

# BIRD-BANDING

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## DISTRIBUTION AND LIFE HISTORY STUDIES OF THE SOUTH-POLAR SKUA

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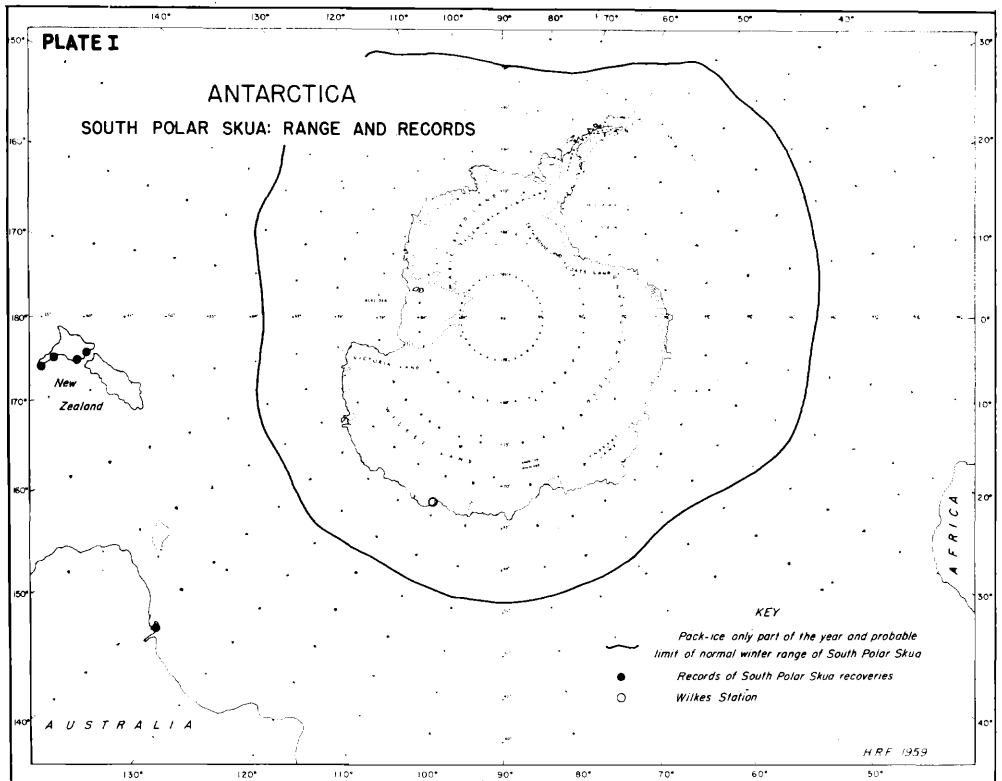
### INTRODUCTION

Skuas are in the Order Charadriiformes, and together with jaegers of the genus *Stercorarius* constitute the Family Stercorariidae. Taxonomists disagree as to whether the skua comprises a single bipolar species or whether it consists of several species and sub-species. In this study four species are recognized and all are classified in the bipolar genus *Catharacta*, with one species normally inhabiting the Northern Hemisphere and the other three the Southern. These include *Catharacta skua*, the great skua of the Northern Hemisphere; *C. chilensis* (Saunders), the Chilean skua found generally in the temperate regions of South America; *C. lonnbergi* (Mathews), the brown skua which primarily inhabits the subantarctic areas; and *C. maccormicki* (Saunders), the south-polar skua which is confined to Antarctica. This latter species, which is the subject for this study, has been commonly called the Antarctic skua as well as McCormick's skua, but south-polar skua is the more common name and this term is followed.

**ACKNOWLEDGMENTS:** This study was used as basis for a doctoral dissertation at the University of Maryland. Funds were initially provided by the United States National Committee—IGY of the National Academy of Sciences, and subsequent banding work was done through a grant provided by the National Science Foundation. Without this aid the study could never have been carried out. Banding records are being kept by the United States Fish and Wildlife Service and this is gratefully acknowledged. Special thanks are due many persons from the United States as well as other countries who so ably cooperated in this international program with their banding and observation work. Whenever possible, an attempt has been made to give proper credit in the text for this work.

The south-polar skua was first collected during Captain James Clark Ross's expedition in the *Erebus* and *Terror* to Victoria Land in 1839-43 (McCormick, 1884, p. 154). Saunders (1893) proposed the name *Stercorarius maccormicki*, and first described it, over 50 years after it had been collected, as a distinct species, on the basis of five specimens forwarded to the British Museum by Dr. McCormick. These had been procured at Possession Island, latitude 71° 14' S., longitude 171° 15' W.

The south-polar skua nests chiefly on lands within the Antarctic Circle, and on the basis of present records the breeding range is generally confined to the area south of the 65th parallel except in Palmerland where it may extend northward to between latitudes 62-64° S. This corresponds roughly to the 32°F isotherm (van Rooy, 1957). Hamilton (1934, pp. 173-174) indicates that the species does not occur



north of latitude  $65^{\circ}$  S. in Palmerland. Gain (1914, p. 109) recorded it at the South Shetland Islands, however, and found it nesting as far north as Admiralty Bay, latitude  $62^{\circ} 06'$  S. This record is further supported by collections from the Danco Coast of Palmerland (Grahamland), latitude  $64^{\circ} 30'$  S., longitude  $62^{\circ}$  W. (Murphy, 1936, p. 1010). Bagshawe (1939, p. 280) describes the brown skua at Water Boat Point on the Danco Coast, latitude  $64^{\circ} 48'$  S., longitude  $62^{\circ} 43'$  W., but this appears to be misidentified. He describes the young as slate-colored. This being the case it must be the south-polar rather than the brown skua, since young of the latter are buff-colored.

Four records of the occurrence of the south-polar skua have been made in New Zealand at locations shown on Plate I. The first *C. maccormicki* resulted from a misidentified specimen of *C. lonnbergi* from Stewart Island (Falla, 1940). Falla recorded another occurrence of *C. maccormicki* from the west coast of North Island, New Zealand, in 1940, and a third was recorded on the New Zealand coast in 1950. All these records were based on identification of dismembered birds. Fleming (1953) describes a fourth record of an exhausted bird that came ashore on North Island. It was surmised that it had been blown into the Tasman Sea by a storm that originated in the subantarctic winter range of the skua.

Argentine naturalists procured a specimen of *C. maccormicki* at Laurie Island in the easternmost South Orkneys, latitude 60° 45' S., longitude 44° 35' W., in November 1904. Up to that time this was the most northern record of the species (Clark, 1906). A specimen collected in the Sagami Sea off the coast of Japan was identified as *C. maccormicki* by Murphy (1936, p. 1007).

#### *Description*

*Plumage.* There is considerable variation in the color plumage of south-polar skuas. The bird is much paler brown than the brown skua, and it lacks the cinnamon or rufous-colored feathers so characteristic of most other forms. The ventral and dorsal surfaces are generally more light brown, with a somewhat streaked appearance, becoming darker posteriorly. The head and neck have a light chamois or straw-color tone. The darker brown of the wing feathers helps accentuate the large outstanding white patch on the primaries, which is so readily recognized in flight.

The feature that most clearly distinguishes *C. maccormicki* from all others is the downy stage of the young. It is the only one of the genus with young of a bluish or slate-gray color. The nestlings of all the other skuas are buff or rufous. Gain (1914, p. 115) maintains that this characteristic distinguishes the south-polar from the brown skua of the subantarctic. In the course of this study the young of the species have been observed at five different regions of Antarctica and all have been slate-colored. Buff-colored young have never been seen in these areas.

Most of the fledgling down is shed by the seventh or eighth week, and the plumage at this stage is a uniform mouse-gray, which later becomes very dark gray. Flight generally takes place after about 9 weeks of age, during the latter half of February and the first half of March in the Windmill Islands. At this time the darker coloration of the young bird makes it quite distinguishable as it flies with the adults.

*Body Measurements.* Measurements taken by Friedmann (1945, p. 311) of south-polar skuas collected in Palmerland show an average wing dimension for 8 males of 373.6 mm., compared with an average of 380.1 for 10 females. Tail measurements averaged 151.9 for males as against 150.1 for females. Tarsus measurements averaged 62.0 for males and 62.6 for females. The culmen, measured from the base, averaged 59.6 for males and 60.4 for females. The average of the middle toe without the claw was 54.2 for males and 56.8 for females.

Sex differentiation through measurements may be indicated after a larger collection of specimens has been examined. Falla (1937, p. 248) examined 15 specimens of *C. maccormicki* and in the measurements found indications of a greater size in the female, although this was not so marked as in *C. lonnbergi*. He felt that in any carefully sexed series of breeding adults the length of the wing might be a dimension in which females would have a decided advantage. Friedmann's examinations of *C. maccormicki* indicated an average difference of 6.5 mm. in wing measurements between the sexes. Wilson (1907, p. 75) says there seems to be a fairly constant though slight advantage in point of size in the female over that of the male.

*Weight.* Weights taken of 20 adults in January-February 1941 at

the East Base in Palmerland (latitude  $68^{\circ} 12' S.$ , longitude  $67^{\circ} 03' W.$ ) averaged 1,295 grams (Eklund, 1945). The average weight of 10 birds at the Hallett Station in January 1957 was 1,500; of 30 adults weighed at McMurdo Sound in the same month, 1,285; and of 50 adults taken at the Wilkes Station in February-March 1957, 1,390. The average weight of these 110 specimens, taken in these four different regions in Antarctica, was 1,355 grams (2 lbs.  $15\frac{3}{4}$  oz.); maximum, 1,940; and minimum, 985.

Body measurements given by previously cited authorities do not include weight. It would be interesting to obtain a truly representative sample to determine whether differences exist here between sexes, as in the case of other polar-inhabiting species such as the giant petrel (*Macronectes giganteus*) and the southern black-backed or kelp gull (*Larus dominicanus*). Unfortunately, weights by sex of the above 110 specimens could not be obtained because all the birds, except 5 of those taken at East Base, were banded and released for migration studies.

*Body Temperature.* The south-polar skua seems more active in everything it does than any other polar species observed. The rapid physiologic or metabolic processes involved in such energy appear borne out by its high body temperatures. Temperature studies were carried out in Palmerland in 1939-41, and of 6 species the skua showed the highest average, as well as the maximum, of all recordings taken (Eklund, 1942, p. 545).

In the above cited study, 28 skuas showed an average temperature of  $106.14^{\circ} F.$ , with a maximum of  $108.40^{\circ}$  for a juvenile as well as for an adult, and a minimum of  $107.40^{\circ}$  for a juvenile and  $103.40^{\circ}$  for an adult. This average was  $2.84^{\circ}$  higher than that of the snow petrel (*Pagodroma nivea*);  $1.11^{\circ}$  higher than the southern black-backed gull;  $2.34^{\circ}$  higher than the Adelie penguin; and  $0.51^{\circ}$  higher than the antarctic tern (*Sterna vittata*).

*Eggs.* A clutch usually consists of 2 eggs. The color varies slightly, but generally is greenish in various shades, with light-brown splotches. Some eggs collected in Palmerland in 1939-41 were more brownish than green, with dull, rather clouded splotches of brown. Many seen in the Windmill Islands appeared much lighter green than others.

