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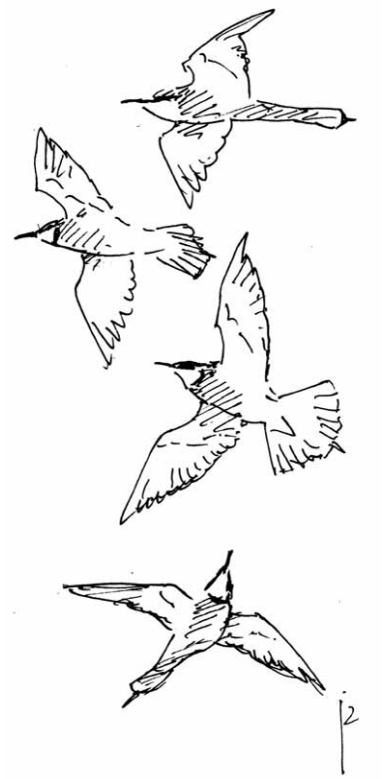
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# Temperature differentially mediates species richness of birds of different biogeographic types

**Gregorio Moreno-Rueda[1,2,*] & Manuel Pizarro[2]**



Moreno-Rueda G. & Pizarro M. 2008. Temperature differentially mediates species richness of birds of different biogeographic types. Ardea 96(1): 115–120.

This study explores the relationship between richness of bird species and climate in Spain, distinguishing groups of species according to biogeographic type. Species richness proved to be related to temperature but in a different way for each of the biogeographic groups. While controlling for other variables, species richness initially increased with temperature, but dropped when temperature increased further. As this drop was less strong in southern species than in northern species, a positive relationship between the percentage of southern species and temperature emerged. Moreover, the percentage of southern species varied with human population density, altitude range and precipitation in a quadratic way.

Key words: climatic change, habitat heterogeneity, human population, land use, Spain

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## Introduction

Climate is one of the most important factors determining the distribution of avian species richness (e.g. Rahbek & Graves 2001) by its effect on primary production (van Rensburg et al. 2002, Chown *et al.* 2003, Hurlbert & Haskell 2003), and by its interaction with physiological requirements and tolerances of species (Turner *et al.* 1988, Woodward & Kelly 2003). Factors determining species richness are not universal, but vary among taxa (e.g. Miller *et al.* 2003). This is because the distribution of species is mediated by their ecological niche (Pulliam 2000, Wiens & Donoghue 2004), and groups of species differentiated by their taxonomy, behaviour, or physiology can have a shared or convergent evolution, responding differentially to certain factors which interact with the necessities imposed by their niche. Knowledge on the way how climate affects the distribution of avian species richness is of prime importance as the Earth is under a climatic warming (IPCC 2001). This climatic change is already affecting bird distribution (Thomas & Lennon 1999), and dramatic changes in the distribution of birds are predicted (Huntley *et al.* 2006).

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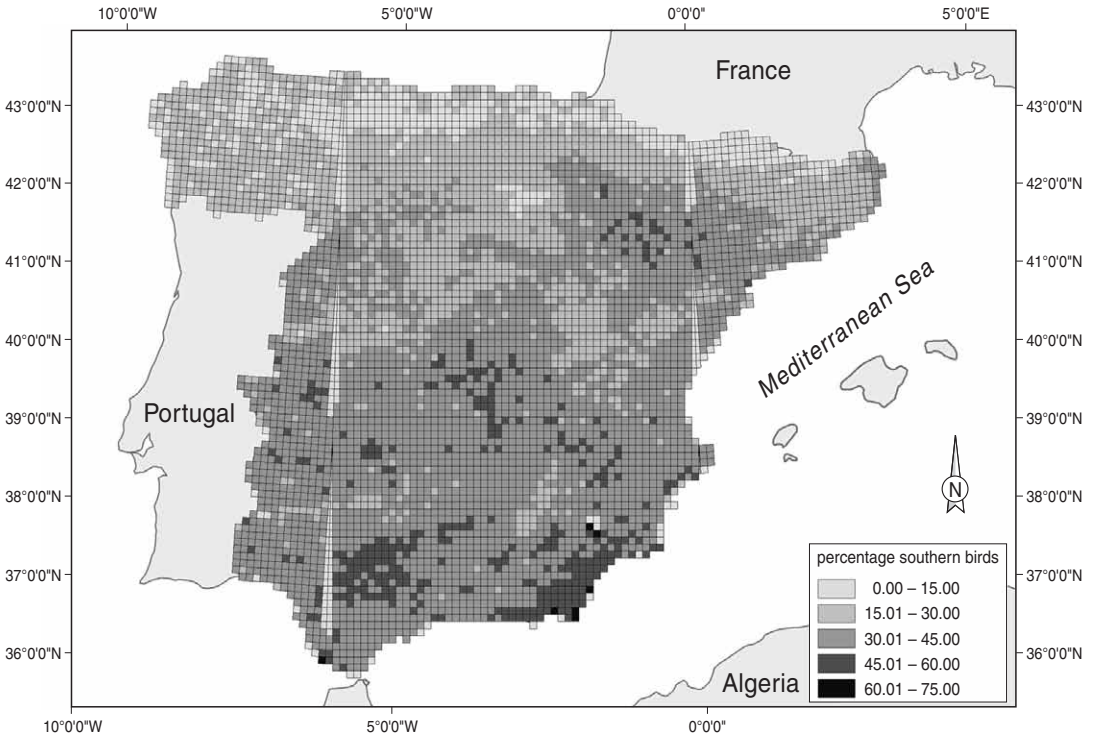



