Phenotypic plasticity i.e., the ability to alter growth form to suit the current conditions
- Tolerance of a wide range of environmental conditions- Ecological competence
- Ability to live off on a wide range of food types

- Association with humans

- Prior successful invasions

According to Rejmanek & Richerdson [53] invasive species tends to be hardy with long life span, voracious feeding habits, aggressively pervasive, very resilient, rapid growth, generalized diet, ability to move long distances and most significant is its profilic breeding. Although, these species pose a substantial threat to biodiversity but may also increase evolutionary diversification due to expansion of geographic range, increase in number of generations, breakdown of host plant resistance etc.

In ecosystem, predators, herbivores and other wildlife evolve alongside each other, regulating each other's populations. But a non-native species can disrupt that balance and wipe out organisms resulting in large populations of the invasive species. Invasive species have profoundly reduced biodiversity in some ecosystems. Human mediated redistribution i.e., both deliberate and accidental distribution of insect species has led to decline in many native species through competition or with displacement by invasive species. The accidental introduction of an Argentine ant species into the unique vegetation community of the Cape Province of South Africa is a notable example. It has led to the decline of indigenous ant species adapted to disperse the seeds of many plants. The reliably identified causes showed that the invasive species contributed directly to the demise of 91 (54%) of 170 extinct species. Particularly, the rates of extinction occurring on islands have been greatly elevated by the introduction of novel predators. Several ecological and life history attributes of island species, such as their naturally constrained geographic range, small population size and particular traits make island biota vulnerable to predation from invading species [54].

A recent study pointed out that an increase in the spread of non-native plant and animal species around the world could lead to dramatic biodiversity loss, causing permanent damage to ecosystems. Prof. Helen Roy of UK Centre for Ecology & Hydrology said: "With invasions, it's not that were trying to return to some kind of pristine environment or some kind of norm, but it's around the functioning of those ecosystems. And that's we need to have a much better understanding of."

4.5 Climate change

Over the course of time, there have been repeated cycles of climate changes and these changes have driven massive alterations in the distribution of species across the Globe. Individual species have experienced alternating episodes of expansion, contraction and fragmentation of ranges. Now, it is the humans who are driving the range shifts and extinctions and doing so in an accelerating fashion on a global scale. Human mediated climate change represents a potentially disastrous sleeping giant in terms of future biodiversity losses. Climate warming can affect species in five principal ways:

- Alterations of species densities including altered community composition and structure

- Range shifts either pole-ward or upward in elevation

- Behavioral changes such as phenology i.e., changes in seasonal timing of life cycle events of migration, breeding and flowering

- Changes in morphology such as body size
- Reduction in genetic diversity that leads to inbreeding depression

Climatic changes alter almost every aspect of plant and animal diversity and particularly insect diversity. The significant alterations may be summarized into following categories or responses [55].

1. ORGANISMAL RESPONSES
    - Genetic responses
    - Behavioral responses
    - Morphological responses
2. POPULATION-LEVEL RESPONSES
    - Population and range expansion
    - Population and range retraction
3. PHENOLOGICAL RESPONSES
    - Voltinism
    - Early emergence and asynchronies
4. COMMUNITY RESPONSES
    - Trophic mismatches

Climate changes have both positive and negative effects on insects especially butterflies. The rapid growth of natural vegetation and the problems associated with intermediate successional vegetation due to climatic change affects the microclimate or the nutritional quality of food plants [56]. The dense vegetation favors drought conditions leading to hot, frequent fires having detrimental effects on insect taxa which are not adapted to high temperature conditions [57]. Multi-voltine species are declining less rapidly than uni-voltine ones in UK [58] whereas the opposite is the case in Mediterranean region of Spain [59]. Phenological plasticity is observed in many species as an indicator of resilience to climate change. The species with complex life cycles i.e., holometabolus insects particularly butterflies suffer from developmental traps if environment cues to enter diapause are disrupted e.g. *Lasiommata megeara* Linnaeus (Wall brown butterfly) in Belgium [60].

Climate change is predicted to increase the frequency of extreme weather events like droughts and floods. Droughts lead to rapid decline in insect populations particularly butterfly abundance. Prolonged rainfall and storms reduce breeding success resulting in reduction of overall population size. Schowalter *et al*. [61] concluded that insect responses to temperature within Puerlo Rico's Luquillo experimentation forest, a hurricane mediated ecosystem are driven principally by storms and post-storm effects rather than by global climate warming. The geographical ranges of some insects have started to shift in response to climate. The European and North American bumblebees tend to disappear from the southern edges of their range [62] and occupied higher elevations in mountainous region [63]. Bark beetles in North America have become more abundant due to warmer winters resulting in defoliation of coniferous forests. The increased frequency, intensity and duration of extreme weather condition events disrupted food webs, producing seasonal mismatches between specialized insect pollinators and the plants associated with such insects. Climate change especially warming temperature makes conflict between morphological traits such as dispersal. The selection for reduced body size in warmer environment leads to associated loss of dispersal capacity. Wu *et al*. [64] studied the reduction of wing size in Bornean geometrid moths at high altitude and linked it to uphill shifts of smaller species after four decades of warming. This unequal redistribution of different sized species significantly affects community size composition.

