

# Mortality and movements of Dartford Warblers in England

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**Vulnerable in the short term to severe winters and heath fires, and in the long term to habitat fragmentation . . .**



**T**he Dartford Warbler *Sylvia undata* is a rare bird of the southern heaths in England and its conservation is a matter of some concern. The heaths where it occurs are of great natural history interest, yet, especially in Dorset, are much threatened by rapid reclamation (Moore 1962).

The Dartford Warbler is generally considered to be resident, in the sense that individuals can be found at all times of the year at the breeding sites; as a result, they suffer badly in severe weather (Tubbs 1967). On the other hand, Walpole-Bond (1914) suggested that some left in autumn to winter in coastal areas, and Venables (1934) found that, while a few

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wintered on the Surrey heaths, they were largely absent until late March, April or sometimes even May. In the southern part of their range, there is evidence that the North African population is augmented in winter (Etchécopar & Hüe 1967), presumably by individuals which have crossed the Mediterranean. In southern France, Blondel's (1969) data suggest that the winter population was higher than that in summer, and Affré (1975) described the species as frequently found in the vicinity of Toulouse where it nested only rarely. Berthold (1973) found that Dartford Warblers (of Mediterranean origin) showed migratory restlessness under experimental conditions. In intensity, this activity was appropriate to a middle-distance or partial migrant and greater than that found for the largely sedentary Marmora's Warbler *Sylvia sarda*.

Based on a ringing programme and sight records, this paper reports on mortality and movements of English Dartford Warblers. These matters are of importance in view of the possible effects of habitat fragmentation in inhibiting the birds' spread, especially after one of their periodic population crashes. Information on mortality rates and site fidelity, though based on rather few birds, is valuable because little is known of these aspects for most British warblers.

## **Methods**

The study was conducted on a fragmented area of about 1,010 ha of heathland at the western end of the Purbeck Peninsula, Dorset, as part of investigations on the ecology of the Dartford Warbler (Bibby 1977, Bibby in press, Bibby & Tubbs 1975). There were few other heaths or breeding Dartford Warblers within 5 km of this area, but there were two major concentrations 5-10 km distant. Within the study area, Hartland Moor National Nature Reserve was visited weekly from September 1974 to August 1976 (when it was burnt) and a number of the adults were colour-ringed. During the summers of 1975 and 1976, extensive studies of breeding were made throughout the larger area to establish the breeding population and success, and to identify any marked adults. Nestlings were marked with a single metal ring and recaptured when possible for subsequent identification. The study ended before 1977, but a visit was made in that summer to estimate the breeding population, and to locate and recatch as many ringed birds as possible; some extra records of sightings were provided by Bryan Pickess.

An investigation of distant movements was made by searching the county bird reports covering 1960-75 for records of Dartford Warblers away from known breeding areas.

## **Site fidelity and mortality of adults**

The histories of all colour-ringed adult Dartford Warblers known to have been territory holders in one summer and to have survived and occupied breeding territories in the next year are summarised in table 1. In all cases but one, a surviving adult remained throughout its recorded life in its original territory or part of an adjacent one. Once, the deaths of a male in one territory and the neighbouring female resulted in the



4. Dartford Warbler *Sylvia undata*, Dorset, May 1976 (Colin J. Bibby)

survivors pairing and occupying part of the area previously partitioned between the two pairs. The exceptional case involved two ( $\delta C$  and  $\text{♀}c$ ) who were paired in April 1974 but did not breed:  $\text{♀}c$  was not seen after early May and was presumed to have died;  $\delta C$  did not breed in 1974, but was in the same territory next year with a first-year female ( $\text{♀}e$ ) from nearby. Then, in 1976,  $\text{♀}c$  was found breeding with an unmarked male in a territory about 1.2 km away. This area was a pine plantation where Dartford Warblers were particularly difficult to see and it must be assumed that she was overlooked there in 1975. Meanwhile,  $\delta C$  had lost  $\text{♀}e$  and remained unmated for most of the summer of 1976, though another female eventually arrived and they reared a late brood. Thus,  $\delta C$  and  $\text{♀}c$  had separated in the summer of 1974, though both survived. Divorce of this kind was probably rare. It is reasonable to assume that adults have died if they disappear from their territories.