**Figure 1.** Distribution map for the percentage of southern species in Spain in 10 x 10 km squares.

Species in different climate zones of the Earth must be adapted to different environmental conditions, which spawned the distinction between biogeographic types (Voous 1960, Newton 2003). As species of different biogeographic types are adapted to different climates, climate might differentially affect species richness of birds of different biogeographic types. We tested this hypothesis on the basis of the distribution of birds in Spain. We predict that the richness of northern species should be negatively correlated with temperature, and positively with precipitation, while the reverse should occur in the richness of southern species (also see Santos & Tellería 1995).

## Methods

The study area was peninsular Spain, which has a variety of environments ranging from Mediterranean aspects to an oceanic climate along the Cantabrian coast. The study area was divided in 5331 UTM squares of about 10 x 10 km (Fig. 1). Cartographic distortions caused some squares to be less than 100 km$^2$, and these were removed from the analyses. Squares without environmental information were also dropped from analyses, resulting in a final sample size of 5070 squares.

Species richness was defined as the number of bird species in each cell. We used all species of breeding birds listed in the national atlas (Martí & del Moral 2003, Ministerio de Medio Ambiente 2003). We assigned each species to the category 'northern' or 'southern', according to its biogeographic type (listed in Online appendix 1). Biogeographic types for which distribution was ubiquitous (e.g. Cosmopolitan or Old World) were discarded (Online appendix 1). With these data, we calculated the percentage of southern species in each square. The percentage of southern species

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was positively correlated with the richness of southern species ($r = 0.66$; $P < 0.001$; $n = 5070$ squares) and negatively with the richness of northern species ($r = –0.64$; $P < 0.001$).

Independent variables were acquired from the European Environment Agency (www.eea.europa.eu), using a geographic information system (SAGA; Conrad 2005). To test effects of climate, we considered two variables for each of the squares: (1) mean annual temperature, and (2) total annual precipitation. Mean annual temperature was strongly correlated with mean temperature in the coldest and hottest months ($r > 0.88$). Moreover, we considered (3) altitude range, (4) habitat diversity, as the sum of types of land use, taken from Corine Land Cover (www.eea.europa.eu), (5) human population density (log-transformed), (6) humanized surface area, as the percentage of area used by humans (croplands and urban zones; arcsine-transformed), which served as a negative indicator of natural land available. Lastly, in order to minimize possible effects of spatial autocorrelation, we introduced the geographic variables longitude (Lon) and latitude (Lat) of the centre of the squares, as well as the composite variables $Lon^2$, $Lat^2$, $Lat^3$, $Lon^2$xLat and LonxLat$^2$, according to Legendre (1993). We did not use $Lon^3$ and LatitudexLongitude because this destabilized the matrix and least squares could not be calculated. The inclusion of these terms successfully removed most of the spatial autocorrelation, indicated by Moran's I of the residual models, always lower than 0.15 (Diniz-Filho *et al.* 2003).

Variables had an almost normal distribution, otherwise they were transformed to fit a normal distribution. Variables were standardized with a mean of 0 ± 1 SD (Sokal & Rohlf 1995). To test the relationship between independent variables and species richness, we used a Generalized Linear Model (GLM) of Ordinal Least Squares (OLS). This analysis statistically controls for the effects of other independent variables. Multicollinearity was not high, as absolute values of correlations between independent variables were 0.66 or less, and tolerance was always higher than 0.3 (Quinn & Keough 2002). To test for curvilinear relationships, we introduced polynomial terms of variables 1–6 into the model. Variables in the final models were selected by a stepwise backward process.

