

Aggregation Behaviour in South American Sea Lion (*Otaria flavescens*) Pups at Isla de Lobos, Uruguay

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Abstract

When otariid females leave the colony to forage at sea, pups stay in the rookery and gather in groups in which they rest and play. The major selective benefits of these groups are to develop social skills and physical abilities, as well as to reduce the risk of aggression by adults. The aim of this research was to study the aggregation behaviour in South American sea lion (*Otaria flavescens*) pups at Isla de Lobos, Uruguay, during the first 2 mo of life. During the breeding season of 2007 (January to March), from 0800 to 1800 h, instantaneous scan-samples were conducted every 2 h to record the number of groups in the area, number of pups per group, behavioral state, and location (land or sea). The number of groups increased during the first month, being positively correlated with the total number of pups in the area. A group size of two pups was most frequent (60.2%), followed by three pups (20.1%). Rest was the most frequent activity during most of the study period, and pup group activity did not vary over the weeks. The type of activity varied according to the time of day, with pups most active early in the morning, and also according to group size (the larger the group size, the higher the proportion of individuals resting in the group). The proportion of groups at sea increased with pup age, and interactions in a large group were more frequent at sea than on land. This research represents one of the first detailed analyses about aggregation behaviour in otariid pups.

Key Words: South American sea lion, *Otaria flavescens*, pinnipeds, pups, aggregation

Introduction

Otariids (fur seals and sea lions) are gregarious mammals with highly seasonal breeding in the majority of species (Riedman, 1990). Females give birth to one pup per breeding season, and they are the sole providers of nutrition. Pups are highly

precocious and, given that maternal behaviour is selective in most cases, the premature locomotory capabilities enable them to keep in close contact with their mothers and so diminish the probability of being injured by other females (Bowen, 1991; Harcourt, 1992). Mothers alternate foraging trips at sea with nursing periods ashore (Boness & Bowen, 1996). When mothers leave the colony, pups stay in the rookery and gather in groups (also known as “pup pods”; Bowen, 1991). In these groups, pups rest and play; and in some species, group formation serves as a thermoregulatory mechanism (e.g., Northern fur seals [*Callorhinus ursinus*]; Ohata & Miller, 1977).

Social play between two or more individuals is very conspicuous in otariid pups, serves to develop social skills and physical abilities, and changes in frequency with ontogeny (see Bartholomew, 1959; Gentry, 1974; Arnold & Trillmich, 1984; Harcourt, 1991a). In males, for example, development of social skills is important for the establishment and defense of a territory as an adult. Moreover, swimming play enables the pups to acquire competitive foraging as well as predator avoidance skills (Harcourt, 1991a, 1991b). Nevertheless, social play is also costly since it might be one of the most energetically demanding activities of pups (Coelho, 1974). In addition, when mothers are ashore, social play increases the probability of separation and so the risk of injury by adults and of predation (Arnold & Trillmich, 1984; Harcourt, 1991a, 1991b). Therefore, the regular lack of maternal attention together with the precocious nature of otariid pups makes the study of the behavioural ontogeny particularly interesting since it will be crucial for the integration of complex social systems as adults (Bartholomew, 1959).

The South American sea lion (*Otaria flavescens*) (Shaw, 1800) is an otariid that is distributed along the Atlantic coast from Rio de Janeiro (ca 23° S), Brazil, to the southern limit of South America, and from there, along the Pacific coast to Zorritos (ca 4° S), Peru (Vaz-Ferreira, 1981).

This sexually dimorphic and polygynous species breeds during the austral summer, with most parturitions occurring in January. After a perinatal period of about a week, mothers begin to alternate foraging trips at sea (*ca* 3 d), with nursing bouts ashore (2 d). Pups may be nursed for 1 y or longer (Campagna & Le Boeuf, 1988) and form groups during maternal absences (Vaz-Ferreira, 1981; Campagna et al., 1992). The main causes of pup death are infanticide by conspecific males and starvation following mother-pup separation and failure to reunite (Vaz-Ferreira, 1965; Vaz-Ferreira & Achaval, 1979; Campagna et al., 1988a, 1988b, 1992; Vila & Cassini, 1990).

