Philopatry in Cory's Shearwater *Calonectris diomedea* in Malta

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Introduction

Philopatry is the return to the natal colony by young animals. This depends on the ability of the young to navigate back to its breeding grounds and to remember characteristics of the natal colony. This is particularly so in colonial birds such as Procellariiformes (Warham 1990). This behaviour has been found to occur also in Cory's shearwater *Calonectris diomedea* (Jouanin, Roux & Zino 1977, Ristow *et al.* 1990, Thibault 1993).

In the Maltese archipelago, the Cory's Shearwater breeds on the two main islands, Malta and Gozo and on the small islet of Filfla. The single egg is laid in caves, crevices and fissures in the vertical limestone cliffs and amongst boulder and rubble screes accumulated along ledges and cliff bases (Cachia-Zammit and Borg 1986-1987). At present the breeding population is estimated at about 7000 pairs (pers. obs.).

Material and Methods

The data has been collected between 1983-1995 from 16 study sites (9 in Malta, 7 in Gozo). Most of these sites are situated on the upper parts of vertical cliff faces. From these sites, 155 nests have been marked and annually monitored. The number of accessible nests in a study area varies from single to 20 nests. A number of inaccessible nests are scattered along the study areas.

Between the years 1983-1990, 399 pulli have been ringed from Malta and Gozo, of which only 36 (9.0%) have been caught as adults. Almost 80% of the chicks were ringed from the accessible nests and the rest were ringed in the first two weeks of October, when these birds were found outside the nests exercising their wings before fledging. The catching of adult birds takes place throughout the breeding season. In the first two months prior to egg-laying, both established as well as prospecting birds are caught, the latter birds normally found sitting along ledges or inside 'makeshift' nests. Between the end of May and the second week of July the pairing of incubating birds takes place, while between the end of June and the first two weeks of August non-breeders visit the colonies. These are caught while sitting in front or near occupied burrows. Birds were sexed by bill measurement following the methodology of Ristow & Wink (1980), by cloacal inspection (Serventy 1956) and by voice.

Results

Return to colonies by young birds

Table 1 shows that males return to the colonies at a younger age than females. It was also found that males mature sexually earlier than females, males found breeding in their 4th and 5th year (exceptionally 2 years) and females in their 5th and 6th year. In Crete, Wink *et al* (1982) found that some young birds return to the colonies at the age of 5 years. While on Great Selvage some precocious birds make first landfall when 4 years old but start to breed between 8th and 11th year (Jouanin *et al.* 1980).

after>	2yr	3yr	4yr	5yr	6yr	7yr	8yr	9yr
male	2		3	7	4	3	1	2
female				2	3	1		
undet.			1	1	4	2		
Total	2		4	10	11	6	1	2

Table 1. Birds ringed as pulli and recaptured in later years from the study areas.

Return rate of adult birds ringed as chicks

The annual return rate of birds ringed as pulli between 1983 and 1990, and retrapped in the following years is shown in Table 2, with a mean return rate of 12.7%. The highest return rate is that of birds ringed in 1985 with 11.7% and the lowest 4.0% from birds ringed in 1987.

These results are slightly biased due to the fact that:

a) some of the study areas were sporadically visited with very few night visits, whereas other sites were regularly monitored

b) since nesting sites are situated along cliff ledges, marked birds may have returned to their natal colony but may be alighting or nesting in an inaccessible crevice at a very short distance below the accessible area.

year of ringing	1983	1984	1985	1986	1987	1988	1989	1990
no. of pulli ringed	34	52	51	64	49	55	51	43
no. recaptured as adults	3	4	6	6	2	5	5	2
Return rate %	8.8	7.7	11.7	9.3	4.0	9.0	9.8	4.6

Table 2. Annual return rate of *C. diomedea* ringed as pulli between 1983 and 1990 and recaptured up to 1995 from the study areas.

Birds recaptured according to their status

Males have a higher return rate to colonies than females and this is reflected in all status categories, as was found elsewhere (Thibault 1993). Table 3 gives three different status levels in which 36 birds where classed accordingly. The return rate for prospecting males was noted to be higher than that of prospecting females. Twelve males and 5 females were found only as prospectors. One male was caught first as prospector, then as breeder, while 9 males and one female were first time captured as breeders.

