be done in this region, and it is hoped that ornithologists will lend interest, support, and guidance to the program. This can be accomplished through the Polar Research Committee Panel on Biology and Medical Science of the National Academy of Sciences.

REFERENCES

AUSTIN, OLIVER L., JR. 1957. Notes on banding birds in Antarctica, and on the Adelie Penguin colonies of the Ross Sea Sector. *Bird-Banding*, **27**: 1-26.

BALHAM, ROGER. Personal correspondence. Research Section, Wildlife Div., New Zealand Dept. Int. Affairs, Wellington, N. Z. Dec. 1958.

EKLUND, CARL R. 1956. Antarctic fauna and some of its problems, in Antarctica in the International Geophysical Year. Geophysical Monograph No. 1, Am. Geophys. Union, Nat'l. Acad. Sci., Wash., D. C., publ. No. 462, pp. 117-123.

——— and CHARLTON, FREDERICK E. 1958. Measuring the temperatures of incubating penguin eggs. Research Reviews, Office of Naval Research, USN, Wash., D. C., pp. 1-6. Dec. Reprinted in *Amer. Scientist*, **47**(1): 80-86, March, 1959.

INGHAM, SUSAN E. Ornithological work at Australian Antarctic Stations. Personal correspondence, Bio. Secr't. ANARE, Dept. Ext. Affairs, Melbourne, C. 1., Victoria, Australia, Oct. 22, 1958.

LAPINA, I. J. A short summary of ornithological work conducted by Soviet scientists in the Antarctic from 1955-58. Personal correspondence, Sci. Secr't., Soviet Ant. Comm., M. Haritonyevsky 4, Moscow, TSENCR, USSR.

NAGATA, TAKESI. Ornithology and general biology in Japanese Ant. Res. Expeds. Personal correspondence, Secr't. Japansese NCIGY, Geophys. Inst. Tokyo U., Tokyo, Japan. Oct. 16, 1958.

SLADEN, W. J. L., and TICKELL, W. L. N. 1958. Antarctic bird-banding by the Falkland Islands Dependencies Survey, 1945-1957. *Bird-Banding*, **29**: 1-26.

SYNOCCHKOVSKI, Y. Y. 1958. Geographic investigations in the Antarctic. Izv. Acad. Sci. (Geograph. Series), Moscow, No. 6: 163-169.

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GENERAL NOTES

Orientation of Gannets*.—The first real advance in the study of bird orientation was made after the Second World War, when Gustav Kramer of the Max Planck Institute at Wilhelmshaven in West Germany discovered that Starlings were able to choose a definite direction, using only the sun and no visible horizon. His later experiments showed that pigeons could be taught to feed at the same compass direction, regardless of time of day; then that the pigeon's "clock" could be shifted through several hours but could not be speeded up or slowed down. The birds "knew" there were twenty-four hours in a day; they would not subscribe to any longer or shorter working hours. Kramer's first publications were in German, but his work has been summarized in English (Kramer 1952, 1957).

A number of theories by which birds may use the sun to navigate have been proposed, presuming the birds can decide where they are and where their homing goal is. These controversial theories are perhaps best summarized in Matthews' (1955) *Bird Navigation*, and by Kramer (1957) (but see also Allen, 1956). Bird navigation, which assumes actual knowledge of location both of the wanderer and his home, differs from orientation which assumes only that the wanderer can establish definite compass directions, not that the bird knows where it is or where its home is.

For recent comprehensive reviews of homing experiments, before and after Kramer's first discovery, see Griffin (1952, 1955). One of Griffin's own experiments was to release Gannets *(Sula bassana)* near the center of Maine and to follow them with a light aeroplane. It was presumed that these Gannets were "looking" for home. The few birds he was able to follow for a considerable distance seemed to be using an expanding search pattern. An expanding search pattern starts from a point and extends out from it as a helix, keeping the same point as center.

Many of us who have spent time at sea have been impressed with the decisiveness with which seabirds take up a direction when they are flying over the sea. My experiences during World War II in trying to run an expanding search pattern indicated that remarkably accurate orientation should be credited to Gannets if they can run an expanding search pattern. For these reasons, some observations that I made on June 9, 1956 while traveling on the Royal Dutch ship *Groote Beer* bound for Southampton, England, seem to be worth publishing.

The weather was warm, wind west at about ten knots, sky overcast, and the sun could be seen as a spot through the clouds for two- to five-minute periods in each half hour. At 0800 local time the ship's position was about 80 nautical miles bearing 195° True from Fastnet Rock, on the southwest corner of Ireland. At 1115 the ship was about 70 nautical miles bearing 175° True from Fastnet. The ship's course was 093° True.

At 0800, 65 Gannets in groups of three to eight birds were seen flying, one behind the other, on a course which wavered slowly between 010° and 025° True. Between 0800 and 0930 I saw about 150 Gannets. At 0930 the Gannets' course was wavering between 005° and 010° True. A loose group of 11 Gannets, in single file, was seen at 1030, and these birds were flying due north. At 1115 20 Gannets, in single file, were seen flying along a course between 350° and 355° True. After 2:00 p.m., local time, the overcast was complete and 6 Gannets in three groups of 2 were flying erratically over the ocean.

My interpretation of these observations is that as the ship passed by Fastnet's gannetry, it crossed the paths being followed by Gannets returning home from their fishing grounds. When our position was plotted on the chart, and a direction taken to Fastnet, at each period the Gannets were headed directly toward the Rock.

It seems clear from these observations that the Gannets had a "picture" of the true homing direction, although it certainly is not clear whether these were actually homing in the sense that a displaced homing pigeon can return, or whether they had kept subconscious track of their wanderings and so were operating on "dead reckoning."

LITERATURE CITED

ALLEN, WILLIAM H. 1956. Bird Navigation (review of Matthews). *Bird-Banding* **27**: 48-50.

GRIFFIN, D. R. 1952. Bird Navigation. *Biological Reviews* **27**: 359-393.

———— 1955. Bird Navigation (in Recent Studies in Avian Biology, Univ. of Illinois Press, pp. 154-197).

KRAMER, G. 1952. Experiments on Bird Orientation. *Ibis* **94**: 265-285.

———— 1957. Experiments on Bird Orientation and their Interpretation. *Ibis* **99**: 196-227.

MATTHEWS, G. V. T. 1955. Bird Navigation. Cambridge University Press.

*Contribution from the Hatheway School of Conservation Education No. 12.

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Egg teeth and hatched shells of various bird species.—The deciduous calcareous denticle that erodes the egg shell in the process of hatching is remarkably uniform in most of the hundred bird species hatched and examined. It is characteristically situated on the upper mandible a few millimeters from the tip. Since the apex of the bill in most species is slightly decurved, and in hawks, owls and parrots greatly decurved, the egg tooth varies in its position relative to that point of reference. In all species examined, however, a line passing along the proximal part of the tomium transects the anterior base of the egg tooth regardless of the curvature of the culmen. In the ducks the egg tooth has a broad basal plate surmounted by a sharp spine, the cutting instrument; in most other species only the cone-like spine is to be found.

Peculiarities encountered in my examinations of species artificially incubated, spontaneously hatched, up to 1957, are as follows: No neonatal American Woodcock *(Philohela minor)* in my collection has an egg tooth. Whether the denticle is never present in this species, or whether it is unusually deciduous, is hard to say. As the woodcock is known to have sensory nerve endings in the bill, the absence of an egg tooth could be adaptively accommodating; but if so, the technique must be singular. The hatched shells did not attract our attention and were discarded; however, Dr. John Aldrich has called our attention to the