From Cape Adare 26 collections measured between 65.5 and 78.7 mm. in length, and 47.7 and 52.0 in width (Oates, 1901, p. 226); and 8 eggs collected in Adelie Land (Etchecopar and Prevost, 1954, p. 243) showed somewhat greater uniformity, the maximum length, 73.7; the minimum, 70; and the mean, 71.9, respectively.

The egg shell of the skua is quite fragile, compared with that of the Adelie penguin. Thicknesses will undoubtedly vary, but one measurement showed the skua shell to be 0.0232 inches, while that of the penguin was 0.0325.

*Age.* Little is yet known of the longevity of the south-polar skua, but by banding recoveries over the years further data on this should be provided. Records of the United States Fish and Wildlife Service show that an adult skua banded in March 1941 at our Palmerland East Base on Stonington Island in Marguerite Bay (USFWS 40-605604) was recovered in the same area (Base E) in November 1949 (Sladen and

Tickell, 1958, p. 20) by Stonehouse of the British Falkland Islands Dependencies Survey. This indicates an age of at least 10 years.

### *Banding*

A primary objective in studying the movements and migrations of the species was to band or otherwise mark a representative number, and in such manner as to make the bands easily recognizable in the field to avoid the necessity of always having to capture or kill the birds. The ultimate success of the study was dependent upon continually observing the skuas and reporting on these observations.

The banding phase of the study was begun in September 1956 by forwarding letters to the participating nations asking their cooperation. Seven countries agreed to take part. These included Argentina, Australia, Japan, New Zealand, Norway, the United Kingdom, and the U.S.S.R. Belgium participated starting in 1957-58, and banding was done at a Chilean station in 1960-61. Banding was carried out at the 16 areas listed in Table I.

Banding kits were provided the cooperating countries, and each included a map (Plate II), unnumbered colored bands, colored vinyl-plastic adhesive tape, fishline, and record and instruction sheets. In addition, some kits contained United States Fish and Wildlife Service numbered aluminum bands, with pliers and instructions for use. The numbered bands were used only if the country doing the banding did not have a bird-banding program or bands of its own.

As many persons as possible were alerted to the study, particularly those on the pan-antarctic islands and in countries adjacent to Antarctica, so that observations might be made. Maps showing locations of banding stations and the color of bands used at each, together with instructions and observation record sheets, were forwarded to the United Kingdom for use at Tristan da Cunha and Gough Islands. The French, in addition to forwarding the information to their Adélie Land Station, sent it also to the Amsterdam and Kerguelen Islands. New Zealand sent the information to Campbell Island, Australia to Macquarie Island, and South Africa to its Marian Island.

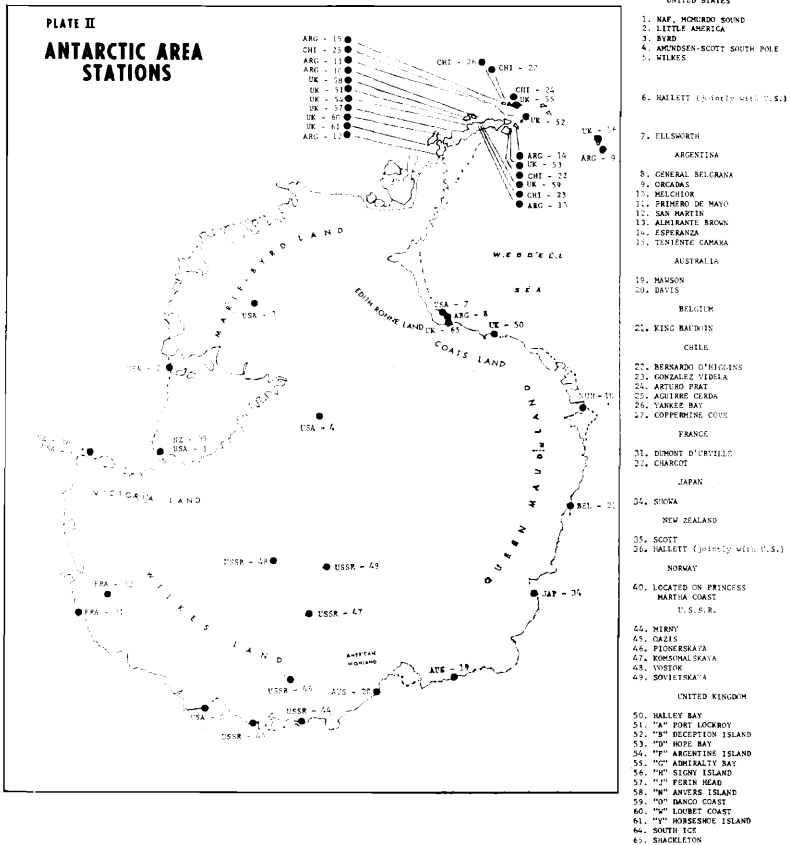
To acquaint ornithologists with the study, a brief descriptive article was published in various ornithological journals. These included *The Bokmakierie*, in South Africa (Eklund, 1957c); the *South Australian Ornithologist* (1958b) and the *Emu* (1958c) in Australia; *Notornis*, in New Zealand (1958a); *The Ring*, in Great Britain (1957b) and, in addition, in a New Zealand news bulletin, *Antarctic* (1957a).

### *Type of Bands*

Numbered aluminum-alloy lock-on bands, 1/2-inch inside diameter (size 7A), supplied by the United States Fish and Wildlife Service, were used at the United States stations. These bands were also supplied to Argentina, Norway, and Japan, although the latter two countries were unable to band any skuas. Besides a number, each band bore the inscription "Write-Avise Fish & Wildlife Service, Washington, D.C. USA." Stations of the United Kingdom, Australia, New Zealand, and the U.S.S.R. used numbered bands employed in their own national bird-banding, or ringing, programs.

TABLE I  
SKUA-BANDING STATIONS

Country and Station or Area	Latitude	Longitude	Band Color
United States:			
Naval Air Facility, McMurdo	77° 50' S.	166° 36' E.	Gray-red & yellow from 1960-61
Little America	78° 11' S.	162° 10' W.	Blue
Amundsen-Scott South Pole	90° 00' S.		White
Hallett (jointly with N.Z.)	72° 18' S.	170° 18' E.	Red
			1½" for adults
			¾" red for imm. 1956-57
			¾" red-white for imm. 1958-59
Wilkes	66° 15' S.	110° 31' E.	Green
			1½" for adults
			¾" green for imm. 1956-57
			¾" black-white for imm. 1957-58
			¾" green-white for imm. 1959-60
Argentina:			
General Belgrano	77° 59' S.	38° 44' W.	Yellow-blue
San Martin	68° 08' S.	67° 07' W.	Blue-green
Almirante Brown	64° 53' S.	62° 52' W.	Yellow-green
Australia:			
Mawson	67° 36' S.	62° 53' E.	Orange
Davis (Vestfold Hills)	68° 35' S.	77° 58' E.	Yellow-gray
Chile:			
Gonzales Videla	64° 49' S.	62° 51' W.	None Assigned
New Zealand:			
Scott (see U.S. NAF, McMurdo)			
Hallett (see U.S. Hallett)			
U.S.S.R.:			
Mirny	66° 33' S.	93° 00' E.	Yellow-red
United Kingdom:			
Deception Island "B"	62° 59' S.	60° 34' W.	Gray-green
Argentine Island "F"	65° 15' S.	64° 16' W.	Yellow-white
Signy Island "H"	60° 43' S.	45° 36' W.	White-blue
Admiralty Bay	62° 05' S.	58° 25' W.	None assigned



Besides the numbered metal band, a colored thermoplastic band made of rubber and styrene was used. This was the first time such a leg band had been tried, and it was developed from a suggestion by Rudersdorf and Van Deusen (1955).

The rubber-styrene material is manufactured in various thicknesses and colors, under the trade name of Boltaron, by the Bolta Company, Lawrence, Massachusetts. The bands, 0.45 (1/22") thick, were made by cutting pieces 1-5/8 by 3 inches. These were then rolled inside a 3/4-inch brass tube and heated at 315°F for 15 minutes. This molded the material in such manner that both ends overlapped about halfway around the band, to form an inside diameter of approximately 1/2 inch. The material shrinks slightly after heating, so the final band is about 1 1/2 inches long. Three-quarter inch long bands were used for immature birds.

The band is applied by springing the ends apart, placing it around the tarsus, and letting it spring back together. Once in place, there is

little chance of its coming off. As further insurance against loss, however, a 3 to 4-inch strip of pressure-sensitive, adhesive, vinyl-plastic tape of the same color as the band was placed around it. This also helped maintain a constant diameter.

Subsequent observations of banded birds over four breeding seasons failed to show that any of the thermoplastic bands had come off. This could be checked in many cases because birds seen with metal bands only would indicate loss of the colored band, since all banding up through 1958-59 except for some at McMurdo Sound and the Hallett Station during 1955-56, and that by the U.S.S.R. at their Mirny Station in 1956-57 and the United Kingdom Admiralty Bay Station in 1958-59 employed both types. The manner in which the bands stayed on the leg exceeded the most optimistic hopes. The material, manufactured in many thicknesses and colors, holds much promise as an effective means of marking birds for field identification, either through use as a leg, neck, or wing marker. The colors do not fade, and in many cases the thermoplastic materials outwore the metal band, as evidenced by thinness of the metal or the metal band being missing from the leg.

Six basic solid colors were used—yellow, red, green, blue, black, and white. These were chosen because there was less likelihood of human error in interpretation.

Seventeen different colors or combinations were used, as listed in Table I. In addition, a plastic, orange-colored ring had been used previously at Australia's Mawson Station, and this was continued. Combinations were obtained by painting half the band with a special vinyl-base paint manufactured by the Interchemical Corporation of Newark, New Jersey. Only blue and yellow colors were available the first year, so other red and green plastic paints were used. These were not so satisfactory as the vinyl-base paint.

A gray thermoplastic band also was used in combination with red, yellow, and green paint, but the gray was employed at only three stations, since it might be too easily confused with white. A similar-colored vinyl-plastic adhesive tape was applied with the two-color combination bands, although in some cases it was possible to apply over only one of the colors.

New Zealand's Scott Station and our country's Naval Air Facility at McMurdo Sound used bands of the same color, because of their 2-mile proximity, as did Hallett Station, which is maintained jointly by New Zealand and the United States.

To provide easier identification in subsequent years of birds banded as juveniles, a  $\frac{3}{4}$ -inch rather than the  $1\frac{1}{2}$ -inch colored band was used. In the 1956-57 nesting season at Hallett Station the  $\frac{3}{4}$ -inch band was solid red, and during the 1958-59 season it was red and white. No juveniles were banded here in 1957-58. At Wilkes Station a green  $\frac{3}{4}$ -inch band was used in 1956-57, black and white in 1957-58, and green and white in 1959-60. Thermoplastic bands were not used at any of the stations after the 1959-60 season. In the 1959-60 and 1960-61 seasons a  $1\frac{1}{4}$ -inch green colored metal band was used at Wilkes for adults, and a similar red band was used at Hallett Station. A yellow metal band was assigned the McMurdo Sound Station at the beginning of the 1960-61 season.



### *Methods of Capturing*

The south-polar skua is relatively easy to catch, and several methods were used. During the breeding season, when the birds are ever active in defense of their eggs and young, they can be readily taken with a hand net, and 156 were thus captured at Wilkes Station in 1956-57 and 1957-58. The net hoop should be 30 inches or more across, with a handle up to 6 feet long. The frame should be made of aluminum to make it light to swing.

