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The effect of the environmental factors on insect diversity

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Abstract :

Distribution of the most diverse groups of insects is highly related to the structural complexity of the plant community, and increasing complexity, in turn, correlates with increasing diversity, richness and abundance of insects. The primary goals of this study are to investigate the species diversity and endemism of Typolite in the areas surrounding the Qinghai Tibet Plateau, as well as to investigate the relationships between the diversity pattern and 25 environmental factors in mountainous and non-mountainous regions. In addition, the study will investigate the endemism of Typolite in these areas. In order to do this, we compiled a total of 2589 records on the distribution of 1219 unique species of Typolite. These datasets cover the whole world. As a consequence of this, we came to the realisation that there are three locations in the region that are close to the QTP that contain Typolite in a high variety. Gogga Mountain, the Kamen River Basin, and the Sikkim-Yalong Region are the three regions under question. Richness and endemism of Typolite are predominantly controlled by hottest quarter precipitation and topographic heterogeneity in mountainous locations; whereas, in non-mountainous regions, richness is mostly affected by precipitation seasonality. There is no regularity in the connection between endemism and environmental parameters. In addition, the richness model applied in mountainous regions generated findings that were comparable to those generated by the GAM.

Keywords: *environmental , diversity, insect*

Introduction

It is possible for the connection between species diversity and environmental heterogeneity to differ depending on the species group being researched. This variation may be due to the fact that the correlation can be affected by both biotic and abiotic variables. However, the distribution of the insect groups that contain the greatest diversity is strongly correlated with the structural complexity of the vegetation. In general, the richness, variety, and abundance of insects rise as the environmental variability increases. This was proven to be true in the order Coleoptera the order Hymenoptera and the order Orthoptera.. Studies have shown that environmental heterogeneity leads to a decline in both the variety and number of insect fauna, which is damaging to human and animal activities that generate disruptions in the structure of vegetation. These disturbances might be caused by human or animal activity Additionally, the replacement of native flora with invasive plants, which are frequently montypic in nature (for instance, regions with Pinus spp.), might directly interfere with the diversity and number of insects Additionally, heterogeneity has a direct impact on the availability of resources as well as the conditions that are suitable for soil organisms (Warren and Zou, 2002). For instance, the Orthoptera family Gryllidae has become more abundant in settings that are more closed, or heterogeneous. This is due to the fact that these locations contain a high relative humidity as well as a significant amount of trash and organic waste (Azevedo et al., 2011). One of the most important factors that determines the species composition of a forest is its structure (Spies, 1998). Through the use of predictive analysis of co-correlation and comparisons between the composition of arthropods and plant species, Schaffers et al. (2008) were able to establish that flora is the most efficient indicator of the composition of arthropods. As a result, several researchers have lately adopted a heterogeneity index, also known as HI, to reflect such composition by making use of various factors This index was first introduced by Morato (2004). (2009). The establishment of guilds is one method that may be used to investigate the complex interaction that exists between different species and their respective environments. According to the definition given by Root (1967), a guild is made up of a collection of species that exploit the same category of natural resources and do so in a manner that is analogous to other exploitation patterns. Because it is a functional unit, the guild makes it unnecessary to consider each species as a separate entity, which makes it an interesting unit for research relating to interspecific interactions as well as analysis of communities. This makes the guild an interesting unit for both types of research (Odum, 1985; Fauth et al., 1996). The purpose of this study was to investigate the influences that environmental variability has on the species richness, abundance, and trophic guilds of insect communities. In addition, the research was conducted with the presumption that an increase in the environmental heterogeneity would lead to an increase in the richness, quantity, and frequency of occurrence of trophic guilds.

A-biotic factors

Arthropod populations are being negatively impacted over time as a result of both natural and manmade changes that are taking place in the ecosystem in which they are located. Certain factors, such as the effect of temperature, are modifying the status of the pest by reducing or increasing its genetic potential, rate of fecundity and mortality, and range of hosts. This is happening because these factors are being influenced by environmental factors. When absorbed by the photosynthetic system, varied wavelengths of white light, most notably red and far-red light, provide as a clear indicator of the proximity of hearers, hence eliciting favourable developmental responses such as shadow avoidance responses. When the temperature was raised to 35 degrees Celsius, even the adults that had emerged from these pupae were unable to lay eggs when they reached adulthood. Because of this, the young of the species Cnaphalocrosis medina, which is also known as the rice leaf folder, had a lower chance of surviving to adulthood. Some biological control agents, such C. dividends, which is an egg predator, have demonstrated a favourable reaction to predation and a reduction in the length of time required for handling.

