

Subalpine and Moltoni's Warblers *Sylvia cantillans* and *Sylvia moltonii*

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Range

The taxonomy of the Subalpine Warbler complex has changed markedly in recent years, first due to the addition of another subspecies to the three traditionally accepted taxons (Gargallo, 1994) and, more recently, due to the fact that this complex can now be split into two distinct species: *S. cantillans* includes all three previously accepted subspecies, while *S. moltonii* is now ranked as a full species (Shirihai et al., 2001; Brambilla et al., 2008). Both species breed in the Mediterranean Basin, from sea level up to 2000 m in the High Atlas of Morocco (Hagemeijer & Blair, 1997; Cramp, 1998). The nominate *S. c. cantillans* occupies continental SW Europe and has a somewhat distinct population in the central and southern Italian Peninsula and Sicily, whereas *S. c. inornata* is present in NW Africa and *S. c. albistriata* in SE Europe (Brambilla et al., 2008). Moltoni's Warbler *S. moltonii* (*S. subalpina* according to Bacetti et al., 2007) occupies the W Mediterranean islands (Corsica, Sardinia and Balearics) and N Italy. All populations are migratory and winter in tropical Africa, chiefly along the southern edge of the Sahara, from Mauritania and Senegal to Sudan (Cramp, 1998). At the study sites, only *moltonii* breeds –in low numbers on Cabrera– and at the rest of sites only migrants are present.

Migratory route

Only three recoveries are available and, interestingly, all involve SW movements (fig. 1). Two adult males ringed on L'Illa de l'Aire were recovered 9 and 27 days later on Cabrera (140 km to the SW), one of them confirmed as Moltoni's. The other recovery is of an adult female ringed at Els Aiguamolls and recovered two days later on Els Columbrets (330 km to the SW). Since there is a small breeding population of Moltoni's Warbler on Cabrera, these recoveries may reflect reverse movements towards breeding sites by overshooting migrants. The bird recovered on Els Columbrets may be a similar case, although we have no clues as to its final destination.

Overall, birds are captured in quite good numbers in the Balearics/Els Columbrets, continental Spain and NE Morocco, suggesting that migration takes place across a broad front through the W Mediterranean (fig. 2). In the Balearics, bird numbers tend to increase eastwards. High frequencies and raw number of captures at sites with unsuitable habitat such as the tiny islands of L'Illa de l'Aire and Els Columbrets, as well as at L'Alfacada (near the tip of the Ebro delta), suggest that these sites act as attraction points for many migrants needing to find resting areas whilst crossing the sea. This view is further supported by the reverse movements observed in some of these birds.

Our data indicates that the nominate race of the Subalpine Warbler is almost the only taxon of this group trapped in Catalonia, L'Illa Grossa and mostly so on Els Columbrets. Moltoni's Warbler is occasionally trapped in Catalonia and less rarely so on Els Columbrets. In Morocco both *cantillans* and *inornata* should be frequent, but their exact frequency is unknown; although it is expected to migrate over this country, so far no records of *moltonii* have been reported (Thévenot et al., 2003; Gargallo, pers. obs.). In the Balearics both *cantillans* and *moltonii* are equally common and the eastern race *albistriata* is also trapped with some regularity, albeit in very low numbers. Interestingly, on L'Illa de l'Aire, *moltonii* is particularly common (c. 50% of all captures), even though it does not breed on this tiny island or on nearby Menorca. As shown by the recoveries (fig. 1), a good number of these birds may be overshooting migrants breeding in more southern Balearic islands (Mallorca, Cabrera), although others may head onwards to Corsica or Sardinia.

Phenology

Subalpine Warblers (not including *moltonii*) mostly migrate through the study area from mid-March to mid-May, the main passage period taking place from between late March and mid-April (fig. 3). The overall pattern is similar to that reported in S France (Isenmann, 1989a), Malta (Gauci & Sultana, 1976) and the Tyrrhenian islands (Spina et al., 1993). The lack of data from March in N Morocco prevents a comparison between this area and Catalonia. However, published data from Gibraltar (Finlayson, 1992) and N Morocco (Thévenot et al., 2003) indicates that passage takes place somewhat earlier in these areas and birds are already rather common in early March. In S and SW Morocco passage occurs distinctly earlier, from late February to mid-April, and peaks during the second half of March (Thévenot et al., 2003; Gargallo et al., unpubl.). Moltoni's Warbler clearly migrates about three weeks later (fig. a), usually beginning in early April and finishing in late May, although most pass through between mid-April and mid-May. Such delayed passage has been linked to the characteristic later breeding season of this taxon (Gargallo, 2002).