Snaring with a fishline is another easy method of capture, and over 200 were taken in this manner at Wilkes Station, and at McMurdo Sound and Hallett Station while our ships were en route to Wilkes in 1956-57. Snaring was usually done at a dog-food seal cache where skuas congregated to feed. The easiest method was to attach a 30 to 40-foot line to a long bamboo pole, which was laid on the ground with the line run to the bait. The snare loop at the end was large enough to permit the bird to enter well into it before reaching the bait. The loop was most successful when placed along the side of a seal with a knife slit through the skin so that the bird had to walk into the loop from one direction in order to get at the exposed portion of the meat or blubber. After a considerable number of birds were thus snared in the same area, the skuas became extremely cautious in stepping into the loop. Snaring was always most effective during snowy, stormy days.

Another device, tried for the first time in Antarctica, was a cannon-projectile net, a method developed for use on waterfowl by Dill and Thornsberry (1950). Modifications and improvements have been made by the United States Fish and Wildlife Service, as discussed by Salyer (1955) and by Crockford and Cannon (1956) of the Georgia State Game and Fish Commission.

The net, measuring 60 by 30 feet, is shot over the birds in a seal-baited area, with three cannon projectiles. Black powder, electric squibs, and a battery are used for firing. More recent developments of the projectile employ prepared cartridges. With this device, 258 skuas and 11 giant petrels were taken in 31 shots. The maximum per shot was 29 birds. Occasionally one or more of the cannons failed to detonate because of poor connections, or a projectile would break loose, making part of the net fall short. This resulted in the escape of over 75 birds.

Juveniles were easily taken at the nest by hand or with a net.

### *Marking Birds for Field Identification*

To determine possible reaction to color and to be better able to follow the daily feeding and other movements, some birds were dyed or sprayed with enamel. DuPont acid-color "milling yellow G. N. concentrate," and "crocein scarlet N extra" dyes were used. These were prepared with methyl alcohol and acetic acid in accordance with the method used by Winston (1954).

At Hallett Station, 7 skuas were dyed yellow and a total of 182 adults were either dyed or sprayed with enamel during the two seasons at Wilkes Station. At the latter station, 37 had been colored scarlet by

the end of the 1956-57 nesting season. In the following season at 6 different areas within the Windmill Islands, 66 were dyed various combinations of yellow and scarlet, and 79 were sprayed with enamel of various colors to provide distinctive recognition marks for each individual.

Some birds were dyed on the wings only, while others were colored on the entire body as well as on the wings. In doing the body coloring it was found that two birds died, possibly from exposure, as do ducks when becoming soaked with oil. The acid-alcohol solution might have destroyed the oil in the feathers, which in turn may have affected the bird's insulation. Thereafter only the white wing patches were dyed, but this still made the birds easily distinguishable in flight.

Of the total birds dyed, 7 were recaptured the same season with some color still remaining, and 8 were retaken the following year at Wilkes Station, but with no trace of the color. A dyed bird was the first recorded return away from the place of banding (USFWS 617-00567). Banded and dyed scarlet on March 26, 1957, it was taken by scientists aboard the Russian icebreaker OB on February 19, 1958, in the pack ice 120 miles westward from Wilkes Station. Another (USFWS 617-00566), banded and dyed scarlet at the same time and place as the Russian recovery, was retaken at McMurdo Sound on January 3, 1959.

One disadvantage of dyeing is that skuas often bathe and thus wash off the dyes. One bird, dyed on November 16, had faint traces of scarlet recognizable in flight on December 26.

During the second nesting season, 79 adults were sprayed with quick-drying Duco enamel on one or both of the white wing patches. Yellow, red, blue, or green colors were used according to the areas in which the birds were taken. This was by far the best method for quick identification in flight, since the enamel did not affect flight and the color did not wash off, but lasted until the feathers were lost in the molt. It was also extremely easy to apply in the field from the spray can.

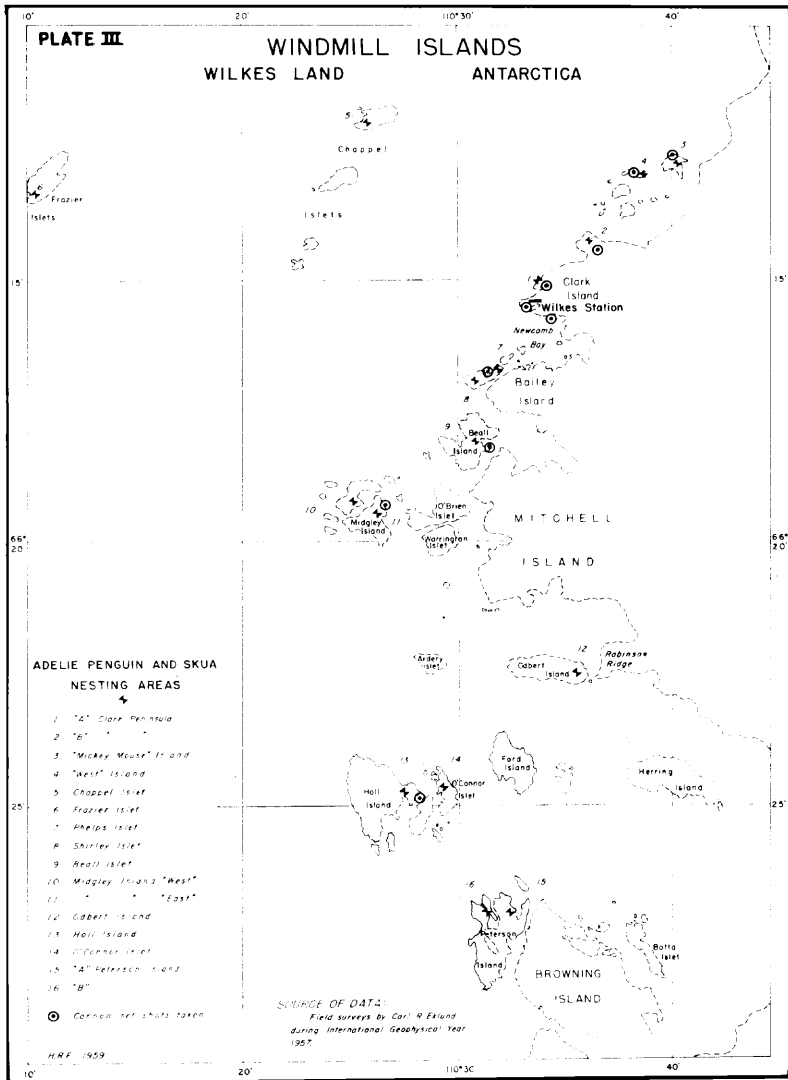
### *Birds Banded*

In March 1941 15 adult skuas (*C. maccormicki*) had been banded at the East Base in Palmerland, during the United States Antarctic Expedition. During the six nesting seasons from 1955-61 there were 2,205 south-polar skuas reported banded at 5 United States and 11 foreign stations. Of this number 1,650 were adults and 555 were immature. Of these, 19 adults and 64 juveniles banded by Austin (1957, p. 13) at Hallett Station and in the McMurdo Sound area during the 1955-56 season were without colored bands. The 37 skuas banded by Syroechovski (Lapina, 1958) at the U.S.S.R. Mirny Station in 1956-57 were also without colored bands, as were the 16 banded by FIDS at Admiralty Bay. An additional 248 adults and 76 immature brown skuas (*C. lonnbergi*) were banded at the United Kingdom Signy Island Station.

The reported total of all skuas banded to date is 2,544. The numbers, area banded, country, age, and bander or reporter are shown in Table II.

TABLE II  
TOTAL SKUAS REPORTED BANDED

Country	Station or Area	No. Imm.	Banded Adult	Summer Season	Bander or Reporter	
United States	E. Base—Palmerland	—	15	1940-41	Bryant, Eklund	
	Little America	—	16	1956-57	Chappell	
	Wilkes	—	14	1957-58	Chappell	
		—	277	1956-57	Eklund	
U.S.-New Zealand	South Pole	126	222	1957-58	Eklund	
		22	—	1958-59	Sladen, Penney	
	McMurdo Sound	6	1	1959-60	Penney	
		—	16	1960-61	Penney	
	Hallett	—	5	1957-58	Released by Remington	
		—	12	1955-56	Austin	
		—	61	1956-57	Eklund, Honkala, Long	
		—	42	1957-58	Drabkin, Remington	
		—	48	1958-59	Dearborn, Caughtley	
		—	19	1959-60	Haven	
New Zealand	Hallett	52	10	1955-56	Austin	
		20	68	1956-57	Eklund, Langeved, Humphries	
	59	22	1958-59	Sladen, Reid, Worthley, Pryor		
	64	126	1959-60	Salmon, Reid		
	Scott Base—McMurdo	94	31	1960-61	Maher	
		37	72	1959-60	Young	
	Australia	Mawson	—	18	1956-57	Willing
			—	7	1957-58	Willing
	Argentina	Davis	—	20	1958-59	Reported by Ingham
		San Martin	—	21	1957-58	Dingle
General Belgrano		17	44	1957-58	Franco, Dallinger	
Almirante Brown		—	1	1959-60	Reported by Villela	
Belgium	King Baudoin	—	26	1959-60	Ageitos, Novatti	
	Gonzales Videla	—	2	1958-59	Reported by Crosby	
	Deception Island	—	100	1960-61	Leech	
	—	—	32	1956-57	Reported by Scotland	
United Kingdom	Argentine Island	—	46	1957-58	Reported by Scotland	
		—	20	1958-59	Reported by Scotland	
	Admiralty Bay	—	15	1956-57	Reported by Scotland	
		—	186	1957-58	Reported by Scotland	
Chile	Signy Island	—	16	1958-59	Reported by Scotland	
	( <i>C. Ionnbergi</i> )	38	40	1956-57	Reported by Scotland	
U.S.S.R.	Mirny	38	56	1957-58	Reported by Scotland	
		—	152	1958-59	Reported by Scotland	
		—	37	1956-57	Syroechovski	
		631	1,913			
	Total					
	Grand Total		2,544			



### *Life History*

Most of the detailed life history studies of the south-polar skua were carried out in the Windmill Islands. These islands, within which Wilkes Station is located, extend 19 to 20 miles in a north-south line along the Knox-Budd coasts in Vincennes Bay (Plate III). The group comprises approximately 65 to 70 rock outcroppings, of which five could be classed as peninsulas but are now mapped as islands. These

include Clark, Bailey, Mitchell, and Browning "Islands," and Robinson Ridge. Some of the exposed rock areas extend as far as 3 to 4 miles westward into Vincennes Bay from the edge of the polar icecap, while the north-south dimensions are up to 3 miles in length, as in the case of Mitchell.

Including Frazier and Chappel Islets there are 60 to 65 remaining islands, islets, or smaller outcroppings that have a long dimension of at least 500 feet. None are more than 2 miles long. Ardery Island, the highest, rises to 371 feet above sea level. The Windmills are the only major exposed land area for at least a 500-mile sector of the coast.