Insects Responses to High Temperature

Temperature is the one environmental factor that has the most impact on whether or not an insect's life cycle is stretched or shortened as a result of its surroundings. Temperatures that are sufficiently high can have an effect on the stage of the insect's life cycle, the rate at which it develops, and even some of the insect's internal metabolic activities. For instance, researchers found that the egg period for Chelicera armiger was 7.9 days when the temperature was 28 degrees Celsius, but that it rose to 10.4 days when the temperature was 25 degrees Celsius. There is a negative correlation between an increase in temperature between 10 and 27 degrees Celsius and the number of degree days necessary for hatching. When the temperature was increased by three degrees, it was anticipated that the generation period of L. acuta would increase by between one and three days. A number of abiotic factors, most notably the salt of the soil, had a crucial role in determining the fitness and chances of survival of terrestrial insects that lived in coastal habitats. This was especially true in locations where the soil had a significant amount of salt. In the case study that was carried out in Korea between the years of 1992 and 2008, the effects of global warming on rice insect pests as well as the influence of other climatic factors were explored. Experiments were performed on a total of eight different domains, and the findings were categorised into groups based on their similarities (I, II, III, IV). Both sets of data—those used for the first two clusters and those used for the last four clusters—were collected prior to the year 2000. When contrasted with the population of L. cryophiles, which had a high density in clusters III and IV, the population of S. lurid had a reduced density in both clusters III and IV (I, II). Herbivorous insects were utilised in another example study that was conducted in European woodlands to evaluate the consequences of climate change, namely global warming. Through the interactions with the community that they took part in, ectothermic organisms demonstrated a substantial response against dispersion, fecundity, mortality, reproduction or multiplication, and resistance. When Thaumetopoein Pity Campa was monitored, it was shown to have a considerable influence on the intensity of the altitudinal and latitudinal dispersion. This impact was measured by the thermal effect, which is an indicator of the change brought on by global warming [40]. The effect of heat or the conditions of drought can also have an effect on the population dynamic of the biological control agent.

Eggs of the Asian lady beetle, Harmonia axiids, were subjected to temperatures of 41, 39, 37, and 25 degrees Celsius, respectively, in a sequence of escalating heat treatments. The temperature that was set at control was 25 degrees Celsius. After being exposed to the elements for an hour at room temperature, these eggs were then placed back in the incubator and heated to 25 degrees Celsius, where they remained until they hatched. After being incubated at a temperature of 41 degrees Celsius, the eggs did not develop any larvae even if the temperature was increased. Although the Asian lady beetle showed significant changes in response to heat effect in terms of weight, survival, longevity, development, and reproduction, these aspects did not reflect the same pattern. The change in temperature had a detrimental impact on the total reproduction of the insect, as well as the duration of the oviposition phase and its overall lifetime; however, it had a positive impact on the preoviposition period. Insects have different responses to temperatures as low as 9 degrees Celsius and as high as 55 degrees Celsius, which results in an increased number of individual insect deaths. After 9 months of storage at 45% relative humidity, the death rate of some species of insects, such as coleopterons, can reach > 99 degrees Celsius when the temperature is lower than 6 degrees Celsius. Temperatures up to 10 degrees Celsius are ideal for the growth of insects. When exposed to temperatures of 50 degrees Celsius, nearly every species of isopteran and coleopteron dies within two and a half hours. The proboscis of certain sucking insects, such as the blood sucking bug (Rhodium prolixus), becomes longer as the insect consumes its food, allowing it to penetrate deeper into the body of the victim. The strength of this proboscis action response (PER) might vary depending on the temperature of the item being probed as well as the thermal effect of the environment in which it is being probed. When the temperature of the thermal background was lower than 35 degrees Celsius, temperatures of 30 and 35 degrees Celsius produced the biggest triggering reaction of PER in Rhodium prolix us. It was discovered that insects prefer temperatures that are optimum, such as those observed in the majority of mammalian species, for maximum proboscis extension response. This was discovered by comparing insect temperatures to mammalian temperatures. Several physiological processes and the varying ambient temperatures were shown to have a significant association with one another in the case of the fluctuation of the insect population that has to be regulated for the purpose of pest management. After being exposed to radiation, two species of flies, a medfly (Ceratitis capitata) and a natal fruit fly (C. cross), displayed a temperature sensitivity that was utilised in the sterile insect approach. In the field trials, the mutant species displayed a better lifetime under the conditions than the other species. This is beneficial for the male sterile insect strategy since it reduces the risk of transmission of infectious diseases. Insect species that live in tropical environments are thought to be more susceptible to the effects of microclimatic shifts and behavioural adaptations than insect populations that live in temperate environments. Ants of the species Irideremia purpures are able to continue their search for food for a short period of time even when the temperature of the soil is 45.81.3 degrees Fahrenheit higher than their thermal limit. The use of plastic reactions in an attempt to assist ants in developing a greater tolerance to the effects of temperature was futile.

