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BREEDING BIOLOGY OF THE KELP GULL (*LARUS DOMINICANUS)* AT SANTA CATARINA COAST, BRAZIL

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Resumo. – Biologia reprodutiva de *Larus dominicanus* (Lichtenstein, 1823) no litoral de Santa Catarina, Brasil. – A gaivota *Larus dominicanus* é amplamente distribuída no Hemisfério Sul e suas populações tem se expandido em ambos Hemisférios. No Brasil são encontradas colônias reprodutivas a partir do litoral do Rio de Janeiro até Santa Catarina, sendo assim, esse trabalho tem como objetivo apresentar informações sobre a biologia reprodutiva de *L. dominicanus* nas ilhas costeiras de Santa Catarina. As amostragens foram realizadas no período de Julho 1996 a Dezembro 2006, sendo que o período de Março a Junho foi utilizado para o deslocamento dos adultos em direção às ilhas, demarcação de território e construção dos ninhos. Os primeiros ovos foram colocados em meados de Julho, e os primeiros filhotes foram avistados em Agosto. A média do comprimento, peso e volume dos ovos foram menores em Moleques do Sul enquanto que os maiores valores para a largura, peso e volume ocorreram em Tamboretes.

Abstract. – The Kelp gull, *Larus dominicanus*, is widely distributed in the Southern Hemisphere, and its population has expanded in both Hemispheres. Breeding colonies in Brazil are found from the coast of Rio de Janeiro southwards to Santa Catarina. This paper provides information on the breeding biology of *L. dominicanus* on coastal islands of Santa Catarina. Population monitoring, nest and egg counts, and measurements were made from July 1996 to December 2006. From March to June of each year, we measured adult gull movement to islands, territorial establishment, and nest construction. Egg laying started in mid July, and nestlings were first seen in August. The average length, weight, and volume of the eggs were smaller than in Moleques do Sul Island while the width, weight, and volume of eggs were higher than on Tamboretes Island. *Accepted 8 July 2009.*

Key words: Kelp gull, *Larus dominicanus*, breeding biology, Santa Catarina, Brazil.

INTRODUCTION

The Kelp gull *Larus dominicanus* (Lichtenstein 1823) is widely distributed in the southern hemisphere, occurring in New Zealand, Australia, southwest of Africa (Watson 1975, Mclachlan & Liversidge 1978, Brooke & Cooper 1979), from north Peru to Argentina (Sick 1997), on Falkland Islands, the Antarctic Peninsula, and most of the islands in the southern Pacific and Atlantic (Higgins & Davies 1996).

In Brazil, reproductive colonies of *L. dominicanus* are found from the coast of Rio de Janeiro south to Santa Catarina (Sick 1997). The reproductive process extends from the June–November, the end of the Austral winter until late spring. One to three eggs are laid per nest (Branco 2004) and incubated for 27

(Watson 1975, Malacalza 1987) to 31 days (Crawford *et al.* 1982).

Kelp gulls are generalistic feeders (Murphy 1936, Brooke & Cooper 1979, Emslie *et al.* 1995, Quintana & Yorio 1998), foraging on a variety of prey in varied habitats (De La Peña 1978, Burger 1988), and readily adapt to use food resources resulting from human fishing, refuse disposal, and kleptoparasitism (Coulson & Coulson 1983, Burger 1988). These factors have contributed to the population expansion of this gull species. Gulls in the Northern (Kadlec & Orury 1968, Spaans 1971) and Southern Hemisphere (Malacalza 1987) can have negative effects on other coastal birds (Furness & Monaghan 1987) and human activities (e.g., risk of aircraft bird strikes and transfer of diseases on humans and pets; Blokpoel & Tessier 1986, Yorio *et al.* 1998).

The breeding biology of Kelp gulls has been studied intensively in the South Pacific and Argentina. Though commonly reported in Brazilian ornithological surveys, there exists only sporadic information on ecological aspects of this gull in Brazil (Prellvitz *et al.* 2009). This paper presents new data on the reproductive ecology of *L. dominicanus* on coastal islands of Santa Catarina, currently considered its main nesting area within the country.