Skuas inhabit the islands within Vincennes Bay for a period of approximately 6 months. The last seen during the 1956-57 season was on April 20, 19 days after the disappearance of all Adelie penguins. The first observed near Wilkes Station in the following season was on October 19, 6 days after the appearance of the first penguin, and 24 days before the first penguin eggs were laid. Richard Penney, who was at Wilkes Station as biologist for a two-year period, sighted the first skua in the 1958-59 breeding season on October 17, and during the 1960-61 season he saw the first one on October 8. The last seen at the end of the 1958-59 and 1959-60 breeding seasons were on April 26.

There were 16 Adelie penguin rookeries on the Windmill Islands during the 1957-58 nesting season, in which approximately 155,000 penguins were breeding. South-polar skuas were found nesting at all these, but the detailed studies were carried out mainly at penguin rookeries A and B on Clark Peninsula,  $\frac{1}{4}$  and 2 miles, respectively, from Wilkes Station.

#### *Breeding-Site Tenacity*

The south-polar skua returns to the same area on which it nested the year before. A skua (USFWS 566-43502) banded during the 1955-56 nesting season by Austin (1957, p. 13) at Cape Royds, McMurdo Sound, was recaptured as a nester at the same area on December 24 of the following season by Honkala and Long, Wilkes Station scientists. The day following another nester was captured here (USFWS 566-43501) that had also been banded by Austin the previous season. These were the first known records of *C. maccormicki* recaptured the following season at the same nesting ground, and this indicated the species to be site tenacious.

At Cape Hallett, Austin banded 10 nesting adults and 52 juveniles during the 1955-56 season. At the same area the next season 4 of these 10 adults were recaptured at their nests (USFWS 577-83065, -83064, -83023, and -83015). The last two birds were again retaken at the same area for the third successive breeding season in 1957-58 by Richard Chappell, the Boy Scout stationed at Little America who had stopped over at Hallett Station en route home. He also recaptured three other nesting skuas that had been banded the previous season at Hallett (USFWS 617-00132, -00123, and -00124). The last two were a mated pair that also had been captured as a nesting pair the year previous. Reid (1961) observed 126 previously-banded breeders here during the 1960-61 season.

At four United Kingdom Falkland Islands Dependencies Survey bases there were 639 skuas (*C. maccormicki* and *C. lonnbergi*) marked with thermoplastic bands. Of this number at least 107 were observed or recaptured during the following summer at the bases where they had been banded. Twenty-nine were similarly observed two years afterward at the original place of banding (Scotland, 1959).

At Wilkes Station, 277 adult skuas were banded during the 1956-57 season, and the following year 69 (24.9 percent) of these were recaptured. These were then further distinguished by placing a white strip of vinyl-plastic adhesive tape around the middle of the green band, to indicate that they had been retaken.

In addition to the recaptured birds, at least 75 green-banded skuas of the previous season were seen at 16 separate nesting areas studied within the Windmill Islands, but could not be retaken. These, together with those actually recaptured, would indicate a known return of more than 50 percent of 1956-57 banded birds to their breeding areas the following season. On the basis of these returns, site-tenacity can be considered a breeding trait of the south-polar skua. No records have yet been obtained of birds using different nesting areas in successive seasons.

Site-tenacity is important in the problem of speciation, since a species may consist of many populations which, though intermingling during the off-breeding season, seldom interbreed. Such isolation during breeding would tend to lessen chances of genetic changes spreading to other populations (Tinbergen, 1953, pp. 86-87).

#### *Age at First Nesting*

In an attempt to determine the age at which south-polar skuas first breed 172 immature birds were marked with  $\frac{3}{4}$ -inch colored thermoplastic bands at Wilkes Station during the 1956-57 and 1957-58 seasons. During these same two seasons, 79 were similarly banded at the U. S.-New Zealand Hallett Station and Austin banded 52 birds during the 1955-56 season.

During the 1960-61 summer, Reid (1961) recaptured a 5-year-old nesting bird (577-83060) which Austin had banded as an immature bird in 1955-56. This is the first such record of *C. maccormicki* to indicate the age at which it first nests. It also indicates the breeding site tenacity for birds hatched in that area.

#### *Territorialism*

South-polar skua nesting areas are governed by the presence of Adelie penguin rookeries. Selection of the territory within this area also appears to be influenced by the availability of nesting penguins, a primary source of food for both adults and young during that period of the year. Nests were found at 17 areas within the Windmills, and 16 (95 percent) of these were adjacent to the penguins. The seventeenth area where nesting was observed was adjacent to nests of the cape pigeon (*Daption capensis*) and silver-gray fulmar (*Priocella antarctica*) on Ardery Island, and only one skua nest was seen (Plate III). Skuas were seen nesting at all of 22 Adelie penguin rookeries visited in five different regions of Antarctica in 1939-41 and 1956-58. It is concluded

that the species will consistently be found nesting adjacent to Adelie penguin rookeries.

### *Mating*

Three known nesting pairs of skuas were banded at Wilkes Station during the 1956-57 season. In the 1957-58 season two of these three pairs were found nesting together again (USFWS 617-00289 and -00290, and 617-00345 and -00347), and at the same areas where they had been banded. During the 1958-59 nesting season Tressler (1959), station leader at Wilkes, observed one of these pairs (617-00345 and -00347) at the exact territory occupied in 1957-58. This was the third successive year the pair had mated. In no instances were any birds of the other two pairs recaptured or observed with a different mate. During the 1957-58 season at Wilkes Station, 17 additional breeding pairs were captured while at the nest. Two hand or dip nets were used to catch them as they dived in defense of the nest. All were banded with the green band and a numbered metal band. In addition, to keep the pairs separate, each 1½-inch-wide green band was distinctively marked with a ¼-inch-wide white, red, yellow, or blue vinyl-plastic adhesive tape, in various combinations, at the top, middle, or bottom of the band.

All the above nests were marked with numbered stakes that showed also the color combination used on the band. Numbers were likewise sprayed in paint on nearby rocks to simplify relocation of the territories in subsequent years. These nest sites were checked during the 1958-59 season by Tressler (1959) and by Penney (1961) during the 1959-60 and 1960-61 seasons to determine whether the pair-bond relationship was maintained as well as whether the pairs returned to the same nest sites or territories.

Tressler observed that 13 of the 19 pairs of record in 1957-58 were mated in 1958-59, and occupied the same territory as previously. Of the remaining marked pairs 1 of each of the 4 pairs was back at the same territory occupied the previous year, but with a different mate. In no instance was the other of the original pair observed on the nesting ground. This would indicate that the pair bond might have been broken because of mortality to one of the birds, rather than to the pair splitting up to mate with another bird. A skua recovered dead in Australia (USFWS 617-00501), as discussed later, had nested at Rookery B during 1957-58, but it was not one of the marked nesting pairs. Penney found seven dead Wilkes banded adult skuas during the 1959-60 season.

During the 1959-60 season Penney observed 6 of the 19 pairs of record back at their original nesting territory, and in 1960-61 4 of these pairs were again back at the sites for the fourth consecutive year. Of the remaining 15 pairs at the end of the 1960-61 season, one of seven pairs nested with a different mate on the same territory, one pair was killed at the end of the fourth nesting season, and two others were found dead.

Records of all marked pairs are shown in Table III.

Continued observation of these marked pairs will provide further information on how long skuas remain mated. Pairs seem to be together early as well as late in the season, and it is possible they remain

TABLE III  
RECORD OF REMATED SKUA PAIRS AT WILKES STATION

USFWS Band No.	Season Paired	Territory Reoccupied	Remarks
617-00289 & -00290	1956-57, 57-58	Yes	—
-00395 & -00776	1957-58, 58-59, 59-60	Yes	-00776 also mated with unbanded bird, 59-60
-00782 & -00783	1957-58	1 of original pr. in 1958-59	Male (-00782) found dead 3/12/59
-00422 & -00672	1957-58	by -00422 in 1959-60 & 60-61	Nest within 30 yds. of original
-00426 & -00778	1957-58, 58-59	Yes	-00426 found dead 1/25/60
-00723 & -00780	1957-58, 58-59	Yes	Neither seen in 1959-60
-00434 & -00775	1957-58, 58-59	Yes	Neither seen after 1958-59
-00345 & -00347	1956-57, 57-58, 58-59, 59-60	Yes	Both killed in 1959-60
-00690 & -00784	1957-58, 58-59	Yes	1 of original pair in 1959-60, 60-61
-00389 & -00777	1957-58, 58-59	Yes	Neither seen after 1958-59
-00474 & -00771	1957-58	—	1 of original pair back 1958-59
-00772 & -00773	1957-58, 58-59, 59-60, 60-61	Yes	—
-00258 & -00785	1957-58, 58-59, 59-60, 60-61	Yes	—
-00257 & -00363	1957-58	1 of original pr. in 1958-59, 59-60, 60-61	—
-00383 & -00774	1957-58	—	1 of original pair back in 1958-59
-00707 & -00786	1957-58, 58-59	Yes	1 of original pair seen at the site in 1960-61
-00421 & -00779	1957-58, 58-59, 59-60, 60-61	Yes	—
-00547 & -00789	1957-58, 58-59	Yes	Neither seen after 1958-59
-00815 & -00816	1957-58, 58-59, 59-60, 60-61	Yes	—



together throughout the winter. Fortunately observation on the pair bond will be possible at Wilkes Station over a long period because the Australian Government took over operation of the station from the United States at the IGY end in January 1959.

At Hallett Station, Reid (1961) recaptured a nesting pair (617-00125 and -00126) during the 1960-61 season which I had banded as mates at this area in 1956-57. This could represent at least the fifth nesting season for this pair.

No information was obtained as to which of the pair selects the nesting territory. In determining incubating egg temperatures with an electronic telemeter, as discussed later, one of the pair, the female, was killed at the end of the study to determine the sex. The following nesting season the mate reoccupied the same territory with another bird.

On the basis of these banding records it can be concluded that the south-polar skua has a pair-bond relationship and will remate the following year. Stonehouse (1956, p. 14) found in Palmerland that some pairs of the brown skua. (*C. lonnbergi*) remated the following year and others did not.

#### *Copulation*

Copulation may take place away from the nesting territory as well as on it. Two skuas were seen copulating on November 17 while grouped with other skuas on the sea ice near a penguin rookery where the pair might eventually have nested. Another pair was observed copulating within its nesting territory. The action is not unlike that of the Adelie penguin, wherein the male stands posteriorly on the back of the female. On one occasion the male made contact for 10 to 15 seconds, covering the female three separate times in this manner, with all action taking place within 6 minutes.

#### *Nesting*

On the basis of a survey in which all land areas were visited in the Windmills during the nesting season, it is believed that 95 percent or more of all skua nests will be confined to exposed lands on which Adelie penguins are nesting (Plate III). A primary reason for selecting these areas is that penguin rookeries are a ready source of food. Only one skua nest was found where there were no penguins. This was on Ardery Island, on which 1,500 to 2,000 silver-gray fulmers and cape pigeons were nesting and from which the skuas obtained their food, based on observation of empty eggs of these species around the nest. The skua-nesting areas within the Windmill Islands are shown on Plate III.

Four pairs of skuas were found nesting near a small Adelie penguin rookery on one of the six Balaena Islets, 25 miles northeast of Wilkes Station. These islets are not considered in the Windmill Group.

