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Original Article

Effects of Selected Environmental Variable upon the Distribution of Hover Fly (Insecta: Diptera: Syrphidae) along with an Altitudinal Gradient

Jayita Sengupta[1]*, Atanu Naskar[1], Aniruddha Maity[2], Dhriti Banerjee[3]

[1]*Senior Zoological Assistant, Diptera Section, Zoological Survey of India, Kolkata, India*
[2]*Senior Research Fellow, Diptera Section, Zoological Survey of India, Kolkata, India.*
[3]*Scientist-D, Diptera Section, Zoological Survey of India, Kolkata, India.*

Correspondence E-mail: jayitasengupta9@gmail.com; atanudiptera@gmail.com; armzool2007@gmail.com; dhritibanerjee@gmail.com*

Abstract

The relationship between species richness of Syrphidae with large scale environmental variables, altitude and latitudinal gradients has been widely studied in selected study area of the state of Himachal Pradesh, India. The study was done over a period of one year (2015-2016) along the selected four districts of Himachal Pradesh. Altogether **34** species under **16** genera have been collected from the selected study areas along the altitudinal slope.

Key words: Syrphidae, Species richness, environmental variables, altitude.

Introduction

Diversity is unevenly distributed over the surface of the earth. The most conspicuous spatial pattern of species diversity is a latitudinal gradient of decreasing richness of species from equator to poles (Gaston 2000; Willig *et al.* 2003). The past decade has seen much interest in the environmental determinants of patterns of large scale species richness (Petrkeil, 2008). In most cases, the number of species has been used as the response variable, although some studies predict different diversity patterns for organisms differing in their trophic rank (Holt *et al*., 1999), degree of specialisation (Novotny *et al.,* 2002), range size (Miller, 2002), body size (Blackburn & Gaston, 1996), thermoregulation regime (Allen *et al*., 2002) or overwintering strategy (Wallisdevries and Van Swaay, 2006). Previously researches have been carried out at local and landscape scales (Davies *et al*., 2003; Stevens *et al*., 2003; Schweiger *et al*., 2007). These works have revealed some interesting phenomena. For example, some relationships between diversity and environment only emerge when study is concerned on a single taxon (Williams & Hero, 2001). Different species within a single taxon may have a species richness determined by completely different factors (Williams & Hero, 2001; Schweiger *et al.*, 2007). This suggests that a functional approach within a single taxon may provide a better base for conservation and applied research (Schweiger *et al.*, 2007). As a taxon suited to the functional approach should have a wide range of ecological traits to allow clear functional groups to be identified, Hoverflies (Insecta: Diptera: Syrphidae) are considered eminently suitable for this study.

As they inhabit most terrestrial and many aquatic environments as well as differing considerably in their body sizes and mobility. Furthermore, their larvae show a variety of life-styles and feeding strategies (Sommaggio, 1999). For being well spread over the whole world except Antarctica (Gahari, 2008), it is always easier to study Syrphidae (Insecta: Diptera) over a large spatial scale (Arryo, 1992). Hoverflies has always shown striking variation in species composition while studied across any large landscape (Mengual, 2010). To study the effect of selected environmental variables over the distributional pattern of hover flies, we have chosen Himachal Pradesh, India, as our study area. Himachal Pradesh is preferred here as study site for its topographical location covering an altitudinal gradient of 450 to 6,800 meters above sea level. This in turn helps to study the pattern of species richness along this wide elevation span (Mishra, 1993). The relationship between species richness of Syrphidae with large scale environmental variable, altitude and latitudinal gradient has been widely studied in selected study area of the state of Himachal Pradesh. The study was done over a period of one year 2015-2016 along the selected four districts of Himachal Pradesh. Altogether **34** species under **16** genera have been collected from the selected study areas along the altitudinal slope.

The primary aim of this paper is to explore whether (and or) the diversity of family Syrphidae differ in their response to latitude and selected environmental variables. Thereby a large region covering an altitudinal range of 500-4000 meters has been chosen instead of focusing on a local scale. It is expected to support the hypothesis that has been established earlier in other geographical landscape (Bispo, 2006). The earlier hypothesis suggest that the diversity and distribution of hoverfly fauna which may be unaffected by latitudinal gradients but still inversely affected by altitudinal and temperature gradient.

