

## “TWO-EGG CLUTCHES” IN CORY’S SHEARWATER (*CALONECTRIS DIOMEDEA*)

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**ABSTRACT.**— In the Cory’s Shearwater (*Calonectris diomedea*) of Selvagem Grande, “two-egg clutches” represented 0.52% of the total number of clutches. “Two-egg clutches” were found principally in attractive nests occupied by inexperienced breeders. The first egg seemed to be laid mostly by lonely females taking advantage of the pre-laying exodus to enter the temporarily empty nest of a young inexperienced pair. These females deserted their egg after a few days; then the legitimate tenants laid the second egg. The first egg was deserted on average after three days and replaced four days later. The breeding success of “two-egg clutches” was significantly lower than that of one-egg clutches, because of the failure of the first egg. Among other Procellariiformes, as in Cory’s Shearwaters, “two-egg clutches” are always rare and show little success.

**KEY WORDS:** *Calonectris diomedea*, *Cory’s Shearwater*, *Selvagem Grande*, “Two-egg clutches”.

**RESUMEN.** PUESTAS “DE DOS HUEVOS” EN LA PARDELA GRANDE (*CALONECTRIS DIOMEDEA*).— Las puestas “de dos huevos” representaron el 0.52% del número total de puestas en la población de la Pardela Grande (*Calonectris diomedea*) de Selvagem Grande. Las puestas “de dos huevos” se encontraron principalmente en nidos atractivos ocupados por parejas reproductivas de poca experiencia. El primer huevo pareció haber sido puesto mayormente por hembras solitarias que, aprovechando el éxodo pre-postura, entran al nido temporariamente vacío de una pareja joven y de poca experiencia. Estas hembras abandonan su huevo luego de unos pocos días, luego de lo cual la pareja legítima retorna y se produce la postura del segundo huevo. El primer huevo fue abandonado, en promedio, luego de tres días, y reemplazado cuatro días más tarde. El éxito de las puestas “de dos huevos” fue significativamente menor que el de las puestas de un huevo, debido al fracaso del primer huevo. Entre otros Procellariiformes, así como en la Pardela Grande, las puestas “de dos huevos” son siempre raras y muestran un bajo éxito.

**PALABRAS CLAVE:** *Calonectris diomedea*, *Pardela Grande*, *Puestas “de dos huevos”*, *Selvagem Grande*.

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One-egg clutches are usual among Procellariiformes (Warham 1990). Nevertheless, two eggs are found in a few nests of several species: Cape Petrel *Daption capense* (Gain 1914, Downes et al. 1959), Slender-billed Prion *Pachyptila belcheri* (Strange 1980), Manx Shearwater *Puffinus puffinus* (Harris 1966), European Storm-petrel *Hydrobates pelagicus* (Scott 1970), Fork-tailed Storm-petrel *Oceanodroma furcata* (Boersma et al. 1980), White-throated Storm-petrel *Nesofregatta albigularis* (Crossin 1974), Grey-backed Storm-petrel *Garrodia nereis* (Plant 1989), White-faced Storm-petrel *Pelagodroma marina* (Richdale 1965), among many others. Some hypotheses have been presented as regards their origin. The possibility of a double laying by the same female is no

more accepted nowadays—and thus the term “two-egg clutch” is not appropriate but it is a time-honoured custom to use it—and the replacement clutches noted in some Hydrobatids (Boersma et al. 1980) seem out of place in the family which lays the biggest eggs compared with the weight of the females.

Nests with two eggs have already been noted in the Cory’s Shearwater (*Calonectris diomedea*) on Malta (Cachia Zammit and Borg 1988). Our aim in looking for them in the population of Selvagem Grande (30°09’N, 15°52’W), the largest of the Portuguese Selvagens Islands situated between Madeira and the Canary Islands, was to know: (1) if they existed, (2) how many birds were concerned and who were they, and (3) if these “double clutches” were successful.

