AIR CORPS
UNITED STATES ARMY

ARCTIC MANUAL

VOLUME II

National Oceanic and Atmospheric Administration

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VOLUME II .

Prepared under direction of the
Chief of the Air Corps

UNITED STATES ARMY

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This Arctic Manual is prepared under direction of the Chief of the Air Corps, and is published for the information and guidance of all concerned. It is not to be confused with the Field Manual series published by the War Department.

BY ORDER OF THE CHIEF OF THE AIR CORPS:

G. E. STRATEMEYER,
Colonel, Air Corps Executive.

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CHAPTER 10

HEALTH, ACCIDENT AND DISEASE

SECTION I

DIET

There are few regions of earth that produce as much meat in proportion to area as the northern polar districts, both land and water. There are few that produce so little of plants that are used for human food. Therefore the only diet locally procurable is 100 percent meat, or nearly that.

Our definition of a meat diet as one from which all matter directly from the vegetable kingdom is absent, would permit, in addition to meat and fish, the inclusion of milk and its products as well as eggs. But that is academic in the Arctic—you can hardly ever secure milk from animals that you hunt, and eggs can be secured only in spring and, even then, only in a few localities.

FAT ESSENTIAL IN MEAT DIET

We state here briefly what has been more fully developed in Section II, Chapter 8: If you are on a meat diet you must have fat with your lean, the fat taking the place of the butter, cream, vegetable oils, sugar, and starches that are present in ordinary mixed diets.

No hard-and-fast rule can be given for the proportions of lean and fat. The basic procedure is to eat by palate—at each meal eat along with your lean as much fat as tastes good to you. At first the fat will taste delicious. Presently, as you approach the point of satiation, it will seem less and less desirable, just as lovers of sweet cream have found that each succeeding spoonful is a little less delicious than the one before. One of the safety factors in getting your calories from animal fat is that you cannot overeat of it, as can so easily be the case with sugars and starches.

In the previously mentioned controlled experiment under the supervision of the Russell Sage Institute of Pathology, when Stefansson and Andersen lived on an exclusively meat diet for 1 year in New York City, it was found that they averaged about a pound and a third of lean per day and a half pound of fat—which is about like eating a 2-pound broiled sirloin with all the fat such a steak usually has on it.

Within the body of any single animal, land, sea, or air, is found a complete human diet, with the exception that skinny animals, such as rabbits and some birds, need supplementary fat. You could, so far as we know, live 3 score years and 10 on geese, for they have enough fat to counterbalance the lean. You could live equally long on rabbits if supplemented with bacon. On rabbit alone you would be ill in a few days.

It is probably true that if one man has nothing but water and another has rabbit and water, they are likely to die in about the same length of time, from 3 to 8 weeks. The one who has just water dies of outright starvation; the other from diarrhoea and kidney afflictions.

As said, any beast from the animal kingdom, fish, flesh or fowl, is satisfactory for a meat diet, if it contains sufficient fat or if you have a stock of supplementary fat to make up a possible deficiency. The kind of meat eaten will, therefore, depend largely on the part of the country in which you find yourself. Where caribou are abundant, their meat will be your chief food supply; at sea you will depend chiefly on seals, with an occasional polar bear; along the coast and in the vicinity of rivers you may for periods live mainly or entirely on fish. (For the manner of cooking, preserving, and handling meat and fish see Chapter 8.)

AVOID POLAR BEAR LIVER

There is perhaps a single part of one of the Arctic animals that should be avoided—the liver of the polar bear. Stefansson reports having eaten a dozen bear livers before suffering any ill effect; but he and several of his companions finally became violently ill from one liver. He has studied the evidence critically, both through literature and by interviewing large numbers of Eskimos, and concludes that once in 2 or 3 dozen cases polar bear livers contain something that makes you ill. The symptoms are excruciating headache and vomiting, lasting from a few hours to as much as 2 days.

Apparently all people everywhere in the world who live mainly or solely on meat dislike and avoid salt. It has been reported occasionally that Eskimos boil meat in salt water. This report must be the result of careless observation or, more likely, invented to fit a theory, unless, indeed, it was an observation on Eskimos who had adopted salt-using from whites, along with other European ways.

It was found on the Stefansson expeditions, by trial with more than 20 persons of European, African, and South Sea descent, that there is no racial difference in adaptability to an all-meat diet. Apart from the possibility of "sensitivity" in rare cases, the individual differences are psychological, depending on what the man believes and what his dietetic experiences have been. Generally speaking, the difficulty of breaking a man to a new diet is small if he is young and adaptable, but it may be considerable if he is older and set in his ways. Probably the difficulty with the older man is not physiological but rather psychological—older persons are likely to be more conservative.

Novices on the Stefansson expeditions were usually broken to meat when traveling over the sea ice and therefore living on seal. Speaking generally and roughly, they got along very well for the first day or two, eating square meals, for they were already as fond of that meat as the average American is of beef. On the second or third day the appetite would begin to fail, and in from 3 to 5 days, especially with those who believed or feared the diet was going to hurt them, appetite would almost or quite cease. Then there might be nausea at the name, sight, and thought of meat. Some would nibble a little every day. Others would go without food for 2 or 3 days, but then they, too, began to nibble. In 2 or 3 weeks from the last tasting of a vegetable element the whole party, of whatever size, was eating square meals, though in some cases under a good deal of protest.

In from 2 to 6 months on exclusively meat and water there is left only such hankering for vegetables and fruits as is parallel to the hankering you have in almost any foreign country for the diet of your home or of your native land.

It was found on these expeditions that when men who had never previously lived on meat were returning to the base camp they talked about what they would like to eat when they got there. It was standard practice to tell them that the steward would have orders to cook separately for each man all he wanted of anything he chose. The commonest things looked forward to were: bread and butter with coffee; mashed potatoes with gravy; hot cakes with syrup.

But there were some who hankered for corned beef, ham, bacon, or sausages. One of the men, who had been a sailor for a number of years, would frequently remark, both on the homeward journey and at other times, that he would give anything to be able to trade the fresh caribou or seal meat he was eating for "a good hunk of salt horse." No other dish was so frequently wished for aloud by anyone else as salt beef was by this man. That he was not expressing a longing for salt, as such, was brought out by questions; besides, wistfulness for corned beef was sometimes expressed when salt for seasoning native meat was available.

When you are new to the meat diet you are likely for several months to have a desire to vary the cooking. You want to fry, roast, and stew, as well as boil. You also desire a variety. You like to change from seal to caribou and from caribou to goose. These hankerings disappear some time during the first year, at latest during the second.

Most often the change in point of view takes place after men have returned from their first long exclusive meat journey. Getting back to the ship or other base camp each stuffs himself with what he has been hankering for, overeats, gets indigestion, and feels rotten. Thereupon he is ready to go back to the meat again, ceases to talk of variety in cooking or in kinds of meat, and will not do much anticipatory talking about food when returning to the base from a later journey.

GENERAL HEALTH ON A MEAT DIET

The broad conclusion to be drawn from study of reports on the lives and health of meat-eating peoples such as the Eskimos, northern travelers who have adopted an exclusive meat diet, and from the controlled experiment of Stefansson and Andersen, is that such a diet affords comfort, enjoyment, and all-around well-being. Another way of stating it is that apparently you can be healthy on meat without vegetables, on vegetables without meat, or on a mixed diet.

There are several beliefs concerning a meat diet that appear on scrutiny to be without foundation but are so common that they should be discussed. Among these are chief that meat is more wholesome for you (or that you like it better) in winter than in summer; that it is best for the Arctic, intermediate for the temperate zone, and worst for the tropics; that it is better for active than for sedentary life; and that it is deficient in needed food elements such as calcium and Vitamin C.

About the heaviest meat eaters of English speech that have been reported were the sheepmen of Australia, in a subtropical environment. Even today it is claimed for Australians that they eat a higher percentage of meat than any part of the British Empire; but during the early nineteenth century, the first 2 or 3 decades of British-Australian colonization, little was eaten except mutton, unless it were beef or game like kangaroo. Sir Hubert Wilkins, whose father was the first white child born in the state of Victoria, reports from information of his family not only what we have said about how they ate the fattest mutton dipped in grease, but also that they relish this food equally in summer and in winter. Carl Lumholtz has reported from the aborigines of tropical Australia that they never ate anything else during a meal if the meat did not run out.

The heaviest meat eaters of the New World are, or were until recently, the cattlemen of northwestern Argentina where summers are long and hot, with the standard food beef and maté.

In the United States few tables groan so with numerous meats on heaping platters as those of old-fashioned country inns, and of certain families, in States like Alabama, Georgia, and Mississippi.

In 1928–29 when Stefansson and Andersen lived for a year exclusively on meat and water in New York City, they found no disinclination to eat steaks and chops or boiled meats that would not have applied equally to other diets—they ate less in hot weather than in cold, as all people do on any diet; the decrease was proportionate to that on other diets. They simply did not need as many calories in summer as they did in winter.

The Stefansson-Andersen experiment was on men who were more sedentary than common in a city. Andersen does take walks for exercise occasionally. Stefansson never takes exercise, whatever his diet. He has reported that on one occasion in the Arctic, the winter of 1910–11, he spent 3 or 4 months that were the most sedentary of his whole life. During this time he seldom went out of doors, or on those occasions more than one or two hundred yards from the house. He did no manual work of any kind, devoting himself to linguistic study, which meant writing and listening all day long. During this period the diet was exclusively meat; his appetite remained normal, and his health excellent.

It appears true that views concerning a meat diet have changed rapidly since 1920. The beliefs discarded since then are, among others, the supposition that meat produces hardening of the arteries and high blood pressure, that it is hard on the kidneys and that it lacks certain dietetic elements, among them calcium and vitamin C. We discuss the vitamin C deficiency idea in section IV of this chapter under Scurvy, but need a separate paragraph here for the calcium.

MEAT DIET CONTAINS SUFFICIENT CALCIUM

It appeared to the chemists who were part of the scrutinizing staff of the Russell Sage Institute while that body was supervising the exclusive meat year of Stefansson and Andersen, that they were not eating enough calcium. No signs of calcium deficiency had appeared toward the end of the year and it was supposed that perhaps one year was not long enough for these evidences to show themselves. Accordingly the department of physical anthropology at Harvard was commissioned to study whether there was indication of calcium lack in the diet of exclusively meat eaters whose skeletons were available in museums. Under the supervision of Professor E. A. Hooton, extensive studies were made of the bones of wholly carnivorous people in the Peabody Museum of Harvard and elsewhere. Dr. Hooten reported no sign of deficiency; he reported, on the contrary, every sign that there had been an abundance of calcium in the food of these people.

That an all-meat diet gives people like the Eskimos sufficient calcium has been said to be due to their eating bones. This argument looks sound if you consider it only with relation to people who live on fish and on land animals; it appears to be without support when you consider those groups which live exclusively, or nearly so, on sea mammals.

When you eat fish, caribou, birds, rabbits, and the like, you will find upon trial that nothing tastes quite so good as the soft ends of bones. Indeed, all bones that are chewable taste good; so that an Eskimo would go farther than Shakespeare, saying not merely that the sweetest meat is nearest the bone but that the bone itself is even sweeter than the meat.

The eating of considerable amounts of bone would seem, then, to explain the calcium situation. The argument, as implied, disappears when you turn to the eaters of water mammals.

There are Eskimo groups who for most of the year, through entire generations, live exclusively on sea mammals—the whale, the walrus, the seal, and perhaps an occasional polar bear. None of these have ordinary marrow in their bones—the fat of their bodies accumulates mainly on the outside, between the skin and the musculature. You learn by observation that people who live on these animals do not chew bones, and you learn by trial why they do not—your attempt to eat the bones will show them hard to chew and, insofar as you can chew them, they do not taste particularly good.

The studies of Professor Hooton, to which we have referred, were in part on the bones of people who had lived on land animals and fish, in part on sea mammal eaters. Neither this investigator nor apparently anyone else has found evidence of a calcium lack in either group—one appears as well supplied as the other.

Nor does there seem to be trouble on the score of wanting bulk. Constipation is rare or absent among those exclusive meat eaters who chew large quantities of the bones of land animals, birds, and fish; but it appears to be just as rare among the meateaters who live on sea mammals. Equally in the case of the bone chewers and those who do not chew bones, constipation becomes troublesome upon the introduction of "civilized" diets—where the first elements introduced in quantity are usually flour, hardbread, rice, beans, dried and canned fruits, canned and desiccated vegetables. For instance, in Coronation Gulf, where among several hundred people no constipation was observed by Stefansson during 1910–11 and little or none by Jenness during 1914–16, constipation is now so developed that one of the chief groups of trade articles with the Hudson's Bay Company and other traders are cathartics and laxatives, ranging from the mildest to castor and croton oils.

In short, it would appear that a diet consisting exclusively of meat is a complete diet even when bones are not chewed—that it contains all the stuffs necessary for health, including calcium and all the vitamins.

SECTION II

EXERCISE

No specific rules for exercise need be given, except those implied in the directions for various aspects of Arctic life. When you are clad in comfortable Eskimo-type clothing, with its nearly perfect insulation from cold and wind, the bracing Arctic winter air will make you enjoy activity of any kind. The best rule, then, for rest periods or other times when duties do not require activity, is to take as much exercise or as little as you feel like.

However, we repeat a few warnings:

WARNINGS

1. If exercising "for the fun of it" or as a matter of routine, keep in mind the suggestions outlined in Chapter 9 for pre-

venting excessive perspiration and the consequent formation of hoarfrost in your clothing.

2. You should probably refrain from violent exercise when temperatures are below —50°, since the rapid breathing might produce either actual freezing of the inside of the breathing apparatus or congestion from over-chill.

Whether it is possible to freeze the inside of trachea and bronchial tubes by rapid breathing of very cold air is one of the debated questions. It is frequently asserted, particularly in the Yukon, that both horses and people die with pneumonia symptoms which are alleged to have resulted from the heavy breathing that accompanies violent exercise. But there are other people in the Yukon who maintain that this has never happened—that the deaths with pneumonia symptoms were from other causes than freezing of pulmonary membranes. Perhaps we should take here the attitude of "better be safe than sorry." In any case, few people breath through the nose when weather is extremely cold—they find by experience that they are more comfortable breathing through the mouth; which has at least one further advantage, that your nose is less likely to freeze when there is cold air merely outside of it instead of both inside and out.

3. If lost in a blizzard, bear in mind the warning given in Chapter 11 against over-exertion, resulting in dampening and freezing of the clothes through perspiration, and in physical exhaustion.

4. Should you, through carelessness or through circumstances over which you have no control, develop scurvy, remember that exercise is of no value in retarding or curing the disease. As developed later in this chapter, the treatment of scurvy is wholly a matter of diet, and whatever energy is expended should be used toward securing fresh food.

Section III

FIRST AID

First-aid problems connected with the Arctic summer are the same as those for other climates, so that no special instructions need be given for dealing with them. In case of immersion or heat stroke (and heat strokes do occur in the Arctic), you would follow the procedure that is in general use elsewhere.

Special first-aid problems do arise under the conditions created by low temperatures. Here it is important to have first a grasp of the underlying principles and then a knowledge of how to deal with the effects of cold.

It is ordinary north Alaska and northern Canada Eskimo practice to jump naked out of bed to stop an outdoor dog fight in any weather. Several members of the Stefansson expedition did the same. Since the dogs do not choose particular weather for their fights, they have to be stopped at all temperatures. No one is known to have suffered ill effect, or even discomfort that lasted more than a moment or two after getting back into bed.

When cold is unaccompanied by wind, the human body does not feel it immediately. The most striking testimony is that furnished unconsciously by children. A naked baby against its mother's back inside her fur coat may begin to cry from overheating or difficulty in breathing. If she is on the march, the mother will simply open wider at the top the breathing and ventilating channel between the coat and her back. But if she has time, she will, if there is no wind, spread a caribou skin out on the snow and place the child upon it naked on its back. The child will at first smile in the most pleased and comfortable way. It may be anything between half a minute and two minutes before the youngster begins to pucker its face and show signs that it perceives a growing discomfort. Before it starts crying the mother slips it up her back inside her coat.

Apparently the most intense possible nervous shock from chill is through a shower of cold water. The coldest, without laboratory manipulation, is a sea water shower at about 28°. It is doubtful whether the shock of this is appreciably greater than that of an ordinary city water shower at around 40°. The shock from water at 50° or even 60° is many times greater than from air at —50° or —60°. In fact, there is no shock at all from going from a warm bed into still air outdoors at —50°.

The preceding detail on exposure of the whole body is to emphasize that there is neither danger nor discomfort through short exposure of parts of the body at intensely low temperatures, so long as the snow is not drifting. If the snow drifts, discomfort comes mainly from what of it gets inside the clothing, to melt later. Snow driving before anything like a 30-mile wind at —30° would bounce off your naked body before melting and would, therefore, produce the sensation of drifting sand rather than that of something clammy.

CARE NEEDED IN EMERGENCIES

We do not mean to discount the advisability of speed and precision when extensive, though partial, body exposure is necessary, as when a man who has fallen into water changes his clothes out of doors. The water in which he has been drenched will produce such a preliminary chilling that almost certainly he could not change completely from one suit to another without assistance—his hands would become numb and unusable before the change was complete. (It follows that a man who is alone when he falls into water should not try to change to dry garments without first making some sort of camp—and by then he cannot change anyway, unless he has a fire, for his clothes will have frozen stiff.)

When the right snow is available, the first thing to do after falling into water is to roll in a deep, soft bank. The snow acts as a blotter, abstracting some of the water from the clothing. The colder the snow the better it works.

A minor change outdoors, as from wet socks to dry, is really no bother at all, whatever the temperature, if the rest of your body was warm at the time you got your feet wet.

A full change of suits in the open can usually be managed, but only with assistance; for, as said, you might get numb and helpless. If there is a wind you will certainly have to find or build a windbreak as a preliminary, and during that time the soaked clothes will freeze. In case of a full soaking it is probably best to do as Wilkins and Eielson did, when Wilkins fell in and got soaked to his armpits, on their way ashore when they had abandoned a fuelless airplane 100 miles north of Alaska. The temperature was —10° and the outside of Wilkins' clothes froze almost instantly. They proceeded to a natural windbreak which they happened to see. During that time the actual running water had soaked downward from the coat and trousers, and they squeezed downward some of the moisture with their hands. When sure that not much would later soak downward, Wilkins, with Eielson's assistance, took off boots and socks, replacing them with dry.

There is a partial compensation in soaked clothes. While they are heavier, better conductors and stiff, they are more windproof than before, giving you a sort of rebate.

DRYING A SOAKED SUIT

When a suit is fully soaked and fuel is scarce, you can dry it successfully in 1 or 2 days only on your body. The best way, if you have time, is to stay in camp for at least a day, devoting yourself to the drying. This would mean you would spend most of your time standing up, occasionally varying by sitting down or kneeling. The change of position is because not much drying would take place between your body and anything on which it rests. (It would probably take 2 or 3 weeks in winter for a wet suit to dry if hung up out of doors.)

FROSTBITE

It is not possible to prevent frostbite entirely, but it is possible to go through winter after winter without suffering any serious consequences, if suitable clothing is worn and the right procedure followed. The frostbites that do occur need be no more serious than a mild sunburn, if you thaw the part promptly.

Assuming proper clothing, only the face is apt to be frostbitten, and the face is the easiest to treat. When the face is frozen you almost necessarily thaw it with your own hand or get someone else to thaw it for you. In moderately cold weather, the point is to keep your hands warm and to run a hand over your face every few minutes to see if any part of it is frozen. You can also keep informed by making grimaces, when a stiff spot is easily detected. All you then have to do is to take your warm hand out of your mitten and press it to the frozen spot a few moments, until the whiteness and stiffness are gone.

In the very coldest weather the method is a little different. When you are properly dressed for winter your coat is loose-fitting and with the sleeves cut so that any time you like you can pull your arm out of the sleeve and carry your hand on your naked breast inside the coat. Whenever any part of the face refuses to wrinkle, you push your hand up through the loose-fitting neck of the coat and press it for a moment on the stiffened portion of the face. As soon as the frozen spot thaws, you pull your hand in upon your breast again. In this way one can walk all day facing a steady breeze at —35° or —40° F., which is the worst kind of weather one ever gets in the Arctic. For when the temperature falls to —50° or below, there is usually a calm.

BE CLEAN SHAVEN

You should always be clean shaven. If you wear a beard, the moisture of your breath congeals on it and makes for you a face mask that is separated by an air space of a sixth or eighth of an inch from your skin. If then you begin to freeze underneath the ice mask you cannot get at your cheek or chin to thaw it out with the warm palm of your hand, as you could do immediately if you were smooth-shaven. If you try to thaw such an ice mask with your hands, you soon find that you have to choose between a frozen face and frozen fingers. There is no choice. Your hands and feet you must protect at all costs.

FACE MASKS

Most travelers conclude after trial that a face mask of skin or cloth is of no avail. It protects you for half an hour or so, but then ice forms on it. The comforting and protective velvet of morning is crusted with ice long before noon. However, there are people of great experience who use velvet masks that cover the whole face, with openings for eyes, nostrils and mouth. One of these is Wilkins.

WRISTS

Next after the face the likeliest part to freeze is the skin of your wrists. If a wrist is frozen, because coat and mitten do not meet, you very likely thaw it by grasping with the other hand, but you may thaw by holding the wrist against your face or, better, slipping it inside your clothes.

PROTECTING HANDS AND FEET

Keeping hands and feet from freezing is primarily a matter of proper clothing, which is described in Chapter 9.

THAWING HANDS

If a hand does begin to freeze, the procedure is as explained for warming the hand to thaw the face—pull the arm out of the sleeve of the coat and carry the hand on the naked breast until it is warmed.

There are conditions where special dodges may be practiced. On a windy day when your hands are cold with two pairs of woolen mittens, you may perhaps soak the outer pair to advantage, provided you can get it back on again before it freezes too stiff. You now have an outer mitten that sheds the wind whereas formerly, when it was dry, the wind came through.

When you are taking fish out of a net with bare hands at $-30°$ to $-50°$, you will find it advisable every half minute to stick your hands deep into the water. The like is so, for a greater reason, when you are skinning a large animal. You can then usually get adequate warmth by putting your bare hands for a few moments in between skin and flesh. Except that it makes your hands slippery, it may be better to stick them into blood, for instance, when you are cutting up an animal after skinning.

THAWING FEET

If a foot is frozen, the situation is the most difficult possible. When you are alone in the open it is hard to say what to do. If you happen to have warmer or more footgear available, you will put that on. Perhaps your foot can be thawed by wrapping a skin around it. If a dog is available, you might in some way get him to help you, say putting your toes in between his thigh and belly. In some cases you can thaw by running. That is dangerous, as elsewhere pointed out, for it may lead to perspiration and exhaustion, which in turn may cause freezing to death. Of course, if there is a camp at a reasonable distance the thing is to run toward it as fast as possible—thereby you may produce a certain thawing while you are on the way and you have, at any rate, shortened the period of freezing.

If you have a human companion, the best way ordinarily is to take off all your footgear and to have him put your foot between his coat and abdomen, or wherever else on his body seems most convenient.

WHEN LOST IN A BLIZZARD

The above precautions to avoid freezing face, hands and feet apply, of course, if you become lost in a blizzard. The larger aspect, that of avoiding freezing to death in such circumstances, is a matter of travel technique. It is, therefore, discussed in this Manual in the section dealing with travel procedure—see Chapter 11, Section II.

TREATMENT OF FROSTBITE

Authorities differ on the procedure to be followed in treating severe frostbite. Because of the difference of opinion, we state the opposing theories and the reasons given for each.

It has been claimed by some Canadian and other physicians that they have secured good results by thawing a frozen part with water heated to just short of scalding. The motives given are: (1) that you want to keep the frostbite from getting deeper, and (2) that you believe the injury to tissues is greater the longer they remain frozen. Stefansson is inclined to agree that the frozen part should be thawed with the warmest thing available, feeling that there is apparently no merit in a slowness of thawing to counterbalance the demerit of long freezing. But, although the above method appears logical, he is prepared to modify his stand if experience supports the gradual application of heat (described below). For in his 10 winters north of the Arctic Circle he associated almost exclusively with people who understood so well how to dress and how to take care of themselves that his experience with severe frostbite is very limited.

THAWING GRADUALLY

The opposing view, that of thawing the frozen part gradually, we quote from a pamphlet issued by the United States Coast Guard, "Directions for Restoring the Apparently Drowned * * * and for the Treatment of Frostbites," Washington, 1939. Under the heading of Third Degree (severe) frostbite, the pamphlet says:

"* * * if the part is dead no reaction takes place upon the application of heat; the dead portion turns black and a line of demarcation appears between it and the living tissue. If the heat is applied suddenly to a badly frozen part of the body, the liability to gangrene (death of the tissue) is increased on account of the intense reaction that takes place in the tissue that is still living."

The topic being at once important and debated we sought the opinion of the Harvard Fatigue Laboratory, submitting to them the opposed views given above. Professor John H. Talbott, that member of their staff who has most devoted himself to problems of freezing, replied that so far as he knew "* * * no particular harm comes from the rapid thawing of tissue * * *" and added his belief that "* * * theoretically certain advantages may be gained by this treatment [rapid thawing]."

DON'T RUB WITH SNOW

The belief in the efficacy of rubbing snow on a frostbite, probably derived from ancient doctrines of sympathetic magic, has been so long and so widely held that it is a part of almost everyone's "knowledge."

Such treatment of frostbite, however, is contrary to the laws of physics that relate to heat and cold. No less is snow application contrary to common sense. For if we stop to think, we must realize that if a cold body is brought in contact with a warm body the warm one is cooled down; and that, if one cold body is brought in contact with another still colder there is a similar lowering of temperature of the body that is less cold. Consider, then, what would be the effect if snow at —50° were applied to a frozen part of the human body. The flesh that had suffered the freezing would then be only a little below the freezing point, while the snow would be 80° colder than freezing. The result must necessarily be a deeper and more solid freezing of the part affected.

Because of the danger involved, we repeat: Never rub snow on a frostbite. Always apply something that is warmer than the affected part.

Don't try to warm frostbite by friction. Heat is generated by friction but slowly, and in the rubbing you are likely to break the skin; for the part that is being rubbed has already become stiff. You may have a mechanical injury to deal with in addition to the frostbite.

SNOW AS AN ANESTHETIC

After the thaw has been completed you may find cold a good local anesthetic, and perhaps the only one available. Indoors, when the thaw is well completed, it is good if you are in considerable pain to use slushy snow, or any cold application. But if you have thawed outdoors, perhaps with your warm hand, a facial frostbite which is deep enough to cause pain, you automatically have an anesthetic application in the cold air which previously froze you. In the case of such frostbite you may notice little pain during the day, because of the said anesthesia produced by the air, and the paining may start after camp time. Then you may safely use slushy snow.

Even for use in a warm camp we have specified slushy snow. Of course it need not be warmed to the slush point before use if you know that the temperature which it brings in with it from out of doors is only a few degrees below freezing. It must always be remembered that, the snow and the air outdoors are about the same temperature—if the air is exactly —50° then the snow is approximately —50°. Now that temperature, 80° below freezing, is so low that you could produce with it in a warm room almost the effects that can be produced by liquid air in a laboratory. There is no doubt that in ordinary room temperature you could freeze a man's entire face by rubbing it with snow, if fresh snow is brought in from outdoors every few minutes.

DANGER OF USING COLD KEROSENE TO "THAW" FROSTBITE

A related belief quite as dangerous as that about snow and frostbite, except perhaps not so widespread, is that a thing is not frozen if it is liquid—that you can thaw a frozen part of the human body in any material which itself has not been stiffened or hardened by cold. There was a horrible illustration of this belief in an Alaska mining camp during the Gold Rush. A man came into camp suspecting that one of his feet might be frostbitten. When shoes and stockings were removed it turned out that the toes of one foot were more or less frozen. Someone then went out of doors, secured a five-gallon tin of kerosene, brought it in, poured kerosene in a bucket and told the man to step into it. He did, and kept his foot there until it was frozen solid. Instead of losing perhaps a few toes, he lost his leg half way to the knee.

GREASE AS FROST PREVENTIVE

There is a debate about greasing the face to prevent frostbite. Some believe that a thick coating of vaseline is a useful protection. This has, however, two dangers which we have mentioned once or oftener. First it is bad practice to have grease around you anywhere, for it is liable to get into your clothes, destroying their insulating quality. Then it is bad to have anything on your face (we referred previously to an ice mask) which prevents the ready application of a warm hand to neutralize a frostbite. If you have tried the vaseline method and are nevertheless freezing you will have to rub off most of the grease, with some grass, moss, or the like, before applying the warm hand for thawing purposes.

AFTER EFFECTS

There is little danger that a wound from frostbite will fester, since the micro-organisms involved are rare in the polar regions and, no doubt, particularly so in winter. You would proceed as with any other wound, except for the said omission of antiseptics. If the frostbite merely produces peeling, like that of sunburn, you treat as for sunburn. Most likely you would do nothing, or you might use lanolin. With such applications, as in every other respect, you must be careful not to get your clothes involved. The gradual accumulation of fats in them, whether mineral or organic, will progressively decrease their value as protection against cold.

SUSCEPTIBILITY TO FROSTBITE

There is no racial immunity or racial susceptibility to frostbite. Norwegians and Spaniards, Negroes, South Sea Islanders, Eskimos, and Indians of the northern woods have been found on observation to be about equally susceptible. A man susceptible to frostbite is not necessarily unsuited for cold-weather service, for he is not of necessity correspondingly susceptible to other effects of cold.

The best Eskimo traveling companion Stefansson ever had, Natkusiak, froze his face more easily than any other of his men, of whatever race, although his hands seemed to stand as much cold as those of the rest of the expedition. But to him frostbites were minor annoyances. He handled them almost subconsciously—thawing out his face at short intervals without this interfering appreciably with his work.

Susceptibility to frostbite is, then, though not racial, highly individual. It may be true as commonly believed that it depends on circulation, then perhaps on the capillaries in the skin. It depends to some extent on facial contours—sharply angular chins and thin noses are apparently predisposed to freezing, although this effect is at times obscured by other qualities, perhaps those of circulation.

Hands that grow numb easily should rule a man out from Arctic service. The third Stefansson expedition had one member whose fingers were not properly nimble except in summer. He reported that his hands used to become numb when he washed them in city water in Seattle, Wash. At temperatures when other men were working barehanded he had to wear two or three pairs of mittens and was able to use his hands only as if they were stumps.

SNOWBLINDNESS

Since snowblindness is not a real disease, we deal with it in this section rather than in the following one on diseases.

For reasons not fully agreed upon, sunlight on snow does not usually produce snowblindness before March or April in those parts of the Arctic where the sun first becomes visible some time in January. Clear sun in spring produces snowblindness, but not so quickly as diffused light. When the snowblindness season has arrived, exposure to any kind of light may bring on and aggravate the difficulty—instances of snowblindness have been reported as developing toward the end of a period of several days during which the party had been confined to camp, the light having come in either through the roof of a snowhouse or through the fabric of a white tent.

CAUSES

Snowblindness is, as said, most apt to occur on days when the clouds are thick enough to hide the sun but not thick enough to produce heavily overcast weather. Light is then evenly diffused and there are no shadows anywhere. You may collide with a snow-covered ice cake as high as your waist and, if anything more easily, you may trip over snowdrifts a foot or so in height; for, wanting the help of shadows, everything that is pure white seems to be level. The eye, therefore, is continually straining to detect obstacles.

SYMPTOMS

Signs of trouble develop slowly. It may be after a long day's march that when you enter camp in the evening your eyes feel as if there were small grains of sand in them. Such things as tobacco smoke will make them water excessively. Gradually they become more uncomfortable and sore, and during the night shooting pains (resembling those of earache or toothache) will start. The period of considerable pain seldom extends over more than 3 days.

If the vision of the eyes is unequal, the weaker eye may be attacked first, for the reason that the glare appears stronger to the stronger eye and you naturally protect it first, as by shading it or keeping it shut. When once you have begun to shield an eye it becomes increasingly difficult to keep it open, for when an eye has been in darkness it is blinded by a light which does not blind an eye that has been exposed to it. Those who become snowblind in both eyes simultaneously have either used great will power to keep both eyes open or have eyes of nearly equal quality.

It is probably true that if one man has keener eyesight than another then he is the one to go snowblind first. If this be so, it would no doubt follow that with eyes of unequal vision the better eye would be blinded first, if both were kept open and used equally.

