Birdsong is one of the most astounding natural sounds which profoundly shaped our evolutionary thinking since the 19th century. Despite a strong interest in birdsong for over 100 years, our understanding of birdsong ecology and evolution over large spatial and phylogenetic scales is still very fragmentary. Answering many basic questions requires a global synthesis covering vast diversity of extant bird species and adoption of multidisciplinary approaches. In presented dissertation thesis, my co-workers and I have explored important patterns in macroecology and macroevolution of song in passerines (Order: Passeriformes), the most diverse and widespread bird order. We have focused on three key song phenomena: (1) song complexity, (2) song frequency and (3) the presence of song in female birds. We have exploited birdsong "big data" available on public citizen science databases and other open sources in order to fill several important gaps in the current knowledge. These data were analysed by a combination of phylogenetically-informed cross-species analyses and spatial macroecological approaches.

Since the publication of Darwin's seminal work, elaborated songs are generally agreed to be the result of sexual selection. We developed a simple but reliable song complexity metric to explore a global diversity in song complexity across 4,939 passerine species. Our analyses revealed that song complexity in Oscines, a clade with learned songs, and Suboscines with innate songs, is associated with several life-history, social and environmental indices of sexual selection in assemblage-based analyses. However, these effects largely disappeared when we accounted for spatially non-random distribution of passerine clades across assemblages or in a phylogenetic cross-species analyses. Song complexity in Oscines, but not Suboscines, positively correlated only with habitat generalism in cross-species models. We conclude that, at least in Oscines, song complexity might indeed be shaped by sexual selection, possibly via environmentally-driven processes, but large proportion of its variation remains unexplained (**Chapter 1**). We then explored associations between widely accepted and biologically relevant song complexity metrics, such as syllable repertoire size and the number of syllable types per song, and several novel metrics derived by machine learning techniques. Those novel metrics, if reliably capturing song complexity, could significantly increase the efficiency of comparative data collection on song complexity; unfortunately, we found no inter-correlation between these two types of metrics (**Chapter 2**).

Passerines use their songs mainly for long-distance communication with conspecifics. In the next step, we therefore explored global diversity in peak song frequency, a signal parameter that greatly affects song propagation, with the use of 5,085 passerine species. Body size is expected to constrain song frequency and frequency may also be sexually selected. Moreover, habitat density, through the habitat-specific patterns of signal degradation, have been proposed to explain the variation in song frequency. We found that song frequency was negatively associated with body mass and sexual size dichromatism, while habitat density had weakly positive or no effect on peak song frequency (**Chapter 3**).

Finally, we tested an effect of several social and environmental traits on the distribution of female song across 269 songbird species of South Africa and Lesotho. We found that, in species in which females produce solo songs, seasonal territoriality was predominant, whereas duetting species defended their territories mainly year-round. This indicates that female solo song and duetting could be distinct song categories associated with different levels of territoriality (**Chapter 4**).