A European endemic warbler under threat? Population changes in *Sylvia* warblers on the island of Cyprus

Derek Pomeroy and Frank Walsh

Abstract In the early 1990s the Sardinian warbler began nesting in Cyprus, and now has two breeding populations, in the west and north of the island. Observations of the western population show that its range is still expanding and that the endemic Cyprus warbler has declined in the areas colonized by the Sardinian warbler. However, the Cyprus warbler is still present in most of these areas, and hence, although the Cyprus warbler is a species of European Conservation Concern, the current situation requires further study rather than alarm. The Sardinian warbler is the more numerous species at lower altitudes, whilst the Cyprus warbler is more common at higher altitudes, especially above 500 m. Within their areas of overlap, both Cyprus and Sardinian warbler populations occur throughout almost all habitats; natural, semi-natural and agro-ecosystems. We recommend that monitoring should continue, with more detailed ecological studies.

Keywords Cyprus warbler, Mediterranean, relative abundance, Sardinian warbler, *Sylvia*.

Introduction

Three species of *Sylvia* warblers breed on Cyprus. The Cyprus warbler *S. melanothorax* is endemic, with most of the population being summer visitors and perhaps a third overwintering (P. Flint, pers. comm.). The Spectacled warbler *S. conspicillata* is considered to be a resident by Flint & Stewart (1992), although Shirihai *et al.* (2001) describe it as a partial migrant in Cyprus. It breeds mainly in the drier parts of the island. The third species, the Sardinian warbler *S. melanocephala*, was formerly a winter visitor to Cyprus, mainly from October to March (Flint & Stewart, 1992). It was first recorded breeding in Cyprus in the early 1990s, and has since been spreading away from its presumed initial sites on the Akamas peninsula, in the far north-west of the island (Cozens *et al.*, 2000). It appears that in the process of establishing itself it has adversely affected the Cyprus warbler, one of only 18 Rectricted Range species in Europe (Heath & Evans, 2000). In 2001 a second breeding population of Sardinian warblers was discovered in the eastern part of the Kyrenia range of mountains of northern Cyprus (P. Flint, pers. comm.). For convenience the two breeding populations are referred to here as western and northern but, unless otherwise stated, the text refers to the western area, as do the figures.

We now have detailed data for the western Cyprus population for 1997–2001, and these demonstrate the continuing spread of the Sardinian warbler. The Cyprus warbler is still found in most of the areas that have been colonized by the Sardinian warbler, but sometimes in lower numbers than previously. The Cyprus warbler is a category 2 Species of European Conservation Concern (Concentrated in Europe and with an Unfavourable Conservation Status; Tucker & Heath, 1994), therefore any potential decline warrants close attention. However, the species is common over most of the island, and is not considered to be globally threatened (Hilton-Taylor, 2000). This paper is part of an on-going study into the birds of Pafos District of Cyprus. In view of the rapid changes already observed we hope to draw early attention to a potentially serious problem.

Methods

The majority of the information in this article refers to Pafos District, and comes from a much larger data set consisting of *c.* 500 Timed Species Counts (TSCs), a method that has been found useful in Cyprus and elsewhere (Pomeroy, 1997; Pomeroy & Dranzoa, 1997). In each of these 1-hour counts all species that are observed are recorded. Almost all of the counts were made in May and June of 1997–2001, mainly by DP but some by or including FW or Martin Hellicar. Each TSC site comprised one particular habitat (although the Cyprus landscape is relatively fine-scale in the sense that 'pure' habitats are often hard to find, so in practice

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one is usually dealing with an area that is predominantly grassland, or vines, for example). The extent of the habitat being sampled at each site limited its size, typically to <1 km^2, and sometimes much less.

As is usual with TSCs, species recorded in the first 10 min of each count were scored 6, those recorded between 11 and 20 min scored 5, and so on to a score of 1 for the final 10 min. At each site scores were averaged for each species, yielding estimates of relative abundance. In this paper, data for each year are treated separately. All sites were counted at least twice for each year included, and some were counted four or more times; only 12 sites were counted in all five years.