Males pass earlier than females (differences in median dates 9 and 6 days in adults and second-year birds, respectively) and adults somewhat earlier than second-year birds (7 and 4 days earlier in males and females, respectively; fig. 3). No data is available for Moltoni's since females are very hard to tell apart from Subalpines and ageing is complex (cf. Shirihai et al., 2001). Similar sex-related differences have also been found in Malta (Gauci & Sultana, 1976), but not in Italy (Rubolini et al., 2004), the latter maybe because of the inclusion of a certain number of Moltoni's Warblers in the dataset.

Biometry and physical condition

Mean wing lengths vary from 57.9 in N Morocco to 59.9 in wet Balearics, within the range reported in various regions of W and C Mediterranean (Cramp, 1998; Shirihai et al., 2001), but shorter than in the E Mediterranean, where the eastern, longer-winged race *albistriata* occurs (Morgan & Shirihai, 1997). Birds from N Tunisia also show significantly higher values (mean 62.3, $n = 82$; Waldenström et al., 2004), which suggests that there is a noticeable passage of *albistriata* and *moltonii* there, the latter also longer-winged than *cantillans*. Mean third primary lengths range between 43.1 in S Morocco to 46.2 in the wet Balearics (table 1), also somewhat less than reported in the Tyrrhenian islands (mean 46.4, $n = 4,041$; Spina et al., 1993), probably due to similar reasons as in Tunisia. The third primary length tends to decrease over time in Catalonia and on Els Columbrets (fig. 6), as previously found in the C Mediterranean (Spina et al., 1993), reflecting the differential migration of sex and age groups detailed above (males and adults being longer-winged; Cramp, 1998; Shirihai et al., 2001). This pattern is obscured in the Balearics due to the differential passage of *cantillans* and *moltonii* (the tendency to increase in length observed in the Balearics from late April onwards is due to the passage of male Moltoni's Warblers).

Mean fat scores vary between 1.6 on Els Columbrets and 3.7 in N Morocco (3.8 in the small dataset from S Morocco), within the range recorded on the islands of the C Mediterranean (Spina et al., 1993). Physical condition tends to increase slightly during the season, but no overall pattern is observed in fat reserves (figs. 7, 9). Mean body mass varies from 8.7 on Els Columbrets to 10.0 in N Morocco without any clear overall seasonal trend (fig. 8). In Catalonia body mass decreases significantly but in the dry Balearics the opposite is observed, probably due to the inclusion, late in the season, of some breeding birds (Moltoni's) from Cabrera. Birds from Catalonia have significantly higher body mass and fat reserves than those from the Balearics (dry) and Els Columbrets, while those from N Morocco have the highest mean figures for body mass, fat and physical condition out of all these areas. Lower values on islands reflect the energy spent on sea crossings, while values reported from Catalonia suggest that during migration through continental Spain birds are able to regain some mass. Data from the wet Balearics is too scarce to provide any relevant information.

Other than N Morocco, mean values are similar to those reported in S France (9.2, $n = 122$; Isenmann, 1989a) and the Tyrrhenian islands (9.2, $n = 4,011$; Spina et al., 1993). Mean body mass in N Morocco is similar to that reported from N Tunisia (9.7, $n = 82$; Waldenström et al., 2004), but somewhat higher than that reported elsewhere in NW Morocco during March (9.3, $n = 10$; Cramp, 1992). Data from S Morocco is

very scarce, but mean body mass is similar to that reported in a nearby area by Gargallo et al. (unpubl.; mean 9.0, $n = 385$) and higher than that given by Ash (1969; mean 8.3, $n = 17$). Body mass in N Morocco is c. 11–22% above that recorded in S Morocco, indicating that birds regain considerable energetic reserves while in NW Africa. Birds migrating along the Atlantic coast, however, may be in less of a hurry since data from Souss Massa (SW Morocco) indicates that birds arrive in better condition there (mean 9.7, $n = 10$; Robson & Durany, unpubl. data), probably reflecting the more favourable environmental conditions found along the west coast of Africa.

