

NEST-SITE SELECTION AMONG ADÉLIE, CHINSTRAP AND GENTOO PENGUINS IN MIXED SPECIES ROOKERIES

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The literature on pygoscelid penguins, the Adélie (*Pygoscelis adeliae*), the Chinstrap (*P. antarctica*) and the Gentoo (*P. papua*) penguins, is replete with statements about their nest-site preferences (Clarke 1906, Murphy 1936, Conroy et al. 1975, Muller-Schwarze and Muller-Schwarze 1975, White and Conroy 1975). Similar cohabiting avian species might be expected to develop specific habitat preferences (Klopfer and Hailman 1965) and some authors (White and Conroy 1975, Muller-Schwarze and Muller-Schwarze 1975) have suggested that sympatrically breeding pygoscelid penguins have nest-site preferences. However, these preferences have never been quantified. The purpose of this study was to quantitatively describe the nest-sites selected by sympatrically breeding Adélie, Chinstrap and Gentoo penguins.

METHODS

All 3 pygoscelids breed in 2 rookeries (after Penney 1968) located near Point Thomas (62°10'S, 58°30'W), King George Island, South Shetland Islands. The rookeries are separated by a glacial tongue, 3 km wide. The Polish Academy of Sciences Antarctic Station, Henryk Arctowski, is located 1 km from the west rookery. Data were collected between 1 November 1977 and 21 February 1978.

A census of penguin colonies (after Penney 1968) was conducted in both rookeries 1-2 weeks following peak egg-laying of each species. Individual counts were made of gentoo and chinstrap nest-sites. Adélie nests were counted individually in colonies of fewer than 150 pairs, and were estimated in larger colonies by determining the colony's area and using the figure of 1.13 pairs/m² obtained from small colonies (Trivelpiece and Volkman 1979).

The majority of measurements were taken on penguin colonies in the west rookery, although some were taken in the east rookery to avoid interfering with on-going studies. Measurements of elevation, slope (degrees) and distances to the nearest landing beach (measured from the center of colonies) were obtained after mapping the colonies on a detailed topographical map of the west rookery. The number of obstacles (rocks and whale bones) large enough to act as windbreaks (higher than 25 cm) were counted in the west rookery. The distances between the outer rim of a sample of 40 penguin nests and the outer rim of the 3 nearest nests were measured in the east rookery. The length, width and volume (displacement of water) of 5 stones selected at random from a sample of nests from 13, 6 and 25 different Adélie, Chinstrap and Gentoo penguin colonies, respectively (one-third or more of the colonies of each species) were measured in both rookeries. Whenever possible, nest-stone samples were collected from areas in which the 3 species nested in close proximity.

For comparisons, measurement of elevation, slope and the number of obstacles/colony were weighted by multiplying each colony's value by the number of pairs in the colony. All statistical comparisons, unless otherwise indicated, were performed using a 1-way analysis of variance and the Duncan's new multiple range test.

RESULTS AND DISCUSSION

The west rookery consisted of 20 Adélie, 9 Chinstrap and 28 Gentoo penguin colonies (Fig. 1), and a population of 11,000 Adélie, 750 Chinstrap and 700 Gentoo penguin pairs. The east rookery consisted of 22 Adélie, 4 Chinstrap and 55 Gentoo penguin colonies, and a population of 7000 Adélie, 290 Chinstrap and 1900 Gentoo penguin pairs. In the 2 rookeries, the number of pairs per Adélie colony was statistically greater than the number of pairs in Chinstrap and Gentoo penguin colonies, which were statistically equal (Table 1). In the west rookery Adélies nested at higher elevations than chinstraps which nested at higher elevations than gentoos (Table 2). The greatest differences in elevation of nest-sites were evident between Adélies and gentoos. The majority of Adélies nested more than 20 m above sea level, while the majority of gentoos selected nest-sites at less than 10 m elevation. The distance that Adélies nested from the nearest landing beach was statistically greater than the distances chinstraps and gentoos nested from the nearest landing beaches (Table 1). Chinstraps nested in areas of greater slope than gentoos (Table 1). The mean number of obstacles/colony was greater in gentoo colonies than in chinstrap colonies, which had more obstacles than Adélie colonies (Table 1). Adélies nested more closely together than chinstraps which nested more closely together than gentoos (Table 1). The volume of stones used by chinstraps to build nests was statistically greater than those used by Adélies and gentoos (Table 3).

