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SHORT REPORT

Timing of onset of breeding in three different Dipper *Cinclus cinclus* populations in France

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Capsule Timing of breeding varies widely.

In recent decades, anthropogenic forces are thought to have driven changes in the timing of breeding (Crick & Sparks 1999, Brown *et al.* 1999, Koike & Higuchi, 2002). Such changes could be of importance for birds, especially those starting to breed early in the spring. Dippers *Cinclus cinclus* are amongst the first passerines species to breed in early spring (Tyler & Ormerod 1994).

Several explanations for early breeding in Dipper have been proposed including the necessity for synchronization between the nestling period and the period of peak biomass in their prey (Shaw 1978). We have suggested that physical factors linked to river function, such as seasonal variation in discharge might also explain the timing of breeding in Dippers (D'Amico *et al.* 2000). It has been reported that low air and water temperatures, heavy rainfall during winter, water quality and food availability may delay laying (Tyler & Ormerod 1985, Schmid 1985, Sackl & Dick 1988, Ormerod *et al.* 1991). Increasing altitude also causes a delay in egg-laying (Schmid 1985, Sackl & Dick 1988, Breitenmoser-Wursten 1988) although some studies have not reported this. Recently, Hegelbach (2001) observed that in the Swiss Lowlands, water temperature and phytophenology indicate an earlier onset of egg-laying in Dippers. This is the first report to suggest that breeding has started there earlier in the spring than before; he hypothesizes that this change was linked to local increase in water temperatures as a result of urbanization.

We undertook a three-year field study using the same methods on three different French populations of Dipper situated along a northeast–southwest axis. Our aims were: (1) to investigate interpopulation variation in timing of breeding and (2) to describe the breeding biology of the Dipper in southwestern Europe where more data are needed to assess any future change in phenology.

The study took place in three defined areas of France along a northeast–southwest gradient (Lorraine: 49°08′N 06°10′E; Auvergne: 45°35′N 03°05′E and the Pyrénées: 42°53′N, 00°25′W) (Fig. 1). In Lorraine, the study sites are on lowland rivers (altitude: 150–300 m asl) while in Auvergne and especially in the Pyrénées, Dippers breed along upland rivers (335–965 and 450–1600 m asl respectively). Study sites are further described in Marzolin (1996), Boitier (1998) and D'Amico & Hémery (2003).

The same methodology was used by each observer in each area (Lorraine: G.M.; Auvergne: E.B.; the Pyrénées: F.D.) during three consecutive breeding seasons: 1998, 1999 and 2000. First-egg dates were observed, or estimated by back-dating from hatching date. Data on breeding phenology are presented on a five-day basis (pentade) following Berthold (1973). We distinguished between pairs of birds that have (1) single clutch only and (2) two clutches. We also checked nests for replacement clutches. We assessed statistical differences in timing of breeding and occurrence of single, double and replacement clutches using a two-way ANOVA (generalized linear model) following log transformation and Fisher's exact test respectively.

Across all years, laying in Dippers took place over a period ranging from the ninth pentade (10–14 February) to the 33rd (10–14 June). When only single and first clutches were combined, there was a significant difference in onset of first-egg laying between the three populations ($F_{2,226}$ = 50.14, P < 0.001), the Pyrénées population laying later than those in Lorraine and Auvergne (Fig. 1). When the different types of clutch were considered, significant differences in timing of laying between the three populations were

