

# Atlantic Cory's Shearwaters Breeding in a Colony of Mediterranean Cory's Shearwaters

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**Abstract.**—We report on the breeding of several individuals of Atlantic Cory's Shearwater (*Calonectris diomedea borealis*) in a small colony of Mediterranean Cory's Shearwater (*C. d. diomedea*) in the western Mediterranean (Columbretes Islands, northeastern Spain). We briefly discuss the potential role of Atlantic Cory's Shearwaters in gene flow at small and declining Mediterranean colonies. Received 16 October 2001, accepted 22 November 2001.

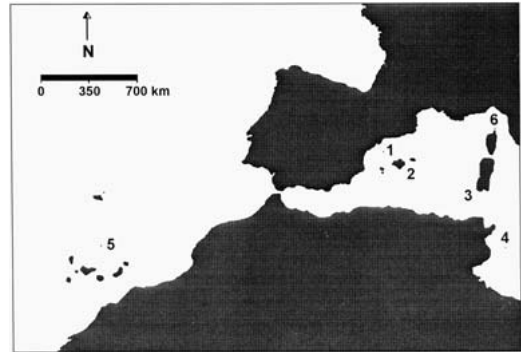
**Key words.**—*Calonectris diomedea*, Columbretes Islands, Cory's Shearwater, gene flow, philopatry, reproduction, Selvagens.

Waterbirds 25(2): 221-224, 2002

Cory's Shearwater (*Calonectris diomedea*) is a polytypic species. The nominate subspecies (*C.d. diomedea*) breeds in the Mediterranean whereas the northeast Atlantic harbors a different subspecies (*C.d. borealis*). Shearwaters endemic to Cape Verde were traditionally considered a subspecies of Cory's Shearwaters, but are now regarded as a different species (*C. edwardsii*) (Thibault *et al.* 1997).

Since 1991, we have been monitoring intensively a colony of Mediterranean Cory's Shearwaters (ca. 100 pairs) located in a small volcanic archipelago (Columbretes Islands, 39°54'N, 0°41'E, see Fig. 1 and Table 1). During monitoring, adult birds were captured, measured and banded. We also determined sex by the size of the vent of birds at the beginning of the laying period (Boersma and Davis 1987), reproductive status (breeding or non-breeding) and taxonomic identity (after Cramp and Simmons 1977; Granadeiro 1993; Sánchez and Castilla 1996; Thibault *et al.* 1997; Lo Valvo 2001) or checking the bands on birds marked as chicks. We have summarized in Table 2 the main parameters monitored at the Columbretes colony during the last decade to give an idea of the effort invested in surveying.

The presence and verified breeding of Atlantic Cory's Shearwaters in Mediterranean colonies has been previously recorded (Lo Valvo and Massa 1988; Sánchez 1997; Thibault and Bretagnolle 1998). During the



**Figure 1.** Colonies of Cory's Shearwater (*Calonectris diomedea*) cited in the text. 1 = Columbretes Island.; 2 = Balearic Islands.; 3 = Southwestern Sardinia; 4 = Linosa; 5 = Selvagens; 6 = Giraglia.

study period, we captured four Atlantic Cory's Shearwaters. The first two birds (a banded eleven year old male and a female determined by biometry: bill length = 53.5 mm; bill depth = 12.9 mm; bill height = 19.8 mm; wing length = 363 mm; tarsus length = 58.4; mass = 710 g) were paired and caught first in 1992. Both individuals belonged to the Atlantic subspecies (*C. d. borealis*). This couple successfully raised a chick, but in 1993 incubation failed after the male disappeared. The female was recaptured at the colony in 1994 but as a non-breeder, and was not found in subsequent years. In 1999, a Mediterranean Cory's female, monitored as a breeder since 1993 and widowed in 1998

**Table 1. Comparison of morphometric data (mean  $\pm$  SD; N) of Cory's Shearwater (*Calonectris diomedea*) from Columbretes Islands, Linosa and Selvagens. After Sánchez and Castilla (1996), Lo Valvo (2001) and Granadeiro (1993).**

	Columbretes Islands		Linosa		Selvagens	
	Males	Females	Males	Females	Males	Females
Tarsus length (mm)	56.4 $\pm$ 6.52 (40)	53.6 $\pm$ 1.33 (44)	54.2 $\pm$ 2.67 (49)	52.8 $\pm$ 2.02 (49)	60.8 $\pm$ 1.61 (34)	58.2 $\pm$ 1.79 (40)
Wing length (mm)	360 $\pm$ 7.76 (38)	347 $\pm$ 7.21 (43)	357 $\pm$ 9.21 (49)	345 $\pm$ 9.86 (49)	376 $\pm$ 6.97 (38)	367 $\pm$ 7.57 (46)
Bill length (mm)	52.4 $\pm$ 6.62 (40)	48.1 $\pm$ 1.33 (44)	52.9 $\pm$ 1.84 (104)	49.6 $\pm$ 1.83 (107)	57.4 $\pm$ 2.33 (38)	53.7 $\pm$ 1.64 (46)
Bill depth (mm)	13.5 $\pm$ 6.52 (40)	11.9 $\pm$ 0.66 (44)	13.6 $\pm$ 0.61 (104)	12.1 $\pm$ 0.49 (107)	17.3 $\pm$ 0.59 (38)	15.5 $\pm$ 0.50 (46)
Mass (g)	738 $\pm$ 17.2 (36)	620 $\pm$ 75.6 (41)	668 $\pm$ 58.4 (317)	561 $\pm$ 40.6 (301)	947 $\pm$ 85.4 (38)	836 $\pm$ 69.2 (46)