The population of Cory's Shearwaters of Selvagem Grande numbers about 36 000 breeders (Mougin et al. 1996), 15–20% of which are new breeders (on average 8.9 years old, range 4–13 years; Mougin et al. 2000a), and less than 10 000 prospecting young birds. At the end of the wintering period spent at sea in the Southern Hemisphere, the birds of Selvagem Grande come back to their colonies (at the end of February and beginning of March) and settle usually on their former nest with their former mate. Most of the nests are more or less hypogeous and show a comparatively low density (0.1–0.8 nests/m<sup>2</sup>) without any vegetation cover. As among other Procellariids, the nest, visited sporadically and cyclically during the pre-egg stage (Mougin et al. 2000b), is deserted by both sexes a few days before laying (pre-laying exodus), on average 19 days for females and 8 days for males (Jouanin et al. 2001). This situation allow birds other than the tenants to frequent the nest, even if the number of potential nests is not limited, the birds breeding nowadays on Selvagem Grande being far less numerous than some decades ago. After laying, the first stint of the female is short, a few hours or a few days, 1.8 days on average. Afterwards, both sexes incubate alternatively.

## METHODS

As an annex to a long-term project dealing with the demography of the population, the search for "two-egg clutches" has been carried out every year since 1980—with the exception of 1991 and 1993—in four colonies of Cory's Shearwaters of Selvagem Grande numbering about 500 pairs in all. The nests were checked every year in June–July, during incubation, which allowed the determination of the rate of occupation (number of years of occupation / number of years of existence of the nest site during the period of study). Between 1983 and 1985, they have also been visited during the laying period. During incubation, nests and adults were checked or marked. Recruits were thus known and therefore their breeding experience during the following years. Measurements taken at the time of ringing allowed sex determination (Mougin et al. 1986). Nearly fledged chicks were censused during a later visit, which permitted the computation of breeding success. A control performed shortly after egg laying is always

hazardous, the birds deserting readily their egg. A few days later, when the rhythm of changeover is well established, it will not jeopardise egg survival, the birds being less shy. So we have not tried to check ringed adults immediately after laying and, as the parents of the first egg in "two-egg clutches" normally desert their egg not long after laying, we only know the identity of those of the second egg.

The statistical analyses were based on Chi-square tests and Student's *t*-tests. Means are given  $\pm$  SD.

## RESULTS

### *Frequency of nests with two eggs*

The frequency of nests with two eggs observed in our colonies between 1980 and 1999, although always very low, has shown a significant annual variation ( $\chi^2_{17} = 65.8$ ,  $P < 0.01$ ), between 0 and 2.3% (Fig. 1). In all, 41 "two-egg clutches" have been observed during 18 years of observation for a total of 7891 clutches (0.52%).

### *Laying and breeding success*

In the 10 "two-egg clutches" observed in 1983 and 1984, the first egg was deserted  $2.7 \pm 2.9$  days after having been laid; the second was laid  $4.4 \pm 4.0$  days after the desertion of the first or  $7.3 \pm 5.0$  days after its laying

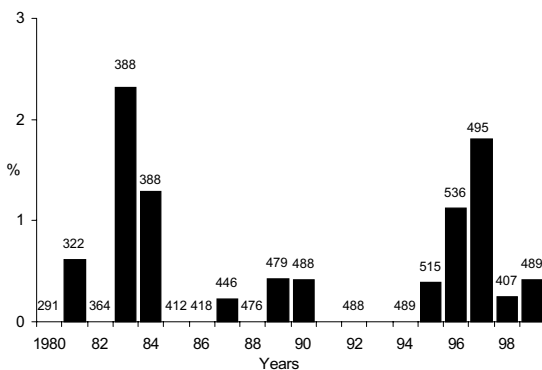


Figure 1. Frequency of "two-egg clutches" in the studied colonies of *Calonectris diomedea* of Selvagem Grande between 1980 and 1999. Total number of clutches is mentioned above the bars. Data are lacking for 1991 and 1993.