## Results and discussion

Figure 1 shows the distribution of the percentage of southern species in Spain. As expected, the percentage of southern species per square correlated with temperature in a positive way ($r = 0.65$; $P < 0.001$; $n = 5070$ squares; Fig. 2). When controlling for effects of other variables, the GLM showed a significant positive relationship between percentage of southern species and temperature (Table 1). This model explained 76% of variation in percentage of the southern species. We repeated the GLMs in order to examine the relationship between temperature and species richness of southern and northern species. After controlling for the other independent variables in this study, species richness of southern and northern species were related to temperature in a quadratic way (Table 1). In both cases, species richness dropped with increasing temperature, but less so in southern species, thus explaining the results found for the percentage of southern species. Other studies have shown that the distribution or abundance of

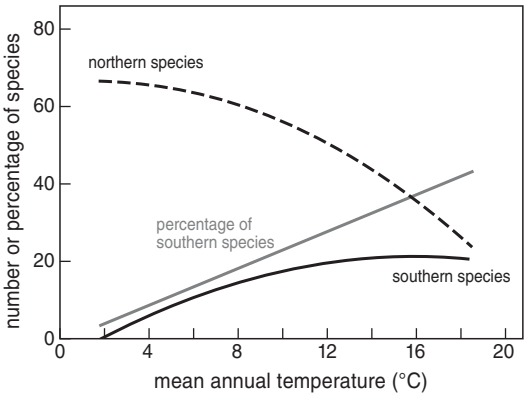



**Figure 2.** Relationship (without controlling for other variables) between temperature and number of southern species ($y=–7+0.24x–0.18x^2$), number of northern species ($y=66–0.66x–0.12x^2$), and percentage of southern species ($y=0.65x$). Data points are not shown for clarity.

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**Table 1.** Results of GLM's analysing dependence of percentage of southern species, richness of southern species, and richness of northern species on various variables. The b coefficients of the multiple-regression model are given, as well as values of $R^2$ and *F*-statistic. In bold, slopes that significantly differ from zero at $P < 0.0025$ (corrected by Bonferroni). - indicates that variable was removed by backward stepwise selection.

| Dependent variable | Percentage of southern species | Southern species richness | Northern species richness |
|---|---|---|---|
| $R^2$ | 0.76 | 0.50 | 0.58 |
| *F*-statistic | 1079.12 | 282.36 | 403.52 |
| df | 15,5054 | 18,5051 | 17,5052 |
| Longitude (Lon) | **4.980** | **6.29** | **–2.47** |
| $Lon^2$ | **–8.73** | **–13.86** | 2.63 |
| Latitude (Lat) | **–211.80** | **–396.05** | **–133.15** |
| $Lat^2$ | **429.34** | **800.81** | **264.82** |
| $Lat^3$ | **–217.67** | **–404.67** | **–131.66** |
| $Lon^2$xLat | **8.35** | **13.10** | –3.23 |
| Lonx$Lat^2$ | **–4.33** | **–5.46** | **3.11** |
| Human population (HP) | **0.21** | **0.22** | **0.05** |
| $HP^2$ | **–0.28** | **–0.30** | - |
| Humanized area (HA) | - | **0.19** | 0.09 |
| $HA^2$ | - | **–0.24** | **–0.24** |
| Altitude range (AR) | **0.42** | **0.36** | –0.17 |
| $AR^2$ | **–0.49** | **–0.30** | **0.26** |
| Habitat diversity (HD) | **–0.03** | **0.10** | **0.11** |
| $HD^2$ | - | - | - |
| Temperature (T) | **0.39** | **0.69** | 0.13 |
| $T^2$ | - | **–0.37** | **–0.36** |
| Precipitation (P) | **0.14** | **0.91** | **0.83** |
| $P^2$ | **–0.28** | **–1.09** | **–0.79** |

avian species, in general, is affected by temperature (Root 1988, Turner *et al.* 1988, Lennon *et al.* 2000), our study extending on this by showing that the effect of temperature depends on the biogeographic type considered.

While, percentage of southern species correlated negatively with precipitation ($r = –0.64$; $P < 0.001$). However, when the relationship with precipitation was controlled for other variables, a quadratic relationship emerged, with higher percentages of southern species for intermediate values of precipitation. Analysing richness of northern and southern species separately, the two biogeographic types showed a similar quadratic relationship with precipitation (Table 1). Probably, precipitation favours species richness through primary productivity (Waide *et al.* 1999, Hawkins *et al.* 2003, Whittaker *et al.* 2007), but high levels of precipitation harm species survival and breeding, affecting plumage impermeability and foraging opportunities (Lennon *et al.* 2000).

The GLM also showed a significant quadratic relationship between percentage of southern species and human population density, indicating a decline of percentage for high values of this variable (Table 1). Many southern species are associated with farmland (Suáres-Seoane *et al.* 2002), which could explain this relationship. On the other

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hand, the relationship between human population density and species richness of the two southern and northern species differed, being quadratic for southern species, while linear for northern species (Table 1). Therefore, although avian species richness usually correlates with human population (e.g. Araújo 2003), this study shows differences in this relationship according the biogeographic type considered. This may have implications for avian conservation, as southern species seem to be more sensitive to high levels of human disturbance.

The percentage of southern species showed a significant quadratic relationship with altitude range, with a decline of percentage for highest values of altitude range (Table 1). The concave-up relationship between richness of northern species and altitude range (Table 1) is probably caused by the inclusion of different faunas in the 'northern species' category, with some species inhabiting mountains, while other dwelling in plains.

