Surface Nesting by Little Penguins on Penguin Island, Western Australia

N.I. Klomp, C.E. Meathrel, B.C. Wienecke and R.D. Wooller
Biological Sciences, Murdoch University, W.A. 6150

EMU Vol. 91, 190-193, 1991. Received 25-9-1990, accepted 23-1-1991

The Little Penguin *Eudyptula minor* reaches the northern limit of its breeding range in Western Australia on Penguin Island, 42 km south-west of Perth (Blakers *et al.* 1984), where up to 500 breed annually. Members of this isolated population breed from April to November, rather than in spring and summer as is more common elsewhere (Dunlop & Wooller 1986; Stahel & Gales 1987). Penguin Island is a 12.5 ha limestone island, thinly covered in places by Holocene aeolian sands bearing low bushes and shrubs (Chape 1984). Lack of a cohesive substrate results in few penguins digging burrows and most nest under dense bushes and shrubs (Dunlop *et al.* 1988). The island lies 600 m offshore, close to a metropolitan area, making these surface-nesting penguins potentially vulnerable to disturbance by visitors. This paper examines the use of Little Penguin nests in relation to vegetation and human activity and explores possible links between surface nesting and the winter breeding regime of the species.

Methods

The main nesting area of the Little Penguins is also the site of greatest human activity (Dunlop *et al.* 1988). Until 1989, when most buildings were removed, it had a small holiday settlement and day visitors came ashore there. Early in 1986, 55 identical plywood nest-boxes (0.9 x 0.4 x 0.4 m), with removeable lids, were placed under, or adjacent to, *Tetragonia* bushes in the main breeding area. Groups of 17, 13, 13 and 12 boxes were placed in four areas where Little Penguins were known to have bred since 1982 but with different levels of human activity. Nest-boxes in group A were placed between the main beach and a toilet used by visitors, and around the nearby generator shed. Group B was in the settlement, group C adjacent to the settlement and group D in a fenced area visited only by researchers. The disturbance varied from weekly inspection of the box by a researcher in the least disturbed area, to sustained proximity to visitors and their recreational activities (ball sports, barbeques, radios, etc.), sometimes accompanied by unauthorised removal of the bird from a box. The entrance of each nest-box was placed near a known Little Penguin route from the sea, and all nest boxes were painted and sited as inconspicuously as possible. From 1986 to 1989, the contents of each nest-box were recorded weekly from April to November, with as little disturbance as possible. A nest-box was considered occupied if a Little Penguin was recorded inside it at least once in a year. All banded birds were recorded and unbanded ones were banded.

On six dates between November 1986 and January 1987, random number tables were used to select five nest sites in each of four categories: (i) natural nest-site under dense vegetation; (ii) natural nest-site in small limestone cave or crevice; (iii) nest-box with <50% projected foliage cover ('lightly shaded'); and (iv) nest box with >50% projected foliage cover ('heavily shaded'). At about 1400 h on each date, air temperatures were recorded with a thermistor probe inside each nest-box (without removing nest-box lids) or natural nest site, and in a shaded area near the entrance to the nest-site at ground level.

Results

Excluding bare rock and sand, 39% of the surface of the island is covered by low (<1 m high) bushes of *Rhagodia baccata* and *Nitraria billardieri*, and 11% by prostrate *Carpobrotus* and *Frankenia* spp., all mainly confined to the northern and southern plateaux (Chape 1984). The central part of the island is covered by low bushes of *Tetragonia decumbens*, alone or with *Spinifex longifolius* (21% area), *Acacia rostellifera* up to 2 m tall (15% area) and patches of *Olearia*, *Alyxia* and *Scaveola* spp. (14% area). Most Little Penguins nest in this central area, especially on the eastern, landward side (Chape 1984). Although some attempt to dig into the sandy substrate, it is too shallow and friable to support burrows. Of 80 randomly selected, natural nest sites, 46%

Table 1 Occupancy rate and reproductive performance of Little Penguins using nest-boxes in areas with different levels of disturbance on Penguin Island, Western Australia, from 1986 to 1988.

