The Microbiology of Exposed Areas of Aquatic Habitats of Northern Ellesmere Island*

INTRODUCTION

It has been known for many years that the soils and waters of the North American Arctic contain a great variety of microbes, such as fungi, bacteria, actynomycetes, myxobacteria and algae[1,2]. Due largely to the stimulus provided by the International Biological Programme, many studies have been made of the organisms and decomposition processes that occur in the North American tundra, and some recently published results[3,4,5,6] contribute much to an understanding of the subject.

The present paper constitutes a report on the microflora in exposed areas of shorelines of ponds and tarns located near Hazen Camp (81°49′, 71°18′W), northern Ellesmere Island. At snow-melt, which generally occurs in early June, water flows into lakes and depression areas, but, as summer progresses, the water level in them drops gradually and progressively wider strips of shoreline are exposed. These contain both newly emerging vascular plants, and also ones in process of decomposition after becoming detached in previous years. Considered as a temporary pond is one which regularly becomes reduced in area to less than one square mile (2.59 km²) of free water, and dries up in most years; a permanent pond is one not reduced to the same extent, and which does not dry up; and a semi-permanent pond may dry up in exceptional years. A tarn is a large permanent body of water which only decreases slightly — if at all — in area. The waters in these ponds and tarns are cold (seldom exceeding 11°C) and are rich in dissolved solids, alkaline and very hard. Their pH range is 6.8 to 8.9.

Day[8] has examined soils from twelve sites of the Hazen Camp area and found only a weak profile development, concluding it to be due to the harsh climate of the area.

MATERIALS AND METHODS

Since it was impossible to send samples off for laboratory analysis immediately after collection, or to conduct microbiological examinations at the camp site, the method used

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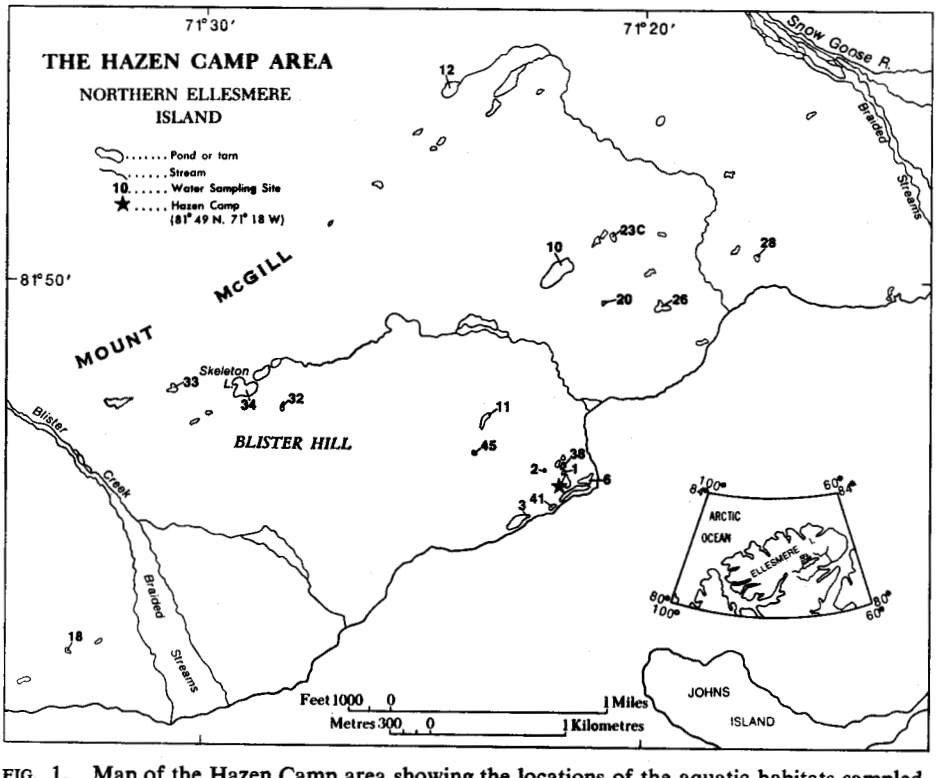

FIG. 1. Map of the Hazen Camp area showing the locations of the aquatic habitats sampled.

