Western Bonelli's Warbler *Phylloscopus bonelli*

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Range

Western Bonelli's Warbler breeds at middle and lower-middle latitudes in W and C Europe, from France, S Germany, W Austria and Czechoslovakia, south to Morocco and Tunisia, including the Iberian Peninsula, Italy, Corsica, Sicily and W former Yugoslavia (Cramp, 1992). It is a long-distance migrant that winters in the Sahel, from S Mauritania and Senegal east to the Lake Chad basin (Cramp, 1992). It does not breed at any of the ringing sites.

Migratory route

There are very few recoveries of Western Bonelli's Warbler (Cramp, 1992) and only three from the study area (fig. 1). One individual captured in April in SW Spain was recaptured a year later in N Morocco; another bird also captured in April (on Els Columbrets) was recaptured in May the following year in SW France; and, finally, a bird recaptured after a short movement in continental Spain was probably a local breeder.

The number of captures on islands is far greater than on the mainland, apparently due to an attraction effect (fig. 2). This effect is particularly clear when comparing the greater number of captures on Conillera than on Formentera: these two sites are less than 35 km apart, but the former is a small island with little vegetation and the latter a much larger one with much more suitable habitat. Captures tend to be comparatively higher in W and SW Balearic sites (*e.g.* Conillera and Dragonera) than in more eastern ones (*e.g.* L'Illa de l'Aire, Cabrera and Colom). This pattern and the notable number of captures from Els Columbrets and L'Illa Grossa agree with the overall migratory route suggested for this species by Pilastro et al. (1998), that is, birds enter Europe following a marked SW–NE path along the eastern coast of the Iberian Peninsula. There are relatively few captures at Moroccan sites, although this warbler is more common and widespread in NW Africa in spring than in autumn (Cramp, 1992; Thévenot et al., 2003).

Phenology

Apart from the arrival of some very early individuals in mid-March, the main passage period takes place from late March onwards, with a peak at the end of April and a steep decrease thereafter during May (fig. 3). This pattern is similar in all three study areas (N Morocco, Catalonia and the Balearics/Els Columbrets). Overall, passage resembles the pattern described for birds on spring migration in the Gibraltar area (Finlayson, 1992) and La Camargue (S France) (Blondel & Isenmann, 1981). Along the Atlantic coast of Morocco passage is somewhat earlier and is occasionally ob-

served in late February in the south (Thévenot et al., 2003), although usually not until mid-March onwards in the SE (Gargallo et al., unpubl.).

Biometry and physical condition

Mean values for third primary lengths range from 45.9 (Las Chafarinas) to 49.2 (Catalonia; table 1). Mean values for wing lengths vary from 60.8 (N Morocco) to 63.3 (Catalonia), within the values reported in spring from other sites in W Europe (Cramp, 1992). The third primary length shows a decreasing trend over time (fig. 6), reflecting the differential migration of sexes: shorter-winged females migrate later than males. There is no clear latitudinal gradient in body mass or fat score, and there seems to be no great differences between sites and habitats (table 1, fig. 4). Mean fat scores are generally low, between 2.0 and 2.3 at all the sites except Els Columbretes (0.9) and Las Chafarinas (1.8). Body mass tends to decrease with time, though only significantly so in Els Columbrets (fig. 8). Fat and physical condition show a slight but significant decreasing trend on Els Columbrets but a positive one in the dry Balearics (figs. 7, 9). Birds captured on Els Columbrets, the most isolated island and the most distant from N Africa, have the poorest body condition of all, as well as the lowest fat reserves and body mass, a consequence of the progressive depletion of birds' energetic reserves during sea crossings.

The few captures from N Morocco have a mean body mass similar to that of Catalonia and the dry Balearics and to those reported from S Morocco (mean 7.2, n = 242; Ash 1969; Gargallo et al., unpubl.). Finlayson (1981) obtained a somewhat lower value (7.0, n = 34) from birds grounded on Gibraltar in spring. All these values are only marginally higher than those recorded in Catalonia during the breeding season (mean 7.1, n = 157; ICO, 2010), indicating that after arriving in N Africa this species does not change mass to any great degree. Migration therefore probably takes place in rather short bouts (and brief stopovers; see below), at least over continental areas. An exception may be birds reaching Europe after crossing long stretches of the Mediterranean. In these cases, birds surely leave N Africa with more reserves than the average birds in N Morocco, otherwise they would be captured on the Balearic Islands with obviously lower mean body masses than those given here.

