



## The White-throated Dipper *Cinclus cinclus* subspecies in Spain

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Based on variations in breast plumage colour, two subspecies of White-throated Dipper *Cinclus cinclus* have been acknowledged to exist in Spain: *C. c. cinclus* in northwestern and central regions, and *C. c. aquaticus* in the eastern and southern regions. Within the White-throated Dipper's Spanish range, 37 rivers were sampled between 2000 and 2007. Dippers with a brownish-red and dark brown breast plumage were both present within the same large areas and rivers. Moreover, because plumage colour changes individually with age, no clear-cut geographical distribution pattern was found. These observations suggest that breast colour cannot be used to distinguish White-throated Dipper subspecies in Spain.

The validity of the subspecies concept has been heavily debated over the last few decades (Mallet 2007). It is still widely accepted, however, that within polytypic species there are subspecies which differ in their external morphology, though they can, either in reality or potentially, reproduce among themselves.

Morphological features have frequently been used to determine subspecies. In passerines for instance, both plumage ornamentation and colour (Møller & Cuervo 1998), as well as biometrics (Eybert *et al* 1999), have been used for this purpose. Nonetheless, many bird species in the Palearctic region show clinal morphological variation (Knox 1994). Moreover, it is not always easy to attribute a specific individual to a pre-established subspecies.

The White-throated Dipper *Cinclus cinclus* is a polytypic species distributed widely across Europe, Asia and North Africa. Numbers of White-throated Dipper subspecies vary between authors between 12 (Vaurie 1959, Ormerod & Tyler 2005) and 13 (Brewer & MacKay 2001). However, the need to revise and update this information has been highlighted by Ormerod & Tyler (2005), since genetic analyses have shown that there is no relation between the geographical distribution, genetic structure and phylogeographic pattern of the subspecies described (Lauga *et al* 2005). Therefore, in this paper we will refer to types rather than subspecies of White-throated Dippers.

Until now, two types of Dippers have been acknowledged to exist in Spain: *C. c. cinclus* in northwestern and central regions, and *C. c. aquaticus* in the eastern and southern

regions (Niethammer 1965, Tellería *et al* 1999), albeit with a high degree of geographical variability (Greenway & Vaurie 1958). Their biometrics were analysed by Campos *et al* (2005), who found no significant differences in the regions of overlap.

The aim of this study was to determine whether plumage coloration is a valid criterion for both the definition and identification of White-throated Dipper types, and whether it illustrates their distribution through Spain.

### METHODS

From 10 representative zones within the Dipper's range in Spain, 37 rivers were sampled between 2000 and 2007. These zones were grouped into four main areas, namely the Northeastern Mountains, Northwestern Mountains, Central Mountains and Southern Mountains (Fig 1).

Dippers were captured with mist-nets and each bird was ringed for individual identification. Trapping was carried out mainly during the summer (from July to September), when 83% of the total number of birds were captured. The age of the Dippers (adults or under one year of age) was determined by plumage criteria (Svensson 1996).

Breast feather colour was used to distinguish between types: dark brown for *cinclus*, brownish-red for *aquaticus*. To avoid any apparent plumage-colour variations due to lighting conditions, all the birds were analysed under direct natural sunlight and with a total absence of shadows. No specimens with intermediate colouring between dark brown and brownish-red were found, thus preventing misattribution of any of the birds to either of the two types.

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A logistic function was calculated to assess the likelihood of a bird belonging to one of the two types, in relation to (1) zone (Northeastern, Northwestern and Central Mountains; data from Southern Mountains were excluded since there were no *cinclus* birds there; see results for further details), (2) age (yearling or adult birds) and (3) sex. The exact month when the birds were captured was not taken into consideration as most were captured during the summer.

## RESULTS

In total, 301 Dippers were captured (167 yearlings and 134 adults), among which 158 were identified as *aquaticus*, and 143 as *cinclus* (Table 1). The *cinclus* type was not captured in the Southern Mountains and therefore this region was not considered in further analyses.

With the exception of sex, all the variables had a significant weight in the logistic function (Table 2). In particular, the probability of a bird being *aquaticus* increased in both the Northeastern and Northwestern regions (and decreased in the Central Mountains). Similarly, this probability increased among yearling birds and decreased, therefore, among adults.

Overall, 69.2% of birds were correctly classified by our logistic function. By types, however, 91.5% of birds sampled

were correctly classified as *cinclus*, whilst only 23.2% of birds were classified correctly as *aquaticus* using the function.

