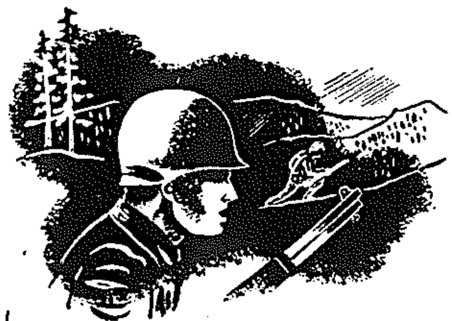

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military rations

COLD WEATHER FEEDING—A REVIEW

By Howard D. Lightbody

Over the years men have gained some insight into how to survive in areas of extreme cold by evaluating the devices used by those who of their own free will have chosen to live in such areas—as, for example, the Eskimos. There exist also numerous case histories of explorers who have contrived to exist for brief or even for extended periods in sub-zero climates. But out of all this lore on life as lived in the frigid or semi-frigid regions of the earth it is not yet possible to completely separate fact from fancy. It is generally admitted that the explorers have not only been trained observers but have also been unusually articulate reporters of their experiences. Their observations, however, being limited to small groups seasoned in arctic or antarctic living, cannot always be expanded into laws applicable to the maintenance of a military force not many of whom are inured to extreme cold weather. Dr. Lightbody seeks in the ensuing article to give some of the technical problems involved in existing in extreme cold a military frame of reference. In this connection he weighs certain nutritional factors in cold weather stress that must be taken into account in designing rations for military operations in areas where extreme low temperatures prevail.

Sensitive to defense needs in the Arctic, much attention has been given by the Armed Forces in recent years to modes of coping with this harsh environment. Transport vehicles, clothing, shelter, weapons have occupied a good share of this attention but feeding under extreme low temperatures has also had study both in the laboratory and in the field. The aim has been to establish a pattern for cold weather rations. The environment, the man — both his psychology and his physiology, the stability and utility properties of ration items and components, are obviously the major considerations.

THE ENVIRONMENT

For present purposes, "cold weather" will be taken as meaning temperatures usually associated with the weather of the Frigid Zone winters. It is assumed that men will be stationed in such areas in relatively small groups and for many weeks or months, and that they will be afforded protection from the elements and supplied adequate fuel and food preparation equipment, except for those times when absent from the stations on special missions. Thus, at least two types of feeding situations exist. One of these, which might be termed a static situation, is not unlike that for which the

B-ration is customarily used and where resupply is expected. The other, the trail situation, requires specially selected and packaged items to be carried on the person, along with small stoves and a small quantity of fuel. Resupply while on the trail is not to be expected. This review was prepared with the latter ration types in mind. These have come to be termed in military nomenclature as "Combat" and "Trail Frigid." Most basic principles of cold weather feeding, involving quantity distribution of food components and caloric intake, apply to both the static and the trail situation. Trail and combat feeding serve to magnify the problem because of the rigorous exercise required, and the severe limitations in weight, in space, and in the possibilities of preparing food in the field for consumption.

Obviously, major problems in small detached group feeding are those of training and disciplining the men in food care and preparation for eating, in the use of the limited equipment available, and the advantages that may be realized by using the environment in manners that afford maximum protection. (See Tables I and II).

Specially designed clothing and rations plus exercise stave off effects of cold.

clothing and exercise in relation to cold weather feeding

There are a number of considerations other than food that can influence the design of cold weather rations. Clothing, for example, has an effect in accordance with the kind of activity the soldier is engaged in. The body of an adequately clothed individual stationed in the Arctic is usually — except for exposed body surface areas — in an essentially tropical environment. Under static conditions where his activities are limited, the effect of cold on his feeding requirements is not significant. But extremely low temperatures and high wind velocity may change this. To attain protection from cold under these circumstances it is often felt necessary to carry so much weight in the form of clothing that movement becomes difficult, energy needs rise sharply, and sweating—with serious losses in body water and some minerals—becomes a physiological consideration of some magnitude. However, clothing — even the best assemblage that can be put on men exposed to 14° F. and below —will not solve the problem. Immobility and consequent failure to maintain the tropical body environment will result in cold injury. If the exposure is prolonged—as may occur when a man is pinned down under enemy fire—the injury can seriously affect the chances of attaining the mission objective. The relationship of temperature and exercise is one that requires serious consideration in cold weather feeding because serious health hazards are involved. When air temperature drops to the neighborhood of minus 50° F. or minus 60° F., even mild exercise under prolonged exposure to such temperatures may cause lung bleeding.