Stopover

Mean stopover length is rather low (*c.* 2-2.5 days; table 2, fig. 5), indicating that birds do not tend to stop for more than one day at the study sites. Birds staying in Catalonia show some degree of mass gain while those on Els Columbrets and in the dry Balearics do not present any clear trend; these differences, however, are not significant. In the dry Balearics birds staying in the area have significantly lower initial body mass than those not trapped again. This pattern suggests that those remaining on the islands tend to be birds that are unable to continue migration due to poor physical condition.

Table 1. Mean (± SD), range and sample size of main biometric parameters according to area.

	n	Wing	Third primary	Body mass	Fat score
Catalonia	139	63.3 ± 2.6 (58.0-69.5)	49.2 ± 2.4 (43.0-55.0)	7.3 ± 0.8 (5.5-9.1)	2.4 ± 1.2 (0-6)
Columbrets	220	63.0 ± 2.8 (56.0-69.0)	48.7 ± 2.4 (43.5-55.0)	6.6 ± 0.8 (5.0-9.4)	0.9 ± 0.9 (0-4)
Balearics (dry)	705	62.6 ± 2.6 (57.0-69.0)	48.3 ± 2.3 (43.0-54.0)	7.1 ± 0.8 (4.6-10.1)	2.1 ± 1.1 (0-7)
Balearics (wet)	2	63.0 ± 0.0 (63.0-63.0)	49.0 ± 0.0 (49.0-49.0)	7.5 ± 0.5 (7.2-7.9)	3.5 ± 0.7 (3-4)
Chafarinas	9		45.9 ± 2.6 (43.0-51.5)	6.9 ± 0.7 (6.2-8.3)	1.8 ± 1.2 (0-4)
N Morocco	11	60.8 ± 1.6 (57.0-63.0)	47.3 ± 2.5 (44.0-54.0)	7.3 ± 0.6 (6.4-8.4)	2.4 ± 1.4 (0-4)
S Morocco	2	61.3 ± 1.1 (60.5-62.0)	47.5 ± 2.8 (45.5-49.5)	6.4 ± 0.5 (6.0-6.7)	1.0 ± 0.0 (1-1)

Table 2. Variation in fuel deposition rate (g/day) according to area and type of retraps involved (mean ± 95% CI and sample size are given).

	Catalonia	Columbrets	Balearics (dry)	Balearics (wet)	Chafarinas	N Morocco
All retraps	0.10 ± 0.21 (10)	-0.03 ± 0.23 (6)	-0.05 ± 0.09 (39)			
Retraps >1 day	0.16 ± 0.35 (4)	0.02 ± 0.35 (3)	0.05 ± 0.09 (23)			