Site tenacity of adults was observed in one spell of snow in April 1975, which caused all the Stonechats *Saxicola torquata* and Meadow Pipits *Anthus pratensis* to leave the heaths, but colour-ringed Dartford Warblers were found in their established territories. Further evidence of site tenacity came in August 1976, when fire destroyed much of Hartland Moor, though several of the Dartford Warblers on it survived. One adult male, known to have been present for at least two summers, was still in his territory six days after the fire, although no heathland vegetation remained within a kilometre and it was most unlikely that much food was available. Of the five colour-ringed adults present before the fire, not one was found to have survived and established a new territory elsewhere in 1977.

**Table 1. Histories of individually marked Dartford Warblers *Sylvia undata* in Dorset**

The first 18 birds were on Hartland Moor and followed weekly during 1974-76; the last eight were at Arne and checked only during the summer. F indicates known loss in a fire

Individual	Date ringed	Date last seen	Alive in summers of			
			1974	1975	1976	1977
♂A	2 Apr 74	-	+	+	+	
♀a	12 Apr 74	10 Aug 75	+	+		
♂B	15 Apr 74	30 Jun 75	+	+		
♀b	15 Apr 74	24 Jul 74	+			
♀c	15 Apr 74	-	+	+	+	+
♂C	15 Apr 74	-	+	+	+	F
♂D	15 Apr 74	12 Jun 74	+			
♂E	16 Apr 74	-	+	+	+	F
♂F	16 Apr 74	-	+	+	+	F
♂G	16 Apr 74	28 May 74	+			
♂H	11 Jun 74	12 Jun 74	+			
♀d	13 Jun 74	14 Feb 75	+			
♂I	13 Jun 74	28 Jul 75	+	+		
♂J	16 Sep 74	17 Jan 75	+			
♂K	22 Apr 75	-	-	+	+	F
♀e	25 Apr 75	16 Jun 75	-	+		
♂L	25 Apr 75	13 Dec 75	-	+		
♀f	16 Jul 75	-	-	+	+	F
♂M	8 Jul 74	-	-	+		
♂N	13 Jul 74	-	-	+		
♀g	24 Dec 74	-	-	+		
♀h	31 May 76	-	-	-	+	+
♀i	27 Jan 76	-	-	-	+	+
♂O	11 Jun 76	-	-	-	+	
♀j	10 Jun 76	-	-	-	+	
♀k	11 Jun 76	-	-	-	+	

Table 1 indicates an annual adult survival rate of at least  $50.0 \pm 8.3\%$ , with no apparent difference between the sexes.

### Survival and dispersion of juveniles

Of 16 juveniles colour-ringed in summer 1974, six were never seen again, two were last seen in August and three in October. One was found about 8.2 km away on 15th November and never again. Four survived to breed in 1975 at distances from their places of origin of 5.8 km (♂), 3.7 km (♂), 1.3 km (♂) and 0.6 km (♀), in all cases but the last on a different heath. One of these (a male) was first located at his new site on 12th October, having settled and started singing in a place previously unoccupied by Dartford Warblers, and attracted a female. He remained in the area throughout the winter and bred in the next summer. Thus, on the basis of a small sample, a minimum of  $25 \pm 10.8\%$  of these juveniles ringed at ages between 20 and about 50 days survived to the next year.

In 1975, 62 nestlings were ringed from 18 successful nests: about one-quarter of the year's production of young in the study area. During the breeding season of 1976, the whole area was searched very thoroughly so that all the breeding pairs were checked for rings, but only two of those

ringed as nestlings were found to have survived. Both were females, breeding respectively about 0.2 km and 1.0 km from where they were hatched: one on its native heath and one not. This observed survival rate of 3.2% from fledging to first breeding was recorded between years when the population in the area fell by 53.3%.