As observed in other species, birds stopping on Las Chafarinas have significantly lower fat scores and body mass than at Kerbacha (fig. 4), although these islands are only a few kilometres north of the Mediterranean coast of Morocco, a sign that a high proportion of birds landing on these islands are in poor body condition and need to stop. Given the proximity of the mainland, a good number of these birds are probably migrants forced to reverse their

migration direction after failing to cross the Mediterranean Sea.

Stopover

Stopover length is short and averages range from 2 to 6 days depending on the area (fig. 5). The percentage of retrapped birds is in general also quite low, varying widely between 3% on Els Columbretes to 18% in N Morocco (table 2). In general, birds tend to stopover more frequently in Catalonia and, particularly, N Morocco, although available data do not demonstrate if birds are able to refuel at all. The wetlands where the study sites are placed, however, may not be the best refuelling habitats for a species linked to dry Mediterranean scrublands. In more suitable habitats on Malta, for example, spring migrants showed a general increase in weight, with daily mass gains in the range of 0.1–0.9 (Gauci & Sultana, 1976). Data from Las Chafarinas indicates a positive fuel gain, although the sample size is too small to be conclusive.

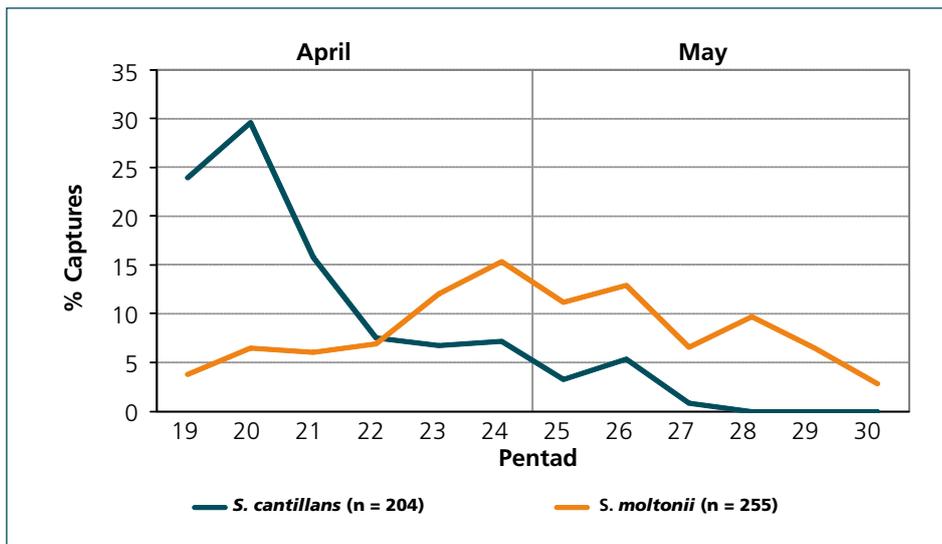


Figure a. Temporal variation in the frequency of captures of *S. cantillans* and *S. moltonii* (data from the Balearic islands only).

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	662	59.0 \pm 1.6 (52.5-64.0)	45.5 \pm 1.4 (40.5-50.0)	9.3 \pm 0.8 (7.3-13.7)	2.8 \pm 1.3 (0-6)
Columbrets	566	58.8 \pm 2.0 (51.0-65.5)	44.6 \pm 1.6 (40.0-50.0)	8.7 \pm 0.9 (5.5-11.9)	1.6 \pm 1.2 (0-6)
Balearics (dry)	2,036	59.3 \pm 2.0 (51.0-65.5)	45.5 \pm 1.8 (40.0-52.5)	8.9 \pm 1.0 (5.3-15.1)	2.3 \pm 1.2 (0-7)
Balearics (wet)	10	59.9 \pm 1.1 (58.0-61.5)	46.2 \pm 0.9 (45.0-47.5)	9.1 \pm 0.3 (8.6-9.6)	2.6 \pm 1.2 (1-4)
Chafarinas	22		44.0 \pm 1.4 (42.0-46.5)	9.2 \pm 0.7 (8.3-11.2)	2.0 \pm 1.4 (0-5)
N Morocco	58	57.9 \pm 1.6 (54.0-62.5)	44.4 \pm 1.3 (42.0-47.5)	10.0 \pm 1.0 (7.8-12.2)	3.7 \pm 1.6 (0-7)
S Morocco	4	58.6 \pm 0.3 (58.5-59.0)	43.1 \pm 0.8 (42.5-44.0)	9.1 \pm 0.1 (8.9-9.2)	3.8 \pm 0.5 (3-4)

