NEST-SITE CHARACTERISTICS OF A GENTOO PENGUIN *PYGOSCELIS PAPUA* COLONY AT CIERVA POINT, ANTARCTIC PENINSULA

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SUMMARY

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Nest-site selection of the Gentoo Penguin *Pygoscelis papua* on the Antarctic Peninsula was analyzed for the 1992/93 breeding season. The importance of 11 habitat variables on nest-site selection was evaluated using stepwise discriminant analysis and comparing their values in both nest sites and random points. The differences observed show that Gentoo Penguins tended to nest on high flat terraces with a prevailing northerly aspect and featuring abundant small pebbles. The results show that availability of nest material and environmental conditions affect nest-site selection at the considered scale.

Keywords: Gentoo Penguin, *Pygoscelis papua*, Antarctica, breeding, nest-sites

INTRODUCTION

Gentoo Penguins *Pygoscelis papua* have a circumpolar distribution and, in the Antarctic Peninsula, usually nest in small colonies in sympatry with Adélie Penguins *P. adeliae* and Chinstrap Penguins *P. antarctica* (Bost & Jouventin 1990). Only 13% of the Gentoo Penguin world population is found south of the ice pack limit and most of the world population is distributed near the Antarctic Polar Front (Woehler 1993).

Although Gentoo Penguins live between 46° and 65°S (Bost & Jouventin 1990), most studies of this species have been carried out at sub-Antarctic and Antarctic islands and little is known about its specific nest-site preferences in locations on the Antarctic Peninsula. The objective of this work was to evaluate quantitatively nesting resource selection and requirements of a Gentoo Penguin colony in the Antarctic Peninsula.

STUDY SITE AND METHODS

The study was carried out in the 1992/1993 breeding season at Cierva Point (64°09'S, 60°57'W), a heterogeneous mosaic of different habitat types in a relatively small area (*c.* 3 km^2, Agraz *et al.* 1994). The Gentoo Penguin colony was comprised of 1009 breeding pairs (Quintana & Cirelli 2000) and was located on an exposed and highly weathered hillside of 18.16 ha – one of the 10 habitat types described for the area (Agraz *et al.* 1994, Fig. 1). This habitat type is characterized by a gentle to moderate slope with several run-off creeks and snow tongues. It has an irregular topography with permanent-snow concave areas and summer snow-free terraces. Patchy vegetation of *Polytrichum alpestre* and *Deschampsia antarctica* associated with *Sanionia uncinata* covers no more than 30% of the flat and convex areas. For a detailed description of the environmental features of the rest of the habitat types, see Quintana & Travaini (2000).

Weather at Cierva Point is moderate, considering the latitude and compared to more northerly Antarctic locations. During summer, the monthly mean temperature ranged between 1.8° and 2.2°C (range –1° to 6.3°C). Relative humidity averaged 79%; it was cloudy and rainy almost every day, and snowy days were frequent. Mean wind speed was 7.9 $km.h^{-1}$ (range 0.0 to 40.6 $km.h^{-1}$).

Human activity is infrequent and limited to summertime. The area has been declared as Site of Special Scientific Interest No. 15 in terms of the Antarctic Treaty System. Consequently, tourism is not allowed.

Eleven habitat variables that had proved to be influential on reproductive success of marine birds (Burger & Gochfeld 1981, Stokes & Boersma 1991, 1998, Goutner *et al.* 2000) were quantified (Table 1). These variables were estimated for 5×5-m quadrats centered on each Gentoo Penguin subcolony and on each random point. Random points were randomly located along eight east-west transects distributed within the studied habitat type. Angular transformations were used for those variables expressed as percentages in order to normalize the data.