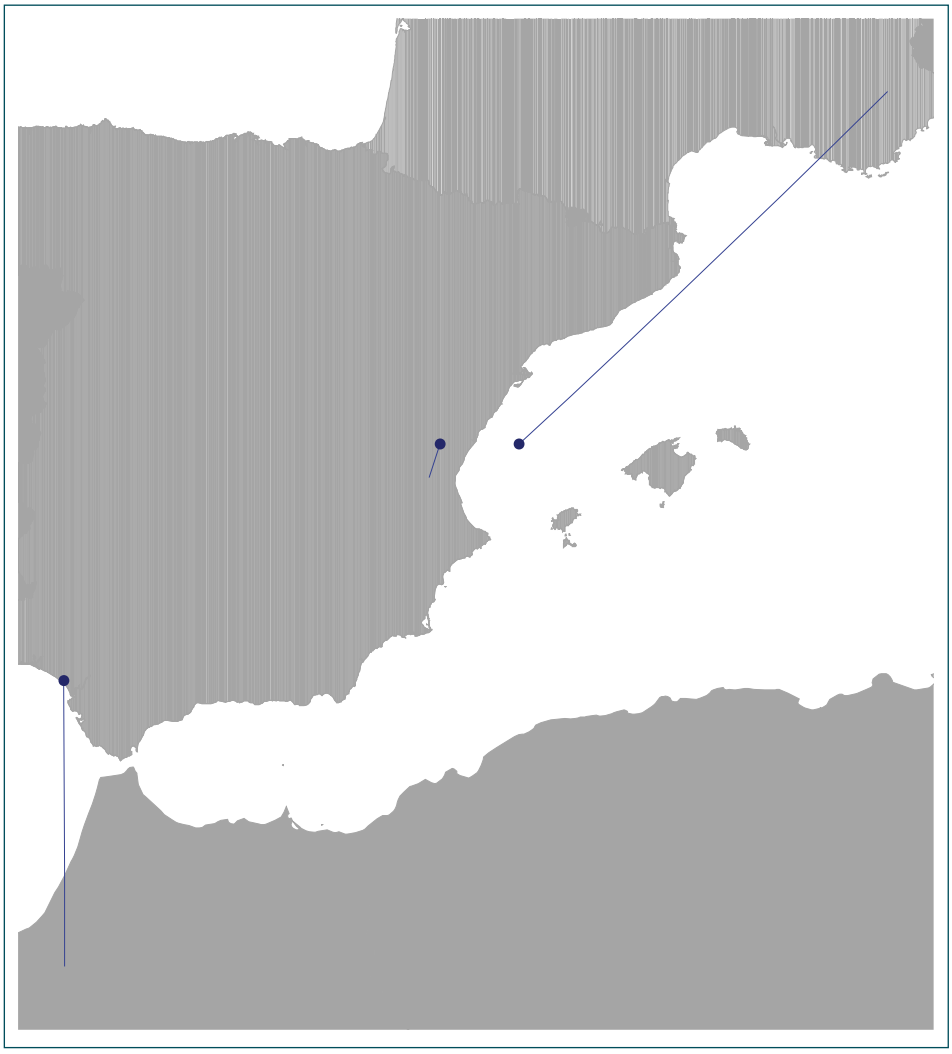

Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

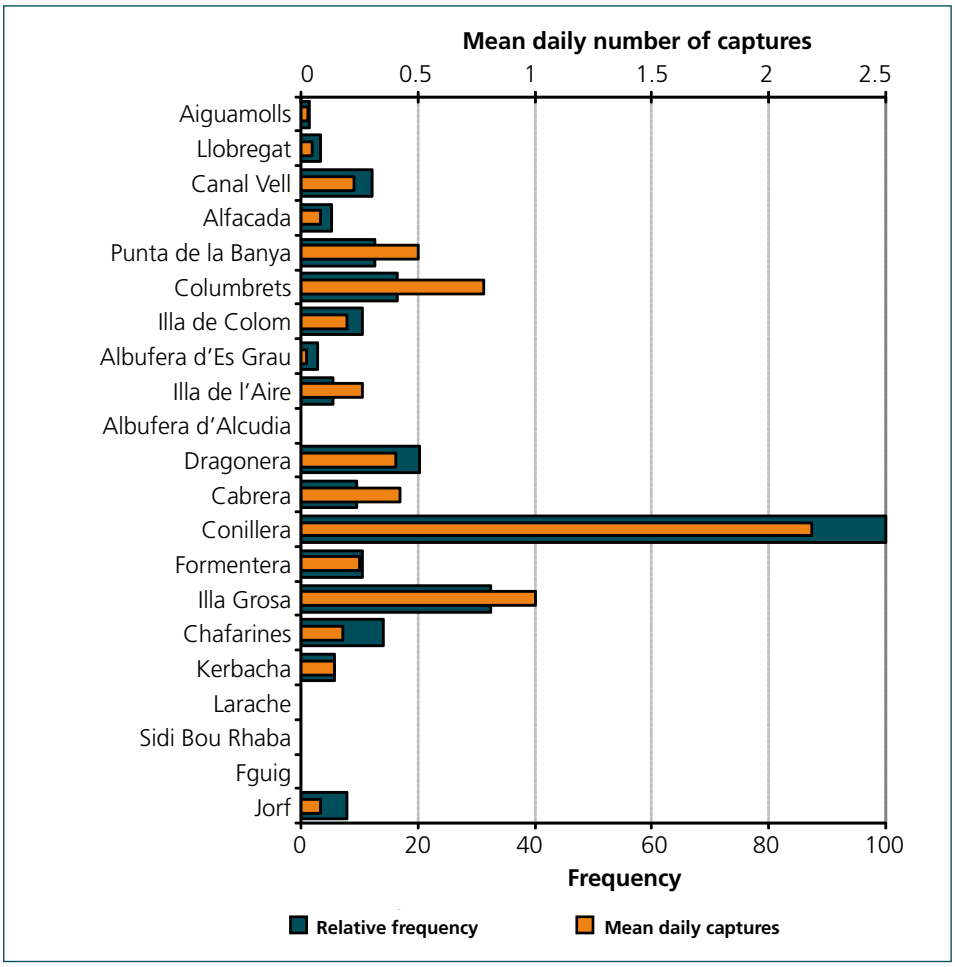

Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

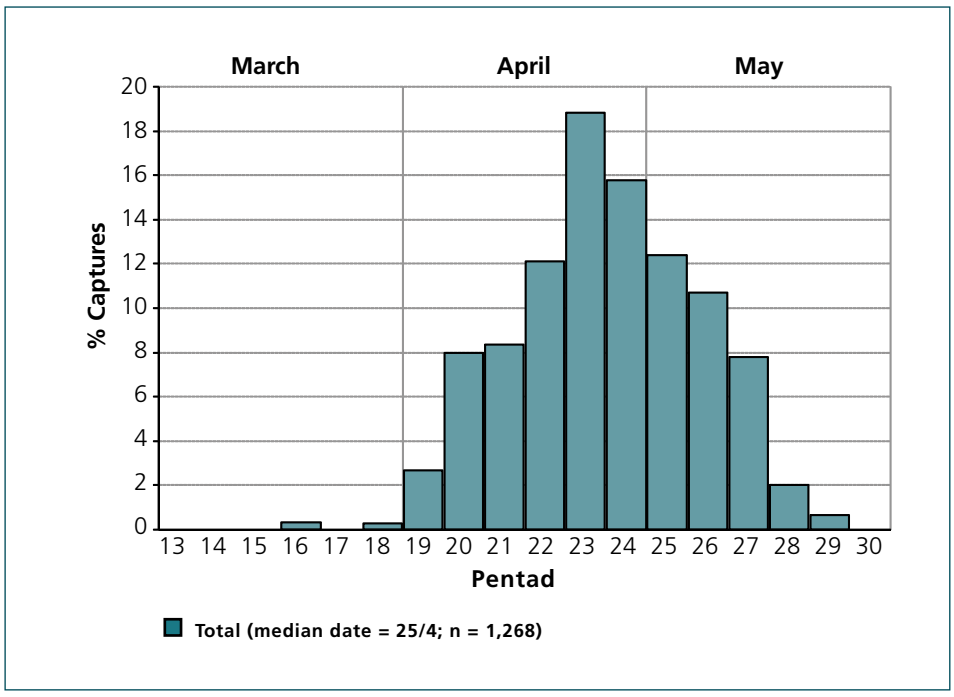

Figure 3. Frequency of captures during the study period.

