Species richness, phylogenetic and functional structure of bird communities in Chinese university campuses are associated with divergent variables

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Species richness, phylogenetic and functional structure of bird communities in Chinese university campuses are associated with divergent variables

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Abstract

University campus is an important component of urban landscapes for biodiversity conservation. However, to our knowledge no study has quantitatively assessed the diversity and structure of bird communities in Chinese university campuses, especially from phylogenetic and functional perspectives. Here, for the first time we linked species richness, phylogenetic structure and body mass structure of campus bird communities with contemporary climate, glacial-interglacial climate change, altitudinal range, population density around campus, area and age of campus to test their associations. We found 393 bird species in 38 university campuses (29% of all Chinese bird species, two species are endangered, four species are vulnerable, and 33 species are near threatened). The variables significantly correlated with campus bird species richness, phylogenetic structure and body mass structure were altitudinal range and mean annual precipitation, glacial-interglacial anomaly in temperature, and altitudinal range, respectively. In particular, there were more species in steeper and wetter campuses, more young species clustered in campuses with stable glacial-interglacial climate, and more species with smaller body size in steeper campuses. Our study highlights the importance of considering both phylogenetic and functional information for biodiversity conservation in urban ecosystems.

Keywords Altitudinal range · Body mass · Campus birds · Species richness · Glacial-interglacial climate change · Phylogenetic structure · Precipitation

Introduction

Biodiversity conservation in urban ecosystem is crucial, because urbanization has caused massive loss of biodiversity, and affected the relations between biodiversity and its associated variables (Aronson et al. 2014; Pautasso et al. 2011; Sol et al. 2017). Urbanization ratio in China has rapidly increased in the past decades, e.g., increasing from 36% in 2000 to 53% in 2013, and will be 60% in 2020 (Pan and Wei 2013). Meanwhile, China is the home to 35,112 native higher plant species, 1371 bird species and 673 mammal species (Jiang et al. 2015; Wang et al. 2015; Zheng 2011). Therefore, biodiversity conservation in Chinese urban ecosystem is particularly important.

Covering about 62,000 ha of urban areas, Chinese university campuses are important component of urban ecosystems (Wang 2010). For example, a recent study about plant diversity in 71 Chinese university campuses records 1565 woody and 1614 herbaceous species (Liu et al. 2017). In addition, they find species richness is mainly affected by anthropogenic factors, e.g., campus age and size, while species composition and leaf traits are mainly driven by climate variables, i.e., mean annual temperature (Liu et al. 2017).

Factors associated with urban bird diversity and community structure are also complex, including both natural and

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anthropogenic features, e.g., contemporary climate, topography, land cover, urban age and population density (Aronson et al. 2014; Gagné et al. 2016). For example, human population density in urban area is negatively correlated with breeding bird diversity in North America (Gagné et al. 2016). Recent urban developments with more remnant fragments harbor more bird species than non-vegetated areas (Barth et al. 2015). Solar radiation is a major driver of bird community composition in Swiss cities (Sattler et al. 2010).

However, most studies about urban bird communities mainly focused on the species diversity and composition, with few studies simultaneously addressing the phylogenetic and functional structure (Morelli et al. 2017). A multifaceted approach, i.e., combining taxonomic, phylogenetic and functional diversity, is needed for biodiversity conservation because they represent three divergent dimensions of biodiversity (Devictor et al. 2010; Monnet et al. 2014). Phylogenetic diversity could be used as a proxy for functional diversity, but more importantly, it represents the evolutionary history of biotic assemblages, which is crucial for conservation (Swenson 2013; Winter et al. 2013). Functional traits directly account the ecological differences among species, and are closely linked with ecosystem functioning (Naeem et al. 2012; Swenson 2013).

In this study, for the first time we associated species richness, phylogenetic structure and body mass structure of bird communities in Chinese university campuses with both natural (contemporary climate, glacial-interglacial climate change, altitudinal range) and anthropogenic variables (population density around campus, area and age of campus) to test their relationships. We aim to answer three questions: 1) how many bird species could be found in these campuses? 2) how about their threatened status? 3) are the three dimensions of bird diversity linked with different variables?

Materials and methods

Bird community data in campuses

We searched published papers about bird diversity in Chinese university campuses at xueshu.baidu.com (including databases of both Chinese and English journals). To check how many species could be found in these campuses, we included all papers (38 papers, Appendix 1) with bird species list surveyed in different seasons. To ensure sufficient sampling efforts of the surveys, we only included papers with bird species list (using only resident bird species) covering at least one year (four seasons, 22 papers) to assess the relationships between attributes of bird communities and associated variables. Threatened status of these birds was evaluated by a recent report (Jiang et al. 2016).

