13 Attendance Behavior of Galapagos Sea Lions ≅ *F. Trillmich*

INTRODUCTION

Galapagos sea lions live under nearly the same environmental conditions as the Galapagos fur seal (Chapter 11) but cope with these conditions quite differently. Sea lions prefer flat beaches that are sandy or rocky, where they have easy access to relatively calm waters and can spend the hot hours around tidepools or, at some colonies, in the shade of vegetation (mostly *Cryptocarpus pyriformis*). Thermoregulatory problems tend to be less acute for seal lion female and pup pairs than for fur seals because of easy access to calm waters, which are safe even for small pups. Sea lion pups enter the sea when only about a week old, whereas fur seals spend their first 3 to 4 weeks on land. This difference may be due to dangerous breakers and currents along the rugged, rocky coasts preferred by fur seals (Chapter 11). The aim of this study was to provide data for comparing the maternal strategy of the large Galapagos sea lion with that of the much smaller, sympatric fur seal.

METHODS

Most of the work was done on Santiago Island at Punta Baquerizo (lat. 0°16′ S, long. 90°52′ W) during June and July 1977. Whenever no island name is mentioned in the Results section of this chapter, data refer to this 1977 period. These data were supplemented by observations on Santiago Island between 21 June and 21 July 1976, 16–19 November 1977, and 20 January to 3 February 1978. Additional observations were made at Punta Suarez on Española Island (lat. 1°22′ S, long. 89°44.5′ W) from 19 January to 7 March 1977. On Santiago Island, colonies were situated on sand beaches, whereas on Española Island the animals used a flat lava terrace having channels and tidepools.

On Santiago Island in 1976, thirty-nine pups were observed (not all from birth), and in 1977 twenty pups were studied from birth, ten of them for more than 20 days (mean = 31; range = 22–42 days). Five of the latter pups were weighed daily, and the other fifteen were weighed once a week. All were weighed with an accuracy

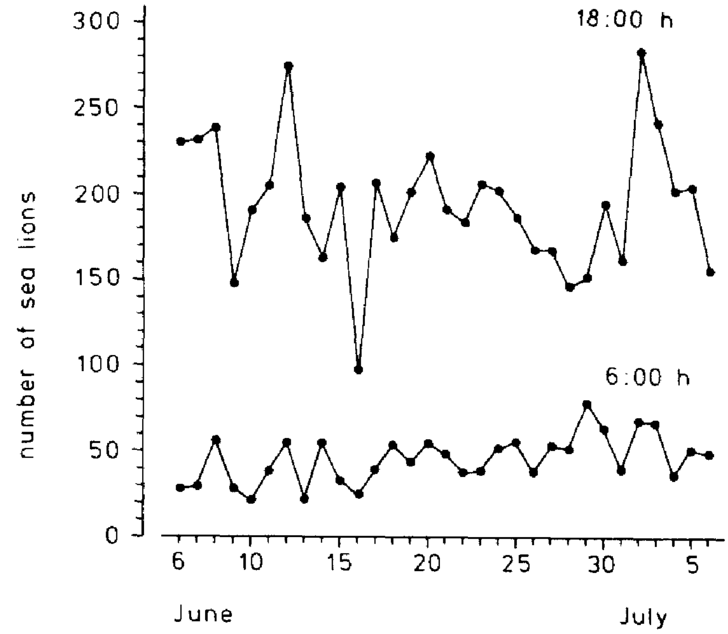

Fig. 13.1. Fluctuation of sea lion numbers in the colony on Punta Baquerizo, Santiago Island, between 6 June and 6 July 1977. Counts give total number of animals excluding pups. Upper curve: evening counts; lower curve: morning counts.

of ± 100 g. The same twenty pups were observed again in November 1977 and in January-February 1978. Pups were individually marked by numbers clipped into the hair of their backs with scissors; female were individually recognizable by natural marks on their skin or by voice peculiarities.