In consideration of the fact that clothing and exercise are limited in

Table I. Problems in Arctic Living with Special Attention to Subsistence

Ration Composition	*Water Supply*	*Kitchen Operation*	*Mess Facilities*	*Waste Disposal*	*Transportation and Storage*	*Packaging*
1. Attainment of maximum nutrition in relation to energy expended.	1. Securing an adequate supply of water from frozen sources.	1. Difficulty of starting fire in extreme cold.	1. Difficulty in maintaining warmth in mess tents or halls.	1. Necessity for burning waste in winter (since it cannot be buried) and consequent drain on limited fuel resources.	1. Severe limitations on transport space permitting shipment of only critical items.	1. Extremes of temperature, dampness, contamination by insect, molds, engine fumes, etc.
2. Supply of food in sufficient quantity to provide 3 big meals per day plus between-meal snacks.	*a.* Through thick ice.[4]	2. Scarcity of natural fuel.	2. Difficulty in maintaining heat in food after initial serving.[6]	2. Excessive labor involved in burying waste in summer to avoid health hazard.	2. Awkward dimensions of some transport media such as dog sleds, "weasels," etc., creating loading difficulties.	2. High velocity winds, sleet, and dust storms.
3. Attainment of high acceptability to preclude waste disposal problems — particularly in forward areas.	*b.* From snow by melting methods.	3. Dangers involved in using combustible fuel such as gasoline and oil.			3. Inadequate facilities at unloading point.	3. Breakage and other impairment due to freezing.[7]
4. Provision for trail use of food bars edible even when frozen.[1]	2. Maintaining water supply under extreme low temperatures:[2]	4. Difficulty of cleaning kitchen equipment in limited space.			4. Stockpiling — usually under open storage conditions.	4. Difficulty of handling under extreme low temperatures.[8]
	a. in canteens;	5. Hazards to mess personnel entailed in going from warm kitchen to extreme outdoor cold.				5. Increased susceptibility to severe impact.
	b. in storage at base camp;[3]	6. Complications, involved in planning menus and ordering supplies for 6-month period due to transportation difficulties.				6. Difficulty of heating can contents on the trail.[9]
	c. in transport media plying from source to camp.					

[1] Dehydrated food meat bar has been developed to meet this need.
[2] Insulated container that would keep water unfrozen for 8 hours is suggested.
[3] Fires are maintained beneath the water storage tank. However, development of a non-freezing type spigot appears to be called for.
[4] Perhaps a small oil-rig type drilling unit would be the answer.
[5] A portable snow-and-ice-melter would be especially advantageous to the soldier on a long patrol.
[6] In the cafeteria-type mess employed, a plastic tray is preferable to the metal tray as it permits food to stay hot longer.
[7] Glass is dangerous for container use under extreme cold conditions, and even flexible packaging must be chosen with care to guard against brittleness.
[8] A can opener which cuts the can into two halves should be developed.
[9] Study should be made to develop some type of self-heating can. This is regarded as most essential — particularly for use on patrols.

Table II. Subsistence and Related Problems with Regard to Typical Arctic Tactical Situations

Rear Area Base Camp	*Combat Center*	*Combat Group Camp*	*Combat Patrol*
1. Difficulty of supplying heat to extensive living quarters, dining halls, and certain of the storage buildings. 2. Danger of attack by air due to importance of this type of installation to the entire arctic combat effort.	1. Difficulty of obtaining sufficient quantities of fuel oil to heat large number of temporary shelters scattered over a wide area to minimize bombing hazard. 2. Difficulties involved in obtaining, transporting, and storing water (in sub-zero temperatures) for use by a large number of troops. 3. Problems of waste disposal — particularly in winter when earth is frozen to considerable depth.	1. Difficulties in heating tents used for eating, sleeping and operations due to extreme shortage of natural fuels and inflammable fuels brought in from rear area. 2. Acute problem of obtaining water in frozen wastes and of maintaining it in an unfrozen state in storage due to short fuel supply. 3. Acute problem of waste disposal (burning out of question due to need to conserve fuel and because of proximity to enemy). 4. Likelihood of boredom resulting from steady diet of canned rations.	1. Problem of providing some type of sustenance and reliable method of heating it despite extreme cold when soldier must remain out on patrol beyond normal 8-hour period. Equipment must be usable despite necessary heavy protection on hands. 2. Problem of providing container for water that will preserve it in liquid state, or else providing means whereby soldier can procure water from ice and snow when needed.