was one designed to stimulate natural conditions and give information on the kinds of microbes that inhabit and colonize the plant residues accumulating and decomposing at the surface of exposed areas of the shorelines. Thus offshore waters, vegetation and sediments were obtained at the 18 ponds indicated in Fig. 1. Samples, which were obtained in 1964, were collected at random in shallow water where vegetation was visible. Each sample, which consisted of approximately 20 grams of sediment, 100 grams of vegetation and 20 millilitres of water, was placed in previously-sterilized, unopened plastic containers. These samples were left outdoors for about 30 days until they could be transported. During this time most of the moisture evaporated. After being capped with plastic tops, the containers were transported by air to the laboratory in Ottawa where sterile distilled water was added to bring each sample to approximately 70 per cent water-holding capacity. A portion of each sample was incubated in its container, at 4, 10 and 25°C. To allow for exchange of air and to avoid contamination, four small holes were bored in the plastic tops and the containers placed in a sterile desiccator with its stopcock plugged with cotton. On the remaining sample, carbon and nitrogen content and pH were determined by standard procedures, and salt concentration was estimated by converting conductivity of extract (in millimhos/cm) to salt content[9]. At weekly intervals, the plastic containers were shaken by hand and the moisture content maintained by addition of sterile water, when necessary.

After two months of incubation at the three temperatures referred to above, bacteria and actinomycetes were enumerated on soil-extract agar, and *Cytophaga* on Difco plate-count agar. Numbers of fungi were obtained by plating on peptone dextrose agar containing rose bengal and chlortetracycline. All plates were incubated at the temperature of the incubating samples, and at each incubation temperature quintuplicate plates for three soil dilutions were made. Cultures held at 25°C were incubated for a period of between one and two weeks before microbial counts were made. Cultures held at 10°C and 4°C were incubated for two to four weeks. For identification of fungi, approximately 100 fungal colonies from each of the plated samples were isolated and subcultured on potato dextrose agar slants.

RESULTS AND DISCUSSION

All of the samples (see Table 1) with two exceptions, had pH values on the alkaline side. Their carbon-to-nitrogen ratios varied from 8 to 29, such values are not being outside the range for many soils. When the conductivity measurements were converted

TABLE 1. Chemical characteristics and plate counts of pond samples

Sampling site no.	Chemical characteristics			Plate counts (in millions) per gram of dry weight									
				Bacteria		Actinomycetes		*Cytophaga*			Fungi		
	pH	Carbon: nitrogen ratio	Salt concentration (meq./l)	25*	10*	25*	10*	25*	10*	4*	25*	10*	4*
Tarns													
10	7.2	13.8	400	3,380	3,230	30	30	22	21	22	4	4	4
12	7.6	19.0	440	1,800	1,200	250	200	23	20	15	6	5	3
34	7.4	16.5	300	474	414	19	16	2	2	1	3	2	3
*Ponds(P)***													
1	6.8	17.6	290	675	490	22	16	0.5	0.5	1	1	1	1
3	7.2	16.2	205	952	666	127	222	1	1	0.2	1	1	1
18	7.3	8.3	290	6,380	6,380	900	800	8	6	4	0.04	0.05	0.04
28	7.2	19.3	240	800	750	150	240	1	1	2	3	3	3
33	7.3	19.0	320	930	690	2,000	1,900	7	6	1	6	7	6
38	7.3	18.2	220	1,533	1,333	100	466	23	18	13	4	5	5
*Ponds(S)***													
11	7.3	26.9	405	1,780	531	71	72	3	4	2	0.2	0.2	0.3
23C	7.4	21.1	50	147	30	21	21	0.4	0.3	0.1	0.3	0.3	0.4
32	7.4	13.9	60	101	92	2	2	0.4	0.4	0.4	0.1	0.1	0.1
*Ponds(T)***													
2	7.4	13.9	60	75	53	4	4	0.5	0.5	0.1	0.04	0.1	0.1
6	6.8	15.0	260	392	1,212	121	121	5	6	2	1	1	1
20	7.2	20.4	115	195	164	0.2	0.2	0.4	0.4	0.2	0.02	0.02	0.02
26	7.2	19.2	160	654	945	0.3	0.3	5	5	1	0.2	0.3	0.3
41	7.3	17.7	50	30	33	0.6	0.4	0.1	0.1	0.01	0.04	0.04	0.04
45	7.2	28.9	120	148	122	23	23	1	1	0.3	0.1	0.1	0.1
AVERAGES:				1,136	1,019	213.4	229.2	5.7	5.2	3.6	1.67	1.68	1.58

*Laboratory temperatures (°C) of incubating samples and agar plates.
**P—Permanent; S—Semi-permanent; T—Temporary.

into salinity classes[10], 22 per cent of the pond samples (nos. 2, 23C, 32 and 41) were found to be slightly saline; 17 per cent (nos 20, 26 and 45) moderately saline; and the remainder (61 per cent) strongly saline.