Immune genetic responses

When exposed to environmental stress, certain insects, like mollusks and crustaceans, have their immune systems altered because this increases the neurohormone or stress hormone. Other insects, like beetles, do not have their immune systems affected. As a direct consequence of the alteration that took place inside these invertebrates' internal milieu, changes have been observed that have the effect of suppressing the immune system. Malpighian tubules, which are responsible for minimising the impacts of environmental stress and play an important part in the continued existence of insects, are responsible for neutralising these consequences. The immunological characteristics that are perturbed by food include the activity of myelinization, the level of lysozyme, and phenol oxidase (PO); more precisely, the amount of carbohydrate consumed influences the activity of phenol oxidase. Because of the impact of temperature, the immunological parameters, as well as the activity of phenol oxidase and anti-bacteria, were more robust at 30 °C than they were at 10 or 20 °C. This was the case even when all three factors were tested at the same time. There was not a discernable change in the typical metabolic rate between the various immunological therapies. The conclusion is that the temperature of the environment around an organism has a significant influence on both the amount of energy that is required for immunity and the immune system's reaction. An examination of the thermal connection was carried out against insects at temperatures of either 18 or 26 degrees Celsius. It was discovered that the relationship between a person's metabolic rate and temperature, which is commonly referred to as MR-T, has a significant influence on adult treatments.

In the stage of development known as the aquatic larva, phenotypic plasticity was shown in response to the influence of temperature. The ovarian dynamics and reproductive plasticity of butterflies (Parerga aegeriid) are influenced by a number of environmental variables. Some of these elements are inherent to the species (body mass and age), while others are extrinsic to the species (temperature and flight). When travelling by aeroplane, the temperature effect is much more noticeable than the ion dynamic. Because of the constantly shifting water content, flying might have an impact on the total mass of the egg. As the temperature rises, the rate of respiration and metabolism in insects speeds up. Insects also tend to produce more waste products. The departure of critical temperature points from their upper and lower limits also has an effect on the endocrine and neurological systems, which in turn has an effect on development, changes in behaviour, and the elicitation of a variety of heat shock proteins.

Aquatic insect biodiversity

Lakes containing freshwater are an essential component of the urban environment, and they offer a variety of advantages to different groups of people, either directly or indirectly. Aquatic insects are incredibly essential to ecological systems for a number of different reasons, and they are the first bio-indicators of freshwater bodies including lakes, ponds, marsh, and rivers. There are also many reasons why aquatic insects are significant. According to Majumder et al. (2013), the presence or absence of particular families of aquatic insects may be used to determine whether a particular body of water is healthy or contaminated; however, only 3% of all species of insects have aquatic stages in some freshwater biotopes. Due to the fact that aquatic insects have varying reactions to the stimuli that are present in their natural environment, this makes them ideal for use in the process of assessing the overall quality of aquatic ecosystems and ensuring their continued viability (Merritt et al., 2008). There is a huge variety of aquatic insects, but the major categories include mayflies, stoneflies, true bugs, dobsonflies, water beetles, tricopterans, true flies, dragonflies, and damsenflies. Mayflies and stoneflies are two of the most common types of aquatic insects (Voshell, 2002). Biodiversity of insects that produce bioluminescence: Bioluminescence, also known as living light, is a fascinating phenomena that may take place in creatures that are currently existing on earth. In bioluminescence, an energy reaction takes place that results in the emission of light. In nature, one will not find any bright blooming plants, birds, reptiles, amphibians, or mammals. Although it may be produced by a wide variety of creatures, bioluminescence is particularly well developed in insects. Collembola, Diptera, Coleoptera, and Homoptera are the four orders of insects that have been shown to have examples of genuine or self-luminescence. The Coleoptera are the most numerous bioluminescent order, and it is estimated that several hundred species within this order have highly developed photogenic organs. The families Lampyridae, Elateridae, and Phengodidae are home to some of the most well-known and easily understood luminous insects. Because the females of some species of lampyridae lack wings and live a sedentary lifestyle, the creation of light is critical to the species' reproductive success (Babu and Kannan, 2002).

