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Review study on altitudinal zonation of floral and faunal species, its richness and distribution

Narayan Lal Choudhary[a], Nadim Chishty[a]* & Puneet Sharma[b]

[a]Wildlife, Limnology & Toxicology Research Laboratory, Department of Zoology, Government Meera Girl's College, Mohanlal Sukhadia University, Udaipur, Rajasthan, India

[b]Department of Life Sciences, Aryan College Ajmer, Rajasthan, India

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Abstract-Many floral and faunal species are restricted in a particular narrow zone of habitat characteristically in mountain ecosystem. The mountain ecosystem acts as an isolated and unique habitat, and sometimes functions as an isolated island like wetland natural ecosystem. Isolated or higher altitudinal ranges create unique habitat for a range of floral and faunal species and increases the degree of endemism as compared to other habitat which can be more vulnerable to local extinction and very sensitive towards topographical changes in a particular habitat. In this regard a collective effort was needed to review the altitudinal zonation in terms of floral and faunal species richness and distribution. During present review studies it has been found that biotic and abiotic factors influences distribution and diversity pattern of floral and faunal species from low elevation level to higher elevation level. Higher altitudinal survival species are very sensitive towards micro changes in their habitat which can affect them adversely. In present time many anthropogenic activities (like mining in hill areas, deforestation, poaching etc.) and natural disasters (like forest fires on mountains, landslides etc.) leads to unfavorable and irreversible alteration in floral and faunal species mountain ecosystem and at certain time vanish them at all. It has been reviewed that variation in altitudinal ranges also affect breeding biology, morphological and physiological adaption in floral and faunal communities and create wide range of diverse habitat and ecosystems.

Key words: Mountain ecosystem, altitude, endemism, adaption, habitat

INTRODUCTION

Biodiversity encompasses the wide variety and variability of living life forms in an ecosystem and ecological processes, at all levels of biological organization and its foundation for human survival and economic well being.[1] Biodiversity closely linked with human demands for food, fuel, fodder, fiber, medicine, oil, timbers and resins[2] and are also helpful and essential for maintaining climatic stability, pollution control, water and soil conservation, nutrient and mineral recycling, ground water recharging, pollination and recreation values of that particular region.[3-5] Biodiversity and ecosystem stability and sustainability mainly depends upon productivity and utilization rate of resources by human beings in recent and past years.[6-8] Low productivity and higher exploitation rate of resources increases risk of loss of biodiversity and shrinkage of natural ecosystem which creates imbalance amongst various ecosystems and their food chains and food web. Variation in abiotic environmental factors like-

*Corresponding author :
Phone : 7976914733, 9799146756
E-mail : nadimchishty@gmail.com

temperature, rainfall, humidity and wind velocity largely influence the distribution and type of species and vegetation composition. Floral and faunal distribution and its density is also affected by spatial, temporal, latitudinal and altitudinal variations at different geographic regions.[9-11] Altitudinal variation show four types of species distribution and richness patterns namely decreasing at low plateau, low plateau with mid elevation peak; with increase in elevation species richness, pattern and number decreases and generally species richness trends increases with higher elevation levels.[12-14]

In the present review study, a compressive overview that effects altitudinal variation on species distribution, density and diversity in relation to various altitudinal and latitudinal ranges was done which can be enumerated as :-