METHODS

Area of study. Adult gull populations, nests, eggs/nest ratios, and egg and hatching sizes were recorded monthly in the nesting sites of *L. dominicanus*, on the northern Santa Catarinaís coast toward the south (Branco 2003). On Pássaros Islands (26°22'10"–48°31'11"W), belonging to the Archipelago of Tamboretes, data collection extended from July 2000 to August 2001, and from July 2002 to August 2003; on Itacolomis Islands (24°42'36"S–48°37'06"W), from July 1997 to December 2003; on Deserta Island (27°16'23"S–48°19'53"W), from November 1998 to September 2000; on Moleques do Sul Islands (27°51'S–48°26'W), sampling was made between June 2000 to December 2006. On Lobos Islands (28°26'50"S–48°42'37"W), forming the most southerly known nesting site of this species in Brazil (Branco 2004), data were gathered from July to December 2002.

At each reproductive site, number of Kelp gulls present, number of eggs per nest, egg length and width (cm), egg volume (cm^3), and egg mass (g) was determined monthly. Material used to manufacture nests was recorded for each site. The volume of the eggs was determined by the equation of Hoyt (1979): $Vol(cm^3) = Kv \times Lt \times Wid^2$, logo: $Kv = V/Lt \times Wid^2$ (with Kv = estimated coefficient of volumetric of 0.5205; Lt = total length; Wid = greater width of the shaft).

We recorded in the observations growth stage and mass (g) of nestlings/juveniles and measured the length of the bill culmen (Lt_{bill}). For biometrics of eggs and nestlings, we used a 0.05 mm caliper and spring scales for 100, 350, and 500 g, with accuracy of 1, 3, and 5 g, respectively.

Stages of nestling development were defined to age in days, using established criteria of length of culmen and bill and plumage characteristics (Branco 2004, modified). As such we defined the following age classes: young I - one to four day old nestlings, average length of bill = 1.97 ± 0.30 cm (range: 1.1–2.3), with "the egg tooth" in the bill and few feathers on the body; young II - five to ten days old, with Lt_{bill} = 2.98 ± 0.60 cm (range: 2.4–3.5), without egg tooth and with definite feather plumage, no longer found in the nest; young III - 11 to 21 days of age, with Lt_{bill} = 4.00 ± 0.42 cm (range: 3.6–4.1), plumage uniformly distributed over the body and showing appearance of rectrices and remiges (Cannon); young IV - 22 to 34 days of age,

bill length 4.44 ± 0.43 cm (range: 4.2–4.7), actively moving in colony, with plumage, rectrices, and remiges well developed; and juvenile - >35 days of age to fledging, bill length of 4.68 ± 0.45 cm).

Data analysis. In determining egg volumes, we sampled nests with one to three eggs, marked "A," "B," and "C" according to the order of deposition when three were present. Average volume of eggs for each sample area, year of sampling, and order of deposition was calculated using analysis of variance (ANOVA), tested for homogeneity of variance (Bartlett test) and for normal distribution (Kolmogorov-Smirnov test). Existence of significant differences between the mass of same age cohorts of young between study sites was determined using non-parametric analysis of variance (Kruskal-Wallis) and ANOVA (Zar 1999). To test for existence of significant differences between sizes and volumes of eggs, the average difference was determined and compared via Tukey-Kramer tests. The Student t-test was used to verify existence of significant differences ($P < 0.05$) between volumes of eggs gathered from Itacolomis and Desert islands.

RESULTS

The abundance of *L. dominicanus* at nesting sites varied depending on the stage of the reproductive cycle and latitude. Patterns of population rise and fall showed similar fluctuations between sites, with populations fairly stabile from August to October, followed by declining numbers in November and abandonment of nesting islands by December, except those islands of the Moleques do Sul where adult Kelp gulls are found throughout the year (Fig. 1). Between March and June, adult Kelp gulls moved from the continent to the island nesting sites, established territories and constructed nests.

Nests were constructed on the ground. Grass was used as nesting material on Tamboretes, Itacolomis, Deserta, and Moleques do Sul. On the islands of Lobos, an excess of rabbits, introduced by local fishermen, consumed virtually all the vegetation. Nests there were made from remains of stems, roots, and fragments of rock.

The first eggs were laid in mid-July, and deposition increased to a peak in August, with a major decline during September. New eggs were not found in the colony once October began (Fig. 2). Number of eggs per nest ranged from one to three. On Moleques do Sul Islands, Deserta, and Itacolomis more than 54.0% of the nests had two eggs, compared to 36.1% at Tamboretes and 49.3% at Lobos (Fig. 2). On Deserta, Tamboretes, and Lobos, nests with three eggs were more common than those with one egg, while in Moleques and Itacolomis nests with one egg were more common than those with three (Fig. 2).

