

SOME MICROBIOLOGICAL AND SANITARY ASPECTS OF MILITARY OPERATIONS IN GREENLAND*

Introduction

The presence in northwestern Greenland of small numbers of U.S. Army personnel under an agreement with the Danish government has afforded opportunities to study some problems related to life and military operations in the Arctic. Until recently the number of personnel involved in these operations has been relatively small and there have been few problems related to personal hygiene and sanitation. As the military and scientific population increased adequate sanitary conditions and facilities for the practice of good personal hygiene have become increasingly important. As a part of the preventive medicine program, these problems have received careful attention at installations of the U.S. Army Polar Research and Development Command in Greenland. This paper reports some results obtained during microbiological surveys at these installations during the summer season of 1959.

Aided by an earlier report published by this laboratory¹, several areas were selected for study. Among these were: 1) studies of general sanitation practices, including microbial studies of water supplies and the problems of sewage disposal, 2) the healing of accidental wounds, and 3) studies of fly-borne contamination at Camp Tuto.

Geographical location

Camp Tuto, located 14 miles from Thule Air Force Base in northwestern Greenland, served as the headquarters and main laboratory of the Microbiology Study Group. The research group consisted of one civilian biologist and two Army enlisted biological assistants under the direct control of the Senior Medical Officer, USA, Greenland. In

addition to studies at Camp Tuto the group conducted surveys at Camps Century and Fistclench located 100 and 220 miles, respectively, inland on the Ice Cap. Members of the group were also attached to the heavy over-snow transports (swings) to monitor sanitation techniques.

Observations and results

Water supplies. Raw and finished water samples were taken at all USA PR and DC installations and on some over-snow swings. These were examined for coliform contamination using molecular membrane filter field monitoring kits. The results of these surveys are presented in Table 1.

Repeated analyses of raw water samples from Lake Tuto failed to disclose the presence of coliform organisms at or near the primary water collection point (Fig. 1,B). Coliforms were isolated in large numbers during August from samples taken below the laundry, shower, and mess hall outflows (Fig. 1, D, G); (Fig. 2). These areas are located approximately 800 and 1600 yards, respectively, downstream from the primary water supply point. The number of bacteria isolated at certain sites in the vicinity of Camp Tuto increased with the onset of winter (Fig. 2). Although isolations would be normally expected to decrease with the approach of cold weather, the observed increases in contamination were probably due to accelerated construction activity near the meltwater stream in the camp area during August.

No coliform organisms were isolated from meltwater-stream samples taken on the southwestern side of the Ramp Road (Fig. 1). Coliforms were isolated near the active dump area (Fig. 1, D₃) from meltwater streams. Since these flow away from Lake Tuto no evidence of cross-contamination between lake and dump waters was observed. Of considerable interest were coliform isolations from water collected from a meltwater stream near an abandoned dump last used in 1958 (Fig. 1, X). This contamination can perhaps be attributed to the survival of organisms

* From the Environmental Medicine Division, US Army Medical Research Laboratory, Fort Knox, Kentucky. Based on material contained in USAMRL Report No. 415.

Table 1. Enteric bacteria in water supplies at PR and DC installations* (non-coliforms in parantheses).

Camp Tuto Sites (see Fig. 1)	Average number of bacteria per 100 cc. water		
	May	July	August
D ₁			3
D ₂			3
D ₃			12
D ₄			0
D ₅			0
A		0	0
C	0(11)	0	0
B (water pump)	0	0	0 (increase in non-coliforms at B, noted at a later date, Fig. 2)
D (above QM laundry)		0	0
D (below QM laundry)		112	42
E	0	0	0
F		95	24
G		38	17
H	0(500)	8(300)	99(300)
J		1	44
K		0	22

Camp Century: (Gram positive staphylococci: 6/100 cc. water; Gram negative rods, urease positive: 8/100 cc. water.) No coliforms.

Camp Fistclench: No organisms isolated.

Heavy over-snow swings: No organisms isolated.

* Includes the coliform group, the Salmonella group, and the group of dysentery bacilli.

through the Arctic winter or to unauthorized use of the area during 1959.

At Camp Century water is pumped to the surface of the Ice Cap from deep pits formed by the injection of steam under pressure. The resulting meltwater is used as a primary water source. Although no coliforms were found in these meltwater samples, non-coliforms (approximately 14 organisms/100 ml. sample) were isolated. Based on these findings chlorination at a level of 2 p.p.m. was instituted to produce potable water of good quality. The exact source of the contamination was not determined, but it appeared to be airborne since the top of the pit was open. As in other cases the possibility of cross-contamination due to lateral spread of organisms along a rather impervious layer of ice (ice lens) from a nearby sewage disposal pit could not be ruled out.

At Camp Fistclench water is obtained

by melting surface snow. No evidence of coliform contamination was recorded.

During the over-snow swings, water is obtained by melting surface snow collected along one side of the trail as specified in USA PR and DC regulations. Wastes are dumped on the opposite side of the trail. Although there was some evidence of disregard for the trail regulations, no evidence of coliform contamination was obtained in any meltwater samples.