Another belief is that each snowblindness you suffer predisposes you to the next one. This is considered true not merely during a given season but also from season to season. It is also believed that recurrent snowblindness gradually weakens your eyesight and tends to produce blindness. If this be true it will follow that one snowblindness does not necessarily lead to another except at first—later on, when the eyesight has begun to be dulled, there will develop that partial immunity to snowblindness of which we have spoken.

After complete recovery a second attack is not likely to come in less than a week but careless persons will have attacks every week or 10 days. No immunity is developed—the more attacks you have suffered the more you are predisposed to the next. It is probably for this reason that Eskimos usually become snowblind more readily than whites.

Since snowblindness is not a real blindness, it is only in fiction that it looks like actual blindness and that people can simulate it for days. During severe snowblindness, for one thing, tears flow as rapidly as in violent weeping.

TREATMENT

The only treatment is to take whatever steps you can to shield the eyes from light—to remain in a darkened place or, if you must be on the march, to wear smoked or amber glasses. Bandages shutting out all light should be used in severe cases, even if you have to travel. (You can then cling to the sledge and stumble along, unless the load is so small that you can ride; or you can get somebody to lead you.)

For ameliorants it may be worth while to use the prescription of an oculist, such as morphine drops, or wash with boracic solution.

AFTER EFFECTS

During convalescence you gradually become better and better able to endure light. On first use of the eyes you will see double—they do not focus. On perhaps the second day (maybe the fifth or sixth day from the onset of a severe attack) your eyes are all right for such things as traveling and camp-making but will not yet serve for purposes such as reading a fine scale on an instrument or taking sure aim with a rifle.

PREVENTION

The constant use of amber glasses will prevent snow blindness. Unevennesses imperceptible to the naked eye can frequently be seen by the aid of these light filters. Smoked glasses are poorest of all. Chlorophyll green is good when the sun is shining but cuts out too much light and on cloudy days interferes with clearness of vision.

Glasses frost over from eye moisture and from moisture of the face. This frosting is not a serious annoyance on a windy day, especially if one keeps the face sidewise to the wind; but on a calm day, if one walks fast enough or works hard enough to perspire, they cannot be worn at all. In such circumstances, keeping the eyes on a dark object is a valuable preventive—for instance, the dogs or the cover of a sledge. It is said that blackening the nose helps, especially if it is a high nose. You can rest eyes by using them alternately, and save them by looking through half-closed lids, through your eyelashes.

Eskimo goggles, made of wood with slits about large enough for half a dollar, have the advantage of not frosting over, but the disadvantage of a field of vision so limited that you cannot, without stooping over, see what lies at your feet.

SECTION IV

DISEASE

The problems of infection are the same in the Arctic as in the tropics and temperate zone, except that the dangers are fewer in the Arctic and that in most cases those present are less serious.

INFECTION OF WOUNDS

It seems to be a general tropical experience, particularly in the humid districts, that every scratch festers, even small wounds are dangerous, and that antiseptics must be the central part of your emergency medical equipment. In the polar regions you have the opposite extreme. Step on a nail, clean or rusty, and there is no danger or any difficulty except from the mere surgically clean wound. Antiseptics are perhaps the least necessary part of an Arctic medical kit. It is reported that the hospital at Barrow, Alaska, uses considerable less asepsis procedure than would be required in the temperate zone.

As mentioned already, cases of blood poisoning from "stepping on a rusty nail" and things of that sort have been reported from polar expeditions in recent years but the statement has usually or always been accompanied by the theoretical explanation that the micro-organisms involved must have been brought by the expedition itself from tropic or temperate-zone lands.

TUBERCULOSIS

Diseases which require person-to-person contact or near association spread in the Arctic as elsewhere. For instance, there is the same danger from sputum in tuberculosis that you have farther south except that in winter the spit is likely to freeze when it is voided. Apart from whether this kills the germs, it does restrict their distribution.

THEORIES TO EXPLAIN HIGH DEATH RATE

It was formerly common in books about the Arctic to say or assume tacitly that the Eskimos had some tuberculosis among them before white influences began to operate and that the heavy death rate from this disease among communities in the process of being "civilized" was due to a weakening of the power of resistance by several factors. The more thoughtful observers, as, for instance, medical missionaries and whaling captains, usually put the heaviest blame upon the introduction of white men's house types and housekeeping methods.

For places like northern Alaska they would argue, for instance, that because the roofs of the native houses were not rainproof the families had to move out of them in the spring. They would shift into tent encampments which they occupied during the summer, moving from place to place and having an automatically clean site each time they moved. After the freeze-up the houses were reoccupied.

A reoccupied house was a clean house, the cleaning process having consisted of chopping out the floor with pickaxes and getting rid of several inches of frozen mud by throwing it outdoors. Any germs not killed by frost were cast out with the debris.

There were supposed to be various contributory reasons for the development of tuberculosis among Eskimos who were adopting white men's ways. The people were no longer as healthy, notably constipation had developed and this was assumed to lessen resistance to other diseases. The natives might catch other white men's diseases which would further lessen their ability to fight off tuberculosis. These and other things were used to explain the terrifying mortality which, in some cases, was believed to have reduced Arctic communities by half in as little as ten years.

But a reexamination of the evidence has brought most students to a different conclusion. The main explanation of the high tuberculosis mortality is now considered to be that the Eskimos did not have the disease until it was introduced by whites. Since their ancestors had not been exposed to it, the present generation does not have what we call inherited immunity. This, by the current reasoning, is the main explanation of the appalling death rate; it is still said that white men's houses, housekeeping and, diet have been injurious, but these are now looked upon as subsidiary factors.

In Greenland, where more scientific thought and care have been put on the welfare of the Eskimos than in any other section, it has been recommended during the last few years, notably by a physiological expedition from the University of Oslo which studied conditions in East Greenland, that natives should be encouraged to eat more meat. With the Greenland Eskimos, as with all Eskimos and perhaps with all people, fashions are powerful. They have seen the Danes eating foods brought from Denmark which they know are costly and which they desire in proportion. They eat as much Danish food as their financial resources permit. The scientists of the Oslo group consider they have established that the prognosis of tuberculosis is much better if the invalid can be put back on his native diet, chiefly seal and fish. For a like reason the chance of catching the disease is said to be less among those who live mainly or solely on meat.

This argument does not of course mean to advance a diet of meat as a panacea. Demonstrably it is no panacea. You see that in districts like Coronation Gulf where as yet there is little departure from native housing practice. By Stefansson's observation there was no tuberculosis in that district among 500 to 700 people in 1911. Diamond Jenness of the third Stefansson expedition, who spent in this neighborhood the years 1914–16, feels that tuberculosis has been introduced to Coronation Gulf since then. By the reports of Richard Finnie, as of about 1939, the tubercular death rate in Coronation Gulf had been through the preceding decade much heavier than anywhere else in Canadian Eskimo territories. The explanation is that other parts of the Arctic went through their heavy death rate cycle anything from several hundred to several score years ago.

POPULATIONS REDUCED BUT NOT EXTERMINATED

A broad statement, covering tuberculosis and the other new factors of destruction, is that the white man's influence, in chief his diseases, reduce Eskimo communities to a half, a quarter, or possibly even a tenth of their former population, but that extinction does not result. At some point the new influences have killed off so many of the susceptibles, and left among the remnants such a high percentage of the partly or wholly immune, that the birthrate begins to compensate for the death rate and finally gains upon it. Today there may not be any part of the Arctic, except northern Canada from Coronation Gulf to King William Island, that is seeing a marked decrease of population. There are small increases in other parts of Arctic Canada and in Arctic Alaska, with a high rate of increase both in Danish Greenland and in the Soviet territories of Arctic Siberia.

TYPHOID

Typhoid is spread by carriers in the Arctic as elsewhere. For instance, there is no reasonable doubt that in 1917 Stefansson contracted typhoid at Herschel Island from a member of the Royal Canadian Mounted Police, or possibly from some other white man there who was a carrier. Of three cases that winter two died, a constable and an Eskimo.

Typhoid is also spread in the Arctic as elsewhere by contaminated water. An approximately conclusive example is from Barrow, Alaska. People who had died of typhoid were buried Eskimo-style (in boxes on top of the ground) on a hill near the pond which is the main water supply of the village. The next year there was an epidemic which cost several lives. The disease came under control when the water supply was changed.

MEASLES AND INFLUENZA

Measles and influenza spread in the Arctic as elsewhere. The first known measles epidemic, around the beginning of the present century, killed as high as 75 percent in some villages and it is not known to have killed less than 25 percent in any village. There is one statement, from the Kuskokwim, that of 99 in a village, 98 died, the only survivor being a half-grown child.

That this heavy death rate is due to lack of immunity and not to a special virulence of the disease appears to be demonstrated by the comparative immunity of Europeans living in the Arctic. Stefansson has been unable to find a single case of an adult European dying there of measles. Except that the recorded cases are as yet perhaps too few for generalization, it seems clear that the children of white fathers and Eskimo mothers have a considerably higher immunity than the full Eskimos.

ITCH AND VENEREAL DISEASES

The spread of itch and the venereal diseases is not affected by the climate. Most or all Eskimos have been exposed to these diseases, which are all apparently of European introduction. Native immunity seems lower than that of whites.

EYE DISEASES

Eye diseases, itch, and some other troubles were greatly accelerated in their spread among Eskimos by the introduction of bathing and face-washing, involving the promiscuous use of towels.

COMMON COLDS

Head colds, though doubtless they obey the same laws as elsewhere, have a superficial difference in the Arctic which has attracted much attention.

When small parties are isolated from all other human beings, their members eventually recover from whatever head colds they may have. After that they do not catch more, no matter how warm or cold they are or how suddenly they change from cold to warm. Neither do any of the other things commonly supposed to produce colds take effect. You can't catch cold unless there is someone or something to catch it from.

The one thing, other than a new person, which has apparently on some occasions started colds on Arctic expeditions is the opening up of packages that date from countries and times where there were colds.

When two previously isolated groups meet, members of both will come down with colds and very likely everybody will catch them. This seems to mean that the disease organisms were present in both parties but each lot had been deprived of the power to make its own community sick, while retaining the power to infect the new community.

Certain travelers have reported that head colds are particularly numerous among Arctic Eskimos in spring and fall and have connected this with the weather as such. In Stefansson's opinion no isolated party will develop colds either spring or fall. The reason for the spread and prevalence of colds at those seasons is that they are the times of most general traveling, yielding the best facility for the transfer of germs between groups.

COLD-AND-FEVER EPIDEMICS

In addition to the epidemics of measles and influenza, which can always be connected definitely with epidemics or other spread of those diseases among neighboring whites or Indians, there are milder but nevertheless serious epidemics with the symptoms of severe head colds and fever, which spread among Eskimos from community to community, not every year but still at rather frequent intervals. These epidemics seldom kill directly, but they are the usual start of a famine.

For instance, a party of fifty or a hundred people may have arrived from inland at a sealing locality on the shore of Victoria Island. They come with their food nearly exhausted and it takes a little while to get camp established and the proper scouting done for the seal localities—which vary from year to year. If a severe epidemic of head colds strikes just then, confining most of the hunters and other workers to houses for a week, and if then there should be a spell of bad weather, you have a combination which first results in the killing of the dogs for food and then in the inability of the people to find seals because they have no dogs to guide them. For, under the conditions given, the mauttok is the only tenable sealing method, and that method rests on the cooperation of dogs (as described in Chapter 13).

The main point, as said, about Arctic diseases is that those you find are never other than the ones with which you are familiar in a more severe form farther south. Many of them have been brought in by Europeans remotely or recently. A number of ailments are still wholly absent from uncivilized or little changed Eskimo districts. Among these are the entire group of deficiency diseases, as well as tooth decay (caries). In a community that still keeps to its native wholly carnivorous diet you never have scurvy, rickets, pelagra, or beri-beri. There is not one decayed tooth in a thousand heads among people who are wholly meat-eaters. Pyorrhea is rare or absent. Alveolar abcess seldom occurs.

CANCER

Cancer has not yet been reported from uncivilized Eskimos. One death from cancer has been reported at Barrow of a man who had been working for or with Mr. Charles D. Brower for nearly 40 years and living to a considerable extent on European food. However, an inquiry from Dr. Greist, medical missionary at Barrow, brings an answer which casts doubt upon the diagnosis.

ARCTIC HYSTERIA

There appear to be no mental symptoms which result from darkness as such—during the more or less prolonged period when the sun is below the horizon. There is, however, the possibility that through powerful suggestion, either just your own belief or your own supplemented by that of your comrades, mental difficulties may result.

The most striking reports of mental trouble that is said to be caused by "the midwinter darkness" are from Yukon Territory and interior Alaska, where the sun is visible at midday during midwinter from 1 to 3 or 4 hours and where people are gathered together in small villages that are comparatively inactive during the midwinter period. On whaling ships that wintered at Herschel Island, where the sun is below the horizon for a month or so, far less mental difficulty was reported; and generally what there was afflicted those who were spending their first winter.

That the "darkness" has more effect in Yukon towns where the sun never wholly disappears than at Herschel where it disappears for a month or two, seems most readily explained on a suggestion basis. In a Yukon camp of 1897 or 1898 very likely the whole village consisted of people who were spending their first winter, who all were afraid of the darkness, and who "knew" that they would be depressed by it. This was an ideal set-up for mass hypnosis. By contrast you saw at Herschel Island on every hand natives who were jolly continually; many of the whalers were veterans who were about as jolly as the natives. The Eskimos would not be able to tell the newcomer anything about the terrors of the darkness, that idea being to them unknown. The most any white veteran was likely to say was that he had been depressed the first year but that he got over it. The chances would then be, on the suggestion hypothesis, that the newcomer would only be mildly depressed, having the belief that it was a condition he would get through all right.

Stefansson has established at least to his own satisfaction that no depressing effect is felt by Europeans during the first Arctic winter if it is explained to them that the cause of the depression, if any, will be their own imagination—and if the newcomer is willing to believe this explanation. There are always people who cannot be induced to believe, and they usually or always succeed in producing, at least during their first winter, enough depression to prove to themselves that they were right.

As to his own case, Stefansson reports that the first winter he spent in the Arctic he wrote a joyous entry in his diary when the sun came back after an absence of a few weeks. At that time he thought himself to have been depressed and to have been released from the depression by the sun; he still knows that he was depressed but thinks the cause was probably his own imagination.

Among people who live in the North, white or native, the midwinter is usually the season of most enjoyment. This is not because the absence of the sun, as such, makes it a preferable time of year. The northerners' attitude to January is in fact about like the common American attitude to August, to which month we look forward not because of its weather but because it is vacation time. Perhaps, then, it may be right to say that August in Missouri and January at Point Barrow are of themselves the least attractive months of the year, but that people in both places find them attractive because it is the vacation time. That it is vacation time results in Missouri from the difficulty of working in the heat of August; at Point Barrow it results from the difficulty of working in the twilight of January.

Arctic hysteria being probably auto-suggestion or mass hypnosis, it is real only in the sense that any trouble based upon imagination may be real. We turn back to diseases that are real in a different sense.

TAPEWORM

Becoming infested with tapeworm is, of course, a serious matter, but the chances for that appear to be small anywhere in the Arctic. There was a scare in northwestern Alaska a few years ago that whites would be getting tapeworm from the reindeer, but this was probably a rumor which started through ignorance, or it may have been propaganda against the reindeer industry.

Certainly there is a chance of getting tapeworm wherever dogs are handled, since they are the chief hosts.

DISEASE FROM SNOW UNLIKELY

Stefansson has heard of no instance connected with Arctic exploration, or with European pioneer life in the Arctic, where diseases have been contracted from the use of snow for water. However, since it has apparently been determined that some germs are not killed by freezing, and since the like may possibly be true with such eggs as those of the tapeworm, it is no doubt best, especially if you are catering to large numbers of men, to take precaution and boil your drinking water.

However, we should insist that the danger of this type of infection from snow in the Arctic is not as great as from the indiscriminate drinking of water from village and city water systems when you travel about. Once more—the dangers in the Arctic are the same as farther south, only with a smaller percentage of risk.

WATER FROM RIVERS AND LAKES IN SUMMER

There are few Arctic rivers which have cities or other communities located anywhere except at the mouth. Accordingly, most of these rivers are safer to drink from than almost any stream in thickly settled temperate zone countries. The same applies to lakes. Again, where numbers of men are involved, it may be a worth while precaution to boil the drinking water.

SCURVY

We now d'scuss in detail the disease which, of all others, has had the most serious consequences in connection with Europeans in the Arctic—consequences which have ranged from discomfort and reduced efficiency to numerous fatalities among the members of exploratory expeditions, ships' crews, Alaska miners, etc. Some expeditions have lost half and three quarters of their men. In one case, that of Sir John Franklin, every one of 129 men was lost, and the main cause likely was scurvy.

Scurvy is a deficiency disease and is considered to appear when Vitamin C is absent from the diet or is insufficient.

It seems clear from an analysis of polar literature and of corresponding records elsewhere that preventives of scurvy are originally present in most foods, whether they are derived from the animal or vegetable kingdom, and that these preventives are weakened or destroyed by storage and by cooking.

No doubt antiscorbutics vary from one vegetable or animal material to another in quantity and efficiency; seemingly, too, they vary in the tenacity by which they retain their virtues against storage and cooking. Generally speaking, it is felt that what destroys the antiscorbutic value of a food is oxidation. This is naturally greater the longer the time through which the food is stored and the more intense and protracted the heat to which it is subjected. Chemistry of media with which it comes in contact no doubt has its effect, too. It seems pretty clear, at any rate, that salted or dried meats and vegetables lose their antiscorbutic power partly because of the salt.

FRESHNESS IN FOODS ESSENTIAL

Not a single case of scurvy has been reported from natives living wholly on meat, and there has been no scurvy reported from any polar expedition which ate a considerable amount of fresh meat that was not over-cooked. There is no doubt, as the quantitative studies have shown, that the percentage of vitamin C, the scurvy-preventing factor, is higher in certain vegetal foods than in meats. But it is equally true that the human body needs only such a small amount of vitamin C that, if you have some fresh meat in your diet every day, and if you don't overcook it, there will be enough C from that source alone to prevent scurvy. Since freshness is the essential element, the thing to do is to find your antiscorbutics where you are, pick them up as you go. In the Arctic fresh foods are almost necessarily of animal derivation.

It is not necessary in order to avoid scurvy to select particular sections of an animal, such as the liver or marrow. For there is ample experience to show that fresh meat from any part of a healthy, normal, well-fed animal, if that forms the main part of your diet, is an adequate protection from scurvy. It is also an adequate protection from all the other deficiency diseases. Children, who appear to be more prone to rickets than adults, are always wholly free from rickets among meat-eating people.

One of the things which show that you do not have to select parts of animals to avoid scurvy is that most meat-eaters give the parts said to be richest in vitamin C to their dogs. Other parts rich in vitamin C are reserved for children; some are taboo and therefore eaten neither by people nor dogs. Thus there are thousands of meat eaters every year who go for long periods (plenty long enough to develop scurvy) on diets from which nearly or quite all the parts specially rich in vitamin C are absent. Yet no scurvy develops—showing that the parts which are eaten are amply supplied with the element to protect health.

BLOOD RICH IN VITAMIN C

There is, of course, the point that if vitamin C is found in milk it should be found in blood, for milk is, approximately speaking, modified blood. Few, if any, hunting people bleed animals deliberately, so that most of the animal's blood remains in the meat. If some blood escapes into the body cavity, as by the cutting of one of the large vessels, then the hunter, be he white or Eskimo, will usually save the blood which he finds accumulated. He will carry it away in a bag made from a part of the entrails and will use it as a thickening for blood soup.

The preceding paragraph was written not so much to state a fact as in reply to an argument; for it has been contended that Eskimo immunity to scurvy when on a diet of nothing but animal tissue may be due to their not following our practice of letting an animal bleed in such a way that most of the blood is removed from the flesh parts that are to be eaten—the assumption here being that white men would get scurvy on a meat diet. But we know through the experience of scores of Hudson Bay Company traders in northern Canada during the last hundred years, that white men no more than the forest Indians or the Eskimos, developed scurvy from a meat diet. The fact is no doubt that there is a higher percentage of vitamin C in the flesh than in the blood of an average animal so that a person who gets, say, 10 percent of his nourishment from blood is not so well off from the vitamin point of view as another who gets only 5 percent of his vitamin C from the blood.

ALL-MEAT DIET HAS AMPLE VITAMIN C

Dr. Arne Høygaard, of the University of Oslo physiological expedition to East Greenland, considers that the people there who still live on the native diet—seal supplemented with fish—receive from these flesh foods about twice the quantity of vitamin C that is required for optimum health.

It seems to take anything from 1 to 3 months on the least desirable diet to produce marked symptoms of scurvy. Probably the lag is due to there being stored in the body a considerable amount of antiscorbutic substance at any given time.

SYMPTOMS

Probably, on careful check by the victim and his companions, the first observed symptom of scurvy would be mental—he becomes less optimistic, more irritable and inclined to gloom, quarrelsome. The next symptom, on close observation, would probably be dizziness—he would fall back into his seat after being startled and jumping up suddenly. Then, perhaps, comes a pain in some joint, which may be taken for rheumatism. The joints first affected are those which in that individual are under the most strain—the ankles or some leg joint if he walks much, an arm joint if he is a blacksmith. Then would appear a light bleeding of the gums, detected perhaps when he bites into a piece of white bread, and likely to be taken for pyorrhea.

The development so far sketched may take between a week and a month from the appearance of the first mental symptoms. These are by now more pronounced, the irritability having become proportionately less noticeable and the gloom more so. The progress hereafter is more rapid, or at least more noticeable. Pain invests every joint. The gums bleed at every touch, they grow purple in color and soften, finally to the consistency of cheese. A man picking his teeth with a wooden toothpick will likely bring out a piece of gum, thinking it a chunk of food. The teeth grow so loose that the patient, feeling of them to see how they are, may pull one out without quite realizing he is doing it.

Some time before the gums turn cheesy there appears a symptom from which the disease gets its vulgar name, "blackleg." The smaller blood vessels break under the skin; often this is noticed first on the calf of the leg where there now are black patches. The same fragility of small blood vessels causes bleeding from the nose and throat. Death, no doubt, usually if not always comes from internal hemorrhage.

Well toward the later stages of the disease the patient maintains a good appetite, good digestion, and for a sick person presents a pleasing appearance. It is, therefore, difficult to see why the name of the disease should have such a particularly disagreeable connotation.

The appetite, as said, is normal, unless perhaps it be slightly excessive. It is claimed by some that patients have a strong desire for the very things that hurt them most. One longing frequently cited is for salt beef, boiled. But those who long for this dish are usually sailors who are accustomed to it and the longing may be no more than the sign of that appetite which we have said is normal if not excessive.

Regular elimination accompanies good d'gestion for the stages observed by the author, which are all but the very last stages.

CURE

The only treatment is to bring the patient back to health by the use of fresh and not overcooked foods. S!nce this is a manual for Arctic use, we consider in detail a treatment involving fresh meat, but the same rules apply for other fresh foods. The treatment here outlined proved successful in curing two scurvy patients who were under Stefansson's direct observation. (They were members of his expedition who became ill through thoughtlessness in eating canned, salted, and dried foods although fresh meat was available.)

At the time the treatment was begun the patients were so weak that one could not walk at all, while the other could barely stumble along holding on for support. One of the men had pulled out a tooth without realizing it until he saw it between his fingers. Their gloom, despondency, was profound. They had pain in every joint.

The treatment was staying in bed on a diet exclusively of fresh caribou (any other kind of meat or fish will do equally well). The morning meal was boiled to an underdone stage in a lot of water, and the weak broth from this was used for drinking all day, supplemented when necessary by water. The other two and sometimes three meals each day were raw meat, slightly frozen (the freezing through circumstance and because the patients were used to it). They were not fed with those parts of the animal which are said to be rich in Vitamin C; they did not get the liver or internal organs, for, Eskimo style, those were fed to dogs. They may have had an occasional kidney or heart.

The parts eaten cooked were boiled caribou head, briskets, ribs, and pelvis; those eaten raw were chiefly hams and shoulders. Since the animals were killed with rifle bullets, they had not bled appreciably and there must have been a good deal of blood in the various tissues.

The only thing given these persons which is now supposed to be particularly rich in vitamin C was marrow from the long bones. They got a larger share than the other two members of the party who were well, not for therapeutic reasons but merely because you give preferred food to invalids.

The meat was boiled as described in Chapter 8. By this method it is considered sufficiently cooked when it is about as rare as our ordinary roast beef—the outside layer well done, the layer next under it medium done, and the center rare. The theory will be that in the center portion the vitamin C content has not been weakened by the oxidation that has taken place in the outer layers of the meat. Broiling or roasting, so long as the center portion is rare, would do equally well.

On the third or fourth day of this diet all pain had disappeared from every joint of both patients and optimism had replaced gloom. But they were still very weak, their gums as yet soft and their teeth loose. In two weeks they were able to begin traveling in easy stages; in four weeks they were completely recovered, except that the gums which had receded from the teeth did not fully regain their position.

Stefansson ascertained later in New York, by comparing notes verbally with Dr. Alfred F. Hess, probably then the leading specialist on scurvy in the United States, that Dr. Hess, using raw crushed fruits and vegetables, had, with patients in about the same stage of the disease, attained approximately the same mental and physical curative results in the same length of time—so far as the two could judge, by practically identical stages.

FORMER THEORIES AND TREATMENT

There was for centuries a firm belief that "lime juice will prevent and cure scurvy." This belief is sometimes said to have originated with Captain James Cook, but it is demonstrably much older. Throughout several centuries expedition after expedition (including the Scott Antarctic Expeditions of 1901–04 and 1910–13) failed to prevent the disease through the most liberal use of lime juice, but these failures were explained away by whatever argument came to hand. The main concern seemed to be to preserve undamaged the faith in lime juice. So it was claimed that the merits of it in the given cases had been counteracted by lack of cleanliness, fresh air or sunshine; it was said that food had been decayed, that the men had not had enough exercise, that the gloom induced by darkness had affected them.

During the same centuries that witnessed the lime juice failures, meat as a preventive of scurvy was discovered, forgotten and rediscovered any number of times, as shown by the narratives of numerous explorers whose expeditions were free of the d'sease. The more general idea, that the antiscorbutic qualities of food depend on the freshness of the food, entirely apart from whether it is vegetab!e or animal, has had the same history. None of these discoveries made enough impression upon medicine to become incorporated in the literature and tradition of the science.

We know now that there is no reason to carry fresh lemon or lime juice as an antiscorbutic into a meat country. Neither is there any reason against carrying it except the bother of doing so.

On ships and in a large establishment it may be well to provide lemon juice, fresh as possible, against the eventuality that fresh meat may not be obtainable. Since vegetables cost less than meats, it is cheaper to protect yourself against scurvy by vegetables if you are in a place where you can buy them. If you are a vegetarian you will insist on that method in any case. But, even if you are a vegetarian, you had better swallow some meat if you get into a place where for several months you are unable to secure fresh vegetable elements.

DANGERS OF OVERCOOKING

Nor has scurvy been the nemesis of explorers only. In the war of 1914–18 the British Army in the Near East was seriously handicapped by it. Upon investigation, it was found that the cooks were boiling most or all foods excessively. It was with difficulty that they were induced to obey orders to cook things only moderately or slightly.

VITAMIN C AS A COMMERCIAL PRODUCT

The preceding is based on the idea that you prevent or cure scurvy by eating the right food and handling it the right way. During the last few years the manufacturing chemists have been putting on the market concentrates of a number of the vitamins, including vitamin C. The belief is at present both that these products are effective and that, except in the possible case of vitamin D, there is no great danger from overdosage. So it is now possible to outfit an expedition, whether civil or military, with prepared concentrates that will keep you free from scurvy, irrespective of the diet. This has obvious advantages. The most apparent disadvantages are two: that you may lose your stock of medicines; and that, in any case, you may secure advantages other than vitamin C by having a considerable element of fresh food in your diet. It would seem best, then, to plan a diet which does not require the taking of vitamin C as a medicine, but to supply a party nevertheless with vitamin C concentrates for use in an emergency.

Summing up: To avoid scurvy by diet you must eat some fresh food, either meat or vegetable, and it must not be overcooked. To cure scurvy, increase the amount of fresh food, at the same time increasing the amount that is eaten rare or raw. Like results can be obtained by vitamin concentrates taken as drugs, but a diet containing the needed vitamin C is preferable.

SECTION V

MONOXIDE POISONING

The dangers of camping in a lee and of poisoning by monoxide are twins—but not Siamese twins, for although they are usually found together they are not inseparable. If you consider them as being one, they are probably responsible for more deaths in the polar regions and more narrow escapes from death than any other single cause. They are the trickiest or dangers and more likely to take toll among the experienced than perhaps any of the other causes.

The chief inconveniences and dangers of Arctic winter camping in a lee on a generally open plain are discussed in Chapter 7. As said there, things outside of your camp are likely to get buried and lost, for instance, snowshoes and such gear, and even a sledge. Dogs sometimes get killed this way, for their fur may freeze to the ground and then when the snow drifts over them they are stifled. Worst of all, the same lee that catches snow enough to bury a sledge and dogs will very likely bury your tent, cutting off ventilation and causing the formation of carbon monoxide.

It is now generally agreed that the death of Andree and at least one of his two companions on White Island of the Svalbard group, in 1897, and the death of the four men of the Anderson party from the *Karluk* (Captain Robert A. Bartlett, commanding) of Stefansson's third expedition, on Herald Island in 1914, were caused by a combination of the two difficulties.

These parties through lack of understanding pitched their camps in lees, the snow settled on both tents so as to stop that ventilation which is through the fabric of the tent. Both were cooking with primus stoves and in both cases (we have no doubt) death came without warning—almost certainly none of these men ever knew what was happening to them, or about to happen.

Inexperienced men, particularly if they are from a forest country, will always want to pitch their winter Arctic camps in shelter; they will try to keep warm by curtailing ventilation. Since this is, as said, one of the chief causes of death in the Arctic we think it worth while to make the basic facts clearer than otherwise through narratives of special cases. We take first a modern one.

In 1910 Stefansson had his first experience with the insistence of a forest dweller for a lee camp. He and his old traveling companion, the Alaska Eskimo Natkusiak, were making a sledge journey northwest from the mouth of the Dease River, northeastern Great Bear Lake, to Langton Bay, at the foot of Cape Parry. They had with them a Bear Lake Indian, named Johnny Sanderson, who was impressed with how much superior his own camping technique was to that of white men, and who was proud of his experience in having been several times a considerable way beyond the margin of the Bear Lake woods out upon the prairies to the north (which, because of the lack of trees, are locally called barrens).

Johnny's technique was undoubtedly good for the woods to which he was used; but it was scarcely better than that of a man fresh from a lifetime in a big city in relation to the plainscraft needed for the Arctic prairie.

When, during a blizzard, Stefansson selected an open place as a camp site, Johnny was displeased, saying that he had seen a cutbank half a mile back, under the shelter of which the tent could have been pitched. Or, said he, only a little way ahead he could see a round hill with a steep slope to leeward that would be a fine place under which to camp, for the hill would break the wind.

Stefansson's and Natkusiak's ideas did not coincide with Johnny's. To them it seemed obvious that if they camped in a lee the drifting snow would in the night cover the tent and place them in danger of being smothered, even were the tent not to cave in with the weight of the snow. Johnny's ideas had all been gained in the forested country, where it really is wise to choose the most sheltered spots; and it seemed to him that his companions were little better than insane. It was only after his sledge was taken away from him by a show of force that Johnny was restrained from pitching the tent in the shelter of the hill.

POOR VENTILATION AND MONOXIDE POISONING

Even when the camp is not in a lee, monoxide may form through faulty construction of the dwelling or through carelessness of the occupants. There is a chain of tragedies and near tragedies connected with such monoxide poisoning from the first of modern expeditions which wintered in the Arctic, that of William Barents in 1596–97, to the 1928–30 and 1933–35 Byrd expeditions of the Antarctic.