In sum, this study shows that ecological factors differentially correlate with richness of species of different biogeographic types, resulting in which factors such as temperature mediate differences in the composition of avian species throughout Iberian Peninsula. Similarly, other studies have shown that ecological factors differentially affect avian species richness according to the distribution range of species considered (Jetz & Rahbek 2002); species richness of birds of different foraging guilds is also affected by different environmental variables (Miller *et al.* 2003). The ecological determinants of avian species richness also vary geographically (Davies *et al.* 2007), which might be a consequence of different avian communities in which species richness is affected by different factors.

Lastly, temperature has increased in Spain in the last century (Hulme & Sheard 1999), and it is predicted to continue increasing in the coming years (IPCC 2001). According to the findings of this study, this will provoke a change in the composition of avian communities in the Mediterranean region by increasing the percentage of southern species. Apparently, northern species are more threatened by climatic change in the region, while in relatively cold zones southern species would be favoured by a rise of temperatures. However, our analysis provides evidence that in relatively hot zones southern species would be harmed as well. Thus, considerable increases of temperature may cause a decline in avian species richness in Mediterranean regions.

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## SAMENVATTING

Rijkdom van vogels wordt voor een groot deel door het klimaat bepaald. Deze studie onderzocht het verband tussen het aantal soorten vogels en het klimaat in Spanje op grond van blokken van 10 x 10 km. Hierbij werd onderscheid gemaakt tussen 'noordelijke' en 'zuidelijke' soorten. Het aantal noordelijke soorten per blok nam af naarmate de gemiddelde jaartemperatuur hoger was, terwijl zuidelijk soorten een omgekeerde trend lieten zien. In de warmste blokken nam ook het aantal zuidelijke soorten enigszins af. Het percentage zuidelijke soorten per blok nam daardoor sterk toe naarmate de temperatuur hoger was. Het percentage zuidelijke soorten nam bovendien toe met bevolkingsdichtheid, hoogteverschillen en neerslag per blok, maar het verband was tegengesteld in het hoogste bereik van deze parameters. (JP)

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**Appendix 1.** Alphabetic list of bird species in Spain (scientific and common name), their biogeographic type according to Voous (1960) and that assigned by us. We assigned as 'northern' the types: Arctic, Northern Atlantic, European, Euroturquestan, Holarctic, Paleomontane, Palearctic, and Siberian-Canadian; as 'southern species' we assigned the types: Etiopic, Indoafrican, Mediterranean, Paleoxeric, Paleoxericmontane, and Turquestan-Mediterranean. The types Old World, Cosmopolitan, 'unknown', Mongoltibetan, and Sarmatic were disregarded, as they are amply distributed or their classification was unclear to us. Distribution maps of each group are available from the authors upon request.

| Scientific name | Common name | Voous' type | Assigned type |
|---|---|---|---|
| *Accipiter gentilis* | Northern Goshawk | Holarctic | Northern |
| *Accipiter nisus* | Eurasian Sparrowhawk | Palearctic | Northern |
| *Acrocephalus arundinaceus* | Great Reed Warbler | Euroturquestan | Northern |
| *Acrocephalus melanopogon* | Moustached Warbler | Turquestan-Mediterranean | Southern |
| *Acrocephalus schoenobaenus* | Sedge Warbler | Euroturquestan | Northern |
| *Acrocephalus scirpaceus* | Reed Warbler | Euroturquestan | Northern |
| *Actitis hypoleucos* | Common Sandpiper | Holarctic | Northern |
| *Aegithalos caudatus* | Long-tailed Tit | Palearctic | Northern |
| *Aegolius funereus* | Tengmalm's Owl | Siberian-Canadian | Northern |
| *Aegypius monachus* | Monk Vulture | Mongoltibetan | Discarded |
| *Alauda arvensis* | Sky Lark | Palearctic | Northern |
| *Alcedo atthis* | Common Kingfisher | Old World | Discarded |
| *Alectoris barbara* | Barbary Partridge | Mediterranean | Southern |
| *Alectoris rufa* | Red-legged Partridge | Mediterranean | Southern |
| *Amandava amandava* | Avadavat | Unknown | Discarded |
| *Anas acuta* | Pintail | Palearctic | Northern |
| *Anas clypeata* | Northern Shoveler | Holarctic | Northern |
| *Anas crecca* | Common Teal | Holarctic | Northern |
| *Anas platyrhynchos* | Mallard | Holarctic | Northern |
| *Anas querquedula* | Garganey | Palearctic | Northern |
| *Anas strepera* | Gadwall | Holarctic | Northern |
| *Anthus campestris* | Tawny Pipit | Palearctic | Northern |
| *Anthus pratensis* | Meadow Pipit | European | Northern |
| *Anthus spinoletta* | Water Pipit | Palearctic | Northern |
| *Anthus trivialis* | Tree Pipit | Euroturquestan | Northern |
| *Apus affinis* | Little Swift | Unknown | Discarded |
| *Apus apus* | Common Swift | Palearctic | Northern |
| *Apus caffer* | White-rumped Swift | Etiopic | Southern |
| *Apus melba* | Alpine Swift | Indoafrican | Southern |
| *Apus pallidus* | Pallid Swift | Mediterranean | Southern |
| *Aquila adalberti* | Spanish Imperial Eagle | Palearctic | Northern |
| *Aquila chrysaetos* | Golden Eagle | Holarctic | Northern |
| *Ardea cinerea* | Grey Heron | Palearctic | Northern |
| *Ardea purpurea* | Purple Heron | Indoafrican | Southern |
| *Ardeola ralloides* | Squacco Heron | Etiopic | Southern |
| *Asio flammeus* | Short-eared Owl | Holarctic | Northern |
| *Asio otus* | Long-eared Owl | Holarctic | Northern |
| *Athene noctua* | Little Owl | Turquestan-Mediterranean | Southern |
| *Aythya ferina* | Common Pochard | Palearctic | Northern |