Soil samples. Soil samples were collected at levels approximately 4 inches below the surface in the vicinity of latrines, mess halls, the laundry, and bath houses at Camp Tuto. Serial dilutions of the soil samples were made in sterile saline and examined for coliforms by the millipore filter technique. The results are summarized in Table 2. Because of the use of rather primitive bucket-type latrines that require the transfer of faecal material from one

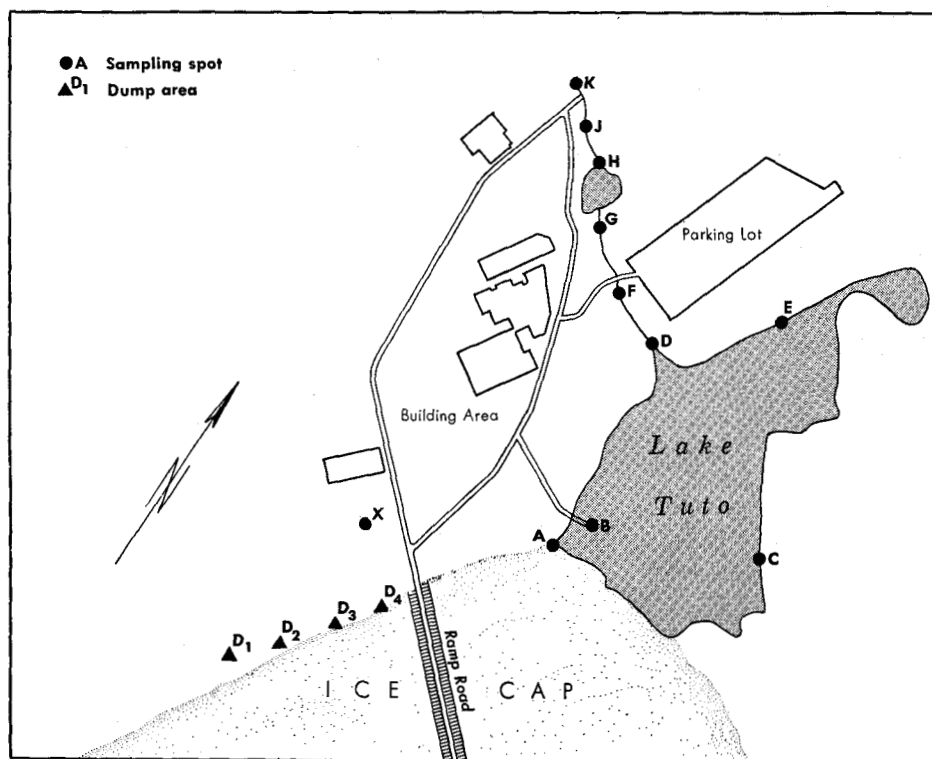


Fig. 1. Map of the Camp Tuto area in Greenland, showing points where microbiological samples were collected in 1959.

Table 2. Enteric bacteria in soil at Camp Tuto*.

Sites	Average number of bacteria per 100 cc. of suspended soil		
	May	July	August
Dump 1**	no coliforms isolated from	1	14
Dump 2†	10 to 70 feet behind dumps	117	14
Dump 3††	analysis on snow	52	12
Latrine 1, Officers		1	1
Latrine 2, VIP		2	1
Latrine 3, EM	0 (frozen snow)	9	2
Latrine 4, EM		2	1
Shower		1	4
Mess hall		0	0

* Includes the coliform group, the Salmonella group, and the group of dysentery bacilli.

** Current site of trash disposal.

† Current site of faeces disposal.

†† Approximately 20 feet from Ice Cap, in line with active dump area.

container to another during collection, the isolation of coliforms in these areas is understandable.

The isolation of coliform organisms from soil samples taken near the active refuse dump (Fig. 1, D₃) indicated that

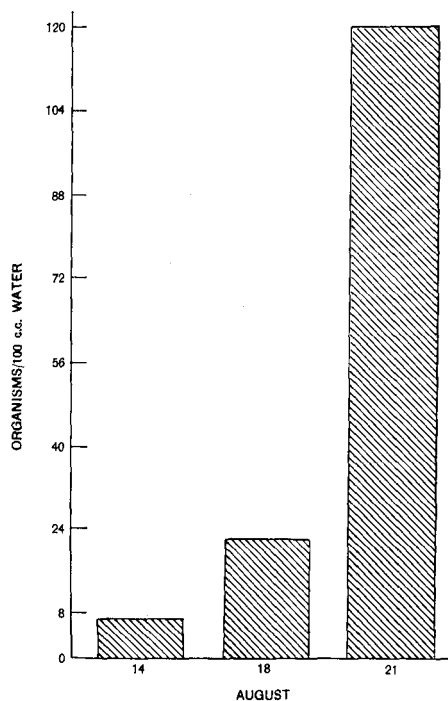


Fig. 2. Increases in the number of non-coliforms recovered from raw water samples taken at the water pumping station (Fig. 1, B) at Camp Tuto during August 1959.

the incineration methods were not adequate. These findings also emphasize again the need for an inexpensive and efficient disposal technique.