This biological phenomena has been utilised in the fields of space research and medical research, as well as in the control of insect pests, and it is also an important instrument in biotechnology. The following is a list of the insect fauna found in India's states and union territories: The insect fauna of India is found in a wide variety of habitats, climate zones, and elevations. The distribution of insects is mostly determined by ecological, climatic, and edaphic variables, such as the kind of vegetation, the amount of rainfall, and the temperature. Palearctic components have an effect on the insect fauna that lives in the Himalayan Zone. This zone includes the mountains of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, north-west Bengal, Meghalaya, and Arunachal Pradesh. However, due to the fact that the mild temperatures in these states can vary greatly from place to place, the insect fauna that lives in the deserts of Rajasthan, Gujarat, and Ladakh (the cold desert) can be quite different. Although the island ecosystems of the Andaman and Nicobar Islands and the tropical humid forests of the Western Ghats and the eastern Himalaya are distinct from one another, the tropical humid forests of the Western Ghats and the eastern Himalaya are home to the highest number of endemic species (ZSI, 2012). The tropical evergreen forests of the eastern Himalaya, as well as the hills of north-east India including the states of Sikkim, Meghalaya, Arunachal Pradesh, Manipur, Nagaland, Tripura and Mizoram and north-west Bengal, are home to the greatest number of insect species. This is followed by the states that are contained within the Western Ghats, including Kerala, Tamil Nadu, Karnataka, and Maharashtra. The western Himalayan region and the Andaman and Nicobar Islands jointly hold the third spot on the list of the world's most diverse locations when it comes to insect species

(ZSI, 2012). There are still a great many inhospitable regions around the country that have not been fully studied for the purpose of determining the diversity of the insects that live there.

Why it's crucial to have a diverse collection of insects: The silk industry, beekeeping, and the pollination of the majority of our fruit and a wide variety of other agricultural products are all examples of crucial economic roles that insects play, sustaining and providing livelihoods for a diverse range of people. The outlines of insects and the colourful patterns that cover their bodies have inspired significant contributions to our art, literature, and culture, and they provide excellent resources for teaching and learning (Pyle et al., 1981). In many parts of the world, the human diet includes insects as an important source of protein. Chinese medicine places a significant significance on the use of certain insects. For instance, the Chinese fungal medication Dong chongxiacao (Cordyceps sinensis) is the plant organ of a parasitic fungus that develops within the larva of a ghost moth. This drug plays a very important function in traditional Chinese medicine and has a very long history. The use of insects in biological control of pests is another prominent application of insects. When it comes to the management of economically destructive insects, it is common knowledge that insect predators are more effective than many insecticides. Because of their obviousness and their sensitivity to the effects of the environment, many different insect taxonomic groups can be utilised as bioindicators (Kati et al., 2004). As an illustration, the dynamics of butterfly populations have been proposed as indicators of species richness for pollinators as a whole and of the structural and floristic diversity of habitats. In addition, butterfly population dynamics have been proposed as indicators of changes in temperature and additional ecological parameters, as well as of the distinctiveness of landscapes (Peter and Settele, 2008). Because of their sensitivity to changes in their habitats and the fact that carabid studies are among the most cost-effective types of scientific research, ground beetles are frequently utilised as bioindicators to track shifts in environmental conditions (Rainio and Niemela, 2003). Insects are essential components of ecosystems because to both the amount and quality of their intellectual contributions. The interactions that insects have with plants are important to the ecosystem because they are responsible for many of the critical services that insects perform. This encompasses a wide range of herbivorous associations, in addition to several symbiotic partnerships that include activities like as pollination, seed dissemination, or defence against predators in exchange for shelter (Qin and Wang, 2001). Plants supply the essential habitat components for a variety of insect species, beginning with a safe haven and progressing all the way to breeding grounds. Plant-insect interactions have direct effects, such as on the storage and cycling of carbon and nutrients, and also strongly influence succession and competition patterns in plant communities and organic phenomenon interactions. One example of these direct effects is the storage and cycling of carbon and nutrients (Weisser and Siemann, 2004). The connection between the wide variety of insects and the plants: Another important issue that needs immediate scientific attention is the relationship between different insect assemblages and different plant ecosystems.