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|---|---|---|---|
| *Aythya fuligula* | Tufted Duck | Palearctic | Northern |
| *Aythya nyroca* | Ferruginous Duck | Turquestan-Mediterranean | Southern |
| *Botaurus stellaris* | Great Bittern | Palearctic | Northern |
| *Bubo bubo* | Eagle Owl | Palearctic | Northern |
| *Bubulcus ibis* | Cattle Egret | Indoafrican | Southern |
| *Bucanetes githagineus* | Trumpeter Finch | Palearctic | Northern |
| *Burhinus oedicnemus* | Stone-curlew | Turquestan-Mediterranean | Southern |
| *Buteo buteo* | Common Buzzard | Palearctic | Northern |
| *Calandrella brachydactyla* | Short-toed Lark | Turquestan-Mediterranean | Southern |
| *Calandrella rufescens* | Lesser Short-toed Lark | Turquestan-Mediterranean | Southern |
| *Calonectris diomedea* | Cory's Shearwater | Unknown | Discarded |
| *Caprimulgus europaeus* | European Nightjar | Palearctic | Northern |
| *Caprimulgus ruficollis* | Red-necked Nightjar | Mediterranean | Southern |
| *Carduelis cannabina* | Linnet | Euroturquestan | Northern |
| *Carduelis carduelis* | Goldfinch | Euroturquestan | Northern |
| *Carduelis chloris* | Greenfinch | Euroturquestan | Northern |
| *Carduelis spinus* | Siskin | Palearctic | Northern |
| *Cercotrichas galactotes* | Rufous-tailed Scrub-robin | Mediterranean | Southern |
| *Certhia brachydactyla* | Short-toed Treecreeper | European | Northern |
| *Certhia familiaris* | Eurasian Treecreeper | Holarctic | Northern |
| *Cettia cetti* | Cetti's Warbler | Turquestan-Mediterranean | Southern |
| *Charadrius alexandrinus* | Kentish Plover | Cosmopolitan | Discarded |
| *Charadrius dubius* | Little Ringed Plover | Palearctic | Northern |
| *Charadrius morinellus* | Dotterel | Arctic | Northern |
| *Chersophilus duponti* | Dupont's Lark | Mediterranean | Southern |
| *Chlidonias hybrida* | Whiskered Tern | Old World | Discarded |
| *Chlidonias niger* | Black Tern | Holarctic | Northern |
| *Ciconia ciconia* | White Stork | Palearctic | Northern |
| *Ciconia nigra* | Black Stork | Palearctic | Northern |
| *Cinclus cinclus* | Dipper | Paleomontane | Northern |
| *Circaetus gallicus* | Short-toed Eagle | Indoafrican | Southern |
| *Circus aeruginosus* | Marsh Harrier | Palearctic | Northern |
| *Circus cyaneus* | Hen Harrier | Holarctic | Northern |
| *Circus pygargus* | Montagu's Harrier | Euroturquestan | Northern |
| *Cisticola juncidis* | Zitting Cisticola | Indoafrican | Southern |
| *Clamator glandarius* | Great Spotted Cuckoo | Etiopic | Southern |
| *Coccothraustes coccothraustes* | Hawfinch | Palearctic | Northern |
| *Columba livia* | Rock Dove | Turquestan-Mediterranean | Southern |
| *Columba oenas* | Stock Dove | Euroturquestan | Northern |
| *Columba palumbus* | Common Woodpigeon | Euroturquestan | Northern |
| *Coracias garrulus* | European Roller | Euroturquestan | Northern |
| *Corvus corax* | Common Raven | Holarctic | Northern |
| *Corvus corone* | Carrion Crow | Palearctic | Northern |
| *Corvus frugilegus* | Rook | Palearctic | Northern |
| *Corvus monedula* | Eurasian Jackdaw | Palearctic | Northern |
| *Coturnix coturnix* | Common Quail | Old World | Discarded |
| *Cuculus canorus* | Common Cuckoo | Palearctic | Northern |