The TSCs covered all species, and were intended to provide atlas data as well as information for more detailed habitat studies. The planned Cyprus Breeding Bird Atlas is based upon 5×5 km grid squares (D. Whaley, pers. comm.), and 92 TSC sites were thus distributed with at least one per grid square; the set of sites covered all the main non-aquatic habitats and a range of altitudes from sea level to 1,000 m. This series of requirements meant that the sampling design was a compromise, and not ideal for the warblers, which by nature are cryptic. Because all warbler records were made in May and June, they can reasonably be considered as breeding records, because the main breeding season was covered (Cramp, 1992; Flint & Stewart, 1992). Males were singing at many sites, and numerous juveniles were seen, although few nests were found.

The full data set for Pafos District includes *c.* 14 habitat types, but there are insufficient data yet to analyse each separately and we have therefore grouped them into three main categories for the present paper: (1) natural habitats include pine and juniper forests, and more open areas dominated by broom and other hard-leaved plants; (2) semi-natural sites include heavily-grazed and degraded areas, especially of maquis, woodlands and grasslands, and areas where the vegetation is regenerating in abandoned cultivation; (3) agro-ecosystems include permanent crops (vines, orchards and groves) and annual crops such as cereals and vegetables.

For more detailed analyses, we have used data from 38 sites at which counts were made in 2001 and at least one other year between 1997 and 2000. Altogether, there were 121 such sets of data. In addition to mean TSC scores for the birds, including both Cyprus and Sardinian warblers, a number of environmental variables were recorded for each site, those used in this paper being: altitude, recorded in five bands of 0–200, 200–500, 500–600, 600–800 and 800–1,000 m (the grouping reflected the characteristics of the sites, and that the altitudinal range within any one site sometimes exceeded 100 m); land use, as forests, semi-natural areas, permanent crops (such as orchards and vineyards), and arable; year, 1997–2001.

The highest coefficient of correlation between any pair of these three variables was 0.123, and we therefore considered them to be independent of each other. It could be argued that the TSC scores for one year at a particular site are to some extent dependent upon the scores for the years before or after, if site fidelity is high and mortality low. However, both *Sylvia* species are at least partial migrants, although in the case of the Cyprus warbler a proportion of the population remains to over-winter, and some Sardinian warblers may now be resident.

Results

By 1999 the western population of the Sardinian warbler was more numerous than the Cyprus warbler in the north-west of Pafos District (Fig. 1), and by 2001 breeding Sardinian warblers occupied an area of *c.* 600 km^2 in the District (Fig. 1). Presumably they are still spreading south-eastwards. Meanwhile, and *c.* 100 km to the north-east, the northern population of Sardinian warblers had occupied at least 80 km^2 by 2001 (P. Flint, pers. comm.). Breeding was also reported at Coral Bay in 2000 (Sanders, 2000), and in 2001 a pair was seen a few kilometres to the east of Pomos. Both of these records are just outside the area that we surveyed.

Whilst the Sardinian warbler has been expanding its breeding range in Pafos District, its numbers have also been increasing in those places where it is now well-established (Fig. 1). In Fig. 1, data for 1997–99 are compared with those for 2000–01, there are more counts for each of the two later years than for the three earlier ones. The Sardinian warbler showed an increase with time in each zone within the area that it occupied by 2001 (Fig. 1). Using a null hypothesis that an increase is as likely as a decrease, each occurring with a probability of 0.5, the probability of seven increases out of seven is 0.5^7 or 0.0078. Meanwhile the Cyprus warbler decreased in six out of seven zones, and the one increase was small. The probability of this occuring is 7×0.5^7 or 0.0547. Thus, the increase in the Sardinian warbler seems to be widespread and significant, whereas the decrease in the Cyprus warbler is not significant at $P = 0.05$.

It appears that the main increases in numbers of Sardinian warblers were from 1997 to 1999, since when the overall populations of both species have not shown any consistent trend (Fig. 2). However, Fig. 2 only includes the zones with the most data in each major habitat category. In those parts of the Akamas and Laona areas of north-west Cyprus where the Sardinian warbler is now well-established, it is almost equally numerous in all habitats (Fig. 1).