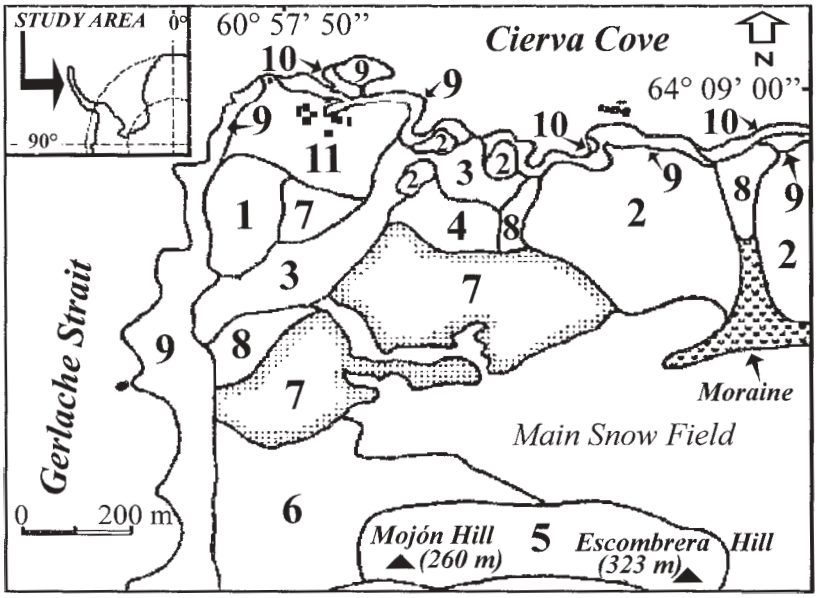

Fig. 1. *Cierva Point, Antarctic Peninsula. 1–10: Habitat types identified in the study area according with Agraz* et al. *(1994). 11: Primavera Station area (▪: buildings). Shaded areas (7) show the location of the Gentoo Penguin colony.*

Differences on habitat characteristics between nests and random points were assess with a one-factor MANOVA test (Morrison 1976) and the most significant habitat variables in nest-site selection were identified using stepwise discriminant analysis (Lee 1971). The percentage of correctly assigned sites was validated using Jacknife classification (Dixon 1992).

RESULTS

Habitat variables quantified for 45 Gentoo Penguin subcolonies and 62 random points (Table 1) differed significantly (MANOVA $F = 15.61$, df = 5, 100, $P < 0.05$). Discriminant analysis showed that subcolonies had a higher proportion of <5-cm pebbles, were located on flat terraces at a higher average altitude than the random points, and had a prevailingly northerly aspect. Percentage of pebbles was the main variable that differentiated both groups, showing the highest standardized coefficient for canonical variables (*SCCV* = 0.81), followed by altitude (*SCCV* = 0.54), topographic position (*SCCV* = 0.45), slope (*SCCV* = –0.39) and aspect (*SCCV* = 0.32).

Topographic position and aspect had the same modal value for both nest sites and random points. However, the percentage of nest sites situated on terraces and with a northerly aspect was higher than that of random points (53% vs 34% and 82 % vs 65%, respectively). The overall percentage of correct assignments after Jacknife validation was 83.9% (88.9% for nest sites and 80.3% for random points).

DISCUSSION

The characteristics of sites where a bird species selects to nest are important since the birds depend on both protection from predators (Martin & Roper 1988) and from environmental stress (Walsberg 1985). At Cierva Point, Gentoo Penguins nest on a hillside characterized by a highly weathered exposed substratum, different from all the other habitat types present in the area (Agraz *et al.* 1994). There, penguins nested in snow-free areas with little or no vegetation, and a smooth slope for easy access from the sea.

Distribution of Gentoo Penguin nests within the breeding area was influenced by the type of substratum, altitude, topographic position, slope and aspect. Other studies (Austin 1976, Birkhead *et al.* 1985, Rendell & Robertson 1989, Stokes & Boersma 1991) have shown that these variables influence breeding success. The habitat type used by Gentoo Penguins had a marked internal heterogeneity and breeding areas were located in patches with the features mentioned above. In these patches, some of the observed pebbles <5 cm could have been deposited by these birds at the site during nest building, increasing the number of them around the nests. However, the source of this type of pebble is coincident with most of the areas where subcolonies occurred, which could be implying a selection of these sites. The higher abundance of pebbles <5 cm around the nest sites than around random points showed the importance of this type of pebble as a nesting resource for this species in the Antarctic Peninsula (Bost & Jouventin 1990).

The location of nest sites at a higher altitude than the random points is linked to the fact that the higher places within this habitat type are usually small and highly weathered outcrops surrounded by snow, mostly occupied by Gentoo Penguin subcolonies. These locations are the first taken up for nesting because of early thawing and the decreased influence of flooding due to the increase in the waterflow of the run-off creeks when snow melts from the upper areas as well as the availability of nesting material.

Most of the Gentoo Penguin subcolonies were located on flat terraces, which were a more suitable place for birds to build their nests. This preference for flatter terraces explains the marked differences with random points in the values corresponding to

TABLE 1

Definition and sample means (and standard deviation) of the 11 habitat variables used for stepwise discriminant analysis between Gentoo Penguin nest sites (GNS) and random points (RP) at Cierva Point

Variable	Category	Value	GNS (n = 45)	RP (n = 62)
Altitude (m)			115.3 (20.4)	95.6 (34.2)
Slope (°)			3.8 (3.6)	9.3 (8.2)
Aspect (°)	315°–45°	4	*	*
	225°–315°	2		
	135°–225°	1		
	45°–135°	2		
Topographic position				
	Flat	0		
	Hill top	1		
	Steep slope	2		
	Smooth slope	3		
	Terrace	4	*	*
	Beach	5		
	Depression	6		
	Slope promontory	7		
Micro topography				
	Flat	1		
	Convex	2		
	Concave	3		
	Grooved	4		
	Cracked	5		
	Pitted	6		
	With knobs	7	*	*
	Crinkled	8		
	Wavy	9		
	Hummocky	10		
Distance from the sea (m)			608.4 (152.2)	545.8 (154.0)
Primavera Base view				
	Yes	1	*	*
	No	0		
Bed rock (%)			43.2 (24.8)	34.9 (28.4)
Rockiness >25 cm (%)			16.0 (13.9)	14.4 (14.8)
Rockiness <5 cm (%)			25.3 (16.1)	13.5 (20.3)
Vegetation (%)			10.4 (16.6)	24.8 (26.6)

