

## DAILY ACTIVITY OF SARDINIAN WARBLER *SYLVIA MELANOCEPHALA* IN THE BREEDING SEASON

### ACTIVIDAD DIARIA DE LA CURRUCA CABECINEGRA *SYLVIA MELANOCEPHALA* DURANTE EL PERIODO REPRODUCTOR

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In contrast to many other European passerines (Cramp, 1985), the daily activity pattern of Mediterranean birds is little known. Activity is controlled by both exogenous and endogenous factors (Dawson *et al.*, 2001; Hahn *et al.*, 1997). Among the endogenous factors, parental tasks during the reproductive period can cause pronounced changes in activity patterns. The activity of the male Sardinian warbler *Sylvia melanocephala* was studied. This species is distributed widely among Mediterranean-type habitats (Hagemeijer and Blair, 1997). The adults are mainly sedentary, although some are migratory (Shirihai *et al.*, 2001). They have a monogamous mating system and both sexes share incubation as well as brooding and feeding the young (Cramp, 1985). The daily activity of the species was studied by radio-tracking. In this way information was obtained on the movements and the daily rhythm of activity of Sardinian warbler males in the breeding season, and determined to which extent the breeding status influences the daily activity.

A 12.25-ha plot containing 7.55 breeding pairs/10 ha of the Sardinian warbler (Bas *et al.* 2005), which was the most abundant bird species in the area, was studied during the

1999 breeding period (mid-April to early August). The study plot was located in the Montgrí massif (Catalonia, NE Spain, 42°05' N; 03°11' E) at 70 - 120 m above sea level. This is a limestone region with a Mediterranean climate with a dense sclerophyllous shrubland is dominated by *Quercus coccifera*, *Rosmarinus officinalis* and *Cistus albidus*.

Seven Sardinian warbler males (one unpaired (A) and six paired males) were captured with mist-nets and marked with miniature transmitters (weight 0.9 - 1.0 g; Wildlife Materials Inc, Carbondale) for 8 days. The tags were glued to the shortened back feathers with cyanocrylate glue (Kenward, 1987). Marked individuals were radio-tracked simultaneously with a TRX-48S receiver and a directional Yagi antenna (Wildlife Materials Inc.; Carbondale). Additional details on the method and effects can be found in Bas *et al.* (2005). The paired males showed different breeding statuses: (i) with the first brood finished and accompanied by a female (males B, C and D); (ii) building the nest together with a female and beginning the brood (male E); (iii) incubating the clutch together with a female (male F); and (iv) feeding fledged young together with a female (male G).

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The study plot was gridded at  $25 \times 25$  metres intervals using coloured stakes that helped to easily record the positions and movements of marked individuals on a detailed map. A total of 10065 minutes were spent tracking during 20 days of field work (range = 570-1935 min / day). Use was made of both triangulations (Johnstone, 1992) and visual observations (the latter possible because of the low vegetation: 0.75 m height in average), to locate the position of individuals (fixes or locations) at random time intervals (mean  $\pm$  SD =  $2.5 \pm 2.1$  min). The distances between consecutive fixes and the time (in seconds) were measured to carry out these movements in three daily blocks: morning (5:00 – 10:00 s.h.), midday (10:00 – 14:00 s.h.) and afternoon (14:00 – 19:00 s.h.). Resting periods were thus defined as periods during which males did not move, or during which their displacements were so short that they were not detected by triangulation.

A total 1047 total fixes (mean  $\pm$  SE =  $149.6 \pm 65.0$  fixes /male, range = 61 - 217 fixes,  $n = 7$ ) were registered. The mean distance covered per minute (arrived at by adding all the trajectories and dividing that distance by tracking minutes) was 2.73 meters / minute (SE = 1.7, range = 0.9 - 6.1,  $n = 7$ ) and differed among males (Kruskall-Wallis test,  $\chi^2 = 50.7$ ,  $P < 0.001$ ,  $n = 986$  trajectories; Fig. 1). Home range size (minimum convex polygon; Bas *et al.* 2005) was not correlated with the mean distance of movements (Spearman correlation;  $r = -0.43$ ,  $P > 0.05$ ,  $n = 7$ ), it might be limited by signalling and defence behaviour of territory owners. The mean distance of movements was not related to the length of time each bird was followed (Spearman correlation;  $r = 0.17$ ,  $P > 0.05$ ,  $n = 7$ ). Although the activity showed a tendency to decrease during the day the differences in mean distances were not significant (Kruskall-Wallis test,  $\chi^2 = 1.3$ ,  $P > 0.05$ ,  $n = 986$  trajectories; Fig. 1). Most of the individuals moved farther, although less visibly, during the midday period than during the after-

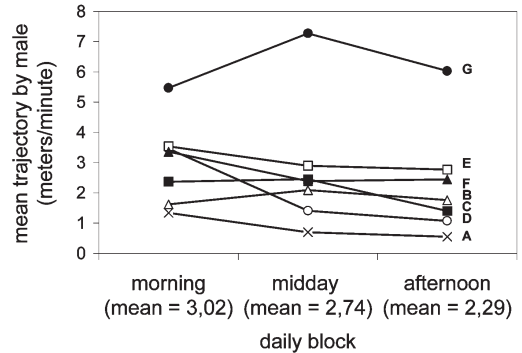


FIG. 1.—Daily activity of Sardinian warbler males (A = unpaired male; B, C and D = male with first brood finished and accompanied by female; E = male building the nest and beginning the brood; F = male with female incubating the clutch; and G = male feeding the fledging young). From home range data see Bas *et al.* (2005).

