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Richness in Bird Species of the Eastern Himalayas in Early Spring

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Abstract—Bird species diversity of the altitudinal belts of the Eastern Himalayas was analyzed in the early spring of 2005 and 2014. Species richness is revealed to be decreasing from the belts of subtropical mixed and coniferous forests to the alpine belt. Specific species that are not beyond the limits of a corresponding belt are immanent to three of four investigated altitudinal belts. The avifaunas of two adjacent belts also have comparatively many common species. One hundred and thirty-three bird species met in both years belong to six faunal complexes, among which most species are Himalayan endemics and subendemics, as well as Palearctic species. The abundance of background species has been determined for each altitudinal belt.

Keywords: avifauna, population, Eastern Himalayas, distribution, altitudinal belts, faunal complexes

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INTRODUCTION

The Himalayas are the highest mountains in the world, stretching in the sublatitudinal direction to 2500 km between Central and South Asia (Gvozdetskii and Golubchikov, 1987). The Himalayas are one of the key biogeographic, zoogeographic, and ornithogeographic borders of Eurasia and the world (Shtegman, 1938; Koblik et al., 2000; Abdurakhmanov et al., 2014; Andreev, 2014), as well as one of the centers of modern endemism and species diversity.

The existing literature on the avifauna of the Himalayas (Bohme, 1975; Koblik and Red'kin, 1999; Bohme and Banin, 2001; Andreev, 2012; Rasmussen and Anderton, 2012; Grimmett et al., 2013) clearly lacks specific information on the environmental ties and altitudinal landscape distribution of different bird species.

This was the basis for the organization of ecological ornitofaunistic research on the southern macroslope of the Eastern Himalayas (Nepal) in 2005 and 2014 that had three main objectives: (1) an overview of the local fauna in the early-spring phenological period, (2) gathering information about the altitudinal landscape distribution of birds in the mountains in the height interval of 2300–5000 m above sea level, and (3) providing expert assessments of the abundance of individual species and bird population structure.

MATERIALS AND METHODS

The southern macroslope of the Himalayas at the foot of Everest was examined from March 17 to 23, 2005, and from March 19 to April 4, 2014, in the process of our ascension from the midlands to the mountainous areas. The ornithological observations covered the section of a mountain walking trail from the village of Paya (2350 m above sea level) to the village of Lobuche (4930 m above sea level) within the valleys of the Mountain Dude–Cauchy, Imja Khola, and Chola–Khola rivers.

The counts, the total extension of which was 165 km, covered four altitudinal landscape belts and one transitional band. The total length of routes was 103 km in forests; 24 km in the transitional band between the forest and subalpine belts; and 23 and 15 km in the subalpine and alpine belts, respectively. The bird counts were made by the methods of Yu.S. Ravkin (1967). The results were presented not in specific ciphers, but in the scale format of "word symbols" (points): very rare, rare, common, and abundant.

Observations were made in early-spring phenological period, when some species had begun to breed while others had not even broken into pairs, continuing to hold to large feeding agglomerations or migrate in flocks.

The level of similarity of the avifaunal lists (the faunal commonness coefficient) was determined using Sorensen's formula (Chernov, 2008).

We followed the identification guide "Birds of the Indian Subcontinent" (Grimmett et al., 2013) in the nomenclature and in preparing the list of birds. Some names of birds were given according to "Birds of South Asia" (Rasmussen and Anderton, 2012).

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ALTITUDINAL ZONATION OF VEGETATION ON THE SOUTHERN SLOPES OF THE EASTERN HIMALAYAS

Seven altitudinal landscape belts were distinguished on the southern slopes of the Eastern Himalayas: (1) terais, (2) tropical rainforests, (3) subtropical mixed or evergreen oak (mixed forests), (4) coniferous or evergreen temperate forests, (5) subalpine shrubs, (6) alpine meadows, and (7) nival belt (Walter, 1975; *Pflanzenwelt der Erde*, 1979; Gvozdetskii and Golubchikov, 1987)[1].

We examined four altitudinal landscape belts: subtropical mixed forests, coniferous forests, and subalpine and alpine belts.