Since Bowen (1991) suggested that pup group formation may serve to reduce the risk of aggression by adults, and due to the importance of studying the behavioural ontogeny in otariids, the aim of this research was to study aggregation behaviour in *O. flavescens* pups at Isla de Lobos, Uruguay, one of the breeding areas along the Atlantic coast of South America. Specifically, the study focused on the number and size of the pup groups as well as on the type of activity (rest, interaction on land, interaction at sea), including the ontogenetic changes that occur during the first 2 mo of life.

Materials and Methods

Study Area and Study Period

Fieldwork was conducted at Isla de Lobos (35° 01' S; 54° 52' W) during the breeding season of 2007, between 19 January and 22 March, corresponding to a pup age of a few days to about 2 mo. About 800 adult females and 350 adult males of *O. flavescens* can be found on this island in summer (Enrique Páez, pers. comm.). The 42-ha granite island is located 6 nmi from the city of Punta del Este in the Atlantic Ocean. Its longest axis is *ca* 1,230 m, oriented from south to north, and its maximum width is *ca* 690 m from west to east. Most of the central area is a plateau covered with grass, calaguala ferns, and cactus.

The study area was the zone "La Cachimba-El Mero," where approximately 80 pups are born each summer, representing 20 to 25% of the total pups at Isla de Lobos (Enrique Páez, pers. comm.). This area, which was 75 m long and 25 m wide, was located at the north-northwestern section of the island and consisted of a flat rocky area with a slope of no more than 10°. Near the northern edge of the colony, there was a small beach of sand and gravel. The South American fur seal (*Arctocephalus australis*) also breeds in this zone. Since fur seals are much more abundant, *O. flavescens* breeding groups are surrounded by them.

Data Recording

A pup group was defined as two or more pups in physical contact. The behavioral states of individuals were defined as (1) rest, including sleep, or (2) interact (i.e., bite, sniff, move, or swim), and activities occurring in the same group were mixed (minimum size in mixed groups is three: two pups interacting and one resting).

Instantaneous scan-samples (Altmann, 1974) were conducted on land at the edge of the colony with binoculars 10 × 50 mm every 2 h from 0800 to 1800 h over the 9-wk study period, and the number of pup groups in the area, number of pups per group, behavioral state of individual pups, and location (land or sea) were recorded. The total number of pups in the area was counted at 0700, 1200, and 1700 h. All observations were made by MR.

Data Analysis

A Spearman's coefficient correlation was used to analyse the daily number of pup groups per scan (total number of groups/total number of scans) and the maximum number of pups (maximum value of the three daily counts). Temporal variation in group size was tested using $r \times c$ contingency table analysis considering the pup group size categories of 2, 3, and 4+ pups by week, excluding the last week because few groups were observed. The pup group size category of 4+ pups was pooled because the frequency was less than 10%.

The number of pup groups in each activity (rest, interaction—including land and sea, and mixed) was examined by week, time of day, and pup group size. Furthermore, in the case of interaction pup groups, the number of pup groups at sea was examined by week and pup group size. For these analyses, $r \times c$ contingency table analysis was used. Correlation analysis was done in *Statistica 6.0*, while $r \times c$ contingency tables were performed online (www.physics.csbsju.edu/stats). Significance level was set at $\alpha = 0.05$.

Results

From 19 January to 22 March, 1,501 pup groups were observed. The number of pup groups varied over time—increasing during the first month and declining after 20 February. The number of pup groups (see Figure 1) was correlated with the number of pups in the study area ($r = 0.8144$, $p < 0.001$).

Pup group size of 2 was most frequent (60.2%), followed by groups of 3 (20.1%) and 4+ (19.7%) pups. Group size (see Figure 2) varied significantly over the weeks of the study period ($X^2_{1,474,14} = 33.6$, $p = 0.002$ for categories 2, 3, and 4+ pups/group and 1 to 8 wks).