1. **EFFECT OF ELEVATION RANGES ON VEGETATION COMPOSITION:-** The evolution and composition of vegetation in a particular region is usually decided by several factors like- time, slope, aspect of elevation level, humidity and seasonal or annual precipitation. All these factors also changes with altitudinal ranges, which lead to climatic and spatial changes among animal and plant community at various elevation levels.[15,16] Altitudinal ranges greatly influence diversity and abundance of plant community at various geographical ranges[8], with strong impact of elevation on vegetation structure of most of the mountain ecosystems of the world, as reported in temperate forest of China, Mexico and central Europe.[9,17] At present time various anthropogenic and natural activities like- inefficient erosion of glaciers, soil and various environmental activities are responsible for reduction in mountain ranges height, which are responsible for modification and alternation of previous ecosystems. Trees play efficient and crucial role in defining and sustaining the structural and functional environment complexity and habitat heterogeneity in forest ecosystems of the Earth.[18] Global warming, invasion of exotic species, anthropogenic activities and climatic changes are also responsible for alteration in vegetation composition in native ecosystem at various altitudinal and latitudinal ranges.
2. **EFFECT OF ALTITUDINAL RANGES ON AVI-FAUNAL SPECIES DISTRIBUTION:-** Avi-faunal species composition and distribution with altitudinal range is determined by biotic and abiotic environmental factors such as elevation or height, prevailing wind intensity and direction, slope, temperature, humidity, rainfall and vegetation composition.[19] Abiotic factors cause major effect on species distribution pattern at higher altitudinal ranges and latitudinal levels which also greatly influences diversity and distribution pattern at ecosystem and community levels. Different elevation gradient leads to changes in composition of species distribution and its pattern. Nöske *et al.* (2008)[20] studied different factors such as canopy area of trees and; altitude may influence changes of species composition among flora and fauna. Rahbek (1995)[21] observed a monotypic decline in species number when altitude level increases. Brown and Gibson (1983)[22] observed that the association between plants and animals and extrapolated the same obtaining a dome shaped curve relationship. When defined in relationship with increase in elevation with mid elevation peak of avi-faunal species richness. Species richness of birds decrease enormously at altitudes above 1000 meter; largely affected ones were insectivore species with sustainable declined in all feeding guild of birds.[23,24] It was also observed that bird activities like feeding, foraging, breeding and singing patterns were also influenced by higher elevation levels. Grytnes and Ventaas (2002)[25] observed interpolated species occurrence between the highest and lowest altitude and concluded that it can cause artificial lump in species elevation curve. Slope shape and size also affected the number and variety of birds with increased altitude. It was observed that changes in the number and variety of birds with increased altitude can be co-related to uniqueness in eco-tone of different ecosystems. Elevation pattern among avian communities identified by Mc Cain (2007)[26] includes mid altitude peak, low altitude that has a mid altitude peak and low plateau common at the low altitude and decreasing pattern exhibited takes form of uni-modal peak at the center than at the base and top on quantifiable definition which can be defined as mid altitude peak pattern. High species richness occurred at low elevation ranges while high diversity was observed at the base of low plateau and mid altitude. Mc Cain and Grythes (2010)[27] Observed a specific pattern followed by species shown along different elevations as a reflection of the relationship between different flora and fauna in the ecosystem.

Higher mountains generally have smaller land area and are more isolated and have simple vegetation composition as compared to the open or forest lands.

3. **EFFECT OF ALTITUDINAL VARIATION ON DISTRIBUTION OF INVERTEBRATE AND VERTEBRATE PHYLUM:-** Variation in invertebrate and invertebrate species richness along altitudinal gradients[21] and across taxonomic groups[28] and continents[29] reveals striking patterns of biodiversity distribution[30]. Distribution patterns along elevation gradients have been noted in invertebrates[31-34] mammals[23,35-39] birds[40-45] and herpato-fauna[46-48]. In general it was observed that species richness along altitudinal gradients followed one of the three patterns namely- decreasing with altitude (monotonic decline), mid domain (hump-shaped pattern or curved at middle altitudinal ranges) and increasing with elevation,[28,21] amongst which most widely observed pattern were mid domain peak and monotonic declination.[21, 43] Observing and analyzing the association between species richness and elevation gradient is necessary and important as it provides insights into the observed patterns and processes responsible for maintaining the relationship in between different species which is turn supports conservation efforts.[28,49,50]

4. **EXTENSION OF MOUNTAIN ECOSYSTEM AND SPEICES DISPERSAL:-**Mountain ecosystems comprises of approximately one fifth of the earths' surface out of which tropical mountain forests represents about 11% of tropical forests of the world.[51-53]. Species richness and biodiversity was observed to be highly diverse in mountain ecosystem as compared to other ecosystems. Maximum biodiversity hot spots were also located at higher altitudinal and mountain ranges which consists of majority endemic floral and faunal species.[53-55] Higher altitudinal ranges and mountain ecosystems were observed to have largely influenced distribution pattern and biodiversity curve.[56-60]. In our review studies it was found that altitude comprises of different multi abiotic factors that controls and regulates floral and faunal species distribution and its diversity pattern and ecology in the surrounding ecosystem.