Table 1. Breeding success in nests with one-egg and "two-egg" clutches in the studied colonies of *Calonectris diomedea* of Selvagem Grande. Egg and chick mortality: total loss / eggs laid.  $\chi^2_1$  refers to the differences between one-egg clutches and both eggs in "two-egg clutches". ns: non significant.

|                         | "Two-egg clutches" |            |            | One-egg clutches | $\chi^2_1$ | P      |
|-------------------------|--------------------|------------|------------|------------------|------------|--------|
|                         | First egg          | Second egg | Both eggs  |                  |            |        |
| Eggs laid               | 27                 | 27         | 54         | 4523             |            |        |
| Eggs lost               | 27 (100%)          | 12 (46.4%) | 39 (72.2%) | 1482 (32.8%)     | 37.3       | < 0.01 |
| Eggs hatched            | -                  | 15 (55.6%) | 15 (27.8%) | 3041 (67.2%)     | 37.3       | < 0.01 |
| Chicks lost             | -                  | 5 (33.3%)  | 5 (33.3%)  | 460 (15.1%)      | 3.8        | ns     |
| Chicks fledged          | -                  | 10 (37.0%) | 10 (18.5%) | 2581 (57.1%)     | 32.4       | < 0.01 |
| Total loss              | 27                 | 17         | 44         | 1942             |            |        |
| Egg and chick mortality | 100%               | 63.0%      | 81.5%      | 42.9%            | 32.4       | < 0.01 |

(Fig. 2). The whole process between the laying of both eggs took a few days only, one week on average and two weeks at the most.

No double hatching has been observed and, on the whole, the hatching success (eggs hatched / eggs laid) has been lower in "two-egg" than in one-egg clutches (Table 1). This being so, if we disregard the systematic failure of the first egg, the success of the second was a little lower, although not significantly, than that of one-egg clutches ( $\chi^2_1 = 1.61$ ,  $P > 0.05$ ). The fledging success (chicks fledged / eggs hatched) of the surviving chick did not differ from that of the chick of one-egg clutches ( $\chi^2_1 = 3.8$ ,  $P > 0.05$ ; Table 1). In all, the breeding success (chicks fledged / eggs laid) of "two-egg clutches" was significantly lower than that of one-egg clutches ( $\chi^2_1 = 32.4$ ,  $P < 0.01$ ; Table 1) because of the failure of the first egg.

#### Nests

The nests in which two eggs have been observed have shown a high rate of occupation, on average  $0.85 \pm 0.21$  (range 0.33–1.00,  $n = 41$ ) versus  $0.63 \pm 0.31$  (0.05–1.00,  $n = 708$ ) for the nests with one-egg clutches ( $t = 6.18$ ,  $P < 0.01$ ). The percentage of the nests with two eggs that were regularly occupied every year was 24.4, versus 11.2% of the nests with one-egg clutches ( $\chi^2_1 = 6.38$ ,  $P < 0.05$ ).

More than half (53.8%) of the pairs settled in the nests where two eggs have been observed had never bred there together, 39.5% of the males and 34.2% of the females having no previous experience of the site ( $n = 38$ ).