Sex/status	Recaptured only as prospector	Recaptured as prospector then as breeder	Recaptured only as breeder	Total
Male	12	1	9	22
Female	5	0	1	6
Undetermined	7	0	1	18
Total	**24**	**1**	**11**	**36**

Table 3. Number of birds ringed as fledglings from the study areas and recaptured according to sex and status.

Figure 1 shows that prospectors of both sexes make first landfall close to their natal nest with 5 males found at the natal nest and another 1m away, the farthest male was found 16m away from its natal nest. Meanwhile the nearest female was found 2m away from its natal nest and the farthest 20m away.

It appears that even females make their first landfall in the extreme vicinity of their natal nest. But unlike males, who remain in the near vicinity throughout their breeding life, females disperse away from the natal nest and even away from the natal colony.

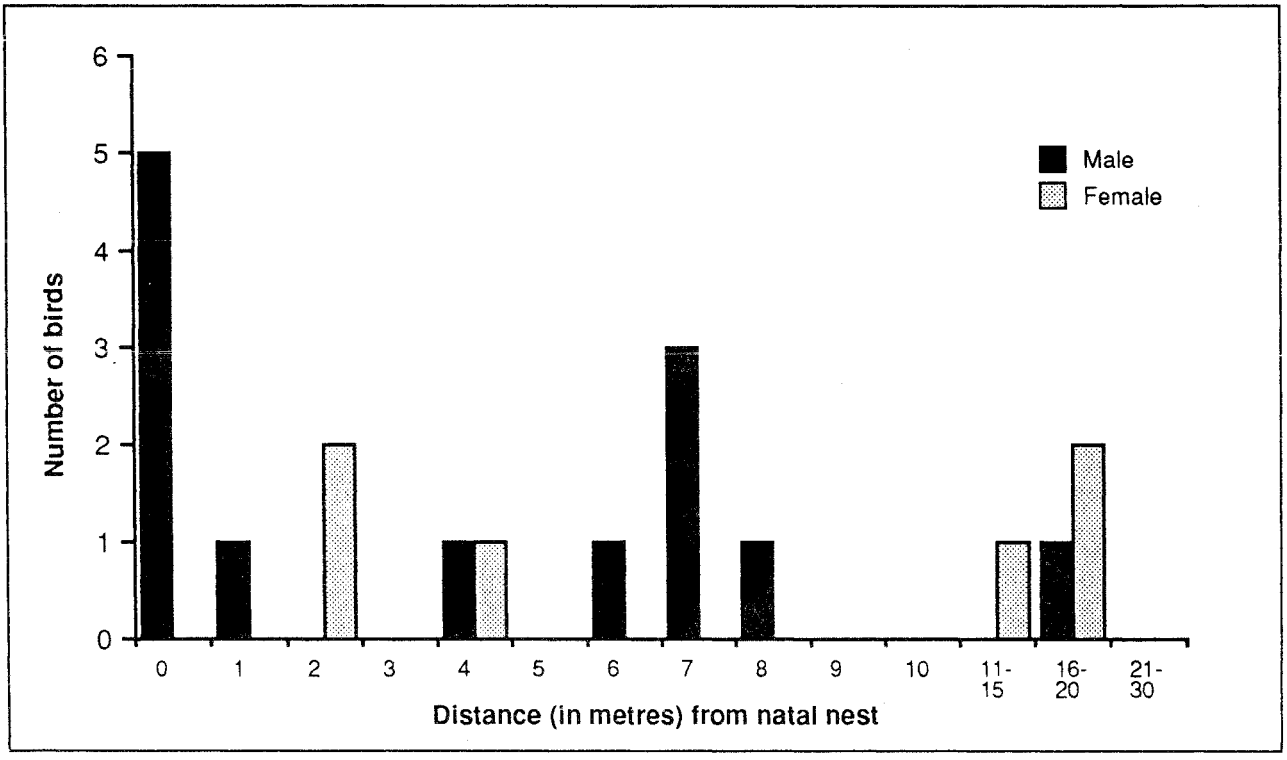

Fig 1. Landfall distance from the natal nest of prospecting birds in the study areas.