A detailed study was made of forty skua nests at Adelie penguin rookeries A and B on Clark Peninsula. Observations were begun early in November, and each nest was visited at least once every 24 hours from the time it was found until the record was completed, either on destruction of the nest or termination of the study. As discussed under "Mating," nesting pairs were captured and each marked conspicuously

on the green band with different colored tape. All nesting birds captured were sprayed on the white wing patches with yellow, red, or green enamel. The study terminated on January 26, when a changeover of personnel was effected.

### *Nest Building*

Nests are usually merely scraped or scooped out of fine pebbles or gravel on a rocky knoll or mound. Fifteen of these scoop-outs, hollows, or cups measured 8 to 10 inches in diameter, and up to 1½ to 2 inches in depth. Sometimes a rim of gravel raises the nest slightly above ground, but usually the hollow is below ground-surface level. There is no lining of any sort, and in this respect it differs from the brown skua in South Georgia, which lines its nest with grass (Stonehouse, 1956, p. 15).

Often two or more scoop-outs are frequent within each territory. The habit of making these is somewhat similar to the selection of nest sites by herring gulls, as described by Tinbergen (1953, pp. 127-129), wherein both mates scrape several cups in the soil of the territory selected prior to final selection by the female. It was not possible to determine which bird, or whether both, took the initiative in preparing scoop-outs and which made the final selection.

### *Egg Laying*

The first clutch of eggs during the 1957-58 season was found on November 21 at Midgley Island "West." Skuas near Wilkes Station, where the detailed nesting studies were conducted, started occupying territories during the second week in November, and the first egg was found on November 23. A total of 72 eggs was laid in the 40 nests under study. Of these nests, 80 percent had 2 eggs, while 8 (20 percent) contained only 1. During the 1960-61 season Penney found the first egg near Wilkes Station on November 26.

### *Incubation and Hatch*

Murphy (1936, p. 1019) states that the skua incubates its eggs about 4 weeks, while Ponting (1921, p. 217) says the period is 3 weeks. Wilson (1907, p. 71) says the period of incubation is 4 weeks for *C. maccormicki*. Stonehouse (1956, p. 17) in three instances found the incubation period of *C. lonnbergi* to be 32 days.

In the Windmill Islands the first hatching noted during the 1957-58 season was on December 22, and the last on January 19. The peak period, when 68 percent of the eggs hatched, was from December 26 to 31. Penney observed the first skua chick at Wilkes on December 28 during the 1959-60 season.

It was impossible to determine the precise hatching period of eggs found after the bird had begun incubation. However, 26 eggs were located within the first day of laying, and observations were made on all these once every 24 hours until hatching. It took 30 days of incubation for 15 (58 percent) of these to hatch; 9 (35 percent) hatched in 29 days; 1 in 31 days; and 1 in 32 days.

Pipping observations made on 40 eggs disclosed that 27 pipped for

2 days before hatching, 12 required only 1 day, while 1 took 3 days from the first cracking of the shell until the chick emerged.

Of the total 72 eggs within the 40 nests studied, 28 (39 percent) were either destroyed or unhatched, while 44 (61 percent) were successfully hatched. More than 90 percent of the unhatched eggs contained embryos, and in many of them pipping had begun.

Both parents take part in incubation. During a 9-day continuous temperature recording of incubating eggs, using an electronic telemeter, as discussed later, one of the pair under study was sprayed with green enamel to provide easy differentiation of both birds on the nest. A continuous 24-hour daily watch was made of the pair for 132 hours and 45 minutes (5½ days). After the temperature study was concluded and the second egg in the nest had hatched, one of the parent birds was collected to determine sex.

During the 5½ days of continuous observations, one or the other of the pair relieved the mate on the nest 13 times, an average of 2.36 times every 24 hours. The female (the bird collected) averaged 7 hours and 33 minutes sitting on the nest before being relieved, while the mate averaged 2 hours and 9 minutes. The longest time the female was on the nest was 15 hours and 22 minutes and the shortest 1 hour and 55 minutes; for the other, the long period was 7 hours and 16 minutes and the short, 9 minutes.

There is little ceremony during the incubation change. Usually the setting bird will fly from the nest to a nearby rock where the mate is roosting. The pair will then stand close together for about 30 seconds during which both will raise the wings upward and call. Immediately following this the relief bird goes to the nest and resumes the incubating.

### *Temperature of Incubating Eggs*

Temperatures of incubating eggs were obtained through use of an electronic temperature telemeter placed inside a skua egg. Another was placed in a penguin egg and simultaneous recordings from both nests were taken over a 9-day period from December 11 to 19, 1957. This study has been previously reported by Eklund and Charlton (1958).

In operation the telemeter egg radiates a modulated electromagnetic signal or pulse, the frequency of modulation being determined by the temperature inside the egg. The signal is intercepted by the loop antenna, relayed by the transmission line to the low-frequency radio receiver in a nearby shelter, where it is amplified, detected, and sent to a loudspeaker and to a decade counter, which records the number of pulses. The pulses were calibrated against a standard thermometer before and after the study. Although signals were continuous a count was taken for each bird only once every 15 minutes on a 24-hour basis, alternately on the skua and the penguin.

Results of the study show that the average temperature of the incubating skua egg over a 58-hour period of continuous record was 96.6°F., with a maximum of 103.5° and a minimum of 87°. The average body temperature of this species is 106.1°F., ranging from a maximum of 108.4° to a minimum of 103.4° (Eklund, 1942). The average tempera-

ture of the incubating egg was thus 9.5°F. less than the average body temperature. The average temperature of the incubating Adelle penguin egg is 92.7°F., with a maximum of 98.2° and a minimum of 84.5°.

The greater range in the incubating temperature of the skua egg is reflected by the number of times the parent bird will change incubation duties with its mate (2.36 times every 24 hours as discussed under Incubation and Hatch), as compared with the long periods the penguin may sit without being relieved by its mate (usually at least 2 weeks continuously by the male at the beginning of incubation).

#### *Care of Eggs and Young*

To learn more about care of a nest, one of two skua eggs was removed and placed a foot away. The bird returned within two minutes and resumed incubation on the remaining egg. Both eggs, however, were in the nest 1 hour and 25 minutes later.

On another occasion a third egg was added to a nest of two. The setting bird returned to the nest, looked at the eggs, and turned around and walked to its mate. After 4 minutes it again returned and started incubating the three eggs. Only one of these eventually hatched, but incubation of the unhatched eggs took place for 32 days.

In another instance an Adelle penguin egg was substituted for one of two skua eggs. The parent bird on returning to the nest set on both eggs without hesitation. After the skua egg hatched the foster parents continued incubation of the penguin egg for 2 more days, after which it was abandoned. Three days later it was eaten. The skuas had been on the penguin egg a total of 31 days.

The parent skua will cover its chicks with the wings at times, but usually one or both fledglings are left exposed. One parent is generally very near the young while the other, if not off feeding, is within the territory and ready to drive off any marauding birds. A strange skua has only to fly over the territory to be pursued by a fast-flying parent.

To determine the reaction of parent birds to chicks other than their own, a 29-day-old natural-colored bird was taken from a nest, which also contained a red-dyed chick. This was placed with a nearby pair, which had one 35-day-old natural-colored fledgling. The parents cared for both. On the next day both chicks were moved and placed in the nest from which the one had been taken originally. At the same time the dyed chick was removed from the first nest and substituted for the two which were taken from the second nest.

The red chick was accepted by the foster parents and was being well cared for at the time the study was concluded late in January. Of the two chicks together, one was dead the day following their placement in the nest from which the dyed one had been removed. It had not been eaten. This experiment would suggest that skuas will care for chicks other than their own, and that color made no difference.

#### *Defense of Eggs and Young*

While incubating, the parent bird will usually stay on the nest until approached to within 20 to 50 feet. Then with wings often upraised it will walk stiffly away while setting up a loud *ha ha ha ha* call. At rare times a bird on the nest can be nudged with the foot before it will leave.

After flushing from the nest the parent bird, together with the mate,

start "dive bombing" the intruder. This generally involves a wide circle followed by a straight-away approach from about 100 feet. The start may be 10 to 50 feet above the ground. The parents usually take turns, and they may come from any angle. Often they approach within 1 to 5 feet of the head before turning off, and at this point they can be taken with a wide hand net, with certain agility on the part of the netter. In this manner 156 adults were caught at McMurdo Sound and the Hallett and Wilkes Stations. It is one of the best of Antarctic sports.

Skuas do not make communal attacks, and diving is carried out only by the parents when an intruder comes within their territory. The birds have dived at me several thousand times, and while the majority of times they will turn away without striking, there have been many occasions when they hit the head. One pair, on the eighth day of incubating their eggs, struck 7 times within 4 minutes while an attempt was being made to count and record penguins. Three of the blows were with such force as to result in a splitting headache. Another time my eye was hit so hard it was impossible to see for several minutes. The skua has few equals among birds as a defender of the home.

Holding a stick over the head will ward off the birds, but this is difficult to do while climbing over rocks requiring use of the hands, or while trying to record penguin counts, as was done every 48 hours at one of the rookeries. Finally in "self defense" a long giant petrel primary wing feather was sewn on my cap. The skuas then contented themselves with hitting the feather. The striking is usually done with the front of the feet as the bird "lowers its flaps" in braking itself just before reaching the person. This is generally a soft blow, though less frequently, they may strike with the front of the wing, and this is a much harder blow.

#### *Survival of Young*

Of the 44 chicks hatched from the 40 nests studied, 34 (77 percent) survived to the last week in January, when the study was concluded. This represents a 47 percent production of chicks from the 72 eggs under study. If one or both juveniles survived to the end of the study the nest was considered successful. There were 28 such successful cases, which represents a nesting success of 70 percent, or mortality of 30 percent.

It is interesting that of 23 successful nests from which eggs were not removed by man, there were only 6, or about one-fourth, in which both juveniles survived to near flying stage. This number would probably have been greater, however, if coloring had not resulted in some increased mortality. Although a rather heavy mortality among second juveniles is indicated by this study, it does not appear so serious as that claimed by Wilson (1907, pp. 71-72). He says that because of the tendency of the young to wander and get separated, it is a noticeable fact, and was "proved conclusively," that though two young are almost always hatched, one of the two is invariably missing after a few days or a week.

While it was impossible to follow the young through to flight stage during the 1957-58 season, this latter phase was observed during the 1956-57 nesting season in the Windmills. Two known pairs of young that had almost reached flight stage were banded on February 7 and 11.

Other nestling pairs were probably also banded, but unfortunately these were not always recorded as pairs.

Of the total of 40 nests, 14 had either one or both eggs or chicks preyed upon by their own species. In conducting this study 10 additional nests were interfered with in whole or in part by man, or by both man and skuas, either through permanent removal or the shifting of one or both eggs.

#### *Effect of Color on Survival*

Wilson (1907, p. 70), in speaking of the skua's eggs and young says, "the bird makes no attempt at concealment, though its color as well as the color of its eggs might be considered to be specially adapted to the nature of the ground, but with such habits as the skua's there is obviously nothing in it." Data obtained during the present studies indicate that protective coloration may be a factor in survival of the young.

In an effort to learn more of the effect of color on survival, 12 of the 44 chicks hatched were dyed either red or purple. These were dyed in the shell after the method devised by Evans (1951), with the exception that dye was not injected into the egg until it first began pipping. This provided about 2 days for the dye to permeate throughout the egg. No loss of chicks in the eggs resulted from the coloring, and it lasted until the down molted after 7 to 8 weeks.

