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EFFECTS OF SAMPLING BLOOD AND UROPYGIAL OIL ON BREEDING SUCCESS OF ANTARCTIC BIRDS

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Abstract.—Samples of blood and uropygial (preen-gland) oil were collected from Adélie Penguins (*Pygoscelis adeliae*) and Southern Fulmars (*Fulmarus glacialoides*) in a study developing methods for monitoring organochlorine pollutants in Antarctica. This sampling and associated activities had no significant effects on the breeding success of these species. The techniques we used appear suitable for implementation in a monitoring program for organochlorine pollutants in Antarctica.

EFECTO DE OBTENER MUESTRAS DE SANGRE Y ACEITE DE LA GLÁNDULA UROPIGIAL, EN EL ÉXITO DE ANIDAMIENTO DE AVES EN LA ANTÁRCTICA

Sinopsis.—Se tomaron muestras de sangre y aceite de la glándula uropigial en individuos de *Pygoscelis adeliae* y de *Fulmarus glacialoides* en un estudio orientado a desarrollar formas de monitorear contaminantes organoclorinados en la Antárctica. El muestreo y las actividades asociadas a este, no tuvieron un efecto significativo en el éxito de anidamiento de las aves. La técnica utilizada parece adecuada para implementar un programa de monitoreo de contaminantes organoclorinados en la Antárctica.

As part of a program to monitor organochlorine pollutants in Antarctica (Van den Brink, in press) we developed methods to sample blood and uropygial oil that would permit long-term monitoring of individual birds. Although these methods are non-destructive, some effect on the birds involved could still be expected. For example, effects of research activities on physiology and behavior of Adélie Penguins (*Pygoscelis adeliae*) have been observed (Clarke and Kerry 1994, Culik et al. 1990, Wilson et al. 1989, Wilson et al. 1991). Unfortunately, we know of no research on the effects of the collection of samples of blood and uropygial oil on Antarctic birds, and more information is needed on the responses of birds towards the collection of blood samples (Fraser and Trivelpiece 1993). Therefore we assessed the effects of the collection of blood and uropygial oil samples on the breeding success of two Antarctic species: the Adélie Penguin and the Southern Fulmar (*Fulmarus glacialoides*).

METHODS

Study plots (n = 40, each containing approximately 10 nest sites) were established within a colony of Adélie Penguins (600 pairs) and a colony of Southern Fulmars (600–800 pairs) on Hop Island, Rauer Islands, Antarctica (68°50′S, 77°42′E) (Green and Johnstone 1986). Within these

plots we compared a group of birds we sampled for blood and uropygial oil (hereafter referred to as sampled) and another group exposed to researchers walking by at distances ≥0.5 m (walked by), with a group to which researchers did not come closer than 10 m (control). For the Southern Fulmar we included a separate group of birds banded with metal bands and plastic color bands (banded).

Sampled.—Birds were captured by hand, taken out of the colony, measured, weighed, and sampled for blood and uropygial oil. One group of birds (hereafter referred to as group 1) was handled at egg-laying and also around egg-hatching. Another group (group 2) was treated only around egg-hatching. These separate treatments were needed to assess the difference in vulnerability of the birds to disturbance at different periods in the breeding season (Götmark 1992) and to study the effects of multiple collection of samples from the same adult during one breeding season. Blood was drawn from a vein in the middle of the footweb of Southern Fulmars, and from the veins in the toes or the ankle joint of Adélie Penguins. With the latter, a vein in the flipper was used if needed. The volume of the blood samples represented less than 0.5% of the body mass (Adélie Penguins: <20 ml, Southern Fulmars: <4–5 ml). Uropygial oil (1–3 mg) was collected by scraping off the feather bundle on top of the uropygial gland using two stainless steel spoons.

To prevent heat stress, birds were not handled in direct sunlight nor when temperatures exceeded 0–1 C. Adélie Penguins were released within 30 min of capture. The sampled Adélie Penguins were marked with picric acid on the breast, and could be distinguished from their partners. Southern Fulmars were banded with stainless steel bands and plastic color bands and released within 15 min. For each species, 25 birds from 10 plots were included in group 1 and 20 birds from 10 plots in group 2.

Walked by.—The second treatment involved measuring the effects of people working near nests. Birds in this group occupied nest sites within the plots from which sampled birds were chosen, but were not captured or handled. The number of nest sites monitored for this treatment was 20 for each group for Adélie Penguins, and 29 for Southern Fulmars in group 1 and 20 in group 2.

Banded.—Forty-nine adult Southern Fulmars were taken from nest sites within the same plots as sampled and walked by birds. The birds were measured, weighed, and banded with a stainless steel band and plastic color band. Twenty-nine birds were banded in group 1, and 20 were in group 2.

Control.—The remainder of the plots were assigned to control groups (see Table 1 and 2 for details on numbers of nests included), with no interference except a nest check at the start of the season. This initial check was done with as little impact as possible (observers 1–10 m from nests), but was necessary in order to assess the breeding status of the birds at the start of the experiment.