The predominant activity was rest (57.4%), followed by interaction (40.3%). Mixed activity

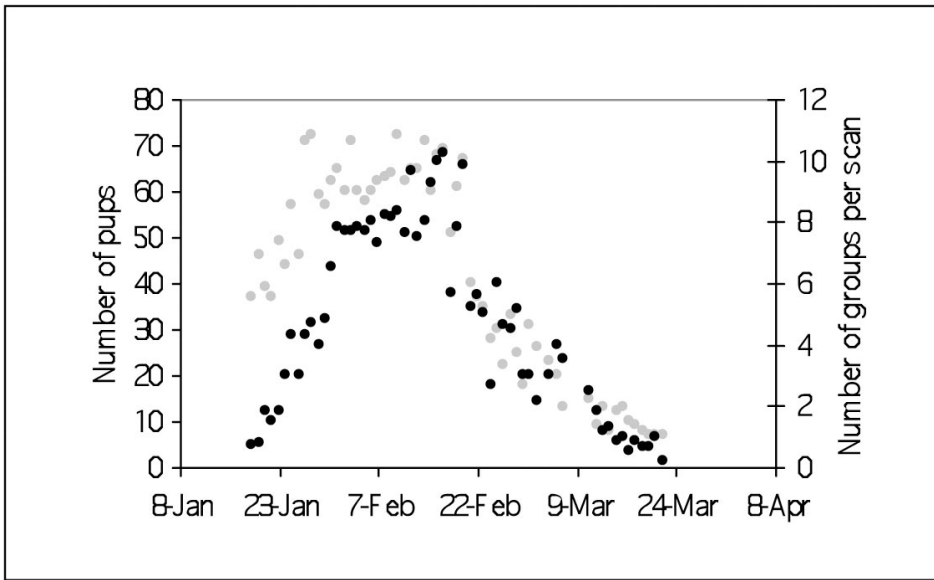


Figure 1. Temporal variation over the study period in the number of pup groups of South American sea lions per scan (black) and in the total number of pups in the study area (gray) at Isla de Lobos

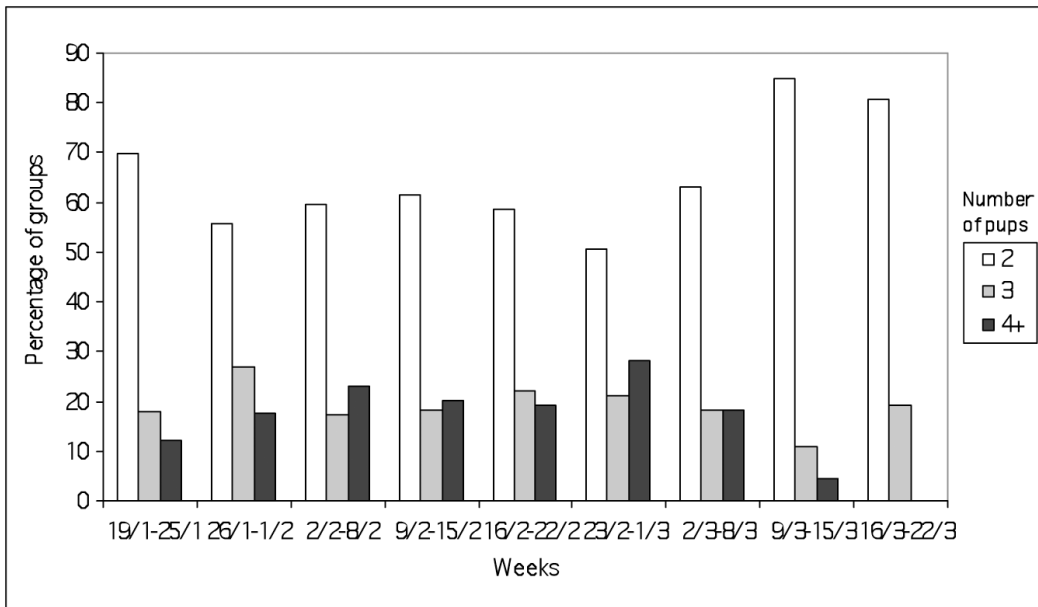


Figure 2. Percentage of pup groups ($n = 1,501$) of South American sea lions in each group size category (2, 3, and 4+ pups) by each week of the study period

constituted only 2.3%. Rest was the most frequent activity during almost all of the weeks. Activity in pup groups did not vary over the 9-wk study period ($X^2_{1467.8} = 12.9, p = 0.115$). However, it varied significantly according to the time of day