Nestlings appeared in August, and reached peak numbers in October. Numbers gradually declined until December, when the islands were abandoned and gulls returned to the mainland. The exception to this timetable was Moleques do Sul Islands, where nestlings/juveniles remained present until January (Fig. 1).

The maxima for average width, mass, and egg volume were obtained on Tamboretes Islands while mimina were found on Moleques do Sul (Table 1). Egg volumes on Itacolomis and Deserta in 1999 ($t = 1.795$, $P > 0.05$, df = 390) and among Tamboretes, Itacolomis, and Moleques in 2001 ($F_{2\text{-}208} = 2.332$, $P > 0.05$) were similar. The average volume of same-numbered eggs in the laying sequence was significantly different between the islands Tamboretes, Deserta, and Moleques in 2000 for eggs "A" ($F_{2\text{-}186} = 7.821$, $P < 0.001$) and "B" ($F_{2\text{-}157} = 6.943$, $P < 0.001$). No significant difference was found between sites in 2000

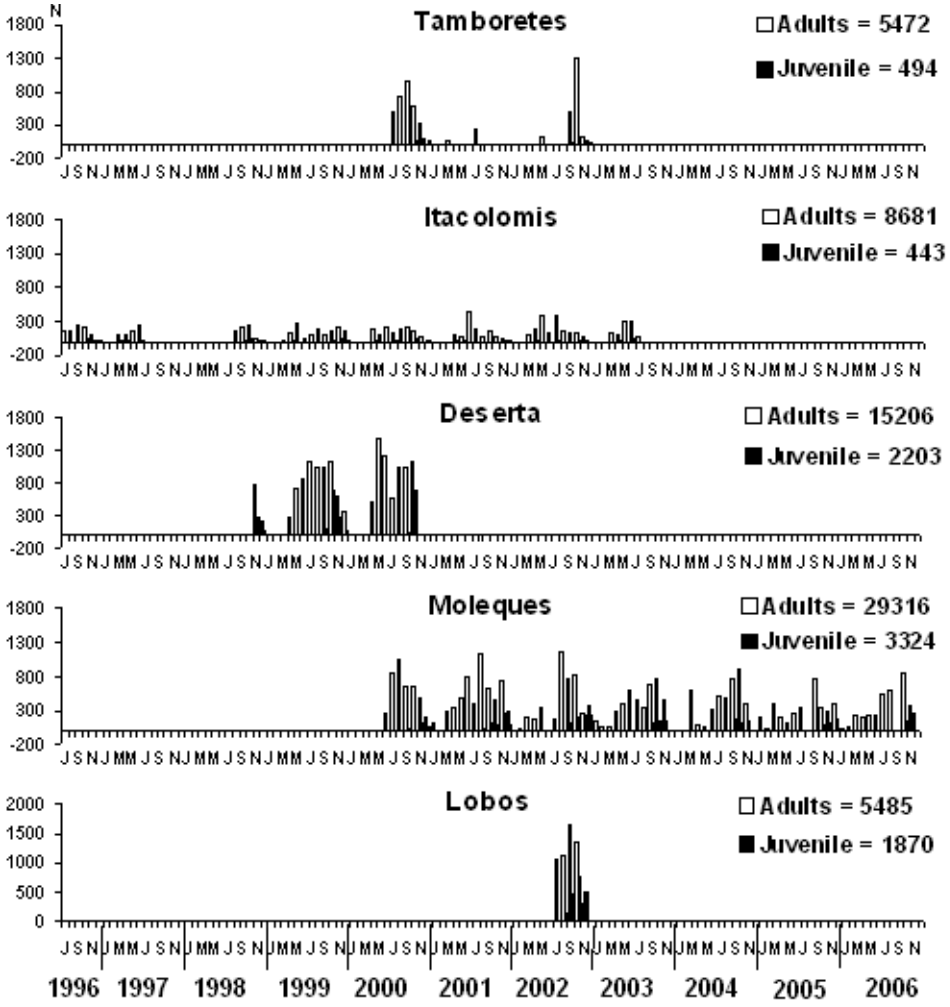

FIG. 1. Monthly abundance of adults and nestlings of *Larus dominicanus* at nesting sites on the islands of Tamboretes, Deserta, and Moleques from 1996 to 2006.

for the volume of "C" eggs ($F_{2\text{-}63} = 1.708$, $P > 0.05$) (Fig. 3).