Phylogeny and body mass data

Bird phylogeny including 170 resident bird species from 22 selected papers was pruned from the global bird phylogeny (http://birdtree.org) under the option of "Hackett All Species: a set of 10000 trees with 9993 OTUs each" (Jetz et al. 2012). Five thousand pseudo-posterior distributions were sampled. The Maximum Clade Credibility tree was constructed using mean node heights by TreeAnnotator (version 1.8.2) of the BEAST package (Drummond and Rambaut 2007).

Body mass is one of the most informative traits of animals because it is directly linked with other attributes, e.g., trophic level, extinction vulnerability and resource utilization (Ding et al. 2013). Body mass data in this study was from published literature (Zhao 2001). A body mass dendrogram was constructed using "Euclidean" distance and "complete" clustering in "vegan" R package. We first generated a body mass Euclidean distance matrix of all species, and then applied hierarchical clustering analysis to this matrix to finally get the dendrogram of body mass (Appendix 2). This dendrogram is analogous to the phylogeny and was used for the functional structure analyses below.

Associated variables

Climate variables, i.e., mean annual temperature (MAT), mean annual precipitation (MAP), MAT in last glacial maximum (LGM), MAP in LGM, were downloaded from WorldClim database (Hijmans et al. 2005). The mean of Community Climate System Model version 3 (CCSM3) and Model for Interdisciplinary Research on Climate version 3.2 (MIROC 3.2) was used to represent climate variables in LGM. Anomaly in MAT/MAP was calculated as the contemporary MAT/MAP minus the LGM MAT/MAP. Age and area of campus were either compiled from the published papers or from the website of each university. Population density data was extracted from the History Database of the Global Environment (HYDE 3.1; Goldewijk et al. 2011). Altitudinal range data was downloaded from http://www.earthenv.org/DEM.html (Robinson et al. 2014). Because the resolution of altitudinal data is 90 m and the area of each campus varies a lot, we constructed round polygons for each campus according to their area, and then extracted the altitudinal range data in ArcGIS 10.3.

Statistics

Phylogenetic and functional structure was represented by Net Relatedness Index (NRI) (Webb et al. 2002), which is computed as:

$$NRI = -1 \times \frac{MPD_{obs} - meanMPD_{rnd}}{sdMPD_{rnd}}.$$

MPD_{obs} is the observed mean pairwise distance (MPD) of birds in a campus, $meanMPD_{rnd}$ is the mean MPD of the null models (shuffle distance matrix labels 999 times), and *sdMPDrnd* is the standard deviation of MPD of the null models. Positive NRI means birds in a campus are more closely related (or similar in body mass) than expected (i.e. clustered), while negative NRI means birds in a campus are more distantly related (or more divergent in body mass) than expected (i.e. over-dispersed) (Webb et al. 2002).

Species richness was log transformed to get normal distributed residuals. To compare the regression coefficients, all variables were standardized (standard deviation = 1 and mean = 0). Ordinary least squares (OLS) models were used to assess the relationships between species richness, phylogenetic structure, functional structure and each associated variable. To account spatial autocorrelation of residuals, simultaneous autoregressive (SAR) models were also implemented for the single-variable analyses.

To better understand the associations between phylogenetic structure, functional structure and each associated variable, we also calculated the standardized effect size of phylogenetic distance (SES.pd) and mean body mass of birds in each campus, and correlated them with each associated variable. SES.pd. is computed as:

$$SES.pd = \frac{PD_{obs} - meanPD_{rnd}}{sdPD_{rnd}},$$

where PD is the observed phylogenetic diversity of birds in a campus, $meanPD_{rnd}$ is the mean PD of the null models (shuffle distance matrix labels 999 times), and $sdPD_{rnd}$ is the standard deviation of PD of the null models. Positive SES.pd. indicates higher proportion of long branches (relative old species/lineages), while negative SES.pd. indicates higher proportion of short braches (relative young species/lineages) (Forest et al. 2007). All analyses were conducted in R 3.3.0 (R Core Team 2016).

Results

We found 393 species in the 38 published papers, which is 29% of all Chinese bird species. In addition, two species (*Acrocephalus sorghophilus* and *Emberiza aureola*) are endangered, four species (*Turdus feae, Aquila chrysaetos, Prunella koslowi* and *Pitta nympha*) are vulnerable, and 33 species are near threatened (Appendix 3).

Single variable ordinary least squares (OLS) and simultaneous autoregressive (SAR) models showed similar patterns about the associations between campus bird species richness, phylogenetic structure, body mass structure and each associated variable (Table 1). The variables significantly correlated with bird species richness, phylogenetic structure and body mass structure were altitudinal range (positive) and mean annual precipitation (positive), anomaly in mean annual temperature (negative), and altitudinal range (positive), respectively (Table 1, Fig. 1).