In the Northern and Central Mountains, 82.1% (n = 203) of the Dippers were captured in nine rivers, both types being present in each of them. The *aquaticus* ratio varied from 6.4% (Cuerpo de Hombre River) to 75.0% (Tea River). In each of the remaining seven rivers, the sample size was  $\leq 4$  birds.

Lastly, breast colour variations were observed even within individual birds. Over the years of the period sampling period took place, 10 Dippers were recaptured. Four of these had been ringed as yearlings and six as adults, which had been through at least one complete moult (Table 3). Plumage colour had changed in two yearlings and one adult, one from brownish-red to dark brown, and two from dark brown to brownish-red. This denotes a certain degree of individual variability according to age.

## DISCUSSION

This study analysed the distribution throughout Spain of both the *cinclus* and the *aquaticus* types of the White-throated Dipper, at four different stages: a) large geographical areas, b) specific zones within each large area, c) rivers within each zone, and d) birds within each

**Table 1.** Number of White-throated Dippers (percentage in brackets) of the *aquaticus* and *cinclus* types captured in the ten sampling zones. Each zone shows the rivers that were sampled.

Large areas	Sampling zones	Rivers	<i>aquaticus</i>	<i>cinclus</i>
Northwestern Mountains	Galician	Lérez, Tea, Xabriña	15 (71.4)	6 (28.6)
	Cantabrian	Bernesga, Curueño	11 (25.0)	33 (75.0)
Northeastern Mountains	Iberian System	Iregua, Mayor, Najerilla, Neila, Urbión	6 (46.2)	7 (53.8)
	Western Pyrenees	Arga, Artius, Erro, Esca, Mediano, Minchate, Urederra	15 (38.4)	24 (61.6)
	Central Pyrenees	Ara, Aragón, Vellós, Veral	7 (87.5)	1 (12.5)
Central Mountains	Sierra de Guadarrama	Lozoya	8 (24.2)	25 (75.8)
	Sierra de Gredos	Barbellido, Tormes	6 (42.9)	8 (57.1)
	Sierra de Béjar	Ambroz, Cuerpo de Hombre, Francia, Garganta Andrés	2 (4.9)	39 (95.1)
Southern Mountains	Sierra de Cazorla	Borosa	16 (100)	0
	Sierra Nevada	Cacín, Dilar, Durcal, Genil, Maitena, Monachil, Poqueira, Valdecasillas	72 (100)	0

**Table 2.** Coefficients (B) and statistics associated with the logistic function used to assess the likelihood of a White-throated Dipper belonging to the *aquaticus* type.

Variable	B	SE (B)	Wald	P	Exp (B)
Zone (Northeastern Mountains)	1.606	0.406	15.641	<0.001	4.983
Zone (Northwestern Mountains)	1.257	0.392	10.288	<0.001	3.516
Sex (Male)	-0.325	0.312	1.082	0.298	0.723
Age (Juvenile)	0.721	0.327	4.857	0.028	2.056
Intercept	-1.820	0.401	20.551	<0.001	0.162

of these rivers. The analysis showed that birds with a brownish-red and a dark brown breast plumage were both present within the same large areas, zones and rivers. Moreover, plumage colour changes individually with age. Only Dippers in southern populations presented the same breast plumage colour. Recently, it has been suggested (Ormerod & Tyler 2005) that the *aquaticus* type is distributed throughout eastern and southern Spain and that *cinclus* can be found in the west and north. Our data demonstrate that this claim is inexact. A clinal variation in plumage colour, *ie* more brownish-red in eastern and southern Spain and darker brown in the west does not seem probable either. In fact, the presence of a large number of Dippers with brownish-red breasts in the west of Spain (Galician, Table 1) and of Dippers with dark brown breasts in the Pyrenees prevents us from accepting the aforesaid conclusion.

In addition, breast plumage coloration changed with age. Dark brown is due to melanin, and controlled by the MC1R gene (Mundy 2005). What is yet to be

demonstrated is whether Dipper populations inhabiting Spain differ in this gene and whether this gene could change depending upon or in relation to age.