On Santiago Island, presence or absence of females was recorded every day at 0600 and 1800 hours, and about five times in between. In 1977 the colony was observed continuously on about 50% of the days. Regular night observations were impossible to make because the scissors marks on pups could usually not be recognized at night. On Española Island, twenty-two pups 5 to 7 months old were tagged with Dalton Jumbo tags. These tags could sometimes be read at night by flashlight without causing undue disturbance of the animals. Young of this age moved around much of the Punta Suarez area. Only eleven of the tagged animals were seen almost daily, but even they were frequently not found during checks. Because the females usually left before dawn and returned after dusk, no attendance records were obtained at Punta Suarez.

Due to the difficulty of observing known females, the partitioning of time between land and sea was analyzed only for mothers of the

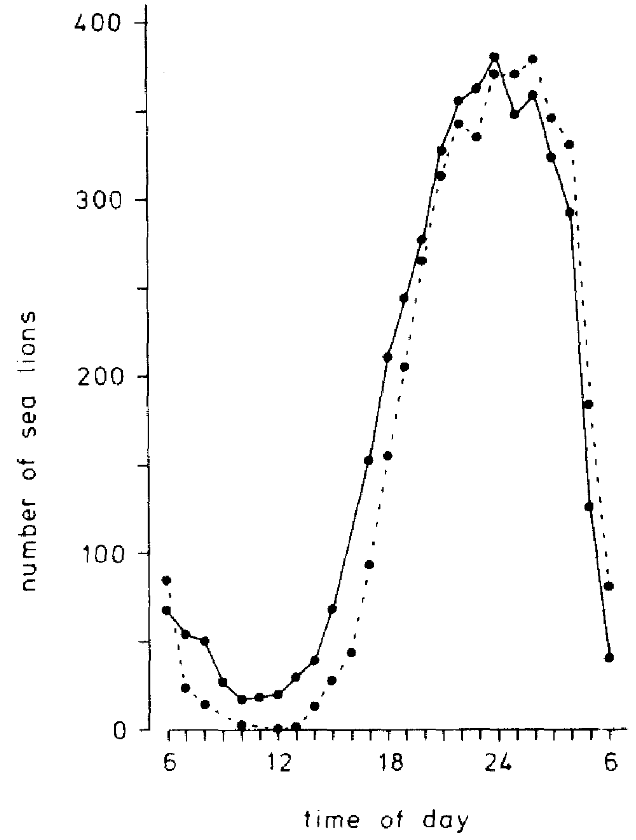

Fig. 13.2. Daily fluctuation of sea lion numbers in the Santiago colony. Counts through 24 hours on two full-moon days. Circles and dashed lines: 30 June 1977 (reproductive period, cold season). Circles and solid line: 24 January 1978 (nonreproductive period, warm season).

five daily-weighed pups on Santiago Island in 1977. For these females, unobserved morning departures of animals known to be ashore the previous evening were assumed to have occurred at 0500; unobserved night arrivals of females not present by evening were assumed to have occurred at 1900 hours. These hours, 0500 and 1900, represented respectively the midpoints of the decrease and increase in numbers ashore as observed during the two full-moon night counts. When both arrival and departure were unobserved, the visit was assumed to last 8 hours. The evidence for such visits is presented under Results.

Counts were made by walking along the perimeter of the colony. Hourly counts were made throughout two full-moon nights, one in the reproductive season and one in the warm season. Animals younger than a year were not counted. Calling activity—vocal ex-