(A. S., unpubl. data), was captured in a burrow with a banded seven-year-old male Atlantic Cory's Shearwater. This pair did not breed, but successfully raised a chick in the same burrow in the next year. In 2001, the female bred again in the same burrow, but with a male of the Mediterranean subspecies. A fourth, Atlantic, banded bird was captured in 1999 by the wardens of the Columbretes Islands, but neither sex nor reproductive status were recorded. All four banded Atlantic birds were marked as chicks at the Selvagem Grande colony (Madeira, Portugal, 30°09'N, 15°52'W, see Fig. 1) where thousands of birds have been banded during the last decades (J. P. Granadeiro, pers. comm.).

Despite Cory's Shearwater showing high philopatry, nest-site tenacity and mate fidelity

(see Thibault *et al.* 1997 and references therein), colonies of Cory's Shearwaters are known to be connected by immigration/emigration processes, especially related to natal dispersal (Rodríguez *et al.* 2000), and are not genetically isolated (Randi *et al.* 1989). While most shearwaters return to their natal colony to breed (Warham 1990; Thibault 1993 and 1994; Warham 1996; Sánchez 1997; Borg and Cachia-Zammit 1998; Rodríguez *et al.* 2000), results suggest that some birds disperse long distances, in a pattern previously recorded in other seabirds such as the Black-legged Kittiwakes (*Rissa tridactyla*) (Coulson and Nève de Mévergnies 1992). In fact, no neighboring Cory's Shearwaters from the large (ca. 12,000 pairs; Aguilar 1994) and well monitored Balearic archipelago colonies (more than 10,000 banded birds since 1973; F. Hernández, pers. comm.) have been captured at the Columbretes Islands (Sánchez 1997; own data), where nevertheless Balearic birds commonly forage nearby (Belda and Sánchez 2001).

Randi *et al.* (1989) suggested that colonies in the central Mediterranean (Linosa Island and southwestern Sardinia) and the Azores formed a panmictic population, with an estimated 4-19 individuals being exchanged among colonies per generation. Our results confirm this exchange rate, but only with Atlantic colonies and suggest that northeast Atlantic and western and central Mediterranean colonies are patches of the same metapopulation. Gene flow from Atlantic birds could decrease the short-term probability of local extinction of small Mediterranean col-

**Table 2. Main monitoring parameters of the Columbretes Island colony of Mediterranean Cory's Shearwaters (*Calonectris diomedea diomedea*) during the study period (1991-2000). Information comes from own data (A. S.) and unpublished reports of the regional government (Generalitat Valenciana). No data available for 1999.**

Year	Occupied burrows	Adults + subadults banded	Adults + subadults recaptured
1991	84	29	43
1992	65	37	58
1993	86	49	98
1994	82	55	76
1995	113	45	122
1996	82	28	120
1997	54	29	102
1998	34	7	73
2000	63	6	48

onies (see Templeton and Read 1984) provided that this process takes place over a long time period, that offspring from mixed couples are fertile and that offspring usually recruit to the natal colony. This effect could be especially valuable in small island colonies like the Columbretes Islands, theoretically prone to loss of variation by genetic drift (Hedrick and Miller 1992). Also, declining colonies, like the Columbretes, may be more likely to be colonized by Atlantic birds, since chances of finding vacant burrows or unpaired birds to breed with are higher. Thibault and Bretagnolle (1998) suggested that Atlantic birds recolonized the small Giraglia Island colony following its extinction.

It is likely that Atlantic birds enter the Mediterranean by following Mediterranean birds on their way back to their natal colonies, since both subspecies share similar wintering quarters (Randi *et al.* 1989; Cramp and Simmons 1977; Warham 1990; Camp-huysen and Van der Meer, in press). However, access to colonies probably happens only when colonies start declining.

The rate of exchange observed does not seem to be high enough to prevent further differentiation of birds of the Mediterranean subspecies over time (see Bretagnolle and Zotier 1998), since according to Randi *et al.* (1989) very low coefficients of selection are enough to counterbalance gene flow. However, genetic studies are needed to assess the implications resulting from the reproduction of Atlantic Cory's Shearwaters in Mediterranean colonies.

#### ACKNOWLEDGMENTS

This study is the contribution No. 5 to the LIFE-NATURE program BA-3200/98/447 "Conservation of island Special Protection Areas in the Valencian region" financed by the Generalitat Valenciana and the EU. We are grateful to all the wardens at the Columbretes reserve who have made possible the monitoring of the colony during all these years. Fran Hernández from the Oficina de Anillamiento (MIMA, Madrid) gently helped us providing banding information. Jose Pedro Grana-deiro provided interesting information on Atlantic birds. M. A. Monsalve kindly helped us designing the figure. Robert E. Ricklefs commented on a preliminary draft of the manuscript.

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