The subtropical mixed-forest belt is located at altitudes of from 1000–1200 to 2300–2500 m above sea level. The forests consist of castanopsis (*Castanopsis indica*) (Roxburgh ex Lindley)), litsea (*Litsea lanuginosa* (Nees)), laurel (*Cinnamomum glanduliferum* (Wallich)), brown oak (*Quercus semecarpifolia* Smith in Rees), bluish oak (*Q. glauca* Thunberg), brown sawtooth oak (*Q. acutissima* Carruthers), lamellar oak (*Q. lamellosa* Smith), Nepalese alder (*Alnus nepalensis* D.Don), bayberry (*Myrica esculenta* Buch.–Ham. Ex D.Don.), photina (*Photinia integrifolia* Lindley), long-needled pine (*Pinus roxburghii* Sargent), and various species of magnolias and rhododendrons.

The coniferous evergreen temperate forest belt is higher, at an altitude interval of from 2300–2500 to 3200–4000 m above sea level. The forests consist of Himalayan pine (*Pinus wallichiana* A.B.Jackson), silver fir (*Abies webbiana* Lindley), Himalayan fir (*A. spectabilis* D.Don), spruces (*Picea smithiana* (Wallich), *P. spinulosa* Griffith), larch (*Larix griffithii* Hooker), hemlock (*Tsuga brunoniana* (Wallich)), and a lush shrub understory, in the formation of which a large role is played by Himalayan cypress (*Cupressus torulosa* D.Don), black juniper (*Juniperus wallichiana* Hooker & Thomson ex Brandis), and Himalayan barberry (*Berberis hookeri* Lemaire).

In the subalpine and alpine belts, shrubs are common at an altitude interval of 4000–5000 m above sea level. In the subalpine belt, there are rhododendrons (*Rhododendron setosum* D. Don, *Rh. Anthopogon* D. Don), blue star (*Juniperus squamata* Lambert), and Himalayan barberry and honeysuckle (*Lonicera obovata* Royle ex Hooker & Thomson). Alpine meadows are widespread at the altitude interval of 3700–4800 m above sea level and start to completely prevail at an altitude of more than 4200 m above sea level. Lush alpine herbs extend in the Himalayas at an altitude of up to 5000 m above sea level.

There is also a transitional band between the coniferous forest belt and the subalpine belt—"the ecotone of the upper forest boundary" (Abdurakhmanov et al., 2014). Here, near the upper forest boundary, at the place of transition to high–altitude belts, there is a well-marked gradual replacement of dense stands by sparse forests with subalpine species in the shrub and grass cover; then there are open woodlands and sparse forests with areas of subalpine meadows and finally individual groups of trees and solitary trees among subalpine meadows and subalpine shrub thickets.

RESULTS AND DISCUSSION

The total number of bird species noted in the study area in early spring was 133, of which 81 species were registered in 2005 and 101 species were met in 2014. The species composition of birds registered in each of two expeditions had significant distinctions. Simultaneously, only 49 species were noted in 2005 and 2014, which is noticeably less than half of the total species list. Moreover, 32 species were observed only in 2005 and 52 species were met only in 2014. The coefficient of similarity of the faunal lists for 2005 and 2015 was 54%.

The bird species that form the early spring avifauna on the southern macroslope of the Eastern Himalayas belongs to eleven orders. Passeriformes constitute an absolute majority (104 species; 78%). In the mountain regions of Asia at higher altitudes, the share of Passeriformes in the avifauna decreases. This regularity is also confirmed by the data from the mountain regions that are located to the north of the Himalayas in the land band limited by the ninetieth and hundredth meridians. In the Altai–Sayan ecoregion located at temperate latitudes, the share of Passeriformes is 46% (Baranov, 2007) and their share does not surpass 39% farther to the north at the subarctic Putorana Plateau (Romanov, 2013).