In 2002, the volumes of eggs "A" ($F_{2\text{-}174} = 4.022$, $P < 0.01$) and "C" ($F_{2\text{-}26} = 6.447$, $P < 0.001$) were different at Tamboretes, Lobos, and Moleques while "B" eggs were similar ($F_{2\text{-}84} = 1.029$, $P > 0.05$) (Fig. 4). The differences between the first and last eggs laid were attributed to lower average volumes of eggs laid in Moleques do Sul.

The average volume of eggs "A" ($F_{6\text{-}377} = 2.014$, $P > 0.05$) and "B" ($F_{6\text{-}261} = 1.33$, $P > 0.05$) measured 2000 to 2006 on Moleques do Sul showed no significant annual differences. Egg "C" volumes there were significantly higher ($F_{5\text{-}50} = 3.02$, $P < 0.05$) in 2000 and 2001 when compared with 2002 and 2003 data (Fig. 5).

Nestlings showed a gradual increase in body mass with increasing age of specimens

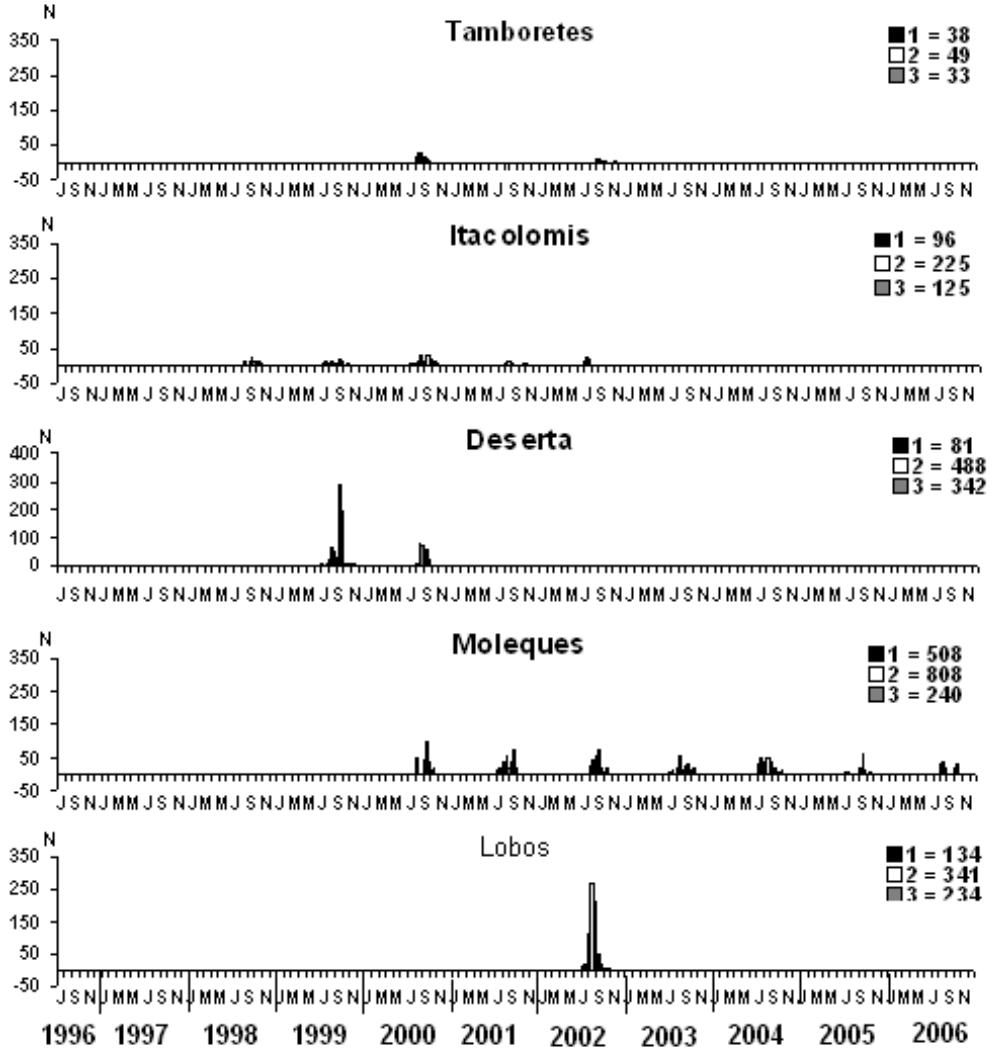

FIG. 2. Monthly abundance of nests with one, two, or three eggs of *Larus dominicanus* at nesting sites on the islands of Tamboretes, Deserta, and Moleques from 1996–2006.