The narrative of the Barents (Heemskerck) expedition gives, in an Elizabethan diction that now seems quaint, the account of modern polar exploration's first encounter with monoxide:

BARENTS' EXPERIENCE

"The 7 of December [1596] it was still foule weather, and we had a great storme with a north-east wind, which brought an extreme cold with it; at which time we knew not what to do, and while we sate consulting together what were best for vs to do, one of our companions gaue vs counsell to burne some of the sea-coles that we had brought out of the ship, which would cast a great heat and continue long; and so at euening we made a great fire thereof, which cast a great heat. At which time we were very careful to keepe it in, for that the heat being so great a comfort vnto vs, we tooke care how to make it continue long; whereupon we agreed to stop vp all the doores and the chimney, thereby to keepe in the heate, and so went into our cabans to sleepe, well comforted with the heat, and so lay a great while talking together; but at last we were taken with a great swounding and daseling in our heads, yet some more then other some, which we first perceiued by a sick man and therefore the lesse able to beare it, and found our selues to be very ill at ease, so that some of vs that were strongest start out of their cabans, and first opened the chimney and than the doores, but he that opened the doore fell downe in a swound [with much groaning] vppon the snow; which I hearing, as lying in my caban next to the doore, start vp [and there saw him lying in a swoon], and casting vinegar in his face recouered him againe, and so he rose vp. And when the doores were open, we all recouered our healthes againe by reason of the cold aire; and so the cold, which before had beene so great an enemy vnto vs, was then the onely reliefe that we had, otherwise without doubt we had [all] died in a sodaine swound."

STEFANSSON'S EXPERIENCE

The danger of poor ventilation in a camp where fire is burning was first and dramatically impressed on Stefansson in March 1911, when, with Dr. R. M. Anderson and the Eskimos Natkusiak and Tannaumirk, he was traveling east along the ice of Coronation Gulf in clear, calm, intensely cold weather. To save the trouble of building, they camped late one evening in a commodious and clean-looking snow house which had evidently been abandoned by a party of Eskimos not more than 2 days before. A new camp is warmer than an old camp, for a new snow house is a snow house, but an old one is partly an ice house. The walls of this one had been melted and then frozen into solid, glistening ice.

In their hurry to get the camp heated up, the Stefansson party closed the door tightly. There was just room for three of the men to sit on the bed platform; the fourth, Natkusiak, sat below them on the floor. Stefansson was cooking, with the primus stove placed on a block of snow while he knelt beside it on the bed platform cutting up snow into the kettle for water.

Suddenly, in the midst of telling a funny story, Tannaumirk fell backward on the bed with a sort of gurgling noise. When Dr. Anderson turned to see what Tannaumirk was up to, he fell face forward on top of the Eskimo.

Stefansson now realized that they were being poisoned by carbon monoxide and extinguished the primus stove. He instructed Natkusiak to hurry and break a hole in the snow wall behind him. But when the Eskimo tried to rise he was powerless to do so. That scared him so that with his last strength he threw himself back against the wall and broke away the loose block of snow by which the door had been closed. He then crawled outside on all fours, but was too weak to stand up. Stefansson followed him out, stood for a moment, and then fell down beside Natkusiak. Both were too weak to get back into the house and drag Anderson and Tannaumirk out.

It must have been 15 minutes that they lay flat outside before Anderson's face appeared at the door. His mind was clear, apparently, but he had no realization of what had happened. When the situation dawned on him he crawled out and started walking about and drawing deep breaths. But he soon found, as Stefansson had, that the deep breathing seemed to make things worse. He finally had to stretch himself out flat on the ground like the others.

It must have been another 10 minutes before Tannaumirk also came to his senses and crawled out. By that time Stefansson, who had been less affected than any of the others, had strength enough to fetch the sleeping bags from the house and to assist Anderson and Natkusiak to crawl into theirs. Tannaumirk, who had been most affected, was unable to think clearly; so he was unwilling to crawl into his bag and began wandering around in circles. Eventually Stefansson forced him into the sleeping bag and then went indoors, lit the primus stove again and started preparing a warm drink. An hour later Anderson, Natkusiak, and Stefansson were feeling comparatively fit again, and the next morning they noticed no ill effects. But Tannaumirk was ill not only that night but also the next day.

In his account of this experience in *My Life with the Eskimo,* Stefansson concludes:

"Of course our trouble had been from closing the house too tightly. Looking back upon our various experiences with primus stoves in the past, I can now see that we must have been near a similar outcome frequently before. We had escaped this time by a narrow margin. Had I gone off my head simultaneously with Tannaumirk and Anderson there would have been no salvation, for the stove would have kept on burning, generating fresh quantities of poison.

"It seemed to us the next day, and it seems so to me still, that this not very romantic adventure was the narrowest escape we had on our whole expedition."

BYRD EXPERIENCE

It was under similar circumstances of a fire burning in a poorly ventilated room that one of the men of the first Byrd expedition to the Antarctic (1928–30) was overcome in the room used as a photographic laboratory. And there is indication of monoxide poisoning in Admiral Byrd's own experience during the "vigil" of his second expedition. Thus has the peril of monoxide poisoning dogged polar explorers at least from Barents in 1596 to Byrd in our time.

Some of the points with regard to monoxide poisoning are:

1. It is unfortunate that the word "fumes" is so often used in describing monoxide poisoning. If there are any smelly and disagreeable fumes they are from another cause; and, while a nuisance, are really a good thing, for they constitute a warning. Frequently there is no such warning.

2. It is equally unfortunate that many associate monoxide with dioxide and believe that, particularly if they are watchful, they are going to notice a warning difficulty with their breathing. There are many, too, who believe that by lighting a match or burning a candle you can get advance notice of how the gas accumulates. Such warning, if any, is indirect and connected with the, from our present point of view, not dangerous dioxide.

3. Even among those who, from automobile experience, understand that monoxide does not smell or give much warning, there is a failure to be suspicious of many common sources. Monoxide, for instance, is produced by charcoal fires and there is danger when, as explained in Chapter 7, you use the inland Eskimo style of making a roaring fire, throwing out the smoking embers, and covering up your smoke hole. Eskimos, when they do this, usually have a door open; but white men, especially those new in the country and afraid of the cold, are likely to close the door.

4. It is not sufficiently realized that carbon monoxide will pass through iron. Apparently it begins to pass right through the sides of a stove out into a room when the iron is at red heat. If and when it gets to white heat the dioxide is said

to pass out through sheet iron, and probably cast iron, almost as readily as if it were air seeping through canvas.

SYMPTOMS

Stefansson feels, in thinking back to his experience described above, that in many cases, if you watch carefully, a feeling as of pressure on the temples can be detected for some little while, perhaps only a few moments, before you keel over. In some cases, particularly if the poisoning is slow, there are auditory symptoms. You hear what may seem like a slow drum or a measured tread but what is really the beating of your pulse.

A DEBATED PROCEDURE

It was the experience of Stefansson and three companions, when two of them "passed out" and two were barely able to move, that when they came out into fresh air and began to breathe it as deeply as they could there was an acceleration or increase of the monoxide effect so that (it seemed to them) the deep breathing produced a collapse—they had been barely able to stand and were now forced to lie down. From this they thought that perhaps the deep breathing had forced the monoxide farther out into the lungs and should be avoided accordingly. However, this does not appear to be sound, in view of recent studies.

Professor Yandell Henderson of Yale has recently done extensive work on the symptoms and effects of carbon monoxide poisoning, as well as in the treatment of this type of asphyxiation.

HENDERSON'S TREATMENT OF MINOR CASES

The treatment which Henderson suggests for cases in which the victim is still conscious and able to take certain precautionary steps is:

"Lie still, keep warm and, if it is available, drink either a bottle of some carbonated water or a cup of coffee. The carbon dioxide in the carbonated water will stimulate deeper, fuller breaths, and thus hasten the ventilation of carbon monoxide from the blood."

HENDERSON'S TREATMENT OF ACUTE CASES

For acute carbon monoxide asphyxia, Henderson has introduced a treatment which is now standard with doctors and hospitals. This is:

Administer an inhalation of CO_2+O_2 for the purpose of increasing pulmonary ventilation and thus expediting the elimination of CO from the blood.

WHAT TO DO IN AN ARCTIC CAMP

On the basis of his own experience and the results of Professor Henderson, Stefansson believes the order of procedure when you realize you are being poisoned should be:

1. Remove the cause; as, for instance, turn the spigot of a primus stove to relieve the pressure, whereupon it goes out instantly.

2. Go outdoors, if you are able, walking slowly or perhaps crawling with a minimum of exertion.

3. If some occupants cannot walk out, the important thing naturally is to do whatever is necessary to secure ventilation.

4. So far as possible follow the treatment outlined by Henderson—lie still, keep warm, draw deep breaths to help elimination of carbon monoxide from the blood.

5. As soon as possible after you get into the open air, crawl into a sleeping bag to avoid danger of freezing—also to comply with the second rule of Henderson's treatment, to keep warm.

CHAPTER 11

TRAVEL

SECTION I

GENERAL CONSIDERATIONS

Many things bearing on travel are discussed elsewhere in this Manual—for instance, in the sections on camps, hunting, dogs, sledges, etc. Here we deal with the general principles and the basic technique of Arctic travel.

MAPS

Besides being inaccurate, most Arctic maps carry only the names of explorers, patrons of exploration, or friends of the map makers. Therefore the places and names on such maps are unidentifiable through information from natives, and commonly even from resident whites. To have full value to the traveler, a map of any given district should carry local names as a supplement to the others. Such maps need frequent amending, since most native settlements are temporary in character and shift in locality from year to year.

CHRONOMETERS

No matter how small the party, three chronometers should be the minimum number carried, for if you have only two and one goes wrong you will not know which one is wrong.

WATCHES

Watches where the dial is numbered to 24 instead of 12 hours are a great convenience and almost a necessity because, in summer when the sun never sets, and when at times there is thick foggy weather for many days in succession, it is often a matter of doubt, if you carry an ordinary watch, whether it shows 12 o'clock midnight or 12 o'clock noon.

It may seem incredible carelessness to lose track of time so far that you are in doubt which of the 12-hour periods you are in; but it happens frequently. Under special conditions you may travel 15 or 20 hours continuously. At the end you may happen to get a blizzard which induces you to rest in camp a while, free to sleep as long as you need or desire. In summer, when there is no darkness, one's irregularity of habits become marked. You may not feel any special inconvenience from staying awake 20 or 30 hours (Eskimo children do it frequently) and you are equally likely to sleep for 15 or 18 hours. Such things may put you 12 hours out of your reckoning, not so likely 24 hours.

CLOCKS

If you are taking sextant observations, you will find few things more useful than an alarm clock. In summer, when most traveling is done at night, you will, without an alarm clock, either have to sit up past camping time and wait for noon or you will neglect your observation because you will not be awake for it. Similarly you may need a midforenoon or midafternoon awakening for a longitude sight.

MAPPING AND SURVEY

If the conditions of visibility are favorable and the coast line pronounced enough so that one can see at a distance the distinction between land and sea, fairly good mapping can be done, on some such scale as an inch to the mile, at the rate of 10 miles a day.

Those unfamiliar with low Arctic coasts will scarcely realize how difficult it is, when you are traveling along offshore, to decide on looking toward land whether you see an island or part of the mainland. An example is the north coast of Alaska. Suppose yourself traveling along, by sledge in winter or boat in summer, and using the best map available to 1940, that made by E. deK. Leffingwell and published by the U. S. Geological Survey. Some of the islands will give you no trouble, being far from the mainland. For instance when you look toward Cross Island, 10 or 12 miles from the shore, you see no mainland beyond and there is nothing to confuse you. It is quite different with an island like Flaxman which is only 3 miles from the mainland. If you are a traveler passing by in summer by boat or in winter by sledge, and if you are 2 or 3 miles outside Flaxman, you will have to depend on your dead reckoning or upon a longitude sight, rather than upon your eyes, to be sure that you are passing an island and not an outward projecting section of the mainland.

The first of travel principles is "Do in Rome as the Romans do." In the Arctic this means using methods of travel which the forces of evolution have taught to the dwellers of northern lands, instead of methods which Europeans, some of them ingenious and energetic, have evolved from their inner consciousness and from the limited experience of half a dozen years.

John Rae and John Franklin probably seemed about equally resourceful in London, England; but in Repulse Bay, Arctic North America, John Rae wintered his party in health and comfort; a few years earlier, in the same locality and with the same resources, John Franklin's entire company of able-bodied Englishmen starved helplessly and died to the last man.

"Better be safe than sorry." A thing that is showy, that looks daring and sportsmanlike, has a strong appeal but frequently leads to distressing results. Equally distressing results, however, follow the too conservative course. The idea, then, is to take such risks as come but do not go out of your way to invite them.

You cannot keep anything secret in the North. This was true even before the days of radio; if a Hudson's Bay agent stubbed his toe in January, everyone for hundreds of miles had heard about it by March. If you want to keep operations secret, you must give them a logical explanation other than the true one.

This disposes of the fiction that is written about criminals hiding successfully in the North. It cannot be done; for people are so few that every newcomer is thoroughly scrutinized and discussed, and his path from one village to another is as clear as if it were studded with torches.

TRAVELING SEASONS

Spring is the worst of all seasons for Arctic travel. The total snowfall of the year among the Arctic islands north of Canada is equivalent to only a few inches of water; but half of this falls in the form of snow, mist, or fog between late April and late June, when the rains commence. On the ground during these spring months visibility is frequently for several days at a time always less than half a mile. Diffused light is continuous for many days at a time. Sledges stick in slush far worse than they do in the soft snow of winter, and much of the time you wade as you walk. Mush ice will ruin a sledgeboat (described elsewhere) after two or three trips.

SPRING CAMPING DETAILS

In spring, travel platforms of some sort are needed at camp time to keep bedding from contact with the ice which, when the sun shines, is wet from thaw water, and in rain even wetter if that be possible. For so keeping bedding off ice you use what you have—box boards, willows, pieces of rope.

ICE TRAVEL SHOULD NOT BE PLANNED AFTER MAY 1

If ice travel is planned, if not the result of emergency, you should not leave shore after May 1. (For the dangers and difficulties of travel at this season, see discussion in Section III of this chapter.)

SUMMER

In summer travel overland, pack dogs are used. As described in Chapter 12, the pack-saddles consist essentially of two big pouches that nearly reach to the ground on either side of the animal when the pack is in place. However, as pointed out there, if the dog is small the mere fact that he has to wade will get your pack wet. Any dog is liable to lie down in water deliberately, to cool off. In Section II of this chapter we tell of the difficulties of summer travel—the number of lakes, the mosquitoes, the swamps, the rocky areas that wear out your boots.

AUTUMN

Autumn is the harvest season on the Arctic tundra. Caribou are still short-haired and their skins suitable for clothing; they are still fat and their meat therefore good eating.

But autumn is a transition period. In travel you are not comfortable for the snow is as yet not hard enough for snow houses but the temperature already too low for comfort in a tent. During a week or two after the equinox you still have more daylight than if you were at the equator; but thereafter darkness comes on with giant strides. Particularly if you are on a small and northerly island, or out at sea north of Alaska or Siberia, fog, fine mist, and snow fill the air continuously for days and even weeks in the period September–October. As will appear in the discussion on winter (below), sea ice travel should not be planned for autumn.

WINTER

Snow and ice are your best friends in the north, for they make travel easy in cold weather. Winter travel and its conditions are dealt with later in this chapter, under Sections II and III. However, the following applies to both sea and land travel.

In midwinter it is cold in the Arctic, but when you are properly dressed you don't mind it. Fifty or sixty below is a little too cold, for if you run or exert yourself violently and take the air rapidly into your lungs in consequence, it has a sort of burning and half-stifling effect. Moreover sledges, unless shod with ice, drag heavy, almost as if the snow were sand.

Forty below is about right. Your first morning in that kind of weather is a marvelous experience. The air is so clear that you can see 3 or 4 times as far as you can in any lowland in the south (mountain air is clear in all parts of the world, though not quite equal to polar air). But if your seeing is improved 2 or 3 times over, your hearing is aided 10 times more—the sounds carry 10 times farther. You can hear distinctly at a mile the footfall of caribou walking quietly through slightly crusted snow. (See also Chapter 3.) From Christmas to April most days have these clear Arctic skies, with help to sight and sound.

Assuming that no emergency is involved, you should not leave land for sledge travel over the sea until after the first part of February. Before this the nights are so long that the probability of getting involved during darkness in ice movement is very high. Attempting to travel without daylight with sea ice breaking under you is almost as dangerous as it would be for a blind man to cross streets in heavy traffic.

TEST OF WINTER TRAVELING WEATHER

Whether your dogs will or will not face the wind is the test of fit and unfit traveling weather in the Arctic, for a properly dressed man will face a wind that is too much for the Eskimo dog.

There is nothing you can do to force a dog to travel into a wind or a snowstorm that he feels is beyond him. He will simply curl up, nose in tail, and try to go to sleep. If you insist on forcing your dogs, you will end by having to go ahead of them and drag the team as well as the sledge.

HEALTH

It seems to be a law of human nature that when you are in good health, relief from discomfort becomes so keen a pleasure that it compensates for whatever has gone before. Even in the discomforts of spring travel, you will find that there is no connection between such ills as rheumatism and being continually soaked with cold water, getting dry in between times. Common respiratory infections (the common cold, for instance) are found in travel only under special conditions that seem unrelated to weather or comfort. For this and other related subjects see Chapter 10.

SORE FEET

It seems to be the general experience of long-distance walkers that you give out through sore feet rather than weariness of the whole body. The best remedy, next to a rest, is to change socks and boots. The new footgear presses on different spots and rests the chafing parts. If your footgear is of the Eskimo type, with no difference of shape between left and right boots, it will be better than nothing to shift boots and socks from one foot to the other.

EMERGENCY DIETS

On a diet of fats alone you gradually lose strength but this symptom of malnutrition is not so conspicuous as a sleepiness and a mental inability to call quickly into action such strength as you have.

The symptoms that result from a diet of lean alone are practically those of starvation. You eat so much that your stomach is actually distended, but you feel continually hungry. See Chapters 8 and 10 for detailed discussion of diet.

In emergency the best practice is to feed your dogs as long as you feed yourself, for the speed of the party depends on the strength of the dogs. Aside from humane considerations, hoarding food to their disadvantage eventually means losing speed to your disadvantage.

RIDING ON SLEDGES

We have said elsewhere (Chapter 12) that no man should undertake Arctic work who cannot walk as many miles a day as his dogs are able to haul his sledge and camp gear. This, naturally, does not apply to a man who is invalided for one reason or another, though the best procedure is, if possible, to stop and camp.

LOADS CARRIED

In cases where it is necessary for a man to pack his own load, it is worth noting that in the early days of the Hudson Bay Company, goods used to be made into 90-pound packages, each of which was known as a "piece." Some men could carry two of these. The Company's rule was to employ no man in portaging who could not make 80 miles in 4 days, carrying, in addition to the 90-pound piece, whatever he needed in the way of food and bedding.

HAULING FOOD

The weakness in a system of travel which takes with you all the food you think you can possibly need on a journey and makes no preparation for gathering more from the country when stores are exhausted, is that when unlooked-for circumstances stretch the time beyond the reckoned limit, supplies run out, dogs are eaten, skin, clothing, and harness follow, and then death comes from cold and starvation.

So long as you are traveling in a country supplied with game, you are safer to start with a rifle and with the resolution to find food (but, if the compensating is required, without a pound of food on your sledge) than you would be in starting with a sledge heavily loaded with food and with no provision made for getting more when the load has been eaten up.

HAULING FUEL

In Chapter 7 of this Manual we discuss the materials that will serve you as fuel. However, we repeat here what we say there: *Hauling fuel is more important than hauling food* and the kind of fuel more important than the kind of food. You get better results from kerosene burned in a blue-flame stove than from seal blubber burned by any method so far devised—a primus stove cooks more rapidly than a seal-oil lamp, and is more cleanly than an outdoor fire of seal blubber.

ERRORS IN JUDGMENT DUE TO DIFFUSED LIGHT OR FOG

If you are in foggy country in winter, you must be continually on guard. The daylight is negligible; the moonlight, if it comes to you first through clouds that are high in the sky and later through an enveloping fog, is a light which enables you to see your dog-team distinctly enough, or even a black rock a hundred yards away, but is scarcely better than no light at all upon the snow at your feet. In mountainous terrain, for instance, your eyes cannot tell whether you are going to step on a bank of snow or into an abyss.

PROCEDURE

Under such conditions you would ordinarily stay in camp unless you could follow a valley where, without great danger of falling, you would be merely inconvenienced by walking now and then against the face of a cliff.

But if you have to travel where there is possibility of walking into a crevasse or over the brim of a precipice, you can at least use some fairly effective precautions. For instance, you could carry two or three dark mittens or boots that you would be able to do without if you lost one of them. With these in your hands or in your pockets you walk ahead of the team. Throw one mitten about 10 yards ahead, keep your eye on it until you get within 3 or 4 yards of it and then throw a second mitten. Keep doing this so that most of the time you can see two black spots on the snow ahead of you separated by 5 or 6 yards of whiteness. You are not safe in throwing one mitten only and walking up to it; for, being light in weight, it may be lying on the snow overhang at the edge of a cliff, an overhang that would break under your weight. (See chapter 4 for a more detailed discussion of diffused light.)

EQUIPMENT FOR TWO OR THREE MEN TO LIVE BY HUNTING AT SEA OR ASHORE FOR 2 YEARS

In keeping with the main purpose of this Manual as a guide in emergency, we give a sample list of equipment by which two or three men can find their way about, supporting themselves, living and traveling in comfort for 2 years, whether on the Arctic pack, on an Arctic shore, or inland in an Arctic country. Substantially this is the outfit used on the third Stefansson expedition when planning a 2-year journey for three men and six dogs.

With the general aviation slant of the Manual, we point out that this is also the emergency outfit that might be carried in an airplane by three men making a flight across the Arctic Sea by any of its diameters. If they make a safe forced landing and can neither fly again nor summon help, if they are in good health at the start, use reasonable judgment, and have reasonable luck, they ought to be able to make their way to some native or white settlement in 2 years, or less, through the use of this equipment.

SLEDGE

For an airplane we recommend a sledge of the type made by Anthony Fiala for Charles A. Lindbergh, in consultation with Stefansson, when Lindbergh was preparing for his survey of Greenland and of the lands east and west of it in 1933. For description see Section IV of this chapter. For description of sledges to be used on a planned journey from a base camp, see Section II, Chapter 12.

DOGS

For a long journey from a base we recommend five large dogs of weights from 80 to 120 pounds, hitched tandem; second choice would be seven smaller dogs driven Nome style—three pairs on either side of a central trace and the seventh dog at the end of the trace as a leader. For methods of hitching see Chapter 12, Section IV.

We make no recommendation as to whether an airplane should take one dog or none. This would depend chiefly on the character of the flyers and on their opinions. If the dog is taken, he is for three chief uses: (1) to help get seals by the mautok method described in Chapter 13, Section II; (2) to give warning of polar bears that may approach camp (not so much because the bear is dangerous as because you want to be waked up or warned so you can go out and shoot him for food; and (3) to help in securing a bear that is fleeing—see Chapter 13, Section II for discussion of dogs in bear hunting.

WILKINS ON EQUIPMENT

Wilkins, who formed his ideas of northern travel during 3 years on the third Stefansson expedition, differs from Stefansson only upon minor points as to equipment for a party planning to live by hunting while making its way ashore from a forced landing. As he has unequaled experience with flying over the northern pack, we give next the actual list of things he took with him in 1928 on the first (and up to 1937 the only) flight by airplane across the Arctic—from Point Barrow to Spitsbergen by a course which took him past Greenland between 100 and 200 miles north from its north coast. This outfit he looked upon as adequate for supporting himself and Ben Eielson for 2 years. They had no dog, so did not expect to use mautok hunting. They carried no sled because they expected to construct one if it were needed from certain parts of the airplane.

As basis for comment on the list we insert numerals within parentheses:

EQUIPMENT FOR TWO MEN FOR 2 YEARS

Combined seal spear and ice chisel (1), an axe, a small alpine axe, an apparatus for securing seals from the water (2), two rifles (3), 350 cartridges (4), 3 snow knives (5), a saw (6), two pairs of snowshoes, two half sleeping bags with waterproof covers, strips of deerskin to place beneath the bags, a wind-proof and waterproof tent with a waterproof flooring (7), straps for making packs of sleeping bags, a duraluminum-shod runner which we could fix to the upper part of the fuselage and so construct a sled-canoe (8), a Primus stove, two cooking pots, cups, plates, and spoons, four half-gallon containers for fuel, one of them filled with alcohol, another filled with ether to be used either for starting the engine in cold weather or in case surgical operations following an accident were necessary, bandages, medicines, a complete field surgical outfit, a small quantity of tobacco and some coca leaves to be used for alleviating hunger (9), two canvas covers for the engine and special stoves for heating them, fishhooks, fish nets, and sinkers. A piece of the fish net could also be used on the end of the seal spear for netting small auks and other birds should we find ourselves marooned on one of the Arctic islands (10). Our spare clothing, with what we wore, provided for each man two fur shirts, two pairs of fur socks, fur breeches, sealskin breeches, one pair of cloth breeches, four pairs of Angora woolen socks, two pairs of sealskin winter boots, two pairs of sealskin summer waterproof boots, two pairs of fur mittens, one pair of waterproof mittens, silk snow shirts and silk snow trousers (11), tooth brushes, tooth paste, hair clippers, safety razors and shaving cream, soap and a towel (12), a small mirror, a small pocket compass, sheath knives and small files for sharpening them, a magnifying glass, a waterproof box for matches, handkerchiefs, a sewing kit, silk and sinew for repairing boots and skin clothing, two pairs of snow glasses (13), and a thermos bottle. For food we carried 5 pounds of sweet chocolate, 20 pounds of biscuits, 20 pounds of pemmican, 24 pounds of malted milk in tablet form, and 5 pounds of raisins (14).

1. An ice chisel should have a hardwood handle, 1¼-inch diameter, 7 or 8 feet long, or should be made of two segments to total that length, for you may have to chisel through 6 or more feet of ice. The chisel itself should be of steel about ¾ inch wide and 1 inch thick. The seal "spear" is a harpoon — an actual spear would be of no value.

2. This is the manak described in Chapter 13, Section II.

3. For economy, and because of the kind of game there is in the Arctic, the rifles should not be of larger caliber than .256 (possibly .22 would be as good). There are special reasons for a very flat trajectory, given in our Chapter 13, Section I.

4. Wilkins allowed 350 cartridges for two men for two years. Stefansson considers this an adequate allowance for three men and six dogs for two years.

5. The snow knives should be butcher knives of rather soft steel. You might have them different lengths, 14-, 16- and 18-inch blades.

6. This would be a carpenter saw with, say, 2-foot or 2½-foot blade, and would be used for cutting snow blocks when the snow was very hard; apart from that it would serve any other purpose of a saw.

7. Wilkins is probably wrong in preferring that a tent shall be self-contained—floor in one piece with the rest. It is not possible to keep snow out of that kind of a tent; and once you have snow in, getting it out is difficult. Better have flooring in a separate piece.

8. Wilkins plans to make a combined sled and canoe out of his fuselage. He had no sled. We recommend carrying a sled and a tarpaulin. You can then construct a sled-boat, as described in Chapter 12, Section II. This tarpaulin will serve also a number of other uses.

9. The tobacco and coca leaves would be intended for use during the same period as the emergency rations listed below. In the long run there is no point in carrying either tobacco or stimulants.

10. Use of such nets is described in our Chapter 13, Section III.

11. The silk must not be of the waterproof type that is filled. What you need is some densely woven unfilled cloth.

12. In the list "tooth brushes, tooth paste, hair clippers, safety razors, and shaving cream, soap and a towel," the only thing necessary is the clippers. They should be beard clippers that will give you the nearest thing to a shave. In summer you can afford to let beards grow; in winter you must always keep them so short that ice does not cling, which means that you use beard clippers about once every 3 days. (Wilkins no doubt carried the toilet equipment because at the end of his journey from Barrow he wanted to make a good impression on the Norwegian colony in Spitzbergen—which he did, having shaved and cleaned up in a camp in their neighborhood before coming into the first settlement.)

13. The glasses Wilkins carried were amber; this color protects the eyes as well as any other and is better than other colors for aiding vision in diffused light.

14. If you add up the weight of all these food articles and divide by two you have 74, the number of days for which Wilkins carried rations. His idea was to use them while getting ashore, if his plane came down near land; alternatively, they were to be used while getting equipment ready, as, for instance, while building a sled canoe out of the fuselage of the plane. There are more than 700 days in 2 years. Obviously you cannot carry food for that length of time whether for two or three men. You could perhaps carry it in the plane, but the men could not haul it with them when they started toward shore—would have to leave most of it behind.

The Wilkins outfitting is on the basis of not using a radio for SOS purposes and then waiting for help. If one relies on a radio and a rescue one should take as much food as the plane will carry in addition to the things it must carry, as gasoline.

As we have explained in the sections on Hunting and on Animal Life, if you camp on a floe waiting for rescue, bears are sure to walk in every now and then, each giving you on the average more than 400 pounds of actual food, for they would run at least 800 pounds live weight. The ice would crack near you now and then and in the leads you could get seals. You could dip up shrimps out of the leads with a net made from a handkerchief.

Important things not mentioned by Wilkins are sextant, field glasses, and miner's pickaxe. He had a sextant and simply forgot to mention it when he made up the list. He also had field glasses. These, if not of too high a power, are, as we have dwelt on elsewhere, next in importance to the rifle itself when it comes to living by hunting. He probably had a miner's pickaxe, for he is a believer in this instrument. It should have a head weighing between 2 and 3½ pounds. Perhaps you might carry a 2-pound pick and a 3½-pound pick, whether there are two men or three in your party.

If the party is three you would want three rifles; as said, the 350 cartridges would be enough for three men whether they have two or three rifles.

Section II

ON LAND

LANDMARKS

When a group sets out for a day's land travel, they may need to be found at evening, perhaps in darkness, by some other person, such as a man who hunts to supply them with food. They should, then, agree in advance that the camp will be made near some landmark, preferably of a linear nature. Pitching camp near the foot of a conspicuous round hill would be of little use, for whenever the weather became thick, or the night dark, you would be unable to see the hill from any distance. A lantern hung on a tent is sometimes of use but is frequently taken to be a star. Besides, you could not see it far in thick weather. The landmark of most use, then, is a long, fairly straight ridge or a cutbank conspicuous enough and characteristic enough not to be overlooked or mistaken for another.

Likewise the group should agree in advance that if one member is separated—whether through accident or through the deliberate purpose of hunting—the trail of the party following a coast by sea ice should go close in at every prominent headland so that the one following will have less difficulty in picking it up. If he loses it, he can make for the next headland and pick it up again there.

LEAVING CAMP TO LOOK FOR GAME IN THICK WEATHER

If you are in a country new to you and if there are no river courses or landmarks that can be followed with the assurance that you can also follow them back again, it is, in thick weather, a matter of the closest observation and the most careful reckoning to find your way home to camp.

NOTE WALKING SPEED AND WIND DIRECTION

As you advance, you must notice the speed at which you are walking and the time you walk on any given course, and you must know exactly at what angle to the wind you are traveling. Furthermore, you must check the wind occasionally, either by a pocket compass or a snowdrift, to see that it isn't changing, for an unnoticed change would throw any reckoning out of gear.

MEMORIZE TOPOGRAPHY NEAR CAMP

Before leaving camp, walk around it, study each aspect of any landmark, until you feel sure that if you strike any point within half a mile of home you will recognize it on the return.

TRAVELING PROCEDURE

When the topography of the half-mile square or so surrounding the camp has been memorized, you strike out perhaps into the wind or perhaps at an angle of 45° or 90° to it and travel straight for an hour or two hours, according to the degree of confidence you have in your ability to get back. If no game has been found, you turn at some angle, commonly a right angle, to your original course, and walk in that direction an estimated distance, perhaps as far as in the first direction. If nothing has been found, you turn again. If this time also you make a right-angle turn in the same direction, it is easy to calculate at what time you are opposite camp and 1 hour or 2 hours' walk away from it. Turning a third right-angle will face you directly for camp. If you have been careful, you will come within half a mile of your mark, or within the area memorized before starting. But should you miss it, you will know at any rate at what time you are close to camp. By thinking the matter out you will see how to walk around in circles or in squares of continually increasing size until you find a place you recognize.

PROCEDURE WHEN GAME IS SIGHTED

If in the course of your walk you do see game, your first thought must be to take the time by the watch or make some similar observation to assure yourself of the direction of your camp at that moment. If you can kill the game on the spot, the matter is simple. But if you have to follow your quarry about a good deal, or if it is a trail you have come upon rather than the game itself and you follow the trail, then it is not so easy to lay down rules for getting back.

Everything can, however, be summarized by saying that you must continually memorize your course; if you do this, angles and distances will determine approximately the course you must eventually take when you start for home.

This outline of procedure in a storm, or at any time when direct vision will not serve, shows at once why it is that a white man of trained mind can find his way home so frequently when a native gets lost and has to camp and wait for clear weather.