By 1976, the population of the study area was only 26 pairs. These raised about 125 young, of which 102 were ringed in the nest. In 1977, numbers had increased to 30 pairs, in spite of the fact that five territories had been burnt and the occupants had probably perished. Of the 60 adults breeding in 1977, 12 were identified as 1976 nestlings and 40 were certainly not; eight were not adequately seen, but, on the basis of the observed proportions, two were probably one-year-olds. Thus, it is estimated that 14 ringed nestlings from 1976 were breeding in the area in 1977, indicating a minimum survival rate of 13.7%. In addition, one male was found breeding outside the area, 9.1 km away: this bird was raised in one of the territories destroyed by fire in August 1976. Six of those within the study area were caught and individually identified. Their movements were respectively 3.4 km (♀), 2.7 km (♂), 2.5 km (♂), 1.2 km (♀), 0.6 km (♂) and 0.5 km (♀), which in all but one case were from one fragment of heath to another.

Considering the three years together, nine nestlings and four juveniles which survived were individually identified. Of these 13, three were on the site of origin and the rest had moved to another 'island' of heath, though the evidence of the next section suggests that an even higher proportion in fact moved. The mean movement of the sexes did not quite differ significantly, though the trend was in the unexpected direction (8♂♂:  $3.28 \pm 2.93$  km; 5♀♀:  $1.28 \pm 1.24$  km;  $p \sim 0.15$ ). Of the nine individuals ringed as nestlings, the early ringed ones apparently provided a higher proportion of the survivors: half the young were ringed before 7th June, but seven of the nine survivors (78%) came from this period ( $p \sim 0.2$ , Kolmogorov Smirnov test).

### **The population equation**

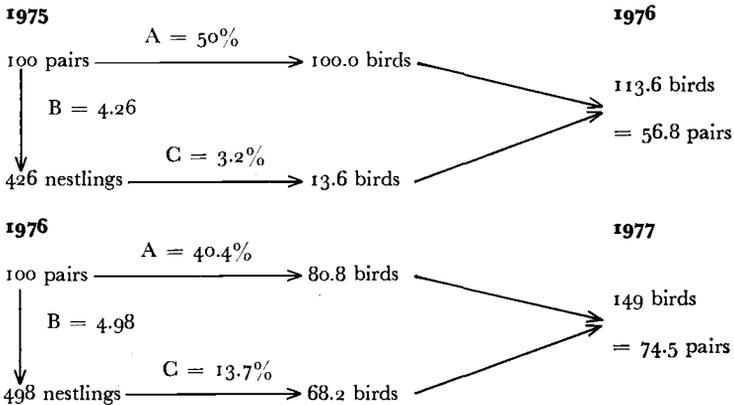
Using the known breeding data (Bibby in press) and the survival rates estimated above, it was possible to assemble putative population equations. Table 2 approximates the situation during the years 1975-76 and 1976-77. In 1975-76, the almost complete failure of the young to survive caused a marked drop in the population which in fact exceeded the estimated adult mortality. In this year, the agreement between observation and prediction was reasonable, though in fact the adults must have suffered a greater mortality to account for the whole population drop. This might have been caused by the same factor which led to the unexpectedly severe juvenile mortality.

In 1976-77, there was a gross difference between prediction and observation, because, in spite of the extra loss of adults as the result of fire, the population increased by 15%, while the known recruitment of young predicted a drop of about 25%. The only possible explanation of this discrepancy was that more young of the previous year in fact survived,

but their breeding dispersion was such that much of the recruitment came from outside the study area. About 50% of surviving juveniles would have had to move more than 5 km to balance the calculations.

**Table 2a. Putative population equations for Dartford Warblers *Sylvia undata* in Dorset in 1975-76 and 1976-77**

A = adult survival rate; B = young reared per pair; C = young survival rate  
Figure of 40.4% for A in 1976-77 is based on 21 pairs surviving normally and five being lost to fire



**Table 2b. Comparison of predicted and observed population changes**

Years	POPULATION CHANGES	
	Predicted	Observed
1975-76	(56.8 - 100) = -43.2%	-53.3%
1976-77	(74.5 - 100) = -25.5%	+15.4%

**Movements**

In Britain, a minimum of 192 Dartford Warblers were recorded outside the breeding areas from 1960 to 1975 (fig. 1). The majority were in coastal areas between Kent, mainly Dungeness (Stone 1972), and Dorset. A juvenile ringed in the New Forest moved to Barnes, Surrey, where it was killed by a cat on 1st November 1975. Four were recorded in Ireland during this period, where one had previously been killed at the Tuskar Lighthouse, Wexford, in 1912 (Barrington 1912), and four also reached the Isles of Scilly. A further movement involving a sea crossing was of one on a tramp steamer in the English Channel at 50°N, 1-3°W (north of the Cherbourg Peninsula and somewhat nearer France than England) on 4th November 1974 (R. J. Prytherch *in litt.*). Though it is possible that some were Continental, British origin is more likely: Dartford Warblers are scarce breeders or absent in the areas of France nearest to Britain, as shown in fig. 1 (data from Yeatman 1976).