(*) Mode value

topographic position and slope. However, some random points were also located on flat terraces, which is why the discriminant analysis classified them as 'nest sites'. At most of these sites, field observations showed nesting traces such as nest remains, feathers and droppings, proving that they had been used as nest sites in the past and had been subsequently abandoned.

Finally, most nest sites were placed with a prevailing northern aspect compared to the random points. This may be due to the higher exposure to radiation of these sites in the southern hemisphere that could be an important factor for the reproductive fitness of this species.

The overall conclusion of this study is that factors such as availability of nesting material and environmental conditions affect nest-site selection at the considered scale. Thus, any strategy for conservation of this Special Site of Scientific Interest should take into account sites with these environmental characteristics for the establishment of Gentoo Penguin breeding areas, particularly considering the small size of the different habitats at Cierva Point.

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REFERENCES

AGRAZ, J.L., QUINTANA, R.D. & ACERO, J.M. 1994. Ecología de los ambientes terrestres en Punta Cierva, Costa de Danco. *Contribución Instituto Antártico Argentino* 439: 1–32.

AUSTIN, G.T. 1976. Behavioral adaptation of the Verdin to the desert. *Auk* 92: 245–262.

BIRKHEAD, T.R., GREENE, E., BIGGINS, J.D. & NETTLESHIP, D.N. 1985. Breeding site characteristics and breeding success in Thick-billed Murres. *Canadian Journal of Zoology* 63: 1880–1884.

BOST, C.A. & JOUVENTIN, P. 1990. Evolutionary ecology of Gentoo Penguins (*Pygoscelis papua*). In: Davis, L.S. & Darby, J.T. (Eds). Penguin biology. London: Academic Press. pp. 85–112.

BURGER, J. & GOCHFELD, M. 1981. Nest site selection by Kelp Gulls in southern Africa. *Condor* 83: 243–251.

DIXON, W.J. 1992. BMDP statistics software. New York: University Press of California and John Wiley & Sons.

GOUTNER, V., PORTOLOU, D., PAPAKONSTANTINOU, K., TSIAKIRIS, R., PAVLIDIS, A., ZOGARIS, S., KOMINOS, T., GALANAKI, A. & ORO, D. 2000. Nest site characteristics of Audouin's Gull in the eastern Mediterranean. *Waterbirds* 23: 74–83.

LEE, P.J. 1971. Multivariate analysis for the fisheries biology. FRB Technical Report 244. Winnipeg, Manitoba: The Fisheries Research Board of Canada, Freshwater Institute.

MARTIN, T.E. & ROPER, J.J. 1988. Nest predation and nest-site selection of a western population of the Hermit Thrush. *Condor* 90: 51–57.

MORRISON, D.F. 1976. Multivariate statistical methods. 2nd ed. New York: McGraw-Hill.

QUINTANA, R.D. & CIRELLI, V. 2000. Breeding dynamics of a Gentoo Penguin *Pygoscelis papua* population at Cierva Point, Antarctic Peninsula. *Marine Ornithology* 28: 29–35.

QUINTANA, R.D. & TRAVAINI, A. 2000. Characteristics of nest sites of skuas and Kelp Gull in the Antarctic Peninsula. *Journal of Field Ornithology* 71: 236–249.

RENDELL, W.B. & ROBERTSON, R.J. 1989. Nest-site characteristics, reproductive success and cavity availability for Tree Swallows breeding in natural cavities. *Condor* 91: 875–885.

STOKES, D.L. & BOERSMA, P.D. 1991. Effects of substrate on the distribution of Magellanic Penguin (*Spheniscus magellanicus*) burrows. *Auk* 108: 923–933.

STOKES, D.L. & BOERSMA, P.D. 1998. Nest-site characteristics and reproductive success in Magellanic Penguins (*Spheniscus magellanicus*). *Auk* 115: 39–49.

WALSBERG, G.E. 1985. Physiological consequences of microhabitat selection. In: Cody, M.L. (Ed.). Habitat selection in birds. New York: Academic Press. pp. 389–413.

WOEHLER, E.J. 1993. The distribution and abundance of Antarctic and Subantarctic penguins. Cambridge: Scientific Committee on Antarctic Research.