($X^2_{1467.5} = 64, p < 0.001$ for categories rest and interaction and 8 to 18 h). Resting pup groups increased throughout the day, while interaction pup groups decreased (see Figure 3a).

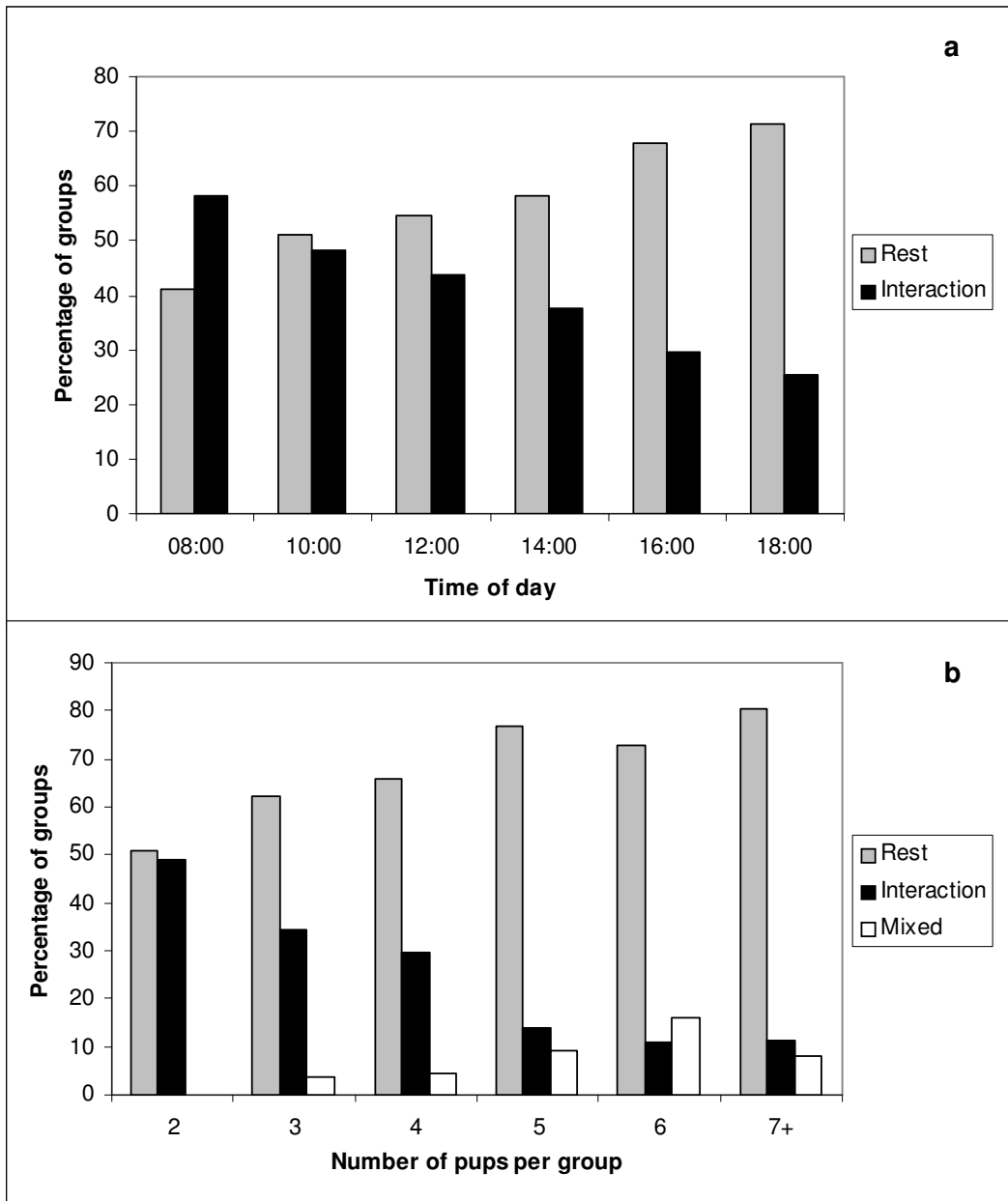


Figure 3. (a) Percentage of pup groups ($n = 1,501$) in rest and interaction of South American sea lions at different times throughout the day; (b) Percentage of pup groups ($n = 1,501$) in each activity by group size (from 2 to 7+ pups).

Activity varied in pup groups according to group size ($X^2_{1467.5} = 78.4$, $p < 0.001$ for categories rest and interaction and 2 to 7+ pups/group, and $X^2_{597.8} = 35.1$, $p < 0.001$ for categories rest, interaction, and