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Black woodpecker *Dryocopus martius* (L., 1758) recent range expansion leads to the coalescence of the two former distribution areas in northern Spain.

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Abstract

In the Basque Country (N Spain) the black woodpecker *Dryocopus martius* (L., 1758) was virtually unrecorded until the late 1990's, but since then the number of observations has increased sharply. To determine the current distribution of the species, extensive, standardized field surveys of suitable forest patches in the province of Álava were performed during the 2011 early breeding season. The presence of the species was recorded in 16 UTM 100 km^2 squares. Furthermore, reliable observations were collected during the 2003 to 2011 breeding seasons in another 23 UTM 100 km^2 squares, adjacent to the study area, where the black woodpecker had gone undetected in the last published breeding atlas for the period 1998-2002. This range increase implies that the two, formerly separate populations in Spain (Pyrenees and Cantabrian Mountains) have currently coalesced into a continuous distribution, highlighting the relevance of the study area in the expansion of forest species between the two great mountain ranges of northern Iberia. Forest biomass growth and ageing of stands due to a reduction in felling operations over the last few decades have probably allowed the colonization of previously vacant localities.

• **Key words:** Picidae, beech forest, expansion, distribution, distribution coalescence, Álava, Basque Country.

Resumen

En el País Vasco (norte de España) se carecía casi por completo de citas de picamaderos negro *Dryocopus martius* (L., 1758) hasta finales de los años 90 del siglo XX, pero a partir de entonces el número de registros se ha incre-

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mentado sustancialmente. Con el fin de esclarecer la distribución actual de la especie, se llevaron a cabo muestreos estandarizados en sectores forestales apropiados de la provincia de Álava durante la primera fase de la temporada de cría de 2011. Se constató la presencia de la especie en 16 cuadrículas UTM de 100 km^2. Adicionalmente, se recopilaron observaciones fiables correspondientes a las temporadas de cría 2003-2011, procedentes de otras 23 cuadrículas UTM de 100 km^2 en regiones vecinas, donde el picamaderos negro no había sido señalado en el último atlas de aves nidificantes publicado, referido al periodo 1998-2002. Este incremento de la distribución implica que las dos poblaciones españolas previamente disjuntas (Pirineos y Cordillera Cantábrica) forman ahora un área de distribución única, lo que ejemplifica la importancia del área de estudio para la expansión de especies forestales entre las dos grandes cordilleras del norte ibérico. El crecimiento de la biomasa forestal y el envejecimiento de las masas como consecuencia de la reducción en las operaciones de corta durante las últimas décadas habría permitido presumiblemente la colonización de localidades anteriormente vacías.

• **PALABRAS CLAVE:** Picidae, hayedo, expansión, distribución, conexión de distribuciones, Álava, País Vasco.

LABURPENA

Euskal Herrian (Espainiako iparraldean) okil beltza *Dryocopus martius* (L., 1758) horren aipurik apenas zegoen XX. mendeko 90eko hamarkadako amaierara arte, baina ordutik hona erregistro kopuruak modu adierazgarrian egin du gora. Espezieak gaur egun agertzen duen banaketa-area argitzeko, laginketa estandarizatuak egin dira Arabako baso-ingurune egokienetan, 2011ko lehenengo kumaldiaren hasieran. UTM 100 km^2-ko 15 lauki-saretan egiaztatu zen espeziearen presentzia. Modu osagarrian, aldameneko eskualdeetako 100 km^{2}ko 23 lauki-sare UTM-tan, 2003tik 2011rako kumaldi garaietan bildutako behaketa fidagarriak gehitu dira; izan ere, argitaratutako hegazti habiagileen azken atlasean, zeinetan 1998-2002 garaiko datuak biltzen baitziren, ez zen seinalatu okil beltza. Banaketa-arearen hedapen horrek berarekin dakar aurrez bi populazio espainiar disjuntuen bat egitea (Pirinioak eta Kantauriar mendikatea), eta hori ikerketa arearen garrantziaren adibide da basoko espezieen hedapenerako iberiar iparraldeko bi mendikate nagusien artean. Basoko biomasaren hazkundeak eta azken baso-formazioen zahartzeak, azken hamarkadetan gutxitu egin diren baso mozketen ondorioz, itxuraz bide eman dute lehenago hutsik egon diren kokalekuak kolonizatzeko.