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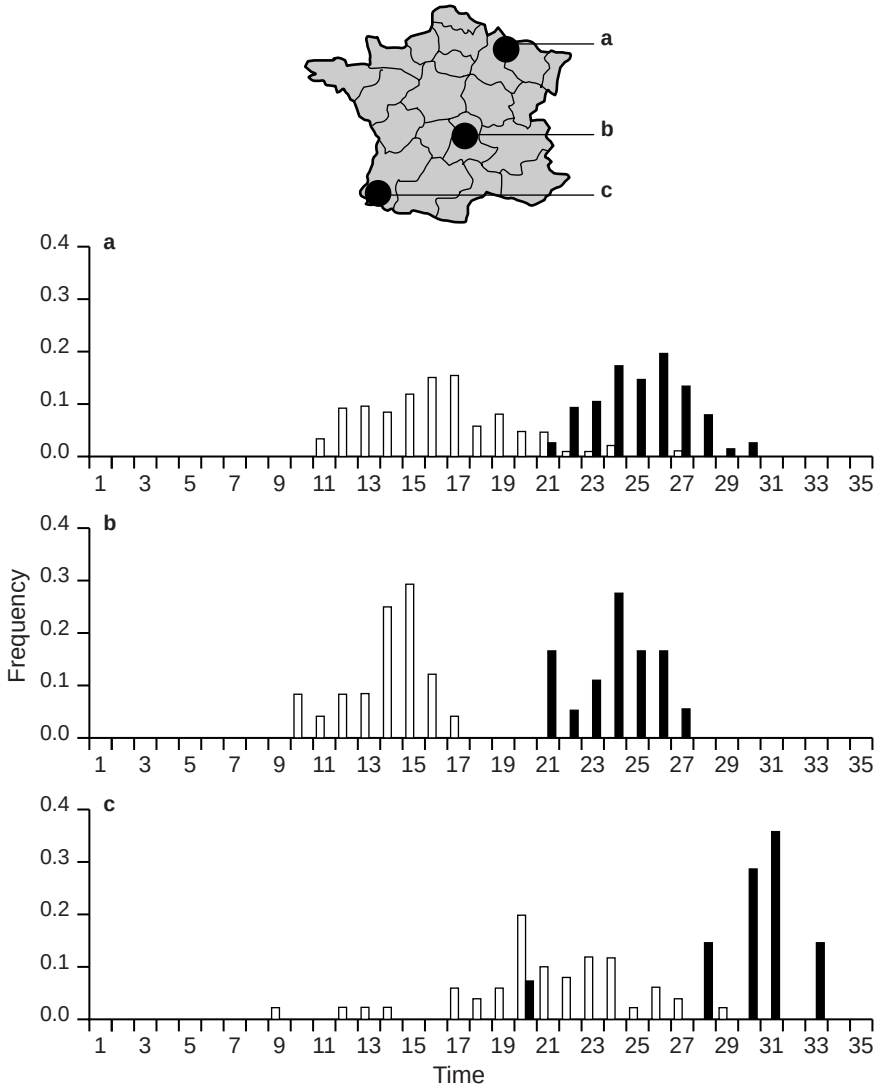

Figure 1. Frequency of first -egg dates of single and first clutches (□) and second clutches (■) for *Cinclus cinclus* (1998, 1999 and 2000 combined) at three locations: (a) Lorraine, (b) Auvergne and (c) Pyrénées. Replacement clutches are excluded. Time is expressed as five-day intervals: pentade 1 = 1–5 January; see Berthold 1973. The inset map shows the position of the three study sites in France.

also revealed (single clutches: $F_{2,92} = 29.66$, $P < 0.001$; first of double clutches: $F_{2,133} = 22.50$, $P < 0.001$ and second of double clutches: $F_{2,107} = 22.26$, $P < 0.001$). The date of first egg in single clutches was significantly later than that for first clutches of double clutches in Lorraine ($F_{1,152} = 75.59$, $P < 0.001$) but not in Auvergne ($F_{1,23} = 1.08$, $P = 0.310$) and Pyrénées ($F_{1,49} = 1.10$, $P = 0.299$). This might be explained by lower altitudinal range in Lorraine compared to the two other populations.

Between years, timing of laying varied according to the type of clutch and the population (Table 1). Significant differences were found in the case of double clutches (first of double clutches: $F_{2,133} = 6.28$, $P = 0.003$; second of double clutches: $F_{2,107} = 5.80$, $P = 0.004$) but not in the case of pairs having one clutch ($F_{2,92} = 1.42$, $P = 0.246$).

The proportion of Dippers having a double clutch varied from 11.8% (Pyrénées, 1998) to 70.0% (Auvergne, 1999), the population in the Pyrénées being characterized by a lower proportion of double clutches and the population in Auvergne by the lowest occurrence of replacement clutches (Table 2). The proportion of single, double and replacement clutches did not vary significantly from site to site (Fisher's exact test; all $P > 0.05$), nor from year to year except in the Pyrénées where the proportion of single versus double clutches varied (Table 2; Fisher's exact test, $P = 0.013$, $n = 44$).

Table 1. Mean timing of laying for Dipper from 1998 to 2000 at three different locations (Lorraine, Auvergne, Pyrénées). Numbers refer to pentade numbers; sd, standard deviation; CV, coefficient of variation).

	Lorraine				Auvergne				Pyrénées			
	1998	1999	2000	**Total**	1998	1999	2000	**Total**	1998	1999	2000	**Total**
Single clutches												
n	16	19	21	**56**	2	3	5	**10**	13	5	9	**27**
Mean	18.1	18.8	18.4	**18.5**	14.5	14.3	14.4	**14.4**	23.5	24.0	21.0	**22.1**
sd	3.3	2.6	2.9	**2.9**	–	0.6	1.7	**1.2**	2.6	3.6	2.0	**3.3**
CV (%)	18.5	13.8	15.5	**15.6**	–	4.0	11.6	**8.2**	11.0	14.8	9.5	**14.9**
Range	14–27	15–24	12–24	**12–27**	14–15	14–15	13–17	**13–17**	18–27	21–29	18–24	**18–29**
First of double clutches												
n	34	29	34	**97**	4	5	5	**14**	1	13	9	**23**
Mean	13.6	15.5	15.4	**14.8**	11.5	15.0	14.0	**13.6**	27.0	19.1	20.6	**19.8**
sd	1.7	2.2	2.3	**2.2**	2.4	0.7	2.0	**2.2**	–	5.1	1.8	**4.1**
CV (%)	12.7	13.9	14.9	**15.0**	20.7	4.7	14.3	**16.2**	–	26.9	8.6	**21.1**
Range	11–17	11–19	12–20	**11–20**	10–15	14–16	12–16	**10–16**	–	9–24	19–23	**9–27**
Second of double clutches												
n	29	22	25	**76**	5	7	6	**18**	0	9	5	**14**
Mean	24.5	25.8	25.4	**25.2**	21.6	24.6	25.2	**23.9**	–	28.7	30.8	**29.8**
sd	1.8	1.9	2.3	**2.1**	0.9	1.0	1.3	**1.8**	–	4.2	1.3	**3.2**
CV (%)	7.4	7.5	9.0	**8.2**	4.1	4.0	5.3	**7.6**	–	14.7	4.2	**10.6**
Range	21–28	21–28	22–30	**21–30**	21–23	23–26	24–27	**21–27**	–	20–33	30–33	**20–33**

