

ASPECTS OF THE BREEDING CYCLE OF KING PENGUINS *APTENODYTES PATAGONICUS* AT HEARD ISLAND

J. VAN DEN HOFF¹, R.J. KIRKWOOD¹ & P.B. COPLEY²

¹*Australian Antarctic Division, Channel Highway, Kingston, Tasmania, Australia, 7050*

²*Present address: South Australian National Parks and Wildlife Service, P.O. Box 902, Norwood, South Australia, 5067*

Received 5 October 1992, accepted 16 March 1993

SUMMARY

VAN DEN HOFF, J., KIRKWOOD, R.J. & COPLEY, P.B. 1993 Aspects of the breeding cycle of King Penguins *Aptenodytes patagonicus* at Heard Island. *Marine Ornithology* 21: 49-55.

An exponentially increasing population of King Penguins *Aptenodytes patagonicus* breeds at seven known colonies on Heard Island. During the 1987/88 summer, breeding activities were closely monitored at one colony. Egg laying commenced in mid-November and ceased three months later in mid-February. Whole-island egg production for the season was estimated at 4232, with 85% laid at the Doppler Hill colony. Three distinct laying periods were noted: 18 November to 18 December (44% of eggs laid), 23 December to 17 January (44% of eggs laid) and 25 January to mid-February (12% of eggs laid). Ten percent of the eggs laid had perished by early March. Of the previous season's (1986-87) eggs, 1672 chicks survived the 1987 winter. At the larger colonies, over-winter survival was variable between 56 and 72% of the eggs laid.

INTRODUCTION

King Penguins *Aptenodytes patagonicus* breed on several sub-Antarctic islands between latitudes 46 and 55S. Heard Island (53 05S, 73 30E), situated immediately south of the Antarctic Polar Front in the Indian Ocean Sector of the Southern Ocean, has an established and rapidly increasing population (Gales & Pemberton 1988). Historical records indicate that sealers made use of the King Penguins at Heard Island. Their oil was used as a fuel source in sealers' huts, shoes were fashioned from skins and eggs and flesh were eaten (Crowther 1970). In addition, carcasses may have been burnt to stoke tryptots as was the case elsewhere (Busch 1985). Following the sealing era (1855-1930s), only small breeding groups were encountered during visits to the island and in 1963 the population included just

23 breeding pairs (Budd 1968). Twentythree years later the number of breeding pairs observed was at least 2000 (Gales & Pemberton 1988).

King Penguins have a breeding strategy characterized by irregular over-winter attendance and prolonged periods of chick fasting, possibly resulting from low food availability to adults (Adams & Klages 1987, Hindell 1987). The fasting appears to increase the time taken for chicks to fledge. When hand fed in captivity, chicks are capable of reaching the final stages of moult in less than nine months, whereas free-ranging chicks take over 12 months to arrive at this stage (Gillespie 1932). Because the chick-rearing period is in excess of 12 months, King Penguins are unable to rear young in consecutive years.

Investigations of the breeding biology of King Penguins have been conducted at South Georgia (Stonehouse 1960), Iles Crozet (Barrat 1976, Weimerskirch *et al.* 1992), Macquarie Island (G.R. Copson in Gales & Pemberton 1988) and Marion Island (du Plessis *et al.* 1991).

Based on data collected during the 1987/88 austral summer, this paper presents the first direct information on the breeding biology and success of the King Penguin at Heard Island. The current status of King Penguins at Heard Island is also reported.

METHODS

A field base was established on Heard Island between 18 September 1987 and 2 March 1988. King Penguin chicks which had survived the winter of 1987 were counted at all colonies in late September and October. The pre-winter chick numbers had been counted (Gales & Pemberton 1988) and were adjusted, using the length of the laying period and chick survival rates determined in the present study, to estimated numbers in early March. At all but one colony, chick numbers were less than 120, thus enabling accurate single ground counts. The largest colony, Doppler Hill, was surveyed using replicate ground counts.

During November, all known King Penguin colonies were examined to establish the timing of various aspects of the breeding biology. Because of its close proximity to the field base, the Spit Bay colony was monitored on a near-daily basis to record dates of first egg, numbers of incubating birds, the rate and duration of egg-laying, the length of the incubation period and egg and chick mortalities. Other colonies were visited on an opportunistic basis (between three days and three weeks apart) depending on their distance from base and their status recorded on each visit. On each census, at least three replicate counts were made by no less than two observers until totals agreed to within 2%. The rate of laying was calculated as a series of periodic means. For periods when the census interval exceeded five days, a constant slope was assumed between data points.