Dates of occurrence, of first sightings for individuals seen more than once, showed a marked peak in autumn, with 60% between 3rd October

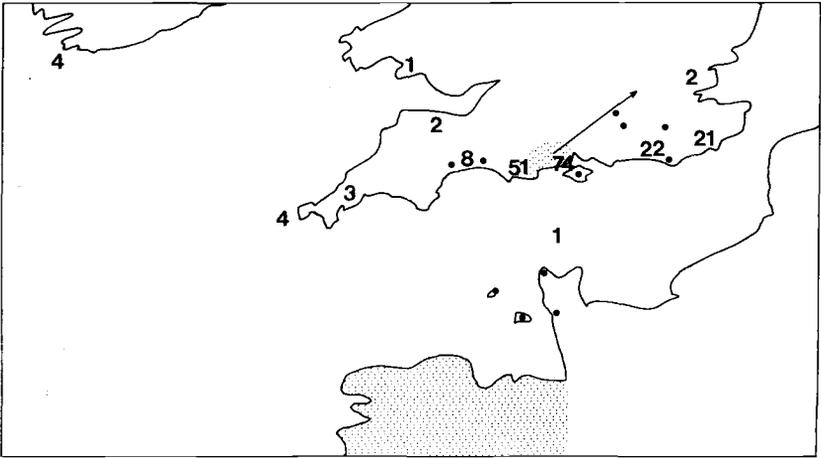


Fig. 1. Distribution of occurrences of Dartford Warblers *Sylvia undata* in Britain and Ireland away from breeding areas, 1960-75; minimum numbers of individual birds shown by county. Stippled areas represent main breeding areas and dots isolated outposts. Arrow shows the only distant ringing recovery

and 6th November (fig. 2). Thus, departure from the heaths generally followed the completion of moult in late September (personal observation), with few found earlier; this exodus coincided with a period of territorial activity and song more conspicuous than that in spring. Records away from breeding areas dwindled in November and December; and there were only two in January. Small numbers (10% of the total) were

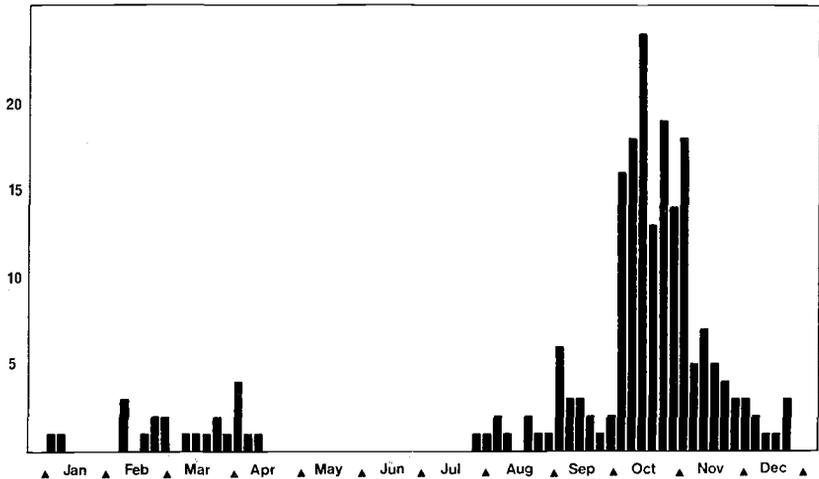


Fig. 2. Seasonal distribution by five-day periods of occurrences of Dartford Warblers *Sylvia undata* in Britain and Ireland away from breeding areas, 1960-75. Each bird is shown only in the period when it was first recorded

seen between early February and mid April, but there was none in the breeding season.