The eastern part of the southern slope of the Himalayas forms part of the East Asiatic (Himalayan–Chinese) region of the Palearctic (which also includes the southeast of the extra-tropical part of Asia: Primorskii krai, Northern and Middle China, Korea, Japan, and Eastern Tibet) and borders the tropics of the Indo–Malayan region of the Paleogene (Abdurakhmanov et al., 2014). According to such an original zoogeographic position of the region of our studies, we found it necessary to analyze the ratio of the number of bird

[1] The descriptions were all given according to these sources.

species that belong to different faunal complexes. The lists of registered birds proved to include the following species: (1) palearctic species (including migrants) (41; 35%); (2) oriental species (Indo–Malayan) (11; 9%); (3) species common for the East Asiatic and Indo–Malayan areas (for the most part, whispered species) (8; 7%); (4) species common for both areas, but which are palearctic faunal elements in the region under consideration (3; 3%); (5) species that are common for both areas, but represent oriental faunal elements in the region under consideration; and (6) Himalayan endemics and subendemics (49; 41%). The Himalayan subendemics include species whose ranges cover not only the Himalayas, but also the territories of the East Asiatic or Indo–Malayan areas, or both of them simultaneously.

The above data suggest that the avifauna of the eastern part of the southern Himalayan slopes that joins species of six faunal complexes is heterogeneous in origin, and in early spring Himalayan endemics and subendemics are the most representative in its formation.

Oriental (Indo–Malayan) birds play a secondary role in the avifauna of eastern part of the southern Himalayan slope, but they nevertheless are of large significance in the formation of local bird communities in early spring. In addition, they bring a well–defined specificity to the diversity of the bird species composition that reflects the historical and regional aspect of the interaction between the avifaunas of large mountain countries.

The avifaunas of the studied altitudinal landscape belts and the transitional band differ primarily in species richness. It decreases with height. The most diverse and richest avifauna is immanent to the lower part of the altitude profile—belts of subtropical mixed forests and coniferous forests (71 and 77 species, respectively). Above, in the subalpine and alpine belts, the avifaunas are much poorer (16 and 15 species, respectively).

We registered the specific species that are only typical for the belts of subtropical mixed forests and coniferous forests (28 and 25 species) and for the transitional band and alpine belt (13 and 5 species). No specific species were noted in the subalpine belt.

The ratio of different faunal complexes in the composition of groups that are specific for each species belt is heterogeneous along the altitudinal profile. It is impossible to distinguish any faunal group that invariably would be the most significant in its share at different altitudes. It is only evident that the species of the oriental (Indo–Malayan) faunal complex play a noticeable role only in the avifauna of the two lower belts of subtropical mixed and coniferous forests.

Each vertical belt includes the specific species typical only for local communities, and the avifaunas of two neighboring belts include comparatively many common species. Thus, from amongst 71 bird species registered in the subtropical mixed forest belt and 77 species found in the coniferous forest belt, 43 species were common. From amongst 77 bird species that held to the coniferous forest belt and 52 species found in the transitional band between the coniferous forest belt and subalpine belt, 34 species were common. From amongst 52 bird species noted in the transitional band between the coniferous forest belt and subalpine belt and 16 species met in the subalpine belt itself, 14 species were common. From amongst 16 bird species of the subalpine belt and 15 species of the alpine belt, 5 species were common.

The avifauna of each altitudinal landscape belt is as similar as possible to the avifauna of the nearest lower belt, and the level of similarity between the avifaunas of two neighboring belts monotonically decreases with height. This is confirmed by the estimate of the similarity between the avifaunas of pairs of neighboring belts. The coefficient of similarity of avifaunas was 58% between the subtropical mixed forest belt and coniferous forest belt, 52% between the coniferous forest belt and transitional band from the coniferous forest belt to the subalpine belt, 41% between the transitional band from the coniferous forest belt to the subalpine belt and the subalpine belt, and 32% between the subalpine and alpine belts.

In early spring in 2005 and 2014, more than 50% of all species (71) were met exclusively within a single altitudinal belt on the southern macroslope of the Eastern Himalayas; about 25% (36) were found within two belts; and far fewer species were met within three (14), four (9), and five (9) belts. These data confirm a well-known regularity: in the mountainous countries of lower latitudes (from 36° S to 48° N), the absolute number of species in both tropical and temperate belts inhabits a very narrow range of heights, which is usually limited to one altitudinal belt (McCain, 2009). This distinguishes the vertical differentiation of the avifauna in mountains of lower latitudes from the mountains located farther to the north, in particular, in the Subarctic, where most species inhabit a wide range of heights that usually covers no less than two belts (Romanov, 2013).