Notably, we found that standardized phylogenetic diversity was negatively correlated with altitudinal range and tended to be positively correlated with anomaly in mean annual temperature (Table 2, P value = 0.08). Mean body mass was also negatively correlated with altitudinal range (Table 2).

Discussion

Around 29% of all Chinese bird species (393 species) were found in the 38 campuses, indicating university campuses play an important role in maintaining bird diversity in China. Notably, two species of them are endangered, four species are vulnerable, and 33 species are near threatened.

Table 1 Relationships between campus bird species richness, phylogenetic structure (Phylo NRI), body mass structure (Mass NRI) and each associated variable by ordinary least squares (OLS) and simultaneous autoregressive (SAR) models. MAT and MAP is mean annual temperature and precipitation. $Anom_{MAT}$ and $Anom_{MAP}$ is the contemporary-Last Glacial Maximum anomaly in MAT and MAP. $Range_{ALT}$ is altitudinal range. Coefficients (coef) and adjusted r^2 were given. The two highest r^2 in each column were in bold. $^{*}p < 0.05$; $^{**}p < 0.01$

	Species Richness				Phylo NRI				Mass NRI			
	$Coef_{\_ols}$	$r^2_{\_ols}$	$Coef_{\_sar}$	$r^2_{\_sar}$	$Coef_{\_ols}$	$r^2_{\_ols}$	$Coef_{\_sar}$	$r^2_{\_sar}$	$Coef_{\_ols}$	$r^2_{\_ols}$	$Coef_{\_sar}$	$r^2_{\_sar}$
MAT	0.29	0.04	0.19	0.09	0.13	0	−0.13	0.09	0.08	0	0.09	0.01
MAP	0.50	**0.22***	0.52	**0.26****	0.35	0.08	0.35	0.16	0.20	0	0.19	0.04
$Anom_{MAT}$	−0.38	0.10	−0.37	0.15	−0.57	**0.30****	−0.56	**0.41****	−0.21	0	−0.20	0.05
$Anom_{MAP}$	−0.21	0	−0.13	0.09	−0.14	0	−0.21	0.12	−0.13	0	−0.12	0.02
$Range_{ALT}$	0.63	**0.37****	0.61	**0.43****	0.37	**0.09**	0.29	0.15	0.49	**0.20***	0.48	**0.25****
Population	−0.34	0.07	−0.33	0.20	−0.12	0	−0.01	0.09	0	0	−0.01	0
Age	−0.06	0	−0.06	0.08	0.16	0	0.42	**0.26***	0.24	**0.01**	0.37	**0.08**
Area	0.15	0	0.21	0.12	−0.10	0	−0.09	0.09	−0.19	0	−0.22	0.05