Using the 121 counts from sites that have data for both 2001 and at least one earlier year, we found that

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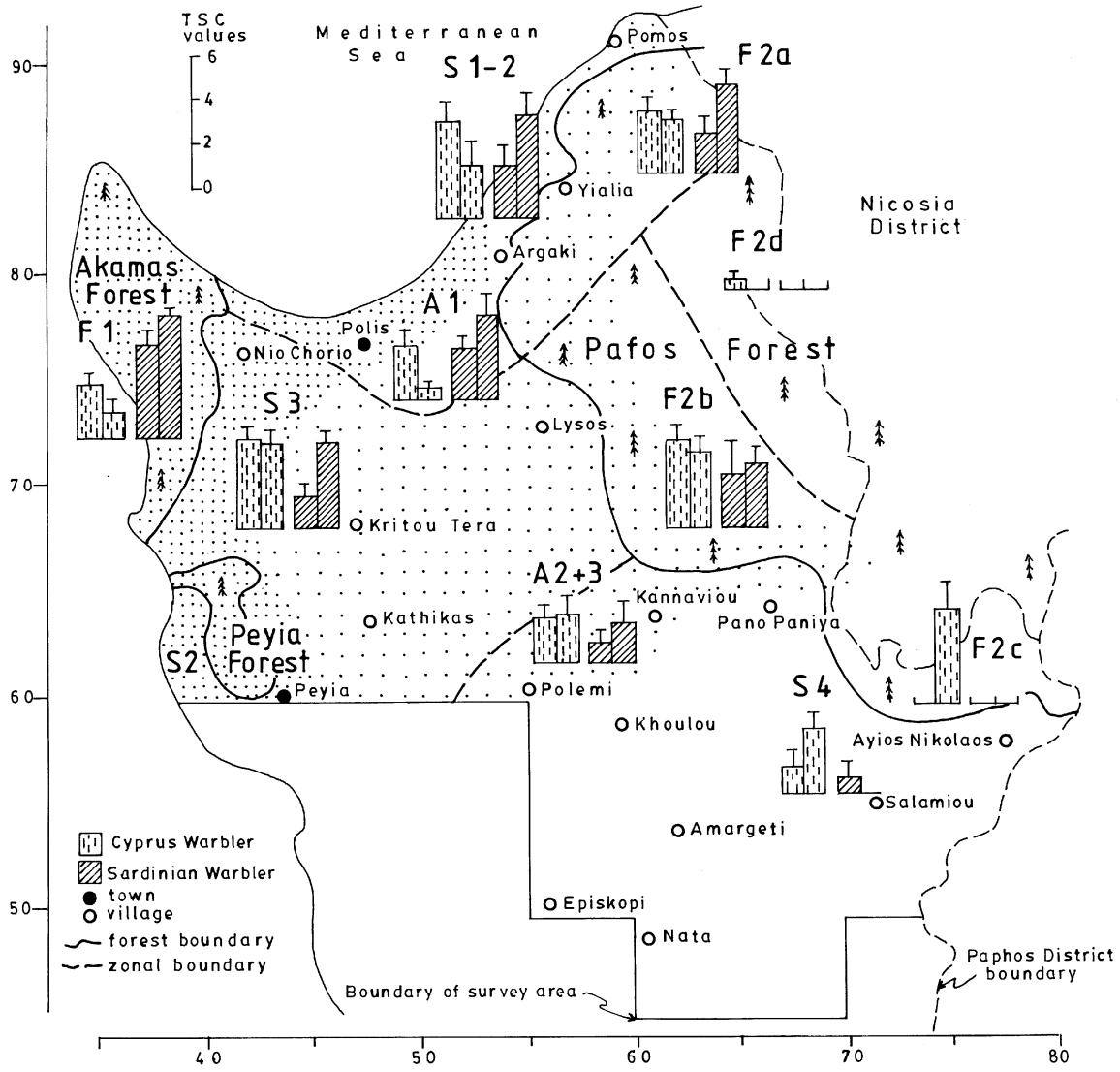