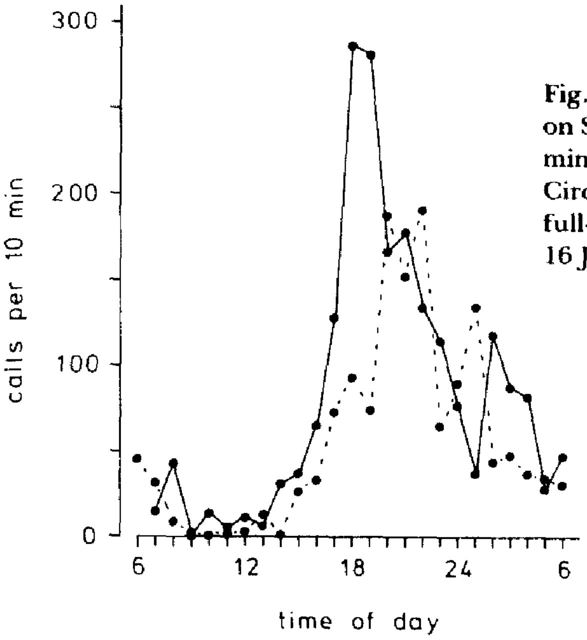

Fig. 13.3. Calling activity in the colony on Santiago. Calls were counted for 10 minutes at the beginning of every hour. Circles and dashed lines: 30 June 1977, full-moon night; circles and solid line: 16 June 1977, new-moon night.

changes that signify reunion of mothers and young—was measured by counting for a period of 10 minutes all calls of adults, immatures, and yearlings that were clearly audible from a fixed position in the colony. Calling activity was used as an index of nighttime arrivals of mothers.

RESULTS

Fluctuations of Female Numbers Ashore

SEASONAL. Sea lions did not appear to migrate in any regular fashion, although some dispersal of yearlings from island to island did occur. Counts on Santiago Island in June and July 1976 and 1977, in November 1977, and in January-February 1978, showed no clear change in sea lion numbers between the cold (reproductive) and warm seasons. Numbers sometimes varied widely from day to day (Fig. 13.1). The average number of sea lions counted in the evenings of June and July 1977 was 173 ± 42 (mean ± SD; N = 52), and in February 1978 it was 149 ± 53 (N = 11).

Individually known females and their tagged young were resighted in all study colonies at all times of the year, which suggests that they stayed there year-round. Also, of about 250 tagged pups and yearlings, more than 95% of the resightings made in the first 24 months of life came from their home colonies. However, some tagged juveniles did show some dispersal. Several yearlings from the Santiago Island colony were seen on Rabida Island, 23 km away, between observations on their birth colony. One yearling tagged on South Plaza Island swam to Santa Fe Island, where it was observed with its mother. A week later the same yearling was seen on Floreana Island, thus having traveled about 76 km. Such wide dispersal seems to be the exception; its exact extent cannot be assessed due to uneven sighting effort.

DAILY. Sea lions were away from the Santiago Island colony during the day and returned between 1600 and 2200 hours (Fig. 13.2) at a rate of about 70 animals per hour (18% of maximum number). They left at a greater rate of 125 animals per hour (33% of maximum number) before sunrise, between 0400 and 0600 hours. The maxima of animals ashore during the two full-moon counts were identical, further demonstrating that sea lion numbers did not change significantly between the warm and cold seasons. However, in the warm season fewer animals spent the day ashore than in the cold, reproductive season (Fig. 13.2).

Calling activity in the colony was roughly correlated with the number of sea lions present during the daylight hours (Fig. 13.3). This correlation broke down at night. Calling peaked in the evening when many females returned and reunited with their young. Thereafter it decreased greatly. A second peak of calling activity occurred between 0100 and 0400 hours—before the major exodus of animals from the colony. When most sea lions actually left the colony—between 0500 and 0600 hours—they called very little (compare Figs. 13.2 and 13.3).

LUNAR. Partial counts on one new moon and two half-moon nights (one decreasing and one increasing half moon) showed roughly similar patterns. Neither these daily fluctuations in numbers nor the counts every morning and evening over two months showed any unequivocal signs of a lunar rhythm of numbers ashore which was so obvious in the fur seals (Trillmich and Mohren, 1981).

Period of Dependence of Young

The breeding season of Galapagos sea lions was much longer than for the sympatric fur seal (Chapter 11) or for California sea lions on the California coast. The reproductive period of Galapagos sea lions shifted slightly from year to year and from island to island. For example, on Santiago Island pupping started around mid-May in 1976, and in 1977 the first pup was born on 15 June. The breeding season started earliest in the west of the archipelago (Fernandina Island: March) and latest in the southeast (Española Island: July-August). In 1977 pups were born on Santiago Island over 6–7 months, between June and November-December.