There is a possibility that characteristics connected with vegetation structure, such as plant height, plant size, or leaf morphology, are causing problems for insect variety (Axmacher et al., 2004). It is common for the number of insect species to rise in proportion to the height of the surrounding vegetation, with the greatest diversity being observed in mature forests (Poyry et al., 2006). This has been linked with a better availability of resources in mature forest ecosystems. However, interactions are exceedingly complicated, and a higher diversity of species has been recorded in open environments in comparison to closed forests.

This may be a response to changes in the local microclimate Both the number of plant species and the overall makeup of the community influence insect diversity. In spite of the fact that the unimodal model is the one that is most commonly used to describe the links between variety and productivity, an increase in plant diversity might steadily boost ecosystem production (Hooper et al., 2005). The productivity of an ecosystem has the ability to increase the diversity of organisms living at higher trophic levels, as well as the number of different herbivorous insects, parasites, and predators. At higher tropical altitudes, an increase in plant variety would have a more significant beneficial influence on the total number of species. However, a recent study indicated that species lower on the food chain responded more strongly to an increase in plant variety than those species further up the food chain in grassland ecosystems (Scherber et al., 2010). If there was a greater variety of plants, there would be a lower incidence of biological invasion, pathogens, and hyperparasitism (Scherber et al., 2010). This trend also indicates that expanding the variety of plant species might potentially increase the stability of ecosystems (Tilman et al., 2006). In ecosystems with a low level of habitat stability, it is easier for predators to keep herbivore populations under control than in environments with a high level of stability (Southwood and Comins, 1976). As a result of the positive association that has been observed to exist between plant variety and the stability of habitat (Tilman et al., 2006), it is expected that plant diversity will alter the connection that exists between herbivorous insects and their predators. Herbivores have a greater propensity to look for and remain on hosts that are grown in monocultures, which is in accordance with the resource concentration theory proposed by Root (1973).

A reduction in plant diversity leads to an increase in the potential harm that may be caused to vegetation by invasive species, while also leading to a reduction in the total insect population. It has been hypothesised, and subsequent research has borne this up, that the diversity of herbivorous insects has a positive correlation with the variety of plant species (Lewinsohn and Roslin, 2008). A wider variety of predators and parasites could be able to take advantage of a more diverse herbivore population (Root, 1973). However, there isn't always a beneficial correlation between the diversity of plants and the diversity of bugs. In fact, a few studies that investigated natural environments discovered that there was actually an opposing tendency.

Conclusion

Every living thing, and especially insects and other arthropods, has some kind of response when the regular limits of their habitat are altered in some way. This is especially true when the temperature and humidity levels are also considered as considerations. The inset is urged to respond in a number of various ways when it is exposed to conditions of high or low temperature threshold, changing humidity, or different wavelengths of light. These conditions can cause the inset to behave in a variety of unexpected ways. It is conceivable for it to have an impact on their ovulation, their rate of fecundity, their development, their ability to survive and reproduce, as well as a variety of immunological and genetic reactions. Additionally, it may have an effect on their capacity to live and reproduce. When biotic stresses are present, certain plant characteristics, such as anti-biopsies and anti-xerosis, as well as nutritional modifications, variations in flora (such as landscape diversity and cover crops), and insect crowding all have an effect on the reproduction, emergence, and migration of insects. Anti-biopsies and anti-xerosis properties are included in these plant traits.

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