SHORT NOTES

THE OCCURRENCE OF GLYCOLLIC ACID IN ANTARCTIC WATERS

By G. E. Fogg,* N. F. Burton* *and* S. J. Coughlan*

Abstract. Glycollic acid, an extracellular product of algal photosynthesis, has been detected in concentrations up to 40 μg. l.$^{-1}$ in sea-water samples from various stations in the Falkland Islands, Scotia arc and Antarctic Peninsula, and in one lake-water sample from Signy Island.

Algae normally liberate an appreciable part of the carbon fixed in photosynthesis in the form of extracellular organic products, among which glycollic acid is a principal component (Fogg, in press (*a*)). Both marine (Horne and others, 1969) and fresh-water (Fogg and Horne, 1970) phytoplankton from Antarctic situations have been found to do this, and corresponding with the high primary productivity which may be achieved the total amount of material made available in this form may be large. Indeed it has been suggested by Sorokin (1973) that a great part of the energy required by coral ecosystems is derived from dissolved organic matter originating in the Antarctic. It thus seems important to know more about the extracellular products of Antarctic phytoplankton and as a first step the occurrence of glycollic acid in Antarctic waters has been investigated.

Sampling and Analytical Methods

Samples of about 7 l. surface water were collected in glass bottles and filtered through glass-fibre filters within 2 hr., having been kept at outside air temperature. Glycollate was estimated by the method of Shah and Wright (1974), in which the substance is isolated and concentrated by adsorption on alumina from which it is eluted with sulphuric acid and determined by the Calkins' colorimetric technique. In this instance, the procedure was carried as far as filtering off the alumina with its adsorbed glycollate in the laboratory of R.R.S. *Bransfield*. Then the samples, while still damp, were wrapped in aluminium foil, placed in polythene bottles, and frozen for transport back to Menai Bridge, where the analyses were completed. Since samples with known amounts of added glycollate were included, any loss of glycollate in the 3 months which elapsed between collection and final processing would be automatically allowed for, but in fact there was no indication that any loss occurred. In each series, duplicate samples were taken of water without added glycollate and single samples each of water with 20, 40 and 60 μg. l.$^{-1}$ of added glycollate, and the reagent blank. Duplicate determinations were made on each sample so that the final mean values and standard deviations, which were calculated by the method of linear regression, are each derived from 12 individual results. Absorption spectra of the colour developed with the Calkins' reagent were determined with a Unicam SP 800 recording spectrophotometer.

Results

The results are set out in Table I. The absorption spectra of the samples from sea-water without added glycollate showed clearly the absorption peak at 540 μm. characteristic of the Calkins' reaction for glycollate. A sample from The Wallows on Signy Island, so heavily contaminated with organic matter that the filtrate was the colour of a pale sherry and the alumina became yellow after having been shaken with it, gave no absorption peak at this wavelength. Although a shoulder in this position on the absorption curve indicated the presence of glycollate, no quantitative estimate of its amount was possible.

Samples from Port William, Falkland Islands, were taken both within a *Macrocystis* bed and about 200 m. away in open water but no statistically significant difference in glycollate content was detected.

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TABLE I. GLYCOLLATE CONCENTRATIONS (MEAN VALUES WITH STANDARD DEVIATIONS) OF VARIOUS SEA-WATER SAMPLES AND ONE FRESH-WATER SAMPLE COLLECTED DURING THE MARCH–MAY 1974 CRUISE OF R.R.S. *Bransfield*

Location	*Time*	*Glycollate concentration* (μg. l.$^{-1}$)	*Probability of result being zero*	*Notes*
Port William, Falkland Islands (lat. 51°40′S., long. 57°48′W.)	12.00 hr. 15 April 1974	26 ± 4·0	<0·001	Samples from within a *Macrocystis* bed and from open water 400 m. from shore
King Edward Cove, South Georgia (lat. 54°17′S., long. 36°30′W.)	12.00 hr. 26 April 1974	15 ± 6·2*	0·01	Samples taken inshore of a *Macrocystis* bed
Factory Cove, Signy Island (lat. 60°42·5′S., long. 45°36′W.)	11.00 hr. 21 March 1974	14 ± 6·7	<0·05	< 1 μg. chlorophyll *a* l.$^{-1}$
Lake 2, Signy Island (lat. 60°41·5′S., long. 45°36·5′W.)	10.30 hr. 21 April 1974	40 ± 11·7	<0·005	High phytoplankton content; filtrate slightly yellowish
Rothera Point, Adelaide Island (lat. 67°34′S., long. 68°07′W.)	14.30 hr. 2 April 1974	8 ± 5·0	~0·05	Sample taken *c.* 1·6 km. offshore; moderate phytoplankton content
Stonington Island (lat. 68°11′S., long. 67°00′W.)	11.30 hr. 29 March 1974	(−4·6 ± 8·8)*	>0·25	Sample taken from shore, content mainly detached epilithic algae

* Blank samples contaminated; values based on mean blank from other series.