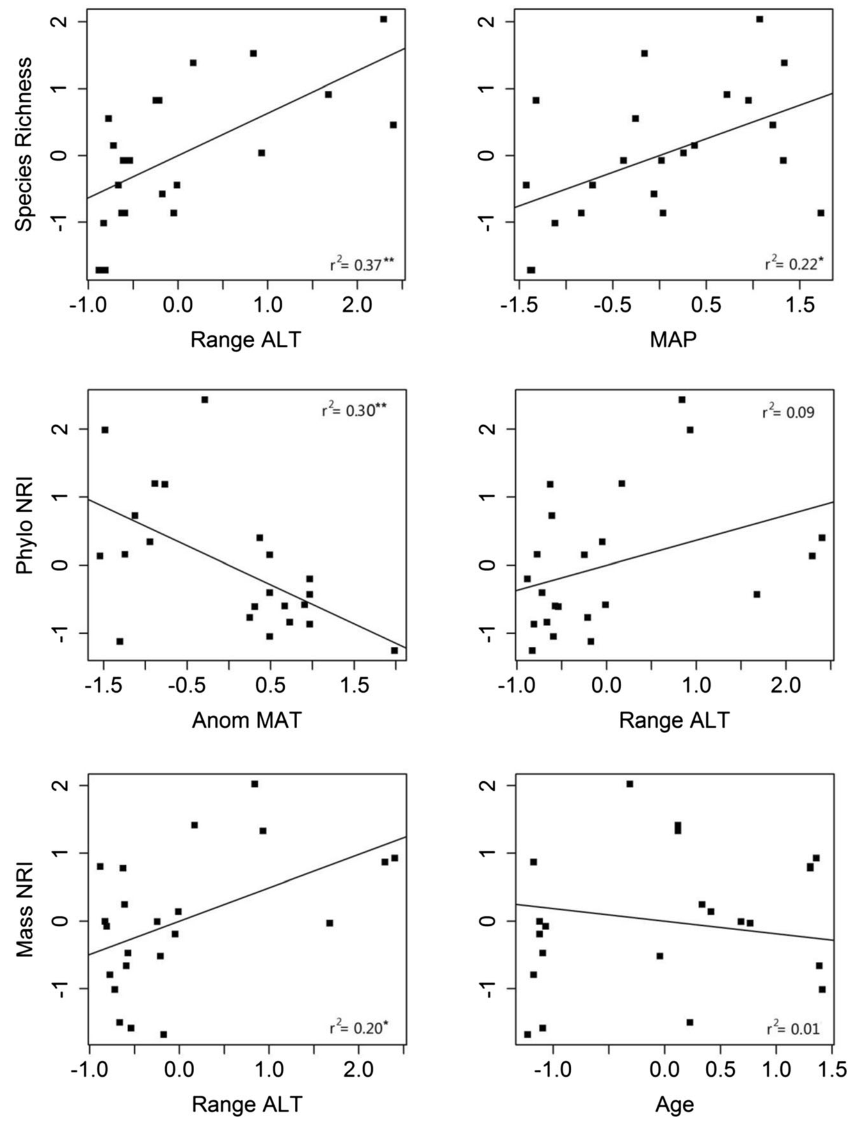

Fig. 1 Scatter plots of campus bird species richness, phylogenetic structure (Phylo NRI) and body mass structure (Mass NRI) against their two most associated variables, which are mean annual precipitation (MAP) and altitudinal range (Range ALT) for species richness, glacial-interglacial anomaly in mean annual temperature (Anom MAT) and Range ALT for Phylo NRI, and Range ALT and Age of campus (Age) for Mass NRI. Linear regression fits and r^2 are given. $^{*}p < 0.05$; $^{**}p < 0.01$

We found altitudinal range was consistently one of the two variables most associated with species richness, phylogenetic and functional structure, with mean annual precipitation, anomaly in mean annual temperature, and campus age being the other most associated variables for them, respectively.

Table 2 Correlations between phylogenetic structure (Phylo NRI), body mass structure (Mass NRI), standardized phylogenetic diversity (SES.pd), mean body mass ($Mass_{mean}$) and each associated variable. The two highest values for each column were in bold. $^{*}p < 0.05$; $^{**}p < 0.01$

	Phylo NRI	Mass NRI	SES.pd	$Mass_{mean}$
MAT	0.13	0.08	−0.19	−0.12
MAP	0.35	0.20	−0.38	−0.22
$Anom_{MAT}$	**−0.57****	−0.21	0.38	**0.28**
$Anom_{MAP}$	−0.14	−0.13	0.35	0.15
$Range_{ALT}$	**0.37**	**0.49***	**−0.49***	**−0.43***
Population	−0.12	0	0.09	−0.05
Age	0.16	**0.24**	**−0.39**	−0.25
Area	−0.10	−0.19	−0.03	0.18

Altitudinal range and species richness as well as community structure

High altitudinal range, as a proxy of large environmental heterogeneity, is widely associated with high bird species richness in natural ecosystems (Jetz and Rahbek 2002; Liang et al. 2018). This relationship between environmental heterogeneity and bird species richness is also tested in urban ecosystems. For example, bird species richness is higher in urban sites with heterogeneous land cover types in Chicago (Loss et al. 2009). Building heterogeneity in Paris is associated with abundance of omnivorous and tree nester species (Pellissier et al. 2012). Consistent with these studies, we also found a positive relationship between bird species richness and altitudinal range in Chinese university campuses.

In addition, we also found a significant relationship between altitudinal range and community structure measured by body mass. The cluster of smaller birds in campus with larger altitudinal range supports the textural discontinuity hypothesis, which assumes that small animals should be associated with a complex landscape texture, and large animals should be associated with a simple landscape texture (Holling 1992). A study in south-eastern Australia also finds more small birds in heterogeneous landscapes than in a relative uniform landscape (Fischer et al. 2008). Moreover, increasing species richness with environmental heterogeneity may result from species packing within communities, especially for the species richness of consumers in terms of the increase in resources (MacArthur 1972; Stevens et al. 2012).

Precipitation and species richness

Precipitation is an important factor influencing animal diversity gradient over most of the earth (Hawkins et al. 2003). And it is generally highly correlated with primary productivity, which may promote more bird species (van Rensburg et al. 2002). For example, bird species richness in South Africa is strongly associated with precipitation (van Rensburg et al. 2002). In Poland, precipitation is positively correlated with farmland (open habitat) bird species richness, while showing no relationship with forest bird species richness (Kosicki and Chylarecki 2012). Covering a large gradient of mean annual precipitation (585 mm – 1736 mm), our results also show an increase of bird species richness with more precipitation.