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| | | | |
|---|---|---|---|
| *Cursorius cursor* | Cream-coloured Courser | Unknown | Discarded |
| *Cyanopica cyanus* | Azure-winged Magpie | Palearctic | Northern |
| *Cygnus olor* | Mute Swan | Palearctic | Northern |
| *Delichon urbicum* | House Martin | Palearctic | Northern |
| *Dendrocopos leucotos* | White-backed Woodpecker | Palearctic | Northern |
| *Dendrocopos major* | Great Spotted Woodpecker | Palearctic | Northern |
| *Dendrocopos medius* | Middle Spotted Woodpecker | European | Northern |
| *Dendrocopos minor* | Lesser Spotted Woodpecker | Palearctic | Northern |
| *Dryocopus martius* | Black Woodpecker | Palearctic | Northern |
| *Egretta alba* | Great White Egret | Cosmopolitan | Discarded |
| *Egretta garzetta* | Little Egret | Old World | Discarded |
| *Elanus caeruleus* | Black-shouldered Kite | Indoafrican | Southern |
| *Emberiza calandra* | Corn Bunting | Euroturquestan | Northern |
| *Emberiza cia* | Rock Bunting | Palearctic | Northern |
| *Emberiza cirlus* | Cirl Bunting | Mediterranean | Southern |
| *Emberiza citrinella* | Yellowhammer | Palearctic | Northern |
| *Emberiza hortulana* | Ortolan Bunting | Euroturquestan | Northern |
| *Emberiza schoeniclus* | Reed Bunting | Palearctic | Northern |
| *Erithacus rubecula* | Robin | European | Northern |
| *Estrilda astrild* | Common Waxbill | Old World | Discarded |
| *Falco naumanni* | Lesser Kestrel | Turquestan-Mediterranean | Southern |
| *Falco peregrinus* | Peregrine Falcon | Cosmopolitan | Discarded |
| *Falco subbuteo* | Hobby | Palearctic | Northern |
| *Falco tinnunculus* | Common Kestrel | Old World | Discarded |
| *Ficedula hypoleuca* | Pied Flycatcher | European | Northern |
| *Fringilla coelebs* | Common Chaffinch | European | Northern |
| *Fulica atra* | Common Coot | Palearctic | Northern |
| *Fulica cristata* | Red-knobbed Coot | Etiopic | Southern |
| *Galerida cristata* | Crested Lark | Palearctic | Northern |
| *Galerida theklae* | Thekla Lark | Mediterranean | Southern |
| *Gallinago gallinago* | Common Snipe | Holarctic | Northern |
| *Gallinula chloropus* | Moorhen | Cosmopolitan | Discarded |
| *Garrulus glandarius* | Eurasian Jay | Palearctic | Northern |
| *Glareola pratincola* | Collared Pratincole | Indoafrican | Southern |
| *Gypaetus barbatus* | Lammergeier | Paleomontane | Northern |
| *Gyps fulvus* | Griffon Vulture | Palearctic | Northern |
| *Haematopus ostralegus* | Oystercatcher | Palearctic | Northern |
| *Hieraaetus fasciatus* | Bonelli's Eagle | Indoafrican | Southern |
| *Hieraaetus pennatus* | Booted Eagle | Turquestan-Mediterranean | Southern |
| *Himantopus himantopus* | Black-winged Stilt | Cosmopolitan | Discarded |
| *Hippolais opaca* | Western Olivaceous Warbler | Mediterranean | Southern |
| *Hippolais polyglotta* | Melodious Warbler | Mediterranean | Southern |
| *Hirundo daurica* | Red-rumped Swallow | Indoafrican | Southern |
| *Hirundo rustica* | Barn Swallow | Holarctic | Northern |
| *Hydrobates pelagicus* | European Storm-petrel | Northern Atlantic | Northern |
| *Ixobrychus minutus* | Little Bittern | Old World | Discarded |
| *Jynx torquilla* | Wryneck | Palearctic | Northern |