• **GAKO-HITZAK:** Picidae, pagadi, hedapena, banaketa, banaketen arteko lotura, Araba, Euskal Herria.

Introduction

The black woodpecker *Dryocopus martius* (L., 1758) is a forest bird with a wide Palaearctic distribution (Gorman, 2011). Its distribution in Spain comprises the two northernmost mountain areas, i.e., the Cantabrian Mountains and the Pyrenees (Simal & Herrero, 2003). This species showed a remarkable geographic expansion in western Europe throughout the 20th century, colonizing The Netherlands, Belgium, Denmark and western France (Cuisin, 1985; Nilsson, 1997; Dubois *et al*., 2008). As for Spain, an increase in range was reported in the eastern Pyrenees during the 1980's and 1990's (Martinez-Vidal, 2004), but for the rest of that range and the Cantabrian Mountains there is no high-quality, standardized data.

In the Basque Country, located midway between the two Spanish ranges, the first atlas of breeding birds (1982-1984; Alvarez *et al*., 1985) recorded just one observation on the eastern border, and in the 1990's the species was considered to be extremely rare (Gainzarain, 1998). However, since the end of that decade, the number of records has increased steadily (Aierbe *et al*., 2001; Lorenzo & Pérez de Ana, 2003). In the Basque province of Álava, the first record dates back to 1998 (Fernández-García & Ruiz de Azua, 1998), and during the 2000's an increasing number of opportunistic observations (i.e. observations recorded in non-standardised or non-specific surveys) was reported (e.g. Onrubia, 2004; García *et al*., 2005; Gainzarain, 2006). Therefore, the breeding distribution of this species is expected to differ substantially from the one depicted in the most recent bird atlas (Simal & Herrero, 2003).

In northern Spain, the known ranges of the Cantabrian and the Pyrenean populations are separated by c. 170 km. There is no data about interpopulation exchange, but few and scattered observations compiled in the last breeding atlas (Simal & Herrero, 2003) already suggested an incipient range increase across the intermediate gap. The eventual colonization of this gap, precisely the Basque Mountains, would evidence the extended distribution and indicate improved conservation prospects (Thomas *et al*., 2001) for this species in Spain. The aim of this paper is to update the status of the black woodpecker in Álava and document its process of expansion in this and other neighbouring areas of northern Spain.

Methods

The main study area comprised 3,400 km^2 and included the province of Álava and the small districts of Treviño and Orduña. Using the EUNIS map of habitats (Gobierno Vasco, 2007) and GIS software (gvSIG 1.12), we identified patches of woodland considered to be suitable habitats for the black woodpecker.

According to previously known records in the Basque Country and the literature in Spain (Camprodon *et al.*, 2007), these types were beech *Fagus sylvatica* and Scots pine *Pinus sylvestris* forests, as well as montane pine plantations (basically *P. sylvestris* and *P. nigra*). These habitats cover a total surface of 549.7 km^2 in the study area (Gobierno Vasco, 2007).

Given the vocal activity of the species and its relatively high probability of detection during pair formation and courtship periods (Bocca *et al.*, 2007), an extensive sampling with a moderate number of field observers was planned. The fieldwork protocol consisted of detailed walks (1 km/hour aprox.) through each forest patch, either using small trails or cross country. While doing the survey, the observer stored in a GPS device every vocalization heard, and every feeding remain or nest hole that could be found on the trees visible from the itinerary. These marks were also photographed to ascertain its origin beyond any doubt. In order to avoid unnecessary disturbance and to standardize the sampling technique, no recordings of this species' calls were used. The surveys were mostly carried out in the morning and under favorable weather conditions.