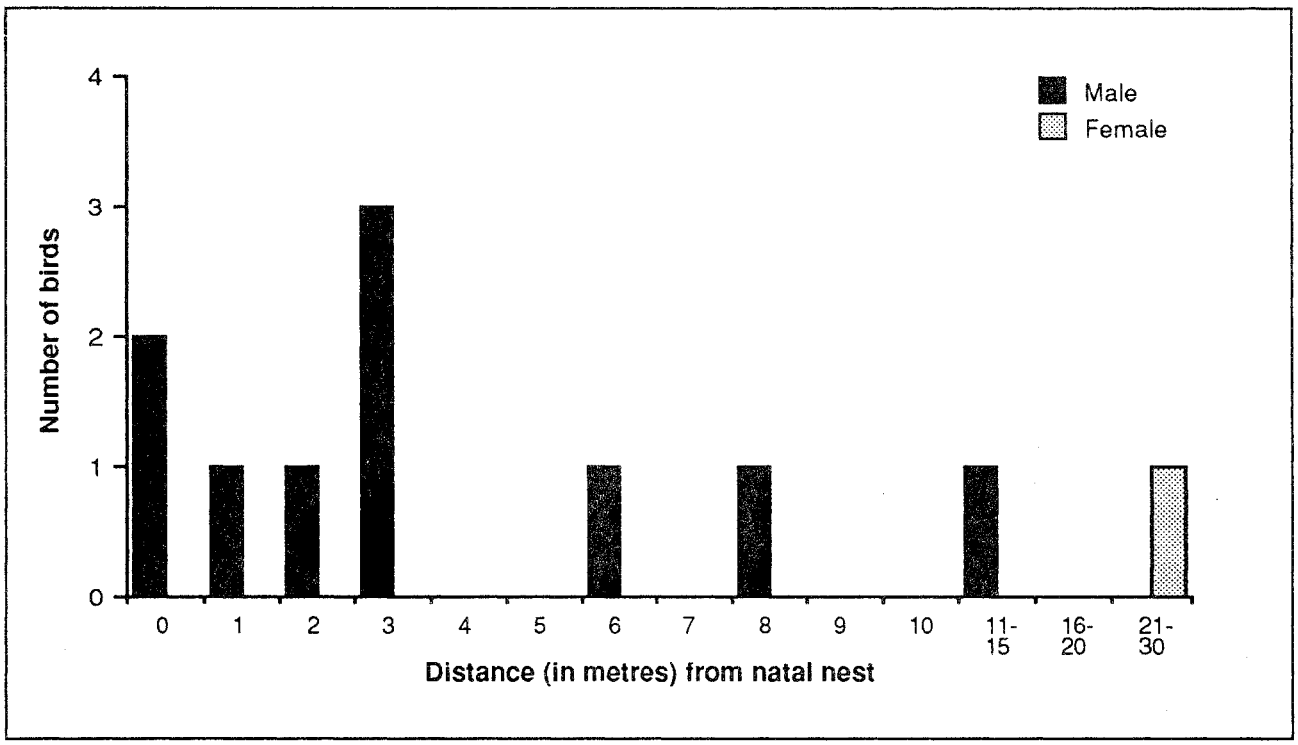

Fig 2. Distance from natal nest of breeding birds in the study areas.

Breeding males remain closer to their natal nest than females (Fig 2) where 6 birds were found breeding in a radius of less than 3m from the natal nest. Two of these birds were found breeding in their natal nest (see below). Two birds were found between 6-10m away and 1 was in a radius of 15m. Only 1 female ringed as pullus was found breeding, and this was found at a distance of more than 1000m from its natal nest.

Male FF00037, ringed as pullus from nest 202 in 1983, was first caught in 1992 as a breeder in the same nest that he fledged from and was still breeding there in 1995. He replaced his paternal parent at least in 1992 when the old bird failed to return, having presumably died. The maternal parent was last caught in 1988, now presumably dead also.

Male FF00884, ringed from outside nests 350-351 in October 1985, was caught again 2 years later, first in March, then found breeding in June of same year. He was found incubating in nest 350. In the first year of breeding, the pair failed to fledge a chick, but in the following years up to 1992, they were always successful. FF00884 moved nest in 1995, and was caught entering nest 352, situated 3m away from 350.