Pups molted when 4 to 5 months old and subsequently began to feed partly for themselves, as evidenced by the changing consistency of their scats. Normally pups did not appear to forage jointly with their mothers. However, in January-February 1978 pups at Santiago Island were sometimes observed returning to the colony with their mothers. On Española Island young were often observed leaving the colony with their mother but returning ashore alone shortly afterwards.

On average, female sea lions could successfully pup every year. All young suckled regularly when 6 months old, and the majority of them were weaned before 1 year of age. However, yearlings and even 2-year-olds often continued to suckle if their mothers failed to give birth that year. Of forty females for which accurate observations were made on Santiago Island in 1976 and 1977, eight (20%) were still accompanied by an older young (seven yearlings, one 2-year-old male) when giving birth again. In five of these cases the older young was driven off shortly after the new birth. In two cases the females allowed the older offspring (including the 2-year-old) and newborn to suckle simultaneously; the yearling suckled simultaneously with its younger sibling for at least one year. In the last remaining case, direct competition and fighting between the two young, possibly for milk, led to the death of the newborn.

The Feeding Pattern around Parturition

Females on Santiago Island, for which we have the best data, hauled out 1 or 2 days before parturition and gave birth in rocky parts of the colony or close to rock outcrops. They defended an area of about one body length around the newborn and frequently barked at and attacked approaching sea lions. They remained with their pups continuously for 6.8 ± 2.1 days after giving birth (N = 20). Estrus apparently occurred about 3 weeks after parturition because the females then became very attractive to small males. But as no copulations were observed for individually known females, the exact time between parturition and copulation is unknown.

Timing of Arrival and Departure for Mothers

Following the perinatal attendance, females established a routine schedule of spending the day at sea and the night ashore. Sea lions

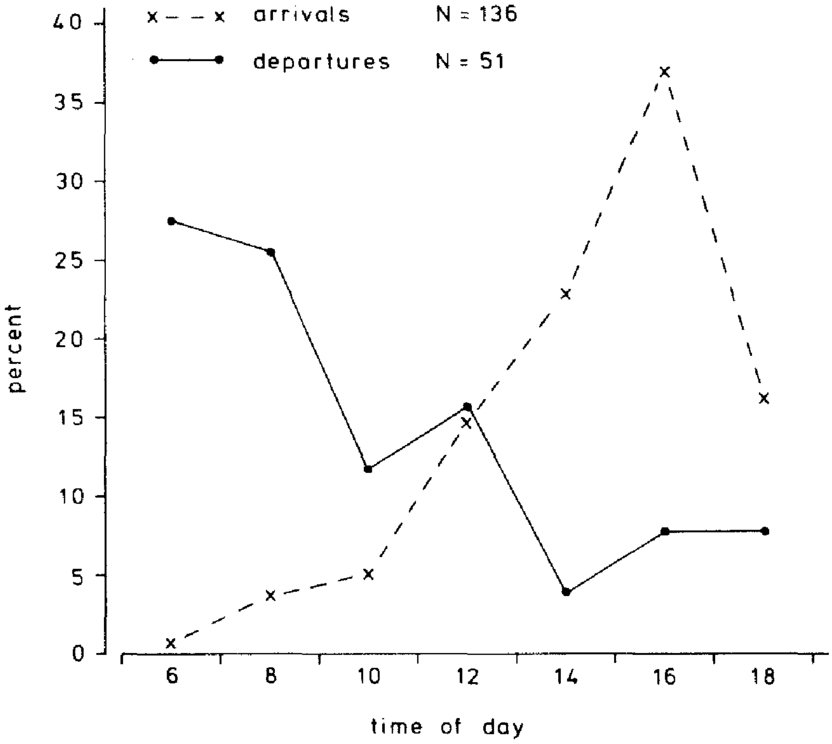

Fig. 13.4. Percentage of total arrivals and departures observed during daytime for 2-hour intervals. Note that daytime departures represent only 29% of total departures. Data from ten pups on Santiago, 1977.