No chicks were dyed in a nest that contained only one egg, and only one of the two eggs in a nest was ever colored. Only six (50 percent) of the total dyed survived until the end of the study. Of the 32 natural or slate-colored chicks 28 (87 percent) survived. While this is hardly a sufficient sample, it does suggest that the slate-gray color, which generally blends well with the rocky habitat, is a factor in protecting chicks from predation by adult skuas.

#### *Renesting*

Skuas will renest if incubation has not started. On November 28 a pair was observed on a territory having several scoop-outs. The next day one egg had been laid, and on the following day it was gone. Since both birds were recognizable by the banding, a watch was kept on the territory. On December 2 another egg was laid within 35 feet of the original nest. This was followed by a second egg on the fifth day. Both eggs were successfully hatched, although neither chick survived. This was the only record obtained of renesting.

No renesting occurred with pairs that had started incubation, only to have one or both eggs stolen. There were seven such records. Nests containing two eggs, one of which was removed, did not cause abandonment.

One pair (USFWS 617-00345 and -00347), which was the first remated pair ever recorded, incubated an egg for 12 days, starting on November 28, 1957. On the twelfth day the egg was cracked, and the next day it had been eaten. Renesting did not take place, but the pair was still remaining on the territory at the time checking was stopped on January 20. This pair also remated on the same territory in 1958-59 and 1959-60.

### *Climatic Factors Affecting Nesting*

There was no evidence that weather conditions, such as snow or wind, affected nesting of the skua in the Windmill Islands. Heavy snows during the nesting season cause mortality among adult Adelie penguins through the smothering of the incubating bird by snow, and the freezing of eggs and chicks. The same could happen to the skua, but no serious snowstorms occurred and there was no opportunity to observe possible nest loss from this cause during the two nesting seasons studied. The winds were strong during this time.

### Feeding

The first seasonal appearance of the skua in the Windmill Islands is around mid-October, about a week after arrival of the first penguins. This coincides with pupping time for the Weddell seals which appears to be a factor in the early attraction of skuas to the area, since the birds feed on seal placenta. At this time they also utilize marine life, such as fish and red krill (*Euphasia*). Three to four weeks after the skua arrives, or about the second week in November, the Adelie penguins begin laying, and from this time until mid-December, when their chicks start hatching, the skuas will feed in large part on the eggs.

In stealing eggs a skua will wait at the edge of a penguin group until a sitting bird can be drawn off its nest. Then it, or another skua, quickly darts in and makes off with an egg in its bill. Oddly enough, penguins never seem too disturbed at the nearby presence of skuas. When one gets too close to the nest, the sitting bird, or others, merely peck at it to drive it away. Often the skua is actually chased by the penguin. Sometimes a bird will fly among a group and stand there waiting a chance to take an egg. Much of the time they are unsuccessful in their thievery.

During high winds a skua pair will hover a foot or two over a group of nesting penguins, with wings outstretched against the wind. Meanwhile the penguins stand up and peck at the skuas above them. Finally one will be drawn off its nest long enough for one of the pair to seize an egg and fly off. It seems like a good example of teamwork on the part of the predators.

During the temperature-telemeter experiment one of the pair of skuas not incubating took an abandoned egg from a nearby penguin group. It flew with the egg in its beak to within 30 feet of its mate at the nest. Then for 11 minutes it tried to break the egg with over 30 hammerlike pecks, in which the head was raised high and brought down with great force on the egg. Finally it gave up and flew away. Inspection showed the egg rather heavily coated with mud, and therefore probably harder to break. After 10 minutes the bird returned to peck at the egg again but finally gave up once more after 4 minutes of trying. An egg being incubated in a penguin nest was then placed on a nearby rock. The same skua immediately flew to this egg, picked it up in the beak, and flew to within 75 feet of its nest. Its mate then left the nest, flew to the egg, broke it, and they took turns eating from it.

Young penguins are a primary food source of the skua and this supply is doubtless the motivating factor in location of skua nests. Sladen (1958, p. 66) presents an excellent discussion of skuas feeding

on young penguins, and it appears there is selectivity in that the skuas tend to weed out the weaklings or those that do not defend themselves. Penguin chicks and eggs, however, are not the sole source of skua food at this time. Food disgorged by adults for feeding their young revealed considerable quantities of fish and red krill obtained from the seas.

Though adults will eat young skuas, I have never seen a parent kill and eat its own live chick. During the nesting study there were several instances when the parent bird apparently ate its own dead chick. This however, is no different from that of many other animals that devour their own dead young. The parent bird does not hear the chick call or see it move, and this probably makes the chick entirely foreign to them and therefore its only significance is as food.

The skua's propensity for eating its own kind, while recognized, may be slightly exaggerated. On April 1 a dead immature bird, which had almost reached flight stage, was found with a broken wing. It had lain exposed at the edge of a penguin rookery for several weeks, judging from its condition, and many skuas could have seen it. In spite of this the adult birds had not touched it for food, whereas they had eaten many nearby penguin chicks.

Skuas are able to swallow large chunks of meat. To test this, hamburger was rolled into meat balls and frozen. These were then fed to a captive bird. The bird was unable to swallow a 2-inch-diameter ball. Neither could it quite eat a 1¾-inch piece until after it had torn off a few small bits. In its efforts to swallow this it would take the ball in the bill, raise the head straight upward, and by a series of up and down jerks of the head and neck it eventually downed the meat. A 1⅝-inch-diameter ball was swallowed whole after 6 minutes of effort.

Usually a skua will allow only its mate to feed near it. When baiting the 60 by 30-foot cannon net, it was seldom possible to draw more than 30 skuas within the baited area of the drop, because each bird seemed to require its own feeding space. A pair of skuas once kept all other birds from feeding in the baited area for more than an hour. This is usually done with upraised wings and loud calls, often followed by an attack.

In fall, following the disappearance of young penguins as a source of food, the skuas feed on marine life. No records are available on their food habits during the winter, when they apparently are in the pack ice to the northward. Probably they then feed on marine life exclusively.

Skuas feed their young by disgorging food on the ground, where chicks pick it up. When juveniles are handled during banding they occasionally regurgitate their food. Of 16 such records, 6 disgorged food consisting of penguin meat, 9 of fish or red krill, and 1 of the head of a skua nestling. This would indicate that parents obtain a good part of the food for their young from the sea. Judging from the condition of the food, wherein some of the fish and red krill appeared almost whole, it does not seem likely it was obtained by the parent skuas from the stomachs of young penguins that they had eaten. Such food would be considerably ground up, since it would first have been eaten by the penguin parent, following which it would have been regurgitated into the nestling where it would undergo further digestion.



Then it would had to have been swallowed by the parent skuas, regurgitated on the ground, and finally eaten and again regurgitated by the young.

While at Hallett Station an attempt was made to determine the distance at which nesting skuas would range daily to find food. Seven birds captured near the ship were dyed yellow, and two of these were later seen on their nests  $4\frac{1}{2}$  miles away. An adult captured at Shirley Islet, in the Windmills, on December 4, was retaken on January 11 at its nest on Holl Island,  $8\frac{1}{2}$  miles distant. Since it was defending its 2 to 3-week-old young at the time, it must have been nesting when first captured. This was the longest distance recorded; probably the daily range during the nesting season is even greater.

### *Drinking*

Skuas are often seen to eat snow or drink at freshwater ponds, and not uncommonly to swallow small pieces of ice. Once during a bad windstorm, drifting snow filled a large box in which two dyed skuas were being kept for feeding and molting studies. Both birds were buried alive; one died and the other was removed to a building where it remained for 36 hours. During this day and a half it ate chicken livers and a half pound of partly frozen seal meat. No water was provided, although the meat contained some moisture. On returning the skua to the box outdoors it immediately ate three chunks of broiled steak. After this it started eating powdered snow by dipping the bill into it, each time raising the head to swallow the snow. This was done 174 times within 25 minutes.

### *Sense of Smell*

Gain (1914) was of the opinion that a skua, seen by Scott and his party on the polar icecap at latitude  $80^{\circ} 20' S$ . during their ill-fated trek to the South Pole in 1911-12, had been attracted there by wind-borne odors from slain sledge dogs. Wilson (1907, pp. 67-68) says that the skua's sense of smell "must be a little short of marvellous." He cites their surprise at seeing one at their camp 170 miles from open water and 150 miles from the nearest spot known to be frequented by skuas. Then they recalled that they had killed a seal the night before, that the wind was southerly, and that therefore "nothing but the scent of blood could have brought the bird those many miles."

With all due respect to Gain and Wilson, I believe their views are erroneous. That skuas are observed by trail parties at long distances from any natural food source is a fact, but I do not believe that they are guided there by smell.

My experience was somewhat similar to Wilson's regarding skuas traveling long distances for food. On a 1,264-mile dog sledging trip made with Captain Finn Ronne during the 1939-41 United States Antarctic Expedition (Ronne, 1945), we observed two skuas at a point about 100 miles from open water at the southern end of King George VI Sound (Eklund, 1945, pp. 302-303). They were the first and last seen after leaving the edge of the open sea ice. Like Wilson, the night previously we had killed one of our dogs and the meat was exposed. There was very little wind at the time, however, and in my opinion

the birds located the meat by their uncanny sight. Our trail could easily have been followed a long distance by the many visible dog droppings.

Studies on the sense of smell in birds have been limited and inconclusive. Romer (1955, p. 493) says the sense of smell in birds is rather feeble and appears to play but a small role in sensory reception. Tinbergen (1953, p. 21) found no indication whatsoever that the herring gull is guided by or has a reaction to smell. Walter presents a good review of the literature on the sense of smell in birds, starting with the early experiments of Audubon and Darwin. He concluded (1943, p. 69) that although birds have a fairly well developed olfactory organ they still did not possess the faculty of smelling.

From a blind used while banding at Wilkes Station I often saw skuas locate small pieces of frozen seal meat in winds up to 35 knots. A bird would hover over the meat at heights up to 30 feet and either drop down to it or circle around and come in low and upwind. With such wind velocities blowing meat odors low and parallel with the ground it would seem impossible that smells could reach up to the heights at which the bird was flying when it first located the food.

On five occasions, fresh seal meat was sealed in a clear, plastic bag from which no odor could escape, and placed on the ground. In all cases the skuas ripped the plastic open within a minute after first sighting it. This, however, merely demonstrated that the birds located the food by sight rather than by smell, and does not prove they could not have found the meat by scent. On six occasions, however, when fresh meat was covered with a 1/2-inch layer of powdered snow, it was never located. On the basis of studies by Ishida and Shimizu (1958), it was determined that light snow, such as was used to cover the meat, has a low density as well as a low airflow resistance. This should then permit odors to pass. This is further substantiated by diffusion tests conducted by Bender (1959) in which, using H<sub>2</sub>S gas as a tracer, he picked up traces of gas in 2 hours through 6 feet of snow.

Fresh chicken livers were buried in a bottomless box containing a captive skua. These were sprinkled with light snow sufficiently to conceal them but through which odors could pass. The bird paid no attention to the buried meat. In fact, it sat down on the slight mound covering the food. When liver was thrown there, the bird ate it immediately.