The study area spreads over 48 UTM 100 km^2 squares, but we limited our surveys to the 35 of these with more than 2% of their surface area covered by suitable forest patches (Fig. 1). The minimum field effort was standardized in proportion to the area of these patches within each square: at least five 4-5 hour surveys in the most heavily forested squares (29 to 37 km^2), two in the least forested (2 to 6 km^2), and three-four in those with intermediate coverage. Scheduled surveys were performed by experienced amateur ornithologists and park rangers in March and the first half of April 2011, with additional visits later in the breeding season to a small number of areas where the actual presence of the species remained unclear. A total of 936.6 km were surveyed, with an average across squares of 1.89 ± 1.09 km sampled per km^2 of suitable habitat. Finally, in order to track the temporal and spatial evolution of the black woodpecker population at a wider scale, we conducted a literature search and requested information from participants and other qualified ornithologists about recent records of the species in previously unoccupied localities within the main study area and neighbouring provinces (Cantabria, Burgos, Bizkaia, Gipuzkoa and Navarra).

RESULTS

A total of 32 direct observations of the black woodpecker (individuals seen or heard) were recorded in the main study area during the 2011 breeding season and the presence of the species was cited in 16 UTM 100 km^2 squares (46% of the total covered; Fig. 1). The survey effort was somewhat higher in the squares

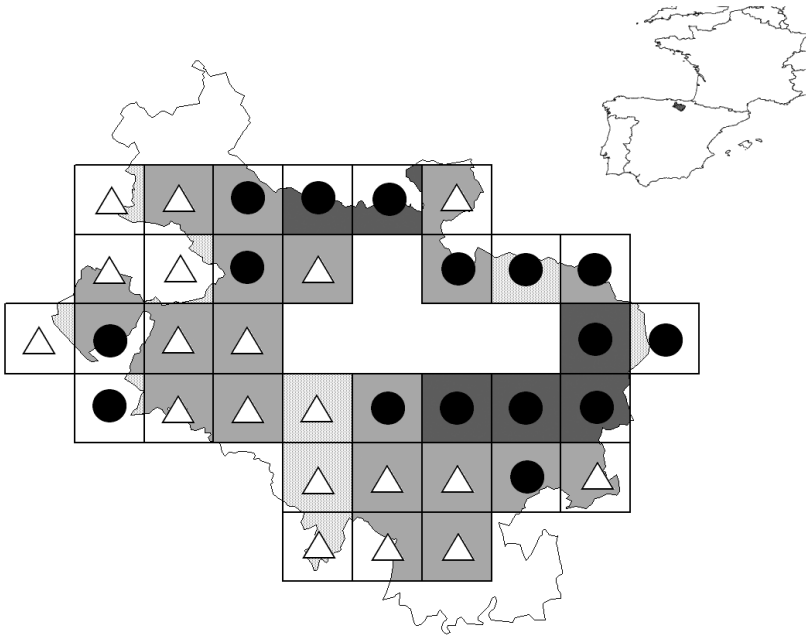

Fig. 1.- Main study area (shaded) and surface covered by either beech forest, Scots pine forest or coniferous plantations in each 100 km^2 UTM square or section within the study area (Gobierno Vasco, 2007): 2-6 km^2 (light grey), 7-28 km^2 (intermediate grey) and 29-35 km^2 (dark grey). Squares with a presence of the black woodpecker are indicated by black circles, and those squares that were surveyed but where no presence was recorded are indicated by triangles .

Fig. 1. Área de estudio principal (sombreada) y superficie ocupada por hayedos, pinares de pino silvestre o plantaciones de coníferas por cada cuadrícula UTM de 100 km^2 o sección de la misma dentro del área de estudio (Gobierno Vasco, 2007): 2-6 km^2 (gris claro), 7-28 km^2 (gris intermedio) y 29-35 km^2 (gris oscuro). Las cuadrículas con presencia de picamaderos negro se señalan con círculos negros, y las muestreadas pero sin presencia mediante triángulos.

where the species was detected than in those whith no records (2.08 *vs* 1.73 km per km2 of suitable habitat), but this different was not statistically significant (Mann-Whitney U = 107, n = 35; P = 0.136).

The species distribution included four geographically differentiated areas: a) the Gorbea Massif and its surroundings (6 records), b) the Entzia-Iturrieta-Vitoria and Izki Mointains (17 records), c) the eastern part of the Cantabric-Mediterranean watershed (6 records) from Arlaban to Elguea-Urkilla-Altzania-Mountains, and d) the western boundaries of the Valles Alaveses district (3 records). There were no records for the southernmost mountain range within the main study area (Cantabria-Toloño).