FINDING CAMP IN THICK WEATHER OR DARKNESS

If you want to try to find a camp in darkness or thick weather, the first rule is not to try making a straight shot toward it. For if you do and miss, you will not know which side to turn to look for it, will flounder, get confused. The thing, then, is deliberately to set your course to the right or to the left of where you know the camp to be.

PROCEDURE WHEN LOST

In the sentence just above, the important word is *know*. If you don't know where the camp is, the first principle is to stop quietly where you are and wait for daylight. Every time impatience whispers to you, "Make a shot at it, you might hit it," let discretion answer, "Yes, but if I miss once I'll never know if the camp lies to the right or left, ahead of me or behind. Now I know it is ahead of me and that I will inevitably find it when I begin to be able to see clearly."

Even when your instincts amount to conviction, you should remember that a night's camping out will do you no harm, but wandering around hopelessly lost will exhaust your energy and endanger your life.

The suggestion here made, that instead of aiming straight for camp you should aim deliberately for a point to the right of it or to the left of it, is applicable to flying. Two flyers who have been particularly successful in supplementing navigational technique by common sense are the American Lindbergh and the British Cobham. They have both said that when flying across an ocean toward a coast they head either for the right or the left of their target so that when they strike the coastline there will be no vacillation—they will know which way to turn and will never have a doubt that after turning they should continue in the chosen direction until their goal is reached.

There are on record many failures due to attempting a direct hit on your target. One of these was the flight of the Americans Bert Hassell and Parker Cramer in 1928, when they took a departure from Labrador and were aiming for the University of Michigan base, Camp Evans, in the Holsteinsborg district of Greenland. When they struck the coast they were disappointed not to recognize the topography. Having attempted a direct hit, they did not have any conviction as to which way to turn, but decided on turning right and flew south along the coast for 100 or 200 miles. They found no camp and were eventually convinced that they should have turned left. Reversing their course, they flew north; but their gasoline gave out before they got as far as the point where they had originally struck Greenland. Obeying an elementary rule, not to descend upon snow-free land if a glacier is available, they flew east, had gas enough to get 20 miles beyond the ice margin, made a safe descent on the Greenlandic Inland Ice, abandoned their plane, and walked back to the coast. It turned out that they had originally struck Greenland only a few miles to the right of their target, Camp Evans. If they had made sure by striking 50 or 100 miles to the right and had then turned left, they would have had ample gas to find the University of Michigan camp.

This is, then, a general principle, applicable whether you are walking, sledging, or flying: If your target is on a coastline, along a river, or along any linear feature that is at an approximate right angle to your course, then never aim direct for the target. Aim farther to one side or the other, so that when you strike your landmark you will be without qualms of doubt on whether you should turn right or left.

TO FIND A CAMP OR DEPOT ON A COASTLINE

When, afoot and in darkness, you get near a place you want to find which is on the coastline, or along some more or less linear topographic feature, you begin a zigzag search—except, of course, if the linear mark is something abrupt and unmistakable, like a river cutbank or a cliff along a seashore. Suppose, for instance, you have been told that a camp you have never seen is on the coast 15 miles ahead of you. Remembering the uncertainties of an estimate based on time and distance, you should not go more than what you think is 10 miles before you start your zigzag.

We have explained elsewhere that it is never pitch dark in the Arctic; so that a camp, even if it be snowhouses invisible in themselves, is certain to have dark markings (like sledges or dogs) that you can see a hundred feet away. You may not know whether the camp is on the sea ice a little way from the shore or on the land some distance from the beach. Accordingly, you will walk as far as you think necessary out to sea; then you turn and walk toward the land so as to strike it not more than 200 feet ahead of where you left the shore (the hundred-foot visibility being your standard). You now continue in the same direction inland. A camp, in ordinary northern practice, whether white or Eskimo, would not be more than a hundred yards from the beach; more likely 25 or 50 yards. Finding nothing, you zigzag back down to the coast and out to sea, repeating until you are sure you have gone well beyond the 15-mile distance. Then you stop and wait for daylight, moonlight, or a mere clearing of the sky that will extend your range of vision. You camp if you think necessary. But it may be that even in daylight it is not easy to tell just where the land meets the sea; numerous travelers have reported that they were half a mile or a mile inland before they realized that they were ashore. If that is the sort of coastline with which you are dealing you must kneel down every now and then and, with your hunting knife, dig through the snow and do some chipping. Probably you can tell from the consistency whether you are driving your knife point into ice or into frozen muck. If not, you should take very small pieces and melt them in your mouth. Don't try a large piece, for you might freeze your lips or tongue, even perhaps losing a piece of skin that stuck to the chunk of ice or mud.

CAMPING OUT

One of the hardest to eradicate of false beliefs is: "When lost in a blizzard you must keep moving; you must not go to sleep, for if you do you will never wake again."

This has led to the deaths of many men, the deaths themselves seeming to furnish corroborative evidence. However, analysis has proved, as will appear below, that these men died not because they were lost in a blizzard but because they kept moving while lost.

By pinching and punching yourself, by forcing yourself to keep awake, you use up energy that is needed to keep you warm. Through exercise and through panic your sweat glands start working and perspiration makes your clothing wet. When you are so worn out that you cannot keep awake any longer, exhausted and wet, you drop in your tracks and then you may never wake again.

It happens fairly often with Eskimos that they are caught in blizzards and that they return to camp when the weather clears, no worse for their adventure. In fact, to their way of thinking, it has not been an adventure at all.

EXAMPLE OF CORRECT PROCEDURE

The winter 1908-09, Stefansson, traveling along the coast west of Herschel Island, came to an Eskimo camp and found there an old woman who had just reached home after being out in a 3-day blizzard. When half a mile from her house, she realized she could not reach it and sat down on a hummock with her back to the wind. But the temperature was well above zero, as it usually is especially at the beginning of a gale, so her body heat melted the snow under her and she noticed dampness. Blaming herself, as she said afterwards, for not having foreseen this, she took off her mittens, laid them one on top of the other, and sat on them, which gave sufficient insulation between her body and the snow. She slipped her arms out of the sleeves of her coat, tucked the sleeve openings under her belt, and sat with her bare arms crossed on her bare body inside the clothes. Leaning forward, she was soon asleep.

But during sleep your "vitality" is lowered and you are chilled more quickly than if you were awake. This chill woke up the old lady, just as a corresponding chill would awaken you if your bedroom window was open and your blankets were too few. Not having a window to close or blankets to put on, the old lady stuck her arms back into the sleeves again, put on her mittens, and walked about until the stiffness from her cramped position was gone, as well as the chill. Then she sat down on her mittens and did exactly as before, including the sleeping.

By alternating procedures, she passed approximately 70 hours, the weather getting much colder toward the end and finally clearing with intense frost. When the drift lessened she saw the house and returned to it. She said the time had not seemed particularly long because she slept a great deal, and that she had not been very hungry except toward the end of the first day.

The principles to remember, then, are:

Don't keep moving—keep still.

Keep your clothing dry.

Sleep as much as you can—because it both saves energy and passes time.

In temperatures of −10° or lower, a makeshift snowhouse, such as described in Chapter 7, or a snow wall will be of advantage. In higher temperatures your clothes are sufficient protection and a snowhouse will make you soaking wet. For snowhouses are dry and really useful only in very cold weather.

If you have a sledge and dogs, you should not, as explained elsewhere, trust them to bring you into camp. They are likelier to lose their way than you are. The exception is that if your camp is up the wind the dogs will take you home, their lead being the sense of smell.

Well-furred dogs need no protection from snow and wind. Just unharness them and let them lie where they want to. In very cold weather, take them into your emergency snowhouse—in your own interest, not theirs, to warm up the house. They are company, too.

When you have a sledge but don't build an emergency house, do whichever you find most comfortable—sit in the snow with your back to the wind (in the lee of the sledge) or lie on the sledge with your head to the wind.

TELLING DIRECTION BY WIND

If you know the country, the wind is an aid in determining direction. Take, for example, a region like that east of the Colville delta, Alaska, where commonly only three winds blow—southwest the strongest, northeast next, and east-northeast third. Ordinarily you will know as a matter of recent history which wind it was that blew last, but in any event an examination of the ground will easily show.

TELLING DIRECTION BY SNOWDRIFTS

You should have learned the traits of drifts by studying the snow repeatedly after storms. The force, duration, and other characteristics you know. Failing that, common sense (if you don't get into a panic) will tell you a lot. Some elementary rules are that drifts made by the strongest winds are hardest, and that drifts are harder the longer ago the storm which made them. Furthermore you can tell the direction of the wind by the fact that the drift is lower and narrower to windward and gets higher and wider to leeward before finally dropping down abruptly to the general level.

You may find, by seeing it or by feeling of it with your feet or your hands in darkness, that there is an overhang at what, by the rest of the signs, you think should be the leeward end of a drift; this means there has been a strong wind after the drift was formed which blew in approximately the opposite direction. This shows the drift you are studying is not from the last blizzard, perhaps from the second-last or third-last. If you were within a hundred miles (or at least within the same wind area) during the preceding few days or weeks, your memory of recent storms will aid in these interpretations and will help to give you your bearings.

As implied, if there is diffused light so there are no shadows, or if it is so dark that you can't see the drifts, you stop and feel them carefully with your feet or drop on all fours and examine them with your hands. Then, having determined either the northeast or the southwest drifts, you may decide to cross every such drift at an angle of about 45°, ignoring all the other drifts. You are then traveling the compass course east or west, and you probably know which of the two it is because you know from memory or otherwise, surely, the direction of at least one of the last two or three storms. If you don't know that, you may find a natural sign to guide you. For instance, east of the Colville, the coast generally runs southeast. An east course will, therefore, take you out to sea and you soon check that by the rough ice. For you cannot go far to seaward on that coast without meeting crushed ice.

On landfast ice you treat the snowdrift compass as if you were on land. To use it out at sea you must call upon knowledge that falls into another group. Floes of ice do not merely drift, in a general way, with the currents and before the winds; they are also pushed around in such a way that they rotate, one turning from left to right, another from right to left, depending on how other floes shove them. If you are within 15 or 20 miles of land, floes are small and they will have moved around a great deal so that the direction of snowdrifts is of very little use to you. The farther you are from shore the less the rotating motion, because of a less active moment and greater size of the floes which, in some cases, are 15 or 20 miles across. Anything more than a hundred miles from shore you can safely put a good deal of faith in the drifts, at least those that were made only a few days ago.

In properly mountainous countries the topography has such control over the drifts that they are of little value, unless you are a local man and know the topography thoroughly. In an Arctic forest there are no drifts that suffice for guidance—you will there have to fall back on woodcraft principles, which are the same as in the forests of the temperate zone.

SNOWDRIFTS ON GREENLAND ICE CAP

On the ice cap of Greenland the snow drift case is special. Toward the center of the cap, and perhaps more along a line running northerly and southerly a little east of the center, is region of comparatively few winds where the snow is soft and drifts not pronounced. Moving from central Greenland toward either east or west coast you have mainly drifts that go the same way you are going, that point downhill or point toward the nearest open sea; for, as explained elsewhere, the winds that produce these drifts are mainly of gravitational nature—the cold air flowing downhill toward the sea.

However, there are naturally gales of broad scope that sweep Greenland, ones not of local gravitational origin. In using for guides the drifts these make, you have to fall back on what we said earlier—your own knowledge of how long ago each of these gales blew, what its direction was and what its strength was.

PROCEDURE FOR CROSSING RIVER ICE

When the course of autumn travel takes you across rivers, a man should walk ahead of the leading sledge with an ice spear. This he jabs methodically into the snow ahead of him every three or four steps.

TESTING THE ICE

It may seem unnecessary to test ice when you have had continuous frosts for more than a month and the temperature is 20° or 30° below zero, but an understanding of the condition will show that this test is indeed necessary.

In the autumn when the river is still open, the falling snow melts in the running water and disappears. Later you may have a sharp frost for 2 or 3 days when there is no snow falling, and ice 2 or 3 inches or even a foot thick may form on the river. Then comes a heavy fall of snow. This blanket, like an eiderdown quilt or a fur robe, keeps the chill away from the river ice.

It now makes little difference how cold the air is above the snow. If the running water is a little above the freezing point, the current will gradually eat away the ice that was formed until there remains only a scum to support the snow above it. In some cases even this scum is eaten away and snow drops into the open water, leaving a gaping hole which can be seen and avoided. However, when an actual hole appears, the frost gets another chance so that it will not be many hours until clear ice, perfectly safe to walk upon, forms over that particular patch. The danger places, therefore, are not where any danger sign is visible but where the snow in front of you lies white and apparently safe.

FLOOD WATER ON RIVERS

In rivers so shallow that there is little danger of drowning there may be special danger of getting your feet wet, for such streams quickly freeze to the bottom in some rapid. The water upstream from the frozen obstruction will then be held back until finally it will burst through the ice somewhere upstream and flood the surface for hundreds of yards or perhaps even for a mile or two.

There are perhaps on the river's surface snowdrifts that lie clean across the stream in ridges, forming obstructions that dam the overflow water back, so that you may have 10, 15, or 20 inches of water on top of the previous ice.

If this flooding has taken place a few hours before you come to that stretch of river, there are only two courses open. Either you must scramble up the hillside and travel parallel to the river till you get beyond the flooded place, or else you must camp and wait till the surface water has frozen over. In winter this is seldom a long wait. The general rule is that if you come to one in the afternoon you camp overnight and expect the ice to carry you next morning.

IF YOU BREAK THROUGH

If for any reason you must travel over thin ice on a river, you are bound to break through several times. As soon as you do, jump instantly out of the water into a snowbank and rub snow over your wet footgear. Dry snow at low temperature acts like the best kind of blotter, soaking up all moisture. If you have on several thicknesses of woolen socks, for instance, you may slip to your ankle into water and jerk your foot into the snow so quickly that this blotter sucks the moisture out before it gets through all the different layers to your skin.

PREVENTIVE MEASURES

If you know in advance that you are going to get into water anyway, and if you are not wearing waterproof boots, go some place where you can stand firmly on one foot while you stick the other quickly into water and then into a snowbank. This will form a coating of frost in your outer stockings which will later on be waterproof and keep out further wettings almost as well as a sealskin boot.

The significant part of the above procedure is that it must be done quickly. It is best, therefore, to practice it at a base camp before you set out on a journey, for if you are inexpert your footgear will get wet through and frostbitten heels and toes may result. (See Chapter 10 for instructions as to what to do if you get wet all over.)

PROCEDURE FOR CROSSING LAKE ICE

In big northern lakes, strong currents are occasionally developed. Far from shore these are not dangerous, but in the vicinity of a point of land in a strait between islands the traveler should be exceedingly careful. Though the ice may be 10 feet thick in places, there are other places where men and sledges will disappear suddenly through the snow because the ice that formed before the snow fell there has since been eaten away.

Not merely proper waterfalls but very strong rapids will remain open all winter. In such cases there is usually an ice foot along either or both shores wide enough for dog sledges and men to pass. This is the case, for instance, with Bloody Falls on the Coppermine, which is a violent rapid rather than a fall. This ice shelf may possibly develop to a width that would accommodate a tractor but would probably not be of the requisite strength. Using an ice foot of this type is, in any case, likely to be dangerous, for it will probably slope towards the water giving the sledge a tendency to slide in sideways. The current being strong, the team would probably be dragged in after the sled and everything would disappear in under the ice at the lower end of the rapids.

A place likely to be open is the head of a river that comes out of a big lake. To travelers this is not a very dangerous situation. For one thing, under practically any condition, you will know that you are where a river is coming from a lake; then it is usually true that the ice is fairly thick right up to the open water. These ice-free places are a blessing to natives and to whites who are living off the country; for the fishing is usually pretty good in that sort of location and you can set your nets in the open water all winter.

DIFFICULTIES OF SUMMER TRAVEL

Unless it be spring travel along a coast, summer travel is the most disagreeable and difficult.

In Chapter 2, Section I, we have brought out in connection with ground frost that in about half of Canada, two-thirds of Alaska and an area in the Soviet Union as large as the whole of the continental United States, there is permanent frost in the ground; which, toward the end of no matter how hot a summer, is on the northern edge of the forest only a few inches below the surface, while near the southern limit of permanent frost the distance down is only of the order of 10 feet.

INNUMERABLE LAKES

The permanent frost, and the more so the nearer it is to the surface, creates innumerable lakes, ranging in size, let us say, from that of a silver dollar to that of Lake Erie. The tiny lakelets are a chief source of trouble in that they breed mosquitoes and other insects. When the lakes get bigger they are a nuisance to the summer traveler in that he must avoid them. When they are of considerable size in an unknown country you frequently are unable to tell when you strike one of them whether you should turn to right or left. You make your best guess and may win through between lakes; or you may find yourself on a peninsula, so that you have to retreat. When out on the tip of the peninsula, however, you have very likely had a good chance to study the lake and may have a clear idea which way to turn for the circumvention.

WADING ACROSS LAKES

If a lake is on flat country it may be worth while, even when the water ahead of you is a mile or two wide, to see whether you cannot wade across. There are cases where you can wade more than a mile at a practically uniform depth of four feet or less—so that, by carrying your baggage high on your shoulders, you can keep it dry. On such wading it frequently proves that you sink a foot or more into ooze at each step; for the tendency is for a thaw to go deeper under a small lake than where there is no water. It is probable that under most or all of the big lakes that do not freeze to the bottom the thaw goes indefinitely down—that there is no ground frost below them.

LAND BETWEEN LAKES MOSTLY SWAMP

On flat terrain lakes a hundred yards or more in diameter will occupy 60 percent of the area. The land between these lakes is mostly swamp, unless you are in rocky country. Accordingly, you sink more or less at every step. There are, true enough, large areas where this sinking is only slight and really agreeable to the feet—it gives a certain springiness to your walk. In other large areas you sink in a good deal and the mud may be sticky, clinging to your boots. There are parts of Banks Island, for instance, where you are likely to be carrying several pounds of mud on each foot except when you are on top of hills.

We have said that where there is ground frost there is no underground drainage. While true, this must not be given too extreme an interpretation—you must remember that where there is a considerable slope there will be surface drainage such that when it is a number of days between rains the ground will be fairly dry. What we just said about areas in Banks Island where you carry a pound or more of mud on each foot has broad application only following a rain.

NIGGERHEADS

A particular nuisance in the North is the niggerhead. These are about the worst at the northern limit of the forest, getting less of a nuisance as you pass from the American mainland out upon the Canadian islands. The formation somewhat resembles a mushroom—it is a knob of earth wholly covered with a grass pad which seems to act as a sort of umbrella against the rain, so that the foundation of earth upon which it rests is less in diameter than the head of the knoll. In between the knolls are cracks of mud. Typically, the knobs are of such size that a man with a good stride will step from the first to the third—stepping over one without touching it.

A perennial unsolved problem is which to do, to try to step upon the center of the niggerheads and slip off every second or third time, or whether to step in between them every time, straight down into the mud. Usually the slip downward, when your foot slides off a niggerhead, is something between 6 and 10 inches—seldom as much as halfway to the knee. It is a considerable jar, particularly when you are carrying a heavy back load.

As long as the ground is mud, grass or sand it is easy on your footgear. If you have the best type of Eskimo water boot, with an upper of small seal and a sole of bearded seal, two pairs will last you all summer—for as much as a thousand miles of walking. On stony ground, however, these soles will go in two or three days. There are known regions in the Arctic, as, for instance, east and southeast of Darnley Bay, where the broken rock is so sharp that your boots will go in 20 miles. For a party of Europeans it is best, if possible, to carry as spares for that sort of ground hobnailed boots of the heaviest type. If you do not have them, you use patches underneath your Eskimo boot soles, in the manner described in Chapter 9. The wear comes mostly on the heel and toe; so that, if the patches are renewed every morning, you can go on indefinitely. It is best, of course, that they shall be of the same leather as the boot sole, but if you don't have that anything else will do. You are probably living on caribou; you then save the fresh hide from the back of the neck of the largest bulls and use it for patches.

SECTION III

ON SEA ICE

a. Along Shore

A glossary of ice terms, together with brief explanation and description, is found in Chapter 2 of this Manual.

One of the ways in which coastal travel is transitional as to conditions and methods is in the ice. Ice that formed from water of brine saltness may be flush against the shore or, as in the mouth of a river, you may have near the land fresh water ice that extends many miles out to sea, even beyond sight of the land. So we discuss here interrelated qualities and behaviors of ice which was formed from salt water and ice derived from fresh water.

YOUNG ICE

The expression "young ice" is *seldom* used for fresh water ice, constantly for salt. The reasons will appear.

When fresh water freezes beyond the slush stage it has that glasslike quality with which we are familiar and which remains substantially unchanged as the ice thickens. The situation is quite other with salt water. The freezing does begin with a slush stage, as in fresh water; but this continues as the ice thickens. You may have fresh ice of glasslike quality only a quarter of an inch thick that is strong enough so you can handle it almost like a pane of window glass. You cannot so handle a piece of sea ice a foot square until it is more than 2 inches thick, perhaps 3. Sea ice as much as 3 inches in thickness will splash out rather than break if you drop a piece of it from a 6-foot height on to a hard surface.

It is because of this consistency of young ice that a man does not venture to walk upright on 4-inch ice, even in a lead only a few yards wide. If he has to cross he will crawl, or walk on snowshoes, or, best of all, on skis. Young ice has to be 5 or, better, 6 inches thick before you dare to cross a lead with dog sledges and men. This ice is stronger the colder the weather; 8-inch ice that has formed in 2 days at −30° and −40° is probably as strong as 10-inch ice that has formed in a week or more at temperatures around 10° and 20°.

After the 6-inch or perhaps 8-inch thickness is attained there appears to be a change if not a reversal of strength ratios. Ten inches of sea ice will probably support as much as 10 inches of fresh ice. It is believed, but not known, that salt ice more than a foot thick supports more than would the same thickness of fresh ice.

Certainly the nature of salt and fresh water ice seems to have undergone a reciprocal change before the beginning of the spring thaw. As we describe below under needle ice, fresh ice crumbles during the thawing stage, even when of a considerable thickness. Salt ice appears to have the opposite nature. We have said that 4 inches of young salt ice would not support your foot if you put on it your full body weight. Experiments have been made where there is a narrow isthmus of salt ice between two water holes, the isthmus perhaps not as wide as your foot is long and only an inch or two in thickness. Upon such an isthmus you can support the full weight of your body on one foot, although perhaps you might break through if you jumped on it with your full body weight. Fresh ice under the same conditions would break for a child if not for a dog.

(Laboratory experiments to check some of the above points would be desirable.)

NEEDLE ICE

This expression is used solely with reference to ice that is thawing and occurs, then, only in fresh-water ice. Seemingly ice that has once been salty and has become fresh through elimination of the salt is, nevertheless, of different structure from ice that was originally fresh, for it does not seem to break down into the needle structure. (This is belief rather than knowledge.)

Needle ice is found at sea but probably only in one of two conditions. It may be ice from water that was "normally" fresh, as in the mouth of a river—the sea is fresh enough for drinking perhaps 40 miles offshore abreast of the delta of the Mackenzie and for less but considerable distances in the case of smaller rivers. Then, out on the paleocrystic ice, far within the pack, you get a lot of needle ice. This may be from the fresh water that has stood on top of the salt water in leads at the end of summer or from lakes of fresh water that have been on top of the ice.

The most striking description of the needle condition has come from river banks where huge chunks of fresh-water ice are left aground by spring floods. Stefansson reports having walked past a boulder of this ice in the morning when going out to hunt from a bank of the Coppermine River, and having found no ice at all in the evening. On this clue he began to examine the ice boulders. When he struck one a smart blow with a stick it crumbled into a heap of pencils—

long crystals, apparently each the length of the vertical thickness the ice had as it lay on the river.

On lakes of the Parry peninsula in the spring thaws the experiment was repeatedly made of driving a stick about the size and shape of a broom handle vertically down through ice that was more than 3 feet thick. The crystals or needles separated to let the stick all the way through. On one of the same lakes a dog that had gone into open water to cool off tried to climb up on the edge of ice that was more than 2 feet thick. The ice crumbled under the paws of the dog and he made a sort of tunnel or bay into it for several feet before he could get enough support to haul himself out.

It appears that ice does not break into needle formation when it is covered with snow, even though the snow is soaked with slush water. It may be, then, that the action of direct sunlight is required to produce separation into needles.

That needle ice is "treacherous" is shown by frequent reports of Indian drownings in northern Canadian lakes in the spring. That Eskimo drownings seldom occur may not be due to their taking better precautions but may be rather because the Eskimos in spring are usually on the seacoast and have little occasion for crossing lakes.

PROTECTING DOGS

The upward points of the needle ice during the spring thaw are so sharp that they lacerate the feet of dogs, no matter how sound their pads are. If you have to sledge in this situation during spring, which is the only time needle ice occurs, you will have to use boots on your dogs. These are best made of some skinlike smoke-tanned moose; they are about the size and shape of the thumb of a large mitten and are tied with a string around the dog's ankle. Rawhide must not be used, for it smells like food to the dog and is eaten. Commercially tanned leather would be good. Canvas may be used. Under conditions where a moose-hide boot lasts 2 days a canvas boot may last a day. Drivers watch the boots on their dogs and when they wear on one side they are turned around, which doubles the life of each boot. It is a bigger chore than you at first realize to make these boots for your dog team—each dog has four feet!

b. Far from land

In planning for operations likely to take you out on sea ice, it is well to remember that Alaskan and Canadian Eskimos are in great and irrational fear of going far from land. In winter these Eskimos make their living upon the ice in the vicinity of land, and they are there competent, confident, and at ease. But they and their ancestors have seldom ventured more than 5 miles from shore, and never willingly more than 10—which is why they fear the region beyond. You are likely to find local seamen, traders, and the rest of any white population agreeing with the Eskimos—on the theory that an Eskimo knows all about ice.

LANDFAST ICE

There are in the Arctic a few headlands—among them Cape Lisburne, northwestern Alaska, and Nelson Head at the south tip of Banks Island—where deep water comes so close inshore, and where strong winds and currents are so frequent, that very little ice clings to the land. Usually even in these places there is, however, an ice foot similar to that which we have described for river shores along an unfreezable rapid. Indeed, the shelf at Lisburne or Nelson Head is likely to be a good deal wider, several yards if not several dozen; but, in the case of Nelson Head at least and probably in the case of Lisburne, there are occasions when the pack tears along the cliff with such force that the ice foot is practically or wholly removed. This is an awkward situation, for it is most likely to occur at the tips of promontories so that a party sledging along the coast would have to climb a mountain to get around to where the ice is wide enough again for travel. The situation is the more difficult in that the mountain configuration produces violent local gales, after a manner already described.

The Arctic rule is that in winter the ice frozen fast to the beach runs out to sea one to several miles. That nearest the land is usually grounded solidly upon a shallow bottom. But as you proceed from the land you come to the flaw, or floe, the place where the edge of the shelf frozen fast to the land meets the moving pack.

RELATION OF PACK TO FLAW

When the pack is in rapid motion, as after a severe gale, its speed on the north coast of Alaska may be as much as 2 miles an hour, rarely a little more. The ice masses are of all sizes and all thicknesses. When a heavy floe moves along the edge of the land ice in such a way as to rub against it, we say that the pack is grinding.

This grinding of the floes against the landfast ice and against each other makes much ice, which may be a soft slush or may consist of fragments the size of your fist, the size of a kitchen range, or of a house. As the floes spin about, open patches of water of all shapes and sizes will form, to close again when the floes continue their revolution.

EFFECT OF GALE ON PACK

After a heavy gale pieces more than a dozen acres in area are rare at the flaw or beyond it for several miles to seaward. The farther from land the larger the pieces, and fifty miles out the hardest gale will leave most of the ice still in the form of big coherent masses, miles in diameter. Naturally, when the edges of such floes meet, a certain amount of mush ice is formed, no matter what the distance from shore.

DANGER ZONE

The handicaps to sledge or foot travel over the pack, then, are usually greater the nearer you are to the flaw. The dangerous edge of the danger zone is the mush belt immediately against the flaw where the pack grinds itself into fragments against the edge of the landfast ice.

SLUSH ICE

As described in Chapter 2, slush ice is a special form of ice from which brine is being eliminated and which, if blanketed with snow, may preserves its slushy character even when air temperatures are at or near winter lows. In travel over this kind of ice, wear the semiwaterproof boots described in chapter 9; for even after a long cold spell you may step without warning into brine that will soak through the sole and upper of ordinary winter footgear.

TELLING AGE OF SEA ICE

Ice which has weathered one or more summers is easy to distinguish from that of the current winter by sight and by taste. This is useful for several reasons, among them to judge its strength for safety in camping upon it and to tell in advance if water formed by melting it is going to be fresh. (See explanation in Chapter 2, Section III.)

During the melting of summer, the pressure ridges and the projecting snags of broken ice change in outline. When the ice has been freshly broken it may well be compared with the masses of rock in a quarry just after the blast; or, if it is thinner, with the broken-bottle glass on top of a stone wall. But during thaw periods all the sharp outlines are softened so that at the end of the first summer they are no more jagged than a typical mountain range. At the end of 2 or 3 years they resemble the rolling hills of a western prairie.

Old ice is easily recognizable at a distance by its outlines, and on closer approach by the fact that the hummocks are frequently glare. That can never be the case with salty ice, which is sticky and therefore always has snow adhering to it. Being glare, the old ice gives poor footing for men and dogs, yet it is commonly preferred by travelers as being smoother than newly broken floes. For young ice is frequently heaped up in indescribable confusion, the jagged ridges sometimes 50 or 60 feet above water level. This sort of broken ice is in rare cases so chaotic that an unhampered dog is not able to make his way over it.

When you come to bad pressure ridges you have to make a road with pickaxes. Progress may be less than a hundred yards per hour. Cases are on record where half a dozen men equ'pped with pickaxes were unable to advance three- or four-dog teams and sledges no more than 400 yards in 10 hours of hard labor.

LET GO OF SLEDGE IF IT DROPS

As described above, the ice of the northern seas, especially just beyond the flaw, is during winter in surface character and appearance something between a system of miniature mountain ranges and the interior of a granite quarry. In traveling over such ice, you must steer sledges as best you can but let them go when they begin to drop. Otherwise they will pull you with them, and cuts and bruises will result. One of Stefansson's men, an old Alaska sourdough named Captain Peter Bernard, was nearly killed through keeping hold of the steering bars of a sledge and falling upon a crossbar. He had to be invalided from the party and sent ashore, causing besides a time loss of several days to the entire party.

As explained in section I of this chapter you should not start out from land for an ice journey later than May 1, nor should you start earlier than the last of January or the first of February. The spring start is inadvisable because thaws and rainstorms are producing the difficult ice conditions. You should not start when the daylight is less than a third of the 24 hours because of the danger that you may not be able to find during daylight a camping area that is safe from that tumbling pandemonium of rearing, crashing, and splashing blocks that results when the pack, in a storm or driven by a current, meets the unyielded shore ice. Whatever the time of winter it is bound to be a tense experience to get your sledges across the first 30, 40, or 50 miles which, in different parts of the marginal area of the Arctic Sea, make up the worst pressure belt—which, as we said a few pages back, is most dangerous at the flaw and gets less and less dangerous as you progress farther from shore.

SAFE AND DANGEROUS DISTRICTS

The danger in crossing the pressure belt is not so great if the base from which you start is on land in some region of sluggish ice movement, such as northern Prince Patrick Island, Ellef Ringnes Island, or Peary's starting point, Cape Columbia, Ellesmere Island. But anyone beginning a journey from a region of violent ice movement, such as the north coast of Alaska or the northeastern coast of Siberia, is taking serious chances if he starts out before the full moon of February.

In taking the chance of starting on a polar ice journey late in January or early in February, the encouraging factor is that your great danger zone is a narrow one in the vicinity of land. If you have a week or so of calm and intensely frosty weather the turbulent shore belt may be quiescent; so that by a "dash" of 3 or 4 days you may be able to get 40 or 50 miles offshore before the first gale strikes. Beyond that distance from shore midwinter travel is reasonably safe no matter how little the daylight.

DIFFICULTIES OF SPRING TRAVEL

After the first warm days of spring the thaw water sinks to the bottom of the snowdrifts and begins to trickle along the ice, gradually eroding little water courses which grow deeper and wider day by day. The snow itself will presently disappear from the ice, except where it is drifted deep in lees. By midsummer year-old ice will be cut into a network of channels a few inches or several feet deep and separating ice islands, analogous to those of a river delta, of all shapes and sizes. Upon old ice the tiniest of these islands resembles mushrooms, a narrow stem with a wide table top. Progress is a continual climbing up on islands of this or other types and plunging into the water beyond. Frequently the dogs have to swim and sledges must be buoyed so that dogs can tow them.