RESULTS

During the 1987/88 summer, breeding of King Penguins on Heard Island was recorded at seven localities. In order of decreasing size these were; Doppler Hill (South Spit in Gales & Pemberton 1988), Spit Bay, Schmidt Glacier, Paddick Valley (Green Valley in Gales & Pemberton 1988), Long Beach, Saddle Point and Red Island (Fig. 1).

Egg-laying began in mid-November with the earliest egg found at Saddle Point on 16 November (Table 1). At Doppler Hill, a total of 50 incubating adults was present on 21 November so laying may have commenced prior to the 16 November at this colony. The first egg to hatch at the Spit Bay colony was on 11 January, after a maximum period of 55 days incubation (18 November to 11 January). The numbers of incubating or brooding adults peaked on 15 February when 241 birds were in attendance (Fig. 2); therefore the duration of the laying period at the Spit Bay colony was approximately three months from mid-November to mid-February. The final count for Spit Bay, made on the 1 March 1988, recorded 231 incubating or brooding adults. At least 251 eggs were laid at the Spit Bay colony during the 1987/88 breeding season and mortality to the end of summer was about 8.7% (20: 18 eggs and two chicks).

At the Schmidt Glacier colony, the final count for the season, made on 3 March 1988, recorded 204 incubating or brooding adults. At least 24 pairs had failed by this date. Thus, at least 228 eggs were laid, with a pre-winter mortality of at least 10.5%.

Three periods of egg laying were recorded at Spit Bay during the 1987/88 breeding season (Fig. 2). These were: 1. early breeders, 18 November to 18 December; 2. middle breeders 23 December to 17 January; and 3. late breeders, 25 January to mid-February. Periods 1 and 2 were separated by a maximum interval, when no eggs were laid, of five days whereas periods 2 and 3 were separated by an interval of eight days. Eighty-eight percent of eggs laid at the Spit Bay colony were produced in the

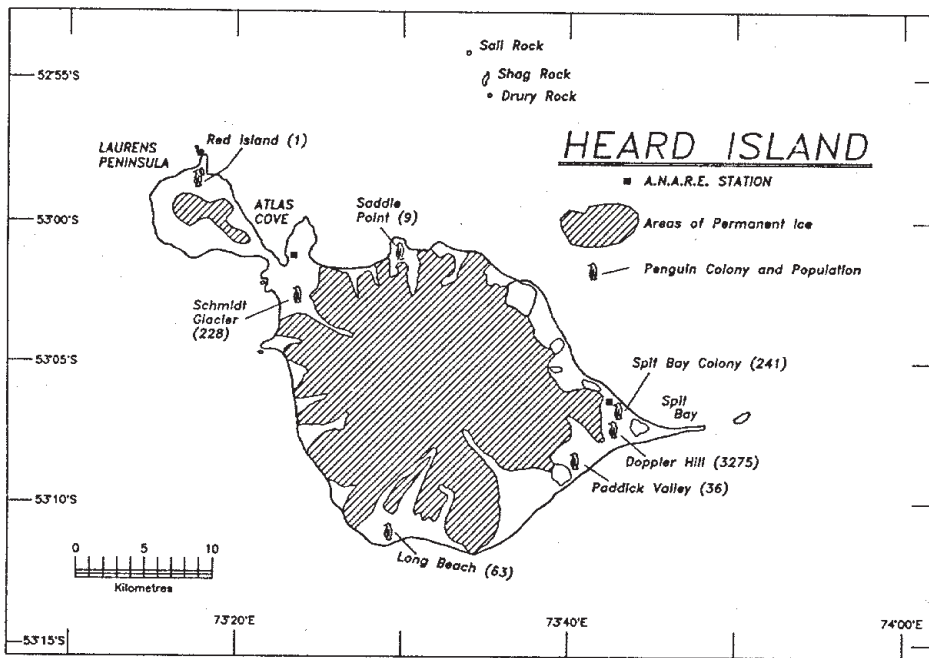


Figure 1

King Penguin breeding sites and maximum count of breeding pairs on Heard Island, 1987/88.