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|---|---|---|---|
| *Lagopus muta* | Ptarmigan | Arctic | Northern |
| *Lanius collurio* | Red-backed Shrike | Palearctic | Northern |
| *Lanius meridionalis* | Southern Grey Shrike | Mediterranean | Southern |
| *Lanius minor* | Lesser Grey Shrike | Euroturquestan | Northern |
| *Lanius senator* | Woodchat Shrike | Mediterranean | Southern |
| *Larus argentatus* | Herring Gull | Holarctic | Northern |
| *Larus audouinii* | Audouin's Gull | Mediterranean | Southern |
| *Larus fuscus* | Black-backed Gull | Palearctic | Northern |
| *Larus genei* | Slender-billed Gull | Sarmatic | Discarded |
| *Larus melanocephalus* | Mediterranean Gull | Sarmatic | Discarded |
| *Larus michahellis* | Yellow-legged Gull | Holarctic | Northern |
| *Larus ridibundus* | Black-headed Gull | Palearctic | Northern |
| *Limosa limosa* | Black-tailed Godwit | Palearctic | Northern |
| *Locustella luscinioides* | Savi's Warbler | Euroturquestan | Northern |
| *Locustella naevia* | Grasshopper Warbler | Euroturquestan | Northern |
| *Loxia curvirostra* | Common Crossbill | Holarctic | Northern |
| *Lullula arborea* | Wood Lark | European | Northern |
| *Luscinia megarhynchos* | Rufous Nightingale | European | Northern |
| *Luscinia svecica* | Bluethroat | Palearctic | Northern |
| *Marmaronetta angustirostris* | Marbled Duck | Sarmatic | Discarded |
| *Melanocorypha calandra* | Calandra Lark | Mediterranean | Southern |
| *Merops apiaster* | European Bee-eater | Turquestan-Mediterranean | Southern |
| *Milvus migrans* | Black Kite | Old World | Discarded |
| *Milvus milvus* | Red Kite | European | Northern |
| *Monticola saxatilis* | Rock Thrush | Paleoxericmontane | Southern |
| *Monticola solitarius* | Blue Rock Thrush | Paleoxericmontane | Southern |
| *Montifringilla nivalis* | Snowfinch | Paleomontane | Northern |
| *Motacilla alba* | White Wagtail | Palearctic | Northern |
| *Motacilla cinerea* | Grey Wagtail | Palearctic | Northern |
| *Motacilla flava* | Yellow Wagtail | Palearctic | Northern |
| *Muscicapa striata* | Spotted Flycatcher | Euroturquestan | Northern |
| *Myiopsitta monachus* | Monk Parakeet | Unknown | Discarded |
| *Neophron percnopterus* | Egyptian Vulture | Indoafrican | Southern |
| *Netta rufina* | Red-crested Pochard | Sarmatic | Discarded |
| *Numenius arquata* | Eurasian Curlew | Palearctic | Northern |
| *Nycticorax nycticorax* | Night Heron | Cosmopolitan | Discarded |
| *Oenanthe hispanica* | Black-eared Wheatear | Mediterranean | Southern |
| *Oenanthe leucura* | Black Wheatear | Mediterranean | Southern |
| *Oenanthe oenanthe* | Northern Wheatear | Palearctic | Northern |
| *Oriolus oriolus* | Golden Oriole | Old World | Discarded |
| *Otis tarda* | Great Bustard | Palearctic | Northern |
| *Otus scops* | Scops Owl | Old World | Discarded |
| *Oxyura jamaicensis* | Ruddy Duck | Unknown | Discarded |
| *Oxyura leucocephala* | White-headed Duck | Sarmatic | Discarded |
| *Pandion haliaetus* | Osprey | Cosmopolitan | Discarded |
| *Panurus biarmicus* | Bearded Tit | Palearctic | Northern |
| *Parus ater* | Coal Tit | Palearctic | Northern |

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|---|---|---|---|
| *Parus caeruleus* | Blue Tit | European | Northern |
| *Parus cristatus* | Crested Tit | European | Northern |
| *Parus major* | Great Tit | Palearctic | Northern |
| *Parus palustris* | Marsh Tit | Palearctic | Northern |
| *Passer domesticus* | House Sparrow | Palearctic | Northern |
| *Passer hispaniolensis* | Spanish Sparrow | Turquestan-Mediterranean | Southern |
| *Passer montanus* | Tree Sparrow | Palearctic | Northern |
| *Perdix perdix* | Grey Partridge | Euroturquestan | Northern |
| *Pernis apivorus* | European Honey-buzzard | European | Northern |
| *Petronia petronia* | Rock Sparrow | Paleoxeric | Southern |
| *Phalacrocorax aristotelis* | Shag | Northern Atlantic | Northern |
| *Phalacrocorax carbo* | Great Cormorant | Old World | Discarded |
| *Phasianus colchicus* | Common Pheasant | Paleoxeric | Southern |
| *Phoenicopterus roseus* | Greater Flamingo | Mediterranean | Southern |
| *Phoenicurus ochruros* | Black Redstart | Paleoxericmontane | Southern |
| *Phoenicurus phoenicurus* | Common Redstart | European | Northern |
| *Phylloscopus bonelli* | Bonelli's Warbler | European | Northern |
| *Phylloscopus collybita* | Common Chiffchaff | Palearctic | Northern |
| *Phylloscopus sibilatrix* | Wood Warbler | European | Northern |
| *Phylloscopus trochilus* | Willow Warbler | Palearctic | Northern |
| *Pica pica* | Magpie | Palearctic | Northern |
| *Picus viridis* | Green Woodpecker | European | Northern |
| *Platalea leucorodia* | Eurasian Spoonbill | Old World | Discarded |
| *Plegadis falcinellus* | Glossy Ibis | Old World | Discarded |
| *Podiceps cristatus* | Great Crested Grebe | Old World | Discarded |
| *Podiceps nigricollis* | Black-necked Grebe | Old World | Discarded |
| *Porphyrio porphyrio* | Purple Swamp-hen | Indoafrican | Southern |
| *Porzana parva* | Little Crake | Palearctic | Northern |
| *Porzana porzana* | Spotted Crake | European | Northern |
| *Porzana pusilla* | Baillon's Crake | Old World | Discarded |
| *Prunella collaris* | Alpine Accentor | Paleomontane | Northern |
| *Prunella modularis* | Dunnock | European | Northern |
| *Psittacula krameri* | Rose-ringed Parakeet | Unknown | Discarded |
| *Pterocles alchata* | Pin-tailed Sandgrouse | Paleoxeric | Southern |
| *Pterocles orientalis* | Black-bellied Sandgrouse | Paleoxeric | Southern |
| *Ptyonoprogne rupestris* | Crag Martin | Paleoxericmontane | Southern |
| *Pyrrhocorax graculus* | Yellow-billed Chough | Paleomontane | Northern |
| *Pyrrhocorax pyrrhocorax* | Red-billed Chough | Paleomontane | Northern |
| *Pyrrhula pyrrhula* | Common Bullfinch | Palearctic | Northern |
| *Rallus aquaticus* | Water Rail | Palearctic | Northern |
| *Recurvirostra avosetta* | Avocet | Turquestan-Mediterranean | Southern |
| *Regulus ignicapilla* | Firecrest | European | Northern |
| *Regulus regulus* | Goldcrest | European | Northern |
| *Remiz pendulinus* | Penduline Tit | Palearctic | Northern |
| *Riparia riparia* | Sand Martin | Holarctic | Northern |
| *Rissa tridactyla* | Kittiwake | Arctic | Northern |
| *Saxicola rubetra* | Whinchat | European | Northern |

