at intervals ranging from 7–35 sec and averaging 16 sec. The female called 39 times at intervals of from 11–37 sec with an average of 20 sec. Thirty-three of the 46 male calls started within 6 sec after the start of a female's call, 27 of them while the female was still calling (fig. 1). The probability of this occurring by chance is $P \ll 0.001$ (χ^2). Of the remaining 13 male calls, 10 occurred when the female failed to call, all of them between 9 and 13 sec after his previous call. Unlike the male, the female called with no detectable reference to the male's calling and on only three occasions called twice in succession (fig. 1).

Temporally coordinated singing in a communicating pair of birds has been termed duetting or antiphonal singing and has been thought to function in mate recognition and behavioral coordination. This phenomenon has rarely been noted in temperate and boreal regions. It has been reported, however, in owls (Witherby et al., The handbook of British birds, H. F. and G. Witherby Ltds., Vol. II, London, 1940) where its occurrence may be related to reduced effectiveness of visual communicatory mechanisms and increased dependence on auditory display (Thorpe, Bird song—The biology of vocal communication and expression in birds, Cambridge Univ. Press 1961). Whether or not the performances described above should be labeled duetting, they are of interest as evidence that the hooting of one member of a pair of Great Horned Owls, the female, may produce a quick and definite response in the mate. Such stimulation by a mate may well have significance for the coordination and strengthening of pair bonds.

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DIFFERENTIAL PREDATION BY SOUTH POLAR SKUAS IN AN ADÉLIE PENGUIN ROOKERY

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During the austral summer the diet of the South Polar Skua (*Catharacta maccormicki*) consists of penguin eggs (fig. 1), penguin chicks, krill lost by feeding penguins during regurgitation, and fish, often of the genus *Pleurogramma* (Young 1963), and at certain rookeries, remains of penguins killed in the water by leopard seals. Occasionally, seal droppings or afterbirths of Weddell seals (*Leptonychotes weddelli*) are taken as food. Thus, though South Polar Skuas typically nest around penguin rookeries, in the Ross Sea area Adélie Penguin (*Pygoscelis adeliae*) rookeries, the penguins are not their sole source of food. Part of a Skua population will routinely fish in the ocean (Young 1963), while many of the breeding pairs of Skua are defending peripheral sections of the adjacent penguin rookery as food territories. In the special case of the small Adélie rookery at Cape Royds, the entire rookery is divided into feeding territories of Skuas (Young 1963).

For penguins, a *colony* is defined as "a geographically continuous group of breeding birds whose territorial boundaries are contiguous" (Penney 1968). A *rookery* "contains one or more colonies of breeding birds and a landing beach or beaches the birds use to reach the nesting areas from the sea" (Penney 1968).

PROBLEM

In the Adélie Penguin rookery at Cape Crozier, South Polar Skuas nest only around the landward periphery, but not within the rookery or near the beach. They defend feeding territories along that periphery. However, Skuas prey and scavenge throughout the extensive rookery. We therefore wondered how variable the predation pressure would be in terms of the entire area of an Adélie Penguin rookery.

FIGURE 1. South Polar Skua carrying away an Adélie Penguin egg. This is done when other Skuas are competing for the egg.

As a side issue, we wanted to learn more about the hunting methods of Skuas. For example, do Skuas search only for familiar items, or do they readily investigate novel objects?

METHODS

During the 1970–71 season, we carried out experiments on food-searching behavior of South Polar Skuas at Cape Crozier on Ross Island (77°27′ S, 169°14′ E) as part of a larger study of predation by leopard seals and Skuas and the antipredator behavior in Adélie Penguins (Müller-Schwarze and Müller-Schwarze 1970, 1971). The rookery, consisting of 150,000 breeding pairs (Penney and Lowry 1967; Emison 1968), occupies an area of about 1400 m by

FIGURE 2. An aerial view of the Adélie Penguin rookery at Cape Crozier. Photo: Courtesy of U.S. Navy.

800 m (fig. 2). There are 950–1000 pairs of breeding South Polar Skuas and 200–400 nonbreeders (Wood 1971). Five different types of experiments were completed between 9 and 23 January 1971 (table 1). At that time the Adélie Penguin chicks were 3–6 weeks old, and provided the main prey for the Skuas that were hunting in the penguin rookery. Our 66 single experiments involved placing dead penguin chicks and eggs at different locations in the penguin rookery.