In 2005, the subtropical mixed forest belt was abundant with *Phylloscopus reguloides* (Blyth) and *Fulvetta vinipectus* (Hodgson); in 2014 it was rich in *Columba leuconota* Vigors. *Delichon nipalense* Moore, *Phylloscopus pulcher* Blyth, *Phylloscopus maculipennis* Blyth, *Garrulax albogularis* (Gould), *Garrulax lineatus* (Vigors), *Garrulax affinis* Blyth, *Yuhina occipitalis* Hodgson, *Myophonus caeruleus* (Scopoli), *Ficedula strophiata* (Hodgson), and *Aethopyga ignicauda* (Hodgson) were common in 2005; *Phylloscopus* sp. was common in 2014, and *Corvus macrorhynchos* Wagler and *Malacias capistratus* Vigors were common in both 2005 and 2014.

In both years the coniferous forest belt was abundant with *Corvus macrorhynchos*; the species that were common in 2005 included *Apus (affinis) nipalensis* (JE Gray), *Pyrrhocorax pyrrhocorax* (Linnaeus), *Pyrrhocorax graculus* (Linnaeus*), Parus monticolus* Vigors, *Periparus ater* Linnaeus, *Phylloscopus maculipennis*, *Phylloscopus reguloides*, *Garrulax lineatus*, *Fulvetta vinipectus*, *Cinclus pallasii* Temminck, *Myophonus caeruleus*, *Chaimarrornis leucocephalus* (Vigors), *Aethopyga nipalensis* (Hodgson), *Carpodacus pulcherrimus* (Moore); in 2014, the common species included *Phoenicurus frontalis* Vigors, *Mycerobas carnipes* Hodgson, *Pyrrhocorax pyrrhocorax*, *Malacias capistratus*, *Pyrrhocorax graculus*, *Aegithalos concinnus* (Gould), *Periparus ater*, *Lophophanes dichrous* Blyth, and *Phylloscopus inornatus* (Blyth), *Phylloscopus* sp.; *Garrulax affinis* and *Columba leuconota* were common in both years.

In 2005, the transitional band between the coniferous forest belt and subalpine belt was abundant with *Leucosticte nemoricola* Hodgson, and in 2014 it was abundant with *Corvus macrorhynchos*, *Pyrrhocorax pyrrhocorax*, and *Mycerobas carnipes*; in 2005, the common species included *Columba leuconota*, *Apus (affinis) nipalensis*, *Corvus macrorhynchos*, *Pyrrhocorax pyrrhocorax*, *Periparus rubidiventris* (Blyth), and *Fulvetta vinipectus*; *Lophophorus impejanus* (Latham) and *Parus monticolus* were common in 2014 and *Pyrrhocorax graculus* and *Periparus ater* were common in both years.

In 2014, the subalpine belt was abundant with *Gyps himalayensis* Hume and *Columba leuconota*; *Gypaetus barbatus* (Linnaeus), *Corvus macrorhynchos*, and *Pyrrhocorax graculus* were common. In the alpine belt, *Prunella collaris* (Scopoli), *Leucosticte brandti* Bonaparte, and *Pyrrhocorax graculus* were common.

Among 11 bird species that were numerous in 2005 and 2015, there were 7 Palearctic species, 2 widespread species that are common for the East Asiatic and Indo–Malayan regions, and 2 Himalayan endemics and subendemics.

Among 50 species that were common in 2005 and 2014, there were 22 Himalayan endemics and subendemics and 17 Palearctic species. There was a smaller number of widespread species that are common for the East Asiatic and Indo–Malayan regions (11), including those which represent the oriental faunal complex in the region under consideration (6).

Among the background species in two lower belts, there are many Himalayan endemics and subendemics as well as species of the oriental (Indo–Malayan) faunal complex. In contrast, the representatives of the Palearctic faunal complex are almost exclusively abundant or common in the communities of the subalpine and alpine belts in the upper part of the profile.