(Figs. 6, 7). Due to the small number of nestlings caught on Itacolomis in 1999 it was not possible to compare nestling masses with those of Deserta island (Fig. 6a). Along the Santa Catarina coast, we recorded significant differences in the body mass of nestlings within age classes of the same year: in 2000, for age class II ($F_{2\text{-}27}$ = 7.21, P < 0.001) and III ($F_{2\text{ -}12}$ = 10.54, P < 0.001) (Fig. 6b): in 2001, in age class II ($F_{2\text{-}18}$ = 4.338, P < 0.01) and possibly within the juveniles (Fig. 6c); in 2002, in age class I ($F_{2\text{-}19}$ = 3.603, P < 0.001) and juveniles (Fig. 6d). Comparing only the hatchlings on Moleques do Sul, we recorded significant differences in body mass between age classes II ($F_{5\text{-}115}$ = 4.73, P < 0.01), III ($F_{5\text{-}97}$ = 4.30, P < 0.05), IV ($F_{6\text{-}59}$ = 3.14, P < 0.01), and juveniles ($F_{2\text{-}20}$ = 3.57, P < 0.05; Fig. 7).

Table 1. Biometrics, mass, and volume of eggs sampled from *Larus dominicanus* on the islands of Tamboretes, Itacolomis, Deserta, Moleques do Sul, and Lobos Islands during the nesting seasons 1996-2006.

Island	N	Length (mm)		Width (mm)		Mass (g)		Volume (cm^3)
		Range	Mean ± SD	Range	Mean±SD	Range	Mean±SD	Range
Tamboretes	164	6.5–7.9	7.17 ± 0,27	4.5–5.3	4.91 ± 0.15	68.5–126.0	96.78 ± 9.86	89.97 ± 7.05
Itacolomis	94	6.3–8.0	7.18 ± 0,26	4.1–5.2	4.83 ± 0.22	62.0–102.0	86.27 ± 10.03	87.63 ± 9.31
Deserta	300	6.3–8.0	7.15 ± 0,30	4.3–5.4	4.89 ± 0.17	60.0–110.0	92.11 ± 8.27	89.33 ± 8.11
Moleques	744	6.0–8,0	7.01 ± 0,31	4.1–5.3	4.83 ± 0.19	52.0–120.0	83.87 ± 9.61	85.53 ± 8.91
Lobos	142	6.4–8.2	7.12 ± 0,29	4.5–5.2	4.87 ± 0.14	69.0–105.0	88.96 ± 6.79	88.23 ± 6.83

DISCUSSION

Reproductive asynchrony within a bird species distributed over a broad geographic range is often linked to differing day length and/or food supply in the environment (Crawford *et al.* 1982, Yorio *et al.* 1994). In South Africa, *Larus dominicanus* initiates nesting colony formation September–October, and the first eggs appear in November (Crawford *et al.* 1982). In Argentina, the nesting pairs arrive in July with egg deposition between October–November (Malacalza 1987, Yorio *et al.* 1994, Yorio *et al.* 1995, Borboroglu 2002). On the coast of Santa Catarina, the first Kelp gulls are seen on nesting sites in March, and eggs first appear between July–October, which is consistent with Prellvitz *et al.* (2009). A similar timing of behavior was also reported in the coastal populations of Paraná (Krull 2004) and São Paulo (Campos *et al.* 2004).

Nest location varies with the site topography (e.g., on soil, bare rocks, or on/in vegetation). Nests used a variety of materials such as feathers, grasses, bone fragments, and rocks. Similar patterns of nest construction were recorded in Kelp gull populations of South Africa (Mclachlan & Liversidge 1978, Burger & Gochfeld 1980). Some gulls added seaweed and/or shells of shellfish (Crawford *et al.* 1982). In Argentina, nests made in grassy areas might include algae, plumes, and any vegetation available (Malacalza 1987) while nests on beaches might incorporate algae and gravel (Yorio & Borboroglu 2002). The average number of eggs per nest ranged in South Africa from 1.5–2.1 (Burger & Gochfeld 1981, Crawford *et al.* 1982), compared to 2.3–2.5 in Argentina (Malacalza 1987). In the islands of Santa Catarina, nests with two eggs predominated. The average length (7.04 cm ± 2.56 and 7.11 cm ± 0.31), width (4.66 cm ± 1.98 and 4.86 cm ± 0.18), mass (86.8 g ± 5.93), and volume of eggs (78.55 ± 7.88 cm^3 and 78.53 cm^3 ± 7.09) recorded on the coast of Argentina (Malacalza 1987, Yorio & Borboroglu 2002, respectively) and on the coast of Paraná (7.07 cm ± 0.29, 4.99 cm ± 0.10, and 91.08 cm^3 ± 6.44) (Krull 2004) were lower than those obtained for all the sites of Santa Catarina except Moleques do Sul.