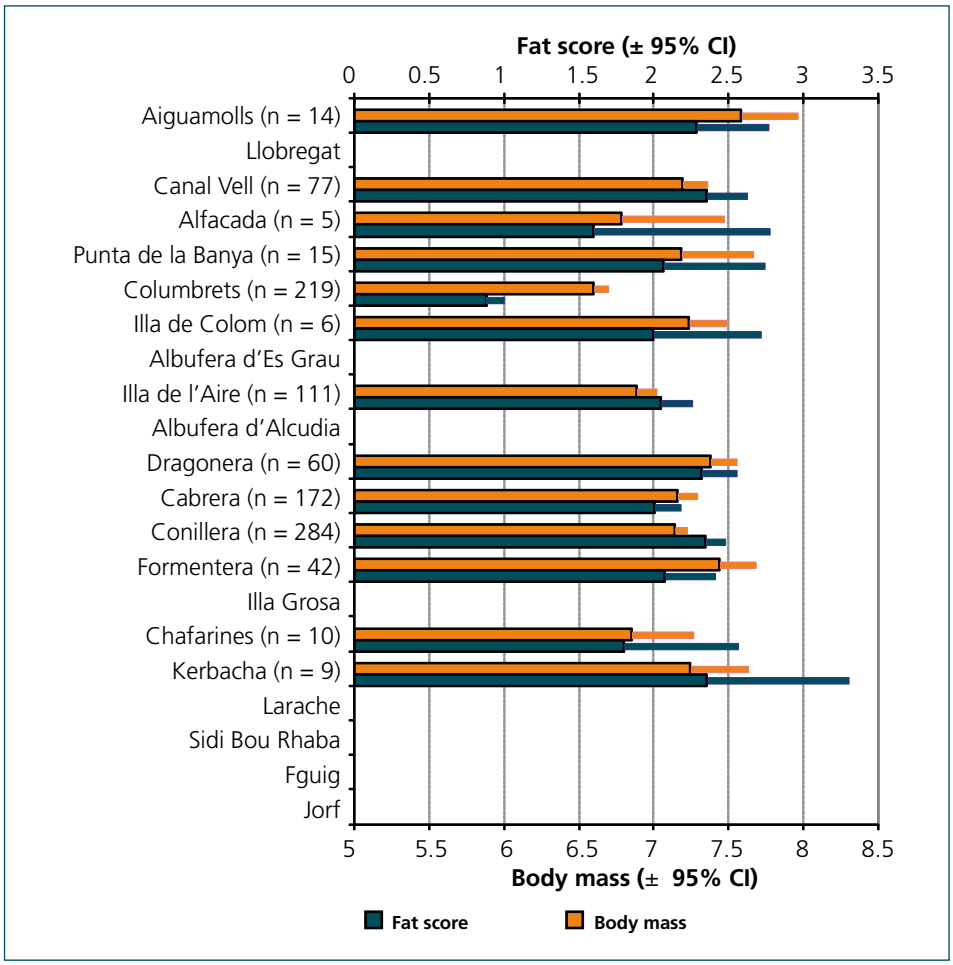

Figure 4. Variation in body mass and fat score according to site during the standard period (16 April to 15 May).

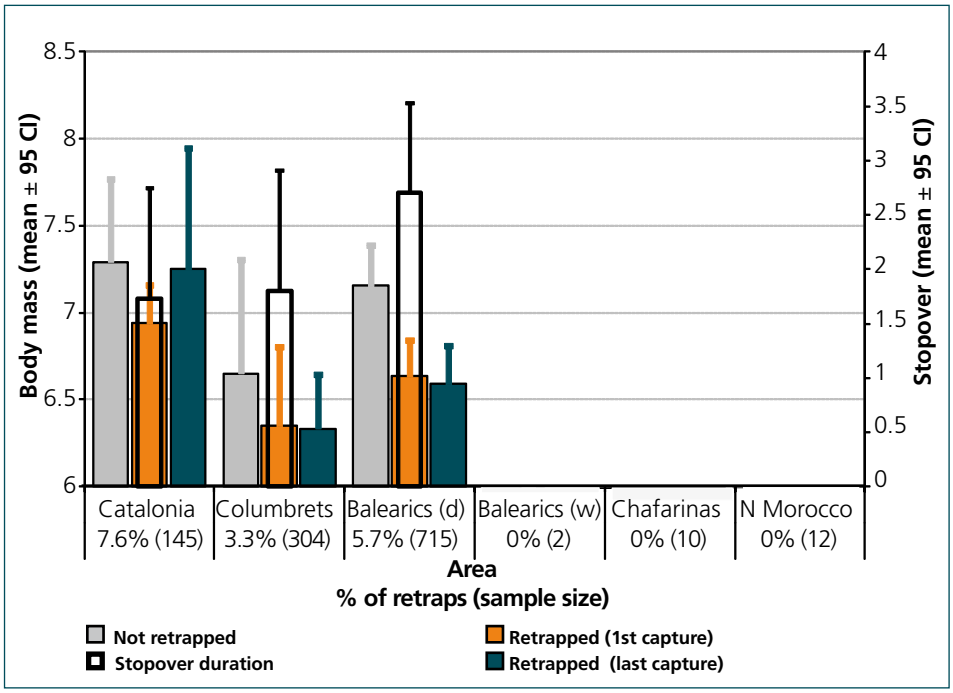

Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.