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

	Catalonia	Columbrets	Balearics (dry)	Balearics (wet)	Chafarinas	N Morocco
All retraps	-0.08 \pm 0.11 (46)	0.05 \pm 0.16 (18)	-0.05 \pm 0.06 (134)		0.18 \pm 0.17 (2)	-0.30 \pm 0.34 (11)
Retraps >1 day	-0.02 \pm 0.10 (30)	0.04 \pm 0.14 (8)	0.00 \pm 0.06 (94)		0.18 \pm 0.17 (2)	0.01 \pm 0.20 (6)

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

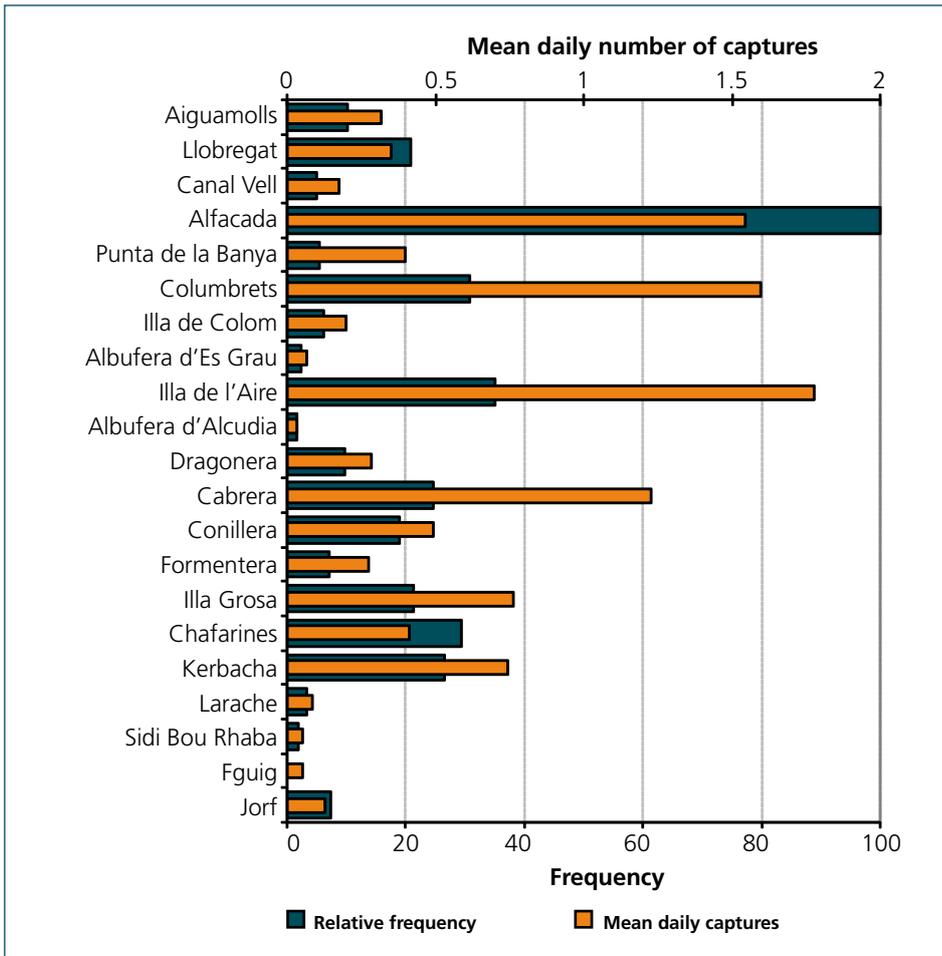


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

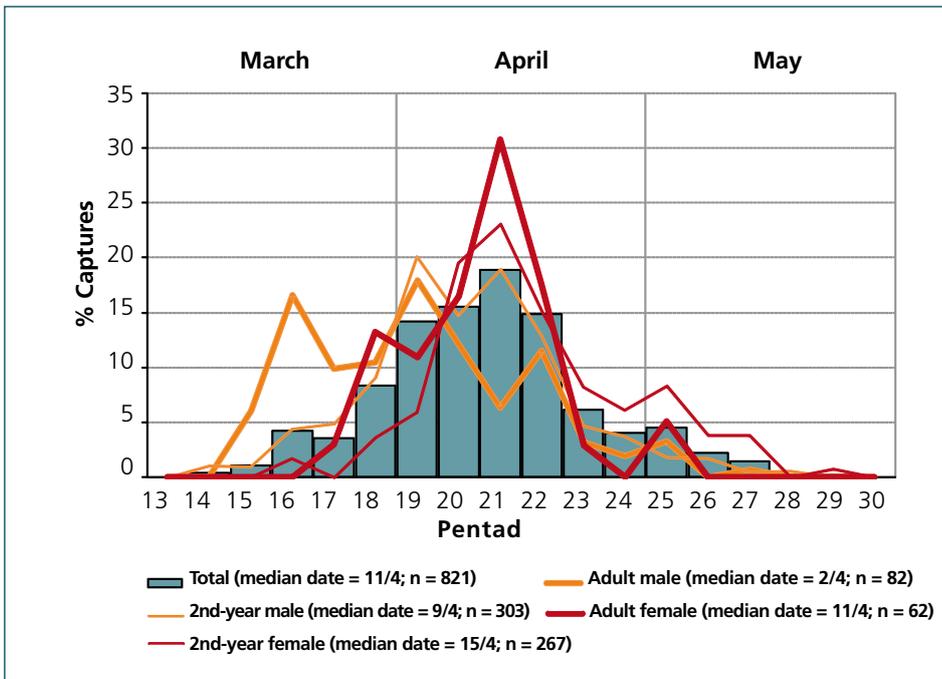


Figure 3. Frequency of captures during the study period (not including *moltonii*).

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

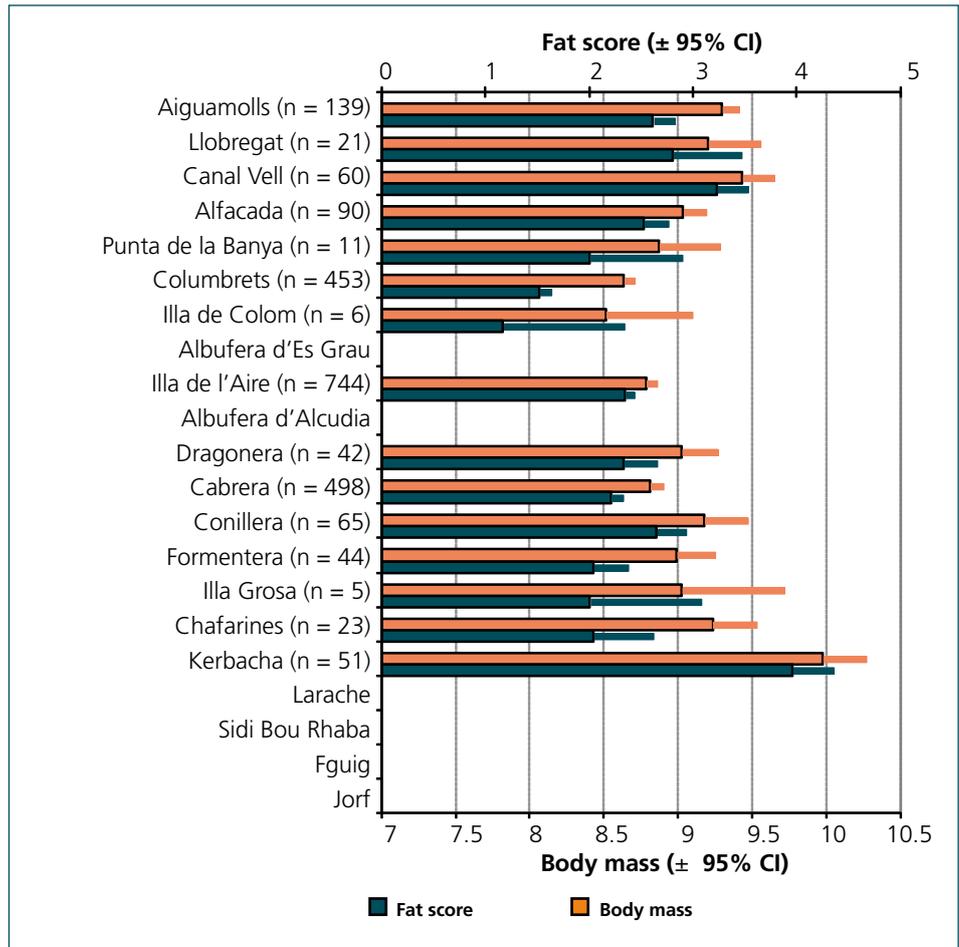
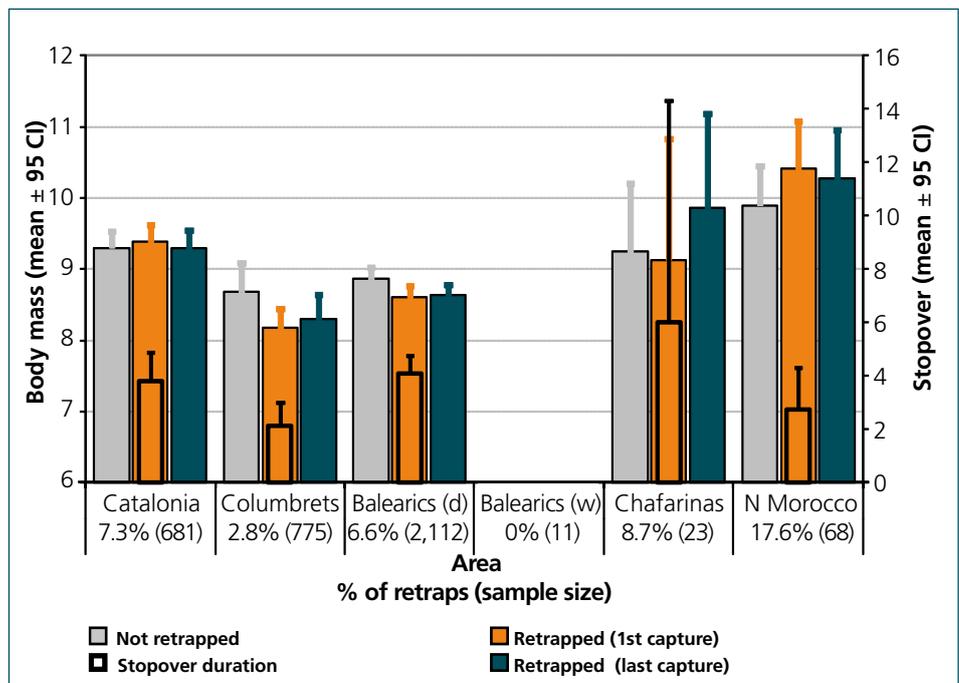