#### *Homíng Instínt*

A skua taken at McMurdo Sound was flown the 780 miles to the South Pole Station, banded there with a white thermoplastic and a metal band, and released on November 30, 1957. The bird stayed at the station for 3 days, after which it was not seen again. Three more were flown there from McMurdo Sound on December 3, 1957, where Remington, station glaciologist, banded and released them the same day. They took off immediately towards the Beardmore Glacier, from which direction they had been flown. None have been seen as yet.

Stoner Haven, biologist at the McMurdo Station, and Evan Young, New Zealand biologist at Scott Station, took a banded breeding bird from each of two nests at Cape Royds on January 3, 1960, and had them flown approximately 350 miles southward to the NAAF Beardmore

Glacier summer base and released. One of these birds was observed back at its nest on January 14.

A paired skua (USFWS 617-00781), with one young in its nest near Wilkes Station, was sprayed with yellow enamel on both wings, taken 51 miles inland to the Icecap Station on December 2, 1957, and released at 2000 hours. On December 4 at 1045 hours it was observed back at its nest with the mate.

### *Populations*

No systematic population study had previously been conducted over an extensive skua-nesting area. Visual estimates have been made of single nesting grounds, but if many birds occupy the area the counts are subject to considerable error.

Capturing skuas with a cannon net, as discussed previously, presented an excellent opportunity to obtain systematic census data within the Windmill Islands. The skuas thus taken consisted of an unselective group of both banded and unbanded birds, in much the same way that widespread shooting of waterfowl results in an unselective return of both banded and unbanded ducks and geese. Such data can be used to determine populations over a given area through use of the so-called Lincoln Index (Lincoln, 1930, and Allee, et al., 1949, pp. 263-269).

The formula for this index is expressed as the ratio of the total unbanded population ( $x$ ) to the total banded population, which is equal to the ratio of the total unbanded captures to the total banded recaptures. The total unbanded population plus the total banded birds thus equals the total population.

The cannon net was fired 10 times during February and March of 1957, and 21 times during the next nesting season, for a total of 31 shots. To provide a representative or random sample of banded and unbanded birds, these shots were made in nine different areas throughout the Windmills, from Holl Island in the southern part of the group to the most northeasterly island. These areas are shown on Plate III.

In this manner a total of 258 banded and unbanded adult skuas were captured, of which 54 had bands and 204 had not. Eleven banded and 52 unbanded were netted during the 1956-57 season, and 43 banded and 152 unbanded were taken in the following season. Five banded birds were captured two or more times, but after the first capture were considered "dead" and were not thereafter counted.

A total of 449 adult skuas were banded throughout the islands during the first two years of the study, of which 277 were taken during the 1956-57 season and 222 the next year. Juveniles were not considered in the census, because banding observations gave no evidence that those banded the first year returned to the area the following year, and those marked the second year were not flying when the net was shot.

In using the formula, it was considered valid to group banded birds of both years together. Also, in the final determination a minor correction factor must be applied to the adult birds banded the first year because of natural mortality to these during the 7 months between seasons when the net was not shot. Based on an assumed average age of 10 years, the correction factor would be approximately 5 percent on the 277 birds.

Application of the Lincoln Index to the above figures, i.e.,

$$\frac{X \text{ (total unbanded population)}}{499 \text{ (total banded)}} = \frac{204 \text{ (total unbanded captures)}}{54 \text{ (total banded recaptures)}}$$

shows a total of 1,885, plus 499, or 2,384 birds. Considering natural mortality to banded birds between seasons of shooting the net, this figure is rounded to 2,300 as being representative of the adult skua population in the Windmill Islands.

The 54 banded recaptures represent 10.8 percent of the total number banded (499), and the 258 total captured in the cannon net represents 11.2 percent of the total estimated population. This is considered a representative sample.

With exception of the minor land areas of Davis Islets, 65 miles from the Windmills, and Merritt Islet, there are no lands westward of the Windmill Group until Bowman Island is reached, approximately 220 miles distant. From the most northeasterly of the Windmills eastward along the coast there are likewise no land areas, except for the six small Balaena Islets, until the Henry Islets are reached 295 miles distant. In a 74-mile trip along this section of the coast only four pairs of nesting skuas were seen and these were at a small Adelie penguin rookery on the Balaena Islets.

This indicates a total of more than 500 miles of coastline in which the Windmill Islands constitute the only major land area to provide nesting habitat for the skua. Based on the estimate that over 90 percent of the total nesting population in this stretch of the coast would probably be in the Windmills, it is concluded that the total adult skua population during the nesting season along this 500-mile section is not more than 2,500 birds.

#### *Skua Populations in Relation to Penguins*

It has been estimated that at least 95 percent of the skua nesting habitat in the Windmill Islands is near Adelie penguin rookeries. This proportion might prevail also in other regions under natural conditions, that is, where the birds are not influenced by a human habitation making it possible for them to obtain such food as garbage or seals killed for dog food.

Austin (1957, p. 12), on the basis of visits to several rookeries in the Ross Sea sector of Antarctica during the summer of 1955-56, has suggested there is a ratio of 1 pair of skuas to about 100 pairs of penguins. As he states, such a ratio will doubtless vary with the size of the area, since small penguin rookeries provide more fringe habitat for skua nesting than do rookeries in large solid blocks.

While unloading operations were taking place at Cape Hallett, it was necessary for us on December 30, 1956, to remove all penguins from an area of 2.06 acres to provide space for station construction. This ground, precisely measured by the engineers, was fenced prior to the removal of the penguins.

The penguins removed included 3,318 juveniles. Not all the adult birds were in the rookery at the time, since many were feeding at sea. Based on observations of young produced at a rookery in the Windmills, it was estimated there would have been a minimum of 4,900 adult Adelie penguins in these 2.06 acres. The observations further indicated that about 20 percent of the adults either were unmated or that some pairs did not produce young. At the time of the removal, therefore,

there would have been about 1.7 young per successful breeding pair.

The size of the hook-shaped rookery at Hallett was determined by planimetry the limits of the nesting area on a 2-foot contour map, on the scale of 1 inch to 100 feet. It was calculated that the rookery covered slightly more than 55 acres. Using the above data it was estimated there would be about 130,000 adult penguins, or a total population of approximately 218,000 using the entire area at that time of the year.

It was conservatively estimated that approximately 150 pairs of skuas nested at Cape Hallett. Allowing an additional 20 percent for non-breeding skuas there would thus be an adult skua-penguin ratio of about 1:360. Such a population would be understandable, considering the relatively large, solid block in which the penguins nested. Also, a large percentage of the fringe area runs closely along the sea, and this was not used by skuas for nesting. Possibly for these reasons most of the birds nest together in a "skuary" close to the base of a mountain at the southwestern edge of the penguin area.

Sladen (1958, p. 66) estimated that a population of over 100,000 Adelie penguins supported about 20 breeding and some nonbreeding brown skuas (*C. lonnbergi*) at Hope Bay in Palmerland (latitude 63°S., longitude 57°W.).

In the Windmill Islands there were 16 Adelie penguin rookeries. Most of these were relatively small, the largest having an estimated maximum population of slightly over 22,000 adult birds.

To determine population fluctuations within a penguin rookery, in which birds are continually coming and going, a count of adults was made every 48 hours throughout the season at rookery A on Clark Peninsula. The rather small maximum population of 3,450 birds, consisting of small groupings within the area, made the count fairly accurate. All the 15 other rookeries within the Windmills were counted at least once. From knowledge of the percentage of the maximum number on any given day in the rookery under detailed study, together with the assumption that all rookeries in the Windmills had similar fluctuations throughout the season, it was then possible to apply a correction factor to all other rookery counts for the days these were taken.

Based on the above studies the total breeding population of Adelie penguins within the Windmill Group was estimated at 155,000. With an estimated total of approximately 2,300 adult skuas for the same area, the ratio of skuas to adult penguins would be about 1:70. The ratios for *C. maccormicki* thus seem to vary from an estimated 1:360 to 1.70, and these appear to be governed by the size and composition of the penguin rookeries.

#### *Occurrence of First-Year Birds*

There is no evidence that skuas return to the same area the first season following that of hatching, but some return as nonbreeders the second year. This is based on Austin's 1955-56 banding of 52 juveniles, and on our 1956-57 markings of 35 similar birds at Hallett Station and 46 at Wilkes Station. None of these birds at either area have been reported observed during 1958-59 season. An immature bird banded at Wilkes (USFWS 617-00328) on February 2, 1957, was recovered at the

USSR Mirny Station on March 19, 1958. Penney captured a two-year bird (USFWS 617-00284) at Wilkes on April 11, 1959, which was banded there as a chick on February 8, 1957. Reid (1961) observed three 24-month-old nonbreeding birds in 1960-1961 at Hallett which he had banded as juveniles during the 1958-59 season.

## SEASONAL MIGRATIONS

### *Banding Returns*

It has been shown in the discussion on breeding-site tenacity that skuas banded at the McMurdo, Hallett, and Wilkes and various FIDS Stations return to the same areas in successive years. A total of over 2,500 skuas banded in six consecutive seasons has now made it possible to also learn much about their movements away from the areas where they were banded.

The first recovery of a skua away from the place of banding was by Kirpichnikov from aboard the USSR icebreaker OB. This bird, an adult (USFWS 617-00567), was banded as well as dyed red at Wilkes on March 26, 1957, and recovered in the pack ice 120 miles westward on February 19, 1958 (Shevareva, 1959). This record might be an indication that the bird was a nonbreeder that had stayed in the pack during the nesting season. The Soviets also recovered another (USFWS 617-00464) in the same general area (latitude 65° 08' S., longitude 111° 15' E.), 80 miles from Wilkes Station, on February 4, 1959. It had been banded at Wilkes on February 24, 1957.

Another adult skua (USFWS 617-00566), banded at the same time and place as that of the 1958 Soviet recovery, was collected by Dearborn at McMurdo Sound, on January 3, 1959. A similar record of an adult (USFWS 617-00359) banded at Wilkes on February 21, 1957, was a recovery at Scott Station in McMurdo Sound on December 20, 1958, by Caughley, Sladen, and Penney. The movement of both these birds was probably eastward around the continent, which would represent a flight of about 1,900 nautical miles.

Dearborn, on January 3, 1959, recovered an adult (USFWS 617-52517) at McMurdo Sound that had been banded at Little America, 375 miles to the eastward, on January 6, 1957.

An adult banded at Midgley Island East, near Wilkes Station (USFWS 617-00660), on November 22, 1957, was recovered by De Gerlache and Frazier, of the Belgium Antarctic Expedition, near their IGY station (latitude 70° 26' S., longitude 23° 19' E.), on January 26, 1958. Assuming a westward flight along the coast, this bird traveled approximately 2,400 miles. Furthermore, it was obviously a nonbreeder. Another adult (USFWS 617-00634) banded at Wilkes on November 17, 1957, was recovered at the French Dumont D'Urville Station, approximately 720 miles eastward, on December 23, 1959.

Dingle reported recovery of a skua (MOSKWA C 66942) at Australia's Davis Station in February 1958, which had presumably been banded at the USSR Mirny Station in 1956-57, and Braunsteffer recovered two more (MOSKWA C 66915 and C 66969) at this station in February 1959. This would represent an eastward flight along the continent of at least 400 miles.

