Moths as ecological indicators

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Abstract

Nothing has more substantially covered the dangerous and unpredictable nature of anthropogenic activities like climate change and which, according to predictions can cause an increase in overall temperature of the earth, change the land use pattern, bring storms and heavy rains, provide a drier climate and forcefully migrate millions of people and other organisms. However the uncertain nature of the changes calls for the use of an indicator and not many have been found to be better in doing the role than butterflies and moths. Ectothermic organisms are affected by changes in the climate directly and show changes in dispersion, mortality, reproduction and development. Various studies were conducted using transect walks and light trap methods to determine the feasibility of using moths as ecological indicators and the results confirmed their suitability for the same though we need many more studies in further depth in future. Moths are found to be suitable as indicators for both open areas as well as forest patches.

Introduction

The impacts of anthropogenic activities on the ecosystem have increased drastically over the last century. The acceleration of human needs and aspirations from a planet having finite resources has led to destruction of the

ecosystem. The quest to development has resulted in many ecological changes. Research has been going on to determine if any group of organisms can be used as an indicator of these ecological changes.

An ecological indicator notify us about the small changes taking place in the surroundings and at times helps us to diagnose the cause of the issue leading to ecological transformation. Basically they are used to determine the health or the condition of an ecosystem. The ecosystem functioning and services are affected by numerous factors such as climate change and an increase in population. The purpose for which a particular species will be chosen as an ecological indicator depends on several factors such as the desirable traits, feasibility to analyze and cost together results into the choice of indicators. Ecological indicators quantify the magnitude of stress, degree of exposure to the stresses, or degree of ecological response to the exposure

(Hunsaker and Carpenter, 1990; Suter, 1993)and are intended to provide a simple and efficient method to examine the composition, structure, and function of complex ecological systems(Karr, 1981). The use of ecological indicators relies on the assumption that the presence or absence of, and fluctuations in these indicators reflect changes taking place at various levels in

the ecological hierarchy, from genes to species and ultimately to entire regions(Noon et al., 1999).

Interest has turned towards selecting that group of organisms as indicators that can be monitored of any type of change in an ecosystem. Moths belong to the order Lepidoptera which in general are accepted as sensitive indicators of environmental quality and changes(Erhardt, 1985; Kudrna, 1986; Kiser, 1987; Porter et al., 1992; Thomas, 2005; Wirooks, 2005)and are considered to be important for ecosystems because of their roles as pollinators, prey for many organisms such as bats and as herbivores and it is generally assumed that moths are suitable ecological indicators(Blab and Kudrna, 1982; Weidemann, 1986, 1988; Ebert and Rennwald, 1991; Hofmann, 1994; Asheret al., 2001; Wirooks, 2005; Settele et al., 2009).

In this literature review, we deal with the current knowledge about the change in moth population in different parts of the world and the potential drivers of change and even analyze the sensitivity and applicability of moths as ecological indicators. The principle drivers of loss of biodiversity, habitat degradation and climate change were examined in relation to the moth population.

Depending on the dimension of the disturbance, local to regional dynamics of insect populations and species

composition will be strongly affected(Bouget and Duelli, 2004).

The difference in the diversity and abundance of moths were measures by various diversity and richness indices and various statistical operations such as principle component analysis was performed.

Therefore, moths are preferred organisms to quantify ecological damage because the change in their distribution or abundance is directly related with the potential change in the community.

Methodology

The literature review was done by searching for peer-reviewed journal articles. The articles that dealt with moth as an indicator of any of the disturbance were included in the assignment. The articles The list of the articles included in the assignment along with its brief conclusion has been mentioned in the table below. The methodology that the literature states, begins with the selection of suitable indicator species. The initial screening has to be done on the basis of various ecological and economical criteria which vary in all the studies.

Once the indicator species has been selected, the data collection was done mainly by using light traps and transects method over different spatial and temporal

scales.

The collected data was then compared with the past data and then the difference was computed. The development of matrix was done on the basis of the collected data and Principle Component Analysis was done.

Author	Year	Location	Objective	Results	Conclusion
Kitching *et al.*	2000	Australia	To determine the Moth assemblages as indicators of forest quality	Some species showed a decrease in the relative abundance with increased disturbance and vice versa	Moths acts as an indicator of presence or absence of host plant species
Summerville *et al*.	2004	North America	To assess whether Moths can be used as	Species richness was found to be higher in	The studied moth taxa can be used as indicators

			indicators of habitat changes within forest sites	unlogged areas as compared to clear cut recovering areas	of habitat changes within forest sites
Netherer and Schopf	2010	Europe	To determine the effects of climate change on moths in European forest ecosystems	The increase in temperature creates a negative effect on maintenance and termination of diapause	Moths are sensitive to temperature change and can be used as indicators
Rakosy and Schmitt	2010	Carinthian Alps	To study the effects of restoratio	The number of moths decrease	The habitat transformation led to negative

			n on moth populatio n	d after restoratio n in the site	effects on moth population
Dieker *et al*.	201 1	Pyrenee s	To determin e whether changing climate or changes in grazing intensitie s influences moth distributio n	Climate change led to an uphill movemen t and even extinction of the studied moth species.	Moths are suitable ecological indicators mainly for forested and open areas.