Fig. 1 The study area, which covers about three-quarters of Pafos District, north-west Cyprus, showing the spread of the Sardinian warbler. Also shown are the three main areas of forest, all of which are administered by the Forest Department. Several forest patches are too small to be shown. By the 1999 breeding season the Sardinian warbler was the more numerous species in the densely-stippled area; it had reached all of the lightly-stippled areas by the 2001 breading season. The figure also shows the relative abundances according to the biogeographical zones listed in Table 1. The histograms show mean TSC scores (see text for details) for all sites within each zone, with their standard errors. The left column of each pair is for 1997–99, and the right column is for 2000–01 (there were no data in 1997–99 for zone F2c). Data from Peyia Forest are included in F1, and in two cases data for two zones were combined to obtain an adequate sample size: A2 and A3, and the small S2 with S1. The extensive Pafos Forest (F2) is divided into four sub-zones (see Table 1). The marginal figures are UTM coordinates.

there is a strong negative correlation between the mean TSC scores of the two species ($r = -0.256$, $P < 0.01$), despite a wide scatter of points. In a stepwise multiple regression of mean TSC scores for Cyprus warblers on the other four variables (mean scores for Sardinian warblers, altitude, land use and year) only altitude ($P < 0.001$) and year ($P < 0.05$) were significant. The latter was a negative relationship, with Cyprus warblers becoming less common each year. The mean TSC scores of the Sardinian warbler was not a significant variable in the regression analysis. This suggests that both species were affected more by variables such as altitude than by each other. As Fig. 3 shows, each species' abundance was strongly correlated with altitude within the observed range, but in opposite directions.

There appears to be no evidence of direct negative interaction between individuals of the two species, even in places where both occur in relatively high numbers. In support of this, we mention the only two cases of close encounters of which we are aware. In late March

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Table 1 Biogeograhical division of the study area in Pafos District, as shown in Fig. 1. Figures in parentheses indicate the numbers of sites contributing to the histograms in Fig. 1.

Habitat category	Code	Description
Forest areas	F1	Peyia and Akamas forests (5)
	F2	Pafos Forest, subdivided into four divisions
		F2a : north, below 700 m (4)
		F2b : central, below 700 m (3)
		F2c : south, below 700 m (2)
		F2d : sites above 700 m (8)
Semi-natural habitats	S1	North coast (2)
	S2	West of Peyia Forest (1; combined with S1 on the map)
	S3*	Mid-north (8)
	S4*	Central (5)
Agro-ecosystems	A1	North lowlands, below 200 m (3)
	A2*	North uplands, above 200 m (2)
	A3*	Central (2; combined with A2 on the map)

*The geographical areas occupied by S3 and A2 are the same, but the individual sites have different habitats; similarly with S4 and A3.

