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BREEDING OF WEDGE-RUMPED STORM-PETRELS (*OCEANODROMA TETHYS*) IN NORTHERN CHILE

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Nidificación de la Golondrina de Mar Peruana (*Oceanodroma tethys*) en el norte de Chile.

Key words: Wedge-rumped Storm-petrel, *Oceanodroma tethys,* breeding colony, Chile.

Storm-petrel (Hydrobatidae) reproduction along the Southeastern Pacific coast is poorly understood and, for some species, the location of breeding grounds is not known at all (Carboneras 1992, Birdlife International 2004). Some authors have suggested that some of these species may even breed in the inland desert (Hellmayr 1932, Murphy 1936). Only in the last decade have some colonies been discovered in coastal areas of Peru and Chile (e.g., Jahncke 1993, Hertel & Torres-Mura 2003, Ayala *et al.* 2004), but virtually nothing is known of their overall population numbers and trends (Carboneras 1992, Birdlife International 2004).

The Wedge-rumped Storm-petrel (*Oceanodroma tethys*) has two known subspecies. The Galapagos Storm-petrel (*O. t. tethys*) breeds on the Galapagos Islands throughout most of the year, but mainly from April to October (Harris 1969, Swash & Still 2000). The Peruvian Storm-petrel (*O. t. kelsalli*) has been traditionally reported to breed only on islands off Peru (Murphy 1936, Carboneras 1992, Ayala *et al.* 2004) during the austral autumn, between April and July (Murphy 1936, Ayala *et al.* 2004). Recently, Simeone *et al.* (2003) reported a small breeding colony of this species on Isla Grande in northern Chile, thus considerably expanding its southern breeding range on the Pacific coast. In the present note we further investigate the colony at Isla Grande to characterize the breeding habits of this species in northern Chile.

Isla Grande (27º14'S, 70º58'W) is a 54-ha island located 0.9 km from the mainland, 30 km south of the city of Caldera in northern Chile. The area has an arid mediterranean climate with mean annual precipitation of 25 mm and mean annual temperatures ranging from 13ºC to 20ºC (Di Castri & Hajek 1976). The substrate is mostly rocky and the scarce

TABLE 1. Measurements (mm) and weights (g) of unsexed adult Wedge-rumped Storm-petrels (*Oceanodroma tethys*) and their eggs from Isla Grande, northern Chile. Values are mean ± SD. Sample sizes are given in parentheses.

	Present study	*O. tethys kelsalli* (Ayala *et al.* 2004)	*O. tethys tethys* (Murphy 1936)
ADULT BIRDS			
Total length	148.3 ± 3.8 (9)		
Bill length	11.7 ± 0.4 (9)	12.1 ± 0.2 (6)	12.9 (22)
Bill depth	3.7 ± 0.3 (9)		
Bill depth with nostrils	5.1 ± 0.3 (9)		
Tarsus	22.2 ± 0.6 (8)	21.7 ± 1.0 (6)	22.8 (22)
Middle toe with claw	19.3 ± 1.2 (8)		
Wingspan	359.8 ± 7.1 (9)		
Wing length	126.9 ± 2.4 (9)	123 ± 2.6 (6)	134 (22)
Weight	22.8 ± 1.9 (6)	23 ± 2 (6)	
EGGS			
Length	26.3 ± 0.5 (8)	26.2 ± 1.6 (12)	26.7 (1)
Width	19.4 ± 0.5 (8)	19.5 ±0.7 (12)	19.9 (1)
Weight	5.1 ± 0.4 (6)		

vegetation is dominated by low shrubs such as *Frankenia chilensis*, *Nolana sedifolia* and *N. crassulifolia* and a single cactus species, *Eulychnia breviflora*. The island is free of terrestrial predators and has no human population.

We made day-visits to the island on 21 February 2003, 9 and 23 February 2004, and from 23 to 25 July 2004. During February 2003, three incubating storm-petrels and their eggs were removed from their nests and measured. During February and July 2004, we conducted an extensive search for nests, mostly at the periphery of the island; in February 2004, six more incubating birds and their eggs were removed from their nests, measured, and weighed. Birds and eggs were measured with calipers and a metal ruler to the nearest 0.5 mm and were weighed with a spring scale pesola to the nearest 1 g. All birds and their eggs were returned to their nests after handling. We considered nests to be crevices which contained incubating birds, unattended eggs, or egg shells and feces. All measurements and weights are expressed as mean ± SD unless otherwise stated.

We compared measurements of birds from Isla Grande with the mean values ± SD reported by Ayala *et al.* (2004) for *O. t. kelsalli* in Peru using a one-way ANOVA. We also compared our data with those obtained by Murphy (1936) for *O. t. tethys* in the Galapagos using a one-sample t-test, this being necessary as mean values reported by Murphy indicated no SD. The experimentwise type I error for simultaneous inferences was controlled through the Bonferroni method (Beal & Khamis 1991). In this method, the type I error probability, usually 0.05, is divided by the number of comparisons performed (three in this case) and rejection is decided at the calcu-

TABLE 2. Breeding activity (number of nests) of Wedge-rumped Storm-petrels (*Oceanodroma tethys*) from Isla Grande, northern Chile.