The paucity of January records shows that coastal wintering birds can not adequately account for the occurrences, so it is presumed that some individuals leave the country for the winter. Variation of migration records, between sites and between species (see for instance Davis 1967 and Sharrock 1968 for *Sylvia* warblers), makes it impossible to assess the significance of the fact that nine times more Dartford Warblers occurred in autumn than in spring.

Comparison of the numbers of records in each non-breeding season with the estimated breeding population of the preceding summer (which varied in the period studied from 11 to 560 pairs, Bibby & Tubbs 1975) (fig. 3) provides evidence of the reasons for movements. If they were

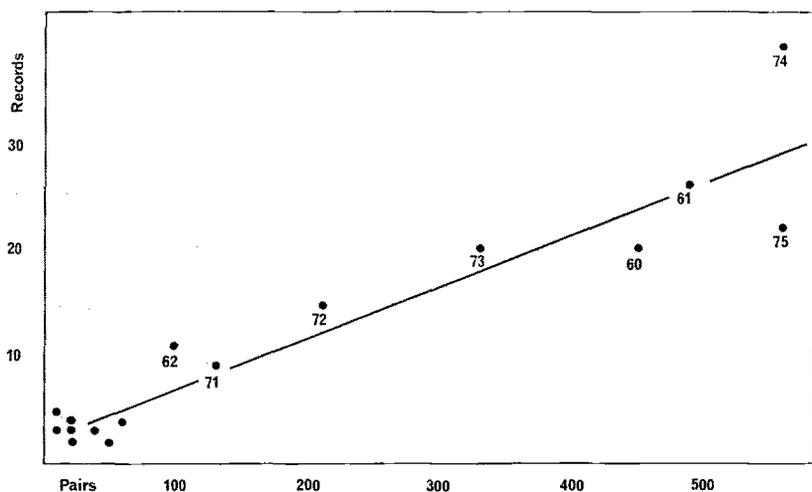


Fig. 3. Relationship between numbers of records of Dartford Warblers *Sylvia undata* in Britain and Ireland away from breeding areas each autumn and winter in 1960-75, and estimated numbers of pairs breeding in England in previous summer. The eight years with highest breeding levels are individually identified by last two digits.

$$(y = 0.048x + 2.47, r_{14} = 0.941)$$

eruptive and influenced by shortage of living space caused by high population levels, then they would be more frequent in proportion to some power ( $> 1$ ) of the population size. In fact, partial migration is indicated, since the records away from breeding areas increased in almost exact proportion to the breeding population, with good correlation ( $r_{14} = 0.941$ ).

Even in the years of scarcity following the severe winters of 1961/62 and 1962/63, Dartford Warblers still occurred far from their native heaths, despite suitable territories being vacant within a few hundred metres. Clearly, a proportion of Dartford Warblers are obligatory migrants. That proportion is not known, but the mean number of migration records

from the data in fig. 3 was one per 15.9 breeding pairs. Using the known breeding productivity of 4.6 young per pair (Bibby in press), this was equivalent to one record for every 105 Dartford Warblers alive in late summer (making no allowances for post-fledging losses). As 1% of England's Dartford Warblers are seen away from their breeding sites each autumn, the proportion emigrating must be high, since the chances of an individual being detected are low.

There is no known way to tell the age of a Dartford Warbler in autumn after the moult (Svensson 1970). There were thus only two records of individuals of known age: an adult female caught at Steart, Somerset, on 11th August 1974 (the recorded details were peculiar, but sufficient to confirm that she was moulting her primaries and hence was adult) and a ringed juvenile. Since, however, as already described, most local movements were by juveniles, it is probable that they were also the major participants in the longer journeys.

### **Discussion**

The calculated mortality rate of adults was much in line with that of other passerines in temperate regions (Cody 1971), especially in view of the wide confidence limits on the estimate. If anything, the established adult Dartford Warbler may be comparatively long-lived; even with a small ringing programme over four seasons, one individual reached four years of age and three more reached three before being destroyed by fire. These figures compare with maximum ages ever recorded by the BTO ringing scheme of four to six years for most other similar-sized warblers (Mead 1974).