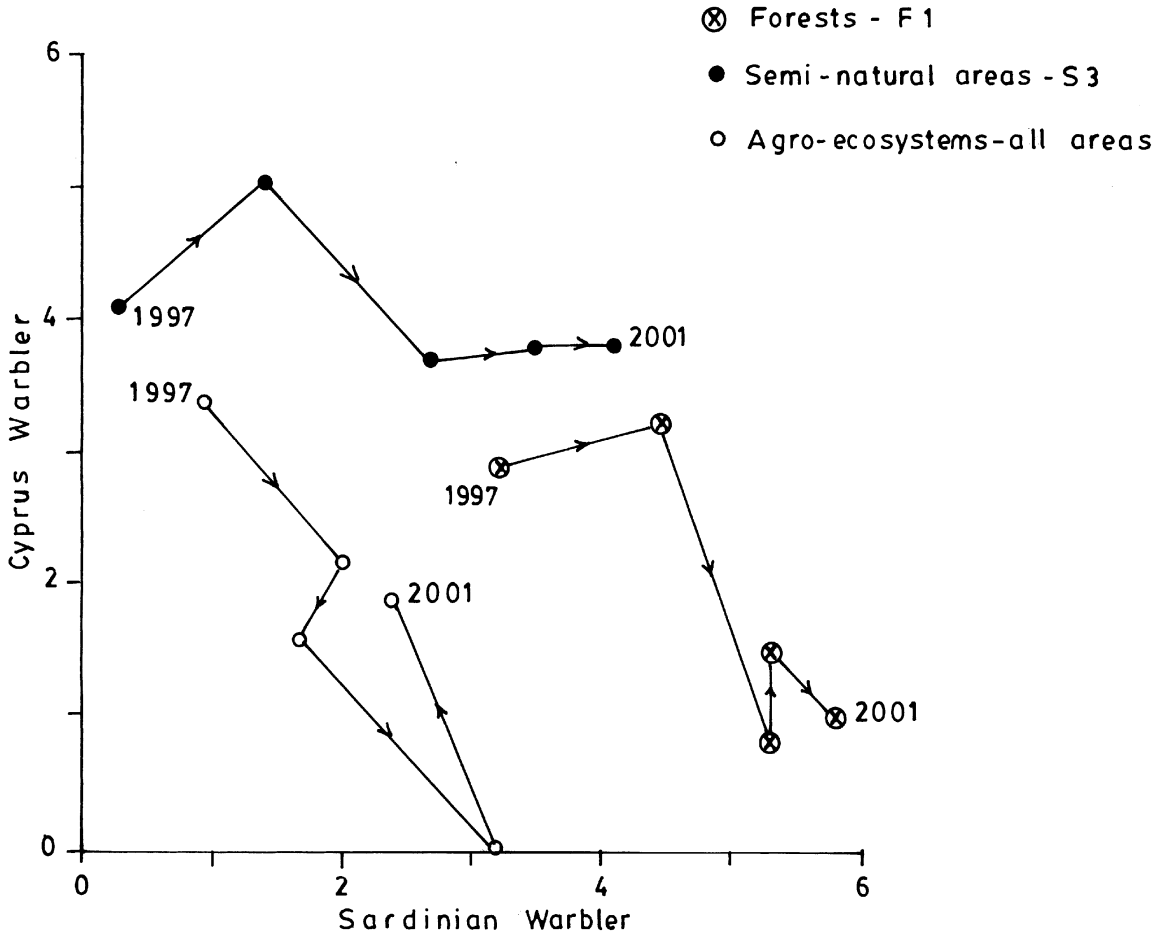

Fig. 2 Population trends of the two species for the three largest data sets (the Akamas/Peyia forests, F1; semi-natural habitats of the mid-north, S3; and the combined data from all agro-ecosystems, A). Data are overall mean scores for each species in each year; lines join consecutive years. Arrows pointing to the right indicate an increase of Sardinian relative to Cyprus warblers; an upward arrow shows the converse.