When the sledge is actually in the water there is little danger of upsetting; therefore your task is to keep dogs and sledges in the water as much as possible, climbing upon the "islands" only occasionally. The danger is when the sledge is crossing one of the islands, especially if there are rounded hummocks upon them, for it is then likely to slide sidewise into the water and upset. When a sledge starts to slide, it is the steersman's task to lessen the chance of an upset by so directing the sled that it slips into the water bow foremost.

This condition of ice is not only bad for traveling but also for seal hunting. A basking seal will likely hear some splash you make; the least splash will send him into the water.

NO CAMP ON ICE IS EVER ENTIRELY SAFE

It is evident that no camp on sea ice is ever entirely safe. Even a hundred miles from shore a crack may open in the middle of the floor of your snowhouse or tent, though the chances of this decrease with the distance from land.

You may also be in danger from a crack originally several hundred yards from camp; for when two floes begin to grind past each other the edges of both tend to break up and the disintegration may soon get to where you are. The danger is greatest when the lines of motion of the adjacent floe and of your floe intersect at some such small angle as 10° to 30°. Huge pieces are then torn rapidly off the edges of both floes if they are of similar thickness, or off the edge of the weaker. If you happen to be camped on the weaker one, it behooves you to move quickly. Pieces of your floe the size of a city lot will rise on edge, tower up and crumble toward you. The ice around camp and under it will begin to groan and buckle and bend. Where it bends down, little rivers of sea water come rushing in; where it buckles up, small pressure ridges form.

FLEEING FROM BREAK-UP

Since the relative speed of the floes can never differ by much more than 2 miles, the rate at which you have to flee is never more than 2 miles an hour and commonly much less. Still, if the breaking up begins when you are sleeping, the awakening is abrupt and something has to be done in a hurry. As described in chapter 7, one important aid to safety is that the tremors of breaking floes are transmitted for miles through the ice, where they might not be audible at all through the air.

PROCEDURE OF BREAKING CAMP

If men camped on ice feel the quivers of approaching pressure, or hear by way of the ice the detonations of the breaking, or the high-pitched squealing as heavy flat pieces of ice slide over each other, one man should run outside to spy out the situation while the others begin to dress. Unless his report is most reassuring, you all dress as quickly as firemen upon the ringing of an alarm bell. The sledges have been kept loaded—except for bedding and cooking gear, and these can be transferred rapidly from camp to sled. Harnessing the dogs takes but a few moments—each man can harness about two dogs per minute.

The need for fleeing precipitately, as above described, does not often occur, since you have been particular to camp on a safe floe. But during the day's march a situation quite as dangerous, though not so startling, may develop. This is most likely when you are traveling across ice that has been grinding and is still under pressure, crossing from one cake to another by the corners where they touch. If you find yourself upon a weak cake a few acres in area that is surrounded on all sides by stronger cakes, its edges crumple up if the pressure is steady, and a ring of ice ridges begins to form around you. As the pressure continues, the ridges get higher, and the level central area of your cake gets smaller. It is not comfortable to have these ridges marching toward you from all sides, with a noise that is anything between a slight rumble and a deafening roar and the ice shivering where you stand. Worst of all, your dogs may get paralyzed with fear and useless.

The thing to do is to select some rather low place in one of the advancing ridges, where the motion is slower and where you think the floe beyond comparatively strong. To find such a place is difficult, more difficult because the weight of the forming ridge depresses the edge of your floe and causes a moat of sea water to separate it from you.

In cold weather dogs are even more afraid of putting their feet in water than of putting them on moving ice. So you may have to drag both teams and sledges by manpower. If you have four or five men and two sledges, you will drag the teams one at a time over the ridge, for the tumbling motion of the cakes is slow enough to cause a sure-footed man no great trouble. A party of three with a single sledge has the advantage that only one trip is necessary but the disadvantage that, with one man at the handlebars to keep the sledge from upsetting, the other two are scarcely stronger than the six dogs. You are, however, able to move them, *for they do not balk in unison.*

When the first team is beyond a ridge, you have less trouble with the others—they will, apparently, sense that their colleagues are safe and will strive to join them.

JUDGE ICE BEFORE CAMPING

When ice breaks in the dark of night the danger is greater, more complicated. For this reason it is advisable, particularly in those months when the nights are without daylight around their middle, to camp an hour or two early if you come upon an exceptionally firm cake that promises a night without a break-up, or to travel 3 or 4 hours longer when you fail to discover one firm enough for a campsite—in fact, you travel either till you find safe camping or else till you get so tired (you or your dogs) that you simply have to stop.

Bright moonlight gives the most help, after sunlight, in ice travel. Cloudy days and nights hold danger, for a reason special to Arctic latitudes which we have described under the head of diffused light.

Sea ice is seldom in reality smooth, but when sun or moon is behind clouds it will appear smooth through absence of shadow. On any landscape color except white, the hole out of which you have just pried a stone looks distinctly different from the stone lying beside it, no matter what the conditions of light (so long as you can see at all). But in the frozen sea a boulder of ice and a hole beside it are just about the same shade of white, and you cannot see either of them unless in the relief produced by shadows.

Either sun or moon in a clear sky will cast shadows, but neither will do so when obscured by clouds, though either may give diffused light enough to reveal a man or a stone at half a mile or a mountain at 20 miles.

On the rough sea ice, you may on an unshadowed day, without any warning from the keenest eyes, fall over a chunk of ice that is knee-high. You may step into a crack that just admits your foot or into a hole big enough to be your grave. And, bad as the cloudy day is, the cloudy night is worse. (For other discussion of diffused light see section II of this chapter, also chapter 4.)

UTILIZING LEADS

When the temperature is −20° or −40°, as in February or March, the opening of a lead is not a serious matter. It may stop you one day but the next it has been bridged and you can cross it if it happens to lie athwart your course. Occasionally luck is such that it lies almost in the direction you are going. In that case the ice traveler can have no better fortune than to meet with a lead. If he finds it already frozen over, it is as if he had come out of the woods upon a paved road; if it is still open he knows that a little wait and a night's encampment will convert it into a boulevard for fast and easy traveling the next day.

WHEN NOT TO USE FROZEN LEADS

But at the end of April, even though the lead may be running in your direction, and though it may be a week old and the ice 6 or 10 inches thick, still it is so soft from the mildness of the frost that it does not form a safe road, and a bridge of older ice must be discovered for crossing it.

The first precaution on thin or rotten ice is to spread the legs and slide the feet along as evenly and rapidly as possible without lifting them from the ice. If this is not enough, get down on all fours with arms and legs spread wide and shuffle along without lifting hands or feet. In extremity, lie flat with arms and legs extended and squirm and wriggle slowly along. If snowshoes or (still better) skis are available to increase further the bearing area and distribute the weight, it is possible to negotiate surprisingly thin ice.

STRENGTH OF ICE

For a statement on the thicknesses of ice, salt and fresh, that will bear a load, see earlier in this chapter.

UTILIZING SKY MAP

In Chapter 4, Section II, we have described in detail how a map of your surroundings may be reflected in the clouds when you are far at sea on a day completely and uniformly overcast; the higher the clouds the greater the area of the sea which will be shown in the map. Looking into the sky, the experienced traveler will see the types of ice which he wants to avoid as well as those which are most desirable. For instance, he may notice early in the morning on a day when he wants to travel north that if he were to go east about 3 miles he would strike an old and smooth lead running 15° west of north. A simple calculation and a view of the sky straight ahead will decide him whether he had better go 3 miles out of his way to secure good travel in a direction that does not quite suit him or whether he had better work doggedly straight ahead, taking good and bad as it comes—and as it is represented in the sky.

See Chapter 4, Section II, for descriptions of Land Sky.

UTILIZING SLEDGE-BOATS

Two of the most important things in travel over pack ice, the retrieving of seals that are shot far off in open water and the crossing of leads, are both managed with a sledge-boat, which essentially is an empty sledge wrapped in a piece of waterproofed canvas. A description of this is given in Chapter 12.

SECTION IV

OVER INLAND ICE

THE GREENLAND INLAND ICE

The occasion for travel afoot over inland ice, from the point of view of this Manual, seems most likely to arise in connection with a forced landing while flying across Greenland.

To a flyer the salient and unique points of Greenland are two:

1. Excepting the snowfree coastal districts and the crevassed regions where the ice flows down toward the sea, Greenland is practically one continuous and nearly perfect landing field for a plane equipped with skis. Most of the inland ice is good for wheels, too, except that near the center the snow might be so soft that you would find it hard to take-off again.

AIR CIRCULATION

2. Because Greenland is a turtlebacked mass of snow with comparatively warm, open oceans on both east and west, it has a local air circulation of its own. Pictorially you are not far wrong if you think of the cold and heavy air behaving like water that is being poured down on the middle of Green-

land to flow off in every direction. A line north and south somewhat east of the middle is the divide. East of this the air generally flows east, and west of it generally west. These local flows are, however, upset at times by storms of wide area. Generally speaking, you can rely on it for the middle of Greenland that if, after a forced landing, you start walking toward either coast you will have a fair wind most of the way, growing stronger as you approach the edge, until you may have a gale at your back on your last 50 or a hundred miles. (See Chapter 2 for further discussion of the characteristics of Greenland.)

Assuming a forced landing on the inland ice, the eventualities are four: You may repair and fly again; you may send an SOS and wait for help; you may try to get your plane to the coast; you may abandon your plane and walk to the coast.

FIRST, REPAIRING

If you succeed in repairing, no comment is needed except to repeat that you may have difficulty in taking off if on wheels and near the comparatively calm center. Likely enough, however, a wind of broad scope will come along in a few days and harden things up.

SECOND, CALLING FOR HELP

If you call for help, you have several advantages. Most days you see the sun and can therefore report your latitude and longitude correctly. The weather is on the average clear when looking down from above, although it may be hazy when you look horizontally, so that rescue planes should pick you up easily; for you are conspicuous in that you and your equipment are the only dark things on a vast white expanse. The temperatures are such that you can build a snow house and make use of the regular Arctic technique for living in comfort—except, as below, that the only food and fuel will be whatever you have with you.

THIRD, TAKING PLANE WITH YOU

With either the third or the fourth eventuality you will travel west unless you are markedly near the east coast;

for there are only two main settlements to head for on the east, Scoresby Sound and Angmagssalik, while on the west coast there are any number of settlements.

The only advantage of the third procedure is to make it more convenient to salvage the plane. Except for the peculiar conditions of Greenland, it might seem absurd to speak of two or three men taking the plane away with them. But part of your preparations should have been to provide sails against this emergency. If you are right at the calm part of Greenland, at the so-called wind center, it may not be possible for your crew to push or drag the plane along on its skis, the snow being soft and the slope negligible. But if you are anywhere well off center you will have harder snow and more frequent and stronger fair winds, even though the slope is not appreciably greater. With something for a sail, or even merely the wind blowing on the plane, the crew may be able to work toward the coast. Eventually the wind may do most of the work.

This has been written on the assumption your engine does not work, through mechanical injury or want of gas. With engine working you may have power enough for taxiing though not enough for taking off. Then, naturally, you taxi toward one of the coasts.

There may, of course, be head winds as you approach the eastern or western sea. Those will, then, be of broad cyclonic nature and will pass. In a few days you are likely to get your local winds back again helping you.

You cannot, naturally, take the plane all the way down. The winds get too violent, the slope is too steep, in places there are crevasses, and in any case the plane would be more difficult to salvage if you did get it down than if you left it at the right place at the edge of the inland ice. For down near the coast it would be in a rough spot and the salvage plane could not land near it nor could that plane and yours take off after repairs. Up on the inland ice there are perfect conditions for landing and take-off.

CORRECT PLACE TO LEAVE PLANE

The correct place to leave your plane is just before you come to the crevassed slope, the location of which you know approximately from your map. You face the plane into the prevailing wind, dig trenches for the skis, anchor with ropes fastened to deadmen, and build a sheltering snow wall.

In view of the comparatively regular direction of the most violent winds when you approach the edge of the Greenland inland ice, a better scheme than facing the plane into the wind may be to put it broadside to. It is more difficult then to protect it by a snow wall, but you avoid the difficulty of having a wind strike effectively surfaces designed for lifting.

After anchoring the plane you walk to the coast and report where the plane is. Somebody flies in with the necessities for bringing it to a coastal base.

DANGER FROM CREVASSES

The dangerous part of the journey comes where the coastward flow of the inland ice begins to speed up, producing crevasses. Many of these, especially in late winter, are likely to be so strongly roofed over with snow that, particularly if you have snowshoes or skis, you will pass over them without knowing it. However, if there are two or three men, they should be roped together and should travel alpine fashion, just in case one breaks through into a crevasse. (See below for needed equipment.)

When the thaws of spring begin, the snow roofs of the crevasses cave in, showing trenches which gape. This is an advantage in that you now see where they are, but a disadvantage in that no snow bridges are available and everything is very slippery. There will be small and large water courses, some digging deep channels and tunnels, and they increase the difficulty. It is now that the length of your sledge becomes important (see below). You can often maneuver so as to make of it a bridge across a crevasse.

CHOICE OF ROUTE WITH RELATION TO FJORDS

For safety's sake you should descend to the coast, unless you have local knowledge to the contrary, at some point about halfway between adjoining fjords, since the ice usually flows more rapidly toward the fjord heads and is there more crevassed and dangerous.

When you are down past the worst crevasses, you naturally head for whichever fjord you feel likeliest to have a reachable settlement. For Greenland, information on this and other local matters will be found in the Greenland Guide Book of this series.

FOURTH, ABANDONING PLANE AND WALKING TO COAST

If you abandon the plane and walk to the coast, a sledge is important. We describe here one that was made specially for use in Greenland by the well-known polar explorer Anthony Fiala for the use of Lindbergh on his flights of 1933. This is now on exhibition at the American Museum of Natural History of New York. It was made by Fiala in consultation with Lindbergh and Stefansson.

The sledge is of the double-ender Nansen type (described in Section II, Chapter 12) but somewhat higher. It is in three pieces, the end sections 4 feet, the middle section 3 feet. It is easily knocked down and set up again. The ends are identical so that separately the two 4-foot sections will make two sledges if it is desired temporarily to carry the middle section as part of a sledge load or to discard it. At one end of the completely set-up sledge is a hoop to guard against breakage in rough ice. The material is ash or hickory; the runners are polished like skis so that no shoeing is needed, but is nevertheless bored for shoeing; the strength is so that with a 250-pound distributed load a man weighing 200 pounds can crawl across it when the seldge is supported by its two ends. (This is important in using a sledge to bridge a crevasse.) Steel shoeing, capable of being rolled into a hoop of not more than 2 feet d'ameter, is furnished already bored so that it can be applied to the seldge in either the 8-foot or 11-foot set-up described.

ALPINE EQUIPMENT

Where the route of a flyer includes a crevassed area such as Greenland, alpine equipment should be taken.

Hassell reports that when he and Cramer landed on the inland ice and had to make their way across the crevasses, they had to follow a more tortuous route simply for lack of this equipment, but particularly for lack of crampons or of hobnails on their boots.

Whether you use the third or the fourth eventuality, it will be worth while to carry six-power binoculars to find your way about after you get down to the coast, to see houses and people at great distances. The rest of the equipment, as said, is that of an alpinist—crampons, alpine axes, alpine ropes.

GLASSES

For mere protection of the eyes you carry along any kind of smoked or colored spectacles (not goggles). For flying across the most flatly white surface in the northern hemisphere, the inland ice, you need amber spectacles—they bring out a sharp and clear horizon when bare eyes or smoked glasses give no idea where snow and sky meet.

Amber glasses are similarly a necessity when you descend from the inland ice to the coast, particularly if the light is diffused. For light filtered through amber will bring out the inconspicuous inequalities of the snow, the subtle danger signs of crevasses, when you would otherwise have no warning.

SUNBURN PROTECTION

The snow on the ice cap is likely to give you a quick and severe sunburn so that it might be well to have a dark veil, either a real one brought with you or something you improvise.

CLOTHING

It may get pretty cold on the inland ice, though probably not quite so cold as it is on certain Arctic lowlands. Nevertheless the flyers would be provided with Arctic winter clothing, except, as implied, that their footgear might be somewhat different, to provide for the use of crampons. However, a good kind of footgear, not unsuited to this travel, is the semi-waterproof winter boot which we described in Chapter 9.

TENT

You will carry some light tent, but it must be capable of standing up against terrific winds; therefore the 6- or 8-sided

Antarctic conical is probably best, if you can carry such long bamboos in the plane. Should that be difficult, carry one of the standard types of mountaineering tents obtainable from any outfitter. It is one advantage of getting ready for Greenland that much of what you want is standard alpine equipment.

BEDDING

The bedding will be substantially the same as that described for Arctic winter travel. Your trip to the coast will, however, be so short that you do not have to take all the precautions for keeping your gear in first-rate condition that are required if you have a journey of several months ahead of you.

FOOD

All food has to be carried, for there are no game animals till you descend from the inland ice to either the west or east coast. Both coasts are inhabited at known points, so that it is doubtful whether to carry a rifle on such flights. Perhaps each plane should have one of the kind elsewhere described, with, say, 50 rounds of ammunition.

The journey will be so short that no antiscorbutic or other dietetic precautions need be taken. Use the most condensed food, requiring little fuel—therefore pemmican, hard bread, chocolate, probably dispensing with tea and sugar.

COOKING EQUIPMENT

Cooking equipment should doubtless be a primus stove and some aluminum gear. There is an obvious advantage in having a stove that burns the same fuel which your plane uses. Some travelers have preferred, however, to carry along a little kerosene in a special container. If you do, you should have alcohol for priming, which is not needed if you burn gasoline.

TRAVEL DIRECTIONS

Directions for making your way to the coast under the fourth eventuality are the same as for the third. If your sledge is equipped with a sail, or if you can devise one, you take advantage of the down-slope winds just as you would with a plane fitted with sail. As you move away from the center of Greenland toward either coast the wind does more and more of the work. It is, in fact, possible that you might ride on the sledge and steer.

When you get nearer the coast the winds may grow to such strength that you actually have to dispense with the sail—the wind may push you and the sledge along quite enough without it.

SECTION V

ON WATER

BOATS FOR SUMMER TRAVEL

Until the coming of the airplane, boats were the chief means of coastal summer travel and of reaching the interior—by rivers or by lakes and portages. Our chief discussion of boat travel is in Chapter 12, but we place here a few generalizations.

For inshore travel by sea and for river, lake, and portage travel, *native Arctic boats are not merely better than ordinary white men's boats but also better than any "patent" ones yet devised, such as those of collapsible rubber.*

An umiak that will carry two or more tons is so light that two strong men can carry it across country; four men carry it with ease. Being flat-bottomed, umiaks draw only a few inches; of dory-type, they have the great seaworthiness of that design so that if you come to a wide lake where high waves are possible you are still suitably equipped. For camping or for taking shelter in a storm they are also good, for you pull them ashore, unload them and prop them up so as to form a combination of a roof and a windbreak. The hide that covers the boat is so tough that you can land on a stony beach in a moderate surf without danger to the cover. If you break a few ribs against boulders it is scarcely more than a pastime to repair these while you are storm-bound or in connection with a night encampment If the boat is partly stove, a number of ribs broken, and if you still have to continue the voyage without repairs you can do that. Your craft will merely be slightly less handy to manage and of course loses cargo capacity in proportion to how much it bulges in; but water does not enter unless the skin has been cut by a rock that was practically as sharp as a knife. A mere bruise against a round boulder is not going to let in water.

Second in merit to the Eskimo umiak for white men's pioneering use is the kayak. Except in Bering Sea, where this canoe sometimes accommodates two or even three, the kayak is a one-man boat, built approximately on the lines of a racing shell but covered over so that not only can the waves dash about without entering but, as already described in connection with waterproof clothing, the kayaker can so dress himself and so lash himself to the boat that capsizing only means righting himself again. A good kayaker will not capsize more than a few times an hour, even in the roughest sea, and it is considered that a strong man who is skillful can right himself 30 or 40 times before becoming so exhausted that drowning results. There are few lakes in the Arctic, perhaps none, so large that you would expect waves which could upset a good kayaker who was not absent-minded.

The kayak has no unmotorized competitor for speed except the racing shell. The Iroquois and certain Algonquins were considered the best canoeists when Europeans first reached the St. Lawrence and Great Lakes regions. In their bark canoes these Indians could paddle away from any crew of European rowers. But when the early explorers, employing these Indian canoeists, met the Eskimos in northern Canada they found that the Eskimos could paddle away from the Algonquins even more easily than the Algonquins could from Europeans.

PURPOSES OF THE UMIAK

The umiak is a traveling boat for considerable numbers of men and a cargo boat. A 40-foot umiak will take ashore 50 unencumbered men from a ship that is being lightered, if the waves are no more than a foot or two high; a 40-foot boat should carry on a river perhaps 30 men with infantry equipment and camping gear.

PURPOSES OF THE KAYAK

The kayak is a boat for hunting, setting fish nets, for scouting and carrying messages. One man carries it with complete ease, except perhaps in a high wind.

SKIN BOATS ARE FOOD IN CASE OF STARVATION

It is no mere crudity of humor to say that one of the advantages of a skin boat over wood or rubber is that the skins can be eaten. For it has been found among all nationalities and all social grades that a starving party will eat anything even supposed to contain food value and is finally driven to cannibalism.

CANNIBALISM

It is rare, except in fiction, that men are killed to be eaten. There are cases where a member of a party becomes so unsocial in his conduct towards the rest that by agreement he is killed; but if his body then is eaten it is not logically correct to say that he was killed for food. What does happen constantly is that those who have died of hunger, or of another cause, will be eaten.

SKIN BOATS STAVE OFF CANNIBALISM

But long before cannibalism develops the party has eaten whatever is edible. It is probable that leathers tanned by ordinary commercial processes have little food value; or, what is much the same, that the chemicals in these leathers will hurt enough to at least partly cancel the food value. But rawhide has no injurious chemicals and does have a large percentage of protein. It is not likely to be disagreeable in taste—rather it is tasteless. If you have plenty of fuel you boil it; when cooked you find that it has a jelly-like consistency, familiar to most of us through having eaten the skin on pig's feet or pig's knuckles. If cooking is not possible, you cut rawhide into small pieces and swallow them. Cooked or not, there is considerable emergency food value in an umiak; there is some in the smaller kayak.

It is elementary that a boat must not be eaten while it is still valuable for its natural use in transportation. It may be doubtful whether it should be eaten later even by men who are starving; they will have to balance in their minds its value as food and its value for bedding and shelter. This seems almost too obvious for mentioning; but the fact is that mistakes of this sort are on record. It is also true that members of a party have differed as to when a leather article should be converted from its original purpose to food. The commonest instance is with leather footgear and body clothing, which has sometimes been devoured from mere animal instincts of hunger when one would think the man would have realized that the value as protection from cold was greater. For if you are cold you need more food. Wearing a garment is a cheaper and better way of securing body warmth than eating it and getting the warmth through the digestive processes.

SCATTERED ICE KEEPS DOWN WAVES

For sea navigation, scattered ice will have more advantages than disadvantages. However rough the ocean where it is open, as soon as you get in among the ice you have no more trouble with the waves. The floes near shore are usually scattered. Few of them are bigger than a city block in area and there likely are between them half-mile open patches where you can sail through water that is smooth even with a stiff breeze.

In the course of such travel you are able to go up to an ice cake and dip fresh water off its surface—as described in Chapter 8.

ICE ALONG SUMMER COASTS DEPENDS ON WINDS ONLY

There are few Arctic coasts where the amount of ice visible from land in summer depends upon the warmth of the season. It is theoretically possible that observations taken through coming years may eventually show a slight relation between local air temperature and amount of ice near land; but, so far as observations have yet gone, all sailors and "practical" men of the North agree that the wind is the only factor that needs consideration. At Point Barrow, for instance, there have been cases where nearly or quite the chilliest season on record had nearly or quite the least ice—the ice went away early in spring, went far off and stayed away long.

However, the wind that controls the ice is not necessarily blowing locally. A gale at a considerable distance may set up special (temporary) currents that move the ice in your locality. As explained in Chapter 12, a striking region for the demonstration of this is the Alaska coast for several hundred miles east from Point Barrow, where ice behavior is profoundly and frequently affected by gales that blow around and north of Bering Strait.

WARM CURRENTS KNOWN TO DESTROY WINTER ICE

It may be gales, perhaps in the North Pacific, that control warm waters which arrive now and then at Barrow, having come, no doubt, from the Pacific via Bering Strait.

It may happen at Point Barrow in winter that seal hunters go 10 or 15 miles out on perfectly safe ice a good many feet thick and come back 6 or 8 hours later to find that, especially beneath snowdrifts, the ice has been eaten away from below by a warm current so that men and sledges may break through into the water below.

As yet this condition has not been observed at Barrow except in winter; but that is no doubt because adequate studies have not been made. We should, therefore, modify our concept on the relation of warmth to absence of ice from the Barrow region in summer by adding a corollary: While there is probably seldom if ever a material relation between the warmth of the air at a given place and the amount of ice offshore, there may be, and probably is, a relation between the amount of ice and the warmth of the sea water—this warmth deriving from accessions of North Pacific water which was perhaps driven north by a gale.

CHAPTER 12

TRANSPORTATION

SECTION I:

SHIPS AND BOATS

ICE MOVEMENTS OFF ALASKA COAST

For a discussion of the underlying principles of tides and currents, and of the differences between Atlantic and Pacific Ocean influences upon the Arctic, see Chapter 2.

It seems illogical when you look at the map, but it is a fact attested by many witnesses between Point Barrow and Herschel Island, that although a west wind there blows off the land, it brings the ice into the land; and although an east wind blows toward land, still it commonly carries the ice away from shore enough to leave handsome room for ships to pass east and west along the coast.

As said, with easterly winds the ice on the northeast coast of Alaska will move away from the land. This is true, however, only with mild winds, and is not true even with these if they persist for a long time. A gale, or a strong breeze of long duration, will bring the ice back in, and cause pressure likely to crush ships that are beset on that shore.

A west wind, although blowing off the land between Barrow and Herschel, will bring the ice landward and set the pack grinding eastward along the edge of the landfast ice.

BASIC IDEA OF ALASKA NORTH COAST NAVIGATION

One of the basic ideas of navigation along the north coast of Alaska, and along the north coast of western Canada, rests on the ocean being shallow inshore, with a number of rivers in the spring bringing warm water from the land to melt away the inshore ice. It happens frequently that while heavy ice still lies offshore too strong for any icebreaker yet constructed to get through, there will be a lane of thaw water along the land through which a ship of small draft can worm her way.

It is told by New England sea captains that when they first navigated the Alaskan north coast they lost ship after ship by following the Atlantic rule of keeping 20 miles from land. Their experience northward from the Atlantic, in Greenland and Spitsbergen waters, had been that if ships got stuck among the ice they were very likely to be let loose again eventually; for in most of these places the current runs south into freer waters where the ice slackens out. But north of Alaska a ship that gets into ice and starts moving with it is not likely ever to get out, or at least not for years, since the pack sets tighter instead of loosening, and the drift is not southward but northward to the more ice-infested regions. As developed in Chapter 2, the movement is really that of a spiral curving north and west, farther and farther offshore, deeper and deeper into the pack—till you finally work out again in the region to the north of Iceland and Norway.

When Yankee whaling ships were wrecked far from land north of Alaska, the men could with difficulty make their escape by boats or sledges. Cargoes were then invariably lost. If a ship was squeezed against the land, or sunk by pressure near shore, the crews were not in serious danger. In some cases entire cargoes were saved, and the more valuable parts in others. These things were so well known that, in olden days, whenever a whaler sank near shore without saving cargo the gossip in the whaling fleet was that the gain from the insurance policy would explain the loss of the vessel.

If a ship is crushed by rapidly moving and tumbling ice floes in summer, a retreat from her with any equipment may become dangerous. But if she is broken in winter, then the process of breaking up is fairly sure to be slow, giving ample time to place on reasonably stable ice in the vicinity the stores and equipment one cares to save.

TYPES OF SHIPS FOR POLAR WORK

Since this is a Manual chiefly for emergency use, we do not attempt to describe ice breakers and other ships made specially for Arctic use. But for the possible use of parties organized in a hurry who may have a chance to secure medium and small ships of various types, the following points are mentioned:

For navigation of icy seas a single propeller vessel is to be preferred to one with twin propellers. The reason is that double propellers are usually placed so that they stick out at angles and are likely to be snapped off by the ice. When a single propeller is in the center, aft, the bulge of the ship in her passage so pushes ice to the sides that none touches the screw.

At least this has been the view of most authorities. The summer of 1939 the Soviet Government exhibited at the New York World's Fair a model of their then new ice breaker, *Josef Stalin*. To the astonishment of American sailors familiar with the Arctic this ship had two propellers and had *no* device (at least had none on the model) which would keep these propellers from striking ice that would be flowing back along the side of a ship that was forcing her way through heavy ice. Since then has come much news of the success of the *Stalin* in what must have been difficult ice, as, for instance, when around the holidays of 1939–40 she struggled far to the northwest of the Spitzbergen Islands to meet the southward drifting *Sedov*. The report said nothing about her propeller striking ice or about any damage suffered by the vessel.

Until a real explanation is available, we shall have to assume one of two things, that the *Stalin* as actually built had cages or other protective devices to shield her propellers from ice contact; or that her propellers, and the shafts and other things connected with them, were so strong that they could safely hit ice—breaking it instead of being themselves broken.

A vessel of shallow draft (drawing, loaded, say not over 4 feet) is frequently to be preferred to a more powerful ship of deep draft. In the spring, when the rivers open and thaw water begins to flow in little and big streams off all parts of the coast, the sea ice is melted by this comparatively warm land water and an open lane is formed along the beach, while the heavier grounded ice is still continuous along the coast a few hundred yards farther to sea and the pack is still heavy in the offing. A boat with a draft of 4 feet can make good progress along such a lane, when no matter how powerful, a ship of deeper draft could make no progress at all.

Besides, the rivers of Canada, Alaska, and Siberia are open to shallow-draft boats. A chief reason why so many northern ships are flat-bottomed, have centerboards instead of keels, and draw only 4, 5, or 6 feet, is that vessels of small draft can carry their ocean cargoes up into rivers—in some cases even 1,000 or 2,000 miles upstream.

SPECIALLY CONSTRUCTED FLAT-BOTTOMED BOAT

An example of what can be done with small boats was the *North Star*, used on the third Stefansson expedition. She had been built to take advantage of inshore thaw waters. She drew 4 feet 2 inches, loaded; in place of a keel there was a centerboard that could be withdrawn into the body of the ship. Her designer, Matt Andreasen, had made no attempt to build her strong, for he had a special method, of which he may have been the inventor, of dealing with the closing in of the ice around her.

The *Star* was only about 50 feet long and could turn around almost in her own length. When her commander saw the ice closing in, where there seemed to be no chance of getting out of the way entirely, he would select in the neighborhood some big ice cake that sloped to the water's edge on one side. He would then steam full speed against this floe.

The bow of the *North Star* was so shaped that, instead of hitting the ice a hard blow she would slide up on it, standing level because she had a flat bottom. Thus, by her own power, she was able to put herself halfway on top of the ice. The crew were prepared to jump out, fasten an anchor into the ice, and with blocks and tackle to haul the ship entirely up on the floe, so that when the other floes closed in and began to crowd each other their pressure did not come upon the ship but merely upon the ice on which she was standing. If this was a solid piece, it was not likely to break; if it broke, the *Star* was no worse off than she was before—had, in fact, escaped at least one squeeze.

On the several occasions when the *Star* was hauled upon a floe the ice under her did not break. She therefore had to be launched again. Accordingly, when the ice slackened out and there was a chance to continue navigation, a small charge of powder was placed in an augur hole in the ice. On exploding this would shatter the cake and let the ship down into the water.

ESKIMO SKIN BOATS

Among Eskimo devices which have not been equalled by other Indians, or by whites, for certain types of work are the two skin boats, the open large umiak and the decked small kayak. They belong to the group of boats which have for chief elements a wicker frame and a membrane cover. These include such well-known examples as the Irish curragh and the Iroquois bark canoe.

According to Irish folklore, which until recently has been considered fantastic by most historians of navigation, the Irish curragh was capable of long ocean voyages and would carry 60 people. There has been ingrained, however, in the belief of the Irish people themselves the conviction that curraghs were the most seaworthy boats possible. For instance, a ballad as recent as from the sixteenth century tells of a number of people who were drowned in a gale that came up when they were on their way to church in a wooden boat. It is a refrain of this ballad that if the boat had been of leather instead of wood the tragedy would not have occurred.

