EXECUTIVE SUMMARY

Understanding the drivers of species distribution and community structure has been a major theme in ecological research. Both abiotic and biotic ecological factors interact and operate at various spatial scales to determine the observed patterns of species occurrence at any site, while the biogeographic species pool from which species are derived is largely a consequence of historical factors acting at large temporal scales. Hence, ecological determinants of species distribution need to be investigated at both the broad geographical scale based on current ecological niche constraints as well as at the local scale with emphasis on species interactions within communities. Similarly, phylogenetic relatedness needs to be taken into consideration to assess the relative importance of historical factors.

The Old World leaf warblers (genus *Phylloscopus*) have been the subject of some notable ecological studies investigating ecological segregation and speciation on continents, owing to the remarkable species diversity, close relatedness among species, and very similar morphology and ecology. In addition, the phylogeny of most of the species is well worked out which allows better understanding of ecological relationships by controlling for phylogeny. Previous studies have examined the nature of ecomorphological relationships and competitive interactions which influence the observed breeding community structure at one site. However, factors influencing the broad distribution pattern of these widely distributed speciose clades across the continental scale have not been investigated.

I carried out this study with the overarching goal of understanding the ecological and historical determinants of geographic and altitudinal distribution of sixteen breeding *Phylloscopus* and *Seicercus* species in the Himalayas. The broad research objectives were as follows:

1. Assess the availability of arthropod resources across the eastern and western Himalaya along the elevational gradients.
2. Identify the climatic correlates of the breeding distribution of Phylloscopidae.
3. Examine the geographic variation in foraging ecology of Phylloscopidae across the Himalayan bioclimatic gradient.

4. Evaluate the drivers of community assembly using phylogenetic community structure of breeding leaf warblers across the Himalayas.

Across east and west Himalayas, I identified sixteen sites situated in relatively undisturbed forested habitats along nine elevational transects. Transects were chosen to cover relatively long continuous forested habitats along a more or less similar aspect. The field sampling was conducted during the breeding season (April-June) over three years (2008-2010). In general, sites situated along elevational gradients in the east were cooler and received more precipitation than sites situated at comparable elevation in the west. I quantified arthropod prey for these strict insectivores using the bagging method from all the sites. Vegetation characteristics were similarly measured from representative plots in multiple sites to broadly characterize the habitats in the east and the west. I carried out fixed-radius point counts at every 25m rise in elevation along the nine elevational gradients. The relative abundances and breeding elevational range for each species was derived for east and west separately by combining data from all the elevational transects situated in each region. I opportunistically collected data pertaining to the foraging ecology of the study species.

Arthropod abundances varied spatially along elevational gradients and across east and west corresponding with the variation in climatic factors. This study provides the first broad-scale assessment of variation in distribution patterns of foliage-dwelling arthropod orders along elevational gradients located across an extensive precipitation gradient in the Himalayas. Abundances declined significantly from the east to the west and peaked at intermediate elevations along elevational gradients. The observed decline in overall and taxon-specific abundances could be related to decline in temperature above the respective peak elevations, while a combination of precipitation and temperature appeared to influence a general increase in abundance from the low-elevations to the intermediate elevations.

By incorporating occurrence records from the breeding distribution range and environmental layers, this chapter predicted environmentally suitable areas across the Himalayas for species restricted to the east and west to test whether lack of suitable climatic niche is responsible for their inability to range across the west and the east, respectively. Annual precipitation and maximum temperature were the environmental variables which contributed the maximum information to the geographic distribution models. In most cases, environmental niches as defined by climatic variables does

exist in the other region (where the species is absent), suggesting that climate alone is inadequate in explaining the observed pattern of breeding distribution.

Across the terrestrial environment more species occur in warm wet areas than in cold dry areas, with explanations broadly classified as historical and unsaturated, or ecologically deterministic and at equilibrium. In the latter hypothesis, more "niches" are available in warm wet areas, but this has been difficult to evaluate. Here, I introduce a test of the alternative explanations based on assessment of geographical variation within species whose ranges straddle species-poor and species-rich regions. Under historical models we predict niche expansions in species-poor regions, because species numbers are further from any ecological carrying capacity. I studied geographical variation in 10 species of Old World leaf warblers (Phylloscopidae) across the Himalayas. Elevational range and feeding method showed niche contractions in the species-poor western communities with respect to species-rich eastern communities, whereas prey size did not vary geographically. For the two traits showing niche contractions, patterns are in the opposite direction to that predicted on the basis of absent congeners but consistent with measurements of resources. Further, species abundances are closely correlated with food availability. Results provide strong support for local determinism in driving species numbers. Other less dispersive taxa may be expected to show a stronger imprint of historical processes.

Finally, in an effort to assess the factors structuring elevational diversity patterns, I examined the patterns of ecological dispersion and phylogenetic structure of Old World leaf warbler communities along elevation gradients distributed in the eastern and western regions of the Himalayas. Blomberg's K statistic was computed to test for niche conservatism in key ecomorphological traits. Phylogenetic structure for each community was quantified using Net Relatedness Index (NRI) and ecomorphological spacing metrics were computed. Linear mixed models were used to relate patterns of species richness and NRI to arthropod abundance, maximum temperature and precipitation seasonality. Among the Phylloscopidae, phylogenetic community structure varied along the elevational gradient. The 16 communities composed of two to eight species ran the entire spectrum of significance in terms of their phylogenetic structure, resulting in many clustered communities at low elevations and few over-dispersed communities at higher elevations. Maximum temperature, resource abundance and precipitation seasonality determined the

variation in net relatedness indices so that warmer, low elevation sites had species more closely related than expected by chance while cooler sites at higher elevations had species from more diverse lineages. Given that ecological traits were niche conserved, maximum temperature appears to act as an environmental filter for this group at lower elevation habitats so that species belonging to only a few lineages have to ability to persist in these sites. In contrast, the communities at higher elevations tended towards over-dispersion, thereby implying heightened inter-specific competition. Examination of ecomorphological space metrics provided greater insights into these contrasting processes.