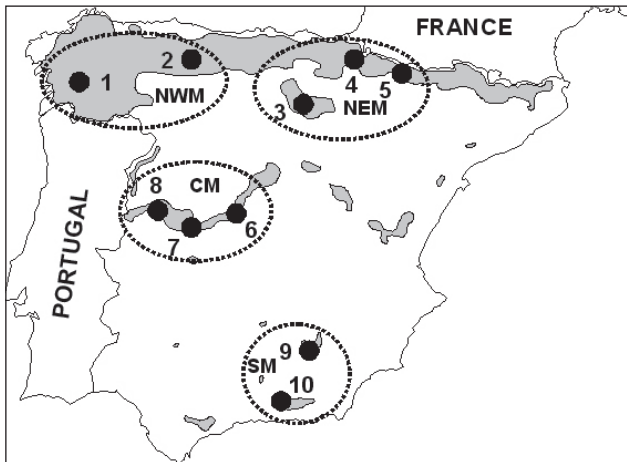
On the other hand, Lauga *et al* (2005) pointed out the need to reconsider the intraspecific taxonomy of the species and Hourlay *et al* (2008) demonstrated the lack of concordance between the morphological races described by Cramp (1988) and the genetic lineages defined in accordance with his results. Both studies clearly questioned the validity of the accepted subspecies of White-throated Dipper, as also proposed by Ormerod & Tyler (2005).

Discrete taxa, such as subspecies, normally diverge in geographic isolation (Mayr 1963, Newton 2003). Our data show that in Spain both types are thoroughly mixed and that a clear-cut geographical distribution pattern is not present. Moreover, the plumage characteristics of individual birds can change within their lifetime. Consequently, and for these reasons, White-throated Dipper types (or subspecies) in Spain cannot be determined solely on the basis of plumage features. In this sense, Vaurie had already proposed that no division of subspecies in the White-throated Dipper (Greenway & Vaurie 1958) deserved recognition, although he later assented to the existence of subspecies *cinclus* and *aquaticus* (Vaurie 1959).

Recently, it has been shown in other passerines that, on its own, plumage coloration may not be a valid criterion to identify subspecies (Willoughby 2007). Nevertheless, it is probable that there are one or more types of Dippers in Spain. In this sense, Dippers from the Southern Mountains (Sierra Nevada and Sierra de Cazorla) present different biometrics from those of other regions (Campos *et al* 2005), share the same breast feather coloration (this paper),

**Table 3.** Data from ring recoveries from White-throated Dippers, with details of river, area (NEM: Northeastern Mountains; NWM: Northwestern Mountains), type according to breast colour, number of days elapsed between ringing and recovery, and the number of complete moults.

River	Area	Ring No.	Year	Ringing			Year	Recovery Days	Type	Complete moults
				Sex	Age	Type				
Erro	NEM	3189758	2000	Male	Adult	<i>cinclus</i>	2001	397	<i>cinclus</i>	≥2
Erro	NEM	3189759	2000	Female	Adult	<i>aquaticus</i>	2002	553	<i>aquaticus</i>	≥2
Erro	NEM	3189761	2000	Female	Adult	<i>cinclus</i>	2002	522	<i>cinclus</i>	≥2
Erro	NEM	3189777	2000	Female	Yearling	<i>aquaticus</i>	2001	377	<i>cinclus</i>	1
Erro	NEM	3189788	2000	Male	Yearling	<i>aquaticus</i>	2002	468	<i>aquaticus</i>	1
Erro	NEM	3197249	2001	Female	Yearling	<i>aquaticus</i>	2002	316	<i>aquaticus</i>	1
Erro	NEM	3197250	2001	Female	Adult	<i>cinclus</i>	2002	380	<i>cinclus</i>	≥2
Erro	NEM	3197256	2001	Male	Adult	<i>cinclus</i>	2002	294	<i>aquaticus</i>	≥2
Curueño	NWM	V036635	2001	Male	Yearling	<i>cinclus</i>	2005	1,497	<i>cinclus</i>	5
Curueño	NWM	V036650	2001	Male	Adult	<i>aquaticus</i>	2005	1,497	<i>cinclus</i>	≥6



**Figure 1.** White-throated Dipper distribution in Spain (shaded area) and sampling zones (full points): 1, Galician Mountains. 2, Cantabrian Mountains. 3, Iberian System. 4, Western Pyrenees. 5, Central Pyrenees. 6, Sierra de Guadarrama. 7, Sierra de Gredos. 8, Sierra de Béjar. 9, Sierra de Cazorla. 10, Sierra Nevada. Broken lines indicate the four main areas to which the 10 sampling zones belonged: NEM, Northeastern Mountains. NWM, Northwestern Mountains. CM, Central Mountains. SM, Southern Mountains.

possess a number of distinct genetic characteristics (pers obs) and in geographical terms are isolated from nearby populations (Fig 1).

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