If we assume that the seaworthiness of the curragh was at all comparable to that of the umiak then Irish faith in the skin boat is being justified. For it is the view of many if not most officers of the United States Coast Guard, good sailors themselves and familiar with the storms of Bering Sea, that there are few if any boats more seaworthy than an umiak they have seen in use there. It would seem from what these officers, and others, can tell us from Bering Sea skin boat navigation that the Irish stories are reasonable which tell about long North Atlantic voyages in curraghs. Nor is the reported size of the ancient curragh absurd when given as ability to carry 60 people; for the early Russians tell from Bering Sea that they saw umiaks carrying 70 passengers.

Judging from a model of the second century B. C., discovered in Ireland, the curragh did not change in design between that time and the sixteenth century. Its lines and general appearance were those of the Iroquois bark canoe, not those of the umiak which is essentially a modified dory form. Since the dory is looked upon as about the safest boat model ever devised, it may be that the umiak is even more seaworthy than the curragh.

Securing Eskimo boats differs from securing Eskimo clothes in a very important way. You cannot buy really good clothes except those which you find already in existence as part of a wardrobe; but Eskimos will make good boats for you—perhaps not quite as good as for themselves, but nearly. This is perhaps because boats have "always" been among them an article of commerce; clothes were made by each family for its own use.

SIZE OF UMIAKS

The largest umiaks dependably reported were 44 feet in length. Those seen by E. W. Nelson, both east and west of Bering Sea and Bering Strait, between 1877 and 1881, were from 15 to 40 feet. He felt that the average length was 30 feet but 36- and 38-foot boats are common. Like the dory the umiak is a double-ender. The keel piece is flat, a plank split and adzed from driftwood (usually spruce). The rim or railing piece is also of spruce, is round and obtained from a driftwood log by splitting and adzing. The ribs, too, are from drift spruce, and so are the one or two strips parallel to the gunwale that are lashed across the ribs to hold them in position. The lashing is preferably of whalebone, but rawhide may be used.

The best of both the umiaks and kayaks are found at the two extremes of Eskimo culture—around Greenland in the east and around Alaska in the west.

From southwestern Alaska northward and eastward to the Mackenzie River the umiak was used for travel in large parties, for transport of goods, for whaling and walrusing. In modern times the umiak did not extend eastward beyond the eastern limit of the Mackenzie Eskimos, somewhere near Cape Lyon, and was not found again until around Hudson Bay, Labrador, Baffin Island, and especially Greenland. Here the uses were the same as in the west, with one exception. In the west the rowers or paddlers and the steerer might be either men or women—usually both men and women paddled and some man steered. In Greenland it was not good form for men to do any work in an umiak except steering. For that reason the umiak is spoken of around Greenland as a woman's boat.

From southwestern Alaska north, and then east beyond Barrow, the kayak is used for journeys by single individuals or by two or three. Men are the ordinary users, but it is permissible for women to use them. They are hunting boats for sea mammals up to walrus and white whale in size, and are used for setting fish nets. (The net, however, is not a primitive Eskimo device; has come into their culture during recent times.)

East of Barrow the kayak changes rapidly in function, becoming largely a boat for caribou hunting—for spearing them when they are swimming lakes or rivers. The kayak is so used in the interior of Alaska; there is practically no other use of the kayak than for spearing caribou when you get east toward Coronation Gulf, and this remains true until you get toward Hudson Bay, Baffin Island, and Greenland, where the uses are similar to those of Bering Sea. Particularly in Greenland, the kayak is a device for hunting seals.

No doubt the similarity of Bering and of Greenland use of the two skin boats is due to the absence of ice from the water, so that the people are water hunters. In the region between, water hunting is practiced in some districts, but generally the hunting technique is more adapted to land and to sea ice.

SKINS FOR BOAT COVERS

When the skins of seals, small or big, are intended for boat covers they are put into tubs and kept in a warm place while the hair rots loose from one side and the blubber more or less loose from the other. When the rotting has gone far enough, both the hair side and the flesh side are scraped, sand, ashes, or other material being used to remove the last traces of blubber. The skins are then sewed together while wet, overlapping seams, with stitching as fine as that needed for water boots. As in the boots, the thread has to be sinew, or some material that swells on getting wet.

While still pliable through being soaking wet, the sewed skins are stretched over the frame of the boat. In the case of the enclosed one, the kayak, the two sides have to be held together by hand while the last seam is being sewn. The wet skin covering is then reasonably tight and becomes as tight as a drumhead upon shrinkage with drying. In the case of the big open boats, umiaks, which are covered with the skins of bearded seals, walrus, or white whale, a great deal of strength is used in stretching the skins. This is possible, for their edges are passed over the gunwale all around and overlap on the inside a little where they are lashed to the ribs or railing by thongs passed through perforations in the edges of the boat cover.

Like a dry water boot, a dry skin boat may leak a little. You dampen them, accordingly, before putting them in the water. An ideal dampening is to have rain fall on them while they are lying bottom side up. If you have to launch a boat that is very dry, you count on it leaking a little and figure on paddling ashore after a while and turning it upside down, spilling the water. After that the seams are watertight.

Neither the big nor small boat should be permitted to remain constantly wet for more than 2 or at the most 3 days if the weather is hot and they are being used in warm fresh water, as on rivers. On the third, fourth, or fifth day of such use the seams begin to go with the decay of the sinew. It is customary to pull boats out of the water whenever you expect to stay several hours, as over night. The kayak is placed upside down, resting on stones or sticks; the umiak is propped on edge, leaning over in such a way that it forms a good camp shelter from rain or wind. Even when tents are pitched, it is customary for traveling parties to work in the shelter of the umiak. They dance in its shelter, too, or sit around telling stories.

It has been stated, as an extreme, that an umiak of bearded seal can stand a continuous 10-day voyage in the ocean without injury—that you could make a protracted coastal voyage if you gave the boat a thorough drying every 10 days. It is considered that the factors which stretch the 3- or 4-day river voyage interval between dryings to 8 or 10 days between dryings on sea voyages are two: Decay of rawhide and of sinew is slower when temperatures are low; Arctic sea water usually runs from 2° or 3° above freezing to 2° or 3° below it, say from 29° to 35° F., while river water may be 10°, 15°, or 20° warmer. The second factor making for slow decay is that salt (NaCl) and perhaps other chemicals in the sea water retard bacterial growth.

Umiak covers are sometimes of walrus hide or of white whale. Some think white whale as good as bearded seal; few think the walrus so good—it is heavier and the cover does not remain so long in good condition.

Kayaks are sometimes made of caribou skin, which has been rotted and in other ways treated as the skin of small seals, which is the usual material.

LIFE OF SKIN BOATS

The average life of an umiak is 3 years. It may be less than that in fresh water, a good deal more than that in salt. The life of a kayak with equal use and equal care is perhaps less. However, a kayak is easier to care for. With hard luck or poor management an umiak may go bad on you the first year.

Greasing the seams of kayaks and umiaks is not ordinarily necessary, but it is not such bad form among Eskimos as greasing the seams of water boots. You see it done every now and then, especially with umiaks. For extreme cases, as when a umiak has either been badly constructed or is in its last year of use, tallow may be employed to fill seams which would otherwise leak. In most cases lard is here better than the native caribou or similar tallows, for they get too hard and may crack out of the seams at temperatures under which the lard would be soft and flexible.

There are districts where umiaks were greased in what might be called white man's style, apparently before the influence of white men began to control. E. W. Nelson describes from Bering Sea a process where a new boat is placed upside down and greased all over, as if it were being painted. The oil, preferably seal, is allowed to dry for 2 or 3 days, which makes it a little sticky. A second coat is applied and allowed to dry; perhaps even a third.

The advantages of the umiak over the wooden New England type whale boat of approximately equal length are: The umiak carries more cargo because of its higher sides and lighter weight—it weighs between one-quarter and one-half as much as a whale boat. It can go in shallower water because of its flat bottom. Most important of all, it is stronger.

A New Bedford whale boat going 5 to 7 miles an hour under sail may be stove by a chunk of ice the size of a bushel basket, or smaller, practically invisible through being awash; an umiak pays no attention how it bunts into ice of such or even considerably larger size. Going full speed into practically any obstruction, it is either uninjured or a rib or two are broken. Only a sharp cutting edge like that on a fractured rock would pierce a hole.

Whether in whale boat or umiak the first emergency repair when pierced would be to pull something, as a piece of skin, outside of the boat over the hole. When you get the two boats "ashore," either on land or ice, you have a big and difficult job with a whale boat; but with the umiak you just get out needles and sinew thread and, in half an hour, either Eskimos or white sailors used to a needle will have a patch on that is either completely waterproof or which allows water to come in so slowly that it scarcely matters.

You can run an umiak ashore in a surf the way you would a dory. It is easier to pull upon a beach than a dory because of its lighter weight—two strong men can carry a umiak of three or four thousand-pound cargo capacity while four men carrying it can walk along at a good swinging gait. It would take at least eight men to carry similarly a dory of equal capacity.

In both Greenland and Alaska a square sail has been in use for centuries. Fore-and-aft sails have been introduced recently, following whites, and are considered dangerous—these boats capsize easily if they carry a big spread of canvas.

Paddling, sailing, or drifting in a river you can have a considerable load with a 4-inch draft, and, because of the combined light weight of the craft and its flat bottom, you can half carry boat and cargo over patches of very shallow water. On the second Stefansson expedition they sometimes worked through with a considerable load where the draft was only 3 inches, the men walking alongside, partly lifting and partly towing the boat.

No craft is better for tracking upstream than the umiak. Preferably there is a mast, and the tracking line runs from three or four feet up it to the dog team ashore or to the men who are pulling. It is seldom easy to track with less than 50 feet of rope. Under special conditions, as rocks or shallows near shore, you might well use two or three times that much line. If things are too unfavorable on your side of a river, you climb into the boat, paddle across and begin tracking on the other side. The dogs will swim over. Toward fall, when rivers are icy, you had better carry the team across in your boat.

The umiak has certain drawbacks which go with its virtues. Being flat-bottomed and with much higher sides than a whale boat it sticks far out of the water unless heavy-laden, takes on a lot of wind and is therefore difficult to paddle against the wind. For the same reasons, you cannot tack it into the wind; while even with a beam wind it makes considerable leeway.

When dealing with rough waters the Eskimos use a number of inflated seal skins tied outboard on both sides, a little back of the bow and front of the stern. Sometimes an inflated seal skin is put crosswise of bow or stern. According to the size of the seal these bags have a buoyancy of 150 to 300 pounds each. (An umiak being made chiefly of rawhide, with only a little wood, will sink on being swamped unless provided with floats.)

A device for rough weather which in 1877 Nelson took to be of pre-white use was what our sailors call a weather cloth, which to the Eskimos would be a weather skin. Flaps of seal, not more than 2 feet wide, were attached to the rail of the boat all around and were folded down inside during smooth weather. When there began to seem danger that the boat would take water during a rough sea these flaps were raised and held in place by sticks lashed to the framework, thus practically giving it that much more freeboard.

It is generally believed that the square sail was borrowed by Eskimos from Europeans, perhaps by Greenlanders from the old Norsemen of the colony which occupied Greenland from 986 to after 1500 A. D. Where Eskimos use oars, rather than paddles, that idea is also considered to be borrowed from Europeans.

KAYAK

The superiority of the kayak over all similar inventions of Europeans or North American Indians has been recognized everywhere at all times. The earliest European explorers found that with oars they could never overtake an Eskimo in a kayak and it was only under the rarest conditions, with oars and sails combined, that one of their boats could equal the paddled speed of a kayak. Even then, the Eskimo could always get away just by refusing to be pursued straight down the wind. Similarly, as noted earlier, the best Algonquin canoe men fell far short in speed as well as in ability to face rough water.

The nearest thing in lines to an Eskimo kayak is the modern racing shell, which is also the only man-propelled boat that can equal the kayak in speed. For practical use there is, however, no comparison. A shell can be used only on placid water; a kayak faces the roughest sea and goes through breakers.

The kayak is a completely enclosed vessel except for the mouth into which the voyager inserts himself carefully while he is alongside of a steep shore, a floe of ice, a log or an improvised dock. He sits with his body flexed at right angles, the legs stretched straight out before him.

Usually in Greenland, occasionally in Alaska, you wear a waterproof coat tied around the mouth of the kayak and around your wrists and neck so as to make your garments and your kayak one piece, water-excluding.

Where water-excluding garments are used, tumbling in kayaks is a recognized sport, whether with double or single paddle, usually double. The kayaker upsets himself and maneuvers around underneath to come up on the other side, righting himself and the kayak with a dexterous twist and shove of the paddle blade.

The sport of kayak rolling leads to practical results, especially in Greenland. In the southern two-thirds of that country most of their food is secured by natives in kayaks, sometimes at considerable distances from land. Indeed, in parts of Greenland kayak hunting is done practically throughout the year.

The use of a kayak is a fine art, but not even the greatest expert can remain stationary in it—comparison is to walking a tightrope, where you are all right as long as you keep a certain amount of motion but where you cannot possibly remain quite still. When an Eskimo stops he has to have the blade of his paddle in the water. When he throws a spear he does it with one hand, the other on his paddle. To fire a gun where both hands are used, boat and man must be facing directly toward the target; the hunter must have the paddle so in hand or so within reach that he controls himself by it almost simultaneously with the recoil of the gun.

The above applies to the kayak of very fine lines. There are kayaks of fairly broad beam which are not so skittish.

When learning to use a kayak, the main thing is skill in getting out of it. You can practice this first on shore, the object being to be able to wriggle free if you capsize. Only after this is thoroughly mastered should you undertake the second step, paddling about. Then you learn such ticklish operations as firing a gun. Finally, with the use of a waterproof suit, you learn to right yourself after capsizing.

Journeys of several hundred miles by kayak are on record, particularly from the Aleutian Islands and southwestern Alaska. When traveling along a hostile coast, or for other reason not wanting to go ashore, two or more kayaks will use cross beams and lash their boats together, side by side. It is then possible for the men of even just two kayaks to sleep, although more or less in a sitting-up position. If three or four kayaks are lashed into a single raft, they can be decked over in such a way that kayakers can emerge from their manholes and sit or lie around. Kayaks are sometimes rafted to prevent capsizing; but in that case there would have to be more than two, or else the two kayaks must be some distance from each other with a bridge holding them together.

Kayaks are sometimes rafted for freighting. A raft of two kayaks kept well apart by a bridge, or of three and more, will be towed by a single kayaker; as when ferrying across a river, or (in modern times) when lightering a ship.

Formerly it was customary both in Alaska and Greenland waters for parties to travel that consisted in part of umiaks and in part of kayaks. Women, children, decrepit old men, and sometimes others, would ride in the umiak; most of those men who owned kayaks would paddle along in them. One reason was that the kayakers could go faster than the umiak and could scout around, as for game. They made detours to secure game, either bringing it to the umiak or signalling the umiak for a detour. In this sort of travel the kayakers would take turns climbing on the umiak to rest and perhaps to sleep. The empty kayak would be ballasted sufficiently, with a stone or something else heavy for its size, and would be towed; or the kayak might be carried aboard the umiak for a while.

Converting sledges into rafts or sledge-boats is described in the following section.

SECTION II

SLEDGES

In outfitting a sledge, essentials are rifles, ammunition and other hunting gear, scientific instruments, cameras and photographic supplies, diaries, spare clothing, bedding, and cooking utensils, snow knives, axe, pickaxe, shovel, etc. Equipment provided, take on as much food and fuel as can be hauled without making the load too heavy. As stated earlier, hauling fuel is more important than hauling food and the kind of fuel is more important than the kind of food. For game is to be found nearly everywhere on the polar sea if you know how and where to look for it and how to secure it.

The scientific equipment might be: two sextants with necessary tables for computing latitude and longitude, three good watches (not pocket chronometers), two thermometers, aneroid barometer, several prismatic compasses. On a journey over sea ice, if you want to pick up a little geographic information (and also for guiding you to land by giving the slope of the sea bottom), you might carry a sounding machine with several leads and about 10,000 feet of wire. The watches, or at least one of them, should (for reasons given elsewhere) have a 24-hour dial numbering.

We said that watches should be preferred to pocket chronometers. For it has been the experience afoot that with a chronometer escapement a jar is much more likely than with a watch escapement to make your timepiece lose a beat.

Every article carried on a sledge should be as immune as possible to breakage or other injury and, of course, should be as light in weight as compatible with other needed qualities. Scientific instruments are protected from jolting by being wrapped in the bedding or in spare clothes. The camera should be protected likewise, for jolting may put it out of order.

SPEED

In Alaska, where you can buy dog feed at roadhouses and where businessmen travel fast because of the value of time, speed driving is useful. But in survey and exploratory work, in country where land and ice are as rough as in most places in the North, you cannot drive fast with a loaded sledge without breaking it—you collide with things every now and then, and the shock of impact varies with the square of the speed.

Cold weather increases the hauling weight of loads. At −50° or −60°, the grains of snow seem to act upon steel shoeing as would grains of sand on a beach. It has not been determined but it seems likely that a drop in temperature from 10° above zero to 50° below will increase at least by three the strain put on dogs in pulling a given load. A popular explanation is that the increased friction is because the snow crystals get so hard that they begin to scratch the sledge runners like sand.

The resistance to the sliding of metals over snow varies with the kind of metal; it also varies with the condition of a given metal. For instance, copper slides better than iron and soft iron slips along more easily than hard at low temperatures, or at least soft iron glides better than steel.

A slight increase of friction on steel sledge runners may begin right from the melting point of snow, increasing coldwards; but in practice we think of it as beginning somewhere between 10° and −10° F. It increases in some growing ratio, perhaps even geometric, so that there is a very big difference between −40° and −50°. The difference is believed by most travelers to be greater between −50° and −60° than between −40° and −50°.

ICE SHOEING

With ice shoeing, as discussed elsewhere in this section, the hauling weight is probably only a quarter or a fifth as much as with steel shoeing. In cases where ice shoeing cannot be applied, the way to minimize the drag, in months when the sun is above the horizon, is to travel only in the daylight, and consequently warmer, hours.

In cold weather, sledges pull very hard, especially if they are metal shod, when crossing leads on new ice. As described in Section III, Chapter 2, this is because the elimination of salt by freezing has already begun and there is a crust of salt on top of the ice.

SLEDGE CONSTRUCTION

The making of good sledges requires so much skill and practice that an apprenticeship is necessary. However, a general discussion will help for the choice and understanding of sledges and also for making them, if you have to in an emergency. We begin with the emergency type.

EMERGENCY SLEDGE FROM HIDE

In country where little wood is available, Eskimos have made runners out of skins and ice. You fold several thicknesses of wet skin, such as musk ox or caribou, into long slabs resembling planks. The skins are soggy, the water having penetrated to the cells in the hide as well as filling in between the hairs. You lay the wet skins out on a very flat surface, as on the ice of a lake, to build up your plank. (Likely wet sail cloth, blankets, and other fabrics would serve as well as hides.)

When the skins have frozen, you adze the plank down into the right shape. This does not have to be a fine job, for there is to be shoeing.

The greatest difficulty with these emergency sledges is to make of skins the crosspieces needed for holding the runners together and holding them on edge. These crosspieces practically have to be of wood.

Approximately speaking, you make the sledge, with its two runners and cross pieces, about as if you were making a ladder out of two planks, with the crosspieces for rungs.

You fasten the crosspieces by countersinking them into the runners and by boring holes through the runners and lashing with rawhide thongs.

When everything has been made as tight as possible you reinforce by freezing. You pour in water that will fill the holes and then you plaster on mushy snow of ice cream consistency. This snow should be mixed with something to make the ice tougher, as grass or the long hair of some animal.

There are various ways of shoeing this type of sledge. One way, the commonest, is to use sods. If the plank of which your runners are made are 3 inches thick, then cut the sod so that it is about 6 inches wide and say 3 inches thick. Along one of the flat sides of the sod you cut a trench into which the plank will fit. When you have enough sods cut to shoe both your runners, you place them in position, set the sledge on top so the runners stand in the grooves of your shoeing where it lies on the level lake ice, pour in water along the edges, and fill in with mushy snow.

When the shoeing is frozen solidly to your runners, you turn the sledge upside down and adze, hack, or scrape away the bumps and ridges. Insofar as there are indentations or cracks you fill these with mushy snow, mixed as before with hair or grass.

When the lower side of the shoeing has been whittled down to approximate smoothness, you take a bucket of water and a swab made of long-haired skin, dip it into the water and swab the bottoms of the shoeing. This should be done on a very cold day, the colder the better; for if the temperature is near freezing the water may erode your runners, getting them out of shape.

This description may seem difficult to follow, but you will find the process easy; for it is all a matter of common sense, and trial and error, when you once get the broad idea.

Sledges such as just described can be used only in cold weather. They will, of course, collapse and disintegrate in the thaws. However, you can use them pretty well into spring by making sure that every time you stop it is on snow rather than on ice or earth. When the sun is warm you carry some kind of awning on the sunward side of your sledge to shade the runners; at camp time you see to it that the sledge is so shaded as to prevent the sun reaching the runners at all. In some cases the best way is to bury them in so much snow that you know it cannot all get melted while you are in camp. You prolong the use in the spring by traveling at night and protecting the runners as indicated while you sleep during the day.

If you have wooden planks, or can make them out of logs, a sledge will be made on the principles above described for hides, the shoeing also similarly applied. In this case, however, you might want to use nails, if you have them, in place of lashings for the crossbars. Lashings are better, on the whole, if the job is well done.

Sledges of the above types that are fairly rigid are sometimes shod by Eskimos with fossil elephant ivory, walrus ivory, caribou antler, the jawbone (not the baleen) of whales, or even with small pieces of rib or leg bone of other mammals. The pieces must either fit very snugly against each other or else they should overlap so that the piece in front goes a little way back on the one next behind. Ivory is perhaps the smoothest gliding of these materials. When the thermometer is in the vicinity of freezing they don't glide more easily than metals, but they do glide more easily at low temperatures. They are usually fastened on to the runners with pegs but occasionally with lashing, in which latter case the shoeing has to be thick enough to permit holes to be bored. Naturally the lashings must not project, so you will have to countersink them both into the edge of the shoeing and into the edge of the runner.

If you kill a seal while on the march you pass a rope through its nostrils, turn it on its back and drag it that way behind the sledge. The hair is smooth, turned backward, and slides very well. A polar bear, unskinned, will not drag similarly, because of his angular shoulders and because he will not stay on his back. But you can make a temporary sledge out of the front portion of his skin. You butcher the animal, remove as much of the hide as seems necessary, put the parts of the meat you want to carry into this, and lash it up in some way so that it takes more or less the shape of a toboggan. On the Stefansson expeditions, improvised sledges of this sort were sometimes used for days at a time—until the meat was all gone.

Caribou and many other skins slide so badly that they cannot well be used for this type of emergency sledge.

NANSEN SLEDGE

It is generally agreed that for travel over such smooth surfaces as the Inland Ice of Greenland or of Antarctica you want sledges to be as light as possible. The Lapp type, as developed by Nansen and borrowed by later explorers, consists of runners which are much like skis, with a light body superadded, all the attachments by lashing. These are easily strong enough for 10 pounds of sledge to carry 100 pounds of load; in some cases 5 pounds of sledge have carried 100 pounds (a 30-lb. sledge carrying 600 lbs.).

Most travelers agree that the Nansen sledge is unsuited to work on rough sea ice. Nansen used them and did not complain, but he knew no other kind and had become fond of them during his previous work on the Greenland Inland Ice. Amundsen approved them for work on the Arctic Sea, but a study of his record will show that he had negligible personal experience with rough ice. Fiala tried them and did not violently disapprove, though he recognized the need for much strengthening and modifying. Mikkelsen and Leffingwell came to northern Alaska fully convinced of the superiorities of Nansen sledges but were undeceived during the first few months of their experience when they had a chance to compare them with the Nome type in properly rough sea ice.

PEARY SLEDGE

If you want a sledge where the main qualifications are lightness combined with strength, probably the native Eskimo type as modified by Peary is best. However, these sledges have serious drawbacks, among them that they are too low when passing over ice snags, and that they are hard to steer and otherwise manage.

BASKET SLEDGES

Basket sledges are of two main types, that developed by the Yankee whalers in northwestern Canada and northern Alaska, and that developed by the gold miners, trappers, and traders of western Alaska—called the Nome sled. They are so springy that an ice-and-earth shoeing, as above described, cannot be used—it would peel off. The Nome design is the springier—which is probably an advantage if you permit springiness at all.

The Nome sledge will be about twice the weight of the Nansen sledge for handling a given load, but it has so many advantages over both the Nansen and Peary types that, especially when equipped with a toboggan bottom (see below), it should be preferred in outfitting an expedition. In real emergencies you are not likely to have available material to make Nome sledges. Moreover, they are so much more difficult to build than the Peary type (though no more difficult than the Nansen type) that the thing to do is to outfit an expedition or a party with enough of these sledges, purchased from northern makers or from firms in cities like Seattle which supply Northerners. If you have tools and a supply of materials, good carpenters or other handymen can learn how to build this type on the basis of a few samples.

A valuable attachment for the Nome sledge was developed by the third Stefansson expedition. The problem was that in soft snow, and particularly in the spring, a loaded sledge will sink down into a drift until the crossbars act as brakes in the snow. The new idea was to put a toboggan bottom underneath the crossbars of the sledges so that when they sank in they would be automatically converted into toboggans. The toboggan boards (of ¼- to ⅓-inch hickory) added 20 to 40 pounds to the weight of the sledges, but this was amply compensated for not merely because of the above toboggan action in snowdrifts but also because the toboggan bottom protected the crossbars against sharp blows from snags of ice—the sledge would ride over ice pinnacles somewhat as it did over snowdrifts.

In previous chapters we have described two sets of conditions from which it will be inferred that sledges sink deeper into snow during spring than at other seasons. The first explanation is that more snow falls during this season than any other and that it is particularly fluffy because of falling in a temperature that is only a little below freezing. Being sticky, too, from this fluffiness and the comparative warmth, it is not swept along the ground by the wind and powdered up as it might be in colder weather. The second cause, and the one which chiefly drives us to this restatement of certain spring conditions, is that old snow which has been in hard drifts will turn granular in the thaw weather and under the light rains of early spring so that you no longer step upon a drift but rather into one, as if it were a bin of wheat. Sledges act similarly. If you have the Nansen type, with runners four or even more inches wide, they may keep on top; but if you have the Nome type, with runners somewhere between an inch and a half and two and a half inches in width, your sledge will sink in—again somewhat as if you were dragging through rather than over a bin of wheat.

It is, then, more against the old granular snow than against the new-fallen soft snow that you need toboggan bottoms in your Nome sledges. The need is greater out at sea than on shore; for, through reasons not well understood, the sort of granulation described is comparatively not troublesome on land.

SLEDGES FOR FOREST USE

With the partial exception of the Nome sledge with the toboggan bottom attachment, all the above sledges are worthless in a forest. They sink down and drag like a snowplow, besides snagging on stumps, bushes, and trees. The only kind there useful is some variety of toboggan, a vehicle so familiar that it needs no description.

A 2-inch width seems about right for steel sledge shoeing and about ⅛ inch the right thickness. If runners are narrower than 2 inches, they cut into the snow more or less like a knife. If they are wider than 2¼ inches, then the increase of drag becomes very noticeable at low temperatures. If you have wide shoeing, the width, for instance, of a ski, the dragging surface must either be polished wood (unless it is ice) or else one of the soft metals, such as nickel. Nickel, however, is so weak that it has never yet stood up under hard usage.

It is said that other metals run more easily than steel over snow at low temperatures, and Nansen had good luck with german silver. However, the experiences of Sverdrup, Mikkelsen, and others with german silver leads to the opinion that, even if steel drags harder, it is better in the long run. For, unless you get tangled in rocky ground, it will last half a dozen years, while german silver gives out promptly in rough ice.

Peary and Stefansson advocate cold-sheared steel with edges sharp as a skate, soft enough to be drilled in the field and hard enough so that it does not wear out quickly. One advantage of this skate-like edge is that when there is an inclination to slide, it "bites" into the ice.

The only shoeing that is really practical besides steel is ice, and this cannot be used on sledges of the Nome or Nansen type, for both are pliable and the ice pulls off when the runner bends. To keep ice shoeing, the sledge runner must be a stout plank on edge, as in the Peary and Eskimo sledges. These are rigid, and ice shoeing will stay on them indefinitely. It needs to be repaired every morning; but swabbing them to provide new icing is only a few minutes' job with each sledge.

Ice shoeing glides so much more easily than any other Eskimo or European invention that rigid sledges of no matter what make have therein a great advantage. Even if the runners themselves weigh an aggregate of hundreds of pounds, as when made of sod, it will be amply compensated for by the smooth gliding qualities—unless, indeed, your journey is a protracted one uphill, as when proceeding from a seacoast toward the interior.

The chief disadvantage to ice shoeing is that, like german silver or copper, it has nothing to keep it from sliding sidewise on an incline.

When spring comes, the ice shoeings melt off. But sledges can be made with steel shoeing underneath the ice, so that one has it to fall back on when the weather gets warm.

SLEDGE COVERS

The Eskimos, before whites came, apparently saw to it that each parcel they put on their sledges was self-contained and protected from snow. Whites have found, and the Eskimos have readily adopted the idea, that a better plan is to have what is called a sledge cover. This may be just a rectangular piece of canvas which you put over the sledge (or inside the basket if it is that type). You load up and the last step is to wrap the edges up on the side and over the load. This cover is held in place with cross lashings that go under the crossbars of an Eskimo-type sledge or under the rail of the Nome type. For midwinter use you require nothing very heavy—8-ounce duck is usually considered to be on the heavy side and drilling is preferred. In spring travel it may be advisable to have something in the nature of a tarpaulin that will cover the load and shed rain. For, especially at sea, you may travel for weeks after the spring rains begin. Besides, the snow will melt on your load and it is well that the resulting water should run off.

ARTICLES FOR EMERGENCY USE SHOULD BE OUTSIDE COVER

As mentioned elsewhere, it is important that things which you may need in emergencies (your rifle, for instance, and your camera) shall not be inside the load, ordinarily not even under the last-mentioned rain-shedding cover. Each such article must have its own waterproof covering.

SLEDGE WITH SAIL

It helps when traveling to leeward just to have the wind pushing on the sledge itself, and on its load. When this does not give enough of a push, square sails are rigged. They can be made out of most anything—a single caribou hide will help a lot, or you might use a blanket. Ordinarily it pays, however, to take with you special equipment. This would consist of two bamboo or other light poles to be erected at the sides of the sledge with anything at all for a crossbar between them at the top. On this you rig the sail. Sometimes a single mast is used, in which case you have some sort of stick for a yard at the top. At the bottom no yard is needed, the corners of the sail being attached to the sledge at either side.

SLEDGE-BOAT

The making of a needed and simple invention, by which a sledge is converted into a boat, was delayed through apparently logical though really incorrect reasoning. Obviously you could make a boat by setting a sledge on a waterproof fabric and wrapping it up on the sides. But it was said this would help you to cross only one lead if the temperature were low; for hundreds, if not thousands, of pounds of water would be converted to ice that would cling to the canvas and compel you to leave it behind. Since you could not possibly afford to carry a separate canvas for each crossing of a lead, the idea was dropped. Sometimes the plan was mentioned, to be dismissed, in books on exploration.

But Ernest deKoven Leffingwell, then joint commander of the Anglo-American Polar Expedition wintering at Flaxman Island, conceived in 1906 an easy solution. If you greased the canvas the ice would peel off like candle grease from the back of your hand. Seal oil was too messy, beef or similar tallows were so hard they would crack off. Lard might be a happy medium. Leffingwell tried it and found that it worked perfectly.

This invention of Leffingwell's was first put to extensive use on the third Stefansson expedition during a journey of five or seven hundred miles (according to which way you figure it) north from Alaska and then east to northern Banks Island.

You must have properly open water. Forcing a canvas boat through young ice chafes it along the water line; half a dozen crossings will probably wear a hole in the cover. But leads can be several hours old and still without ice at —40°

if there is a fairly strong wind. Then they are as crossable as an ordinary river in the summertime.

PROCEDURE

A tarpaulin for this purpose is No. 2 canvas, treated with lard or otherwise waterproofed. It is about 18 feet long and 10 feet wide. Unload the sledge; spread the cover on the ground and place the sledge upon the middle of it. Take two sticks, about 6 feet long (carried for the purpose) and lash one crosswise of the sledge near the back end, another near the front end. Between the ends of these sticks lash one ski on each side. Or a second pair of skis may take the place of the special cross-sticks—they may prove handy to have along even on travel over sea ice.