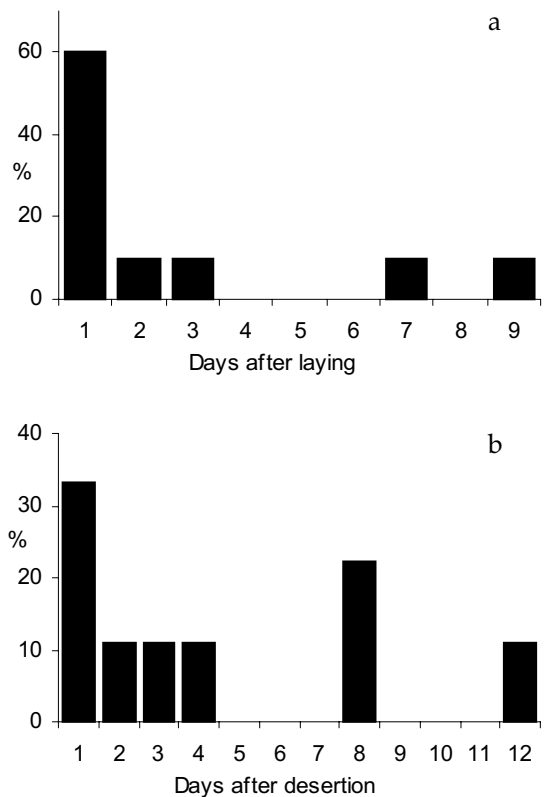


Figure 2. Chronology of desertion and laying in 10 "two-egg clutches" in the studied colonies of *Calonectris diomedea* of Selvagem Grande in 1983 and 1984. (a) Frequency of desertion of the first egg (in days following laying). (b) Frequency of laying of the second egg (in days following the desertion of the first).

Table 2. Breeding experience and length of pairing of the breeders observed in nests with one-egg and "two-egg" clutches in the studied colonies of *Calonectris diomedea* of Selvagem Grande. Data reported are means  $\pm$  SD, with range in brackets, and sample size (*n*). Data for "two-egg clutches" concern only the pairs having laid the second egg. \*:  $P < 0.05$ , \*\*:  $P < 0.01$ .

|                           | "Two-egg clutches"                    | One-egg clutches                       | <i>t</i> |
|---------------------------|---------------------------------------|--|----------|
| Experience (years)        |                                       |  |          |
| males                     | 4.3 $\pm$ 4.0 (1–18)<br><i>n</i> = 39 | 7.1 $\pm$ 5.7 (1–23)<br><i>n</i> = 461 | 3.97 **  |
| females                   | 5.8 $\pm$ 4.8 (1–18)<br><i>n</i> = 38 | 7.4 $\pm$ 5.9 (1–23)<br><i>n</i> = 474 | 2.00 *   |
| both sexes                | 5.0 $\pm$ 4.5 (1–18)<br><i>n</i> = 77 | 7.2 $\pm$ 5.8 (1–23)<br><i>n</i> = 935 | 4.04 **  |
| Length of pairing (years) | 2.2 $\pm$ 1.8 (1–9)<br><i>n</i> = 38  | 3.2 $\pm$ 2.8 (1–17)<br><i>n</i> = 355 | 3.04 **  |

### Birds

In several avian species, homosexual female-female pairs sometimes laid the supernumerary clutches (Conover et al. 1979, Ryder and Somppi 1979, Bried et al. 1999). This is not the case in the Cory's Shearwater of Selvagem Grande.

Table 2 compares the breeding experience and the length of pairing of the birds settled in nests with "two-egg" or one-egg clutches. The pairs having laid the second egg in "two-egg clutches", males as well as females, are always significantly less experienced than those having laid one-egg clutches, and the length of their pairing is shorter.

The birds having laid the first egg have never been checked and we have previously explained why. However, no significant difference was apparent between the duration of the stint preceding the desertion of the egg and that of the first female stint during a successful incubation ( $t = 0.95$ ,  $P > 0.05$ ), therefore we may probably assume that only lonely females are concerned, deserting the nest when they normally should have been relieved by their mate.

### DISCUSSION

In the Cory's Shearwaters of Selvagem Grande, "two-egg clutches", always very rare, are laid by birds short of experience in nests attractive for breeders. The first egg seems to be mostly the product of lonely females taking advantage of the pre-laying exodus of

young inexperienced pairs to lay in their temporarily deserted nest. At the end of a stint of normal duration, not relieved by a male, they will desert the egg. When returning from their feeding trip, the "legitimate" tenants of the nest will lay the second egg, which will afterwards be brooded more or less assiduously, as is usual in birds rather devoid of experience. We have no information on the fertility of the first egg laid but the probable loneliness of the female at laying does not imply that she was also lonely days earlier and that no fertilization had occurred then.