Each stimulus situation was replicated in the beach area, the center, and the hill zones of the Cape Crozier rookery. Within each zone, the six feeding sites (one per experiment) were placed approximately 150 m apart. This was meant to assure that different individuals would respond in each experiment. Because of the quick movements of the Skuas, it was not always possible to read their band numbers. In 23 of 55 cases of landing Skuas, some numbers were read. Only once did we notice the same Skua to appear at two different sites. After laying out the objects, the two experimenters sat down 20 m uphill and observed for 30 min. The following parameters were recorded:

a. *Reaction time*: Time span elapsed between placing of objects and first bird landing at objects.

b. *First object*: The object first approached, pecked at, and/or eaten.

c. *Number of birds*: Number of birds landing at the site and competing for the food.

d. *End of experiment*: The time required to terminate the experiment as measured from the time of placing objects to the time the eggs were taken or the Skua(s) were eating at the chick for one continuous minute. If neither of these two responses occurred, the experiment was discontinued after 30 min.

e. *Duration of interest*: The time from first approach to the end of the experiment (d minus a).

Experiment 1. One dead penguin chick and eight white eggs were deposited on light, guano-stained ground in a vacant section of a penguin colony. (The penguin chicks had gathered in creches, so that the former nest areas were vacated.) The eggs were placed around the chick in the arrangement of a cross; each arm of the cross was formed by one egg ½ m from the chick and another egg 1 m away. The total surface of the eight eggs approximated that of the single chick.

The responses of the Skuas showed that the Adélie Penguin rookery cannot be regarded as one uniform area. Eggs and chicks were discovered sooner at the beach and in the center than at the periphery of the hill. It took an average 56 sec for the first Skua to land in the beach and center areas, but 14 min 22 sec on the hill. The food was taken earlier and there were up to 15 birds competing for the food in the center and beach colonies, but only up to three at the

TABLE 1. The five different experiments carried out.

Experiment	Prey objects laid out	Number of presentations			
		beach	center	hill	Total
1	8 white eggs and one chick on light ground	6	6	6	18
2	1 white egg and one chick on light ground	6	6	6	18
3	1 black egg on dark ground	2	2	2	6
4	1 black egg on dark ground, and 1 black on light ground	2	2	2	6
5	1 black and 1 black-and-white egg on light ground	6	6	6	18
	Total				66

TABLE 2. The results of experiment 1.

	Hill	Center and beach	Significance of difference[a]
Reaction time	14′ 22″	0′ 56″	< 0.01
Egg taken as first object	5 of 5 times	11 of 12 times	NS
Average number of birds landing	1.3	8.6	< 0.01
End of experiment	18′ 35″	5′ 39″	< 0.01
Duration of interest in experiment	9′ 17″	4′ 43″	NS

[a] Mann-Whitney and *t*-tests, one-tailed (also in following tables).

hill areas. The average numbers of birds arriving at the site were 8.6 and 1.3, respectively (table 2).

In all areas, the Skuas landed most often (16 out of 17 lands) at one of the eggs, and in only one case at the chick. The eggs were also taken first.

Experiment 2. Because the eight eggs in experiment 1 might have attracted Skuas disproportionately in comparison with only one chick, in experiment 2 only one white egg and one chick were put on light ground.

All responses duplicated those noted with the eight eggs (table 3). Again in 15 out of 17 cases, the Skuas first turned to the egg; and the differences between the areas were the same as in experiment 1. The significance levels of the differences are shown in table 3.

Experiment 3. Because the Skuas easily found the normal eggs and chicks (probably due to past extensive experience), novelty was introduced as a new dimension. Eggs were painted black and placed on dark basalt near penguin colonies. In none of the six replications of this test did a Skua pay attention to the black egg, although on the average nine Skuas (range 2–19) flew over the site at a height of 6 m or lower during each 30-min observation period.

Experiment 4. Next, one black egg was placed on light ground, while another one was placed 2 m away on a black background. Again, the Skuas made no response to either of the eggs in any of the six tests, although an average of 12–13 Skuas (range 8–14) flew over the site at 6 m or lower during each 30-min period.

Experiment 5. In this experiment, some of the eggs were painted only half black. One such egg and a black egg were placed 1 m apart on light ground. The end of the experiment was defined as the time when one of the eggs was either opened or carried away by a Skua.

The Skuas typically approached the half-white, half-black egg first (15 times in the 18 single tests). Out of these 15 cases, the investigating Skuas went on to the black egg six times. The black and white egg was actually eaten in 14 of the 15 cases. In four such instances, birds proceeded to the black egg (table 4). These figures show that the stimulus situation had reached a point at which the Skuas approached the black as often as they ignored it after having been near the black-and-white egg (χ^2 test). The Skuas that approached the black eggs or the black-and-white eggs from the black side pecked cautiously at it, without opening it, then spread their wings and jumped back, or they sat down next to the egg. Most of the reactions seemed to be signs of conflict.