The average volume of eggs "A" and "B" laid by Kelp gulls in Argentina was similar, but in three egg nests, "A" and "B" were significantly larger in volume than "C" (Yorio & Borboroglu 2002). In Santa Catarina, egg volumes were different between study sites and between reproductive years sampled, which is consistent with Prellvitz *et al.* (2009).

Our sampling methods did not permit us to gauge hatching success, but it was 51% in Deserta Island (Prellvitz *et al.* 2009). On the coast of Argentina, egg loss was estimated to be between 28.17 to 28.88% (Yorio & Borboroglu 2002) and 51.5 % to 58.3% (Malacalza 1987), respectively. First losses occurred

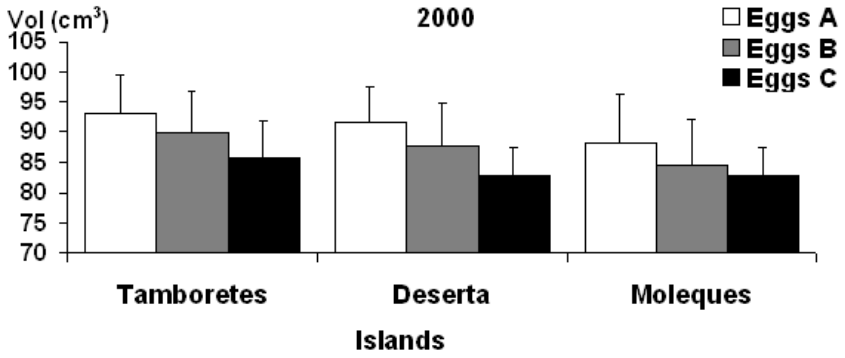

FIG. 3. Average volume of first (A), second (B), and third (C) eggs/nest for *Larus dominicanus* in 2000 on three islands on the coast of Santa Catarina. Vertical bars indicate the standard error of mean values.

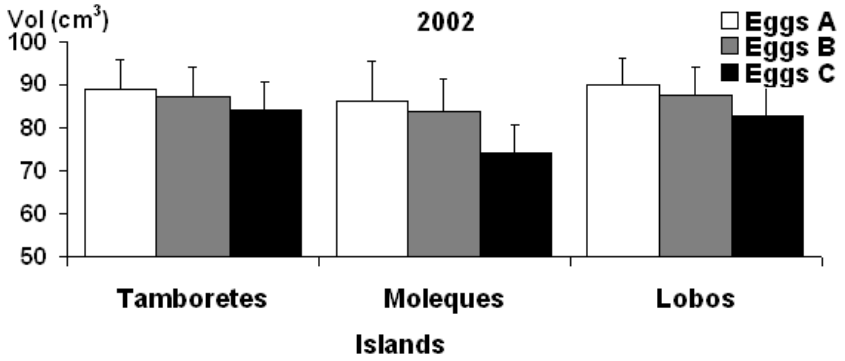

FIG. 4. Average volume of first (A), second (B), and third (C) eggs/nest for *Larus dominicanus* in 2002 on three islands on the coast of Santa Catarina. Vertical bars indicate the standard error of mean values.