Nest group	Number of boxes	Level of human activity in area	Nest-boxes occupied	Hatching success	Breeding success
A	13	High	49%	44%	26%
B	17	Moderate	61%	74%	36%
C	13	Low	80%	78%	41%
D	12	Very low	94%	82%	40%

were in *Tetragonia* bushes, 33% in *Rhagodia*, 4% in other vegetation, 4% in the limestone caves and crevices around the periphery of the island and 13% under wood, concrete or other human structures. No Little Penguin nested in the open (i.e. on sand, rock or *Carprobrotus*), or under *Acacia* shrubs unless they also had bushes underneath. This represents a significant (χ^2_1 = 37.8, P < 0.001) preference for nesting in bushes, especially *Tetragonia* bushes (χ^2_1 = 13.0, P < 0.01).

Access to most natural nest-sites was by one main entrance whose direction was recorded. Nest entrances facing NW to NE, NE to SE, SE to SW and SW to NW accounted for 20%, 20%, 29% and 31% of nests respectively The slight tendency for more entrances to face south and west, seawards and into the prevailing wind, was not significant (χ^2_1 = 3.2, P > 0.05).

From 1986 to 1988, the occupancy rates of boxes were very similar in each year (64%, 68% and 75%) and data for the three years have, therefore, been combined. In all three years, there was a clear trend towards lower nest-box usage as the level of human disturbance rose (Table 1). Boxes in the most disturbed area had an occupancy rate only about half that in the least disturbed area.

Overall, only 44% of eggs laid in boxes in the most disturbed area hatched, compared with a hatching success around 80% in the two least disturbed areas. (Table 1). Breeding success (young fledged per egg) was also somewhat higher in the less disturbed areas, although the differences were less pronounced. The two areas disturbed most (A and B) differed significantly from those disturbed less in their occupancy rates (χ^2_1 = 18.75, P < 0.001) and hatching success (χ^2_1 = 7.82, P < 0.01) but not in their breeding success (χ^2_1 = 1.21). On average, the number of young fledged per box per year was 0.13 in the area most highly disturbed, 0.23 in the area of moderate disturbance, 0.46 in the area or low disturbance and 0.46 in the relatively undisturbed research area. The breeding success of birds using nest-boxes did not differ significantly from the breeding success of birds at natural nesting sites (χ^2_1 = 1.71).

During the laying period (April to November), the minimal air temperature at nest level rarely fell below 5°C or exceeded 25°C. In contrast, during December and January, when penguins on the island moult, daytime temperatures commonly exceed 30°C and, occasionally, 40°C. Afternoon temperatures recorded inside, and just outside, different types of nests during this period were very similar (Table 2). The mean difference between inside and outside temperatures was 1.10 ± 0.02°C at heavily shaded nest-boxes but only 0.57-0.63 ± 0.02°C at all other nests, a small but significant difference (t = 6.03, P < 0.01). Only in heavily shaded nest-boxes was the inside temperature lower, on average, than the outside temperature.

Discussion

In the eastern states of Australia and in New Zealand, Little Penguins breed between September and January, and moult in February/March (Stahel & Gales 1987). Temperatures such as those recorded on Penguin Island during summer (Table 2) are likely to cause discomfort to Little Penguins (Stahel & Nichol 1982; Stahel & Gales 1987). In addition, the low humidity at such times would render effective incubation extremely difficult (Grant 1982). Caves, bushes, and even nest-boxes, appeared to provide little relief from the heat. Thus, high temperatures, exacerbated by being forced to nest on the surface, rather than in burrows, may account, in part, for the unusual winter breeding chronology of Little Penguins on Penguin Island. There appears to be little seasonal or annual variation in the diet of Little Penguins from Penguin Island, which consists mainly of small, schooling fish caught inshore (Klomp & Wooller 1988a; Wienecke 1989), and changes in food availabili-

Table 2 The mean (± *s.e.*) air temperatures (°C) at 1400 h inside, and just outside, Little Penguin nests in bushes, caves, lightly shaded and heavily shaded nest-boxes on Penguin Island, Western Australia, from November 1986 until January 1987. Means of five nests in each category.