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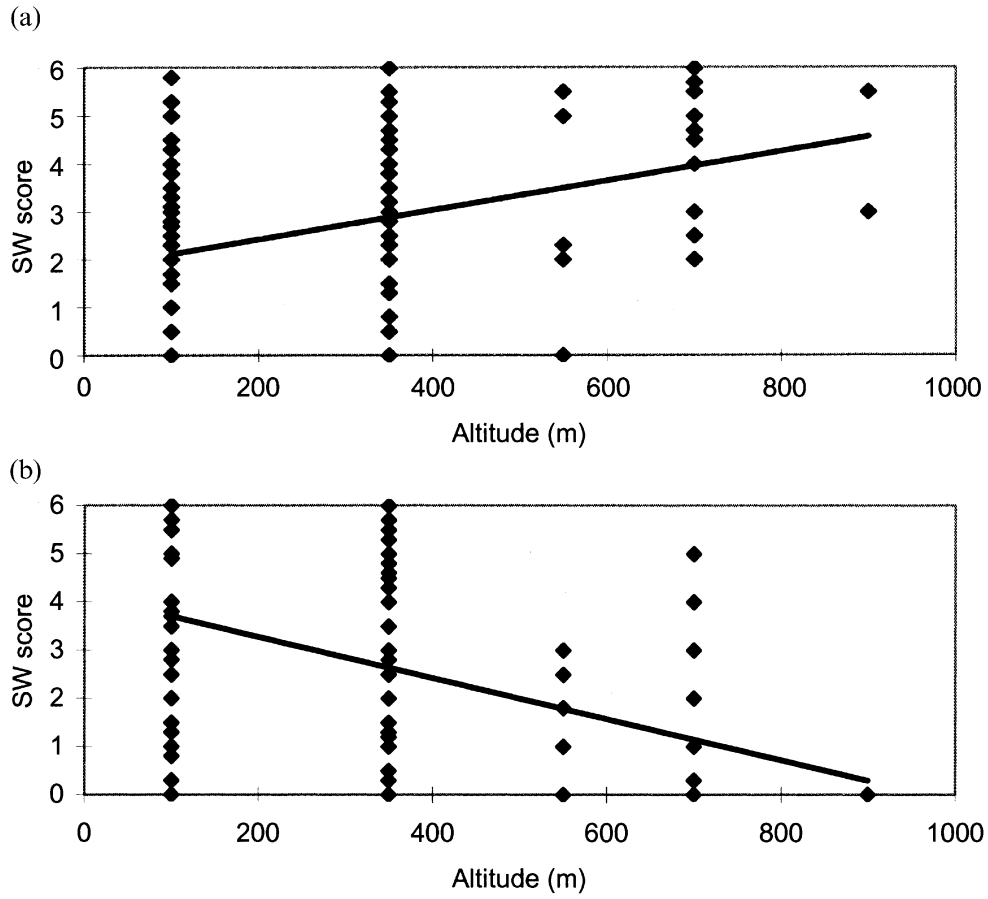

Fig. 3 Mean TSC (Time Species Count) scores for Cyprus and Sardinian warblers at various altitudes. (a) for the Cyprus warbler, CW = 0.003(alt) + 1.825; r = 0.364, P < 0.001. (b) for the Sardinian warbler, SW = −0.0044(alt) + 4.180; r = 0.422, P < 0.001.

1998 David Whaley (pers. comm.) saw a male Cyprus warbler singing in the same large shrub as a male Sardinian warbler, which appeared to follow the Cyprus warbler, but there was no direct interaction; both flew away separately. On 14 May 2001, shortly after 07.00, DP saw a male Cyprus warbler in the same small bush as a male Sardinian warbler. The Sardinian warbler hopped in short stages down through the bush, and was apparently followed, at a distance of *c.* 0.5 m, by the Cyprus warbler. They showed no other interaction, and after *c.* 10 s of this behaviour, left the site separately. There is also a record of both species nesting within 20 m of each other near Coral Bay (Sanders, 2000).

Discussion

The Sardinian warbler breeds throughout the Mediterranean basin, so it is perhaps surprising that it has only recently begun to breed on Cyprus (Cozens *et al.*, 2000). It breeds at altitudes as great as 1,800 m in north-west Africa (Shirihai *et al.*, 2001) but is more typically a bird of lower elevations (Cramp, 1992). Cody & Walter (1976) considered it to be the most generalized of the Mediterranean basin's *Sylvia* warblers, because it is found typically in degraded habitats with abundant low vegetation.

During our study period on Cyprus, both Cyprus and Sardinian warblers showed marked tendencies to occupy different altitudinal zones, although there is considerable overlap. It is possible that the Sardinian warbler will increase at higher altitudes in the coming years, athough the areas where it was first dominant (Fig. 1) are mostly below 500 m. The mean scores for the Sardinian warbler did not feature in a stepwise regression of variables possibly affecting Cyprus warbler scores, supporting the view that the species are not in direct competition with each other, but rather that they are choosing different habitat features, albeit with overlap. Alternatively, the two species may be using the same resources, but these are ample for both. Nevertheless, the dynamic nature of the present situation is reflected in the declines of Cyprus warblers in areas where the Sardinian warbler is now well established. In the almost total absence of detailed information on the foods of the

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two species, one can only suggest that this is a topic worth studying, especially as there are examples of warblers being highly responsive to food availability (Johnson & Sherry, 2001).