mixed and 3 to 7+ pups/group). The larger the group size, the higher the proportion of resting groups (Figure 3b).

Twenty-two percent of pup groups were recorded at sea. The proportion of pup groups at sea (see Figure 4) increased significantly over the weeks of the study period ($X^2_{1,501.8} = 43.9$, $p < 0.001$). The number of interaction groups at sea varied significantly according to group size ($X^2_{605.3} = 29.2$, $p < 0.001$ for categories 2 to 5+ pups/

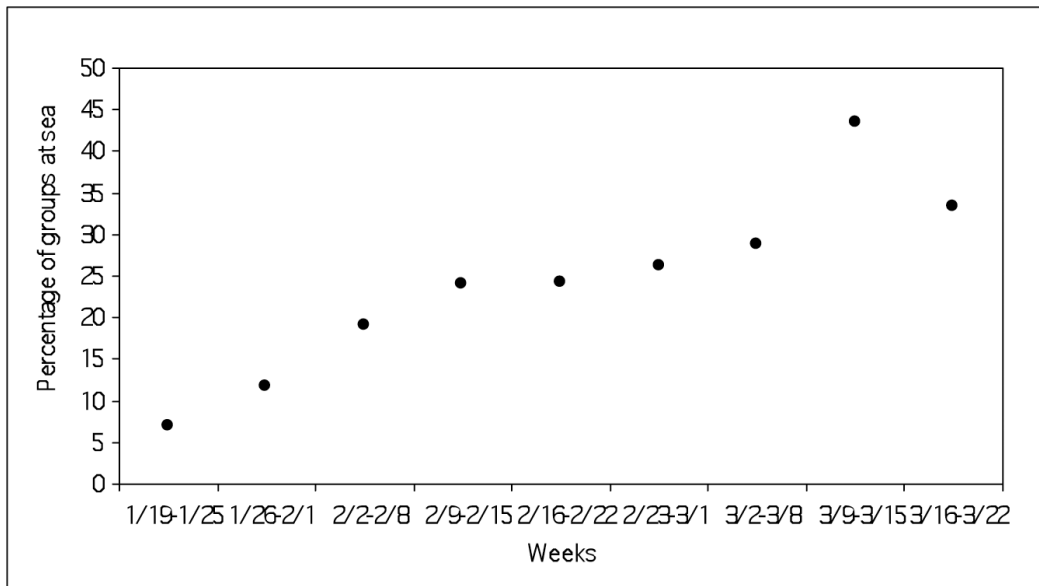


Figure 4. Percentage of pup groups ($n = 328$) of South American sea lions at sea by weeks of the study period

group); large groups in interaction were more frequent at sea than on land.