	Nests in bushes		Nests in caves		Lightly shaded nest-boxes		Heavily shaded nest-boxes	
	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside
2 November	26.4 ± 0.2	26.0 ± 0.2	26.6 ± 0.1	26.4 ± 0.1	26.2 ± 0.1	26.4 ± 0.1	25.4 ± 0.3	25.2 ± 0.1
23 November	29.2 ± 0.1	29.0 ± 0.2	28.6 ± 0.3	29.0 ± 0.2	28.6 ± 0.2	29.0 ± 0.0	27.2 ± 0.2	29.0 ± 0.0
14 December	28.6 ± 0.3	27.8 ± 0.2	27.6 ± 0.1	27.6 ± 0.2	28.6 ± 0.2	27.8 ± 0.1	28.6 ± 0.5	28.6 ± 0.7
22 December	28.8 ± 0.3	28.8 ± 0.1	28.8 ± 0.3	28.8 ± 0.2	28.6 ± 0.1	28.2 ± 0.2	28.6 ± 0.1	28.4 ± 0.2
28 December	30.6 ± 0.2	31.0 ± 0.2	31.4 ± 0.2	31.0 ± 0.2	30.8 ± 0.2	31.0 ± 0.2	29.8 ± 0.3	30.6 ± 0.3
5 January	30.6 ± 0.3	30.6 ± 0.3	30.8 ± 0.2	30.4 ± 0.2	30.8 ± 0.1	30.6 ± 0.3	29.4 ± 0.3	30.6 ± 0.3

ty seem unlikely to influence the timing of breeding in most years. Indeed, this relatively favourable trophic environment may be linked to the very prolonged breeding period at this colony (Dunlop & Wooller 1986) and the significantly larger size of the birds there (Klomp & Wooller 1988b).

Lack of suitable substrate does not permit Little Penguins to burrow on Penguin Island and large caves are few; neighbouring islands are very similar. As a consequence, these nocturnal and secretive birds are forced to nest above ground, albeit sheltered under bushes, a situation also recorded in the Magellanic Penguin *Spheniscus magellanicus* (Boswall & MacIver 1975; Scolaro & Kovacs 1978). At a similar latitude on the west coast of southern Africa, more Jackass Penguins *S. demersus* nest on the surface in the austral winter than during the hot, dry summer (La Cock 1988). Burrow-nesting reduced the impact of ambient temperature extremes experienced by surface-nesting Jackass Penguins (Frost *et al.* 1976a) and burrow-nesters bred more successfully than surface-nesters (Frost *et al.* 1976b). In other surface-nesting seabirds of temperate origin, conspecifics breeding in more tropical environments also choose nest-sites sheltered from the sun by dense vegetation (Burger & Gochfeld 1985, 1987).

Diurnal flying birds, such as gulls, must offset the need for shade against the need to see, and escape from, predators (Burger & Gochfeld 1987; Meathrel 1990). Little Penguins, nocturnal and non-flying, need few such anti-predator devices. Currently, and in the recent past, Penguin Island has no aerial or ground predators capable of killing an adult Little Penguin, although large lizards (*Egernia kingii*) take the eggs of those that have been disturbed (Meathrel & Klomp 1990). It is not surprising, therefore, that these birds choose to nest in the middle of dense bushes, albeit with limited visibility, since these provide the best protection available from insolation and wind. Few Little Penguins nested in the *Acacia* thickets, although these would have provided substantial shade, apparently because of their lack of cover at ground level. The preferred area of bushes was also readily accessible from the gently sloping eastern beaches, whereas the western side of the island is protected by reef platforms (Chape 1984).

Unfortunately, human activity is concentrated where most penguins can obtain suitable nesting sites. The rapid occupation of many of the nest-boxes indicated that they provided suitable nest-sites, but those most subject to human disturbance were least used. Since the breeding success of Little Penguins in nest-boxes did not differ significantly from that of those nesting in bushes, it is likely that nest-sites in bushes are similarly affected by human disturbance. Several studies have shown the adverse effects of human disturbance upon penguin and other seabird breeding success (Anderson & Keith 1980; Hockey & Hallinan 1981). Little Penguins appear to have no other more suitable nesting grounds in this area of south-western Australia and plans to allow increased numbers of unsupervised visitors to this island, or to develop it for tourism, seem to be incompatible with the continued well-being of this most unusual Little Penguin colony.