Regarding the occupied habitat, 68.8% of all records took place in beech forests, 6.3% in Scots pine natural forests and 25% in conifer plantations, closely matching

the proportion of these formations within the occupied squares (beech forests 67.2%; Scots pine forests 10.2%; conifer plantations 22.6%) (χ^2 = 0.61, *df* = 2, *P* = 0.736). Breeding of the species was only confirmed in three patches of the same forest massif (Gorbea, in the north-central sector of the study area), where signs of reproduction had been found in previous years (nest cavities in 2007 and family groups in 2009 and 2010; J. Villasante & Consultora de Recursos Naturales, *pers. comm.*). In the rest of the study area, most direct records referred to solitary birds.

Fig. 2 shows the evolution of the number of opportunistic records of the black woodpecker in the main study area. Until 2002 there were occasional observations, but in 2003-2004 a steady increase in the number of records was noticed, due initially to the regular occurrence of the species in the Gorbea range, and from 2007 onwards in other forested locations.

Apart from the main study area, we collected for the period 2003-2011 reliable, opportunistic records of the species during the breeding season in a further 23 UTM 100 km^2 squares located midway between the Cantabrian and Pyrenean ranges of the species and not mentioned by Simal & Herrero (2003; Fig. 3). Therefore, this accounts for a total of 39 UTM 100 km^2 squares for which recent, reliable records were available, but where the black woodpecker had not been detected in the 1990's breeding atlas. This means a 14% increase in the black

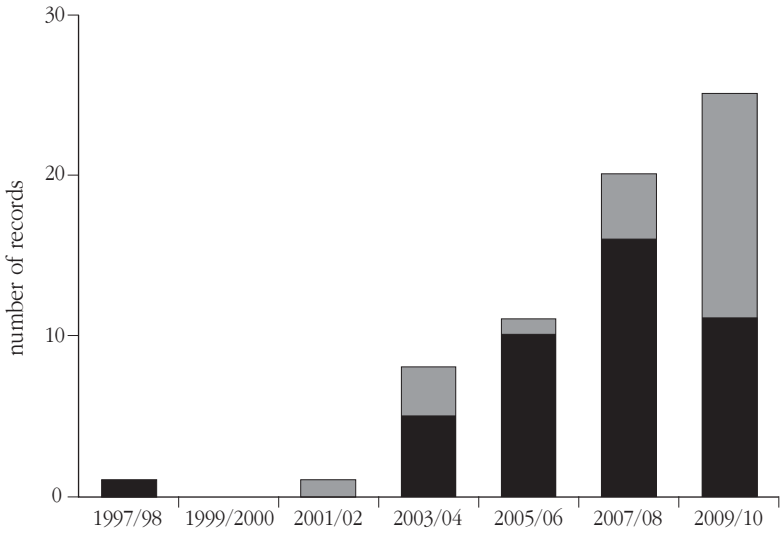

Fig. 2.- Number of opportunistic observations of the black woodpecker in Álava since the first record in 1998. The black color refers to the Gorbea massif and the grey color to the rest of the study area.

Fig. 2.- Número de observaciones oportunistas del picamaderos negro Dryocopus martius en Álava desde la primera cita en 1998. El color negro corresponde a las citas del macizo de Gorbea y el gris a las del resto del área de estudio.