Columba leuconota, *Corvus macrorhynchos*, and *Pyrrhocorax pyrrhocorax* are abundant in two altitude belts; *Columba leuconota*, *Apus (affinis) nipalensis*, *Pyrrhocorax pyrrhocorax*, *Parus monticolus*, *Periparus ater*, *Phylloscopus sp*., *Phylloscopus maculipennis*, *Garrulax lineatus*, *Garrulax affinis*, *Fulvetta vinipectus*, *Malacias capistratus*, and *Myophonus caeruleus* are common. *Corvus macrorhynchos* and *Pyrrhocorax graculus* are the only species that is abundant in three and four belts, respectively.

Our observations indicate the space–time instability of the background composition on the southern macroslope of the Eastern Himalayas in early spring due to active migrations of a number of bird species in both the latitudinal (sublatitudinal) and vertical directions. Thus, for example, *Pyrrhocorax graculus* and *Aegithalos concinnus* were abundant in the coniferous forest belt only on March 19–21, 2014, and *Periparus ater*, *Lophophanes dichrous*, *Phylloscopus inornatus*, and other species of the *Phylloscopus* genus were abundant only on March 28–31, 2014.

Let us note that the ornithocomplexes of the subtropical mixed forest belt and coniferous forest belt have similar characteristics as regards the zoogeographic gravity at the level of the species composition (regardless of the abundance estimates). Himalayan endemics and subendemics are abundant in them (56–43%), Palearctic and widespread species account for about one-third (28–38%), and the share of oriental elements is significant (18–20%). The situation changes in the transitional zone at heights of about 3200–3800 above sea level: the share of Himalayan endemics decreases to 29%, the share of oriental elements falls to 8%, and the share of Palearctic and widespread species grows to 64%. Similar indices are also typical for the subalpine belt (the share of Himalayan and Indo–Malayan species is somewhat lower, and the share of Palearctic species is somewhat higher). Palearctic and widespread species prevail in the alpine belt (93%); Himalayan subendemics (7%) are on the whole represented only by species from the Palearctic groups. Himalayan endemics, subendemics of the tropical origin, and oriental elements are almost absent. The identified properties are largely correlated with the change in the faunal bird complexes in the valley of the Kali–Gandak River, which is to the west (in Central Nepal) (Koblik et al., 2000). However, the share of Palearctic elements is similar to the share of Himalayan endemics and representatives of the tropical fauna at lower altitudes (1500–3000 m above sea level). In the region of the Eastern Himalayas, the "equilibrium" fauna fails to be distinguished and, according to our data, the faunal boundary between the Palearctic and Indo–Malayan region of the Paleogene must be drawn near the upper forest boundary, somewhat below the village of Namche–Bazar (3440 m above sea level).

The representatives of ornithocomplexes that have different ecological confinement and different trophic preferences also have a number of peculiarities in the distribution by altitudinal belts. The most stable distribution is immanent to the species of the dendrophilous complex, particularly insectivorous birds, which examine trunks, large branches, and crowns of trees and shrubs in search of food. These are tits (*Parus monticolus*, *Periparus rubidiventris*, *Periparus ater*, *Aegithalos concinnus*, etc.), warblers (*Phylloscopus trochiloides*, *Phylloscopus inornatus*, *Phylloscopus reguloides*, *Phylloscopus sp.*), and small tree babblers (*Fulvetta vinipectus*, *Malacias capistratus,* etc.). Their abundance and diversity were higher in the forest belts according to the results of observations in both years. At least eight species have adapted to the transitional band, but only three tit species rise to the subalpine belt and above; they are not abundant here, and their distribution is in the form of local centers.

Similar distribution is immanent to insectivorous–omnivorous species of the ground-level forest tier—babblers (*Garrulax affinis*, *Garrulax lineatus*, and *Garrulax albogularis*), as well as forest “flycatchers” (*Phoenicurus frontalis*, *Tarsiger rufilatus*, *Ficedula strophiata*, *Eumyias thalassinus*, etc.) and representatives of the guild of nectar eaters (*Myzornis pyrrhoura*, *Aethopyga nipalensis*, and *Aethopyga ignicauda*).