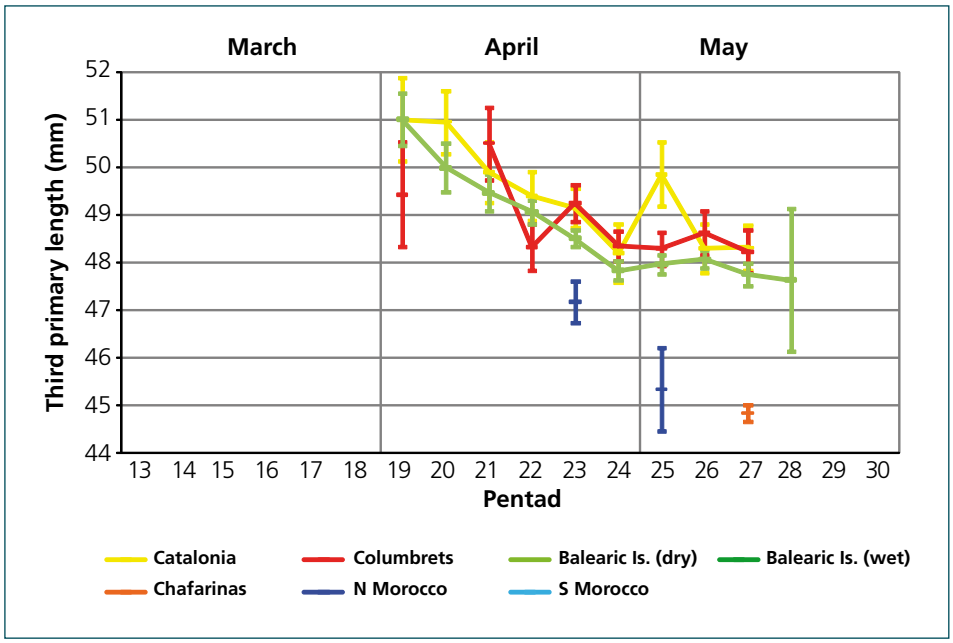

Figure 6. Temporal variation of third primary length according to area.

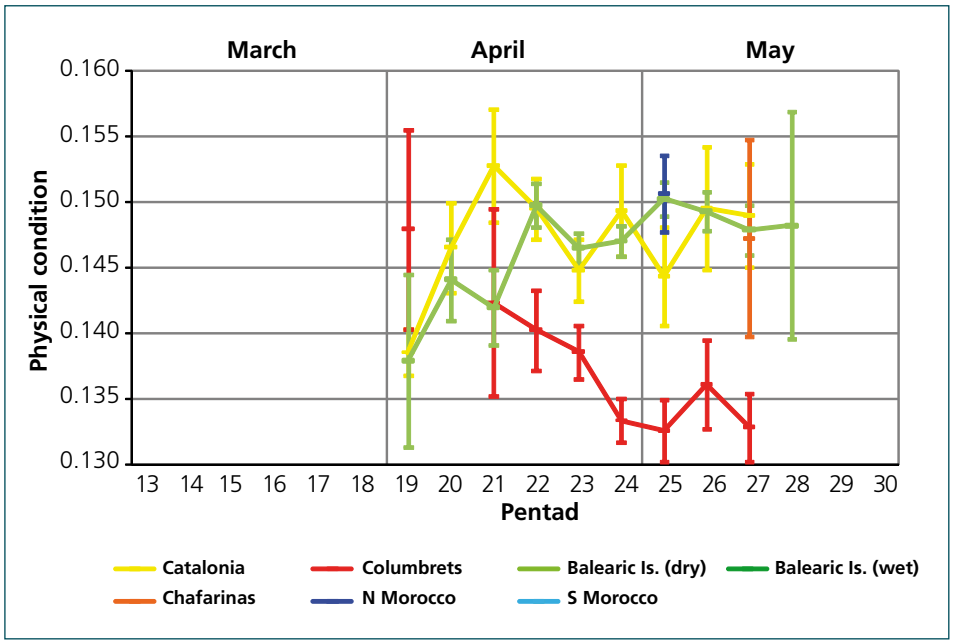

Figure 7. Temporal variation of physical condition according to area.