Glacial-interglacial climate change and phylogenetic structure

Present patterns of biodiversity distribution are determined by both contemporary climate and historical events (Hawkins et al. 2003; Lei et al. 2015). Notably, since speciation and extinction could be shaped by glacial-interglacial climate change, it could directly affect the phylogenetic structure of present communities (Jansson 2003; Price et al. 2000; Turgeon et al. 2005). Regions with stable climate would preserve paleoendemics and have divergent gene pools, which would favour the evolution of neoendemics (Jansson 2003). Moreover, diversification rate of birds in the past 50 million years (till the near present) has increased rapidly, especially in Asia, where inhabiting a high proportion of species from recent rapid radiations (Jetz et al. 2012). Consistent with these statements, our results show that campuses with stable historical climate have phylogenetic clustered communities, mainly composed of young bird species.

Effect of area, age and population density

In addition to those natural variables, other anthropogenic factors are also associated with urban bird species richness and community structure in previous studies (Devictor et al. 2007; Gagné et al. 2016; Hagen et al. 2017; Schütz and Schulze 2016). For example, human population density in urban area is negatively correlated with breeding bird diversity in North America (Gagné et al. 2016). Land cover changes driven by urbanization in French have strongly affected functional composition of bird communities, leading to functional homogenization (Devictor et al. 2007). However, our study did not show significant effects of these anthropogenic variables. One reason could be that our study region covers a large gradient of natural variables, i.e., contemporary climate, historical climate and altitudinal range, which are more important for large-scale biodiversity patterns. Although plant species richness in Chinese university campuses is correlated with campus area and age (Liu et al. 2017), birds may not be so sensitive to these anthropogenic variables as plants.

Summary

Being the first study about the patterns and drivers of Chinese campus bird communities, we find natural factors, i.e., altitudinal range, contemporary and historical climate, are generally more important than anthropogenic variables, i.e., population density, campus age and area. Notably, species richness, phylogenetic and functional community structure are shaped by divergent variables, indicating the importance of considering the three dimensions of biodiversity in urban biodiversity conservation.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1. Reference list of the 38 papers collected in our study