Male FF00965, ringed as pullus outside nests 66-68 in October 1985, was found incubating in nest 68 (1992). In the first and following years, breeding was always successful.

Male FF00463, ringed as pullus in August 1984 from nest 165 was retrapped outside nest 165 in April 1989. In June of the same year he was retrapped outside 163, about 5m away. Between 1991 and 1995 he was found occupying nest 173, located halfway between 165 and 163.

Female FF00850, ringed from nest 359 in August 1985. was found breeding in 1992 in nest 465, a distance in excess of 1000m.

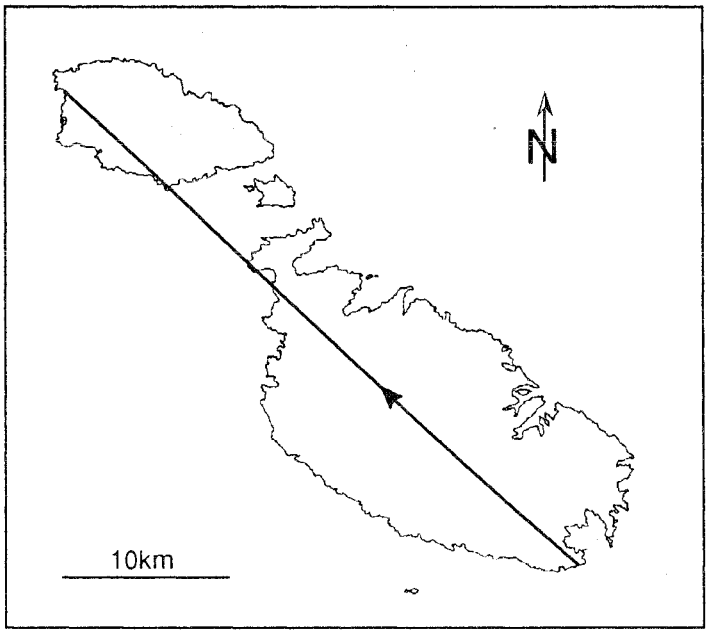

Fig 3. Maximum displacement between natal nest and breeding nest by a female *C.diomedea*.

Why males are more philopatric than females

Thibault (1983) states that it is not known why males show a higher degree of philopatry than females. He gives two reasons to explain why fewer females return to Lavezzi Island (Corsica):

a females may have a higher mortality, but this does not appear to be the case on Lavezzi

b females disperse further than males and return less often to the vicinity of the natal site.

In Malta the Cory's Shearwater follows the same trend as the birds in Lavezzi. In view of the first explanation, there was no significant difference in survival rate between sexes in Malta, where both had the same minimal survival rate of 77% (Table 4). For the second explanation, as was shown above, females make their first landfall at their natal colony/nest, but was found to disperse some time later in their first or second year from first landfall.

Breeding	Marked in year x	Alive in x+1	Not checked	Survival of x+1	Full survival
Male	169	34.7	2.83	77	83.1
Female	163	32.1	3.25	77	84.2
Male + Female	332	66.9	6.08	77	83.8

Table 4. Minimal survival of breeding birds (male, female and combined) for the years 1983-1995. Some birds may have moved nest and are still alive in inaccessible areas.

As argued by Brooke (1990), the higher male philopatry in Manx Shearwaters *Puffinus puffinus* was associated with burrow defense. This may also be the case for *C. diomedea* as suggested by Thibault (1993). Greenwood (1980) suggests that for several species the higher degree of philopatry in males than females is because that it is to the males' advantage to be familiar with the territory they have to defend against other males.

Males of *C. diomedea* return earlier to the colony than females; this is so in order to secure and defend the best nesting site, preferably its natal nest or as close as possible. The natal nest represent a 'good' nest as the bird had hatched and fledged successfully from there, so to the bird, its natal nest is a sure site for reproduction, and the general area of the nest has long been imprinted in the period before fledging.

Prior to actual breeding, prospecting males need to secure two things of fundamental importance; a nest and a mate, although not necessarily in that order. So in the first part of the breeding season before egg-laying, the prospecting male is indulging either in 'house hunting', mate-searching or both. However it is thought that, at least for the first time breeders, 'house hunting' may take place after birds are paired (Cachia-Zammit & Borg 1986-1987). Prospecting males, as shown above, venture very little from their natal nest, preferring a well-known area rather than a new unknown site when searching for a nest.