Wide variations in numbers of microorganisms were observed, as indicated in Table 1. Salt concentration, pH and carbon-to-nitrogen ratio had no effect on the numbers; and, except possibly in the case of *Cytophaga*, temperature of incubation appeared to have no effect on them either. Numbers of Cytophaga tended to decrease somewhat as the temperature decreased. Holding *et al*[3] and Parinkina[4] also found fluctuations in the microbial counts for tundra sites, and there was no evidence that temperature was responsible for them[3].

In contrast the situation found in studies dealing with cool-temperature regions of Canada[11,12], the number of fungal genera in the samples from the Arctic now being discussed was low, only eleven being identified. A similar paucity of fungal genera was noted by the present author in his study[13] of four permafrost soils from the Mackenzie Valley.

In the same study, the dominant fungal genus was Chrysosporium, to which an average of 45 per cent of all isolates belonged; the next most populous was *Penicillium*, which accounted for 20 per cent, and then *Mortierella* with 16 per cent. *Phialophora*, *Cladosporium* and *Phoma* each accounted for 4 per cent of the total isolates, and sterile *mycelia* 3 per cent. The remaining four genera (Oidiodendron, Cephalosporium, Coniothyrium, Gliomastix) were isolated with a frequency of 2 per cent or less. These results are similar to those of Dowding and Widden[5] who, after assembling data from 33 tundra sites, found the most widespread fungal genera to be the sterile forms *Penicillium*, *Chrysosporium*, *Cladosporium* and *Mortierella*.

It was also observed in the course of the study that, as the incubation temperature decreased, *Chrysosporium* was recorded far more frequently. This genus was represented by a single species *C. pannorum*, which is often abundant in cold environments[13,14] and appears to be an important colonizer of such habitats.

Since there are many more environmental parameters affecting microbial activity and numbers than were examined in this investigation, it would be difficult to discuss the relationship of the results to the High Arctic ecosystem. Nevertheless, if one keeps in mind that a large proportion of tundra mycoflora are psychrophilic[5,6] and most of the nutrients in dead plants are released by microbes to aid growth of future vegetation, it becomes obvious that the presence of viable microbes in these lake shorelines, situated approximately 600 miles south of the North Pole, is very important. They are undoubtedly not only active in supplying plant nutrients but are helping to transfer part of the decaying vegetation to produce "stable" humus which takes part in the formation of the underlying and surrounding weakly-developed soil profiles. They also play an additional role in providing food for larger organisms, for Whittaker[15] found that in Arctic sites the population peak for mites follows that for fungi.

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Contacts between American Whalemen and the Copper Eskimos

It has often been maintained that the Copper Eskimos did not have contacts with white men between the early eighteen fifties and the first decade of the twentieth century. The earliest recent encounters are generally believed to have occurred in 1902, when David Hanbury conducted explorations on the mainland near Coronation Gulf, and in 1905-06 and 1907-08, when Christian Klengenberg and Captain William Mogg respectively wintered on the schooner *Olga* at Victoria Island.[1] Stefansson described a whaler's harpoon found by the Eskimos in a dead whale that was stranded in Coronation Gulf,[2] but he believed there had been no direct contacts on Victoria Island before Klengenberg's meeting.[5]

Evidence does exist, however, to indicate that American whalers encountered Copper Eskimos during the last decade of the nineteenth century. Captain Hartson Bodfish, who was master of several whaling and trading vessels in the western Canadian Arctic, reported having made contact with these Eskimos long before any explorers had reached the area.[6] These encounters may have begun as early as 1891 because, in the spring of that year, Bodfish, after wintering at Herschel Island, wrote to his mother: "Just as soon as we can get out we are going, and are bound to that undiscovered country that lies to the eastward of us."[8] In 1898, while wintering in Langton Bay near Cape Parry in the steam bark *Beluga,* he noted in the ship's log that one of his native hunters had left the ship in the March to look for other Eskimos, and returned several weeks later with a group of them, and added: "They report seeing lots of seals and whales as they came along the coast in the neighborhood of Dolphin and Union Straits." Bodfish's ethnographic collection, in the Cleveland Museum of Natural History, contains at least one Copper Eskimo artifact, an *ulu.*

The ethnographic collection of Captain Horace P. Smith, at the Old Dartmouth Historical Society Whaling Museum, also suggests an early encounter because it contains a musk-ox horn ladle with a copper rivet in the handle; this piece is similar to other ladles collected from the Copper Eskimos,[3,9] and Smith's only voyage in the Canadian Arctic took place between 1892 and 1894, when he twice wintered the steam bark *Narwhal* at Herschel Island.