

Northward Expansion of Birds in China: A Response to Global Change

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Abstract

Based on the analysis of published data, 72 avian species (49 residents and 23 summer breeders) were found to expand northward in China during the past 30 years. The expansion distance of those birds varied from 11 kilometers to 1788 kilometers. The mean value of the expansion distance was 413.30 kilometers. The northward movement of birds was relevant to increasing temperature, NDVI and land-use pattern in northern China.

Keywords: Bird dispersal; Climate change; Global warming; NDVI; Avifauna

Due to the effects of intensified human activities, the temperature of the earth notably increased in recent decades and caused birds to shift their geographic range [5, 8, 10, 27]. The bird observation revealed a trend of northward expansion, which was consistent with the phenomenon at the temperate northern hemisphere [9, 23]. Despite of imprecision in orientation, there was an obviously poleward movement of the birds in China [6, 22].

Analysis of the references showed that 72 species of birds (49 residents and 23 summer breeders) expanded northward in China during the past 30 years. Some representatives of these birds were showed in the map for illustrating their northward expansion (**Fig. 1**). The mean value of expansion distance of these 72 species was 413.30 ± 32.43 kilometers. The maximum expansion distance of 1788 kilometers was found in white-breasted waterhen (*Amaurornis phoenicurus*), while the minimum expansion distance of 11 kilometers was found in intermediate egret (*Mesophoyx intermedia*). Additionally, some summer breeders, such as lesser necklaced laughingthrush (*Garrulax monileger*) and the rusty laughingthrush (*Garrulax poecilorhynchus*), were recorded as residents in their new distribution area. From this data, the birds averagely expanded about 20 kilometers to northern China annually.

The similar results were found in various avian species. Valiela and Bowen found the northward shift in winter range of birds in Massachusetts [24]. Carrillo et al. reported that trumpeter finch (*Bucanetes githagineus*) in north Africa had expanded to Spain since the mid-20th century [4]. In Arctic tern (*Sterna paradisaea*), dispersal changed rapidly in response to changing climate conditions [16].

Generally, some environmental factors such as climate change, habitat conversion and landscape shift were considered to be the key factors that led animals to disperse. The linkage of bird dispersal to climate change could be found in many reports. For example, global meta-analyses documented significant range shifts averaging 6.1 km per decade towards the poles, which meant that animals dispersed towards north poles due to climate change [18]. Another example was that global climate change had led to warmer winters in northwest Europe and shortened the migration distance of many birds [25]. Guo et al. suggested that China had undergone a remarkable increase of atmospheric temperature since the mid-1980s [7]. The trend of the warming was most significant in northern China with the increase of $0.2\text{-}0.8^\circ\text{C}/10\text{a}$ [7]. Thus, the increase of temperature in northern China was probably one factor that accounted for the northward expansion of birds.

Normalized difference vegetation index (NDVI) was considered to be another possible factor that caused the redistribution and changes of species richness of birds [13, 20]. Rapid urbanization resulted in a sharp decrease of NDVI in southern China, while irrigation and fertilization contributed to an increase of NDVI in northern China [19]. Indeed, NDVI in the northern hemisphere has increased noticeably during the past 30 years. For example, around 61% area between 40°N and 70°N of Eurasia showed a persistence increase of NDVI in growing season [28]. Changing weather affected birds directly, or altered their habitats by changing the primary productivity that provided them food resources, appropriate breeding sites and shelters [12, 26]. Therefore, the improving vegetation (i.e. NDVI) in northern China could be another factor that induces the northward movement of birds.

Furthermore, land-use and land cover change affected habitat quality and bird

dispersal [11]. Li analyzed the land-use pattern in China and found that the eco-environment in northern China was obviously degraded due to the unreasonable human activities such as agricultural practices and urbanization [14]. It was likely that, because of the agricultural development and human population increase, the habitats for birds in northern China have fragmented and degraded as same as those in southern China [14]. In another word, birds in northern China faced the same problem of habitat loss and deterioration as in southern China. In this circumstance, the bird would stay in southern China rather than expand to northern China. However, our analysis revealed an overtly northward movement of many residents and summer breeders and implied that climate change and NDVI played more important role than land cover change and habitat conversion in determining bird dispersal.