Several differences were apparent among the nest-site characteristics of penguins at Point Thomas. The Adélie Penguin nested in larger, denser colonies which contained fewer obstacles, were at higher elevations and were farther from landing beaches than those of its congeners. The Chinstrap Penguin tended to nest in steeply sloped areas, whereas its congeners nested in generally flat or gently sloped areas, and chinstraps built nests with larger stones than Adélies and gentoos. On Signy Island, Adélie, Chinstrap and Gentoo Penguins are "crest," "slope" and "ridge" nesters, respectively (White and Conroy 1975). In the area of the Antarctic Peninsula, Adélie Penguins nested on knolls and ridges, chinstraps on rocky slopes at higher elevations, and gentoos in low flat areas (Muller-Schwarze and Muller-Schwarze 1975). With the exception of the fact that White and Conroy (1975) reported gentoos at Signy Island nesting primarily on ridges, our findings concur with these.

Chinstraps, in addition to using larger nest-stones than Adélies and gentoos, build their nests with fewer stones than gentoos (Bagshawe 1938). Stones are abundant at Point Thomas, and competition for them is probably nonexistent. Nests built of relatively larger and fewer stones may be an adaptation to nesting in steeply sloped areas where larger stones would provide a more stable anchorage for the nest cup.

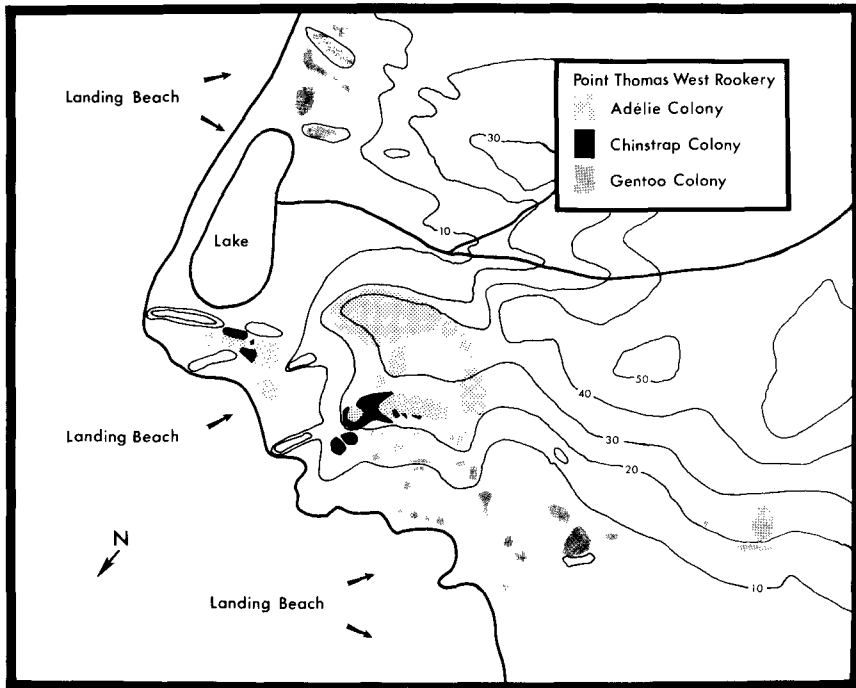


FIG. 1. Map of the Point Thomas west rookery showing the positions of pygoscelid colonies with respect to landing beaches and elevation.

As ice- and snow-free areas suitable for nesting are limited, the nest-site preferences of pygoscelid penguins described in this and other studies may be the result of competition and resource partitioning. Alternatively, we suggest that these preferences may result from differences in their ecology, especially in the degree of coloniality evident in each species. In terms of colony size and nest density, Adélies are the most colonial and gentoos the least colonial. The formation of relatively larger colonies by Adélies requires relatively larger areas, free of obstacles. At Point Thomas these areas are either flat or gentle slopes. In contrast, chinstraps and gentoos, which are less colonial, can exploit nesting habitat which is more broken up, i.e., has more obstacles, is steeper, or is flat, but can accommodate only a few nests, i.e., ridges. The Adélie Penguin, the only pygoscelid which breeds in high latitude rookeries (e.g., Cape Crozier and Cape Royds, Ross Island), nests there on open, wind-swept knoll and ridge tops in order to avoid drifting snow (Yeates 1975). The majority of Adélies at Point Thomas do not nest on knoll and ridge tops, and drifting snow (possibly because of warmer temperatures) does not appear to affect