of all ages and sexes (except pups) returned to the colony in the evening, many of them after nightfall, and left in increasing numbers from about midnight until dawn (Fig. 13.2). Females with pups followed much the same routine except that, in contrast to the animals in general, 84% of their arrivals occurred during the afternoon hours (Fig. 13.4). Unlike arrivals, daytime departures were rare and represented only 29% of total departures. Night observations, as well as the data in Figure 13.2, suggest that females left usually between 0400 and 0600 hours (Fig. 13.4).

Arrival and departure times were known for only a few presences and absences because mothers of pups often left before the early morning census. Of eighteen such stays ashore, females spent 66% of the time at night and 34% during the day. Of twenty-six such absences they spent 40% at night and 60% during the day. This difference was significant ($p < 0.05$; Wilcoxon test).

Some seasonal differences were found. During the warm season females on Española Island spent most of the daytime at sea and usually came ashore after dusk. The mothers of eleven regularly observed 5- to 7-month-old pups were in attendance on only 15% (N = 59) of the mornings and 14% (N = 160) of the evenings on which the young were found. In contrast, during the cold, reproductive season (June and July) the mothers of six pups on Santiago Island were in attendance on 22% of the mornings (N = 163) and on 55% of the evenings (N = 166).

The Normal Feeding Pattern

At Santiago Island the five females of daily-weighed pups spent an average of 48% (range = 38%–51%) of the total observation time ashore. Individual stays ashore, calculated by the assumptions discussed under the Methods section of this chapter, lasted between 6 and 34 hours, with a median of 13.75 hours. The time at sea, similarly calculated, varied between 6 and 58 hours, with a median of 12.0 hours. Eighteen presences with known arrival and departure times averaged 12.0 ± 7.6 hours in duration, and twenty-eight such absences averaged 17.9 ± 10.6 hours. The distributions of presence and absence durations (Fig. 13.5) were significantly different from each other (absences showed a distinct tail of long stays at sea) despite their similar medians (Chi-square test; $p < .025$). A cycle of attendance plus absence lasted more than 24 hours (N = 86) in only 22% of the observations. On average, females returned to their pups every night but would remain at sea every fifth night. In 42% of cases when a female was seen neither arriving nor departing, the pup gained weight overnight, proving that she had been ashore overnight. This conclusion was valid because females suckled their own pups exclusively (Trillmich, 1981).

Attendance data on females at Española Island during the warm season were hard to obtain because mothers usually returned after sunset and left before dawn, a behavior that was rare during the cold season. In nightly checks (between 2000 and 0400 hours) mothers were present in 55% of thirty-eight sightings of marked young, which suggests that the mothers of these ca. 6-month-old young returned ashore only every other night.

Weight Gain of Pups

Until at least 30 days after the perinatal attendance, male pups grew significantly faster than female pups (Mann-Whitney U-test; $p < 0.025$; Fig. 13.6). Male pups gained 154 ± 30 g/day; female pups gained 116 ± 40 g/day. Fasting pups lost between 107 and 288 g/24 hours with an average of 181 g/24 hours. These values were ob-