5. **EFFECT OF ALTITUDE VARIATION ON CLIMATIC CONDITIONS:-** Four main trends were observed at high elevation levels in relation to species richness and environmental factors. Several factors predictably with increasing elevation were responsible for native climatic conditions out of which the most obvious was linear decrease in temperature at higher altitudinal ranges. Temperature decreases by an average 0.6°C at every 100 meter elevation level.[61] Climatic variables such as temperature, rainfall, humidity and atmospheric pressure were also observed to be decreasing with gradual increase in elevation peak. Emission of solar radiations and fraction of UV radiations especially UV-B was seen to increase as altitude increases.[24, 60] Other abiotic climatic factors such as light intensity, cloudiness, soil texture and depth (organic matter, humus content, available free nitrogen, carbon-nitrogen ratio) increases with altitude, whereas pH, mineralization and nitrification rates were observed to decrease when altitude range increases at higher elevation levels.[9,24,60,62-65] All environmental factors were observed to be responsible for habitat alteration at various elevation levels which largely influences the distribution, diversity, dispersal patterns of various species and animal taxa.[66-69] Relationship between elevation and species richness may also vary and majority depends upon species specific availability of suitable habitat like- herbaceous life forms which grows highly and diverse in more light intensity tolerant and shade intolerant species.[67,70-74] Other climatic conditions and abiotic factors vary along mountain gradient but observed to have more complex relationship with altitude. Altitudinal variation largely influences annual precipitation at various ranges and create wider variety of micro environments.[61] Precipitation can be in the form of rainfall, condensation from clouds, snowfall (e.g. horizontal rainfall pattern in clouded forests) its pattern slightly increases when elevations gradient increases.

6. **EFFECT OF ALTITUDE VARIATION ON TETRAPOD LIFE:-** In present review studies it was observed that terrestrial tetra pods are predominantly distributed in a particular altitudinal range. Non flying small mammals (e.g. rodents, shrews etc.) were found to be abundant at mid elevation ranges[23] where as Pteropus and other flying mammals were evenly distributed at low elevation levels and sharply declined at mid elevation ranges.[75] Avian taxa follow all four common patterns of distribution and abundance of

species at higher altitudinal ranges[43] and reptiles predominantly declined at higher elevation levels.[76] Preliminary analysis of amphibians like Salamanders preferred mid elevation peaks where as other amphibians follow all four common distribution patterns evenly and with similar frequencies as it was the case with other tetrapods.

7. **EFFECT OF ALTITUDINAL VARIATION ON EGG SIZE AND CLUTCH SIZE:-** One of the most frequently studied trait has been variation in egg clutch size with variation in avi-faunal species along latitudinal gradient[77]; typically tropical species lay smaller egg clutch size as compared to northern temperate climatic conditions both intra and inter specifically.[78] Altitudinal gradient ranging from low to high altitude produces variety of species distribution patterns namely tropical-temperate gradient, lower temperatures, greater seasonality and high environmental variability for bird's behavior like-higher altitudinal resident birds having smaller breeding season as compared to low land birds.[79] Also it was reviewed that bird's egg clutch size variation increase elevation levels increasing from lowland to mountain ecosystem.

8. **EFFECT OF HIGHER ELEVATION LEVEL ON ANIMAL PHYSIOLOGY:-** It was observed in our present review studies that lower temperature and oxygen availability at higher elevation levels can increase metabolic rates and thermoregulation in an organism while in contrast slow metabolic rates and high thermoregulation reduces reproductive effort through reduction in egg clutch size its mass and periods of development and times of hatchling.[79-80] Lower atmospheric pressure at high elevation level leads to water loss from eggs and create hypoxic condition and increase water loss content from eggs during early developmental stages.[81] Increased seasonality in temperature and precipitation at higher elevation level implies that favorable for breeding may be constrained to a shorter period at high elevations, thus limiting components of fecundity such as number of broods.[79,82] Food availability play critical role for egg size, clutch size, incubation periods and nesting success as well as juvenile survivorship.[83] Food limiting factors and scarcity also reduces breeding strength among birds at higher elevation level due to colder environment and hypoxic conditions.[84] Pattern of variation in nest predation risk across elevation gradients are unclear with studies reporting decreasing at higher elevations[85-86] and increasing at higher elevations.[87] It was found in review studies that lower to higher altitudinal level highly influences animal physiology and behavioral biology.

CONCLUSION

Different altitudinal and latitudinal ranges highly influence the distribution and diversity patterns of floral and faunal composition. Altitudinal gradient also determines the distribution, density and abundance pattern of various invertebrate and vertebrate animals and as well as plant communities. Higher altitudinal ranges in habitat wide variety of floral and faunal species particularly of native nature due to which mountain ecosystems are occupied with maximum number of biodiversity hotspot areas. Our review studies conclude that high species richness and biodiversity plays essential and curial role for human existence and survival and are necessary for factors for ecosystem balance and stability. At present time over exploitation, habitat alteration, deforestation and natural disasters are becoming limiting factor for biodiversity decline at both regional and global levels.

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