In July and August non-breeding/bachelor males, frequently in the company of females, are found in groups or 'clubs' of 3-4 birds, sitting and calling in the vicinity of occupied nests. This 'clubbing' behaviour also demonstrates some degree of nest-site competition. These bachelor/non-breeders return night after night to the same spot awaiting a nest to be vacated or the eventuality of a single 'widowed' (male or female) bird which may have lost its partner in that year and is already in possession of a nest.

Prospecting males often indulge in direct confrontations with the male occupant of a nest (Cachia-Zammit & Borg 1986-1987) and so are not accepted in the vicinity of occupied nests. But the male occupants, even if mated, accept the company of nubile females close or inside the nest when the partner is out. During the pre-laying exodus, with the total absence of breeding females, males continue to return at night to occupy and defend the nest. During this period the only female birds visiting the colonies are the single, unmated females who visit mated males, sometimes within the nesting chamber. Because of this, females who do not need to establish and defend a nest, fly randomly, roaming from one area to another in search of a nest already secured by a single male in waiting for a female.

Inbreeding as a result of philopatry?

Monogamous and philopatric populations with high colony fidelity may lead to reduced gene flow (Cachia-Zammit & Borg 1986-1987, Randi *et al.* 1989). It is possible that with such a degree of philopatry in *C. diomedea*, cases of incest could occur.

From the number of birds ringed as pulli and recaptured in later years, a male was found breeding in its natal nest. Male FF00884 was found breeding in nest 350. This bird was ringed in October 1985 outside nests 350-351 which

are close to each other. His partner was FF00974, caught first time as adult entering 350 in 1986, when FF00884 was 1 year old. In the following year, FF00884 was found incubating in nest 350 with partner FF00974, where they remained together until 1993, when the female moved nest. The male was not caught until 1995, when he was found entering nest 352 which is 2m away from 350. Incestuous behaviour by *C. diomedea* has been recently noted in Corsican birds (C. Rabouam pers comm.).

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Note on the wintering of the Cory's Shearwater *Calonectris diomedea* in the Mediterranean

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Introduction

In the Mediterranean the breeding period of the Cory's Shearwater *Calonectris d. diomedea* shows an important inter-annual constancy and a high synchronism between individuals and colonies (Thibault *et al.* 1997), with some annual differences not exceeding several days (Rabouam *et al.* in press). Most birds, whether young or old individuals, leave their breeding grounds between mid- and late October (Round & Swann 1977, Thibault 1985, Cachia-Zammit & Borg 1986-87), rapidly reaching the Atlantic Ocean via the Straits of Gibraltar from mid-October to mid-November (Telleria 1980, Finlayson 1992). Unsuccessful breeders also desert the colony sites, doing so generally earlier than the successful breeders, depending on the failure stage and on individual behaviour (Mougin *et al.* 1988, Thibault *et al.* 1997). This migration results in birds wintering for a relatively short time off South Africa in the South Atlantic and Indian Oceans (Brooke & Sinclair 1978, Mougin *et al.* 1988), although this has never been confirmed by recovered birds ringed in the Mediterranean (Thibault *et al.* 1997). However, Cory's Shearwaters have been recorded wintering in the Mediterranean basin. The aim of this paper is to evaluate and discuss the extent of this wintering.

Methods

In autumn, the majority of the birds leave the Mediterranean rapidly, but are regularly recorded in several areas until late November; in spring they return to the colony sites gradually from late February to late March (Thibault *et al.* 1997). We have therefore only selected data obtained from 1 December to 31 January to be considered as corresponding to wintering birds. Data are derived from both published as well as unpublished sporadic observations. Standardised observations at sea by boat and by plane were conducted off the French coast (Bouches-du-Rhône, Var and Alpes-maritimes) and Corsica (G. Hémery, unpubl. data). Finally, we eliminated records which evidently concerned other species, e. g. record of birds calling at night close to the shore in January (Moltoni 1975) are best referred to the Levantine Shearwater *Puffinus yelkouan*.