If the Sardinian warbler continues to spread, it will be interesting to see what happens when it reaches areas occupied by the Spectacled Warbler, which is restricted to places with lower rainfall and sparser vegetation and is absent from almost all of the currently known sites of the Sardinian warbler.

Warblers in the Mediterranean basin have been extensively studied, and the genus *Sylvia* seems to have attracted most attention (Blondel *et al*., 1996; Shirihai *et al*., 2001). Two cases concerning changes to *Sylvia* species and populations in other parts of the Mediterranean basin are worth noting. In Menorca the Dartford warbler *Sylvia undata* was first reported breeding in 1975 (Bergman, 1978; Muntaner, 1980), whilst the last breeding of the Balearic warbler *Sylvia sarda balearica* in Menorca was reported in 1974. (Shirihai *et al*., 2001, have split Marmora's warbler into two allopatric species, Marmora's warbler *S. sarda sarda* on Corsica, Sardinia and other Italian islands, and Balearic warbler *S. sarda balearica* on Balearic islands except Menorca). Surveys in 1978 showed that Dartford warblers had almost completely replaced the Balearic warbler. Similar surveys in 1979 indicated that Mallorca, Ibiza and Formentara had not been colonized by the Dartford warbler (Muntaner, 1980), although subsequently Sunyer (1998) has reported the colonization of north-east Mallorca by Dartford warblers in 1997. This strongly suggests that Dartford warblers had rapidly replaced the Balearic warblers and driven them to local extinction. Although the former breeding status and distribution of Balearic Warblers on Menorca is poorly documented (Gargallo, unpubl. in Shirihai *et al*., 2001), and it is possible that Dartford warblers had been present in Menorca for much longer, the general conclusion still seems justified.

In Malta the Sardinian warbler is believed to have first bred in 1884 (Sultana & Gauci, 1990–91, in Hagemeier & Blair, 1997). In 1981 the Spectacled warbler of Malta declined drastically, and by the mid-1990s the population was fewer than 500 (Snow & Perrins, 1998). Meanwhile the Sardinian warbler has become very common. Although the sudden decline of the Spectacled warbler seems unlikely to have been the result of direct competition between the two congeners, the failure of the Spectacled warbler population to recover could owe something to the presence of a large population of the Sardinian warbler, whose behaviour is noticeably more aggressive (Cody & Walter, 1976).

These examples indicate the threat to existing *Sylvia* populations on relatively small Mediterranean islands when another *Sylvia* species becomes established. However, only three species of *Sylvia*, including the Sardinian warbler, breed regularly in Cyprus, while the somewhat larger and smaller islands of Sardinia and Corsica respectively each host the same six regularly breeding *Sylvia* species (Shirihai *et al*., 2001; Thibault & Bonaccorsi, 1999). Furthermore, the range of altitudes on Cyprus, and its variety of habitats, suggest that even though the Sardinian warbler is an extremely generalized species (Cody & Walter, 1976), fairly closely related to the Cyprus warbler (Blondel *et al*., 1996; Shirihai *et al*., 2001), and sharing broadly similar habitats (Pomeroy & Walsh, 2000), both Cyprus and Spectacled warblers may be able to survive in at least some parts of the island, although it is too early to be sure.

It seems clear that the Cyprus warbler has declined in those parts of Cyprus where the Sardinian warbler has been longest established, and as the latter continues to spread, it is important to continue monitoring the situation, which we propose to do. We hope to ensure that future analyses will have more precise data available (for example, more sophisticated characterization of land use types is possible). Meanwhile, detailed ecological and other studies are needed to fully understand the changes that we have observed, and are necessary to develop action plans.

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Biographical sketches

For the past 6 years Derek Pomeroy has been visiting Cyprus during the avian breeding season, and contributing records to the proposed Cyprus Bird Atlas. He is also a co-author of bird atlases for Kenya and Uganda, where he presently lives. His interests range widely around conservation issues, particularly of birds.

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