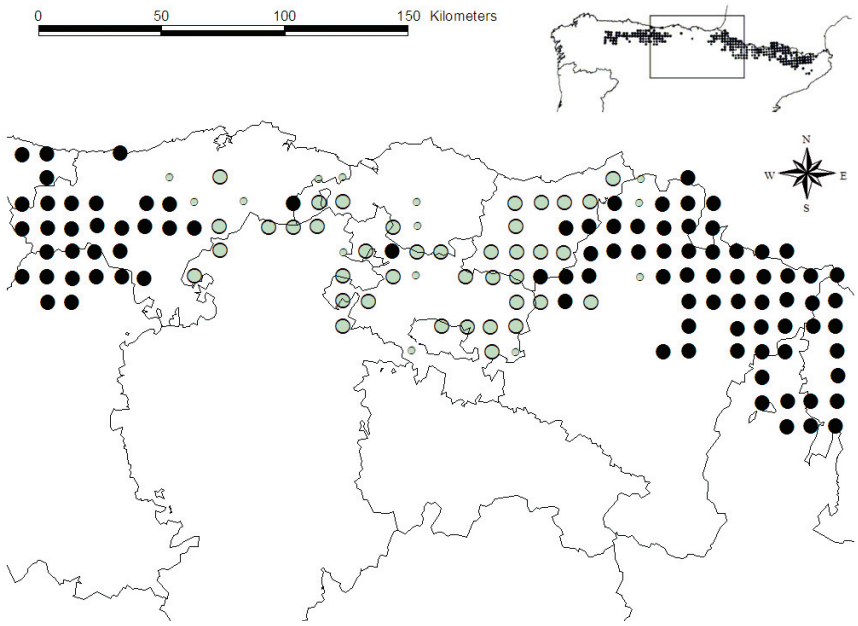

Fig. 3.- Presence of the black woodpecker referred to the UTM 100 km^2 grid in the intermediate geographical area between the Cantabrian and Pyrenean populations. The topright corner map shows the distribution depicted in the Atlas of Breeding Birds of Spain, 1998-2002 (Simal & Herrero, 2003). Black circles in the main map stand for occupied squares according to this atlas, larger grey circles indicate those squares with observations recorded during breeding seasons from 2003 to 2011, and smaller grey circles indicate squares where only records outside of the breeding seasons 2003-2011 have been collected..

Fig. 3.- Presencia constatada del picamaderos negro en cuadrículas UTM de 100 km^2 correspondientes al área geográfica intermedia entre las poblaciones cantábrica y pirenaica. El mapa de la esquina superior derecha muestra la distribución obtenida en el Atlas de las aves reproductoras de España de 1998-2002 (Simal & Herrero, 2003). Se señalan con círculos negros en el mapa principal las cuadrículas ocupadas según este atlas, con círculos grises grandes las que disponen de citas durante las temporadas de reproducción de 2003-2011, y con círculos grises pequeños aquellas para las que sólo se han podido recopilar citas durante los años 2003-2011 fuera de la época de cría.

woodpecker previously known breeding range in Spain (Simal & Herrero, 2003), at the scale of the UTM 100 km^2 squares. Observations outside the breeding season were compiled for another 14 squares. The distribution depicted at the scale of 100 km^2 squares showed an almost continuous range, filling the intermediate gap between the two previously known black woodpecker populations in Spain.

Discussion

Extensive sampling with experienced volunteers has proved useful to effectively cover a broad study area and to obtain an accurate picture of the current situation of the black woodpecker. The fieldwork was considerably facilitated

by the detection of the specific and conspicuous holes and feeding signs left in trunks, which allowed us to focus the search for the current presence of individuals, even if no birds were detected during the initial visits to a particular forest patch. However, and despite intensive sampling efforts, we cannot rule out that some occupied patches may have gone unnoticed, especially because the species' density in Álava is expected to be low in view of its situation on the periphery of the core distribution area in Spain and the short period of time that has elapsed since colonization, as both features are commonly associated with lower densities in territorial forest birds (Bullock *et al.*, 2001; Pigot *et al.*, 2010). But the fact that the occupied patches already known from previous years were readily detected by field observers suggests that unnoticed patches represent a minor proportion.

It has been described for several woodpecker species that a fraction of the population could be made up of floating birds (Pasinelli, 2006; Robles *et al.*, 2008), and particularly in the case of the black woodpecker, Bocca *et al.* (2007) found in their study area in the Alps that 25% of individuals were not paired. Since the structure of the black woodpecker population in our study area is unknown, and the proportion of young, transient or unpaired birds dispersing from saturated localities is probably higher when the population dynamics is driven by immigration (Christensen, 2002), our decision not to estimate the population size in terms of number of territories seems to be justified. The scarcity of breeding evidences found indicates, apparently, a small proportion of territorial pairs in the population, but this is not necessarily the case as in this species pair members exhibit independent behavior all year round (Bocca *et al.*, 2007; Gorman, 2011) and fieldwork was performed mostly outside the nesting and fledging seasons.