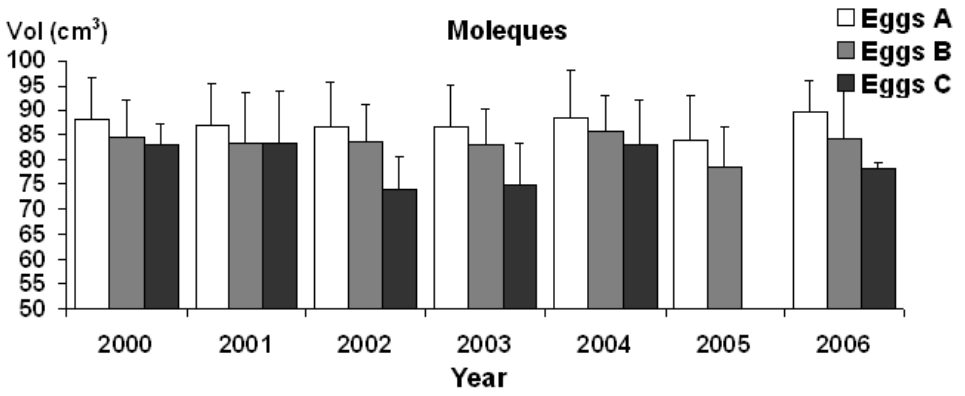

FIG. 5. Average volume of first (A), second (B), and third (C) eggs/nest for *Larus dominicanus* in 2002 at the reproduction sites on Moleques do Sul, Santa Catarina. Vertical bars indicate the standard error of mean values.

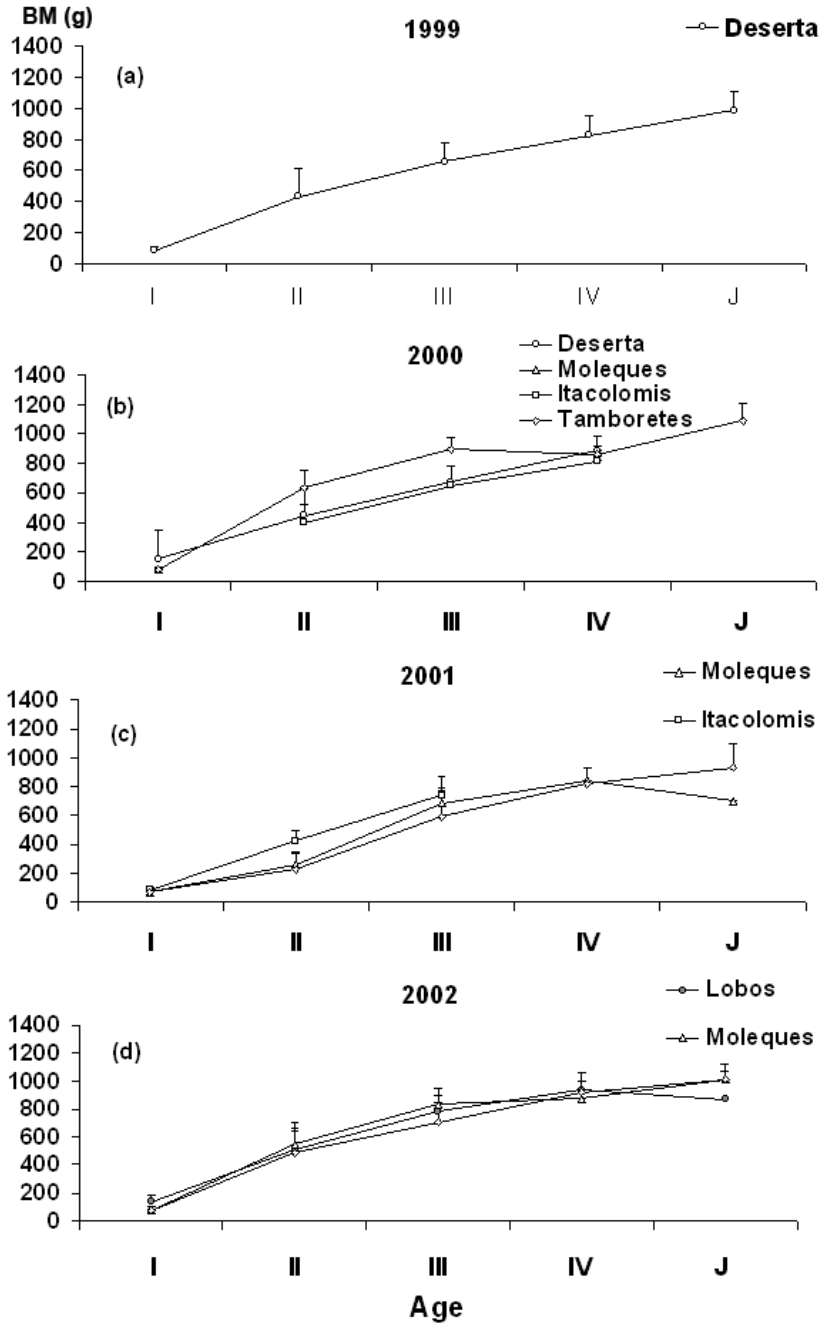

FIG. 6. Relative body mass in relation to age class of Kelp gull hatchlings/juveniles sampled on islands of Santa Catarina in 1999 (6a), 2000 (6b), 2001 (6c), and 2002 (6d). Vertical bars indicate standard deviation of means, * = indicates significant differences tested by ANOVA.

