

## Age-dependant adult survival in the Cory's Shearwater (*Calonectris diomedea*)

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**Abstract** - In the Cory's Shearwater *Calonectris diomedea* of Selvagem Grande (30°09'N, 15°52'W), the annual survival rate of the adult is age-dependant. After having remained almost constant during the first breeding years, it begins to decrease shortly after the 15<sup>th</sup> when the bird has not much passed its 25<sup>th</sup> year. Such a trend having also been observed in other seabird groups, it is likely to be widespread. The scarcity of the related data published is thus likely to be only a consequence of the length of the studies necessary to get them.

The results of long-term studies have shown only recently that, in Procellariiformes, the annual survival rate of the adults decreased with ageing (Bradley *et al.* 1989, Robertson 1993, Sagar *et al.* 2000, Warham 1996, Weimerskirch 1992). Having studied for more than 20 years the Cory's Shearwater *Calonectris diomedea* of Selvagem Grande, we have tried to know: 1. if such a decrease existed in that species; and 2. if so, when (age, experience) did it began to appear.

### Material and methods

The work has been carried out on Selvagem Grande (30°09'N, 15°52'W), Portuguese island situated between Madeira and the Canary Islands. The population of Cory's Shearwaters, after many vicissitudes caused by exploitation and poaching, numbers now about 36,000 breeders (Mougin *et al.* 1996). Four colonies are studied, grouping now about 500 nests in all. All the breeding adults are ringed or recaptured – and all the nests marked or checked – during yearly visits, in June-July, during incubation. Adults have been ringed every year since 1977, capture-recapture data thus collected allowing the estimation of the annual survival rate using a Cormack-Jolly-Seber model (Cormack 1964, Jolly 1965, Seber 1965). Almost all the adults being ringed during their first breeding year, the number of years after banding represents in fact the breeding experience of the birds. Chicks have been ringed shortly before they fledge, in September-October, every year from 1968 to 1971

and, after a break, every year again since 1977. In the following pages, they are taken into account since their 13<sup>th</sup> year, when all the surviving birds have returned to land and have begun to breed (Mougin *et al.* 1992). In all, the work has concerned 1274 birds ringed as adults during 8 years – respectively 70 (1977), 133 (1978), 332 (1980), 121 (1981), 204 (1982), 115 (1985), 161 (1988) and 138 (1989) – and 178 birds ringed as chicks during 7 years and having reached their 13<sup>th</sup> year – respectively 31 (1968), 31 (1969), 22 (1970), 30 (1971), 20 (1977), 18 (1978) and 26 (1979).

### Results

#### Evolution of the survival rate as a function of the breeding experience

Figure 1A shows, for the 5 cohorts taken into account, a survival rate relatively stable during the 15 years or so following ringing (12-16 years according to the cohort), then decreasing rapidly and consequently. The period of stability gives an average value of  $0.9403 \pm 0.1546$  (0.8123-0.9904,  $n = 75$ ), significantly higher ( $t = 2.72$ ,  $P < 0.01$ ) than that of the period of decrease,  $0.8531 \pm 0.1067$  (0.5000-0.9211,  $n = 17$ ). The mortality rate for that second period (14.7%) is thus almost 2.5 times higher than that of the first period (6.0%). None of the cohorts taken into account having completely disappeared at the end of our study, the mortality rate calculated for the period of decrease is thus likely to be under-estimated.

One could object that the decrease of the survival rate observed during the last years of study could be a consequence of the scarcity of subsequent years of control – the birds not recaptured because absent or overlooked being not likely to be observed later on because there will be so few occasions, they would thus be taken as dead. However, if that assumption was founded, such a decrease should be observed in all cohorts, independently of the number of years following ringing. This is not the case, no decrease occurring in the cohorts studied since 1985, *i. e.* during less than 15 years (Fig. 1B) – respectively  $0.9213 \pm 0.0461$  (0.8502-0.9899,  $n = 17$ ) for the first breeding years *versus*  $0.9082 \pm 0.0978$  (0.8056-0.9980,  $n = 15$ ) for the last ( $t = 0.47$ , *n.s.*).

#### Evolution of the survival rate as a function of age

A similar work carried out on known-age breeders has given similar results (Fig. 2A). The survival rate is almost stable until about 25 years of age (23-26 years according to the cohort), then it decreases rapidly. For the 4 cohorts studied, the average values given by the period of stability and by the period of decrease are