Generally speaking, global warming brings some other phenomena that have negative effects on birds. It has been reported, for instance, a considerable number of birds in Europe has experienced a dramatic decline in population size because of the global warming [2]. Many evidences also suggested that the climate change and land-use impacted the phenology and sequentially the fate of birds [1, 3, 21]. Some threatened species could even face extinction since they responded less well to the change of air temperature [17].

Taken together, the scope and the trends of northward movement of birds correspond to climate change and the increase of NDVI. However, more extended research is needed to study those expanded birds in their new distribution area. Owing to climate change and habitat degradation, the protection of birds meets great challenge. For bird management, long-term data accumulation will identify the effect of climate change and benefit the conservation of endangered species.

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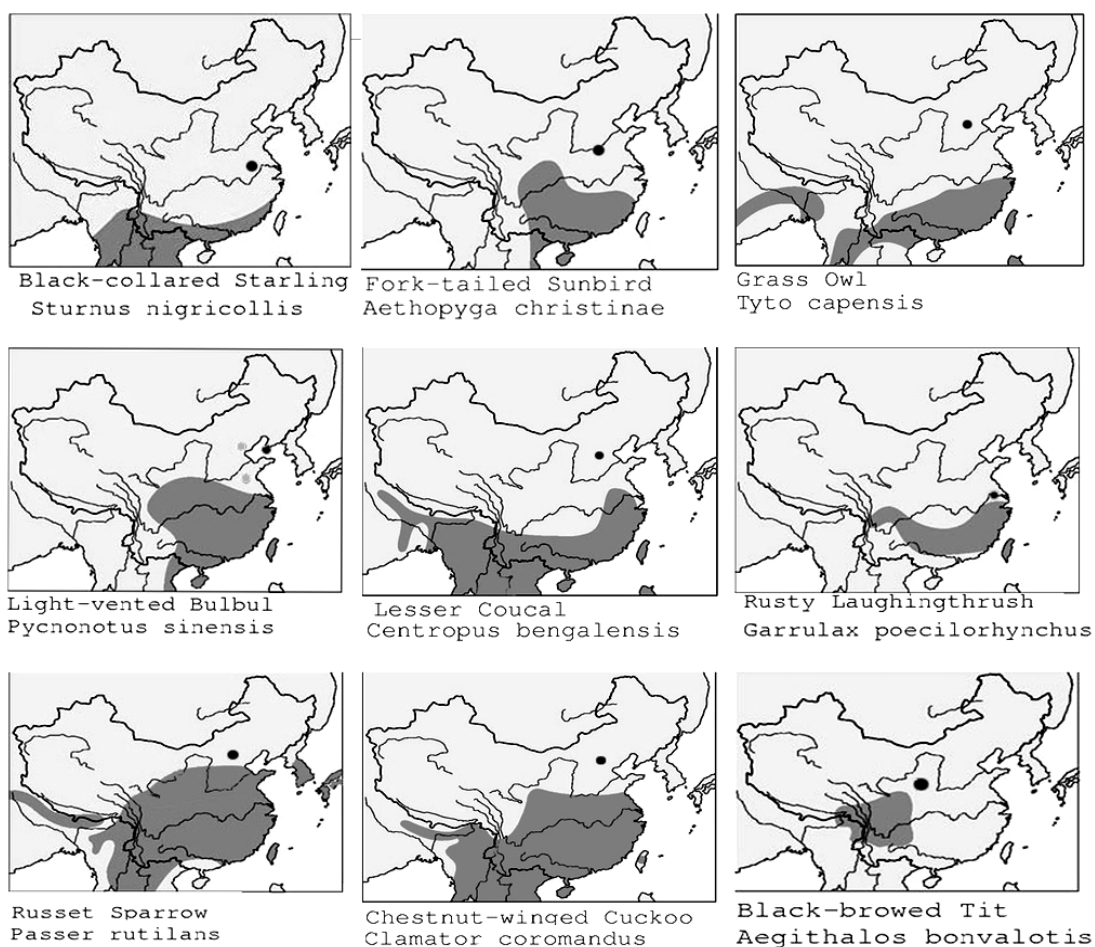


FIG. 1 Some representatives of the bird residents that expanded northward. The black dot is the newly northern distribution site after the range expansion, and the grey area represents the original distribution area [15].

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