The described frame gives the boat a beam of 6 feet instead of only 25 or 30 inches. The frame constructed, the tarpaulin is lashed up on the sides of the sledge. The whole is now a boat which carries about a thousand pounds. For propulsion, use a paddle, or, if you haven't one, a shovel or a ski.

Sometimes at low temperatures a great deal of ice will form on the canvas while you are crossing; but as all the interstices are filled with lard or similar material the tarpaulin cannot possibly become water-soaked. The grease makes a surface to which ice cannot adhere tenaciously, and can be removed by rolling the tarpaulin about, walking on it, or beating it with a stick.

The tarpaulin with its waterproofing weighs about 40 pounds. Its weight is seldom increased as much as 5 pounds by the ice that still adheres when you roll it in a bundle and put it back on your sledge. The bundle resembles a bolt of flannel as you see it in a dry goods store and is loaded in the bottom of the sledge, conveniently and with no danger of injury during travel.

The advantage of this system of crossing a lead is manifest to anyone, but especially to those who have read, for instance, the account of Nansen's use of boats for crossing open water. These were of fragile canvas; and, as he carried them on the sledges with the canvas stretched tightly over their frames, they were easily punctured when the loads happened to upset or to collide with broken ice. Nansen, accordingly, found that, besides the disadvantage of the great care they required, the canvas canoes were so badly damaged, their covers so full of holes, when open water was reached that it took several days of repairs to make them seaworthy.

SLEDGE-RAFT

For crossing leads Peary used sledges supported by inflated seal skins. These would have to be lashed, on his type of sledge, to the outside of the runners, so as to give more beam. Additional buoyancy could be secured by an inflated skin set between the runners. As said elsewhere, the buoyancy of these skins will range from 150 to 300 pounds, so that it would not take many to transport a considerable load.

The disadvantage of this method is that ice forms on the sledge itself and has to be chipped off. The main advantages are that the skins are not heavy, that they fold flat when uninflated, and that toward the end of their usefulness they can be fed to dogs, cut up into patches for clothing, or used in some other way.

SECTION III

SKIS AND SNOWSHOES

Where the ice is smooth or the land flat, skis are useful especially before a fair wind when one can glide almost without effort and at a higher speed than is attainable on snowshoes. But among jaggedly broken ice of the open ocean skis are almost as out of place as in a thick forest. Their main use on the third Stefansson expedition, several members of which were originally prejudiced in favor of skis, proved to be for occasional crossing of leads on thin young ice and, as said, for use in constructing the frame of a sled-boat.

KAMCHATKA SKI

Bergman reports that the ski as developed in Kamchatka has points of superiority over that developed in Sweden. The Kamchatka skis are about 2 yards long and 8 inches wide. Undernenath they are covered with sealskin with the hair lying back. Their advantage is that they do not slip backward when going up hill even if one is not using staffs. They have the further advantage that they do not get clammy in a thaw and are particularly effective making a road for dogs in loose snow. If, however, it is merely a question of getting from one place to another, he agrees the Swedish (Norwegian) skis are better.

SNOWSHOES

Wilkins reports that the submarine *Nautilus* carried both skis and snowshoes. When there was hauling to be done, the Norwegians used skis while he wore snowshoes. When the Norwegians saw how much better he got on they began to use snowshoes themselves. Eventually his greatest difficulty was trying to keep a pair for his own use. Stefansson had earlier met a like situation with Norwegians on his third expedition, of which Wilkins was a member.

INDIAN AND ESKIMO TYPES

The hunting snowshoe of one of several Indian models is useful in any Arctic work except on the roughest ice. The type used by the Eskimos on the north coast of Alaska—with a length of between 3 and 4 feet and a greatest width of about 10 inches—is most convenient.

PEARY TYPE

Peary carried two sizes of snowshoes, both made in Maine. Those furnished his white men were 6 foot by 1 foot; those furnished his Eskimos 5 foot by 1 foot. The shoes were made with raised toe, as were those used by Stefansson, and with a ski curve in the middle.

SIBERIAN TYPE

Vanderlip reports of Sibebria that two sizes of snowshoes are in use, one for soft snow 5 feet 10 inches long and 8 inches wide, pointed and curved up in front and gathered to a point at the back, and one for use in hard snow, 3 feet long and 8 inches wide. These were shod with reindeer skin with the hair pointing back, which prevented slipping.

ALASKAN TYPE

In the softest and deepest snows on earth, found in certain parts of central and southern Alaska, snowshoes of great size are used—almost as long as Norwegian skis and, of course, much wider.

Wherever snows are soft and deep, which includes all forested Arctic and sub-Arctic lands, at least two kinds of snowshoes should be carried by each party—large ones for hunting and ordinary travel, small ones for walking ahead of the dogs, breaking trail. These should not be particularly wide. The trail-breaker should use short steps so placed that the two shoes together make a trail the width of the toboggan which is to follow. Two or even several men should walk ahead to break and tamp down the trail. It is a good plan at camp time, if there are extra men, to send one or more ahead to break next morning's trail for some miles. A trail well tamped down in the evening will be hard enough next day to support the feet of dogs, which is not so if the team immediately follows the trail-breaker.

COMMERCIAL TYPE

Commercial makers often sell and stoutly recommend snowshoes of size and design not suitable for northern work. But when it comes to strength (resistance to breakage) and wearing qualities, the commercial product from Maine and elsewhere is better than anything made by the natives of northern North America, either Eskimos or Athapaskans. The thing, then, in outfitting an expedition, is to get commercial makers to adopt a proper style and weight and then secure from them all the snowshoes you think you are going to need.

MAKESHIFTS

A man who has used or even merely examined attentively a pair of snowshoes can, under most conditions, construct makeshifts for himself. Steamed hickory and woods like it are best for the frame, but you can use the Arctic willow rather effectively, and even driftwood spruce.

The thongs that support the foot can be cut from any heavy leather there is on hand, either rawhide or tanned. Rope can be used, but it stretches more than rawhide in cold weather and is then comparatively undesirable. On the other hand, rawhide stretches badly when wetted by slushy snow.

For the meshing of the snowshoe, other than beneath the foot, you also use leather thongs—fine (*babiche*), preferably of rawhide.

ALL-METAL TYPE

All-metal snowshoes have been considered but perhaps never made. They could easily prove most desirable. For instance, the frame might be of duralumin or similar tubing, with the equivalent of the fine mesh perhaps on aluminum sheet perforated with numerous holes. Or you could have (copper?) wire replacing the *babiche*. Under the foot probably you would still want thongs, even in an otherwise metal shoe.

For attaching the snowshoe to the foot you might, under certain conditions, find an elaborate gear useful—such as employed on skis. But snow is liable to pack in these, especially in warmer weather, and perhaps a thong fastening such as used by the natives is, on the average, the best.

SECTION IV

DOGS

We have discussed in chapter 5 the origin and characteristics of northern dogs, the best types for cross-breeding, etc. Here we deal with their care and use in Arctic work.

WEIGHT

Large, heavy dogs, weighing about 120 pounds, are more satisfactory than lighter dogs, say those weighing 50 to 70 pounds. It is obvious that there is an advantage in having six heavy dogs pull a sledge which would require nine light ones—not so much in the amount of food consumed, since heavy dogs need more than light ones, but in such things as harnessing, unharnessing, etc. In addition, when sledges are cached at the end of the snow season and dogs are used as pack animals, not only will the bigger dog carry a heavier back load but he carries it higher above the ground. A small dog may drag his pack through water where a bigger dog carries it high and dry.

One of the reasons to prefer big dogs is that, although you have to feed them more than smaller dogs, you do not have to increase the food quite in proportion to the dog's weight and strength. More nearly you increase it in proportion to his greater body surface, though probably somewhat more than that. It was Stefansson's experience that when an 80-pound dog did well on a pound of food a day, a 120-pound dog would manage with a pound and a quarter.

Dogs must be well furred. A poorly furred dog needs more food because he has to use some of it as fuel to keep himself warm. (Travelers usually put it that you can't keep a dog fat unless his fur is good.) A short-haired dog may freeze, particularly on the flanks, as discussed below. He needs a windbreak when others do not; he may need housing.

A dog in cold weather requires fur so thick that the snow *does not melt under him* when he curls up to sleep or rest. When a dog is thinly furred he gets wet. Chunks of ice will then freeze to him, or, worse still, he may freeze fast to the ground if he has been sleeping on a thin covering of snow. In such cases a dog is prisoner until he dies, if a man does not liberate him.

If big dogs and small ones have to be used with tandem harness (the kind described below as most efficient and as the only one suited to wooded country), the smallest should be in the lead, the size increasing toward the sled; alternatively, the biggest dog should be in front and the smallest near the sled. The reason is that if a small dog is between two big ones the tandem harness will, through its nature, give an upward pull which, although it may not lift the small dog clean off his feet, will decrease his traction power—the firmness of his step on the ground. Or if you have a big dog between two small ones he has to more or less carry them so that in addition to pulling he is also burdened.

Another disadvantage of having dogs of various sizes in a team with tandem harness is that, if it becomes necessary at any time for them to swim, the rear dogs, if large and therefore faster swimmers, will overtake and bunch up with the ones ahead. (The occasion for swimming is chiefly in spring when you sledge over sea ice.)

RATIONS

Fresh meat of any kind is the best food for dogs. They will eat parts of an animal that men do not—entrails, for instance, and bones.

It is the best practice to feed the dogs as long as you feed yourself, for the speed of a sledging party depends on the strength of the dogs. If you are not motivated by feelings of humanity, you should at least be aware of the poor economy of hoarding food to the disadvantage of your team when speed is the thing to be desired.

EMERGENCY RATIONS

In an emergency, dogs can be fed worn skin boots, skin clothing and hides.

PEMMICAN

Dog pemmican requires careful supervision in the packing, since the packers, who do not know the conditions under which it is used, are not always careful to stick to specifications. Often they put in too high a percentage of lean and of salt. Dogs fed on such pemmican suffer from excessive thirst, develop symptoms of starvation, and in some cases become pronouncedly ill, doubtless either from "protein poisoning" or as a result of the saltiness.

In Peary's view the proper composition of dog pemmican is one-half dried lean meat and one-half fat. Stefansson believes that, if they receive it every day, dogs will not overeat of fat any more than a man will, so he prefers one-third of a pound of lean and all the fat (e. g., seal blubber) the dog wants. This, he believes, will come to less than a pound per day total for a 60- or 70-pound well-furred dog—the kind of dog Peary used. No salt or other ingredient should be added.

TIME OF FEEDING

Opinions differ as to how often a dog should be fed, but probably once a day is best—in the evening, not when you stop but after the dogs have been tied (if they are going to be) and when you are yourself ready to call it a day. The dogs will then curl up and go to sleep. They have, true enough, done this when you stopped to camp and have slept till you are ready to unhitch them; but if you feed them at that time they sort of resent being disturbed when you come to the unhitching. (It may be partly imagination, but many drivers agree that the procedure just outlined is psychologically and physiologically advantageous.)

There are drivers who give a small feed in the morning and a big one in the evening, and there are others who give a snack every few hours; but all agree that a big feed in the morning or during the day decreases a dog's efficiency—makes him lazy.

FOOD PREJUDICES; HOW AND WHEN TO OVERCOME THEM

Dogs brought up around ships and used to foraging in slop pails will eat any food that is offered them. The conclusion is that a dog already used to many sorts of food does not mind eating one sort more.

Dogs brought up on a diet restricted to two or three articles will, if they are more than a year old, always at first refuse when an entirely new food is offered to them. This prejudice is stronger the older the dog, and probably stronger in females than in males.

A dog's objection to new food is apparently based on the sense of smell—if a strange meat offered is high enough so that the putrefaction smell completely hides the native smell, then the dog will eat it. In other words, all rotten meats smell substantially alike and are, therefore, recognized as a familiar diet; while any new kind of fresh meat offends the dog through its strange smell.

New litters of pups should be fed many varieties of meat so that they will not acquire food prejudices. Older dogs should be broken of their prejudices as quickly as possible so that your whole team shall consist of animals that will eat whatever food is available.

The first procedure is to offer the unfamiliar meat again and again, feeding no other. You may have to do this for 3 or 4 days before any of your dogs touch it. They will then start eating, in the order of their age, the youngest being the first to give in. The oldest dog may fast as much as 2 weeks. (Stefansson reports one old dog which apparently would have died on hunger strike rather than eat fresh goose.) The procedure can be shortened by feeding decayed pieces of the strange meat at first, and later pieces that are fresher and fresher. It is also possible, if time is not ample for breaking in, to induce dogs to eat a new meat by dipping the pieces in seal oil—the smell of the oil hiding that of the meat.

METHODS OF HARNESSING

On hitching dogs to sledges there is historically little reason to follow Eskimos. For there are few if any parts of their territories where they had large dog teams until after white men began to influence them, so they do not have in this respect the advantage of a weeding out of mistakes through long-continued processes of trial and error.

GREENLAND OR FAN METHOD

The Greenland or fan method of hitching dogs to a sledge seems to have developed when people who were used to attaching one or two dogs to a sled almost any old way found themselves using many dogs. They would then at haphazard attach them each with a separate trace. Later, no doubt, came the development of having a longer trace on the best trained dog so that he would become the leader.

ADVANTAGE

The chief advantage of the fan method, as usually given, is freedom of movement. This would seem to be an advantage chiefly from the dog's point of view.

DISADVANTAGE

The disadvantages of the fan method are that the traces become tangled, that the dogs get in each other's way and start fighting, that the dogs may go on opposite sides of an obstruction, snagging the sledge, and that they pull at various angles, the efficiency being decreased as the angle increases.

HITCHING TO A SINGLE TOW LINE

The method of hitching alternately to a single tow line was developed at the Mackenzie River and some other places. This gives considerable freedom but has the disadvantage that all dogs except the leader pull at some angle from the straight ahead, so that force is wasted. Another disadvantage is that when there are many dogs in the team, say nine or over, they are strung out excessively far ahead, making it bad when you turn a corner.

The method of hitching in pairs, with a single dog out ahead, seems to have been developed chiefly in western Alaska, and no doubt by whites or under their influence. Their analogy was from pairs of horses. In some cases whiffle trees were used as on horse wagons, in others the dogs were attached to the tow line by shorter individual lines. The advantage over the Mackenzie method is that large teams do not string out so far. The disadvantage is that in each pair the dogs pull away from each other, to a certain extent wasting their strength.

THESE THREE METHODS WORTHLESS IN FOREST OR BRUSH

All these three methods are bad at sea among very rough ice and worthless in a forest or among bushes. For the dogs are continually snagged. In a forest the only method to use is tandem, the dogs working one ahead of the other between traces that extend the full length of the team. Each dog's harness is fastened to the traces by or in the vicinity of the collar.

The disadvantages are that freedom is interfered with in such a way as to decrease speed (but this is hardly significant except in racing) and that the rear dogs of the team are thrown out of line or jammed against obstructions when you turn a corner. Also, if there is a long team and they go over a ridge, a downward strain from the front dogs will press those toward the rear down to the ground or compel them to carry a heavy back load at the same time as they pull. Conversely, if they cross a hollow, the dogs in the middle and aft portion of the team will be lifted up, sometimes completely off their feet. These latter difficulties are significant only in long teams. Tandem teams should therefore be short. Some notable journeys have been made with as many as six or seven dogs tandem, but four or five should usually be the limit. In a forest three big dogs make a good team on a toboggan.

The tandem method, with teams of not more than five dogs, is well suited to rough sea ice where the danger of snagging is next after that of a forest. For sea ice journeys big dogs should be hitched tandem and small ones either Mackenzie or western Alaska style. One of Stefansson's tandem teams, averaging well over a hundred pounds in weight and running up to 140 pounds per dog, hauled an average of more than 240 pounds per dog more than 20 miles per day. With other methods of hitching and smaller dogs, few expeditions over broken sea ice have averaged 100 pounds. Some have averaged around 60.

HARNESS

Harness for all methods but the tandem are simple to make and sort of logical. You will develop them from your own common sense when the need arises. Supplies for harness making should include webbing of several widths of the standard types carried by wholesalers who trade with Alaska.

The harness should be tailor-made for each dog. The essential is the collar which must not be small enough to choke him or big enough to slip back on his shoulders. Roughly it is shaped like the collar of a man's ordinary business suit, where the top coat buttons corresponds to a place between the dog's forelegs. From that point there should be a single strap far enough to clear the forelegs; then two straps will come up to meet about the middle of the dog's back. There they connect with a single strap that comes from the collar at the back of his neck and continues backward to somewhere near his croup where it fastens on to the individual trace by which he is attached to the tow line. That is the simplest and more or less Eskimo style. Whites perhaps secure somewhat more efficiency by not having one strap running along the back but rather two straps along the sides of the dog—the idea no doubt borrowed from horse harness.

Dog harness for tandem use is almost necessarily a great deal like horse harness. There is a round, stiff but padded collar. The two traces run from the sides of the collar to back of the dog's forelegs where there is a band around his body, again as in horse harness. The belly band is fastened with buckle or toggle. At side points of the back-and-belly band the individual harness is attached to the two main traces.

When you are outfitting you will buy your supplies from those dealers who professionally outfit dog drivers and you will get things more or less made up. You will be justified in taking the dealer's advice, at least to a certain extent. In emergencies you will make up this type of harness, like the other types, out of whatever you have.

Raw skins are well enough for harness as long as they keep dry. Such harness, if not eaten during the winter, will rot in the spring unless you dry it carefully after each use. Dogs when hungry may chew anything and those not so very hungry may eat not only rawhide as rawhide but also canvas harness if it smells like food through being greasy. Then you lose not only the harness but also the dog, for canvas in pieces of any considerable size will stick in his entrails. Tanned leather has several advantages: It does not rot easily, it does not seem like food to dogs, and does not kill dogs if they do eat it.

CHAIN HARNESS

You can protect your harness and the towline by having them of light chain wound or sewn in with lampwick or canvas. Chains naturally cannot be used for the collar or any part of the harness that presses hard on the dog, for they would bruise and chafe him.

If you figure on making tandem harness, you should have along with you for stiffening the collars iron rods a little less thick than a lead pencil. Wood is lighter, perhaps hickory which by steaming or otherwise can be bent into bows.

BELLS

The use of bells on dog harness is for ornament, sentiment and swank. The only time dogs pull better under the influence of bells is when they hear them from another team, and then only under conditions of surprise or other keen interest.

PACKS

On summer hunts the dogs are equipped with pack saddles, consisting essentially of two big pouches that reach about to the knee on either side of the animal when the pack is in place. These pack saddles are loaded with the heaviest and least bulky things. A fifty-pound dog will carry a thirty-pound pack or even heavier and he will carry it all day, although his walking gait is rather slow, perhaps not much over 2 miles an hour. The people of the party carry on their backs the bulky things, such as bedding, tents, and cooking utensils.

In some cases the dogs can carry at least a part of the bedding. It is tolerably safe when the packs are heavily ballasted with meat or some such thing, in which case the bedding can be tied in small bundles on top of the dogs' backs.

In traveling with pack dogs in summer, however, it must be remembered that they often lie down deliberately in water to cool themselves off, in which case the entire load gets wet.

LOADS CARRIED

As said, a team of big dogs, hitched tandem, can haul an average of more than 240 pounds per dog more than 20 miles a day. The Nome (pair) hitching and the Mackenzie will give intermediate results. Dogs hitched fanwise may pull no more than 150 pounds each.

In figuring on the load for a team you remember that intense cold will increase the hauling strain or weight. At

$-50°$ or $-60°$ the grains of snow have (or some think they have) angles sharp and hard enough to act on the steel shoeing of the sledges somewhat as grains of sand would. No laboratory experiments have been conducted, but, as said elsewhere, it is likely that a drop in temperature from 10° above zero to 50° below increases by at least three times the strain put on the dogs in pulling a given load.

It is unfair to the dogs and unwise policy to ride on a sledge. If they can haul you on top of the rest of the load 25 miles a day, they can perhaps haul the load without you 30 or 35 miles. *No man should be engaged in Arctic work who is unable to walk as many miles a day as his dogs are able to haul his sledge and camp gear.*

REST PERIODS

On journeys the Indians of the northern Canadian woods stop to smoke pipes at regular intervals, say, 2 hours apart. Then the dogs curl up to rest. In sea travel you frequently come to ridges of ice where you have to make a road with pickaxes, or at least have to search about for a way, and that gives the team a rest. Opinions differ as to how frequently you should stop on purpose to rest dogs. In the Alaska races teams have gone 2 or 3 days without a single stop, day or night. On the Stefansson expedition, when dogs were making 3 or 4 miles an hour pulling more than 200 pounds each, they seemed to be indifferent to rest, went steadily ahead for any number of hours, say, 4, 5, or 6. When this team stopped, it showed no particular fatigue. The dogs would either stand around or lie in alert positions.

WHEN NOT TO REST DOGS

It can hardly be amiss, however, to rest a team under ordinary conditions for a few minutes every 2 or 3 hours. But under one condition, resting a team is dangerous—when you know they are tired but when you nevertheless feel bound to reach a certain place before camping. If you let tired dogs lie down they apparently become stiff, really; certainly they hate to pull. So don't rest a very tired team unless you are prepared to stop long enough to give them a chance to recover from fatigue. Two or three hours might do this, but 20 or 30 minutes would not.

TEST OF TRAVELING WEATHER

As stated earlier, whether your dogs will or will not face the wind is the test of fit and unfit traveling weather in the Arctic. If you try to force them on, they will curl up with their noses in their tails, in spite of anything you can do. In a snowstorm their eyes fill with snow, and you will either have to keep freeing their eyes from it, or else you will have to go ahead dragging the dogs. Your sledge will upset, and the dogs will curl up; the process must be started all over once the sledge is righted.

USE OF DOGS IN HUNTING

Seals.—If the mauttok method of hunting seals is used, the help of dogs is indispensable. This method is described in Chapter 13.

Bears.—If, from yelping of dogs or otherwise, you have reason to believe that a bear is approaching, your first concern should be to see that your dogs are securely tied. It is the nature of dogs to set upon the bear, and it frequently happens that dogs are injured or killed by stray shots while the bear has walked away unscathed. (The use of dogs for bears is described in the section on Hunting, Chapter 13.)

Caribou.—Dogs will fly after caribou whenever they see or smell them. You will need to keep a firm grip on your sledge. Dogs carrying packs have been known to dash off, pack and all, sometimes returning after days but more often not returning; for a pack may come off in such a way as to drag on the ground while still fast to the dog's neck. Some dogs will then bite themselves loose; others do not, and remain tethered until they starve to death. Remember, in this connection, that northern dogs are not, as a rule, as good as ours in finding their own way home. This is no doubt because their owners are continually on the move and the dog does not get used to a permanent home.

Wolves.—It is not safe to leave a camp without a man on guard. So long as it is unguarded it is at the mercy of wolves, whether there are dogs or not. Dogs do not have the sense to stay in the camp and attempt to protect it, but will give chase to wolves. In a fight there can be no doubt of the outcome. Dogs may be of the same size as the wolves but they have neither the swiftness nor the cunning. Wolves do not allow themselves to be overtaken by dogs unless they are numerous enough to get the best of the fight.

TRUSTING TO DOGS FOR DIRECTION

A corollary to the above statement, that most northern dogs are not used to permanent homes, is that it is futile to give a dog his head and expect him to bring you to camp. It may be fatal, for it has been recorded that parties following dogs (which they thought were guides) have passed within a hundred yards of a camp without noticing it. By the time you realize the dog is not bringing you home, you may not be able to form any idea yourself of what direction to take.

The exceptions to the above rule are two: A dog may take you to camp along a trail he can smell (but he has an even chance to go wrong each time the trail forks), and a dog will take you home up the wind (but this applies only if you know you are directly to leeward, if the wind does not change on your way home, and if no trail he crosses interests him more—such as a fresh animal spoor).

Dogs, like bears, have been known to smell a camp 10 to 12 miles. They take you there, then, equally whether it is your own camp or some other.

As said above, dogs will follow trails. It is not safe to unhitch them near the place where you bought them, for they are apt to get homesick and to follow their own trails back.

METHOR OF HANDLING DOGS ON MOVING SEA ICE

It happens occasionally that a camp will be endangered through break-up of the floe on which it stands, and the campers must move to another floe. The shivering and crashing of ice may so paralyze the dogs with fear as to make them worse than useless. (See Section III, Chapter 11.)

In emergencies of this sort, the tandem system of harnessing is especially valuable. In the Nome type the dogs have too much freedom and are able to turn completely around and face the sledge. The fan system is even worse, for there each dog has complete freedom and can pull in any direction he likes.

HOUSING

There is no point, ordinarily, in housing dogs if they are well-furred and well-fed. To illustrate:

It was the custom of the Stefansson parties when traveling over sea ice to make on very cold days individual windbreaks for the dogs. Those which gratefully slept behind them were really too thin-furred—under ideal conditions you would not take that kind of dog with you at all. Most of the dogs were indifferent to the shelters and some used to climb on top of the (intendedly) sheltering wall and sleep there. Some dogs would do this even in the most trying weather that ever comes to the polar sea, temperatures of —20° or —30° with a fairly strong wind. (If the weather is colder than that you hardly ever have wind.)

Some dogs when loose will come voluntarily to sleep in the alleyway of your house but the motive is more likely to be a desire for companionship or the hope of food than a search for warmth.

However, at least a small saving in food can be effected, even with a well-furred dog, by housing him. The barn should not be warm, for if it is, filth will develop and contagious diseases, should there be any, will spread more rapidly. A dog barn should be almost as cold as outside, protecting the animals merely from wind. But that in itself is a good deal of protection. In a barn, each dog should have a separate stall, or at least they should be tied as described below.

METHODS OF TYING DOGS

Dogs have to be restrained to prevent fighting. It is probable that they seldom mean to start a fight but in the exuberance of play one will bite another too hard and then there is a scrap. The worst thing is that the whole bunch will pile on the under dog, perhaps injuring him so severely in less than a minute that he may need several days to recover. In another minute they perhaps would kill him.

Ordinarily, even at permanent camps, dogs are accordingly tied either to separate stakes or at intervals along a tie rope. Because some dogs will bite rope you use chains, and for the tie rope either a wire or a chain. The chains are long enough to give each dog individual freedom of movement, and not long enough so he can reach the next dog. There should be a swivel in the dog's individual rope; otherwise he will kink it up, even to the point of choking himself—better have two swivels at opposite ends of his rope for he may lie on one and get it so iced up from melted snow that it will not work.

If there is nothing permanent available for fastening, the ends of the tie rope are usually anchored with deadmen in the snow. On ice you can fasten the ends by digging two parallel trenches a few inches apart and then perforating the ice partition. Such toggles are very strong. They are used by Eskimos, for instance, in hauling a whale out of water onto level ice. A toggle in a partition no more than 4 inches thick will therefore stand a strain of several hundred pounds, and probably several thousand.

NOISE OF FIGHTING TRANSMITTED THROUGH ICE

As described in the section on snow houses, a snow camp on ice is so soundproof that the barking and snarling of fighting dogs outside can seldom be heard. Their spurning of the snow and tumbling about, however, is plainly audible, especially if you are lying in bed with your ear not far from the ice. Such fights must be stopped promptly, as said above, and can be stopped in from 30 seconds to 2 minutes. For such (very necessary) promptness you must dash out unclad if you have been sleeping naked, and you should do this *via* a door that is never shut—both these things are discussed elsewhere in this Manual.

Healthy mongrel dogs have a great deal of resilience. If, in emergencies, they are thin and weak from long-endured hunger, they recover quickly when you are able to feed them fresh meat. As outlined under food prejudices, it is important that your team is broken so that they will eat this fresh meat, whatever kind it happens to be.

FROSTBITE

A frozen flank may incapacitate a dog. It is difficult there to heal a sore, for the skin stretches with every step the dog takes. The only chance after a severe frost injury is to give the animal a rest for several days, preferably to confine him, best of all inside your own house. This is certainly no more difficult or objectionable in many cases up North than it is to keep a house dog in a city.

If the dog's own flanks are insufficiently protected with fur, a piece of skin (say caribou) is suspended under the belly, cut to fit, and tied with strings over the dog's back. This must be taken off at camp time and, preferably, should be taken off during the day every time the team stops to rest, for a dog never freezes his flanks except when walking. When at rest he curls up.

The reasons for removing the blanketing skin when you make even a short halt are two: The dog may eat the skin if you are not watching him—he may not be starving but his appetite is good. If he does not eat the skin he will lie on it, melting the snow and making it wet. The snow that melts may be chiefly what is between the protecting skin and his body.

PROTECTION OF FEET

Under some conditions (as, for instance, when a thin film of ice has formed over snow, whether or not snow has again fallen on this shell of ice) dogs break through the snow and get sharp angular pieces between their toes. The toes will bleed and the pads will be sore and raw. In such case it is the practice to use boots on the dogs. These are made preferably of canvas, without much shape (somewhat like a mitten without a thumb) and will serve 1 day, if this is spring travel over needle ice (q. v.) or several days if it is winter travel on snow. If the dog wears a hole in one side in the forenoon, you change the boot so that the use comes on the other side in the afternoon. Seal and caribou skin boots have the advantage of longer wear but the disadvantage that the dogs will eat them unless constantly watched.

HYDROPHOBIA

Hydrophobia is practically absent from the Arctic. However, there are other diseases the nature and origin of which are obscure.

ARCTIC DISEASES

It is impossible to count on the length of a polar dog's life. Peary's dogs worked hard on almost nothing to eat, withstood exposure to the worst storms, and then, with plenty to eat and little to do, would be suddenly taken with a malady which he calls *piblokto.* The victim of this disease refuses all nourishment and howls and snaps, biting any other dog it comes in contact with, dies in convulsion frequently the same day it is attacked.

In Kane's second expedition, only 6 dogs survived (of 44) a disease which ended in lockjaw. Kane describes the malady as "clearly mental." The dogs, unlike Peary's, ate voraciously, retained their strength, and slept well, but "They bark frenziedly at nothing and walk in straight and curved lines with anxious and unwearying perseverance. They fawn on you, but without seeming to appreciate the notice you give them in turn; pushing their heads against your person or oscillating with a strange pantomime of fear. * * * Sometimes they remain for long hours in moody silence, and then start off howling as if pursued."

At Cape Kellett, Stefansson's dogs began to die one by one. In some cases it was the fattest and youngest, in others the oldest and most decrepit. Stefansson isolated the dogs and this may have helped, but one or two died that apparently never had any contact with those that were diseased.

CONCLUSIONS ABOUT DISEASE

Peary made no conclusion about the cause of the disease, but in buying dogs he allowed for 60 percent probably dying from accident or illness. Kane made the conclusion that absence of light accounted for the malady by which his dogs died. Stefansson noted that his expeditions never lost any dogs that had been living on caribou or other land game, but only dogs that had been living on seal.

J. Baashuus-Jessen, after a study of the published accounts of polar explorers, believes that what resembles rabies is not true rabies because he can find no instance where the disease was transmitted by bite to man or beast. He concludes that the trouble is caused by a deficiency of fat in the diet. He adds that apparently all fats are not alike as preventatives, for Peary had bad results from feeding his dogs on pork, whereas he attained good results when they were fed walrus meat. (This conclusion is the opposite of Stefansson's; for caribou-fed dogs get little fat and there is plenty of fat available whenever men or dogs are living on seals—as explained, earlier, when you secure enough seals to give you all the lean you need you have fat to throw away.)

DANGER IN CAMP FROM OILY RAGS

There is one usually little-considered danger to a dog in camp, that he will in some manner get hold of a piece of rag which you have been using in connection with animal fat or other food. Getting the food smell he will bolt the rag; it cannot pass through his intestines and he will die. You must therefore be careful to keep well out of a dog's reach any cloth, cotton waste, or the like, which has animal fat or other food smell on it.

WHIPS

It is probably true, though debated, that Eskimos had no whips until they were introduced by Europeans. The use of the whip among Eskimos first developed in Greenland where they have associated with Europeans for nearly a thousand years. Indeed they began intermarrying with Europeans nearly that long ago.

In the Mackenzie River delta there were as late as 1906 only a few young men who used whips. The practice met the disapproval of the older generation; it was considered one of the signs that the young people were a degenerate lot.

Around Coronation Gulf in 1910 whips were unusued and appeared unknown. By 1918 they were in nearly universal use around the mouth of the Mackenzie; they had been in use earlier, back to varying dates, in different parts of Alaska. In Coronation Gulf their use did not become usual until perhaps 1925.

A good many of the best white Alaska drivers use no whips and on some expeditions, such as those of Stefansson, they were not used except for stopping dog fights. For this they were always carried, however; for you are more likely to stop a fight without injury to the dog if you use a whip than if you use a club.