the contributions they make toward protection against extreme cold, it is necessary to survey the potentialities of food in the maintenance of bodily heat. Within the low temperature limits (minus 60° F. to plus 14° F.) more research data than now available are needed before we can determine the attributes optimum in subsistence for men performing tasks requiring physical effort.

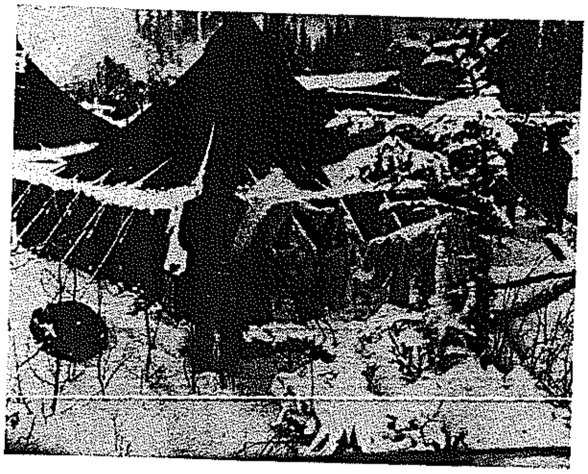
THE MAN—HIS PSYCHOLOGY AND PHYSIOLOGY

The mental response of the individual to his environment is, of course, a matter of great concern in military operations. Under low temperature conditions, where the struggle for survival against the elements may be as determining as the struggle against a military foe, the morale factor comes under particular scrutiny. Adverse mental response to his environment may not only determine the individual's attitude toward food and result in consumption of amounts inadequate to meet the energy demands, but it may also influence the body mechanisms and inhibit the release of energy from the consumed food. It is at this point that psychology and physiology merge. Untangling the degree to which the former, psychology, affects the physiological mechanisms of the body is a problem that will yield but slowly to research. Let us examine further, on the basis of field experience, this morale problem as it relates to food.

In a report on an abrupt acclimatization test wherein troops were transported by air from Tampa, Florida, to Camp Shilo, Canada, in late January and early February—the heart of the North Canadian winter — the observation is made that all troops displayed on arrival very low morale; they also showed the biochemical symptoms of stress. For purpose of study, the group was divided into four parts. One of these was fed a diet very low in calories. The second and third groups were fed experimental rations less deficient in calories (1650 and 1940). The fourth was given food in amounts permitting consumption of 5900 calories per man per day (actual average daily intake, 4470 calories). Those who received the low calorie rations showed visible morale improvement on the second day, but did not appear to display additional improvement during the following six days of the experiment and showed subsequent rapid deterioration. A noteworthy observation was that at the end of the 12-day exposure the three groups given food inadequate in calories had suffered sharp drops in morale. It was necessary, in fact, to withdraw some of the subjects from the experiment before its completion. The high calorie control group maintained its morale near normal, except for the first 24 hours, and except for a perceptible lowering during the final three days. It is obvious that the amount of food consumed has an important influence on morale during the period of acclimatization to cold.

The significance of leadership on troop morale is nicely portrayed in the results of an arctic trail experiment at Ladd Field, conducted jointly by the Medical Nutrition Laboratory, by the Military Planning Division, and by the QM Food and Container Institute of the Research and Development Branch, OQMG (February - March 1950). Two groups of men were subsisted on an identical ration under identical environmental conditions and at the same time. One group was led by the "follow me" type of officer, the other by the "driver" type who did not share in the physical tasks of his team. The two officers displayed marked personality differences. These were reflected in the results of the experiment which showed differences in the quantities of food eaten by the groups. Biochemical stress criteria of body fluids further verified the effect of these personality differences in the leadership. The experiment was repeated after changes in leadership. The same dissimilarities were found to be associated with the leaders and it can safely be assumed that personality differences in leadership were again the cause. The authors remarked that it is possible that the "driver" worked his men harder than did the "leader." The observers commented that, "Whether he accomplished more is a matter of conjecture."