"Two-egg clutches" seem to be always rare in Procellariiformes, from 0.02% to 5.60% according to the species (Fisher 1952, Prévost 1953, Warham 1962, Tickell and Pinder 1966, Fisher 1968, Mougin 1970, Imber 1976, Schramm 1983). As in the Cory's Shearwater also, they seem to be laid by inexperienced birds (Fisher 1968). The competition of two pairs for the same nest site has been noted, as well as the reoccupation by a pair of a nest site deserted after laying by another pair (Pinder 1966, Fisher 1968, Imber 1976). Breeding failure is always important: 80% in Warham's sample (1962), 100% in Pinder's (1966), and one hatching only observed by Imber (1976). Only the Giant Petrels *Macronectes* sp. seem likely to succeed in hatching two eggs but, like the other Procellariiformes, they cannot fledge two chicks (Warham 1962). In other species, one egg is always lost, and sometimes both (Pinder 1966, Imber 1976), which is perhaps more related to the inexperience of the birds than to the size of the clutch.

The existence of "two-egg clutches" is not likely to favour the populations of Procellariiformes, as one egg is systematically lost and the other moderately successful. But it is not either likely to affect them, even if the first egg had produced a chick if laid in a free nest, because they seldom occur and because, in that case, the success of the second egg is not compromised by the existence of the first. In fact, as far as the fate of the egg is concerned, the laying of a supernumerary egg in a nest seems to be similar to the "laying on the ground" observed in some Procellariiformes, e.g., the Madeiran Storm-petrel (*Oceanodroma castro*; Mougin et al. 1990) and several shearwaters (*Puffinus griseus*, *P. bulleri*, and *P. puffinus*; Harris 1966, Warham et al. 1982, Harper 1983). Cases much more surprising of apparently useless laying of viable eggs are known in groups laying more than one egg, the Spheniscids for example. In the Macaroni Penguin *Eudyptes chrysolophus*, the first, smaller egg is discarded usually before the laying of the second, bigger, egg (Mougin 1984, Williams 1989). Anyway, in the Cory's Shearwater, either laid in the nest of another bird, on the ground or anywhere else, the eggs of lonely females have no chance of hatching. As they are rare, the loss is small for the population.