Materials & Methods

- **Study area:** 4 districts along a large spatial scale have been chosen as study area namely Chamba (altitudinal range: 500-1000 m), Kullu (altitudinal range: 1000-1,500 m), Shimla (altitudinal range: 1500-2500 m) and Lahul - Spiti (altitudinal range: 2500- 4,000 m). (Figure 1A). The overall latitudinal range for this study was 32˚.55'N-32˚.65'N.

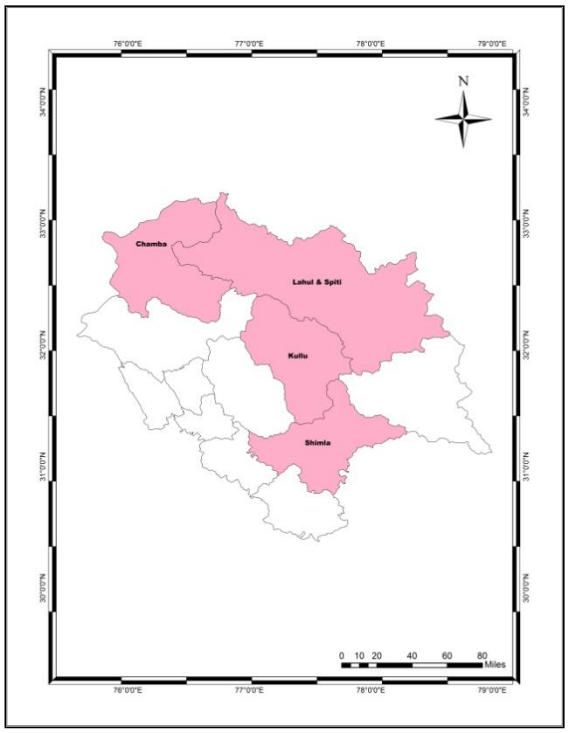

Figure 1A: Selected study sites from the state of Himachal Pradesh, India

- **Collection method:** Syrphid flies were collected by net sweeping and sometime by using traps mainly malaise trap, pan trap etc. After killing those specimens using benzene, they have been kept into special dry envelope and bring back to laboratory for further identification purpose.
- **Identification purpose:** Leica EZ4 microscope has been used for identification purpose while Identification of the adults followed the keys of Thomson (2013), Vockeroth (1992) and Brunetti (1923) keeping in mind the recent nomenclatural changes (Pape and Thompson, 2018; Pape and Evenhuis, N.L.2010). All the identified specimens were deposited in the designated repository of National Zoological Collection, Diptera section, Zoological Survey of India, Kolkata, India.

- **Technical area:** The graphical representations have been made by using Microsoft Excel 2013. The 3D map generated by using ARC GIS software, version 10.1.

Result

Relationship between the species richness of family Syrphidae (Insecta: Diptera) with large scale environmental variables and latitudinal gradient have been widely studied over two years (2015-16) in the selected study area of the state of Himachal Pradesh. Overall 854 examples of hover flies were collected during our study period. Altogether **34** species under **16** genera have been identified from the selected study areas along an altitudinal slope (Figure 1B). *Episyrphus (Episyrphus) balteatus* (De Geer, 1776) found to be the most prevalent syrphid along the whole elevation span while *Eristalis (Eoseristalis) cerealis* Fabricius, 1805 the most abundant among the whole species group.

It has been found that Species has presented a direct negative correlation in term of elevation (Correlation coefficient ≤ 1) that is their diversity is getting decreased with increasing altitudinal slope (Figure 1B).

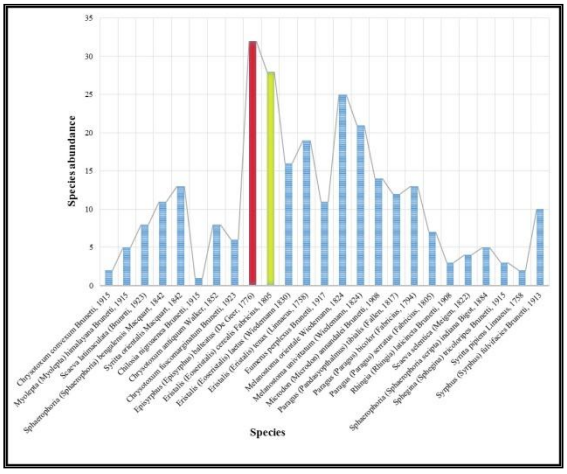

Figure 1B: Species abundance scenario

Species has presented a direct positive correlation in term of temperature (Correlation coefficient ≥ 1) that is their diversity is getting decreased with decreasing temperature gradient (Figure 1C).