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



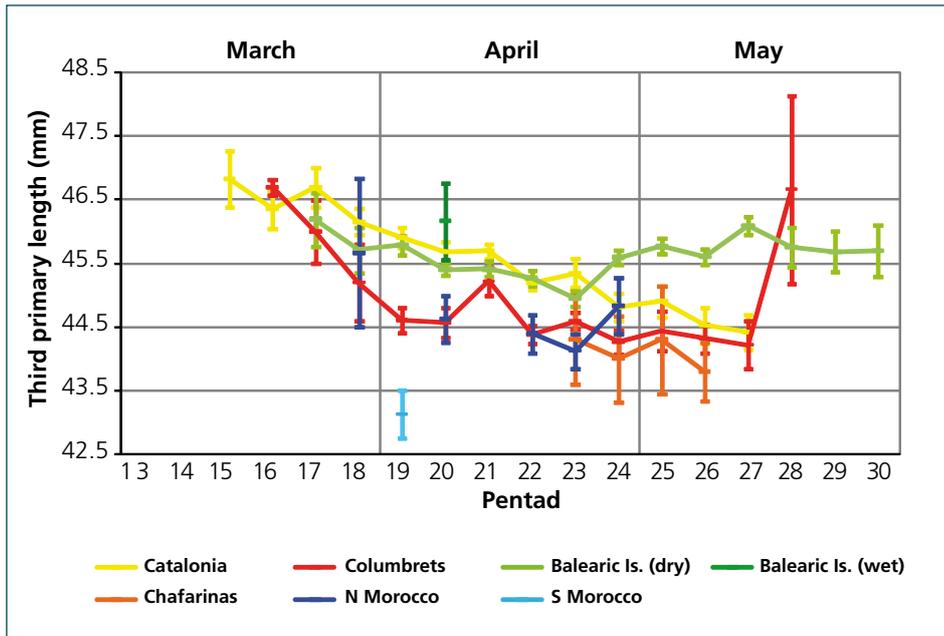


Figure 6. Temporal variation of third primary length according to area.