The timing of laying varied from year to year, from site to site and in relation to breeding attempt (Table 1). This result is similar to that of medium- or long-term studies available (e.g. Hegelbach 2001). However comparative analysis remains difficult even if some trends can be identified. Our results for Auvergne match those given by Roché & d'Andurain (1995) compared to the very few published studies on Dipper breeding phenology in France. A lot of data exists on comparative timing of breeding in Dippers within Europe (reviewed in Roché & d'Andurain 1995, Wilson 1996, Fracasso *et al.* 2000). Observations for the Lorraine population are similar to that for Germany (Schmid 1985). The breeding phenology of the Pyrénées population is similar to Swiss populations (Breitenmoser-Wursten 1988) although median first-egg laying period in the Pyrénées (11–15 April) is earlier than in the Swiss Alps (29–30 April). This difference is probably due to the altitudinal range in our study (440–1600 m) being larger than in Breitenmoser-Wursten's study (980–1700 m). Although the population studied by Esteban (1997) in Navarra (Spanish western Pyrénées) and the population studied here in the French western Pyrénées are close (*c.* 100 km), their first-egg dates appear different being earlier in the former population; it is probably due to different climatic factors and lower altitude in the former study (0–900 m). In Navarra, the timing of breeding for first and second clutches match those observed elsewhere in France (Auvergne, Lorraine) and in the Italian Alps at medium altitudes (Fracasso *et al.* 2000). The timing of breeding in this group of populations (France except the Pyrénées, Spain & Italy) is later than for populations in Scotland, Wales and Ireland (Tyler & Ormerod 1985, Wilson 1996, O'Halloran *et al.* 1999).

The proportion of double clutches varies greatly throughout Europe (Tyler & Ormerod 1994). The

Table 2. Proportion of single, double and replacement clutches for *Cinclus cinclus* from 1998 to 2000 at three different locations (Lorraine, Auvergne, Pyrénées).

	Lorraine				Auvergne				Pyrénées			
	1998	1999	2000	**Total**	1998	1999	2000	**Total**	1998	1999	2000	**Total**
Sample size, *n*	50	48	55	**153**	8	10	11	**29**	17	18	18	**53**
Single clutches (%)	32.0	39.6	38.2	**36.6**	25.0	30.0	45.5	**34.5**	76.5	27.8	50.0	**50.9**
Double clutches (%)	54.0	43.8	40.0	**45.8**	62.5	70.0	45.5	**58.6**	11.8	55.6	27.8	**32.1**
Replacement clutches (%)	14.0	16.7	21.8	**17.6**	12.5	0.0	9.1	**6.9**	11.8	16.7	22.2	**17.0**

lowest proportions are observed in Scandinavia (Mork 1975, Efteland & Kyllingstad 1984, Borgström 1991) and in Ireland (Smiddy *et al.* 1995). In France (Roché & d'Andurain 1995, present study), the average proportion of double clutches is amongst the highest in Europe, being similar to that observed in Germany (Baake 1982 cited by Fracasso *et al.* 2000, Schmid 1985), Italy (Fracasso *et al.* 2000) and Spain (Esteban 1997).

To date, there is no evidence of any latitudinal gradient in timing of breeding for Dippers in Europe. Our data simply indicate that there are large variations in the onset of breeding for distant populations of Dippers situated along a northeast–southwest axis in France. Complex interactions between local (e.g. altitude, climate), regional and historical factors may account for this. Nevertheless, some general geographical trend can be recognized: populations in the northwest of Europe (Ireland, Wales, Scotland) and the north (Sweden, Norway) are characterized by low numbers of double clutches and delayed timing of breeding compared to populations from the south (Spain, Italy) and central Europe (France, Germany). In this respect, and given the between-site and between-year variability in timing of breeding of populations, caution is required before concluding that local or global changes may drive earlier onset of egg-laying in Dippers.

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