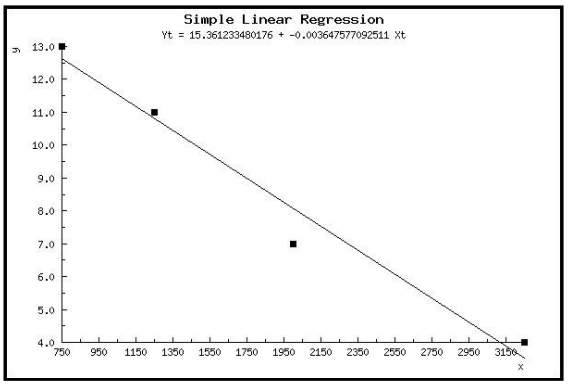

Figure 1C: simple linear regression depicting correlation between elevation and species diversity

Thus pattern of distribution of family Syrphidae along horizontal and vertical gradient has been represented here which hence revealed an overall inconsistencies in latitudinal diversity gradient and diversity-climate relationship (Figure 1D & 1E).

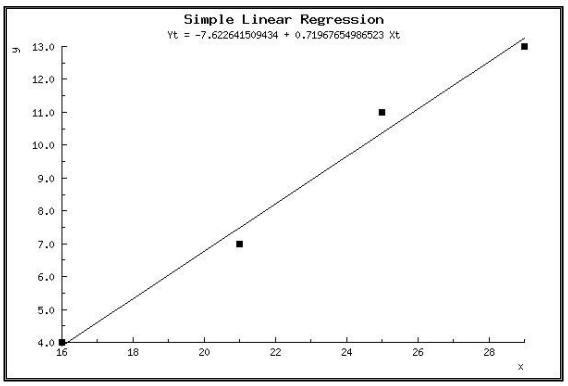

Figure 1D: simple linear regression depicting correlation between temperature and species diversity.

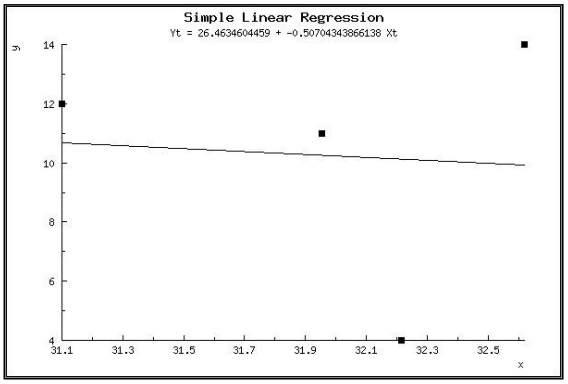

Figure 1E: simple linear regression depicting correlation between latitude and species diversity**.**

Discussion

The diversity of several anthophilous dipteran flies are troubled by cloudiness, wind and rain. Rain and wet fog generally lead to a cessation of flower-visiting by flies even within the Syrphidae there can be significant differences in responses to temperature and light, which can result in spatial partitioning. The distribution of insects along elevational gradients is due to difference in to habitat heterogeneity. Current long-term sampling studies have likely to reveal peaks at lower elevations. Analysis of all studies taken from the literature as well as from our survey data add the possibility that the latitude at which a study is undertaken influences the elevation of peak species richness. Harsh environmental condition at higher elevation contributed to low species abundance there. Syrphid abundance and estimated species richness increased with increasing temperature at lower altitude only while in higher altitude temperature gets too low to establish local population there. Thus it is clear that in higher altitudinal gradient lower temperature, longer period of snow and ice cover, stronger winds and lack of vegetation make it more difficult to establish reproducing population there. Surprisingly there is striking absence of northward decrease in total species distribution, it may be due to variation directions of latitudinal gradient leads to overall no effect of latitudinal gradients upon species diversity. Our study thus reveals distribution of hoverflies along both vertical and horizontal gradient along a large scale of altitudinal and environmental gradients (Barry, 1992).

Conclusion

A more detailed and grid-based extension of this study should be done as soon as India wise grid-based data for hover- flies are available. Grid data are already available for the U.K. and the Netherlands (Biesmeijer *et al.,* 2006), and there are strong efforts to compile such data for Germany. Finally, it is now time to undertake further analyses of large scale species-richness data using single taxon approaches in order to understand macro ecological patterns correctly and also to ensure the future food security.

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