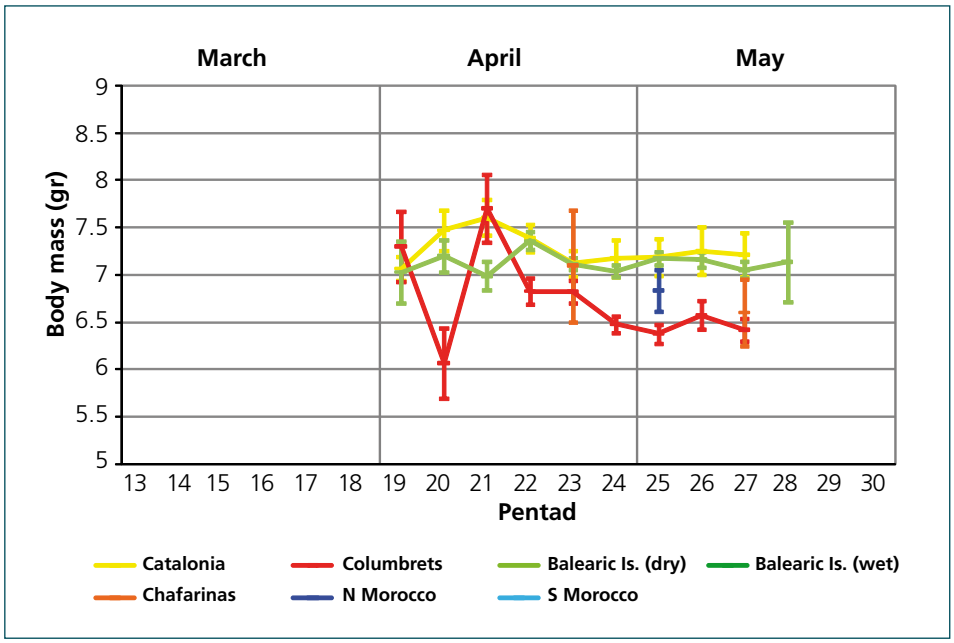

Figure 8. Temporal variation in body mass according to area.

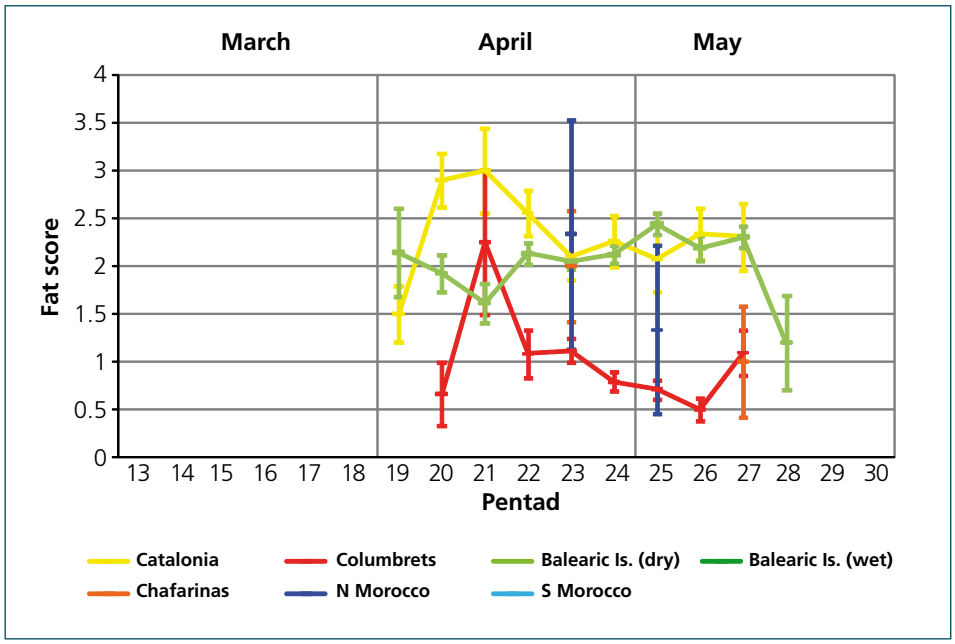

Figure 9. Temporal variation in fat score according to area.