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AFRICAN CLIMATE WARMING ADVANCES SPRING ARRIVAL OF THE COMMON QUAIL *COTURNIX COTURNIX*

EL CALENTAMIENTO CLIMÁTICO AFRICANO ADELANTA LA LLEGADA PRIMAVERAL DE LA CODORNIZ COMÚN *COTURNIX COTURNIX*

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The Common Quail is one of the most popular steppe-land birds and is also one of great economic interest. Despite this, some aspects of its life cycle remain unclear, especially those concerned with the wintering phase. Here we report a long-term study of the spring arrival phenology of this species and the effects of recent global warming on the temporal trends observed. Moreover, the results from these analyses contribute to the understanding of the use of wintering grounds by the Common Quail and its migratory routes.

The first arrival date (FAD), defined as the first male song heard, was recorded between 1983 and 2004, in an area of 600 Ha (41° 22'N, 1° 18'E) in Northeast Spain. The study area was located in a typical farmland region at low altitude (300 m) near to the coastline where arable fields occupy nearly 70% of the area. A recorded female song was used to induce an audible response at 40 listening points, placed every 300 m along a 12 km transect covered by car. The breeding population at the site was stable during the study period (Rodríguez-Teijeiro *et al*., 2004). Thus, changes due to variations in the population size or posibles trend of observer activity and skill were rejected as possible sources of bias in temporal changes of arrivals (Sparks *et al*., 2001, Lehikoinen *et al*. 2004, Møller and Merilä, 2004).

The first male song of the Common Quail at the site was heard on March 27 (2000 and 2002) and the latest on April 20 (1984). Arrivals showed a significant advancement of –0.874 days/year during the study period (r^2 = –0.614, $F_{1, 20} = 31.816$, $P < 0.01$).

Monthly mean temperatures for December, January, February and March were collected from 52 meteorological stations (GHCN database; Peterson & Vose, 1997) located in the wintering range and at potential migration areas of this species. Stations were gathered into five geographical areas (Fig. 1). For each of these groups of stations the mean value of temperatures was calculated for each month. It should be denoted that in area 5 part of the population also breeds before reaching European grounds.

Pearson's correlations were performed between FAD and climatic data, adjusting the periods and areas corresponding to each time point, that is to say December and January for wintering areas (1, 2, 3 and 4) and February and March for passing areas (5), following the literature (Curry-Lindahl, 1981; Guyomac'h, 2003). Negative correlations were found between arrivals and temperatures in wintering and migration areas (Fig. 1). From a geographical point of view, correlations were higher in western wintering areas. Region 4 did not show significant relationships, whereas region 1 showed the strongest correlation coefficient. The lack of correlation observed when advancing to the East in the Subsaharian strip could be associated with the importance of these areas as wintering ones of the Atlantic metapopulation (Guyomarc'h, 2003). That is, region 1 would hold the maximum number of indivi-

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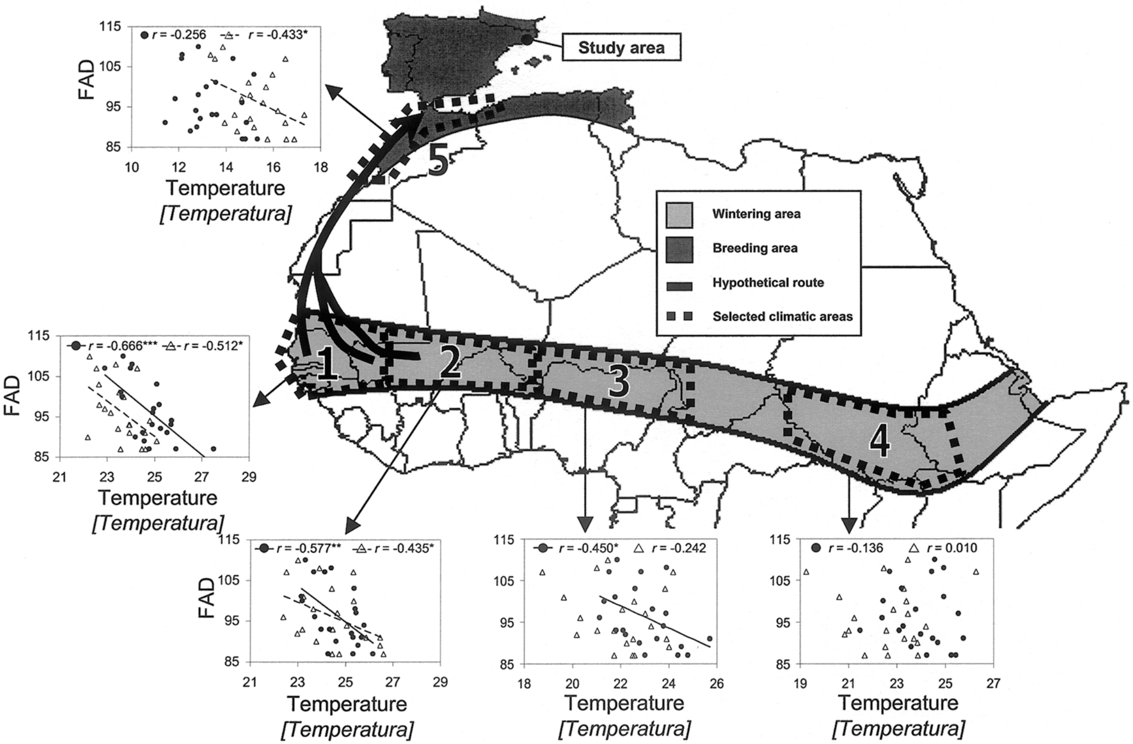

