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PRELIMINARY REPORT ON CELLULOLYTIC ACTIVITY IN THE ANTARCTIC REGION (EXTENDED ABSTRACT)

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The biochemical and ecologic cycle of life in its simplest form involves three major processes, production, consumption and decomposition, but most biological research in the Antarctic region has concentrated on aut- and synecology, and primary production. Several studies on organic matter decomposition in the region has been reported (ELLIS-EVANS, 1985; LAWSON, 1985; WYNN-WILLIAMS, 1985). But few study on the decomposition of cellulose, which is the most abundant organic compound in nature and has a special significance in the biological cycle of carbon, was reported except a study in South Georgia (SMITH, 1981; WALTON, 1985). In the present study, a preliminary investigation on cellulose decomposition by soil microoragnisms was carried out at Syowa Station and Langhovde, Antarctica.

Benchkote sheet method (TATSUYAMA *et al.*, 1984) was used for the estimation of cellulose decomposition in the soil. The sheet is polyethylene-backed filter paper containing 0.06% of ash. Cellulose material amounts to 78% of the sheet in weight. A protocol of the method is summarized in Fig. 1. Five sites in Syowa Station, three sites at a hut for biological research in Langhovde and six sites in the Yukidori Valley (KANDA *et al.*, 1990) located in the central part of Langhovde were selected for the investigation. Several sheets cut into $10 \times 10\,cm^2$ were buried horizontally, with polyethylene side at bottom, at a depth of 5 cm in January 1988 and taken out in January 1989. Details of the sites are shown in Table 1.

Cellulose decomposition rates in soil at the respective sites are shown in Table 2. The decomposition rate observed at every site in the Yukidori Valley and the hut in Langhovde and at S5 site in Syowa Station were only a few percent, while those at four sites (Stn. S1–S4) near a urinal drum in Syowa Station were significantly higher, 9 to 25%. Many colored spots which may be caused by bacterial or fungal colonization were recognized on most of the sheets.

The major environmental factors affecting the decomposition rate are the available nitrogen level, temperature, aeration, moisture, pH and the presence of other carbohydrates (ALEXANDER, 1977). In southwestern Japan, generally, 1–3% day^{-1} of cellulose material is decomposed in agricultural field soil. Temperature (OHTANI *et al.*, 1990) and moisture level (Table 1) in the investigated sites are far lower than in the temperate zone, and the texture are sand which can hold few nutrients in addition to low supply of organic materials. Therefore, it is easily supposed that a number and an activity of

A sheet (Whatman, Benchkote) is cut into appropriate size.
|
kept it desiccator overnight
|
weighed (A)
|
buried in soil horizontally or vertically
|
taken out after a certain period (depending on the condition such as temperatuse, moisture, etc.)
|
washed gently to remove large soil particles
|
air-dried and kept in desiccator
|
weighed (B), then ashed by heating at 500°C for 2–3 h
|
The ash is weighed (C) and the decomposition rate is calculated from the figures A, B and C.

Fig. 1. A protocol of Benchkote sheet method for an estimation of cellulose decomposition in soil (TATSUYAMA et al., 1984).

Table 1. Investigation period and some environmental characteristics of the sites.

Investigation site		Buried on	Taken out on	Characteristics
Yukidori Valley	Y1	Jan. 15, 1988	Jan. 9, 1989	same place as MCS-3*, sand-small gravel, poor moss and lichen colonies, W. C. 1.1–1.7%**
	Y2	Jan. 15, 1988	Jan. 9, 1989	sand-gravel, poor moss and lichen colonies, W. C. 0.2–0.5%
	Y3	Jan. 16, 1988	Jan. 9, 1989	same place as MCS-2*, sand-small gravel, poor moss and lichen colonies, W. C. 0.3–2.5%
	Y4	Jan. 16, 1988	Jan. 9, 1989	sand-small gravel, rocks, rich moss and lichen colonies, close to rookery of snow petrel, W.C. 0.1–1.7%
	Y5	Jan. 16, 1988	Jan. 9, 1989	sand-small gravel, poor moss colonies, margin of Lake Yukidori, W.C. 0.1–12.8%
	Y6	Jan. 17, 1988	Jan. 12, 1989	same place as MCS-1*, sand-small gravel, algae and rich moss colonies, W.C. 2.5–62.7%
A hut for biological research, Langhovde	H1	Jan. 15, 1988	Jan. 9, 1989	close by a urinal drum, wet sand, no macroscopic organisms, W.C. 1.5%
	H2	Jan. 15, 1988	Jan. 9, 1989	1m far from a urinal drum, dry sand, no macroscopic organisms, W.C. 0.5%
	H3	Jan. 15, 1988	Jan. 9, 1989	5m far from a urinal drum, dry sand, no macroscopic organisms, W.C. 0.4%
Syowa Station	S1	Jan. 30, 1988	Jan. 26, 1989	close by a urinal drum, wet sand, no macroscopic organisms, W.C. 6.7%
	S2	Jan. 30, 1988	Jan. 26, 1989	2m far from a urinal drum, wet sand, no macroscopic organisms, W.C. 5.7%
	S3	Jan. 30, 1988	Jan. 26, 1989	4m far from a urinal drum, wet sand, no macroscopic organisms, W.C. 3.0%
	S4	Jan. 30, 1988	Jan. 26, 1989	6m far from a urinal drum, wet sand, no macroscopic organisms, W.C. 3.7%
	S5	Jan. 30, 1988	Jan. 26, 1989	120m far from a urinal drum, dry sand, no macroscopic organisms, W.C. 0.8% (control site for Syowa Station)

* Microclimate Station (OHTANI *et al.*, 1990).
** Water content of −5cm soil at the time of taking the sheets out.

Table 2. Cellulose decomposition rate in soil at the Yukidori Valley, a hut for biological research, Langhovde and Syowa Station, Antarctica.

Investigation site		Decomposition rate		
Yukidori Valley	Y1	2.2±0.52%	a*	(*n*=3)
	Y2	2.3±0.93	a	(*n*=4)
	Y3	2.6±0.55	a	(*n*=4)
	Y4	2.8±0.87	a	(*n*=3)
	Y5	3.9±1.78	a	(*n*=6)
	Y6	1.4±0.35	a	(*n*=6)
A hut for biological research, Langhovde	H1	3.2±2.41	a	(*n*=5)
	H2	1.7±0.33	a	(*n*=5)
	H3	1.0±0.13	a	(*n*=5)
Syowa Station	S1	15.6±5.93	c	(*n*=5)
	S2	9.0±3.38	b	(*n*=5)
	S3	20.1±2.24	c	(*n*=5)
	S4	25.2±9.63	d	(*n*=5)
	S5	1.4±0.40	a	(*n*=5)

* mean±S.D; Numbers followed by same letter do not significantly differ from each other at $P=0.01$ according to Duncan's multiple range test.

cellulolytic microorganism may be extremely low level in the Antarctic natural environment. The decomposition rates at Syowa Station, however, were significantly higher than those at Langhovde. Although the location of sites H1, H2, and H3 in Langhovde was similarly close to a urinal, the decomposition rates were only a few percent. The hut in Langhovde was established in 1986, while Syowa Station has been maintained over 20 years. It can be considered that there are marked effects of man's activity in an aspect of supply of organic matter and nutrients for microorganisms.

Further investigations should be made on the problem in the Antarctic region, especially the relation between the decomposing activity and environmental factors such as soil nutrients, microbial flora, microclimate and so on.

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