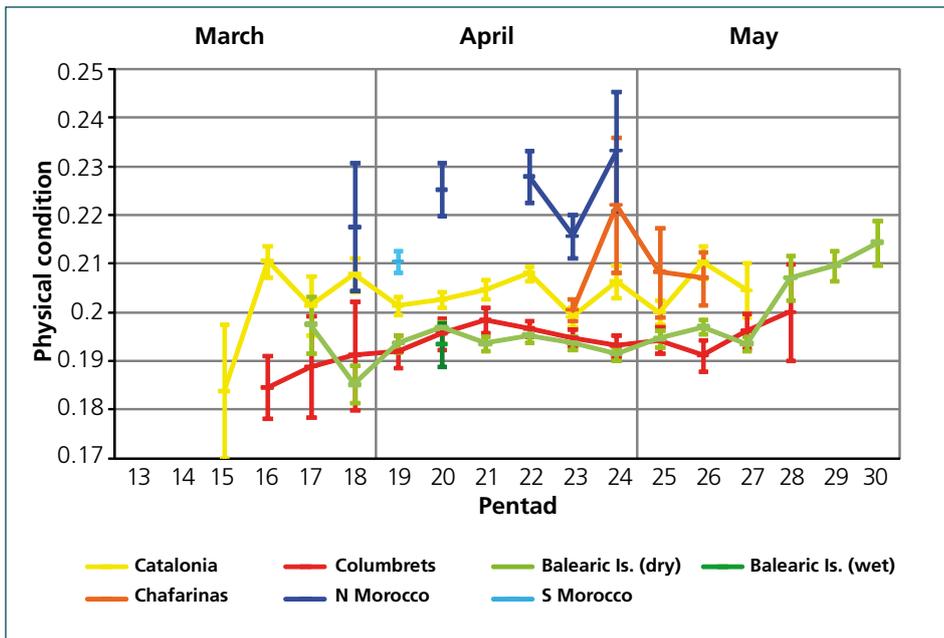


Figure 7. Temporal variation of physical condition according to area.

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

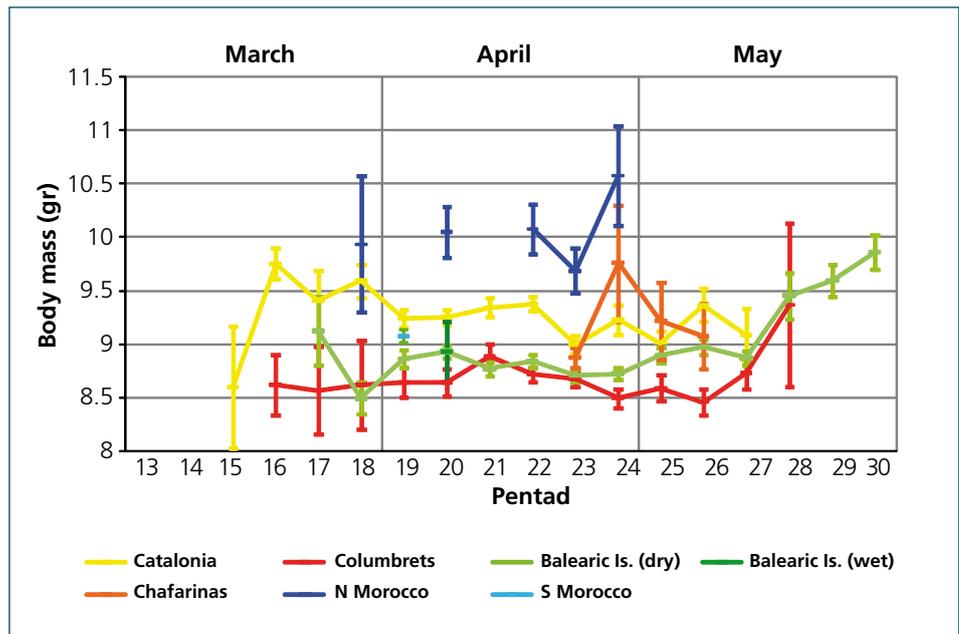


Figure 9. Temporal variation in fat score according to area.