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|---|---|---|---|
| *Saxicola torquatus* | Common Stonechat | Palearctic | Northern |
| *Scolopax rusticola* | Woodcock | Palearctic | Northern |
| *Serinus citrinella* | Citril Finch | Paleomontane | Northern |
| *Serinus serinus* | European Serin | Mediterranean | Southern |
| *Sitta europaea* | European Nuthatch | Palearctic | Northern |
| *Sterna albifrons* | Little Tern | Cosmopolitan | Discarded |
| *Sterna bengalensis* | Lesser Crested Tern | Unknown | Discarded |
| *Sterna hirundo* | Common Tern | Holarctic | Northern |
| *Sterna nilotica* | Gull-billed Tern | Cosmopolitan | Discarded |
| *Sterna sandvicensis* | Sandwich Tern | Cosmopolitan | Discarded |
| *Streptopelia decaocto* | Eurasian Collared Dove | Indoafrican | Southern |
| *Streptopelia turtur* | European Turtle Dove | Euroturquestan | Northern |
| *Strix aluco* | Tawny Owl | Palearctic | Northern |
| *Sturnus unicolor* | Spotless Starling | Mediterranean | Southern |
| *Sturnus vulgaris* | Common Starling | Euroturquestan | Northern |
| *Sylvia atricapilla* | Blackcap | European | Northern |
| *Sylvia borin* | Garden Warbler | European | Northern |
| *Sylvia cantillans* | Subalpine Warbler | Mediterranean | Southern |
| *Sylvia communis* | Common Whitethroat | Euroturquestan | Northern |
| *Sylvia conspicillata* | Spectacled Warbler | Mediterranean | Southern |
| *Sylvia hortensis* | Western Orphean Warbler | Mediterranean | Southern |
| *Sylvia melanocephala* | Sardinian Warbler | Turquestan-Mediterranean | Southern |
| *Sylvia undata* | Dartford Warbler | Mediterranean | Southern |
| *Tachybaptus ruficollis* | Little Grebe | Old World | Discarded |
| *Tadorna tadorna* | Common Shelduck | Sarmatic | Discarded |
| *Tetrao urogallus* | Capercaillie | Palearctic | Northern |
| *Tetrax tetrax* | Little Bustard | Paleoxeric | Southern |
| *Tichodroma muraria* | Wallcreeper | Paleomontane | Northern |
| *Tringa totanus* | Common Redshank | Palearctic | Northern |
| *Troglodytes troglodytes* | Wren | Holarctic | Northern |
| *Turdus merula* | Blackbird | Palearctic | Northern |
| *Turdus philomelos* | Song Thrush | European | Northern |
| *Turdus torquatus* | Ring Ouzel | Paleomontane | Northern |
| *Turdus viscivorus* | Mistle Thrush | Euroturquestan | Northern |
| *Tyto alba* | Barn Owl | Cosmopolitan | Discarded |
| *Upupa epops* | Hoopoe | Old World | Discarded |
| *Uria aalge* | Common Guillemot | Holarctic | Northern |
| *Vanellus vanellus* | Northern Lapwing | Palearctic | Northern |

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