#### LITERATURE CITED

- BOERSMA PD, WHEELWRIGHT NT, NERINI MK AND WHEELWRIGHT ES (1980) The breeding biology of the Fork-tailed Storm-Petrel (*Oceanodroma furcata*). *Auk* 97:268–282
- BRIED J, DURIEZ O AND JUIN G (1999) A first case of female-female pairing in the Black-faced Sheathbill *Chionis minor*. *Emu* 99:292–295
- CACHIA ZAMMIT R AND BORG J (1988) The occurrence of two eggs in a nest of Cory's Shearwater *Calonectris diomedea*. *Il-Merill* 25:12
- CONOVER MR, MILLER DE AND HUNT GL JR (1979) Female-female pairs and other unusual reproductive associations in Ring-billed and California Gulls. *Auk* 96:6–9
- CROSSIN RS (1974) The Storm Petrels (Hydrobatidae). Pp. 154–205 in: KING WB (ed) *Pelagic studies of sea-birds in the central and eastern Pacific Ocean*. Smithsonian Institution Press, Washington
- DOWNES MC, EALEY EHM, GWYNN AM AND YOUNG PS (1959) The birds of Heard Island. *Australian National Antarctic Research Expeditions Reports, B*, 1:1–135
- FISHER HI (1968) The "two-egg clutch" in the Laysan Albatross. *Auk* 85:134–136
- FISHER J (1952) *The Fulmar*. Collins, London
- GAIN L (1914) *Oiseaux antarctiques*. Documents Scientifiques de la Deuxième Expédition Antarctique Française. 200 pp.
- HARPER PC (1983) Biology of the Buller's Shearwater (*Puffinus bulleri*) at the Poor Knights Islands, New Zealand. *Notornis* 30:299–318
- HARRIS MP (1966) Breeding biology of the Manx Shearwater *Puffinus puffinus*. *Ibis* 108:17–33
- IMBER MJ (1976) Breeding biology of the Grey-faced Petrel *Pterodroma macroptera gouldi*. *Ibis* 118:51–64
- JOUANIN C, ROUX F, MOUGIN JL AND STAHL JC (2001) Prelaying exodus of Cory's Shearwaters *Calonectris diomedea borealis* at Selvagem Grande (30°N, 16°W). *Journal für Ornithologie* 142:212–217
- MOUGIN JL (1970) Le Pétrel à menton blanc *Procellaria aequinoctialis* de l'île de la Possession (archipel Crozet). *L'Oiseau et la Revue Française d'Ornithologie* 40(sp. n°):62–96
- MOUGIN JL (1984) La ponte du Gorfou macaroni *Eudyptes chrysolophus* de l'archipel Crozet. *L'Oiseau et la Revue française d'Ornithologie* 54:281–291
- MOUGIN JL, DESPIN B AND ROUX F (1986) La détermination du sexe par mensuration du bec chez le Puffin cendré *Calonectris diomedea borealis*. *Comptes Rendus de l'Académie des Sciences de Paris* 302:91–96
- MOUGIN JL, GRANADEIRO JP AND OLIVEIRA P (1996) L'évolution des effectifs des reproducteurs chez le Puffin cendré *Calonectris diomedea borealis* de Selvagem Grande (30°09'N, 15°52'W) de 1992 à 1995. *Boletim do Museu Municipal do Funchal* 48:171–178
- MOUGIN JL, JOUANIN C AND ROUX F (1990) Chronologie de la reproduction chez le Pétrel-tempête de Castro *Oceanodroma castro* (Harcourt). *L'Oiseau et la Revue Française d'Ornithologie* 60:136–150
- MOUGIN JL, JOUANIN C AND ROUX F (2000a) Démographie du Puffin cendré *Calonectris diomedea* de Selvagem Grande (30°09'N, 15°52'W). *Revue d'Écologie (Terre et Vie)* 55:275–290
- MOUGIN JL, JOUANIN C AND ROUX F (2000b) The attendance cycles of the Cory's Shearwater *Calonectris diomedea borealis* on Selvagem Grande. *Comptes Rendus de l'Académie des Sciences de Paris* 323:385–390
- PINDER R (1966) The Cape Pigeon, *Daption capensis* Linnaeus, at Signy Island, South Orkney Islands. *British Antarctic Survey Bulletin* 8:19–47
- PLANT AR (1989) Incubation and early chick-rearing in the Grey-backed Storm Petrel (*Garrodia nereis*). *Notornis* 36:141–147
- PRÉVOST J (1953) Notes sur la reproduction du Fulmar antarctique *Fulmarus glacialis* (A. Smith). *Alauda* 21:157–164
- RICHDALE LE (1965) Biology of the birds of Whero Island, New Zealand, with special reference to the Diving Petrel and the White-faced Storm Petrel. *Transactions of the Zoological Society of London* 31:1–85
- RYDER JP AND SOMPPPI PL (1979) Female-female pairing in Ring-billed Gulls. *Auk* 96:1–5

- SCHRAMM M (1983) The breeding biologies of the petrels *Pterodroma macroptera*, *P. brevirostris* and *P. mollis* at Marion Island. *Emu* 83:75–81
- SCOTT DA (1970) *The breeding biology of the Storm Petrel Hydrobates pelagicus*. PhD thesis, Oxford University, Oxford
- STRANGE IJ (1980) The Thin-billed Prion, *Pachyptila belcheri*, at New Island, Falkland Islands. *Gerfaut* 70:411–445
- TICKELL WLN AND PINDER R (1966) Two-egg clutches in albatrosses. *Ibis* 108:126–129
- WARHAM J (1962) The biology of the Giant Petrel *Macronectes giganteus*. *Auk* 79:139–160
- WARHAM J (1990) *The Petrels. Their ecology and breeding systems*. Academic Press, London
- WARHAM J, WILSON GJ AND KEELEY BR (1982) The annual cycle of the Sooty Shearwater *Puffinus griseus* at the Snares Islands, New Zealand. *Notornis* 29:269–292
- WILLIAMS TD (1989) Aggression, incubation behaviour and egg-loss in Macaroni Penguins, *Eudyptes chrysolophus*, at South Georgia. *Oikos* 55:19–22