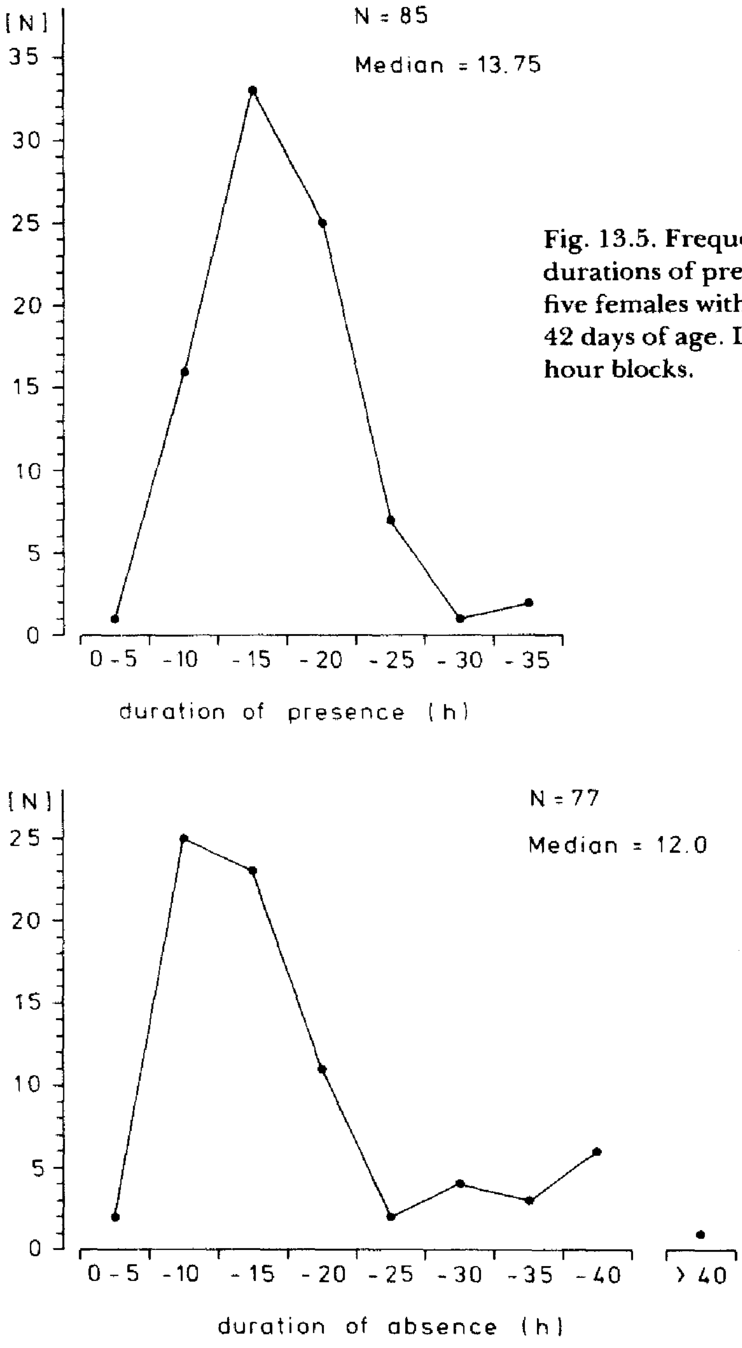

Fig. 13.5. Frequency distributions of durations of presence and absence for five females with pups between 7 and 42 days of age. Data are grouped into 5-hour blocks.

tained from three pups (weights between 6.5 and 9.3 kg) during the second consecutive day of their mother's absences, when the pups were presumably in a postabsorptive state. Pups that had drunk a lot of milk during one attendance (500–1,300 g weight gain) subsequently had increased weight loss (31 g/hour or 740 g/24 hours).

The rate of weight loss correlated with the previous weight gain ($r = 0.64$; $p < 0.05$).

The maximum amount gained by a pup during one attendance of its mother was 1.3 kg in 34 hours. This weight gain did not equal the amount of milk transferred since fasting pups lost about 200 g/24 hours. Therefore, this mother must have transferred at least 1.6 kg of milk during her attendance to produce a 1.3 kg weight gain. Sometimes a pup lost weight over 24 hours even though its mother had been with it. In the most extreme case weight loss was 300 g over 24 hours; during 12 hours of this period the mother had been in attendance.