TABLE IV  
REPORTED SKUA BAND RETURNS AWAY FROM AREA OF BANDING

Band Number	Age	Banded		Recaptured		date	By	Miles Coastline
		Area	date	Area	date			
USFW'S								
617-00567	A	Wilkes Sta.	3/26/57	Ind. Ocean, 65° 53' S, 114° 01' E.		2/19/58	Kirpichnikov	120
MOSKWA								
C 66942	—	Mirny Sta.	1956-57	Davis Sta.		2/6/58	Dingle	400
C 66915	—	Mirny Sta.	1956-57	Davis Sta.		2/10/59	Braunsteffer	400
C 66969	—	Mirny Sta.	1956-57	Davis Sta.		2/10/59	Braunsteffer	400
617-00501	A	Wilkes Sta.	3/1/57	Yorke Pen., So. Australia		5/19/58	Barrett	2,200
617-00660	A	Wilkes Sta.	11/27/57	King Baudoin		1/26/58	Frazier, de Gerlache	2,400
617-52517	A	Little America	3/6/57	McMurdo Sound		1/3/59	Dearborn	375
617-52519	A	Little America	12/15/57	McMurdo Sound		1/8/60	Young	375
617-00566	A	Wilkes Sta.	3/26/57	McMurdo Sound		1/3/59	Dearborn	1,900
617-00359	A	Wilkes Sta.	2/21/57	Scott Base, McMurdo Sd.		12/20/58	Caughley, Penney Sladen	1,900
617-00464	A	Wilkes Sta.	2/25/57	Indian Ocean, 65° 08' S, 111° 15' E.		2/4/59	Shevareva	80
617-00424	A	Wilkes Sta.	2/22/57	Mirny Sta.		2/26/58	Kuznetsov	450
617-00328	Imm.	Wilkes Sta.	2/2/57	Mirny Sta.		3/19/58	Kuznetsov	450
Unknown (green band)	—	Wilkes Sta.	—	Mirny Sta.		4/—/60	Korotkevich	450
617-00634	A	Wilkes Sta.	11/17/57	Dumont D'Urville		12/23/59	Digeon	720
617-52032	A	San Martin Sta.	12/18/57	FIDS Sta. "Y"		2/26/60	Hudson	20
617-52036	A	San Martin Sta.	12/21/57	FIDS Sta. "Y"		1/21/60	Hudson	20
FIDS 405689	A	Deception Is. "B"	1/27/60	Gonzales Videla (Chile)		3/7/61	Leech	120
FIDS 405268	—	66° S, 65° 21' W.	1958-59	Gonzales Videla (Chile)		2/10/61	Leech	90
FIDS 403545	A	Argentine Is. "F"	12/20/58	Gonzales Videla (Chile)		3/13/61	Leech	30
FIDS 405906	Imm.	Signy Is. "H"	2/4/59	Gonzales Videla (Chile)		3/11/61	Leech	500

Rubin, U. S. exchange scientist stationed at Mirny during 1958-59, reported recovery of two Wilkes-banded skuas there by Kuznitsov. The first return (USFWS 617-00424) was taken on February 26, 1958, and was of an adult banded at Wilkes Station on February 22, 1957. The second bird (USFWS 617-00328), banded as a nestling on February 2, 1957, was taken on March 19, 1958. This is the first return made in Antarctica of an immature south-polar skua away from the place of banding, and is further indication of a circumpolar movement of the nonbreeders. Dewart, U. S. exchange scientist with the Soviets in 1960-61, reported that Korotkevich had collected a green-banded Wilkes skua at Mirny in April 1960.

Two recoveries by Stonehouse and Freeman at the British FIDS base on Stonington Island, in Palmerland, which had been banded there during American occupation in 1941, have been reported in the discussion on age.

There have been many observations of skuas at various stations in Palmerland which have returned to the area of banding. As shown in Table IV, birds have been reported recovered away from the place where they were banded, and this indicates a general north-south movement along the peninsula. However, of the more than 900 skuas banded by the British, Argentines, and Chileans in this area, it is peculiar that there have been no returns which would indicate an eastward or westward movement along the Antarctic coast away from Palmerland. Neither have any of the more than 1,600 skuas banded in other parts of the continent been seen on the peninsula.

A recovery in Australia of a Wilkes-banded bird represents the first wintertime return (Eklund, 1959). This was also the first record of *C. maccormicki* in Australia, although a specimen taken in Queenscliff, Victoria, Australia, identified as *Megalestris maccormicki* (Campbell, 1924, p. 77), was later correctly identified as *Catharacta antarctica* (Anon., 1924, p. 119). The recovery (USFSW 617-00501 and with a green band also) was banded on March 1, 1957, and found dead by the children of Mr. L. S. Barrett on the southern shore of Hardwicke Bay, York Peninsula, in South Australia, on May 19, 1958 (Plate I). In reporting it, Mr. Barrett stated the bird had been dead probably less than 7 days and that this would coincide with a storm period of gale-force winds from the west, which apparently had originated in the polar or sub-polar regions.

Records of dead birds such as those recovered in New Zealand, and the Australian recovery, would not indicate a normal range for the species since the birds were apparently carried and exhausted by strong winds. It is believed that storms originating in Antarctica cause considerable mortality and would result in the greatest source of records of *C. maccormicki* outside that area. On the basis of this, as well as the failure thus far to obtain sufficient recoveries outside the south polar regions, no definite conclusions can be made on the normal winter range of the species. Probably it is confined to within the extreme northernmost limits of pack ice during the maximum cold season from June through August as shown on Plate I.

Records of recoveries away from the area of banding are shown in Table IV.



TABLE V  
COLORED BAND OBSERVATIONS AWAY FROM AREA OF BANDING

Band Color	Station	Banded	Date	Area	Observed Date	Seen or re-reported by	Miles Coastwise
Red	Hallett	Jan. 1957		McMurdo Sound	12/20/57	Cadwalader	380
Red	Hallett	1956-57		McMurdo Sound	11/20/58	Miller	380
Blue	Little America	1956-57 or 57-58		McMurdo Sound	12/20/58	Sladen	375
Green	Wilkes	1956-57 or 57-58		Cape Evans, McMurdo Sound	12/13/58	Sladen	1,900
Green	Wilkes	1956-57 or 57-58		Davis Station	1/24/59	Norris	850
Green	Wilkes	1956-57 or 57-58		Davis Station	1/26/59	Norris	850
Green	Wilkes	1956-57 or 57-58		Davis Station	2/4/60	Black	850
Green	Wilkes	1956-57 or 57-58		Mawson Station	1/5/59	Evans	1,200
Blue	Little America	1956-57 or 57-58		Hallett Station	1/6/59	Reid, Salmon	700
Blue	Little America	1956-57 or 57-58		50 miles inland on icecap from Wilkes	11/7/60	Penney	2,400

### *Banding Observations*

In addition to the band recoveries, the movements of skuas have been followed through observation of the colored bands. The red bands of two birds banded at Cape Hallett during the 1956-57 season were observed at McMurdo Sound by Cadwalader on December 20, 1957, and by Miller on November 20, 1958. These represent a southward movement of approximately 380 miles.

Sladen observed a skua at McMurdo Sound on December 20, 1958, which had been marked with a blue band at Little America during the 1956-57 or 1957-58 seasons. This indicates a westward movement, probably along the Ross Shelf Ice, of about 375 miles. The same observer saw a green-banded bird at Cape Evans in McMurdo Sound on December 13, 1958, which had been marked at Wilkes in either the 1956-57 or 1957-58 seasons. Salmon (1959) reported seeing a blue-banded skua from Little America at Hallett Station on January 6, 1959, and if this bird followed the coast it would represent a west-north flight of about 700 miles. Penney reported that a blue-banded skua was seen in November 1960 by a trail party near the Wilkes Icecap Station (Site 2), 51 miles inland, at an elevation of 4,200 feet.

Ingham (1959) reported observations by Norris and Evans of two Wilkes green-banded skuas at Australia's Davis Station, 850 miles westward, in January 1959, and Black saw another there in February 1960. A Wilkes bird was seen at the Mawson Station, 1,200 miles westward, on January 5, 1959.

Observations of skuas away from the area of banding are shown in Table V.

### *CONCLUSIONS*

The results of studies on the south-polar skua, conducted over the past five years, have led to the following conclusions with respect to the life history and distribution of the species:

1. Site tenacity is a breeding trait of the south-polar skua.
2. The south-polar skua has a pair-bond relationship and will remate and reoccupy the same territory in successive years.
3. Ninety-five percent or more of all skua-nesting sites in the Windmill Islands are confined to the vicinity of Adelie penguin rookeries.
4. The incubation period of the south-polar skua eggs averages 30 days, and the incubating temperatures taken over a nine-day period averaged 96.6° F. and ranged from 103.5° to 87°.
5. A detailed study of 40 nests indicated a nesting success of 70 percent, a 39 percent mortality of incubating eggs, and a 23 percent loss of chicks up to 4 weeks of age.
6. The daily feeding range of the south-polar skua may be up to at least 8 miles from the nest site.
7. The south-polar skua has a homing instinct, as shown by its breeding-site tenacity as well as by homing experiments wherein breeding birds returned to their nest sites from various points of release.
8. The total population of adult skuas within an approximate 500-mile sector of the Wilkes Land Coast is about 2,500.

9. The normal winter range of the south-polar skua has not yet been determined conclusively, but it is probably confined to the limits of the Antarctic pack ice.

10. Distribution of the south-polar skua is circumpolar, and returns and observations from over 2,500 banded birds show that its migratory movements are north and south as well as east and west along the coasts. The circumpolar flights appear to be made primarily by nonbreeding birds during the summer.

11. South-polar skuas do not return to the area where hatched until at least the second year of age, and they return to nest for the first time at this same area at five years of age.

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## AGE OF LAUGHING GULL CHICKS INDICATED BY TARSAL LENGTH

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This paper investigates the possibility of predicting the age of a Laughing Gull (*Larus atricilla*) chick from measurements of its tarsus. Often bird banders and field ornithologists desire to know the age of a bird in the field for population and mortality studies or other reasons. I desired to know ages of chicks for two reasons: (1) to analyze banding results (Hailman, 1960), and (2) to assemble groups of wild chicks of a certain age in order to compare their behavior with that of hand-reared chicks of the same average age (in prep.).

### *Age Criteria*

In Laughing Gulls, color pattern of plumage and color of soft parts do not change appreciably prior to flight, and the egg tooth disappears at varying rates, so that these characteristics cannot be used to determine early ages very accurately. Total body weight, which increases with age, depends partly upon how recently chicks have fed and seems to be too variable to be used in age determination in gull chicks (Goethe, 1955); furthermore, it is generally impracticable to carry an accurate balance or scale in the field. The problem requires a quantitative measurement that does not demand elaborate equipment. Tarsal length was tried because (1) it depends largely upon the length of the tarsometatarsus bone, which is rigid, and (2) it can be easily measured with a simple rule, without the use of calipers.

### *Chicks*

The 18 chicks used in this study were hatched from the eggs in an incubator during June, 1960. The eggs were collected from a colony of over 1000 pairs, located on an island in Pamlico Sound, North Carolina. Tarsus measurements were taken about twice a day, the exact time being noted. The time of hatching is known to within 15 minutes on 10 birds and to within 2 hours on the remaining 8. As part of behavior experiments to be reported elsewhere, the chicks were raised in dark boxes and force-fed to satiation three or more times per day. It is impossible to assess the effects of hand-raising upon the growth rate of the chicks' tarsi. All appeared to be growing normally in all