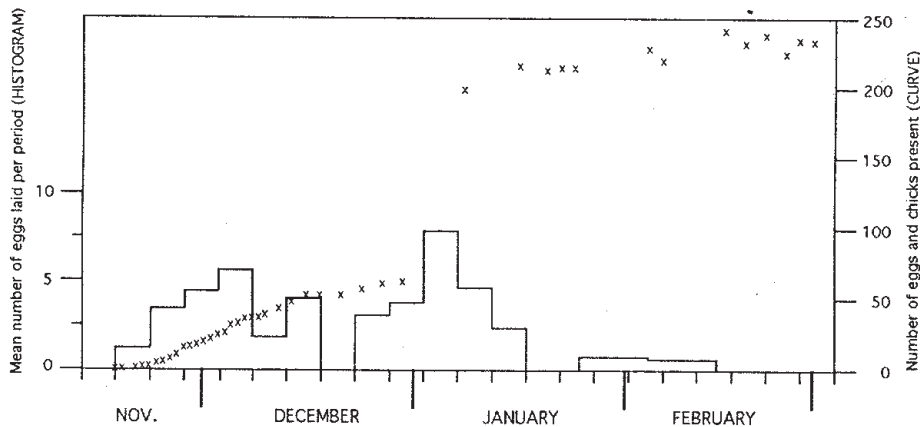


Figure 2

Rate of egg laying and the trend in the number of breeding pairs of King Penguins at the Spit Bay colony on Heard Island, 1987/88. Time periods are five-day intervals.

TABLE 1

CENSUS DATA FOR KING PENGUIN COLONIES ON HEARD ISLAND FOR THE 1986/87 AND 1987/88 BREEDING SEASONS

Colony	Pre-winter estimate*	Post-winter chick count (date & no.)	Over-winter chick survival (%)	Date & no. first egg/s seen (1987)	Max. count of eggs and chicks (date and no.)	Estimated total egg production (1988)
Doppler Hill	1964	20 Sept 1420	72	21 Nov (50)	24 Feb 3275	3594
Spit Bay	211	20 Sept 114	54	18 Nov (1)	15 Feb 241	251
Schmidt Glacier	198	22 Sept 114	58	30 Nov (44)	29 Jan 228	268
Paddick Valley	ND	24 Sept 2	ND	25 Nov (6)	21 Feb 36	39
Long Beach	ND	06 Oct 20	ND	19 Nov (2)	12 Feb 63	69
Saddle Point	6	10 Oct 1	-	16 Nov (1)	04 Feb 9	10
Red Island	1	01 Nov 1	-	02 Dec (1)	12 Feb 1	1
TOTAL		1672				4232

*1987 pre-winter estimate obtained by extrapolating to the end of the laying period census data in Gales & Pemberton (1988), using the pattern of laying determined for Spit Bay in 1987/88 - Fig. 2; ND=not determined.

early and middle periods (44% in each period), late breeders accounting for the remaining 12% (Fig. 3). Peaks in the early and middle-laying periods at the Spit Bay colony occurred on 5 December and 3 January, respectively (Fig. 2). At the Schmidt Glacier colony, which was similar in size to the Spit Bay colony but monitored less frequently, a single laying peak occurred between late December and early January.

Table 1 shows the maximum count for each colony visited. Using data from the Spit Bay colony, the number of eggs likely to be present at the end of February at each colony was estimated. Then, assuming approximately 10% mortality to this date (8.7% at Spit Bay and 10.5% at Schmidt Glacier), these figures were converted to total egg production (Table 1). Following these assumptions, a total of about 4232 King Penguin eggs was laid at all colonies during the 1987/88 breeding season.

A total of 1672 King Penguin chicks from the 1986/87 breeding season survived the 1987 winter (Table 1). Over-winter chick survival, at both Spit Bay and Schmidt Glacier colonies, was estimated to be 54 and 58%, respectively. Therefore, if pre-winter survival (10%) was comparable between the years, survival to October expressed as a percentage of eggs laid would have been 46%.

The estimated over-winter survival of chicks at Doppler Hill was 72%. If pre-winter survival was similar between colonies (i.e. 10%), chick survival to the end of winter at Doppler Hill would have been 62%. One chick survived of the six eggs recorded at Saddle Point prior to the winter whereas the single breeding attempt at Red Island succeeded. A pre-winter count was not made at the Long Beach and Paddick Valley colonies where 20 and two chicks survived the winter, respectively.