DISCUSSION

Attendance of female Galapagos sea lions was difficult to monitor because arrivals and departures occurred mostly during the night (Figs. 13.2, 13.4). The maximum number of sea lions ashore occurred around midnight, when about twice as many were present as in an average evening count (compare data in Fig. 13.1). The diurnal fluctuation of calling activity (Fig. 13.3) further confirmed that many mother and pup reunions took place after dark. As both arrival and departure may have occurred at night, a female's attendance then may have been missed. Also, for an animal that usually returned in the afternoon, a slight shift in the arrival made mother and young reunion unobservable. Due to the synchrony of decrease and increase of sea lion numbers ashore, slight shifts in average arrival and departure times toward midnight (Figs. 13.2, 13.4) could make a colony appear deserted in the daytime. This effect was very obvious during the warm season on Española Island, where females were rarely in attendance during daylight hours. Day-to-day and even seasonal fluctuations in numbers, assessed by daylight counts, may thus be misleading indicators of actual events in a sea lion colony.

The effects of the lunar cycle, if any, on the number of sea lions ashore were not as obvious as in the sympatric fur seal (Chapter 11). Compared to the full moon counts shown in Figure 13.2, the fewest animals were ashore on one new-moon night and intermediate numbers were present during the moonlit parts of two half-moon nights. However, the data were insufficient to establish any firm relation with the lunar cycle.

The data suggest, surprisingly, that pups did not drink milk at

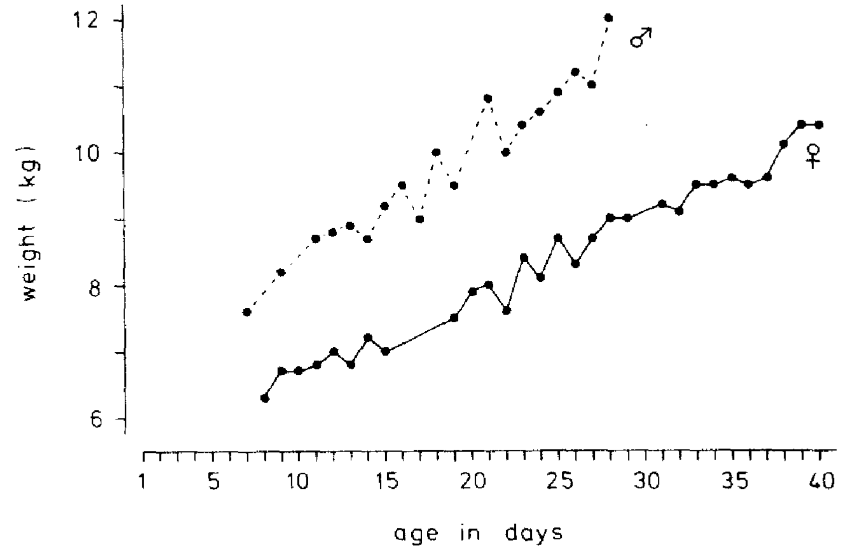

Fig. 13.6. Growth of one male and one female pup gaining weight at close to the average rate.

every reunion with their mothers. Several pups lost weight, one of them 300 g, during 24-hour periods when their mothers were known to be present (see "Weight Gain of Pups" in this chapter). Although slight milk uptake (100 to 200 g/24 hours) might have gone undetected, this seems unlikely to be the whole explanation, given the 24-hourly schedule of weighing and the limited accuracy of the scales (± 100 g). Behavioral observations showed that pups sometimes left their mothers shortly after reunion to play with other pups. Because of the short intervals between female attendances, pups may still have been satiated from milk taken up during the previous night. Mothers with small pups thus apparently formed more milk and came ashore more often than their pups needed. This interpretation is supported by the lack of any correlation between duration of female attendance and weight gain of her pup during that attendance; weight increase of pups was sometimes rapid and at other times gradual (Fig. 13.6).

During the warm season, females on Española Island spent more time foraging and made shorter and less frequent visits to shore than at other sites during the cold season. The different feeding pattern was presumably caused by the increased milk demand of the older and bigger pups. Furthermore, it is just during the warm season, when marine productivity is lowest, that the older pups need more milk for maintenance and growth. This combination may force their mothers to spend more time foraging, leading to shorter and less frequent female attendances.