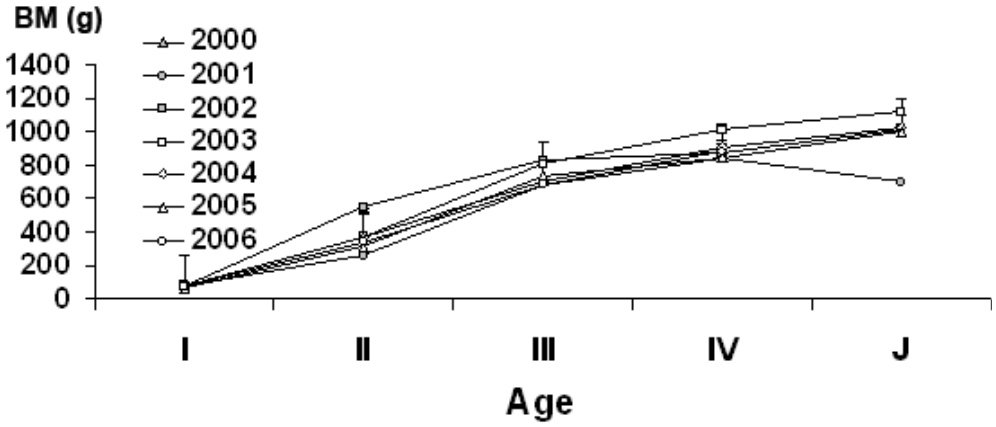

FIG. 7. Relative body mass in relation to age class of Kelp gull hatchlings/juveniles sampled on Moleques do Sul, Santa Catarina, from 2000–2006. Vertical bars indicate standard deviation of means, * = indicates significant differences tested by ANOVA.

in mid-October (Malacalza 1987), continuing until the beginning of December (Yorio & Borboroglu 2002), and so extended much later than observed on the sites of Santa Catarina.

The average body mass of nestlings varied significantly between the islands studied, probably due to limited or variable food supply before or during the reproductive season. The nestlings born in the colonies of the Islands Itacolomis, Moleques do Sul, and Lobos had the highest average bill length and body mass/age class, probably as a result of the increased fish availability from discarded "by-catch" by the fishing of Sea-Bob Shrimp Inc., boats that work near these sites during much of the year (Branco 2001, 2004).

L. dominicanus is an extremely opportunistic species and usually forages on refuse associated with fisheries (Fordham 1970, Abrams 1983, Burger 1988, Steele & Hockley 1990, Yorio & Caille 1999, Bertellotti & Yorio 2000, Bertellotti *et al.* 2001, Branco 2001) and urban trash/garbage dump sites (Bertellotti & Yorio 1999, Ludynia *et al.* 2005). This type of information is crucial in understanding the foraging ecology, population dynamics, potential conflict with human activities (Bertellotti & Yorio 2000), or its potential as a vector of pathogens, such as enterobacter, to humans and domestic animals (Frere *et al.* 2000).

Newly hatched nestlings from Argentina had on average a longer bill length (1.9 ± 1.3 cm) and a higher mass (79.5 ± 5.0 g) (Malacalza 1987) than we found on the islands of Tamboretes and Deserta. According to the same author, the growth curve in tarsal length of juveniles hatching from "C" eggs was lower, but at 28 ± 1 day, it equalized to that found for nestlings from "A" and "B," reaching the asymptotes in approximately 40 days (Yorio & Borboroglu 2002). Although the methodology applied on the Santa Catarina coast was inappropriate for direct comparison with the results from Argentina, we also observed a gradual increase in body mass between successive age classes of nestlings.

In general, five to six weeks-old nestlings can be found settled at sea near the colony, and by seven to eight weeks they join the adult gulls on mainland. A similar behavior was reported for this species on the coast of Argentina (Malacalza 1987, Yorio *et al.* 1994, 1995).

Following the worldwide trend of research about the dispersal and consequent occupation of new habitats by gulls, the data obtained in this work will help to track changes in the colonies along the Brazilian coast. Of special concern are populations of Kelp gulls near urban and protected areas.

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