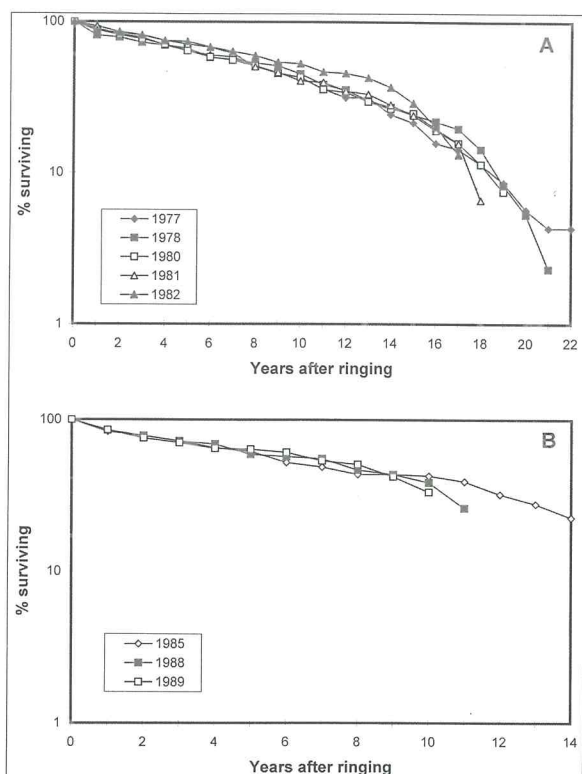


Fig. 1. The survival of adults Cory's Shearwaters as a function of their breeding experience. A: five cohorts of birds ringed as breeders between 1977 and 1982. B: three cohorts of birds ringed as breeders between 1985 and 1989.

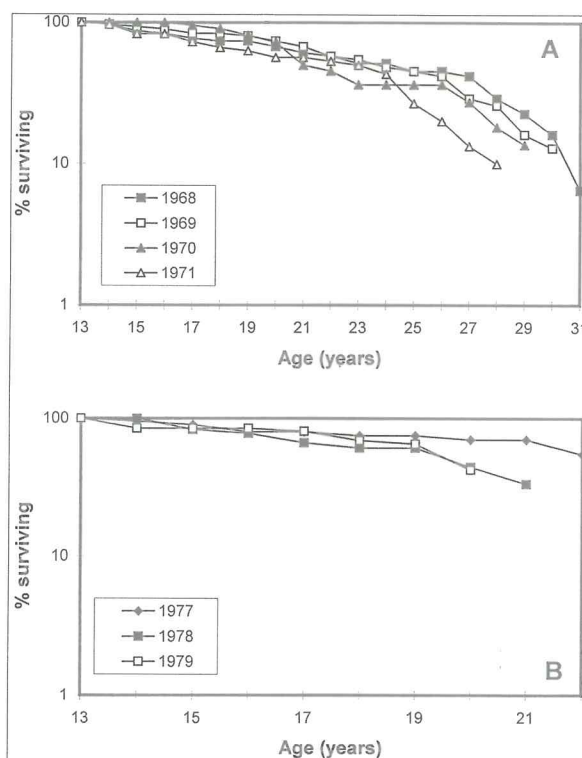


Fig. 2. The survival of adults Cory's Shearwaters as a function of their age. A: four cohorts of breeders ringed as chicks from 1968 to 1971. B: three cohorts of breeders ringed as chicks from 1977 to 1979.

$0.9609 \pm 0.1108$  (0.8145-0.9942,  $n = 51$ ) and  $0.7733 \pm 0.0937$  (0.6462-0.9524,  $n = 11$ ) respectively ( $t = 5.82$ ,  $P < 0.01$ ). In that sample, the mortality rate is thus 6.0 times higher during the second period (22.7%) than during the first (3.9%). The decrease being not observed among birds less than 23 years old (Fig. 2B), it cannot be taken as an artefact.

## Discussion

In the Cory's Shearwater of Selvagem Grande, the annual survival rate of the adult is age-dependant. After having remained almost constant during the first breeding years, it begins to decrease shortly after the 15<sup>th</sup> when the bird has not much passed its 25<sup>th</sup> year. Few results allowing comparisons have been published. However, after having detected decreasing survival with age in the Fulmar *Fulmarus glacialis* (Dunnet and Ollason 1978), Dunnet (1982, 1991) has seemed to change his mind, although reluctantly. The annual survival rate of the Short-tailed Shearwater *Puffinus tenuirostris* begins to decrease about 20 years

on average after the first breeding (Bradley *et al.* 1989). In the Diomedeids, the survival of Wandering Albatrosses *Diomedea exulans* more than 27 years old (Weimerskirch 1992) and of Royal Albatrosses *D. epomophora* more than 25 years old (Robertson 1993) is lower than that of younger birds, as well as, in the Buller's Albatross *D. bulleri*, the survival of the birds with more than 25 years of experience compared to that of less experienced birds (Sagar *et al.* 2000). Finally, among Hydrobatids, survival decreases in the Leach's Petrels *Oceanodroma leucorhoa* more than 25 years old (Huntington in Warham 1996). Such a phenomenon having also been observed in other seabird groups, Phalacrocoracids (Harris *et al.* 1994), Larids (Aebischer and Coulson 1990) and Alcids (Harris *et al.* 1997), it is probably widespread. The scarcity of the related data published is thus likely to be only a consequence of the length of the studies necessary to get them.

Résumé - Chez le Puffin cendré *Calonectris diomedea* de Selvagem Grande (30°09'N, 15°52'W), le taux de survie annuel des adultes est dépendant de l'âge. Après être resté presque constant pendant les premières années de reproduction, il commence à décroître peu après la 15<sup>ème</sup>, quand les oiseaux ont dépassé de peu leur 25<sup>ème</sup> année d'existence. Une telle tendance ayant également été observée dans d'autres groupes aviens, on peut penser qu'elle est très répandue et que la longueur des études nécessaires à leur obtention est l'unique cause de la rareté des données publiées à ce sujet.

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