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Appendix 2

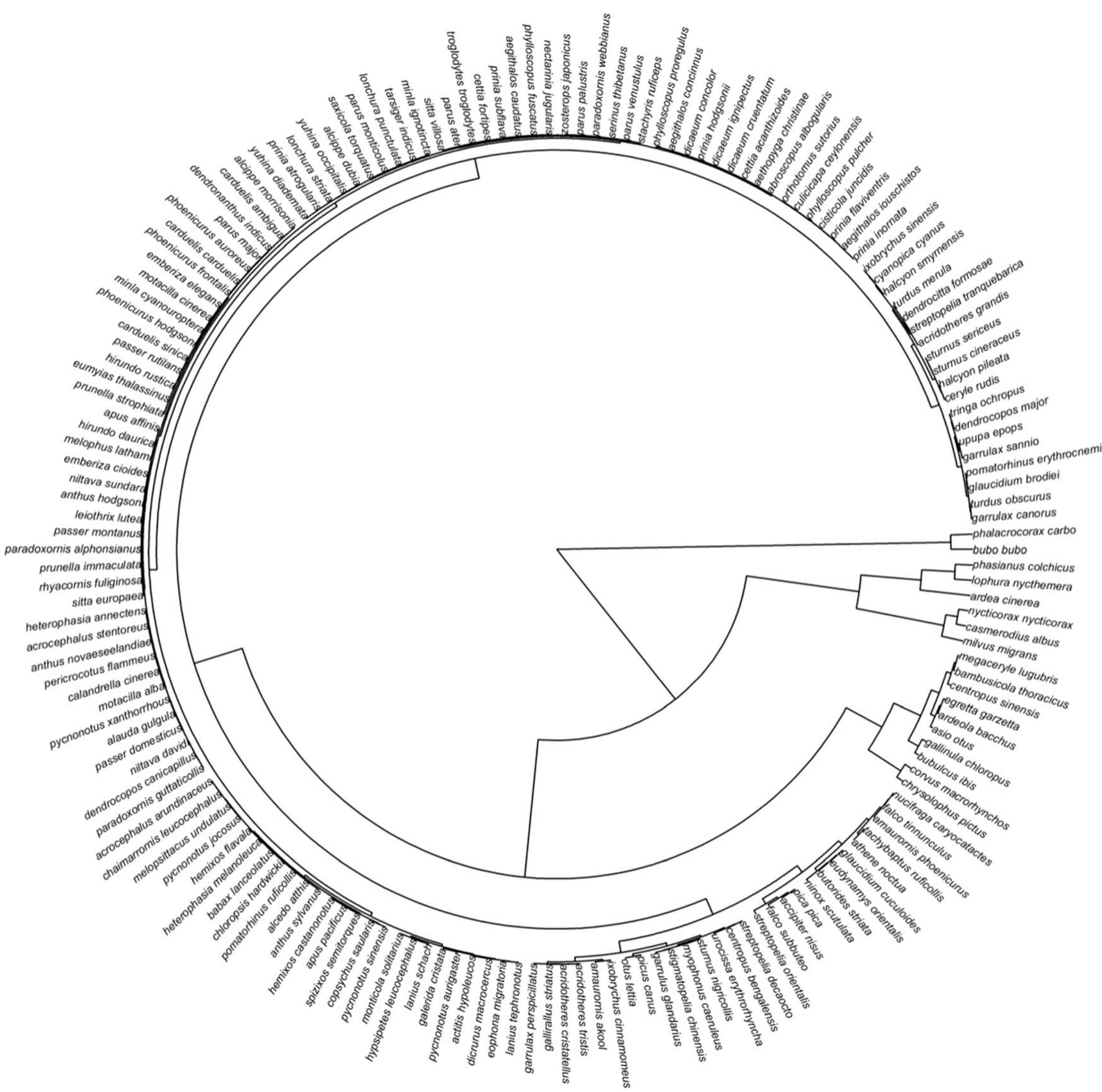

Fig. 2 The dendrogram of body mass

Appendix 3

Table 3 Species list of the 393 species found in our study, with threatened status information

Species name	Threatened status
Acrocephalus sorghophilus	EN
Emberiza aureola	EN
Turdus feae	VU
Aquila chrysaetos	VU
Prunella koslowi	VU
Pitta nympha	VU
Circus cyaneus	NT
Accipiter gentilis	NT
Pandion haliaetus	NT
Pernis ptilorhyncus	NT
Falco amurensis	NT
Porzana fusca	NT
Butastur indicus	NT
Locustella lanceolata	NT
Terpsiphone paradisi	NT
Cygnus columbianus	NT
Ninox scutulata	NT
Falco peregrinus	NT
Aix galericulata	NT
Emberiza tristrami	NT
Accipiter trivirgatus	NT
Harpactes erythrocephalus	NT
Eophona personata	NT
Hydrophasianus chirurgus	NT
Falco vespertinus	NT
Bubo bubo	NT
Asio flammeus	NT
Garrulax canorus	NT
Aythya nyroca	NT
Charadrius placidus	NT
Ibidorhyncha struthersii	NT
Sitta villosa	NT
Platalea leucorodia	NT
Emberiza yessoensis	NT
Numenius arquata	NT
Chrysolophus pictus	NT
Buteo lagopus	NT
Carduelis thibetana	NT
Aerodramus brevirostris	NT
Acridotheres cristatellus	LC
Pycnonotus sinensis	LC
Turdus naumanni	LC
Phoenicurus auroreus	LC
Dendrocopos major	LC
Cuculus canorus	LC
Parus major	LC
Upupa epops	LC
Dicrurus macrocercus	LC
Gallinula chloropus	LC
Eophona migratoria	LC
Amaurornis akool	LC
Lanius cristatus	LC
Acrocephalus aedon	LC
Charadrius alexandrinus	LC
Phasianus colchicus	LC
Emberiza elegans	LC
Phylloscopus inornatus	LC
Emberiza chrysophrys	LC
Phylloscopus proregulus	LC
Sturnus cineraceus	LC
Emberiza spodocephala	LC
Cyanopica cyanus	LC
Streptopelia tranquebarica	LC
Phylloscopus borealis	LC
Hirundo rustica	LC
Carduelis sinica	LC
Charadrius dubius	LC
Spizixos semitorques	LC
Passer montanus	LC
Alcedo atthis	LC
Tringa nebularia	LC
Emberiza cioides	LC
Streptopelia orientalis	LC
Sturnus sericeus	LC
Cuculus micropterus	LC
Pica pica	LC
Emberiza pusilla	LC
Alauda gulgula	LC
Corvus corone	LC
Fringilla montifringilla	LC
Lanius schach	LC
Coturnix japonica	LC
Delichon urbicum	LC
Egretta garzetta	LC
Zoothera sibirica	LC
Turdus obscurus	LC
Amaurornis phoenicurus	LC
Turdus mupinensis	LC
Ardea cinerea	LC
Ardeola bacchus	LC
Tadorna ferruginea	LC
Corvus dauuricus	LC
Corvus macrorhynchos	LC
Regulus regulus	LC

Table 3 (continued)