Results

Articles from peer-reviewed journals, revolving around the topic of moths as ecological indicators, were collected and reviewed. The articles dealt with various studies conducted in different parts of the world and reveal the relationship between various anthropogenic impacts on

ecosystem and change in moth diversity.

To begin with, the studies carried out in the Australian rain forest, the moth assemblages were considered to be an effective indicator of the ecosystem. Light trap method was used to study the differences in diversity and richness of moths between the disturbed and undisturbed sites. As a result, a clear decrease was accounted in the number of moths of few of the studied species from less disturbed to more disturbed locations whereas few other species showed the exact opposite response. The reason behind this variation in the response could be the presence of the flora on which that particular species depends for its food. The literature shows that the moths present on the undisturbed site were mainly dependent on those large trees and the moths on the disturbed sites depend on herbaceous plants.

Another study was carried out in the Eastern deciduous forests of North America where several moth families were studied as indicators of habitat disturbance. The selection of moth species was done on the basis of ease of sampling and the ease of identification. A comparative study was done in terms of accessing the moth communities of the prevailing forest edge and that of the interior habitat. Forest edges, recovering clear-cut stands, and small forest remnants were considered disturbed habitat types(Brown

and Hutchings, 1997; Usher and Keiller, 1998; Hamer and Hill, 2000; Summerville and Crist, 2003). There was a considerable decrease in the species richness in the interiors as compared to that of the edge. This shows that the selected species of moths can be considered as indicators of habitat disturbance.

The phenomenon of global warming has devastation implications. The next study deals with the effects of climate change on moths in the forest ecosystem. The change in climate leads to an increase in temperature which in turn leads to termination of diapauses. It is a condition during which the development is on a standstill. This is considered to be a good example of indicator of climate change.

Another article deals with the study carried out in Carinthian Alps in the years 2002 and 2004 which dealt with the study of population trends of moths as a result of restoration and the conservation and control sites were defined and monitored. It revealed that there was a decrease in the number of moths from 2002 to 2004 but the decline was more in conservation sites that control ones. This decline was attributed to the transformation of dense forest like habitats into open landscapes with the final outcome of semi natural grasslands with are rich in

species.

Therefore, the transformation from forest to open habitat is considered to be negative for moths. Moths proved to be an effective indicator to define the health of a forest ecosystem. The final article is based on the similar concepts and addresses the impacts of climate change on moth populations.

Discussion and conclusions

The study involved a literature review of several articles from peer-reviewed journals and was focused on the consideration of moths as ecological indicators. The main factors identified were: the effects of restoration, habitat changes, climate change and other anthropogenic activities on the moth population and the way in which they respond to it.

Overall, the review revealed that the influence of the above mentioned factors on moth population has been well studied. However, there were many constrains in the studies. The studies were mainly limited to the local scale and local geographical and environmental conditions which can be considered as a limiting factor.

The selected species of moths might be considered as an accurate indicator of ecosystem quality the articles reflected the same. The selection of such an indicator

species to monitor the health of an ecosystem can be considered as a powerful tool for the analysis. It can be noted from the articles that climate shifts are the drivers of extinctions and the habitat contractions of moth species.

It can also be inferred that the role of the host plant plays a major role, in the response of moths, towards ecological changes. As we saw in one of the articles, few species of moths showed higher richness in the disturbed sites because of the presence of the preferred plant.

We can even compare the inferences of this article with the results we obtained at Agumbe Rainforest Research Station, where we studied the moth diversity over three different sites. By taking into consideration the results of the Shannon-Wiener index, the highest diversity was obtained in the forest site which was the least damaged as compared to the other two sites where the damage was comparatively higher. However, we cannot completely rely on the results because the study was too short. An inference can still be made out of it because the disturbance had negative impacts on moth diversity.

Therefore, the decline in the moth population has been a matter of concern and these declines point towards the catastrophic loss of biodiversity because of anthropogenic

environmental and habitat changes.

On a concluding note, I would like to say that a future research based on the impacts of anthropogenic activities and climate change and its relation with moth population is necessary.

An understanding has to be developed regarding the decrease in moth population and related conservative steps has to be taken.

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