Because the 1975 crop of young largely failed for unknown reasons, only one realistic estimate of survival from nest to first breeding was made (13.7% within the study area). This figure was insufficient to account for the population growth from 1976 to 1977, which would have required a nestling survival rate of about 30%. The only explanation of this is that some 16% more nestlings did in fact survive, but bred outside the area and were replaced by a comparable number of immigrants. The fact that one was found breeding at a distance of 9.1 km shows that this is possible, while the high average distance of recorded movements ( $\delta$  3.3 km;  $\text{♀}$  1.3 km) confirms that larger movements taking birds out of the study area would be expected.

High mobility of young birds would account for the rapid spread of Dartford Warblers from the low population in 1963. The mean rate of increase was 45% a year, and this involved the recolonisation of new sites at the same time as existing ones were filling up. Had the species been highly sedentary, it would have been expected to fill all the gaps on the occupied sites before crowding led to eruptive dispersal and further colonisation. The derived figures of adult survival (50%), nestling survival (30%) and young reared per pair (4.6) would predict a population growth rate of about 20% a year. There is some evidence that earlier nesting might have led to more productive breeding in some of these years (Bibby in press), although this alone would have been insufficient to



5 & 6. Dartford Warblers *Sylvia undata*, Dorset, June 1976 (M. W. Richards)





7. Dartford Warblers *Sylvia undata*, Dorset, May 1975 (F. V. Blackburn)

explain such rapid population growth. It seems that the survival of adults or nestlings must have been still higher in this period. The latter would be more likely as those leaving their native heaths would have had a higher chance of encountering a suitable vacant area at a time when there were more heaths and fewer Dartford Warblers.

Thus, it appears that adult Dartford Warblers are faithful to territories once established, and maintain them even in such drastic circumstances as failure of food availability caused by snow or fire. Young, on the other hand, have a high tendency to move in their first autumn, even at times when numbers are so low that suitable areas are vacant within a few hundred metres. The benefit of finding a more distant area which is completely vacant must be high, since the first immigrants could found a whole new colony. From the young's point of view, the prizes are high, but so are the stakes if the fragmentation of heaths leads to a high risk of total failure to find a suitable place to settle and breed.

There was no significant difference between the sexes in the extents of their dispersion, although, if anything, males moved farther than females within the study site. This is not the common pattern: females are usually more dispersive (Greenwood & Harvey 1977 and references

therein). If the interpretation of Dartford Warbler movements is correct, a juvenile male might benefit by wandering rather than staying and having to compete with established birds for a territory and a mate. A juvenile female would perhaps secure a better chance of rearing young if she settled with the first single male territory-holder she encountered. The sex ratio of the 50% of young estimated to have moved more than 5 km is unknown, so this aspect remains a matter for conjecture.

There was suggestive evidence that early-reared young were more likely to be found settled near the natal site, suggesting that, at high population levels, the more distant movers might have been forced to go farther through joining the autumn competition for territories too late.

Those birds which appeared well away from the breeding areas in autumn had obviously failed to establish a territory. The large proportion of records in Kent and Sussex in relation to the very small breeding populations nearby may be no coincidence. In these counties, the suitable breeding areas are so few and scattered that the chances of a dispersing bird's finding one would be low. A high loss of juveniles in this way may have caused the comparatively slow rate of recovery of Dartford Warbler populations in these fringe areas after 1963. In the Dorset and New Forest strongholds, the number of coastal records was lower in proportion to the nearby breeding populations, perhaps because of the less fragmented nature of the heaths in these areas. As the heaths become more isolated from each other in future, the Dartford Warbler's rate of recovery after a population slump may be decreased.

The evidence (fig. 1) suggests that the longer movements of Dartford Warblers are orientated southwards, although the paucity of northerly movements may have reflected the lower chances of detection inland. Further, it is possible that they moved along the English south coast rather than undertaking a sea crossing, which could bias the distribution of records. The combination of lack of midwinter records, followed by signs of a spring movement, suggest that some probably left England altogether. There was no direct evidence of this, but the single record in the middle of the Channel, and the occurrences on the Isles of Scilly and in Ireland are suggestive. One may conclude that the Dartford Warbler ought to be regarded as a partial migrant in England. Such partial migration could be beneficial if, by moving south, individuals increased their chances of surviving a severe winter in comparison with those which remained. If such a characteristic is reasonably heritable, then the degree of migratory behaviour in the population could rapidly be selected at a level appropriate to the average frequency of severe winters. The recent development of partial migration by the Bearded Tit *Panurus biarmicus* (Axell 1964) might be a similar case. It is not beyond the bounds of possibility that the survivors of the 1962/63 winter were out of the country at the time. Ash (1964) reported that all the resident Dartford Warblers had apparently vanished after the first heavy snowfall and subsequent sightings were on the coast in March. These latter birds could have been returning migrants, which might then have settled well away from their natal areas.