Morale, of course, is a subjective as well as an objective matter. Although published records of polar expeditions and military studies do not indicate that much special attention has been given to the pre-selection of personnel based on psychological, physiological, and biochemical measurements, it is probable that polar expedition leaders using very general criteria accumulated from their own experiences have practiced selection of men whose inherent morale—that is, their capacity for maintaining morale from inner resources—was high and *per se* contributed to the maintenance of morale in the group. It is doubtless for this reason that Wilkins recommends using only men in the "normal" intelligence range. He rejects the subnormal on the basis of lack



In rear area camps such as this, heating, water supply, and waste disposal are among the ever-present problems.

of ability to learn how best to use the equipment supplied for cold weather operations. This equipment is necessarily limited which means that it is essential to use it to the utmost advantage. He rejects the supernormal because, ". . . they believe they must do a greater amount of work, and they are forced to work until they are exhausted, and the breakdown of the supernormal person has much more material effect on the average and lower-than-average than the breakdown of the normal person."

Recently, efforts have been made to determine the feasibility of selecting the best type of personnel by personality tests measuring psychic tendencies. By correlating the results of the tests with observed maintenance of morale and, in turn, with food intake records it has been shown that even the very meager studies to date indicate positive correlations.

nutrition and stress

Latent, and, under ordinary circumstances, unimportant nutritional deviations may be the sources of serious functional derangements that appear when the subjects are obliged to operate under adverse environmental conditions. To uncover these latent weaknesses is very difficult, and success, even when the weakness is clinically identified, is not always readily correlated with objective measurements due to lack of sensitivity of the methods. New and rapidly accumulating evidence indicates that all forms of stress may be reflected by biochemical changes attributed to activity of endocrine systems. This evidence may prove to be very useful in following the changes in metabolic state and in estimating the potentialities of the individual. Such information would enable us to know what to look for in the screening process.

Keeping the foregoing factors in mind, the inherent morale of the individual and his susceptibility to stress, we can examine the more strictly physiological and nutritional considerations. There are at least three questions that immediately become obvious: namely, (1) Does exposure to cold weather, of itself, and through mental or physical stress result in special requirements which are reflected in changes in the quantities and kinds of food demanded? (2) Can the human body adapt itself by changes in eating habits and readjust its metabolism in accord with such changes? and (3) How far can clothing, tentage, field practices, and discipline be relied upon to minimize or obviate these changes, especially when insufficient time may be available to permit readjustments? The available evidence indicates clearly that affirmative answers can be given to the first two questions. There are increased energy requirements for nutrition in cold climates and the body can adapt itself to changes in eating habits. An answer (or answers) to the third—the extent to which equipment can offset stress—is outside the scope of this presentation. Data have been and are being collected by other research groups of the Quartermaster Corps pertinent to this question.

the role of calories in adjustment

Attention has been directed by nutritionists and others dealing with the interrelation between the psychology and physiology of stress to the evidence that a high caloric intake will do much to aid in building a defense against stressful conditions. There are actually two problems here; namely, (1) attaining increases in caloric value of the rations with retention of acceptance, and (2) distributing calories among the three major food components, i.e., fat, carbohydrates, and proteins, in order to assure the maintenance of the best nutritional stage for operational efficiency and survival.

As to the first problem—a study of the ambient temperature effect on food consumption made in 1947 showed a striking correlation between average voluntary intake and the mean environmental temperature to which the men were exposed. The range in caloric intake was from 3100 calories daily in the desert (mean temperature 92° F.) to 4900 calories daily in the Arctic (minus 30° F.). Factors such as the hobbling effect of the clothing and consequent increase in physical effort appear to play a determining part in the increased energy requirements.