[*Actividad diaria de los machos de curruca cabezinegra* (A = macho no apareado; B, C y D = machos con la primera cría finalizada y acompañando a la hembra; E = macho construyendo el nido y empezando la cría; F = macho con hembra incubando la puesta; y G = macho alimentando los pollos). Para los datos de dominio vital ver Bas *et al.* (2005).]

noon. These data are in contrast to the majority of small European birds which all show two peaks of activity, one in early morning and another one in late afternoon (McNamara *et al.*, 1994; Pravosudov and Grubb, 1997). According to McNamara *et al.* (1994) and Pravosudov and Grubb (1997), this bimodal situation represents an optimal compromise between predation and starvation risks when foraging conditions are moderate and foraging can be interrupted during the day. Although Sardinian warbler males are also more visible early morning and late afternoon, they remain active during midday, although less conspicuously but always with a noticeable singing activity. This singing activity during the middle of the day can be used for territory mapping purposes (Bibby *et al.*, 1992).

McNamara *et al.* (1994) modelled daily foraging routines of small birds. They predicted that foraging activity peaks in the early morning under poor foraging conditions and decreases steadily throughout the day. This could explain the pattern observed in the Sardinian warblers as food availability is usually low in Mediterranean shrubland (Pons, 1998). Thus, warblers may be forced to forage continuously without any significant interruptions at midday, which is remarkable considering the high temperatures around noon.

The results also suggest that the movements of Sardinian warbler males are related to pairing status and to the progress of breeding (Fig. 1). This is clearly observed in the afternoon when males are ordered according to their breeding status: (i) A; (ii) B, C and D; (iii) E and F; (iv) G. Fledgling demands force adults, such as male G, to move farther away of the nest to obtain a greater quantity of food per time unit (Fig. 1 and *pers. obs.*). This situation lasts while the juveniles are accompanied and fed by the parents (2 - 3 weeks after fledging; Cramp, 1985).

On the other hand, pauses in activity occur homogeneously during the day without differences in the median duration of rest between the different males (Kruskall-Wallis test;  $\chi^2 = 7.3, P > 0.05$ ), nor in the median time of rest between the three daily blocks (Kruskall-Wallis test,  $\chi^2 = 0.53, P > 0.05$ ). The resting periods are generally short (mean: 32 min; median: 22 min) but they can reach up to 169 min ( $n = 153$  periods).

These results show that the foraging activity is relatively constant throughout the day, and suggest that the level of starvation and the predation risk may also be relatively constant. By contrast, resting activities (*e.g.*, daily rest, cleaning, incubation) are probably more heterogeneously distributed throughout the day. This is supported by observations that the mean duration of rest periods of the males is not significantly correlated with their home range sizes (Spearman correlation;  $r = 0.64, P > 0.05$ ,

$n = 7$ ), or with their total distances of movement (Spearman correlation;  $r = -0.71, P > 0.05, n = 7$ ), or with the number of fixes conducted (Spearman correlation;  $r = -0.36, P > 0.05, n = 7$ ), or with the duration of minutes radio-tracking per male (Spearman correlation;  $r = 0.57, P > 0.05, n = 7$ ) (Home range data; Bas *et al.*, 2005).

RESUMEN.—*El momento concreto del periodo reproductor puede incidir sobre la actividad diaria y los periodos de reposo de las aves paseriformes. Para investigar este aspecto, hemos analizado los movimientos diarios de 7 machos de curruca cabecinegra Sylvia melanocephala mediante radioseguimiento en un matorral mediterráneo. La actividad tiende en general a decrecer a lo largo del día aunque con algunas variaciones dependiendo del momento concreto del periodo reproductor de cada macho en particular. Se han registrado largos periodos de reposo que no dependen ni del estado reproductor ni del momento del día.*

ACKNOWLEDGEMENTS.—We are grateful to William Liao and Lluís Zamora for advice on radiotracking methods and materials, and three anonymous reviewers for critical comments on an earlier draft. This work has been financed partially by the Spanish Ministry of Science and Technology (REN2000-0300-C02-02/GLO) and by the Spanish Ministry of Education and Science (CGL2004-05240-C02-02/BOS). The trials complied with the laws of Catalonia (Spain).

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[Recibido: 22-03-07]

[Aceptado: 01-10-07]