

TIMING AND DURATION OF FORAGING TRIPS IN MAGELLANIC PENGUINS

SPHENISCUS MAGELLANICUS

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SUMMARY

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A survey of nest relief times and nest occupation by Magellanic Penguins *Spheniscus magellanicus* was made with the aim of obtaining information about nocturnal versus diurnal activity. Nests were observed while both parents were engaged in nest guarding and foraging. Fifty nests were labelled and the parent staying in the nest was marked. All nests were inspected every two hours to record the arrival time of the unbanded parent, departure time of the banded penguin and arrival time of the latter. Length of foraging trips was distributed into two main groups of *c.* one and two days. Both groups, however, exhibited similar arrival times. Very few birds returned during the day and most departures from the nest occurred during hours of darkness. Thus, the pattern of nest occupation suggests that Magellanic Penguins forage during daytime and feed their brood during the night.

INTRODUCTION

Studies by several authors have suggested that most penguin species leave their breeding sites at dawn and return at dusk (Wilson 1985, Wilson *et al.* 1989, Wilson & Wilson 1990). In addition there is little information about nocturnal activity and feeding at sea and only some diving records have been made (Brooke & Prince 1991, Kooyman *et al.* 1992, Wilson *et al.* 1993). Observations at any colony of Magellanic Penguins *Spheniscus magellanicus* show that the parade of well-fed birds gradually increases during the evening hours, suggesting that both foraging and brood feeding would be related to circadian factors. Analysis of nest occupation also indicates that Magellanic Penguins return at dusk or later (Capurro *et al.* 1988). However, to

date, there are no studies of Magellanic Penguin behaviour during the night hours.

During a recent study of maximum diving depths (Scolaro & Suburo 1991), it was found that many banded birds were recovered between 21h00 and 08h00 the following day, suggesting that these birds were foraging nocturnally. Since knowledge of the exact time at which birds return to the nest is important for a complete understanding of penguin foraging behaviour, we have made a survey of nest relief times and nest occupation during both day and night hours.

METHODS

Observations were made at the breeding colony of Magellanic Penguins at Estancia San Lorenzo,

(42°04'S, 63°21'W) Argentina, during December 1989. At that time of the year, parents are engaged both in nest guarding and foraging. One parent takes care of the brood while the other goes to sea. The latter returns with food between 24 h and 48 h later on average (Scolaro 1984, Boersma *et al.* 1990, Scolaro & Suburo 1991). On return of the bird that has been foraging, roles are normally reversed.

Fifty nests with one adult and one or two chicks were marked. These nests were placed along two lines parallel to the sea shore, about 120 m from the hightide line. Shrubs close to the nest were labelled with a white ribbon and the adult staying in the nest was marked with a flipper band

carrying a glued depth recorder (Scolaro & Suburo 1991). All the nests were marked at the same time, between 20h00 and 21h00 on 18 December 1989, and time of banding was assumed to be 20h30 for all penguins. Sunset was at 21h30 and sunrise 05h30. Nest inspection began at 22h00 and was repeated every 2 h for the next 72 h. Each inspection round lasted 15 min. Three times were recorded: the arrival time of the unbanded partner, the departure time of the banded penguin, and the arrival time of the latter. It was assumed that penguins left or arrived at half-time between two nest inspections. Thus, if a banded penguin was observed at 22h00 but not at 24h00, its departure time was recorded as 23h00.