TABLE 1
CHARACTERISTICS ($\bar{x} \pm SE$) OF PYGOSCELID PENGUIN COLONIES AT POINT THOMAS

	Adélie Penguins	Chinstrap Penguins	Gentoo Penguins
Number of pairs	416.5 ^{a,b} ** \pm 131.7	81.5 \pm 18.7	35.5 \pm 4.9
Distance to nearest landing beach (m)	131 ^{a,b} * \pm 4.3	93 \pm 1.1	92 \pm 3.3
Slope (degrees)	5.7 \pm 0.4	9.3 ^{a,c} ** \pm 0.2	4.0 ^c ** \pm 0.2
Number of obstacles per nesting pair	0.09 \pm 0.06	0.22 \pm 0.04	0.39 ^{a,c} ** \pm 0.04
Inter-nest distances (cm)	43.2 \pm 1.3	59.9 ^c ** \pm 2.2	74.3 ^{a,c} ** \pm 3.8

^a Differs statistically from chinstrap.

^b Differs statistically from gentoo.

^c Differs statistically from Adélie.

* $P < 0.05$.

** $P < 0.01$.

their reproductive success (Trivelpiece and Volkman, unpubl.), and thus, is probably not as important a factor in their choice of nest-sites here as it is at higher latitudes.

Among the possible adaptive advantages of coloniality to penguins are: (1) protection from predation, (2) protection from adverse weather conditions, (3) social facilitation (i.e., colonies as "information centers," [Ward and Zahavi 1973]), (4) "social stimulation" (after Darling 1938), and (5) maximal exploitation of limited ice- and snow-free areas. At present, data to refute or substantiate any of these possibilities are limited. However, based on available data, a preliminary analysis suggests that none of the first 4 possibilities explains the differing degrees of coloniality among the

TABLE 2
PERCENTAGES OF PYGOSCELID PENGUINS NESTING AT DIFFERENT ELEVATIONS IN THE
POINT THOMAS WEST ROOKERY

Species	Elevation (m)			
	1-10	11-20	21-30	31-40
Adélie** N = 20	13.8	1.2	40.0	45.0
Chinstrap** N = 9	17.0	15.2	67.8	0.0
Gentoo** N = 28	66.5	22.6	10.9	0.0

** χ^2 significantly different from either congener ($P < 0.01$).

TABLE 3
THE MEAN (\pm SE) LENGTH, WIDTH AND VOLUME OF NEST-STONES USED BY PYGOSCELID PENGUINS

Species	Length (mm)	Width (mm)	Volume (ml)
Adélie N = 45 nests	41.1 \pm 1.4	11.1 \pm 0.4	6.2 \pm 0.4
Chinstrap N = 50 nests	52.1 \pm 1.5**	11.5 \pm 0.6	11.4 \pm 0.9**
Gentoo N = 54 nests	35.0 \pm 1.2	10.6 \pm 0.5	5.2 \pm 0.5

** Significantly different from Adélie and gentoo ($P < 0.01$).

pygoscelid penguins. The Adélie Penguin does nest farther south than its congeners (see Watson 1975) and there is a correlation between coloniality and latitudinal distribution. Assuming that the amount of ice- and snow-free habitat decreases with increasing latitude, coloniality in pygoscelids may be related to exploitation of ice-free habitat. This conclusion is, of course, preliminary and further data on the ecology of pygoscelid penguins are necessary to substantiate its validity.

SUMMARY

The nest-site preferences of sympatrically breeding Adélie (*Pygoscelis adeliae*), Chinstrap (*P. antarctica*) and Gentoo (*P. papua*) penguins were quantified in rookeries at Point Thomas, South Shetland Islands. Adélies nested in larger, denser, more open colonies, at higher elevations and farther from landing beaches than those of its congeners. Chinstraps nested in steeply sloped areas; Adélies and gentoos nested generally in flat and gently sloped areas. It is suggested that differences in pygoscelid nest-site preferences may be partially attributable to differences in the degree of coloniality evident in each species.

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