	9 February 2004	23 February 2004	23–25 July 2004
Adult with egg	28	22	0
Adult with chick	2	6	0
Unattended egg	8	6	20
Egg shells	4	5	36
Unoccupied*	10	6	46
TOTAL	52	45	102

*Only feces and footprints were evident.

lated significance level (in this case, P = 0.017).

All nests found were located in natural rock crevices. A total of 12 crevices ranged from 7–16 cm in height (11.3 ± 2.7), 15–48 cm in width (25.3 ± 10.3), and 20–53 cm in depth (33.2 ± 8.5). Nests were hollow scrapes in the soil and no nest material was evident. Eggs were oval in shape, completely white, without marks of any kind. Egg measurements are given in Table 1.

We captured and measured a total of nine breeding adults of unknown sex at Isla Grande (Table 1). No significant differences (one-way ANOVA $P > 0.017$) were found for bill, tarsus, and wing length between these birds and those of *O. t. kelsalli* from Peru reported by Ayala *et al.* (2004). Birds of Isla Grande were significantly smaller for bill ($t = -8.01$, $P < 0.0001$) and wing length ($t = -9.00$, $P < 0.0001$) than those of *O. t. tethys* from Galapagos reported by Murphy (1936), but were similar in tarsus length ($t = -2.91$, $P = 0.0224$). Murphy (1936) stated that the Peruvian Storm-petrel averages slightly smaller in all dimensions, particularly in wing length, than the Galapagos subspecies. Thus we are inclined to consider *O. t. kelsalli* as the subspecies present on Isla Grande.

In early February 2004, we checked a total of 52 nests: 54% contained incubating birds and only 4% had adults raising chicks (Table 2). In late February, we checked a total of 45 nests: 49% contained incubating birds and 13% adults with chicks. During July 2004, none of the nests had adults and nocturnal visits confirmed that no birds were attending the colony at all. It is noteworthy that 35% of the nests in July contained only egg shells and 20% unattended eggs (Table 2). It is likely that these eggs and shells were remains from the previous nesting season (or seasons) that had not yet been discarded. Carboneras (1992) suggests that storm-petrels have a rather low breeding success compared with other seabirds, egg infertility and chilling being the most common causes for egg mortality.

Assuming early February as the time of first hatchings, and considering that incubation usually takes 6–7 weeks in storm-petrels (Carboneras 1992), the first egg laying may have occurred sometime around late December (early summer). If chicks fledge after 7 to 11 weeks (Carboneras 1992), fledglings are likely to abandon the colony between mid March (late summer) and mid April (early fall). By the time of our visit to Isla Grande in July (mid winter), no breeding activity was apparent, suggesting that the Wedge-rumped Storm-petrel has no winter breeding in this area.

In Peru, *O. t. kelsalli* breeds during the fall and Ayala *et al.* (2004) found incubating birds at Chao and Corcovado Islands (8°S) during early April, whereas Beck (*in* Murphy 1936) reported birds with eggs and chicks during early May at the Pescadores Islands (11°S) and chicks during July at San Gallán Island (13°S). A similar breeding pattern has been described also for Markham´s Storm-petrel (*Oceanodroma markhami*) at Peruvian colonies (Jahncke 1993, García-Godos *et al.* 2002). On the tropical

Galapagos Islands, *O. t. tethys* breeds throughout most of the year with a peak activity between April and October (Harris 1969, Swash & Still 2000).

Our data contrasts with the breeding patterns described for the Wedge-rumped storm-petrel both on the Galapagos Islands and along the Peruvian coast. It seems that birds in arid mediterranean Chile have adopted a summer breeding strategy rather than a year-round or winter nesting. A possible explanation might include an adjustment of the breeding season to local food availability, so as to coincide with the time of the year with highest food availability and optimal weather conditions (Lack 1954). In the less seasonal tropics (e.g., Galapagos), productivity is relatively uniform throughout the year, and so too is seabird breeding (Harris 1969, Hamer *et al.* 2002). In Peru, coastal upwelling (strongly linked to marine productivity) is almost permanent throughout the year due to the trade winds, with some places being even higher during winter (Rojas de Mendiola 1981, Huyer *et al.* 1987, Tarazona *et al.* 2003). Isla Grande is located at the southern edge of the Northern Upwelling Region (*sensu* Escribano *et al.* 2003), where upwelling is more seasonal and intense during spring (Escribano *et al.* 2003, Halpin *et al.* 2004). In accordance with this, Murphy (1936) reported that the Peruvian Pelican (*Pelecanus thagus*) and Peruvian Booby (*Sula variegata*) nest throughout the year along the Peruvian coast, but adopt a single breeding season during austral spring and summer in north and central Chile. An exception to this latitudinal trend seems to be the Humboldt Penguin (*Spheniscus humboldti*), which has developed a two-peak breeding season both in Peru and central Chile, despite the obvious differences in marine productivity at both regions (see Simeone *et al.* 2002). More detailed studies would be desirable to estimate the colony size at Isla Grande and further investigate the breeding strategy of this storm-petrel in northern Chile.

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