

group of birds was seen on the sea ice near a glacier tongue between Davis and the Larsemann Hills (69° 14' S., 76° 53' E.). From aerial photographs taken then, the population at that time was estimated to be between one thousand and two thousand birds.

Other parties operating in Antarctica have also reported in personal communications recent discoveries of new emperor penguin rookeries. With the five discovered by A.N.A.R.E. parties it now seems that, although they are by no means numerous, emperor penguin rookeries are no longer a rarity.

Since this communication was drafted, a sixth rookery has been discovered by members of A.N.A.R.E. It is situated in approximately 68° S., 69° 45' E., among a large group of icebergs on the eastern side of Cape Darnley. It was discovered in August 1958 by Flight Lieutenant H. O. Wilson, R.A.A.F., during a flight from Mawson to Davis. The population is roughly estimated as 5,000.

RICHARD L. WILLING

Antarctic Division,
Department of External Affairs,
Melbourne.
July 7.

¹ Wilson, E. A., Nat. Antarctic Exp. 1901-4, Nat. Hist., 2, Part 2 (1907).

² Mawson, Sir D., "The Home of the Blizzard", 2, 114, 273 (1915).

³ Stonehouse, B., Falkland Is. Dependencies Survey, 6 (1953).

⁴ Sapin-Jaloustre, J., *Oiseau*, 22, 143 (1952). Willing, R. L., *Nature*, 182, 194 (1958).

The Tide at Shackleton

THE sea tide has been measured at the Trans-Antarctic Expedition's Shackleton Base, on the Filchner Ice Shelf in the Weddell Sea. The ice shelf is afloat over some 500 fathoms of water, and is not thought to be aground anywhere within at least 15 miles; the nearest known land is more than 20 miles to the east. In the absence of any fixed point to which the tide could be referred, a Worden gravimeter was used as an altimeter. The gravimeter was placed in a cavern dug 18 ft. below the snow surface, and photographs automatically taken through the eyepiece every hour. A ten-minute exposure was used so as to average out the continual movement produced by unsteadiness of the ice shelf. The Worden is normally used by adjusting a micrometer head until a pointer seen through the eyepiece is in its zero position; in this work the micrometer was left untouched for many days at a time, and the displacement as photographed through the eyepiece was converted into a correction to the constant setting. In this way readings were obtained from August 8 until October 3, 1957. 145 readings were missed, mostly in the early stages and mainly in two big gaps; these were due to my carelessly dropping a key into the works when reloading the camera, and so fusing the lamp.

Allowance was made for the direct tidal variation of gravity (modified by earth tides) as tabulated by Coguel¹; this produced what are referred to below as 'corrected readings'. Gravimeter drift was calculated by computing a mean reading at each sixth hour, using a formula which takes account of constituents up to sixth-diurnals; these values were then smoothed. The big gaps were filled by fitting a fifth- or seventh-degree polynomial, and using the

curve of residuals. Sub-tabulation was then carried out at hourly intervals. Subtracting the 'corrected readings' from these drift values gave figures proportional to the height of the tide above mean sea-level.

These readings were then divided into two 29-day periods, sharing a common day—first, August 8–September 5, and secondly, September 5–October 3. Each period was then subjected to analysis by the method given in "The Admiralty Tide Tables"², with the results set out in Table 1. In the averaging, the first period is somewhat arbitrarily given half the weight of the second, because the readings have more gaps and the gravimeter drift was more erratic in the first period. Gravimeter readings were converted to heights by the usual Bouguer formula with an insignificant modification for the acceleration implied by the rise and fall.

Table 1. SHACKLETON BASE. 77° 59' S., 37° 10' W.

	M_2		S_2		N_2	
	H	g	H	g	H	g
Period 1	2.14	157°	1.52	180°	0.32	150°
Period 2	1.98	160°	1.44	174°	0.34	148°
Mean	2.03	159°	1.46	176°	0.33	149°

	K_1		O_1		M_4		MS_1	
	H	g	H	g	H	g	H	g
Period 1	1.06	348°	0.75	303°	0.02	179°	0.05	279°
Period 2	0.48	342°	1.02	325°	0.07	131°	0.04	206°
Mean	0.67	345°	0.91	319°	0.05	136°	0.04	235°

Central days: period 1, August 22, 1957; period 2, September 19, 1957. Standard time: 4 hr. west. Heights, H , are given in feet.

It can be seen that the constants derived from the two periods are in poor agreement for the diurnals, that the semi-diurnals are well determined, and that the quarter-diurnals are negligible. It is known that there is a spurious constituent of variable amplitude (of the order of 0.3 ft.) and period 40 hr., coinciding with the interval between visits to the cavern to re-load the camera. This is bigger than was expected; but for just that reason makes it plausible that there should be another spurious constituent large enough to produce serious interference with the diurnals, and of period 24 hr. The constants in Table 1 are tolerably compatible with other measurements in the South Orkneys and Graham Land as given by Roberts and Corkan³, and are well placed to strengthen the co-tidal charts in a little-known area.

I am indebted to the Director of the Liverpool Observatory and Tidal Institute for help in the analysis, and also to Dr. G. P. Woollard of the University of Wisconsin for the loan of the gravimeter and to the British Petroleum Co. for the automatic camera. A full account of this work is to be published in "The Trans-Antarctic Expedition Scientific Reports".

J. G. D. PRATT

c/o F.I.D. Scientific Bureau,
Crown Agents,
4 Millbank,
London, S.W.1.
Sept. 8.

¹ Coguel, Jean, "Geophysical Prospecting", 4, Supp. 1 (1956).

² Doodson, A. T., and Warburg, H. D., "The Admiralty Tide Tables", Part 3 (1936).

³ Roberts, Brian, and Corkan, R. H., British Graham Land Expedition 1934-37 Scientific Reports, 1, No. 5.