A similar study designed to explore free food choice was also reported in 1947. The amount of food consumed voluntarily by troops of the United States and Canada stationed in widely different climatic regions showed that regardless of the environment the proportion of food calories derived from proteins, fats, and carbohydrates was much the same. The subjects were from groups of men receiving ample rations of wide variety and of such quantity that selections of items characterized by contents high in fat, proteins, or carbohydrates were possible. The point to be made here is that there is no mechanism, apparently, that leads an individual to select a protein, a fat, or a carbohydrate diet in accordance with climate. It may still be possible that special taste requirements are engendered by the increased caloric demands and validation of presently available acceptance data under arctic operations may provide useful guidance. If space and weight limitations require a diet high in energy value, a diet high in fats for example, men can as was pointed out earlier adjust their metabolism when forced to subsist on foods high in fats. A ration for frigid trail use is a case in point. There is no possibility of "free choice" in the design of such a ration. High caloric density must be obtained through the carbohydrates and fat constituents.

Much has been learned about the physiological adjustment to foods by observing the Eskimos. These people have little choice as to foods; they are obliged to subsist largely, at times exclusively, on foods of animal origin, usually quite high in fat content, very deficient in carbohydrates, and higher in protein than appears to be desirable, as measured by eating customs of people living in temperate zones. As indicated by objective criteria, their metabolism has adjusted to the situation. Although this metabolism differs in several respects from that of people residing in temperate zones, it would be unwarranted to say that there is an "abnormal" diet. Both the Eskimos and temperate zone people have probably made physiological adjustments to the foods available to them. The Eskimos have had many generations in which to make the more specialized metabolic adaptation.

Physiological and food habit adaptations can be effected in a much shorter time than "generations," however, as the experiences of polar explorers will attest. Stefansson states, "We find, on an exclusively carnivorous diet, that if you derive less than 60 per cent of your calories from fat you begin to have a feeling of dissatisfaction; when you derive only 20 per cent to 30 per cent of the calories from fat you are constantly uncomfortable." No doubt Stefansson had plenty of time to make the required adjustments. Physiological adjustment may be significant in arctic trail feeding where the time of subsisting on the ration is a matter of a few days. Space and weight considerations point to high caloric density but if the body is unable to release the energy, because of insufficient time to adapt, the nutritional objective is not attained by use of such rations.

Some types of change in eating habits do not appear to require a difficult, or at least prolonged, readjustment to the metabolic systems. Experimental results have established the fact that at least part of the fat eaten ordinarily goes indirectly to deposits beneath the skin. Because of the heat insulating action of this subcutaneous layer it is desirable to include sufficient fat in cold weather rations to maintain it at optimum thickness. Frequent eating, say at intervals of two hours, appears to assist in building and maintaining this layer.

Low-temperature areas are likely to be well supplied with water. However, since it is present in the solid state it becomes available only after melting which requires the already overburdened men to carry stoves and fuel.

Added flavors may be used to improve palatability provided the water is wholesome. It seems desirable to supply foods that will require but small quantities of water in preparation for serving, will yield the most water as an end product of body use, and at the same time minimize the requirements for water as a solvent for excretory products, and will not provoke thirst. Fats and carbohydrates are the best food sources of water, while excess protein or protein of low biological value increase the demands for excretory water as does also fat consumption in quantities in excess of the ability to completely metabolize. There is very little available information regarding thirst-provoking properties of food items and seasonings. Fibrous food items are to be avoided as ration items because of waste of space, useless weight, and because they are conducive to unnecessary body exposure.

a brief recapitulation

Up to this point we have been discussing the presumed characteristics required in the design of cold weather rations; namely, the factors to be considered in setting up the component and assembly requirements which guide the ration development.

Perhaps a brief recapitulation of operational and environmental relationships is in order. It is assumed that (1) special cold weather feeding problems are associated with special troop missions; (2) limited resupply is possible but not to be depended upon; (3) servicemen, unlike the Eskimos or arctic explorers, will be rarely obliged to subsist solely on food of animal origin; (4) psychological stress is common and that the stress requires adaptation, which can be made in a relatively short time, provided the food is adequate, though attention to selection of personnel seems advisable; (5) the daily caloric requirement is in the neighborhood of 4700 to 5000 calories; (6) available space is at a minimum and the weight must be rigorously limited, thus favoring a high caloric density; (7) caloric densities are perhaps limited by physiological and food habit considerations.