DISCUSSION

The first unexpected result was that the Skuas that flew over the experimental sites apparently reacted to the sight of the egg(s) rather than the chick and landed beside an egg first. At the time of these experiments, however, the Skuas were hunting in the rookery only for penguin chicks because eggs were no longer available.

The Skuas did not discover the black eggs, neither on dark nor on light ground. This would indicate that they do not look for, respond to, or investigate novel objects which occur very rarely in their normal habitat.

In this context, it is of interest to note that the Adélie Penguins—in contrast to the Skuas—showed an intense interest in the experimental eggs. Both adults and chicks would walk to the eggs from distances of up to 5 m, inspect them, and even push them around. It is remarkable that the predator did not respond to abnormal eggs, while the penguins did, even though their incubation season had ended 4 weeks earlier. The penguins responded as often to the black eggs as they did to half-white ones.

The Skuas started to become interested in black eggs only with the aid of a half-white egg. Unfortunately, time limitations did not allow an investigation of whether a complete switch to, and preference for, black eggs could be initiated. We assume this might take place with more experience with black eggs. Skuas learn fast—they feed on seal meat, garbage, discarded steaks, etc.

TABLE 3. The results of experiment 2.

	Hill	Center and beach	Significance of difference
Reaction time	11′ 20″	1′ 24″	< 0.01
Egg taken as first object	5 of 5 times	10 of 12 times	NS
Average number of birds landing	1.2	5.5	< 0.01
End of experiment	15′ 30″	3′ 26″	< 0.01
Duration of interest in experiment	9′ 08″	2′ 03″	NS

TABLE 4. The results of experiment 5.

	Hill	Center and beach	Significance of difference
Reaction time	9′ 15″	11′ 17″	NS
Black-and-white egg approached first	6 of 6 times	9 of 12 times	NS
Black-and-white egg taken first	5 of 6 times	9 of 12 times	NS
Average number of birds landing	1.5	2.7	NS
End of experiment	14′ 42″	20′ 40″	NS
Duration of interest in experiment	5′ 27″	12′ 13″	NS

The most surprising result was the behavioral difference noted between the Skuas around the hill zone and those frequenting the center and beach zones. More Skuas were competing in the beach and center areas. They responded sooner and ate or carried away the eggs sooner than those in the hill area. In other words, there was more predation (and scavenging) pressure exerted on the lower areas than on the hill zone. Whether this results in higher penguin mortality remains to be shown.

In Skuas it is difficult to separate predation from scavenging. There is agreement that the taking of eggs is predation. But Skuas often only take spoiled eggs lying outside the penguin nests. On the other hand, single specialists among the Skuas may pull the tail of incubating penguins in order to get access to the eggs. At this point, it is not known whether individual differences account for the variability of food-getting behavior, or whether one and the same Skua will change from scavenging to active preying if a need arises.

The breeding territories of the Skuas were along the periphery on the hill. From each Skua nest site, the two birds of a pair penetrate about 50–80 m deep into the penguin rookery looking for eggs, chicks, or krill dropped by a penguin during feeding. Whether these "owners" of a section of penguin rookery prey actively or are resting on or near their own nest, they invariably will attack and chase away any other Skua entering their "air space." Therefore only one pair of Skuas hunts in that area while large numbers of birds assemble in other areas of the rookery.

In mid-January we found four to ten dead penguin chicks in a number of peripheral feeding territories of breeding Skuas. Some of these chicks still were near their nests, where they had obviously died, and they were untouched by Skuas. Some were opened but only partially eaten. At the same time, no dead or partially eaten penguin chicks were left in the center and beach zones. This difference is in contrast to the situation at the small Adélie rookery of about 1000 breeding pairs at Cape Royds (77°30′ S, 166°09′ E) where the entire rookery is "owned" by six Skua pairs (Young 1963).

In late January and early February, the hill area no longer held surplus food. It seems that breeding Skuas "manage" their resources; they defend the surplus food in the feeding territory in early January, and can fall back on it when the penguin chicks grow so large that it is very difficult to kill them.

The relationship between Skuas and penguins varies from rookery to rookery, or even within one rookery. At Cape Crozier, for example, there is a cluster of closely neighboring Skua nests on a hill at the northwest end of the rookery. Attacks on penguin chicks are frequent there and mortality seems to be higher than along the main boundary on the hill.

We lack data on the distribution of the Skuas in the center and beach areas of the rookery. The fact that different Skuas responded at different places, and occasional observations of agonistic behavior between Skuas seem to indicate that attempts are made to establish exclusive feeding areas there, too. Skuas breeding farther away forage there, but are unable to be present all the time.