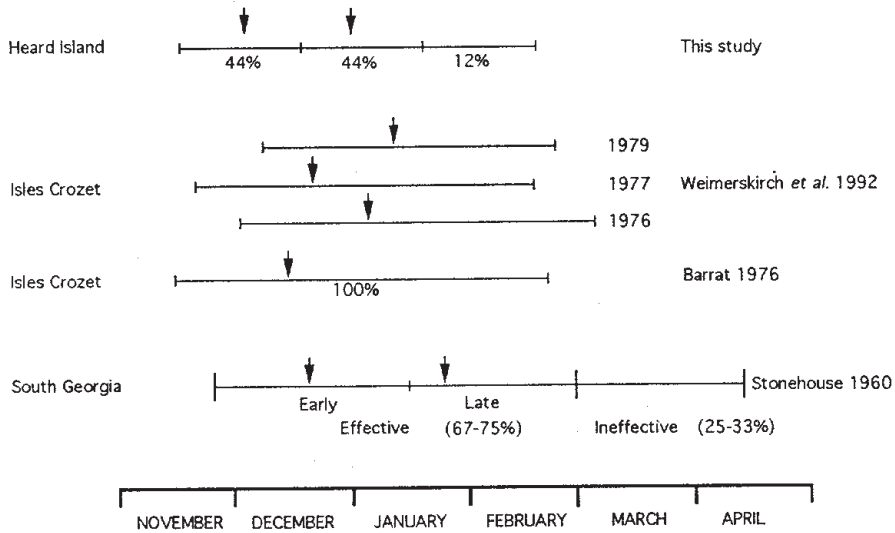


Figure 3

A comparison of the egg-laying periods by King Penguins at various breeding localities. The arrows indicate peaks in egg laying.

TABLE 2

A BETWEEN-ISLAND COMPARISON OF EVENTS IN THE BREEDING CYCLE OF KING PENGUINS

Breeding locality	Position	Egg-laying period	Incubation period (days)	Fledging	Over-winter survival (%)	Reference
<u>South of the Antarctic Polar Front</u>						
Heard Island	53 05S; 73 30E	3 mths (mid Nov-mid Feb)	55	Oct-Dec	60	This study
South Georgia	54 30S; 37E	4½ mths (late Nov-mid Apr)	54-55	Dec +	84	Stonehouse 1960
<u>North of the Antarctic Polar Front</u>						
Isles Crozet	46 25S; 51 45E	3 mths (late Nov-late Feb)	53.2	Oct-Dec	50 40.9	Barrat 1976 Weimerskirch 1992
Macquarie Island	54 30S; 158 55E	4½ mths (Nov-Apr)	-	-	53	G.R. Copson pers. comm. 1992

Downy chicks began moulting into juvenile plumage during late October and early November with the majority completing their moult by early December. With laying starting in mid-November and chicks being fledged by early December, the maximum duration of parental attendance would be in the order of 12.5 months.

DISCUSSION

First eggs of the King Penguin were laid in mid-November at all colonies on Heard Island in the 1987/88 breeding season and this appears to be typical for other breeding localities investigated (Table 2). Laying does not start later at islands south of the Antarctic Polar Front (APF), despite the longer winter conditions experienced there. An incubation period of around 55 days is also common to all locations.

At Heard Island, laying extended over three months, a period comparable to that at Iles Crozet (Barrat 1976, Weimerskirch *et al.* 1992) (Table 2). There is a longer laying period of four-and-a-half months at both South Georgia and Macquarie Island (Stonehouse 1960, G.R. Copson in Gales & Pemberton 1988). Because islands both north and south of the APF exhibit both the shorter and longer versions of the duration of laying, climate is not considered as a dominant factor controlling this aspect of breeding chronology.

The pattern of laying in King Penguins differs between locations (Fig. 3), leading to different predictions of the frequency of breeding. At South Georgia, the identification of three egg-laying periods, termed early-effective, late-effective and ineffective, led to the understanding that some King Penguins bred twice in three years (Stonehouse 1960). At Iles Crozet, breeding was reported to be biennial (Barrat 1976, Weimerskirch *et al.* 1992). At Heard Island, three distinct laying periods were identified at one colony, as recognized at South Georgia (Stonehouse 1960), though this alone does not give an indication of the frequency of breeding. Multi-year banding studies are needed to clarify this.