Genetic variation allows a species to develop tolerance in different environments as selection acts on dispersal capacity [65]. While studying the thermoregulation and behavior of lowland species of a cold-dwelling butterfly genus *Erebia Dalman,* Kleckova and Klecka concluded that the selective pressure on butterfly populations altered due to anthropogenic mediated climatic changes and led to allele frequency shifts associated with dispersal [66]. Genetic polymorphism in *Pgi* gene encoding phosphoglucose isomerase influences key history traits in adult insects including dispersal, flight metabolism, longevity and fecundity [67]. *Pgi* heterozygote butterflies have increased fitness in cooler climates as they are capable of flying at lower ambient temperature than their homozygote counterparts [68]. In *Araschina levana* (Linnaeus) (map butterfly) individuals have higher levels of dispersive *Pgi* alleles at new colonized sites even though no morphological changes which improve flight performance such as increased wing or thorax size are seen [69]. *Pgi* alleles are also associated with heat resistance in Lepidoptera. In *Colias* butterflies, the genotypes that are most heat stable have low fecundity, so selection for heat tolerance greatly reduces population sizes [70]. Another molecular marker important in response to climate change is the heat shock protein (Hsp70). It plays a critical role in helping insects to survive in extreme temperature by increasing tolerance [71]. Both *Pgi* & Hsp70 offer a robust comparison of key genes and phenotypes directly impacted by changing climate.

All the forces or factors may act independently or synergistically and thus identification of a single cause of a particular species extinction event is difficult. For instance, habitat loss may cause some extinction directly by removing all individuals, but it can also be indirectly responsible for extinction by facilitating the establishment of an invasive species or disease agent, improving access to human hunters, or altering biophysical conditions. As a result, any process that causes a population to dwindle may ultimately predispose that population to extinction. When climate change and habitat loss act synergistically with each other, leads to a deadly anthropogenic cocktail which is more deadly when there is an increase in intensity at the same time [72].

The cognitive abilities of honeybees have found to be impaired by low electromagnetic fields such as those created around high-voltage cables. Shepherd *et al.* concluded that this has contributed to bee colony losses and more broadly could impact on insect navigation and dispersal [73]. It seems that there are other human activities which affect insect health in many ways and are yet to be recognized and assessed by scientists for their impact on the insects and their environment.

5. Future steps in conservation strategies: a call to action

Being the major constituents of biodiversity, insects have high ecological and economic importance. These creatures play key roles in species interactions and constitute a major component in all food webs to provide resources for organisms at higher trophic levels [61]. Insect decline is not the prime matter of concern but highly important for well-being of humanity. The necessary conservation activities needed to counteract main drivers of insect decline are also equally important. The following steps are required for developing conservation strategies of insect fauna:

1. Conservation of high quality habitats: The first and foremost priority is to protect high quality insect habitats. For this, high quality habitats in the agricultural matrix have to be reestablished with extended size as small and isolated nature reserves are not able to guarantee long lasting preservation of insect species [74].

2. Increasing landscape permeability: Healthy population network with high functional connectivity is the main reason behind long term persistence of many species [75]. The government authorities should provide economic incentives for ecosystem conservation and such incentives help to stop landscape fragmentation, in creation of additional high quality habitats and improvement in quality of existing habitats such as reversion of monotonous, high productivity grasslands into diverse flower rich meadows. The ecological intensification of agriculture e.g. field margin extension and roadside ecological landscaping increase habitat connectivity in an area of flowering plants and improves the landscapes to insect friendly conditions; grassy strips encourage ground beetles to move into adjacent fields [76]; small temporal fallows of arable fields improve condition for bumble bees and butterflies. It acts as long term insurance policy for future delivery of irreplaceable and essential insect services.

3. Safeguarding habitat quality: The detrimental effects of pesticides and herbicides have to be reduced both in agricultural and urban arenas particularly neonicotinoids which reduce the capacity of bee species to establish new populations [77]. The chemicals known to strongly harm insect diversity even in sub lethal doses should be banned. Organic farming practices along with in field plant diversification greatly benefits insect fauna especially pollinators.

The insect decline and conservation have to be understood as a societal and economic challenge along with scientific concern [78]. It requires six basic requisites, all on economic viable platform i.e.,

- Philosophy (establishing the ethical foundation)

- Research (the finding out)

- Policy (framework for action)

- Psychology (understanding how to engage humans in insect conservation action)

- Practice (implementation of action)

- Validation (establishing how well we are doing at conserving insects)

There must be a coordinated effort among scientists, NGO's, policy makers, funding agencies, science communicators and citizens around the globe to find solutions to curb decline in insect diversity and abundance.

6. Conclusion

Insects act as key components for the functioning of the world's ecosystems. Insects create the biological foundation in all ecosystems by cycling nutrients, pollinating plants, dispersing seeds, maintaining soil structure and fertility, controlling populations of other organisms and by providing major food source for other taxa. Their accelerated decline in numbers and extinction due to anthropogenic activities cause unpredictable negative consequences for the biosphere. Declines have not only been observed among species with narrow habitat requirements but also among those that are broadly distributed and abundant. Anthropogenic pressure is shifting multiple insect communities towards species-poor assemblages dominated by experts [79]. The falling number of insect populations is likely due to a multiplicity of factors, habitat destruction, deforestation, fragmentation, urbanization and agricultural conversion being among the leading factors. All the forces or factors may act independently or synergistically and thus identification of a single cause of a particular species extinction event is difficult.

Insect decline is not the prime matter of concern but the necessary conservation activities required to neutralize main drivers responsible for insect decline are mainly important for well-being of humanity. Not only the Government and legislative actions are required, even the action of individuals can create immediate impact. It is justified by a simple fact that conserving even a backyard or apartment balcony can be an important stopover for the smallest insect groups upon which we all depend.

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