DISCUSSION

These results show clearly that glycollate may at times occur in appreciable amounts in Antarctic waters. The concentrations found in the sea-water samples lie within the ranges found for the Gulf of Maine (0–78 μg. l.$^{-1}$) by Shah and Wright (1974) and for the Menai Straits (0–60 μg. l.$^{-1}$) by Hasan, Coughlan and Pant (paper in preparation). The concentration found in the lake-water sample likewise is within the range of 0–61 μg. l.$^{-1}$ found in Windermere, English Lake District, by Fogg and others (1969). Since single samples only were taken in this work and since considerable variation in glycollate concentration may occur according to season (Shah and Wright, 1974; Hasan, Coughlan and Pant, paper in preparation), little significance can be attached to the actual concentrations found. Thus it cannot be said whether there is any real tendency for the concentration of glycollate to decrease as one goes south as the results in Table I might suggest. Hasan, Coughlan and Pant (paper in preparation) have found a significant correlation of glycollate concentration with that of phytoplankton chlorophyll. No determinations of phytoplankton biomass were made in the present work but the highest glycollate concentration was found in Lake 2 (Signy Island), in water containing a visibly rich phytoplankton population. It has been shown that seaweeds liberate glycollate in much the same way as unicellular algae (Fogg, in press (*b*)) and the fairly high value recorded for Port William may be attributed to the large amounts of *Macrocystis* present. On the other hand, the water from Factory Cove (Signy Island) contained an appreciable amount of glycollate, although the phytoplankton population was exceptionally low and the principal growth of macro-algae was *Desmarestia* spp. growing at a depth of more than 5 m. at a light intensity which presumably would not favour liberation of glycollate. It seems likely that heterotrophic bacteria are the main agents removing glycollate but the expectation that the concentrations of this substance in Antarctic waters should be high, because low temperature may reduce the rate of heterotrophic relative to photosynthetic activity, does not appear to

be realized. In general, it appears that the role of glycollate excreted by algae is likely to be much the same in the Antarctic as it is in temperate waters.

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AN UNUSUAL FORM OF PATTERNED GROUND, COOPER BAY, SOUTH GEORGIA

By P. STONE

ABSTRACT. Lines of *Poa flabellata* stools form a series of large-scale non-sorted stripes at Cooper Bay, South Georgia. The stripes are described and possible origins discussed.

AN unusual and distinctive form of patterned ground has developed in the south-east of South Georgia, approximately 0·5 km. north-west of Cooper Bay (lat. 54°47′S., long. 35°48′W.) and about 40 m. a.s.l. A linear arrangement of stools of the tussock-forming grass, *Poa flabellata*, on a 25–30° south-west-facing slope (Fig. 1) forms a series of large-scale non-sorted stripes (Washburn, 1956). Trenches cut across the stripes revealed only a varying depth of sticky, dark brown loam with a high humus content overlying completely unsorted slaty talus (Fig. 2). It is difficult to decide whether the tussocks are growing on original ridges or whether the root complexes of the stools have built up over a number of years. The furrows between the tussock lines are covered by mosses.

The tendency of *Poa flabellata* to form tussocks is frequently reinforced by the movement of animals (Greene, 1964) but this is definitely not the case with the examples discussed here. In fact, a penguin track can be seen in Fig. 1 crossing the stripes as a darker moss-covered line from bottom right to top left. Abandoned gentoo penguin rookeries in the vicinity are separated from the tussock lines by more irregular stool development. From Fig. 2 it is evident that there is no underlying control of the position of the stripes. The slaty talus is not sorted and root action at that level is very unlikely to have been strong enough to destroy any original patterns. The stripes have formed at an acute angle to the structural trend of the local bedrock and at an equally acute angle to the prevailing wind.