For each species the experiment was conducted in a single colony to avoid differences in behavior due to between-colony variation in local

TABLE 1. Average breeding success (number of offspring per nest) of handled Adélie Penguins (mean, number of nests in parentheses) in the Rauer Islands, Antarctica. Week 0 is start of experiment, week 4 is beginning of hatching, and week 6 is start of crèche stage. There were no significant differences between treatments (*t*-test, $P > 0.05$).

	Group 1			Group 2		
Week	Sampled	Walked by	Control	Sampled	Walked by	Control
0	2.00 (25)	2.00 (20)	2.00 (40)	—	—	—
1	1.96 (25)	1.95 (20)	1.90 (40)	—	—	—
2	1.84 (25)	1.95 (20)	1.88 (40)	—	—	—
3	1.84 (25)	1.95 (20)	1.88 (40)	—	—	—
4	1.84 (25)	1.95 (20)	1.85 (20)	2.00 (20)	2.00 (20)	2.00 (20)
5	1.64 (25)	1.70 (20)	1.75 (20)	1.75 (20)	1.85 (20)	1.90 (20)
6	1.12 (25)	1.10 (20)	1.43 (20)	1.35 (20)	1.35 (20)	1.55 (20)

conditions. At the start of the experiment (first samples collected during egg-laying: Adélie Penguin: 12–16 Nov. 1993, Southern Fulmars: 8–12 Dec. 1993), the breeding status of all nests was checked from a close distance (1–10 m). For Adélie Penguins, we selected birds from nests containing one egg. At this stage of the breeding cycle it was likely that the pair would produce a second egg and the selected sites would be synchronized. For Southern Fulmars, we selected birds from nests containing one egg. When chicks were seen hatching in the colonies, more samples were collected (Adélie Penguins: 15–19 Dec. 1993, Southern Fulmars: 20–25 Jan. 1994).

A map was drawn of each study plot to enable recognition of the individual nest sites. Breeding success was monitored weekly, using binoculars from a distance >10 m to avoid unnecessary disturbance. Adélie Penguins could be monitored until the moment the chicks left their nests and started to form crèches. Thereafter it was not possible to assign individual chicks to a pair of breeding birds without marking the chick, which would have created disturbance in the colony. The breeding status of Southern Fulmars was monitored until we left the area (20 Feb. 1994). At this date the chicks were about 1-mo old. Treatments were assigned to nests within plots using a random number generator of the statistical program GENSTAT (GENSTAT 1987).

Statistics.—The experiment was designed to assess effects of handling, each week being considered separately. The number of offspring per nest was compared to controls and tested using *t*-tests. Data were logit-transformed to standardize the variances between treatments, and the tests were performed assuming the number of offspring to be binomially distributed; the maximum number of offspring for Adélie Penguins is 2 and for Southern Fulmars is 1.

RESULTS

The average breeding success of each treatment group of Adélie Penguins is shown in Table 1. No significant differences in breeding success

TABLE 2. Average breeding success (number of offspring per nest) of handled Southern Fulmars (mean, number of nests in parentheses) in the Rauer Islands, Antarctica. Week 0 is start of experiment; week 7 is beginning of hatching. There were no significant differences between treatments (t-test, $P > 0.05$).

	Group 1				Group 2			
Week	Sampled	Banded	Walked by	Control	Sampled	Banded	Walked by	Control
0	1.00 (25)	1.00 (29)	1.00 (29)	1.00 (40)	—	—	—	—
7	1.00 (25)	0.97 (29)	0.90 (29)	0.88 (20)	1.00 (20)	1.00 (20)	1.00 (20)	1.00 (20)
8	1.00 (25)	0.93 (29)	0.76 (29)	0.85 (20)	1.00 (20)	0.85 (20)	0.85 (20)	0.98 (20)
9	0.92 (25)	0.90 (29)	0.66 (29)	0.73 (20)	0.95 (20)	0.84 (20)	0.85 (20)	0.83 (20)
10	0.80 (25)	0.83 (29)	0.62 (29)	0.65 (20)	0.80 (20)	0.70 (20)	0.85 (20)	0.73 (20)

between groups could be detected in any week (t-test, $P > 0.05$). In the last monitoring week, the control group had a slightly higher breeding success, but this was not statistically significant. No additional effects of multiple collection of samples could be detected.

Figure 1 shows the percentages of nest sites of sampled birds being attended by the sampled bird, with or without its partner, plotted over time. The lines converge towards 50%, meaning that at week 6 about 50% of the nests in the sampled group were guarded by a bird that was captured and handled. The other nests were attended by partners of the handled birds.

The breeding success of the treatment groups of the Southern Fulmar is shown in Table 2. Distant visual observations of Southern Fulmars during part of the incubation period (week 1–6) did not allow us to be certain that an egg was under the birds at the site. There were no significant differences between the treatments (t-test, $P > 0.05$). No additional effect of the second handling of the birds could be detected.