Since both Camp Century and Camp Fistclench are located on the Ice Cap no soil samples were available for examination. Cultures of surface snow, as mentioned previously, yielded no evidence of coliform contamination. The possible bacterial contamination of subsurface snow and ice due to the lateral spread along ice lenses from the disposal pits is a problem of primary importance in the design and location of future installations on the Ice Cap. A specimen of sludge from the sewage disposal pit at Camp Fistclench was collected by lowering a sterile bottle into the pit by rope. When plated out in the routine manner on selective media and incubated for 24 hours at

37° C. only normal faecal flora was observed. When duplicate plates were incubated at 5° C. for several days an unusual cigar-shaped, gram-positive bacillus was isolated.

Wound healing. Barquist and Moore¹ observed that lacerations were attended by a high incidence of infection in Greenland. Such infections usually appeared late and were accompanied by minimal signs of inflammation. Poor hygiene practices as well as the possibility of an altered bacterial flora due to environmental factors were suggested as causes of the increased infection rates and the accompanying delays in healing.

In an effort to collect additional information concerning wound healing, this important item was included in the 1959 study. A total of 43 accidental wounds and lacerations was studied at Camp Tuto. Cultures were taken at the time the wound was first treated at the dispensary and again, where indicated, following debridement and cleansing. Wounds that became infected were cultured on a continuing basis. During the study a total of seven wounds became infected. These occurred mostly among the enlisted men engaged in construction activities. From all infected wounds only gram-positive cocci were isolated. The strains were non-pigmented, coagulase-negative, and untypable by bacteriophage techniques. They were sensitive to a wide range of antibiotics, including penicillin, dihydrostreptomycin, the tetracyclines, bacitracin, chloramphenicol, and neomycin. With a single exception, all strains were also sensitive to polymyxin B.

Wounds that did not become infected healed within a period of time considered normal by the senior medical officer.

Flies. Beginning late in May, numerous flies were observed during the warm days in and around Camp Tuto. These flies were trapped at various localities and taken to the laboratory for examination. They were first permitted to walk across the surfaces of plates containing EMB, blood, S-110, Sabouraud-dextrose, and trypticase soy agar. The flies were then crushed in sterile saline.

Serial 10-fold dilutions were prepared and plated on the media described above. After incubation at 37° C. for 24 hours, duplicate plates of each dilution were counted and examined. Although the total counts varied widely all flies were shown to be carrying or harbouring coliform organisms.

Discussion

Since the use of molecular membrane filter techniques in the examination of water has been shown, in some cases, to produce counts slightly below those obtained by the MPN method², this factor should be considered in the evaluation of these surveys. With the exception of the increase in the number of non-coliforms during August (Fig. 2) at the primary water point (Fig. 1, B) at Lake Tuto, nothing unusual was found in connection with the water at Camp Tuto. After chlorination, studies showed the finished water to be satisfactory and safe. No evidence was obtained that suggested cross-contamination between the meltwater streams and Lake Tuto. Water supplies at the other USA PR and DC installations, with chlorination, were considered potable.

The isolation of coliform organisms from soil samples taken in the dump areas near Camp Tuto and from water samples collected from nearby meltwater streams serve to emphasize the difficulties of human waste disposal in the Arctic. The presence of coliforms in samples taken from a dump site abandoned in 1958 suggests that faecal organisms may be able to survive the Arctic winter in sufficient numbers to present problems during the summer. Similar conditions were observed and reported in Barrow, Alaska, by Cullison and Davis³. It is possible that sufficient pathogenic organisms to reinfect the population can survive from one summer to the next.

With the construction of additional installations on the Ice Cap, which will use snow pits for sources of water and for waste disposal, the problem of cross-contamination due to lateral spread may become serious. A detailed study of this

problem is in progress.

Delayed wound healing was investigated in seven cases that became infected. No unusual bacteria were isolated from the wounds by accepted techniques. The difficulties and inconveniences in maintaining good personal hygiene were considered sufficient reasons to explain the infections. No delays in the healing of uninfected wounds among the native Eskimo population have been observed by the Danish Chief Medical Officer for Northwestern Greenland⁴.

The problem of fly-control during the short summer season is common to both military and civilian installations along the coast of Greenland. Givskud⁴ believes that fly-borne contamination is responsible for most of the diarrhoeal disease among the Eskimos during the summer season. It is also possible that such contamination is responsible for some of the gastroenteric diseases reported among personnel stationed at Camp Tuto. Improved disposal methods for sewage and garbage together with an intensive insect control program will minimize this seasonal occurrence.

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⁴Givskud, I. 1959, 1960. Personal communications. Chief Danish Medical Officer, Kanak, Greenland.