FIG. 1.—Partial distribution map of the Common Quail (breeding area in black and wintering area in grey, adapted from Guyomac'h, 2003). Hypothetical route from wintering areas to study area is showed by arrows. Climatic areas used are showed by dashed lines and numbered in each case (see text for correspondences). A scatterplot between temperatures and arrivals and their Pearson's product moment correlations ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$) for the period 1983-2004 is showed for each one. In areas 1, 2, 3 and 4 black dots series are December and white triangles January temperatures; in area 5 black dots are February and white triangle March temperatures.

[Mapa de la distribución de la Codorniz Común (áreas reproductoras en negro y áreas de invernada en gris, adaptado de Guyomac'h, 2003). La ruta hipotética desde las áreas de invernada hasta el área de estudio está mostrada por flechas. Las áreas climáticas se muestran por líneas de rayas y numeradas en cada caso (ver el texto). Una gráfica entre las temperaturas y la llegada, junto a la correlación de pearson ($^{*}P < 0,05$; $^{**}P < 0,01$; $^{***}P < 0,001$) para el periodo 1983-2004 se muestra para cada área climática. En las áreas 1, 2, 3, y 4 los circulos negros corresponden a la temperatura de diciembre y los triángulos blancos a la de enero, en el área 5 los circulos negros corresponden a febrero y los triángulos blancos a la de marzo.]

duals of the population, whereas region 3 would hold the minimum. Region 4 could be the wintering area of the eastern subpopulation (which uses the Egypt-Baltic flyway for movements, see Guyomarc'h 2003). However, this lack of correlation could be a consequence of the possibility that regions above mentioned might be partially independent climatic zones (Lehikoinen *et al.*, 2004). From a temporal point of view, the best results were obtained in December for wintering areas, and in March for the migration area. The correlation value with region 5 was the lowest and just slightly significant at $P < 0.05$.

The FAD for the Common Quail in this study is consistent with the changes reported in spring migratory phenology in many previous studies (Lehikoinen *et al.*, 2004). To date, the advancement is one of the largest detected in a trans-Saharan bird species, and clearly contrasts with that reported by Peñuelas *et al.* (2002) in Cardedeu (Eastern Vallès). However, it must be in mind that the species has suffered a notable decline in Eastern Vallès; even more, it has not been detected in some recent years (Ribas, 2000) and Rodríguez-Teijeiro *et al.* (2004) quote the species as sporadic in this area. Probably, reduction in agricultural areas could be the cause of this rarity. This evolution could have directly affected the probability of encountering an early individual, provoking the above-mentioned relationship. Furthermore, the high correlation with climate in sub-Saharan wintering grounds is not consistent with a hypothetical overwintering in North Africa, with the consequent reduction in migratory distance (Coppack & Both, 2002) or an increase in sedentariness caused by hybridization with the subspecies *C. c. japonica* (Derégnaucourt *et al.*, 2005).

The environmental cues of Common Quail migration remain largely unknown. In this study, temperature was a good predictor. However, increasing values of correlation with western Sahelian areas may be attributable to segregation in wintering grounds of European breeding populations. The three ways of spring passage described for the European Common Quail population (Morocco-Iberian Peninsula, Tunis-Italy and Egypt-Baltic countries; see Guyomarc'h, 2003) are geographically associated with the variations in the correlations found, so it could be hypothesized that Iberian and Italian breeders would then winter in the Senegal-Mali area (regions 1, 2 and 3), whereas eastern European breeders, which use the Egypt-Baltic way, would winter in the Sudan and Ethiopia (region 4). Furthermore, significant correlation values coincide with the expected departure time from wintering and passing areas (Guyomarc'h, 2003).

The predicted trend towards warmer temperatures in Africa (Hulme *et al.*, 2001) allows prediction of earlier arrivals for the studied population, on the basis of the negative sign of all significant correlations and benefits its conservation because its response is adequate and coherent with the advancement of the vegetation cycle in the Iberian Peninsula (Peñuelas *et al.*, 2002).

RESUMEN.—*La fecha de la primera llegada de la Codorniz se ha avanzado bruscamente entre 1983 y 2004 en el noreste de España. Estos cambios fenológicos se correlacionaron significativamente con las temperaturas registradas durante los meses previos en la franja subsahariana pero sólo en su parte más occidental. Esto indica que ésta podría ser el área de invernada para algunas poblaciones ibéricas. El fuerte efecto del tiempo atmosférico sobre la fenología de los movimientos migratorios en esta especie beneficia su conservación, ya que la respuesta encontrada es adecuada y coherente con el avance del ciclo de la vegetación en la Península Ibérica.*

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