The black woodpecker was recorded in beech and coniferous forest patches, showing a frequency of occurrence in proportion to the relative surface of both types of stands, as described in other Spanish regions (Sánchez-Corominas *et al.*, 2009). Nevertheless, feeding signs were more commonly observed in coniferous stands, while every nest hole was recorded in beech stands. This apparent preference for beeches as nesting trees and for pines as feeding substrates has been noticed in other localities where both kinds of forest occur (Fernández & Azkona, 1996; Bocca *et al.*, 2007). In most of Europe, the black woodpecker does not exhibit strict habitat selection, colonizing fragmented, lowland forests and even commercial plantations, provided there are trees tall and broad enough to excavate cavities, and foraging substrates (Rolstad *et al.*, 1998; Gorman, 2011). However, on the southern edge of its range, as is the case of Spain, the species is less tolerant and favors only montane forests within the Eurosiberian ecoregion (Garmendia *et al.*, 2006; Camprodon *et al.*, 2007).

The recent colonization of Álava and neighbouring provinces by the black woodpecker is remarkable because this range increase means that the c. 170 km

gap between the formerly disjunct Pyrenean and Cantabrian populations, according to the distribution atlases drawn up by Ceballos & Purroy (1997) and Simal & Herrero (2003), has been filled. Currently, both ranges have coalesced and the species shows a continuous range in Spain. This fact implies an improved conservation status, especially in the case of the former Cantabrian population. Despite the long-distance natal dispersal abilities shown by some black woodpecker individuals (Gorman, 2011), this smaller population was probably isolated, as suggested by the absence of records concerning dispersing birds across the gap before the current process of expansion (Álvarez *et al*., 1985; Román *et al*., 1996; Gainzarain, 1998; Sanz-Zuasti & Velasco, 2005).

In western Europe, the range increase of the black woodpecker throughout the 20th century has been attributed primarily to the regional maturation of forest stands, rather than an increase in woodland surface (Mikusinski, 1995; Nilsson, 1997), and this factor would also apply to the range increase in the Spanish eastern Pyrenees (Gil-Tena *et al*., 2010). In our main study area, the comparison between the last three published forest inventories (1996, 2005 and 2011; Villanueva, 2008; Dirección General de Desarrollo Rural y Política Forestal, 2013) shows that the standing volume of beech biomass increased by 51% (from 3.75 to 5.69 million m^3), while the surface of beech tracts remained stable (from 29,738 to 31,249 ha). The average volume in beech stands in 2011 was 183 m^3/ha, while in 1996 this was only 135 m^3/ha. Six per cent of this volume was dead wood in the form of snags (25.6%), stumps (22.6%) and logs (16.8%; Alberdi *et al*., 2012). In addition, the growth in biomass was based more on larger trees (15% regarding diameter categories >45 cm and above) than those with smaller diameters (5%). Overall, these data suggest that habitat structure and the availability of basic requirements for the black woodpecker, like decaying wood, food supply and wide-girthed trees have probably improved in recent decades in the study area (Alberdi *et al*., 2012). The underlying reason was probably a drop in the price of timber, driving a sharp reduction in the number of felling operations (Gobierno Vasco, 2011) and exposing beech and coniferous stands to less intensive forestry, which in turn should lead to higher biodiversity standards (Hardersen, 2003; Paillet *et al*., 2009). The improvement of habitat quality could allow the colonization of formerly vacant localities by the black woodpecker and the range increase of several other forest bird species, as has been described elsewhere (Fernández-García & Gainzarain, 2004). However, if the model proposed by Gil-Tena *et al*. (2013) to describe the colonization process of the black woodpecker in the eastern Pyrenees applies to our study area, the range increase of the black woodpecker is dependent on the interpatch connectivity between mature forests and the dispersal from source sectors, rather than the landscape and structural changes occurring within the colonized localities.

The coalescence of the two former black woodpecker distributions in northern Spain illustrates the relevance of the study area, at the landscape level, to facilite

the expansion of forest species between the Pyrenees and the Cantabrian Mountains, two areas with an outstanding biodiversity in the western European context. This large-scale biogeographical pattern has been highlighted by several modelizations and species-specific studies in the context of the Landscape Ecology (Gurrutxaga *et al.*, 2010; Ruiz-González *et al.*, 2008).

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