Depending on breeding frequency, a breeding population may be between one and two times the number counted in a single season. The variations in breeding frequency, therefore, have important implications for the estimation of a population's size. Furthermore, breeding strategies are likely to vary considerably between populations, depending on local prey availability, for example.

There appears to be some similarities in breeding success at colonies of similar size. Over-winter survival of 54-58% at the Spit Bay and Schmidt Glacier colonies compares with estimates of 50.5% at Iles Crozet (Barrat 1976, Cherel *et al.* 1987) and 53% at Macquarie Island (G.R. Copson in Gales & Pemberton 1988), all these results coming from small colonies. At South Georgia, an 84% survival was recorded for a colony at Paul Beach (Stonehouse 1960) which was similar in size to the Doppler Hill colony on Heard Island where 76% survived the 1987 winter. Also at Iles Crozet, chick survival to October from eggs laid was 40.7% (averaged over three breeding seasons, Weimerskirch *et al.* 1992) compared with the 46% estimated for the Spit Bay and Schmidt Glacier colonies on Heard Island. Post-winter survival appears to differ between localities. During the period from the end of the winter fast to fledging at Iles Crozet, a further 10% of the chicks perished, resulting in a total breeding success of 30.6%. At the Spit Bay colony at Heard Island only one of the 114 winter-surviving chicks died prior to fledging and breeding success remained at 46%. Again, local foraging regimes and environmental events may be responsible for this disparity between populations.

ACKNOWLEDGEMENTS

We wish to acknowledge the field assistance of Jill Tideman, Eric J. Woehler, Simon Goldsworthy and other members of the 1987/88 ANARE to Heard Island. Graham Robertson and Mark Hindell made comments on earlier drafts of the manuscript. Wayne Z. Trivelpiece, Bernard Stonehouse and an anonymous referee assisted considerably with the final presentation.

REFERENCES

- ADAMS, N.J. & KLAGES, N.T. 1987. Seasonal variation in the diet of the King Penguin (*Aptenodytes patagonicus*) at sub-Antarctic Marion Island. *J. Zool., Lond.* 212: 303-324.
- BARRAT, A. 1976. Quelques aspects de la biologie et de l'écologie du Manchot Royal (*Aptenodytes patagonicus*) des Iles Crozet. *Com. Nat. Franc. Rech. Antarct.* 40: 9-52.
- BUDD, G.M. 1968. Population increase in the King Penguin, *Aptenodytes patagonicus*, at Heard Island. *Auk* 85: 689-690.
- BUSCH, B.C. 1985. The war against the seals: a history of the North American seal fishery. Gloucester: McGill-Queens University Press.
- CHEREL, Y., STAHL, J.-C. & LE MAHO, Y. 1987. Ecology and physiology of fasting in King Penguin chicks. *Auk* 104: 254-262.
- CROWTHER, W.E.L.H. 1970. Captain J.W. Robinson's narrative of a sealing voyage to Heard Island, 1858-60. *Polar Rec.* 15: 301-316.
- DU PLESSIS, C.J., SEDDON, P.J., VAN HEEZIK, Y.M. & ADAMS, N.J. 1991. Aspects of the incubation period of the King Penguin *Aptenodytes patagonicus* at Archway Bay, Marion Island. *Mar. Orn.* 19: 148-151.
- GALES, R. & PEMBERTON, D. 1988. Recovery of the King Penguin, *Aptenodytes patagonicus*, population on Heard Island. *Austr. Wildl. Res.* 15: 579-585.
- GILLESPIE, T.H. 1932. A book of penguins. London: Herbert Jenkins Ltd.
- HINDELL, M. 1987. The diet of the King Penguin, *Aptenodytes patagonicus*, at Macquarie Island. *Ibis* 130: 193-203.
- STONEHOUSE, B. 1960. The King Penguin, *Aptenodytes patagonica*, of South Georgia. 1. Breeding behaviour and development. *Falkland Isl. Depend. Surv. Sci. Rpts.* 23: 1-81.
- WEIMERSKIRCH, H., STAHL, J.C. & JOUVENTIN, P. 1992. The breeding biology and population dynamics of King Penguins *Aptenodytes patagonicus* on the Crozet Islands. *Ibis* 134: 107-115.