ADJUSTING RATIONS TO COLD WEATHER REQUIREMENTS

If minimum weight, maximum energy, and best body water economy were the only questions, the design of rations for cold weather feeding would be relatively simple. One answer would be to design a ration containing almost 100 per cent fats. However, taste acceptance alone would preclude this solution. As has been said, proteins of high biological value at the usual level of intake are of course highly desirable to assure maximum utilization, the best water economy, afford greater protection against disease, and accelerate recovery.

Unless we are dealing with men who, like the Eskimos, are adjusted metabolically to subsist on a meat

On long patrols, soldiers must be provided with sustenance and an adequate source of heat.

diet, attention must be given to the incorporation of an adequate amount of carbohydrates — an adequate amount being that which will permit complete energy utilization of the fats and prevent an increase of water requirements for the excretion of unused fat fragments. This amount has been experimentally set at approximately 100 grams per day.

Very little can be said regarding special vitamin requirements. This is in part due to insufficient study. At present it seems reasonable to say that there is little evidence that vitamins exert specific influence on cold weather adaptations and that intakes, estimated by temperate zone requirements, are essential on the practical basis that a sick man is a poor risk. While it appears that the vitamins already investigated fail to indicate specific relation to protection against cold weather stress, deficiencies lead to reduced food intakes, decreases in available energy and lowered resistance.

caloric considerations

The choice of items to be assembled into a cold weather ration is severely limited. The protein requirement may serve as a starting point. Since cold weather adds nothing to the requirement, the National Research Council's recommendation may be applied, i.e., 70 grams of protein per man per day. Considerations of biological value lead to protein of animal origin as first choice. Topping these would be the proteins of milk and eggs, but the exclusive use of the bland milk or egg proteins does not appear to be feasible because the proteins must be depended upon to contribute to palatability. Fortunately, meat products contain considerable quantities of fat intimately mixed with the high value proteins, the result being to obscure the detrimental taste effects of the fat. Meat, then, is the most likely major protein source. To meat it is possible to incorporate added fat, properly selected for physical and chemical stability, up to 40-45 per cent of the total calories and retain, if not high palatability, reasonable taste acceptance. Using meat and added fat it is possible to (1) avoid fat separation, (2) impart reasonable stability, and (3) assure fair taste acceptance.

Turning now to the carbohydrate components, we have already noted a minimum physiological requirement of about 100 grams of carbohydrate daily. This quantity is insufficient of course to meet normal acceptance requirements. The problem is to provide sufficient protein to meet the palatability requirement and to furnish as much fat as possible without adversely affecting this requirement. The remainder of the formula consists of carbohydrates. We find that in practice 45-50 per cent of the weight of the ration will be carbohydrate, thus accounting for about 40-45 per cent of the total calories. Part may be supplied by sugar and candies. However, acceptance places a ceiling on free sugar. This appears to be in the neighborhood of 125 grams — more than enough to meet physiological requirements. We still need nearly 1500 calories. This can well be supplied by cereal products, a dried fruit (raisins), and a precooked dehydrated soup. The cereal preparations in the form of cookie sandwiches, biscuit, and premixed breakfast cereals, and also the soup, afford the opportunity to mix in some well-camouflaged fats and high biological value proteins from milk and eggs. The items may also carry with them some less desirable proteins, but this is a necessary compromise.

With the exception of vitamins A and C, these same items also provide for very liberal daily allotments of minerals and vitamins. The nature of components required to attain high caloric density imposes a special problem in assuring adequacy of vitamins A and C from naturally occurring and readily available food components. Enrichment becomes almost mandatory. This is readily accomplished with vitamin C by adding it to the dry beverage preparations—cocoa, soluble coffee, and soluble tea. By this means, satisfactory storage life of the vitamin is secured. There remains the uncertainty that the beverages will be accepted by all individuals, but by overdosing and by scattering the nutrients through three beverages reasonable assurance of adequacy is attained.