The stable distribution and high local abundance in optimal habitats are demonstrated by species–synanthropes (*Apus nipalensis*, *Corvus macrorhynchus*, *Delichon nipalense*, and *Passer montanus*) and representatives of the complex of rheophiles that gather food in the shallows of fast flowing streams or on their shores (*Cinclus pallasi*, *Myophonus caeruleus*, *Rhyacornis fuliginosa*, *Chaimarrornis leucocephalus*, and *Motacilla cinerea*). As a rule, they were also more common in the lower belts, but, not being closely linked to forest vegetation, they are also found in the usual habitats of the subalpine and alpine belts.

According to our observations in both years, significant fluctuations in abundance and an absence of clear confinement to habitats and belts are demonstrated by omnivorous, seed-eating, and seed-eating–insectivorous birds that are typical just for mountain landscapes, but are not directly confined to forest belts. Some species of these groups could demonstrate only local abundance in some years, but could be not met at all in others, or could be met in another altitudinal belt and in another habitat. As usual, such species rise to the alpine and subalpine belts (and many become common or abundant just here) and are met in groups and flocks, but on the whole their abundance is comparatively low and distribution is very sporadic. In the first place, these are the snow pigeon (*Columba leuconota*), crows (*Corvus corax*, *Pyrrhocorax pyrrhocorax*, *Pyrrhocorax graculus*), many finches (*Leucosticte nemoricola*, *Leucosticte brandti*, *Carpodacus pulcherrimus*, *Carpodacus edvardsii*, *Carpodacus thura*, etc.), and dunnocks (*Prunella collaris*, *Prunella himalayana*, *Prunella rubeculoides*, *Prunella strophiata*, *Prunella immaculata*). We believe these peculiarities are due to the high degree of nomadism in birds of this complex, their dependence on the seasonal and local abundance of foods, and their ability to easily surmount large distances and height amplitudes in search of favorable conditions. The same properties are also demonstrated by some forest species that depend on seed yields of coniferous trees (*Nucifraga caryocatactes* and *Mycerobas carnipes*).

CONCLUSIONS

The avifauna on the southern macroslope of the Eastern Himalayas in early spring is represented by 133 bird species, of which the absolute majority (78%) is representatives of the passerine order.

The bird species of the local avifauna belong to six faunal complexes; among them, the Himalayan endemics and subendemics, as well as Palearctic species, account for the largest share as regards the species richness. Oriental (Indo–Malayan) species are secondary.

The species richness decreases with height. The most diverse avifauna is immanent to the lower part of the altitudinal profile—in the subtropical mixed forest belt (71 species) and coniferous forest belt (77 species). The avifaunas of the subalpine and alpine belts are poorer (16 and 15 species).

About 30% of the avifaunas in the subtropical mixed forest belt, coniferous forest belt, transitional band between the coniferous forest belt and subalpine belt (13 species), and alpine belt are accounted for by specific species, each of which does not go beyond the limits of a corresponding belt.

Each vertical belt contains specific species that are characteristic only of local communities, and the avifaunas of two neighboring belts have comparatively many common species. The avifauna of each altitudinal landscape belt shows the maximum similarity to the avifauna of the nearest lower belt, and the level of similarity between the avifaunas of two neighboring belts monotonously decreases with height: from 58 to 32%.

On the southern macroslope of the Eastern Himalayas, more than 50% of bird species inhabit a very narrow range of heights that is usually limited to a single altitudinal belt.

In local communities, eleven species are abundant and 50 bird species are common. Among background species in two lower belts (the subtropical mixed forest belt and coniferous forest belt) there are enough Himalayan endemics and subendemics, as well as species of the oriental (Indo–Malayan) faunal complex. In contrast to this, the representatives of the Palearctic faunal complex are almost the only species among background species of the bird communities in the subalpine and alpine belts in the upper part of the altitudinal profile.

The species that are environmentally related to woody vegetation, as well as to specific habitats (settlements and water flows) on the whole, show stable population sizes and distribution. Among the distinguished belts, the representatives of these ornithocomplexes are more common for the three lower ones. The species that consume seasonally unstable resources (including seeds) are found in all belts and can be locally common in the upper belts. As a rule, their abundance and distribution vary widely.

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