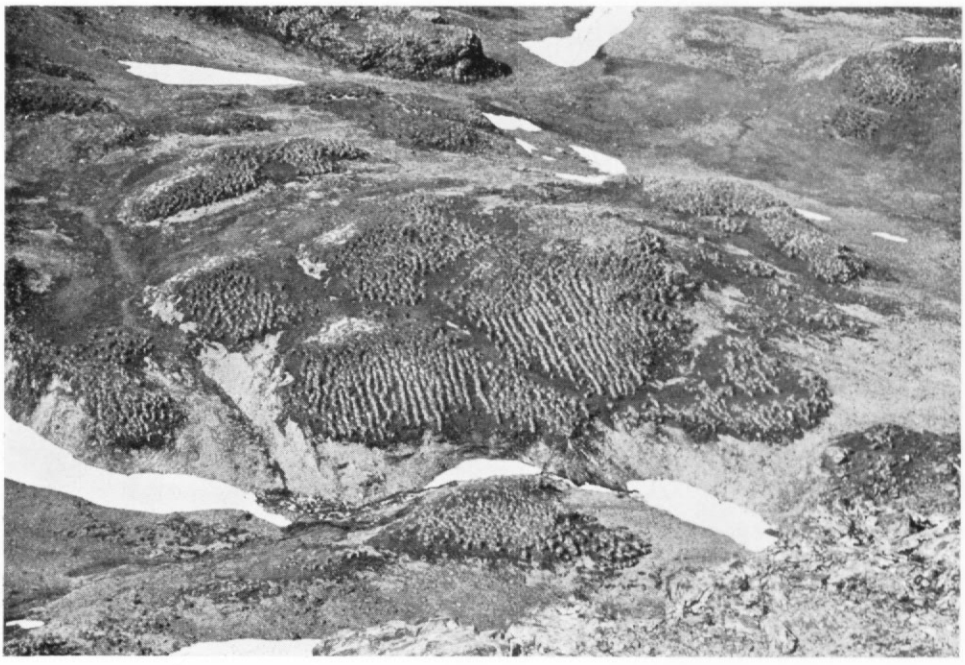

Fig. 1. Stools of *Poa flabellata* forming large-scale non-sorted stripes. The stripes are up to 1 m. apart.

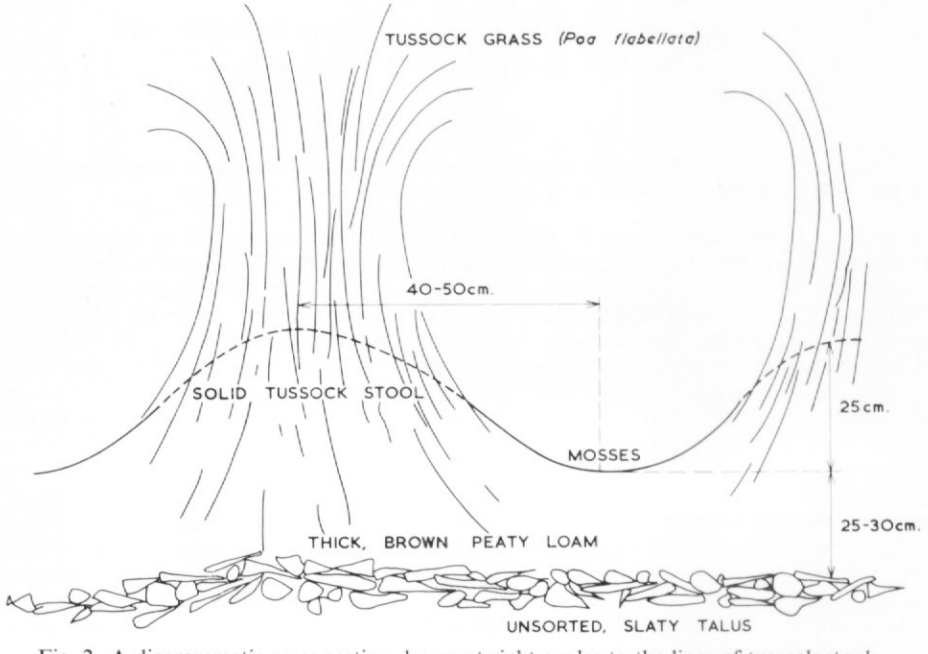

Fig. 2. A diagrammatic cross-section drawn at right-angles to the lines of tussock stools.

Although there are no signs of active movement, the orientation of the stripes suggests that significant down-slope movement has occurred. Slurry runs of fine material across unsorted scree probably produced the original lineament, a process which can be widely observed on active screes in the vicinity. This would not account for the regularity of the stripes but, once established, growth of the tussock plants may determine the interval between the lines. Separation of the tussock stools along the length of the stripes would be caused as individual plants moved slightly down-slope before they became firmly rooted in position. An origin of the stripes by such means would not require periglacial conditions but would be considerably assisted by the wet climate of South Georgia.

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