Acknowledgements

We thank the Western Australian Department of Conservation and Land Management for permission to work with Little Penguins on Penguin Island and for their support of the study. We are also grateful for support from Australian Geographic and the Western Australian Tourism Commission, as well as many friends and colleagues at Murdoch University and to Graeme Smith and an anonymous referee for their comments on the manuscript. The Australian Bird Banding Scheme kindly provided all banding equipment used in this study.

References

Anderson, D.W. & Keith, J.O. 1980. The human influence on seabird nesting success: conservation implications. Biological Conservation 18, 65-80,

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. 1984. The Atlas of Australian Birds. RAOU and Melbourne University Press, Melbourne.

Boswall, J. & MacIver, D. 1975. The Magellanic Penguin *Spheniscus magellanicus*. Pp. 271-305 in The Biology of Penguins. Ed. B. Stonehouse. Macmillan, London

Burger, J. & Gochfeld, M. 1985. Nest site selection by Laughing Gulls: comparison of tropical colonies (Culebra, Puerto Rico) with temperate colonies (New Jersey). Condor 87, 364-373.

Burger, J. & Gochfeld, H. 1987. Colony and nest-site selection behaviour in Silver Gulls *Larus novaehollandiae* in Queensland, Australia. Bird Behaviour 7, 1-21.

Chape, S. 1984. Penguin Island. Department of Conservation and Environment, Western Australia.

Dunlop, J. & Wooller, R.D. 1986. Range extensions and the breeding seasons of seabirds in south-western Australia. Records of the Western Australian Museum 12, 389-394.

Dunlop, J.N., Klomp, N.I. & Wooller, R.D. 1988. Penguin Island, Shoalwater Bay, Western Australia. Corella 12, 93-98.

Frost, P.G.H., Siegfried, W.R. & Burger, A.E. 1976a. Behavioural adaptations of the Jackass Penguin (*Spheniscus demersus*) to a hot, arid environment. Journal of Zoology, London 179, 165-187.

Frost, P.G.H., Siegfried, W.R. & Cooper, J. 1976b. Observation of the Jackass Penguin (*Spheniscus demersus*) (L.) Biological Conservation 9, 79-99.

Grant, G.S. 1982. Avian incubation: egg temperature, nest humidity, and behavioural thermoregulation in a hot environment. Ornithological Monographs 30, 1-75.

Hockey, P.A.R. & Hallinan, J. 1981. Effect of human disturbance on the breeding behaviour of jackass penguins *Spheniscus demersus*. South African Journal of Wildlife Research 11, 59-62.

Klomp, N.I. & Wooller, R.D. 1988a. The diet of Little Penguins *Eudyptula minor* from Penguin Island, Western Australia. Australian Journal of Marine and Freshwater Research 39, 633-639.

Klomp, N.I. & Wooller, R.D. 1988b. The size of Little Penguins *Eudyptula minor* on Penguin Island, Western Australia. Records of the Western Australian Museum 14, 211-215.

La Cock, G.D. 1988. Effect of substrate and ambient temperature on burrowing African Penguins. Wilson Bulletin 100, 131-132.

Meathrel, C.E. 1990. Little Eagle *Aquila morphnoides* predation of Silver Gulls *Larus novaehollandiae* at a colony in south-western Australia. Emu 90, 195-197.

Meathrel, C.E. & Klomp, N.I. 1990. Predation of Little Penguin eggs by King's Skinks on Penguin Island, Western Australia. Corella 14, 129-130.

Scolaro, J.A. & Kovacs, O. 1978. El Pinguino de Magallanes (*Spheniscus magellanicus*) – III. Nota sobre una nueva colonia de reproduccion. Publicaciones Ocasionales del Instituto de Biologia Animal, Universidad Nacional de Cuyo, Argentina. Serie Sientifica No. 8.

Stahel, C.D. & Gales, R.P. 1987. Little Penguins: Fairy Penguins in Australia. University of New South Wales Press, Sydney.

Stahel, C.D. & Nicol, S.C. 1982. Temperature regulation in the Little Penguin *Eudyptula minor* in air and water. Journal of Comparative Physiology 148, 93-100.

Wienecke, B.C. 1989. The breeding patterns of Little Penguins on Penguin Island, Western Australia, in relation to dietary and oceanographic factors. B.Sc. Hons. thesis, Murdoch University, Perth.