DISCUSSION

Combining treatment groups, the losses of eggs for the Southern Fulmar around hatching are similar to those reported for an earlier season (1988–1989) in the same colony (3–14% this study vs. 15% in Norman et al. 1992). The number of hatched chicks of Adélie Penguins was higher than reported by Clarke and Kerry (1994) (1.7 chicks per nest in this study vs. 1.25). Unlike Robert and Ralph (1975), who studied gulls, we observed no effects of disturbance. Possibly a threshold level of disturbance has to be reached before effects on breeding success become evident. If this were the case, this would concur with the view of Wilson et al. (1991) that physiological effects may not be accompanied by behavioral changes. This threshold level was apparently not reached in this study. Our results show no differences in vulnerability of the birds towards the types of disturbance caused at the moment of egg-laying or hatching. The fact that the chicks were not mobile in the latter period may be of importance. At this early stage in the breeding cycle the chicks do not

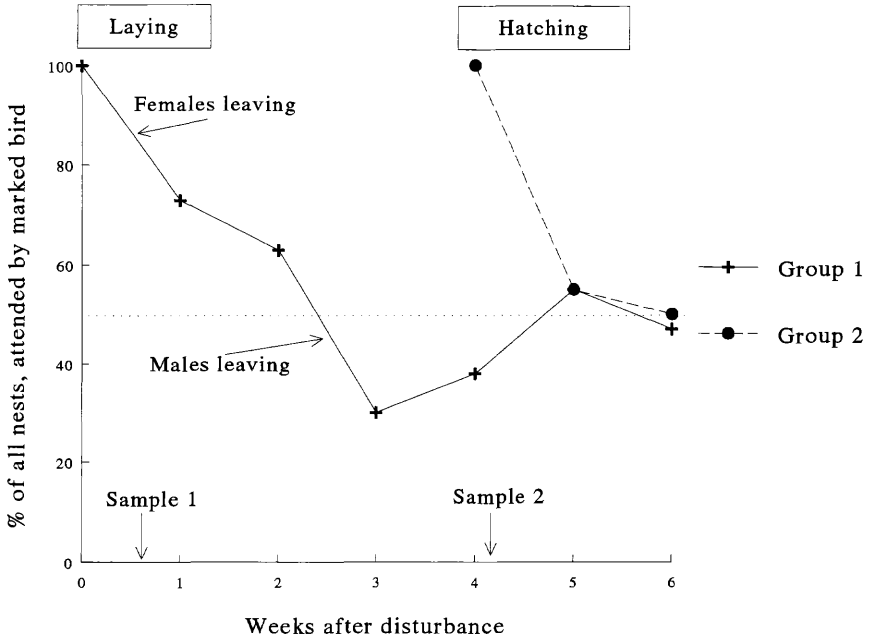

FIGURE 1. Percentage of nests of handled Adélie Penguins that were attended by the handled bird. Group 1 contained birds handled at egg-laying and at egg-hatching. Group 2 contained birds only handled at egg-hatching.

react strongly towards their surroundings nor defend themselves. Hence, no direct effects on the chicks are expected (Robert and Ralph 1975). Later in the season chicks start to defend themselves, which means that researchers may cause more disturbance in the colony (Götmark 1992). At this later stage in the breeding cycle, effects of research activities might be more pronounced. This difference in vulnerability was observed by Culik et al. (1990) in Adélie Penguins.

It has been suggested that when a bird is disturbed the partner can alleviate the effects by performing a larger share of parental duties (Götmark 1992). We assume that, especially later in the season when shifts of each Adélie Penguin parent are short (Taylor 1962, Trivelpiece et al. 1990), undisturbed male and female birds equally share the duties of chick raising. The percentage of nests attended by handled Adélie Penguins tended over time towards 50% in our study (Fig. 1). This could not be compared to controls, because we did not mark the controls. The line does not converge directly towards 50% because males and females were not equally represented in the group of handled birds. All the birds leaving between week 0 and 1 were female, all the birds of known sex leaving between week 2 and 3 were male. The attendance pattern observed im-

plies that breeding pairs of which one bird was handled showed normal breeding behavior, equally sharing the duties of chick raising.

Absence of short-term effects of our methods does not necessarily imply that there would be no effects in the long term. Declines in local population densities of Adélie Penguins have been attributed to persistent human disturbance, although this disturbance was not scientific research (Wilson et al. 1990). Fraser (1992), however, did not detect any effect related to human disturbance (scientific research and tourism). Based on long-term census data, he suggests that Adélie Penguins have a relatively high tolerance to human disturbance. For the Southern Fulmar a similar conclusion could be drawn from the fact that the small population of this species in Terre Adélie maintains fairly constant numbers in spite of annual research disturbance (Thomas 1986).

We conclude that there are no significant short-term effects of the sampling of blood and uropygial oil on the breeding success of Adélie Penguins and Southern Fulmars. Although long-term effects should be investigated, both species appear to have sufficient tolerance to regular disturbance, and they can be considered as good candidates for being included in long-term projects, such as the intended study of organochlorine contaminants.

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