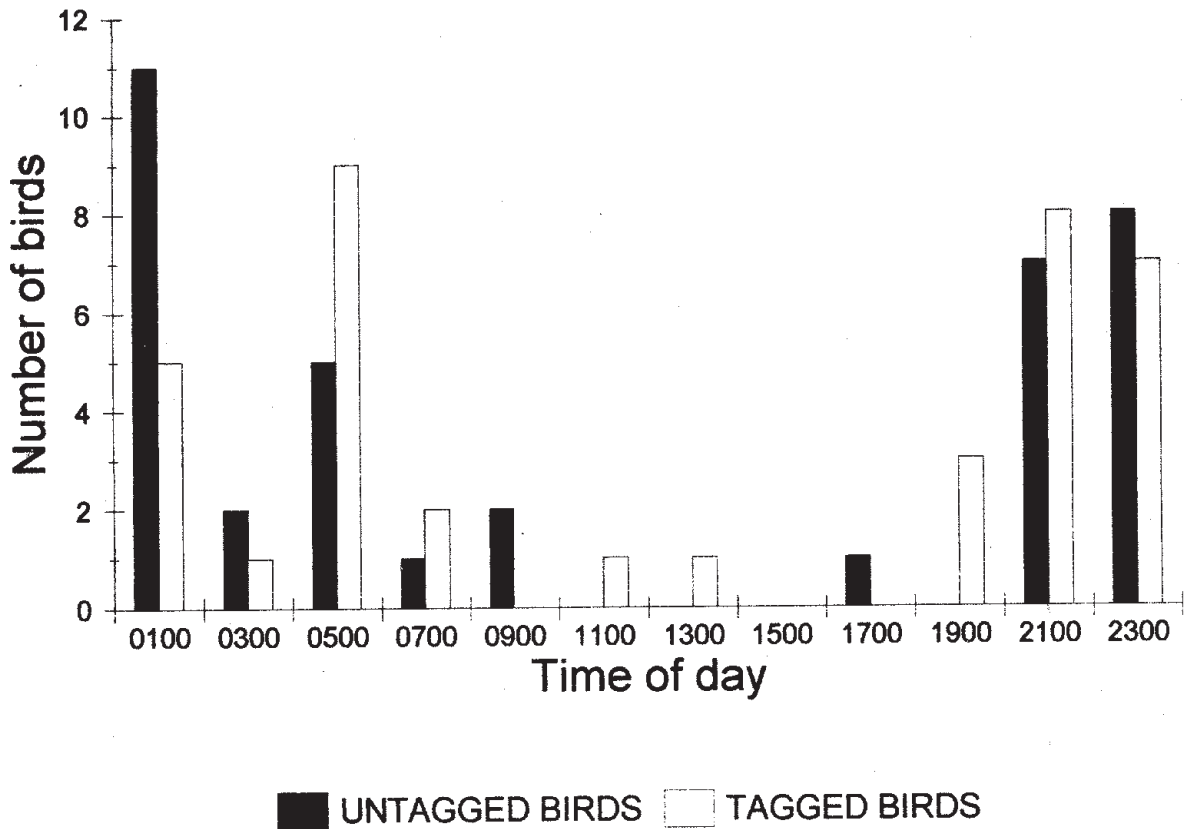


Figure 1

Arrival time of foraging Magellanic Penguins *Spheniscus magellanicus* at Estancia San Lorenzo, Argentina.

RESULTS

All banded penguins left their nest within 35 h of the beginning of the study, with a mode of 4.5 h and a mean of 7.1 h ($n=37$). A banded or an unbanded bird was always present in each nest. Arrival of the unbanded bird and departure of the banded one usually occurred during a single 2-h observation period. A lag between arrival of one parent and departure of the other was only observed in three nests. Thus, although adult birds do not leave their nests unless they have been replaced by their partners they do go away very soon after arrival of the relief. The same trend has been observed in brooding Adélie Penguins *Pygoscelis adeliae* (Wilson *et al.* 1989).

Banded birds remained out of their nest from 16-68 h. Lengths of foraging trips were distributed into two main groups of *c.* one and two days, comprising 51% ($n=19$) and 46% ($n=17$), respectively, with only one banded penguin retrieved after a foraging trip of *c.* three days. For the two main groups, mean lengths of time out of the nest were 25.3 h and 43.8 h, respectively. There were no detectable differences in the departure or arrival times of these two groups ($X^2=13.9$, $df=7$, $P > 0.05$, and $X^2=7.1$, $df=8$, $P > 0.05$, respectively). Lengths of foraging trips were similar to those observed in our previous study conducted on a sample of 63 penguins (Scolaro & Suburo 1991). As shown in Fig. 1, very few birds returned during the day. Most reliefs (73%, $n=27$) occurred after 19h00, during the evening or the night. Only 10 partners (27%) returned during daylight, although five of them returned immediately after sunrise. Banded and unbanded birds ($n=40$) followed the same pattern ($X^2=1.9$, $df=4$, $P > 0.05$) and the highest frequency was observed around midnight. This was the period of most intense darkness during the sampling days, since the moon, which was in its last quarter, appeared between 02h00 and 04h00. Further studies are required to evaluate the influence of moonlight on penguin

behaviour (Challies 1988). No difference in trip length was detected between penguins returning during light (07h00-20h00) or dark hours (Mann-Whitney U test, $z=0.18$, $P > 0.05$).

Most departures from the nest (86.5%, $n=32$) occurred during the hours of darkness. However, our sampling method did not allow to measure whether birds immediately went to sea or whether they lingered along the shoreline. No correlation was found between the time of departure and the length of the foraging trip ($r=0.11$, $n=37$, $P > 0.05$).

DISCUSSION

Return times suggest that Magellanic Penguins forage during daytime and feed their brood during the night. Most likely, they use available luminosity to catch their prey and then return to their nests when no more light is available. This hypothesis is mainly based on the timing of foraging trips but is also supported by the lack of direct observations of feeding during the night and by the behaviour of Anchovy *Engraulis anchoita*, the main prey of Magellanic Penguins. Gentoo Penguins *Pygoscelis papua* rarely appear to dive at night (Brooke & Prince 1991), but it has recently been reported that King Penguins *Aptenodytes patagonicus* can engage in shallow feeding dives during the night, following vertical movements of prey (myctophid fishes, Kooyman *et al.* 1992). However, Wilson *et al.* (1993) have found that despite nocturnal diving, King Penguins feed little at night and strongly argue that light is a limiting factor determining when penguins can hunt and the depths they can exploit. Vertical migration of Anchovy suggests that Magellanic Penguins would catch them more easily during daytime, when they form more compact shoals in deep waters, than during the night, when they disperse close to the sea surface (Brandhorst & Castello 1971). Vertical migration of Anchovy probably does not restrict penguin foraging to only day or night hours; however, it

is probably only during the day that birds can catch enough fish to feed their brood.

Both foraging and brood-feeding behaviours of Magellanic Penguins are consistent with the general structure of their eye and retina (Suburo *et al.* 1988, 1991, Suburo & Scolaro 1990), that seem to be adapted to low illumination levels. Thus, the same visual adaptations would allow Magellanic Penguins to detect and catch their prey in relatively dark deep waters during daytime and to pursue an active social life in the colony at night. This division of time would allow a more efficient division of the day between foraging and brooding, as has been postulated for other seabirds (Brooke & Prince 1991).

In our previous survey, penguins returning during daylight (07h00-20h00) had been out of their nests for a longer period than those penguins returning during dark hours (Scolaro & Suburo, 1991). This was not the case in the present study, where no difference in trip length was detected between the two groups. This could be related to differences in the sampling method or to differences in prey availability during each season.

Diving depths did not show any correlation with the timing of arrival or departure, indicating that maximum diving depths are probably limited by the hydrographic environment (Scolaro & Suburo 1991) and do not reflect specific foraging behaviour.

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