To supply vitamin A (or its precursors) is a special problem. The vitamin in naturally occurring carriers lacks storage stability. The carriers possess poor flavor acceptance and may be quite fibrous. Enrichment, by adding concentrates or the synthetic vitamin, is not yet feasible because of deterioration resulting in reduction in potency and development of off-flavors. The problem is not solved, though the future appears promising. Fortunately, the vitamin is normally stored in the body in sufficient quantities to permit lapses of several days on an inadequate ration without endangering the nutritional state. This state of affairs makes it very necessary that feeding at points of resupply provide adequate vitamin A to permit body storage.

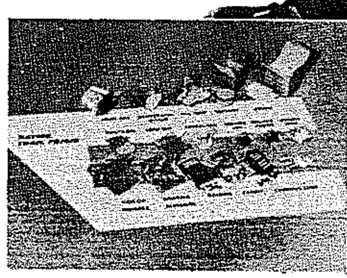
packaging

Packaging is an integral part of cold weather feeding and is closely related to stability and utility. It is perhaps more critical than with any other type of feeding, except possibly in certain survival situations. In addition to the usual packaged ration, requirements of space economy, protection from air and moisture, and ease of issue, there are imposed unusual space and weight requirements and possible restriction in use of the hands. The shape of packages for individual items becomes important, since it is necessary that the ration container be broken down and the items be distributed about the clothing. Flexible packaging is a promising answer. Vinyl and polyethylene films on aluminum foil and kraft paper or on cloth are presently used. The materials permit satisfactory sealing, are reasonably rugged, and can be opened by use of standard equipment without ungloving the hands.

conclusions

In summary, we believe we can state with considerable confidence that the desired nutritional characteristics of rations for cold weather feeding, as we presently know the characteristics, can be and are reasonably well met. The same can be said for the stability and utility characteristics. It is true that stability at a range of minus 80° F. to plus 160° F. for two years has not been attained, but progress may be expected as new information becomes available. It is not likely, however, to be rapid progress.

There are two parts of the overall picture that appear urgently to need further research and firming up. One of these is the psychology and physiology of the men in relation to food requirements. The other is the problem of taste acceptance



Alone and wounded in the frozen wastes, this trooper derives a mental lift as well as necessary physical strength from his excellent Ration, Individual, Trail, Frigid.

which will insure consumption at intake levels that will meet the requirements. Solution of the latter problem depends on more knowledge of human behavior under the special environmental conditions involved than is now available.

It is likely that food items more nearly in accord with national food habits can be developed for cold weather feeding with the restrictions placed by space, weight, utility, and caloric density. The extent to which we can go in providing the high acceptability that the serviceman might desire is obviously limited. We cannot promise multicourse dinners on the trail. But any progress in the development of greater acceptability in these foods that will assure adequate food intake will be taken advantage of.

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DOCUMENTATION

In developing the material for the preceding article, the following reports covering research on various phases of cold weather feeding were consulted. Sources of information on special points are as follows: the "Quartermaster Critique on Arctic and Sub-Arctic Testing, Winter 1946-47, Vol. I," which contains valuable data developed by Hoyt Lemons on the dangerous effects of immobility in extreme cold and by Sir Hubert Wilkins on selection of personnel for polar expeditions. The matters of effects of exercise in the Arctic, ambient temperature effect on food consumption, and adjustment to the available food are covered by H. H. Mitchell and Marjorie Edman in the QMFCI publication "Nutrition and Resistance to Climatic Stress with Particular Reference to Man."

Data on free choice of foods are also reported by Robert E. Johnson and Robert M. Kark in their Harvard Fatigue Laboratory study, "Environment and Food Intake in Man" (*Science*, Vol. 105, No. 2728, 1947). This material is also contained in a QMFCI publication by the same authors, entitled "Feeding Problems in Man as Related to Environment." The effects of cold climate on morale and of morale on food intake are set forth in two studies published by the Medical Nutrition Laboratory — "Final Report, Survival in the Cold," and "Report of Arctic Winter Trials, 1950." Another study of value on the highly important subject of nutritional deviations as a result of cold environment is the report on "Arctic Field Trial USAF Survival Rations, Blair Lake, Alaska, 1950," published by the Aero Medical Laboratory. Finally, some excellent basic information on the subsistence adjustments of Eskimos is to be found in a foreign report — "Studies on the Nutrition Physio-Pathology of Eskimos" by Arne Hoygaard.