For a hypothetical pup born in early July and weaned in April or May of the next year, we can roughly estimate the number of feeding trips its mother must make to raise it. Assuming that a female maintains the foraging pattern observed for mothers of young pups, she would make about 150 feeding trips during the cool season, i.e., during the 180 days from July to December. If she returned only every other night from January to April or May, she would make an additional 60 to 75 foraging trips. As young increasingly forage for themselves and demand less maternal investment, close-to-weaning females may make decreasingly frequent visits. Thus about 200 feeding trips may be made from birth to weaning. Time to weaning and number of feeding trips during this interval are much reduced compared to the sympatric Galapagos fur seal (Chapter 11).

Attendance patterns have been little studied in other species of sea lion. Peterson and Bartholomew (1967) found that early in the season—in June—California sea lion females were on land on only 50% of the observation days and that the frequency dropped to 10% of observation days in August. This frequency is certainly too low since even resident pups were observed on only 45% of the days. Early in the season females may have been in attendance every other day. The authors suggested that females attended older pups less frequently than young ones, but no quantitative comparisons with the Galapagos sea lion are possible.

Female Steller sea lions (*Eumetopias jubatus*) left their young overnight and were in attendance during the day (Gentry, 1970). Female absences, not including fifty-seven short overnight absences, averaged 2.3 days. If the overnight absences are included, the absence duration decreases to about 1.9 days. Because absence times of these females lengthened with age of the young, the attendance pattern of Steller sea lion females early in the season may be very similar to that of Galapagos sea lions.

It appears that sea lions have shorter cycles of absence and presence than fur seals. The Central Place Foraging model of Orians and Pearson (1979) predicts that for the exploitation of a patch of given quality, time in the patch should increase as traveling time to the patch increases. Because the larger sea lions swim faster than fur seals (Chapter 15), travel time to a given patch should be shorter for the former. Consequently, the ratio of travel cost to energy gained in the feeding area will be lower for the sea lions, making shorter trips to sea energetically economic. This hypothesis could explain the differences between fur seal and sea lion attendance patterns (see also Chapter 15).

SUMMARY

Attendance behavior of the Galapagos sea lion was studied at Punta Baquerizo, Santiago Island, in 1977, with supplemental observations at Punta Suarez, Española Island, Galapagos archipelago. The Punta Baquerizo site was a sandy beach, while the Punta Suarez site occupied a lava terrace. The breeding season varied in onset and duration from year to year. It usually lasted 16 to 40 weeks between June and December. Adults were in attendance at breeding sites throughout the year, which suggests that no annual migration occurred. Weaning occurred at 11 to 12 months of age. The weaning process was slow and not always total (a few females suckled both a yearling and a newborn). No data were collected on prepartum attendance patterns. The interval from parturition to copulation was about 3 weeks (exact duration unknown), during which time females made trips to sea. The duration of the first visit to land was about 6.8 days. All subsequent visits averaged 0.6 days, and about two hundred such visits were made prior to weaning. No data were collected on the portion of shore visits spent suckling by the pup. Females departed from shore in the morning hours and returned in the late afternoon or after dark. Some visits to shore were made only during the dark hours. The mean duration of absences from shore was 0.5 days. No data were collected on trends in duration of trips to sea throughout the season, but census data suggest that durations increased. No data were collected on the comparative attendance behavior of mothers and nonmothers.

Niche separation between the sympatric Galapagos fur seal and sea lion was more extensive than different habitat choice on land. While fur seals fed mostly at night and at shallow depths (Chapters 11 and 12) sea lions did most of their feeding during the day, thus also avoiding many thermoregulatory problems on land. Sea lion females returned almost daily to their pups and weaned them within one year. During the first month of life, male pups grew significantly faster than female pups. Differences between fur seal and sea lion attendance patterns are briefly discussed.