Species name	Threatened status
Phylloscopus tenellipes	LC
Phylloscopus humei	LC
Acrocephalus arundinaceus	LC
Dicrurus hottentottus	LC
Phylloscopus reguloides	LC
Megaceryle lugubris	LC
Phylloscopus fuscatus	LC
Turdus ruficollis	LC
Acrocephalus bistrigiceps	LC
Oriolus chinensis	LC
Luscinia calliope	LC
Otus scops	LC
Falco tinnunculus	LC
Luscinia sibilans	LC
Tarsiger cyanurus	LC
Zosterops erythropleurus	LC
Urocissa erythrorhyncha	LC
Zoothera dauma	LC
Parus venustulus	LC
Turnix tanki	LC
Ixobrychus sinensis	LC
Streptopelia decaocto	LC
Turdus hortulorum	LC
Pericrocotus cantonensis	LC
Picus canus	LC
Actitis hypoleucos	LC
Troglodytes troglodytes	LC
Phylloscopus schwarzi	LC
Halcyon pileata	LC
Luscinia svecica	LC
Ixobrychus cinnamomeus	LC
Urosphena squameiceps	LC
Anas crecca	LC
Butorides striata	LC
Anas platyrhynchos	LC
Parus ater	LC
Phylloscopus coronatus	LC
Bubulcus ibis	LC
Erithacus rubecula	LC
Buteo buteo	LC
Apus apus	LC
Rallus aquaticus	LC
Caprimulgus indicus	LC
Scolopax rusticola	LC
Accipiter nisus	LC
Copsychus saularis	LC
Cettia diphone	LC
Accipiter gularis	LC
Eurystomus orientalis	LC

Table 3 (continued)

Species name	Threatened status
Rhopophilus pekinensis	LC
Gallinago gallinago	LC
Garrulus glandarius	LC
Bombycilla garrulus	LC
Phylloscopus magnirostris	LC
Cuculus poliocephalus	LC
Locustella certhiola	LC
Tachybaptus ruficollis	LC
Bombycilla japonica	LC
Certhia familiaris	LC
Riparia riparia	LC
Falco subbuteo	LC
Nycticorax nycticorax	LC
Aegithalos caudatus	LC
Cuculus sparverioides	LC
Phylloscopus yunnanensis	LC
Alauda arvensis	LC
Asio otus	LC
Pericrocotus ethologus	LC
Parus palustris	LC
Gallinago stenura	LC
Ixobrychus eurhythmus	LC
Phylloscopus armandii	LC
Cisticola juncidis	LC
Paradoxornis webbianus	LC
Athene noctua	LC
Monticola gularis	LC
Muscicapa griseisticta	LC
Muscicapa sibirica	LC
Muscicapa dauurica	LC
Ficedula zanthopygia	LC
Ficedula narcissina	LC
Ficedula albicilla	LC
Dendronanthus indicus	LC
Motacilla flava	LC
Motacilla citreola	LC
Motacilla cinerea	LC
Anthus hodgsoni	LC
Anthus gustavi	LC
Prunella montanella	LC
Fringilla coelebs	LC
Carduelis flammea	LC
Carpodacus erythrinus	LC
Carpodacus roseus	LC
Carduelis spinus	LC
Emberiza leucocephalos	LC
Emberiza rutila	LC
Coccothraustes coccothraustes	LC
Dendrocopos canicapillus	LC

Table 3 (continued)

Species name	Threatened status
Dendrocopos hyperythrus	LC
Loxia curvirostra	LC
Delichon dasypus	LC
Pycnonotus xanthorrhous	LC
Pycnonotus aurigaster	LC
Lanius tephronotus	LC
Dicrurus leucophaeus	LC
Acridotheres tristis	LC
Prunella strophiata	LC
Prunella immaculata	LC
Tarsiger indicus	LC
Phoenicurus hodgsoni	LC
Phoenicurus frontalis	LC
Pomatorhinus erythrocnemis	LC
Garrulax sannio	LC
Heterophasia annectens	LC
Heterophasia melanoleuca	LC
Yuhina diademata	LC
Yuhina occipitalis	LC
Paradoxornis guttaticollis	LC
Phylloscopus pulcher	LC
Prinia flaviventris	LC
Niltava davidi	LC
Niltava sundara	LC
Eumyias thalassinus	LC
Culicicapa ceylonensis	LC
Parus monticolus	LC
Aegithalos concinnus	LC
Aegithalos iouschistos	LC
Zosterops japonicus	LC
Passer rutilans	LC
Carduelis ambigua	LC
Lophura nycthemera	LC
Halcyon smyrnensis	LC
Lonchura striata	LC
Glaucidium cuculoides	LC
Lonchura punctulata	LC
Ceryle rudis	LC
Aethopyga christinae	LC
Chloropsis hardwickii	LC
Centropus sinensis	LC
Prinia inornata	LC
Garrulax perspicillatus	LC
Pycnonotus jocosus	LC
Dicaeum ignipectus	LC
Porzana pusilla	LC
Myophonus caeruleus	LC
Alcippe dubia	LC
Tichodroma muraria	LC

Table 3 (continued)