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## Summary

During a limited study, adult Dartford Warblers *Sylvia undata* were found to be faithful to territories once these had been established, and to survive at  $50 \pm 8.3\%$  per annum. Survival rates of nestlings to first breeding were 3.2% and 13.7% in two successive seasons, but nearly 90% moved from their natal heaths. In the period 1960-75, there were records of 192 Dartford Warblers well away from breeding areas in England, the majority being in October. The numbers of these distant movers increased in direct proportion to the size of the breeding population and some still occurred in the years when Dartford Warblers were very scarce. In discussion, it is suggested that movements represented a partial migration as much as post-juvenile dispersal. This might aid the Dartford Warbler's expansion after a population slump or raise the chances of some surviving a severe winter, but increasing fragmentation of the heaths could increasingly become a limitation.

## References

- AFFRE, G. 1975. Dénombrement et distribution géographique des fauvettes du genre *Sylvia* dans un région du midi de la France. 11—Résultats. *Alauda* 43: 229-262.
- ASH, J. S. 1964. Observations in Hampshire and Dorset during the 1963 cold spell. *Brit. Birds* 57: 221-241.
- AXELL, H. E. 1966. Eruptions of Bearded Tits during 1959-65. *Brit. Birds* 59: 513-543.
- BARRINGTON, R. M. 1912. The Dartford Warbler in Ireland. *Brit. Birds* 6: 220.
- BERTHOLD, P. 1973. Relationship between migratory restlessness and migration distance in six *Sylvia* species. *Ibis* 115: 594-599.
- BIBBY, C. J. 1977. *Ecology of the Dartford Warbler Sylvia undata (Boddaert) in relation to its conservation in Britain*. PhD thesis, C.N.A.A.
- BIBBY, C. J. In press. Breeding biology of the Dartford Warbler *Sylvia undata* in England. *Ibis*.
- & TUBBS, C. R. 1975. Status, habitats and conservation of the Dartford Warbler in England. *Brit. Birds* 68: 177-195.
- BLONDEL, J. 1969. *Synécologie des Passereaux Résidents et Migrateurs dans le Midi Méditerranéen Français*. Marseilles.
- CODY, M. L. 1971. Ecological aspects of reproduction. In FARNER, D. S., and KING, J. R. (eds.) *Avian Biology* vol. 1. pp. 461-512.
- DAVIS, P. 1967. Migration seasons of the *Sylvia* warblers at British bird observatories. *Bird Study* 14: 65-95.
- ETCHÉCOPAR, R. D., and HÜE, F. 1967. *The Birds of North Africa*. Edinburgh & London.
- GREENWOOD, P. J., & HARVEY, P. H. 1976. The adaptive significance of variation in breeding area fidelity of the Blackbird *Turdus merula* L. *J. Anim. Ecol.* 45: 887-898.
- MEAD, C. J. *Bird Ringing*. BTO Guide 16. Tring.
- MOORE, N. W. 1962. The heaths of Dorset and their conservation. *J. Ecol.* 50: 369-391.
- SHARROCK, J. T. R. 1968. Migration seasons of the *Sylvia* warblers at Cape Clear Bird Observatory. *Bird Study* 15: 99-103.
- STONE, R. C. 1972. The Dartford Warbler in Kent. *Kent Bird Report* 20: 109-111.
- SVENSSON, L. 1970. *Identification Guide to European Passerines*. Stockholm.
- TUBBS, C. R. 1967. Numbers of Dartford Warblers in England during 1962-66. *Brit. Birds* 60: 87-89.
- VENABLES, L. S. V. 1934. Notes on territory in the Dartford Warbler. *Brit. Birds* 28: 58-63.
- WALPOLE-BOND, J. 1914. *Field-studies of Some Rarer British Birds*. London.
- YEATMAN, L. 1976. *Atlas des Oiseaux Nicheurs de France*. Paris.

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