We were able to read the band number of 38 different Skuas during the feeding experiments. At Cape Crozier, about 90% of the Skuas are banded (Wood 1971). On the hill, without exception, only Skuas breeding directly at the edge of the penguin rookery came to the feeding station. In the center and at the beach, the majority (20 of 29) were breeding birds from the upper slopes to the west and south. Their nests were not adjacent to the penguin rookery, and as far as 500 m away from its edge. The distance between their breeding territories and their feeding areas in the center of the rookery or at the beach ranged between 1 and 1.5 km. There were also five nonbreeders foraging in the beach and center areas.

The edge zone of an Adélie Penguin rookery may be under less predation and scavenging pressure than its beach and center areas. On the other hand the Skuas breeding adjacent to the penguins are probably in the best position to raise their young successfully. In conclusion then, the zone of close proximity between well-spaced Skua nests and large penguin colonies serving as food territories for the Skuas may actually be an area of maximum benefit for both species.

SUMMARY

In five different experiments, eggs and dead chicks of Adélie Penguins were laid out in three different regions (hill, center, and beach) of the rookery at Cape Crozier. The reactions of South Polar Skuas to these food items indicated differences of the combined predation and scavenging pressure on the penguins within the rookery. The breeding territories of the Skua are located at the landward edge of the penguin rookery ("hill"). The preying behavior of the territorial Skuas at that edge was less intense than that of Skuas which hunt in the center and beach areas of the penguin rookery. The Skuas never found eggs which were painted black, but eggs painted only half-black were eaten in most cases.

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FURTHER NOTES ON THE WESTERN GREBE IN MÉXICO

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Since the publication of my note suggesting the use of the name *Aechmophorus occidentalis clarkii* (Lawrence) for the populations of the Western Grebe nesting in México (except for those of northern Baja California) (Condor 65:66–67, 1963), a number of additional specimens of the Mexican populations have been collected. These extend the nesting range of the species within México to the States of Nayarit, Guerrero, Puebla, and San Luis Potosi. They help define the frequency of color phases in this population, and thus nullify the color characters believed originally to be diagnostic of *clarkii*.

Measurements of the additional 17 adult males and 13 adult females (table 1) confirm the diagnosis of *clarkii* as being smaller than adult *A. o. occidentalis* taken on the breeding ground, with little or no overlap in respective measurements of wing chord or culmen from anterior edge of nostril.

During the preparation of the earlier paper on the Western Grebe in México, I had available three specimens from Laguna San Pedro Lagunillas (18 km E of Compostela) Nayarit. Because these three individuals differed markedly in color (but not in size) from the 11 other specimens then available and because of the locality in extreme western México, I did not include them in that paper, believing *clarkii* to be a pale form. Subsequently, Palmer (Handbook of North American Birds, Vol. I, 1963) and Storer (Living Bird, 4:59–63, 1965) have described the two color phases: one is dark dorsally, with the black of the crown extending below the eye and with dark lores; and the other is paler dorsally, with the black often not touching even the top of the eye and with white lores. Storer indicated there apparently is a cline in the percentage of pale birds in a population extending from Manitoba, where only about 1% of the birds had white lores, to México from whence at that time only pale birds were known. The 48 adult or subadult Western Grebes now available from México are clearly separable into the two phases, with 20 dark and 28 pale. The sexes are essentially equally divided between the two phases. Although the series from any one lake is small, it indicates there may be some geographic segregation of the phases. All 19 specimens from central and northern México are pale. In western México (Nayarit and western Jalisco) 17 of 22 are dark. At the southern edge of the species range, the only specimen from the State of Puebla and two of six from Laguna Tuxpan, Guerrero, are dark. Because of the small size of each of these disjunct populations, it will be of interest to see if there is a noticeable shift in color-phase ratios in future years.

Two large, downy young Western Grebes from México (Laguna San Pedro Lagunillas, 25 May and

TABLE 1. Measurements (in mm) of Western Grebes.

	A. o. clarkii				*A. o. occidentalis*			
	No. Specimens	Range	$\bar{x}$	SD	No. Specimens	Range	$\bar{x}$	SD
Adult males								
Wing[a]	16	172–188	180.8	4.5	27	188–208	197.2	5.6
Culmen[b]	17	49–60	55.1	2.6	25	50–67	59.4	3.8
Bill[c]	14	9.7–11.9	11.1	0.5	22	11.0–13.8	12.5	0.7
Tarsus	14	69–77	73.1	2.2	23	74–81	77.4	2.2
Adult females								
Wing	12	164–172	168.2	3.5	17	173–196	183.4	5.7
Culmen	11	45–50	46.7	1.4	12	49–58	53.1	2.4
Bill	13	7.4–9.4	8.6	0.6	12	8.3–10.7	9.5	0.8
Tarsus	13	63–69	65.5	2.1	16	67–75	71.9	2.1

[a] Chord.
[b] From anterior edge of nostril.
[c] Depth at nostril.