Species name	Threatened status
Stachyris ruficeps	LC
Rhyacornis fuliginosa	LC
Lanius tigrinus	LC
Anthus rubescens	LC
Bambusicola thoracicus	LC
Minla cyanouroptera	LC
Cettia fortipes	LC
Cacomantis merulinus	LC
Tringa ochropus	LC
Dicaeum concolor	LC
Melophus lathami	LC
Cyornis hainanus	LC
Motacilla alba	LC
Prinia atrogularis	LC
Hypothymis azurea	LC
Alcippe morrisonia	LC
Prinia hodgsonii	LC
Gallirallus striatus	LC
Monticola solitarius	LC
Cyornis banyumas	LC
Turdus cardis	LC
Centropus bengalensis	LC
Acrocephalus stentoreus	LC
Orthotomus sutorius	LC
Dicaeum cruentatum	LC
Pomatorhinus ruficollis	LC
Ardea purpurea	LC
Sterna hirundo	LC
Corvus frugilegus	LC
Lanius sphenocercus	LC
Cuculus micropterus	LC
Carduelis carduelis	LC
Columba livia	LC
Lanius bucephalus	LC
Coracina melaschistos	LC
Turdus pallidus	LC
Hemixos castanonotus	LC
Turdus boulboul	LC
Pericrocotus flammeus	LC
Hypsipetes leucocephalus	LC
Anas poecilorhyncha	LC
Recurvirostra avosetta	LC
Podiceps cristatus	LC
Vanellus vanellus	LC
Tringa erythropus	LC
Larus ridibundus	LC
Vanellus cinereus	LC
Anthus spinoletta	LC
Chlidonias hybrida	LC

Table 3 (continued)

Species name	Threatened status
Calidris subminuta	LC
Botaurus stellaris	LC
Anthus cervinus	LC
Anthus sylvanus	LC
Milvus migrans	LC
Heteroscelus brevipes	LC
Anthus richardi	LC
Phylloscopus trochiloides	LC
Glaucidium brodiei	LC
Galerida cristata	LC
Fulica atra	LC
Parus montanus	LC
Passer ammodendri	LC
Larus crassirostris	LC
Lanius excubitor	LC
Eremophila alpestris	LC
Oenanthe deserti	LC
Emberiza rustica	LC
Emberiza pallasi	LC
Columba rupestris	LC
Phoenicurus ochruros	LC
Cuculus saturatus	LC
Corvus monedula	LC
Phoenicurus erythrogastrus	LC
Apus pacificus	LC
Chaimarrornis leucocephalus	LC
Rostratula benghalensis	LC
Ardea cinerea	LC
Anas strepera	LC
Aythya fuligula	LC
Phylloscopus affinis	LC
Phylloscopus maculipennis	LC
Saxicola ferreus	LC
Passer domesticus	LC
Phalacrocorax carbo	LC
Egretta garzetta	LC
Phylloscopus subaffinis	LC
Cinclus pallasii	LC
Leiothrix lutea	LC
Paradoxornis alphonsianus	LC
Minla ignotincta	LC
Abroscopus albogularis	LC
Babax lanceolatus	LC
Tringa totanus	LC
Charadrius hiaticula	LC
Cettia acanthizoides	LC
Sitta europaea	LC
Nucifraga caryocatactes	LC
Anthus roseatus	LC

Table 3 (continued)

Species name	Threatened status
Prinia polychroa	LC
Parus rubidiventris	LC
Hypsipetes mcclellandii	LC
Accipiter virgatus	LC
Enicurus scouleri	LC
Seicercus burkii	LC
Centropus sinensis	LC
Hemixos flavala	LC
Dendrocitta formosae	LC
Anser albifrons	LC
Picumnus innominatus	LC
Acrocephalus agricola	LC
Anser fabalis	LC
Calidris alpina	LC
Anser anser	LC
Latoucheornis siemsseni	LC
Seicercus castaniceps	LC
Tringa glareola	LC
Acridotheres grandis	LC
Turdus merula	LC
Gallicrex cinerea	LC
Hirundo rustica	LC
Lanius cristatus	LC
Pica pica	LC
Ficedula zanthopygia	LC
Phylloscopus borealis	LC
Regulus regulus	LC
Streptopelia capicola	LC
Bradypterus davidi	LC
Sturnus sturninus	LC
Hirundo daurica	LC
Otus bakkamoena	LC
Stigmatopelia chinensis	LC
Saxicola torquatus	LC
Prinia subflava	LC
Sturnus nigricollis	LC
Nectarinia jugularis	LC
Surniculus dicruroides	LC
Apus affinis	LC
Eudynamys scolopaceus	LC
Anthus richardi	LC
Gracupica nigricollis	LC
Casmerodius albus	LC
Mesophoyx intermedia	LC
Oenanthe hispanica	LC
Calandrella brachydactyla	LC
Calandrella cheleensis	LC
Garrulax elliotii	LC
Melopsittacus undulatus	LC

Table 3 (continued)

Species name	Threatened status
Enicurus immaculatus	LC
Pomatorhinus erythrogenys	LC
Ficedula parva	DD
Himantopus himantopus	DD
Columba janthina	DD

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