Discussion

The results of this study suggest that pup aggregation is frequent during ontogeny in South American sea lions at Isla de Lobos. This finding supports anecdotal reports for other otariids. Previous authors have suggested that the selective benefits of pup aggregation would include the development of social skills and physical abilities, and the reduction of risk of adult aggression (Bowen, 1991). Campagna et al. (1992) found that pup mortality in *O. flavescens* in Argentina was much less in rookeries of hundreds of individuals compared to solitary mating pairs for which the main causes of mortality were infanticide by conspecific young males and starvation following mother-pup separation and failure to reunite. As pups' aggregation behaviour was typical in the colonial context (Campagna et al., 1992), we could suggest that it contributed to pup survival. However, pup group size was not studied in those rookeries nor its relationship with male attacks.

The increase in the number of groups of *O. flavescens* pups over time until mid-February could be explained by the increase in the number of newborn pups due to parturitions, while the decrease observed since that date could be associated with the decreasing number of pups in the area due to their movement to other beaches with their mothers (Trimble, pers. obs.). The low number of pup groups formed during the first week is likely due to the close contact that pups maintain with

mothers during the perinatal period as well as to the lower degree of pup mobility.

Results also showed that *O. flavescens* pups at Isla de Lobos usually form small groups of two or three pups. This could be mainly explained by the low density of pups in the area. However, the great number of individuals of the sympatric species *A. australis* may also prevent *O. flavescens* pups from getting closer with each other to form bigger groups. During this study, we observed some interspecific groups of pups, but we did not record their presence.

Even though pup group size varied over the study period, we did not find an obvious trend since groups of two pups were the most represented in all weeks. We would have expected an increase in pup group size with age due to greater mobility as pups grew. This was found in *C. ursinus*, although on a larger scale: groups consisted of several dozens of pups at the beginning of the breeding season and after some time they consisted of several hundreds individuals (Bartholomew, 1959).

The finding of rest being the predominant activity in pup groups (57.4%) could mean that pups may need to save energy during maternal absences, and in this way, weight gain would be maximized. On the other side, interaction groups (40.3%) could be linked to the development of physical and social skills as previously mentioned. The very low frequency of groups with mixed activity may be partially explained by the predominance of group size of two pups in which rest and interaction cannot occur at the same time. Additionally, it can be a consequence of the low rate of sampling

(instantaneous scan sampling), which minimizes the likelihood of encountering brief activities.

Although the activity of pup groups did not vary significantly over the study period, we would have expected an increase in interaction with age since the physical and social abilities are greater as pups grow as has been found in *C. ursinus* (Bartholomew, 1959) and *Arctocephalus galapagoensis* (Galapagos fur seal) (Arnold & Trillmich, 1984). However, this trend might be counteracted if females' feeding trips were longer as pups grew since pups would need to fast for a longer period.

Variation in pup group activity during the day indicates that pups are most active early in the morning and rest more in the afternoon. Time variation in pup group activity has not been reported in other otariids.

The highest proportion of rest in larger pup groups could be explained by the dilution effect. Since pups in resting groups would be less aware of adult behaviour than when they are interacting, they would benefit from spending less time on vigilance (Krebs & Davies, 1993). Alternatively, interaction enhances the development of behaviours necessary for successful adult interactions. Resting in large groups might serve as a thermoregulatory mechanism.

The increase in the proportion of pup groups at sea over the weeks might be expected due to the development of locomotory abilities with age. In other otariids, it has been found that pups spend more time at sea as they grow (*C. ursinus*, Bartholomew, 1959; *A. galapagoensis*, Arnold & Trillmich, 1984; *A. forsteri* & *A. gazella*, Bowen, 1991; *A. australis*, Harcourt, 1991a). Interacting at sea may enhance swimming skills that eventually lead to predator avoidance and foraging skills after weaning. Larger group size at sea may reduce attacks by both conspecific males and other predators such as sharks.

To sum up, this research represents one of the first detailed analyses about aggregation behaviour in otariid pups. It would be very interesting to conduct similar studies in other rookeries along the distribution of *O. flavescens* so as to investigate the influence of different factors such as population density, adults' behaviour, and beach topography.

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