COMMON TREATMENT OF DOGS

One of the things to which a person of any feeling or imagination does not soon grow callous is the cruelty and thoughtlessness with which dogs are treated by the northern forest Indians and by many whites—also increasingly by civilized Eskimos. It is a common thing that they are not fed all summer; some therefore die of starvation, while most of them survive only as living skeletons until the approach of fall makes it necessary to feed them up for their winter's work. On the Mackenzie River some white men treat dogs better than the average native, but a dog used to uniform kindness is seldom found. Expecting a kick, they will receive your approach with a snarl. Stefansson bought some of these dogs and found that, even after this sort of upbringing, most of them quickly became under kind treatment as friendly as our usual house dogs. One of them, 4 years old, did require half a year before he became reasonably gentle.

If you are fond of house dogs you will like good northern dogs even more. They have the same loyalty; in addition they work for you uncomplainingly even when they are tired and hungry.

COMPARISON OF PONIES WITH DOGS

Peary argues that even if a pony is equivalent in tractive force and weight to a team of 10 dogs, you should still use dogs. His reasons are: Fewer ponies required but each dead one is a greater percentage loss; ponies break through ice where the dispersed weight of 10 dogs will enable them to cross; dogs live on meat, bulky food must be carried for ponies; dogs need no assistance on the march, no care or shelter at camps. Stefansson comments, without disagreeing with Peary, that there is more to the story. Ponies can live on meat (do so in Iceland); on land they will scrape away snow and find grass underneath, being in that nearly equal to reindeer.

SECTION V

REINDEER

In Section II, Chapter 5, we have dealt with the reindeer as an important source of food supply and as a source of material for clothing for civil or military establishments in Alaska. Here we discuss their value as draft and pack animals.

Reindeer are the gentlest of all domestic animals—do not become vicious or pugnacious after the manner of rams and bulls. The danger of stampede is about the same as with horses, probably somewhat less. In good reindeer country—most any part of the prairie, or in clear and semiclear patches of wood—a large number of pack reindeer would require about as much grazing area per head as horses would in nonmeadow portions of a Montana range.

USE BY ALASKANS

As stated earlier, in Alaska there is at present little utilization of reindeer as draft and pack animals, although 2 decades ago considerable use was made of them. However, as colonization advances and defense operations are increased in the Territory, more and more reindeer will no doubt be used for draft purposes. They will do work corresponding to that of mules, winter or summer—they are adapted to the terrain; large deer, such as some of those in Alaska, can carry from 100 to 150 pounds each; they graze and browse where they go, so there is no need to carry feed for them.

In the Finnish-Russian campaign the Finns demonstrated their value in Arctic and sub-Arctic military operations. In addition to transporting supplies, reindeer were found useful in ambulance work. One beast, attached by a single trace to a toboggan sort of sled, could transport a wounded soldier through a pathless forest with comparatively great speed.

Although the breeding stock which established the Alaska reindeer industry came from Siberia, the methods of handling came from Norway. For the U. S. Government imported a number of Norwegian Lapp families to instruct the Eskimos of Alaska in herding and other utilization, including the technique of driving. We describe the Lapp technique as practiced both in the Old World and, with some modification, in Alaska. In the main we depend on a manuscript by Arnold Haverlee who has made several journeys in Lapland, traveling and living with reindeer Lapps.

HARNESS

The most common harness is a simple leather collar resting on the shoulders and running around the neck of the deer. A rope tied to the lower part of this collar passes between the legs and under the belly of the deer to the sleigh where it is fastened to the bow. The rein is a single line fastened to the left antler, its other end is wound around the right arm and hand of the driver, so that if the harness should break the driver is still able to hold on to the deer. To check the speed of the sleigh the Lapps sometimes have another deer tied to the back of it. This is especially effective when going down hill where the sleigh has a tendency to exceed the speed of the deer that is pulling it. On long trips this second deer may be put in the lead for relief. Ordinary distances covered on long journeys are said in Norway to be 30 or 40 miles daily when 1 passenger uses 2 reindeer alternately. There is an apparently reliable report that a distance of 112 English miles was covered in 26 hours.

SLEIGHS

The sleigh most popular among the Lapps is called the *akja* (pronounced akya), a Gothic word; in pure Lappish it is *kerres*. This is an open sleigh made of thin planks, shaped a bit like an Indian canoe. It is approximately 5 feet long, 1 foot deep, and 18 inches wide, with a sharp bow and a square stern. The driver, on a reindeer skin at the bottom of the sleigh, sits in an upright position, his back resting against the sternboard, his legs stretched out along the bottom of the sleigh.

PULKA TYPE

While the kerres is the most common sleigh for transporting goods and people, several other types, of Finnish inspiration, may be found among the Lapp tribes. Of these the *pulka* is the most popular and is used only for human transportation. It is built on the same principle as the kerres but shows much finer workmanship and sometimes is adorned with designs. The front part is often covered with sealskin. This sleigh is used by families for special occasions, such as going to church or other formal functions. The harness used, though on the same simple principle, may be highly adorned, i. e., made of white reindeer skin onto which have been sewn red, green, and yellow strips of cloth and in some cases bells and silver buttons. To climax the effect a white reindeer is used for pulling.

The word pulka or pulk is Finnish but has been widely adopted among the Lapps who often use it in describing any type of sleigh.

LAKKEK TYPE

A characteristic and also most purely Lappish sleigh is called the *lakkek.* It is used only for the transportation of goods and provisions. It is a covered sleigh made of thin planks slightly curved, approximately the same length and width as the kerres but somewhat deeper. A square or oval opening is cut in the center of the top and through this the load, among natives frequently frozen or salted meat, is tightly packed. A lid fits the opening snugly.

CARAVAN TRAVEL

The lakkek and the kerres are the two sleighs which are most characteristic in the making of a *raid* (caravan). A raid may consist of just a few sleighs or dozens of them, according to the size of the family and distance they are moving. The raid moves slowly, led by a Lapp on skis. The other Lapps walk alongside. Only women and children ride. The daily distance covered is seldom over 12 miles. If two or more raids are moving in the same direction the custom is to overlap, so that the last one to start will pass the camp site of the preceding raid, stop for a short rest and continue on ahead to pitch camp. On the following move the raid now left behind will pass the camp site of the other, stop for a rest and in turn proceed ahead for another camp, and so on till the destination is reached. In this way each party has its fair share of breaking trail, if the snow is soft and deep. When stopping for the night the deer are let loose to shift for themselves and feed. In the morning they are rounded up and the trip continues.

PACKS

The reindeer is also used for transportation in summer. The Lapps have not adopted the idea of the wheel and carriages are unknown among them, even in terrain where fairly level ground might have made them of value. The transportation of goods during summer is therefore by pack animals. Babies are carried in baskets strapped to the sides of the deer. Great care is taken that weights are evenly balanced on the two sides of the deer. Sometimes a broad strap is used around the body holding a reindeer skin or blanket in position over the back and down both sides. Lapp reindeer are perhaps the smallest of any of the domestic deer, so that 80 pounds in all, 40 on each side, is considered a maximum load.

Haverlee described a journey which gives an idea of the small Lapp reindeer as a pack animal. They were traveling in very mountainous country, each beast carrying 80 pounds. On a 25-mile march they stopped only once and then for only half an hour. In spite of some steep climbing the reindeer showed no signs of fatigue, during the journey or at its end. (Alaska reindeer, being partly of the large Tungus stock and having interbred somewhat with the large Alaska caribou, may be expected to do somewhat better.)

Alaska and northwestern Arctic Canada are the only reindeer countries where driving them is not extensively practiced. Across Bering Strait in Siberia, whether you follow southwest toward Kamchatka or west along the Arctic shore toward and beyond the Kolyma, you will find everywhere people used to driving reindeer, and many animals that have been trained.

USE OF THE PACK REINDEER BY PROSPECTORS

An effective use of reindeer has been made in Alaska by prospectors, especially those searching for gold in the Brooks Range or to the north of it. Formerly, these prospectors carried their own packs, in some cases using dogs. There were prospectors, too, who used horses as pack animals. These did well, except that they were driven crazy by the mosquitoes and other biting insects.

The reindeer were not as much troubled by the mosquitoes as the horses, and were taller than the dogs and thus able to keep their pack loads out of water and mud. They had the great superiority over dogs that they secured their own food; in this they were to a degree superior to the horses also, especially in the high mountains where (although not in the low country) lichens and mosses were sometimes found to be the chief vegetation.

Thawed Arctic ground is always a swamp. The feet of the reindeer did not sink in as deep as those of the horses. However, neither horse nor reindeer would be in danger of being properly mired in an Arctic country, except perhaps right along the shore of a river, for elsewhere the ground frost would usually be only a few inches, and at most 2 feet, below the surface.

EMERGENCY USE OF UNTRAINED ANIMALS

If you should find yourself in a community of reindeer-owning Eskimos, even though they are not accustomed to the use of reindeer as pack or draft animals, you should with no great difficulty be able to adapt one or another of the Lapp methods to your needs. From canvas or skins you can rig up some sort of harness and sleigh. Breaking a reindeer to pull a sleigh, or to carry a load, would not compare in difficulty or in the time required to breaking a Western bronco. For, as said, reindeer are naturally gentle animals. With patience in accustoming them to their new function and with ingenuity in putting together a makeshift harness and toboggan-like sleigh, or the even simpler pack harness, it should not be more than a few days before you can set out on a journey.

CHAPTER 13

HUNTING AND FISHING

SECTION I

GENERAL

a. Introductory

It is a safer emergency plan now than ever before to live in the Arctic by hunting; under certain circumstances it may be as necessary to do so now as it ever has been.

Wilkins has said that there is no point on the ice-covered surface of the Polar Sea from which he does not believe he could walk out to the nearest settlement if he had one good companion, good clothes, an adequate hunting outfit, and a sled or the means of constructing a sled—as, for instance, from portions of an airplane in which he had made a safe landing. This is probably right, especially if you postulate that there should be one dog—not a trained dog necessarily—but one with a keen sense of smell for use in the mauttok hunting method, described below in this chapter.

The journey to a settlement from a descent in a central region of the Arctic pack might require 2 years, or two winter seasons with an intervening idle summer. The danger would be greatest if the descent were made somewhere between

Greenland and the Franz Josef Islands, for it might be difficult to move rapidly enough to west or east to reach land before the ice was carried south into the warm waters to the north of Iceland, melting from under the travelers.

There seems little doubt that, for men skilled in hunting and properly equipped, the Arctic sea is safer than most Arctic lands, so far as securing food and fuel is concerned. However, it averages farther from a sea landing to a settlement; besides, you might have to cross some Arctic lands after having managed the journey ashore.

Although there are more European settlements now in Arctic lands than there were a hundred years ago, there is probably a less total number of people, at least in the Canadian and Alaskan sectors, for white men's diseases have killed off many of the natives that used to live here and there on the northern lands, and many of the rest have been drawn to rivers and seacoasts by the influence of whites, so that the lessened chance of finding encampments of natives more than cancels the greater chance of finding whites. This is, of course, assuming that lack of radio, or radio failure, has made it impossible to send out information on the position of a stranded party so as to arrange for relief.

Game is on the polar sea about what it "always" has been. On the polar lands it seems likely that game is more abundant now than it was a hundred years ago, for the diseases and other white man influences which have depopulated large sections of Arctic territory have thereby removed the hunters that used to kill thousands and tens of thousands of caribou and other game animals. The second enemy of the caribou, the wolf, has probably decreased in numbers, also; the primitive caribou hunter was not much of a wolf hunter, but trappers of recent years have been killing a great many wolves, particularly in the northern edge of the forest. With fewer wolves, there are more caribou.

We said it was easier now to make a living by hunting than it used to be. This is partly because on the average game is more abundant; but a greater reason is that hunting appliances are constantly being improved. The musket was better than the bow and arrow, if the user was an equally good hunter. The breech-loading black-powder rifle was better than the musket. The modern rifle using .22, .25 or .30 caliber bullets, with a muzzle velocity of perhaps 3,000 feet per second, is a great improvement on the 45–70 or 40–82 Winchesters that were standard at the turn of the century. Then there has been an improvement in field glasses, and they are second only to the rifle in the equipment of a caribou hunter—important, too, in the equipment of a seal hunter.

LONG RANGE MILITARY CRAFT SHOULD CARRY HUNTING EQUIPMENT AND CAMP GEAR

In the event of a war on a grand scale, involving the polar sea and the Arctic lands, there are bound to be every now and then cases of an airplane that comes down for want of gas or through engine trouble; cases, too, of men who bail out. As many as possible of these should have, to begin with, the necessary information and skill; and then some practical minimum equipment that will enable them to live indefinitely in a given locality without travel, waiting in that case for rescue; or that will enable them to subsist while they travel in the direction of some possible or probable source of help. (See also Chapter 14.)

b. *Principles*

ON SEA ICE PARTIES SHOULD KEEP TOGETHER

On sea ice that is not landfast, parties of no matter what size must always keep together unless numbers and policy indicate that they ought to separate into two or more groups permanently or semipermanently. For not even the strongest paleocrystic floe is immune to cracking and the formation of a lead. If this forms between different members of a party they will of course attempt crossing so as to reunite, using any of the methods we have described for that purpose or others which they devise. But it can be that no methods will suffice and that the parties will not find each other again, even if both survive.

ON LAND PARTIES SHOULD NOT KEEP TOGETHER

On land the contrary principle applies—the rule is that parties should separate, or spread out, for greater probability of success in finding game. If all men are carrying packs there is no reason why each should not take his own way to an agreed-upon rendezvous; if there is a sledge, or other reason why some of the men have to cooperate in transportation, then one or more free men can hunt parallel to the course. There should be, of course, arrangements for communication by signal. What these will be depends on circumstances; men of sufficient ingenuity to have a chance for survival at all will devise communication methods that are suitable for each day or situation.

Living by hunting was practiced more extensively on the third Stefansson expedition than has otherwise been the case in the entire history of Arctic journeys by white men. For an estimated 20,000 miles of his own travel afoot, whether accompanied by sledges or not, at least half the distance covered both on sea and land depended exclusively on hunting for the food and fuel of men and dogs when at sea, and for food though not fuel when on land. Then there were many separate parties, as, for instance, when a dozen people made a living while resident most of a year in Melville Island and again when four men drifted for 6 months in a floe encampment at varying distances of 200 and 300 miles north of Alaska, depending for themselves and about 20 dogs exclusively on game.

Accordingly, we shall in the following discussion depend most exclusively upon the experience of the said expedition, and upon the views therefrom developed; but we shall mention the experience and views of others now and then to illustrate or to bring out disagreements.

We discuss first travel on land or along a coast.

On a journey dependent upon hunting it is standard practice for the men engaged in transport to travel as direct as possible toward a destination, and by the easiest routes possible. Arrangements should be made each morning for the probable location of the camp. During that length of winter day which permits the hunter about 20 miles of walking at three miles per hour, the transportation members of the party should travel perhaps 10 or 12 miles. It may be that during the day the hunter can see the sledging party, once or oftener; they will be more conspicuous than he. But the main thing is that camp shall be made in some such location that it can be found even in a blizzard, in a thick fog, or in the dark of a cloudy night. Instructions for finding camp under such conditions, and alternatively for passing a night in the open, have been given in Chapter 11. However, we stress here some elementary precautions.

ELEMENTARY PRECAUTIONS

Camping in a place easily found means, among other things, that camp must not be where there is any difficulty in distinguishing the meeting place of the sea ice and the land; nor may the camp be in toward the bottom of a deep bay.

On a coast the trail must close in to very prominent headland but should cut across the mouth of a bay as direct as convenient.

The hunter has a rough idea whether the sledges are ahead of him or behind. He goes to some promontory they should pass and picks up the trail; or determines from its absence that they have not passed. The campers, after dark, put a lantern outside, if they have one; if not, they burn tallow or oil dip within the camp so that the flame will show through. In foggy weather and in blizzards the camp cannot be seen more than a few yards, but even then it can usually be found; if it cannot be found, you merely have the tedium of passing a night in the open or in an unheated snowhouse which you build for yourself.

NUMBER OF HUNTERS TO A PARTY

For a journey of dependence on hunting, there ought to be at least two good hunters in a party of three. On many occasions two men will have to travel where the sledge can go while the third takes a different route to find game. In that case, and in all cases except emergencies, the best hunter, rather than the senior officer as such, should do the hunting. Nor can you afford to alternate men just from a sense of fairness, or to break the monotony; the journey is not sport but a serious undertaking where success, if not life and death, may be at issue. Several Arctic journeys have been made where it was necessary to secure for food practically every animal seen. A slight increase in the percentage of failures would have been disastrous.

We said two good hunters out of three, which is because in most cases one man has to be at camp anyhow, doing such things as protecting the dogs in case a polar bear arrives or preventing fights where a dog may get maimed or killed. If there are no dogs, you need protection for the camp anyway, though not so badly. Anybody, whether a hunter or not, can kill a polar bear that is walking into camp, or stop a dog fight. It is, of course, best that all members should be good hunters; but from the angle just presented it is not essential.

That one good hunter for a party of three is not enough depends on the chance that he may be lost or disabled. For instance, on one of Stefansson's journeys he sprained a leg so that he could not walk for several weeks. At this time the party was depending exclusively on hunting. Had there not been a second hunter, the three travelers would have had to turn toward home and probably would not have made it, at least not without killing and eating most or all their dogs. Because all three were hunters they were able to continue the journey, traveling steadily away from home instead of retreating homeward. The sprained ankle did cause a loss of speed, since one of the three now had to ride on the sledge. But it did not otherwise interfere with safety or success.

CHOOSING MEN FOR HUNTERS

You choose comrades for a hunting journey both for physical and mental fitness, but the mental is the more important. For there are in the literature reports on men whose physical equipment was approximately perfect, who were both of athlete and sharpshooter rank, but who were unsuited for living by hunting because of a tendency to assume that game would not be found ahead and that the only safe and sensible thing was to retreat.

The man who thinks there is probably game beyond the first range of hills, or, if not there, then beyond the second or third, is the right one for your work. The man who knows that it would be a waste of time to go and look is wrong for this particular job, no matter how well he could do if he would try. The justified deduction from hunting retreat experience is that it averages as safe to advance as to retreat.

On the average, white hunters are better than natives. Where both know the country, both are good. In a strange land a white man has several resources which are missing from the native's equipment. For instance, an Eskimo is more likely than a white to decide there is no use hunting because game is certainly not going to be found. If safety is your main concern, the native is all right, for he will induce you to turn back in time; but if success is paramount, the white on the average is better.

With men equally qualified otherwise, patience should be a deciding factor in choosing hunters. Here the native is likely to excel, but there is no reason why an exceptional white man may not develop the same quality.

Perhaps the chief superiority of a white hunter over a native is in ability to find his way about. By timing himself carefully, by making either a written or mental record of all distances and angles of travel, the white man will frequently know just what direction to turn for home when the native is completely muddled.

The only important superiority of the native is that he is familiar with local conditions and not afraid of them; but this familiarity can be acquired by the white man, and fear will diminish as knowledge grows. Besides, you cannot make a very long journey without passing beyond your native guide's familiar ground.

c. Equipment and Its Care

RIFLES AND AMMUNITION

When you plan a long journey where men and dogs, or men without dogs, are to live by hunting, you must of necessity rely on big game. A cartridge weighing half an ounce fired from a rifle weighing 7 pounds may give you a thousand pounds of food by killing a polar bear; a 10-gauge shotgun shell weighing two ounces fired from a gun weighing about the same as the rifle would give you only a pound or two of food by killing a ptarmigan or a duck. Though never, except in emergencies, firing at an animal smaller than a wolf, the various Stefansson expeditions were able to average 100 pounds live-weight of animals per cartridge. These cartridges (6.5 mm. Mannlicher-Schoenauer) ran more than 30 to the pound. There has never been an actual competition of the man-miles and dog-miles involved, but a conservative estimate might be 50,000 man-miles, which would mean several hundred thousand dog-miles, perhaps one-quarter or one-fifth of all this on ice drifting above the sea out of sight of land, sometimes several hundred miles from shore.

The food average per cartridge was considerably better at sea than on land; and all those who took part in the expedition's various deep sea sledge journeys appeared in agreement that living by hunting is both easier when you are successful and more likely to be successful at sea than on shore.

The first principle of living by hunting is, then: Depend on big game.

The second principle is: Use one arm, though perhaps with varied ammunition. The main points of arming the whole party with a single type of weapon are, of course, that ammunition and spare parts are interchangeable, and that a damaged weapon can be dismembered into parts that will be useful for others.

TYPE OF RIFLE

In 1912 when the third Stefansson expedition was being outfitted, a study was made of rifles in the United States, Canada, and abroad. The one selected was Mannlicher-Schoenauer 6.5 mm., of Austrian manufacture but rechambered by Gibbs of London. The muzzle velocity claimed was 2,860 feet per second. The carbines weighed 6¼ pounds; with full rifle length a pound or so more. The carbines were full wood, to protect the hand from iron at low temperatures. For midwinter use such other parts as experience suggested were bound with adhesive tape to keep the hand from metal. Both ordinary and set triggers, for instance, were taped.

BULLETS—THREE TYPES

The three bullets carried by the Stefansson expedition were ordinary soft nose, hollow point, and full jacket. Experience showed that a thousand rounds would be ample for supporting a sledge party of three men and six dogs for 2 years. Of the 1,000, 800 were soft nose, 150 hollow point, and 50 full jacket. The full jackets were intended by the expedition for two purposes: to shoot a small animal in an emergency with something that would not mess it up too much, and to kill without too much mutilation animals the skins of which were wanted for scientific purposes.

VALUE OF DUMDUM QUESTIONABLE

The advisability of the 150 hollow points should not be insisted upon. They were carried in the belief that if you wanted to be extra sure of killing a medium-sized animal, such as a caribou, they would serve. Experience seemed to confirm this, for on caribou, at any rate, the hollow points had an explosive effect. Experience also appeared to show that for very large animals, if struck in certain parts, the hollow point bullet did not have sufficient penetration.

FLAT TRAJECTORY

A flat trajectory has a special importance under Arctic winter conditions; for, as explained elsewhere, it is difficult to judge distance even for those experienced, while an inexperienced man is nearly helpless.

We have dealt elsewhere with the general problem of diffused light; here we note some of the confusions that may result from it, and that are made somewhat less of a problem to a hunter if he carries a gun with a flat trajectory.

RELATION OF DIFFUSED LIGHT TO TRAJECTORY

It may seem incredible that in daylight so intense that the eyes have to be protected against it, objects not of a dark color are frequently invisible. McClintock points out that a snowclad hill with thawed ground on top does not appear as a white hill with a black top, but only as a black horizontal line apparently suspended in the sky. This is because the daylight on cloudy days is so evenly diffused that no shadows are cast. When, in diffused light, a man is seen to walk behind a snowclad hill, his legs disappear without visible cause of eclipse and then his whole body. You infer the hill conceals him, but you cannot see it doing so. A snag of ice will be equally invisible until you stub your toe against it, though it may show then by contrast with your feet.

It sometimes happens, even on clear days, that things may be easily misidentified. Nordenskiold tells of mistaking a walrus for an island and of identifying the white tusks with two extensive glaciers coming down between mountain ranges to the coast. Hanbury tells of mistaking a mouse for a polar bear. On Stefansson's first expedition, officers and passengers on the Hudson Bay Company's boat *Wrigley* steamed toward what they thought was a stranded steamer but which proved to be a small log lying on a sand bar. He also records mistaking a marmot for a grizzly bear.

However, while diffused light may cause you to waste a rifle bullet on a mouse or squirrel when you think them polar bears or grizzly bears, and while you may waste other bullets that fall short of your target when you mistake a grizzly for a wolverine, your chief light difficulty in shooting, or the chief thing which makes a flat trajectory of paramount importance, is what we also dwelt on before and here recapitulate briefly—the "incredible" clearness of northern air, particularly at low temperatures.

If you do not know the size of your object, and have nothing for scale, you judge distance by clearness of outline and by what fine details you can see. We have described how an experienced traveler mistook a jagged peak 2,000 feet high for a broken ice hummock of 20 or 30 feet. You cannot make quite that much of a mistake with animals, for not even in the clear air we are describing can you see a bear or musk ox at 20 miles. But you can be sufficiently deceived by noting details of antlers and other fine markings or small parts of a caribou to conclude that an animal which is really 300 yards away is only 100. You are then a lot better off if your rifle drops a few inches in 300 yards and not two or three feet.

SIGHTS

Several types of extra sights were provided for each gun so that they might be varied according to the preference of each user and according to experience as it is accumulated in the field. In the main three sights turned out to be used—a bead front sight, a leaf sight on the barrel, and a peep sight back on the stock which folded out of the way and was seldom used. However, this was very convenient to have, for under certain conditions a hunter could take several aims at an animal, comparing the peep-sight effectiveness with that of the leaf sight before pulling the trigger.

It is difficult and perhaps impossible to lay down for choosing sights valuable directions beyond the above, for the variation is not merely in the kind of light and your angle to it but is also in the color of the animal, color of the terrain and in the varying conditions of the user's eyes. For instance, incipient snowblindness or an incomplete convalesence from it may give you a better effect now with one sight and now with another.

TELESCOPE SIGHTS

The rifles were also provided with telescope sights of 2.5 magnification. These were particularly useful when the sun was below the horizon for that power makes an excellent night glass. The telescopes were used at other times but the only occasions upon which they were practically indispensable were during the midwinter absence of the sun.

Where hunting is to supply all the food (at sea, all the fuel as well), you cannot afford to carry any arms but rifles if the journey is to be longer than 3 months. For a party of three or more there should be a rifle per man, while a party of two should carry three rifles in case one goes wrong or gets lost. A revolver is not worth carrying from the food provision point of view.

For a journey of less than 3 months, you can more or less carry what you like, a shotgun, for instance, or an extra rifle which you think may have special use because of its caliber being either notably larger or smaller than that of the standard weapon.

FISHHOOKS AND FISH NETS

For long overland journeys you might perhaps carry some fishhooks, since they weight practically nothing, and a fish net or two. If nets are carried there must be extreme care both in keeping them dry before they are used and in drying them after each use. Otherwise they drop to pieces. There are examples in travel literature of difficulty and tragedy through the rotting of nets.

CARE OF HUNTING EQUIPMENT

For the summer period the care of northern hunting equipment needs little discussion, for precautions and methods are those to which we are used. In midwinter the treatment has to be very special on certain points.

IN WINTER DO NOT TAKE RIFLE INDOORS

You should never bring your rifle into house, tent, or camp of any kind. If through carelessness a rifle has been carried indoors, you must not rush it out again immediately, for the harm has been done in the first few seconds. In that case, take the rifle fairly near whatever heating arrangement you have. It will first get covered in every metal part with icing. This melts into water and you facilitate the drainage by suspending the gun upside down. If you can't do any better, dry the rifle thoroughly and then carry it out. Best of all, take it to pieces and wipe every part before putting it out again.

At the beginning of steady cold in the fall remove all grease. Take down your rifle, wipe every part carefully. Should you fear that you haven't quite the skill for this, use gasoline to eat up the oil; but doing so appears to have the drawback that it produces a tendency to rust. However, that need not worry you much, for it is scarcely possible that appreciable rust will take place, at least during the midwinter period of fairly steady and pronounced cold.

KEEP RIFLE IN CASE

Keep snow out of your rifle. You should always carry it in a case or else wrap something around the muzzle that is bulky enough so you are sure to notice it and take it off before firing.

Ordinary stiff commercial leather or canvas rifle covers are not good, for snow is liable to sift in. One of the best covers is that used by many northern Indians and Eskimos, a buckskin sack of the right shape into which you slide the rifle and then tie at the bottom. A case on similar principles can be made out of any cloth you have available.

METHODS OF CARRYING RIFLE

Be careful how you carry the rifle. You may have to use it in an emergency, either because of attack by an animal or because you have a fleeting glimpse of one you need to get and time is important. If you carry the rifle crosswise on your back, Eskimo and northern Indian fashion, you can (unless in a blizzard) have the end of the case open, whether it is buckle or drawstring, and the gun will come without a hitch when you need it. If the rifle is carried diagonally across the back, European style, then its position should be the reverse of what we are used to; for if you carry it muzzle down you can have the case open at the butt end.

If it seems necessary to carry a rifle without its case, as when you are crawling up on an animal, you must be very careful not to let snow get in. An ordinary precaution in such cases is to slip a mitten over the front end of the barrel.

When rifles are carried on the sledge they should be on top of the load, in positions where you can get them out quickly.

Whether you have buckle fastenings or drawstrings, you must be sure that these are always clear.

IMPORTANCE OF RIFLE

Particularly in sea travel, you must remember that you are not going to survive many days the loss of your last rifle. For that reason, where travel is particularly dangerous, the man who walks ahead to break trail should carry a rifle and 20 or 30 rounds of ammunition. For the sledge may sink through young ice and disappear.

Should two or three men find themselves well dressed but with everything gone except one rifle and some ammunition, they could very likely get ashore safely even a distance of one or two hundred miles, and perhaps farther. The main determinant would be that footgear should last, for in an emergency you can eat raw the animals you kill. Fortunately boots do not wear out quickly on snow—a pair of soles may take you 1,000 miles. The same pair, however, may wear out in a day on stony ground; the brine of slushy young sea ice will shorten the life of a bootsole, though not to less than 500 miles.

FIELD GLASSES

For Arctic hunting, field glasses are second in importance to rifles. Each member of the party should have one. The best all-round power is probably 6. It is a fair night glass, it is good in dull daylight, and it is not seriously affected by the pulse in your wrist. Eight-power, which sounds like a happy medium, is usually voted unsatisfactory on trial. It is worth while in a party of three to have at least one 12-power glass, which you use lying down or resting it on something—or perhaps you mount it on a snag of ice, a camera tripod, or the like. The 12-power is particularly valuable for identification of things you pick up with the 6-power. Glasses of 4-power are excellent for twilight or for use in a forest. They are doubtless good from an airplane. (For the use of binoculars in hunting, see Section II of this chapter.)

Field glasses, like all metal instruments, should be kept outdoors all winter.

EFFECTS OF COLD

In cold most things shrink and many become harder and more brittle. A green spruce log may break an axe blade, both because the steel becomes brittle and because the log has been hardened. Formerly, and perhaps still, steel bits were welded on to soft iron axe bodies; the break might be either by notching the cutting edge or by having the bit separate from the body of the axe at the line where the two are joined.

Knives intended for outdoor use have to be of different temper and character for cold weather. For instance, there is said to be general preference for Rogers over Wilson (Sheffield) knives in Africa, but the reverse is true for the Arctic, where, both from experience and hearsay, Rogers knives are (or at least were) reported to break almost like glass, while Wilson knives stood up under practically any use. For a long time—several decades—no hunting knives but Wilson were sold on the lower Mackenzie by the Hudson Bay Company. Natives learned to look for the diamond brand and "refused all substitutes"—or at least paid more and more cheerfully if they found the diamond.

There seems no doubt that rifles frequently become ineffective at low temperatures, but there is doubt as to the cause. It seems possible that a proportionately greater shrinkage of the rifle barrel than of the bullet may so tighten the gun that much of the bullet's velocity is taken up by friction; or it may be the reverse, that the bullet shrinks so much that a lot of gas escapes.

Rifle springs and other parts may break; the hardening of springs may change their action and force; the hardening of lubricants may retard or block moving parts.

Moisture from a dry face or dry hands will, particularly at temperatures in the $-40°$ to $-80°$ range, cloud spectacles, field glasses, and sextants. The moist eye produces more pronounced clouding and frosting of instruments; the breath is still worse. Such clouding of surfaces can be avoided, or lessened, in various common-sense ways: You wear mittens, you hold field glasses a little way from the eyes instead of close up to them, you wear spectacles a little farther from the eyes than usual, you try to have the wind at right angles when you use field glasses or instruments so that it may blow the moisture away before it reaches a surface to condense upon.

Section II

METHODS OF HUNTING

a. At Sea, Along Shore

SEALS AND BEARS

At sea in winter there are two main animals, the polar bear and the seal. We consider the methods of hunting them.

The hunting of seals does not call for original methods. The best are those borrowed from the Eskimos, unchanged except for the omission of a number of superstitious practices.

Where seals exist, they are found in one of three situations: on top of the sea ice, under it, or in open water between the floes. Accordingly, there are three branches to the method of the hunter.

IN OPEN WATER

The simplest case is when you hunt seals in open water. On arriving at the edge of a lead or other body of water you may find dozens of seals swimming about within gunshot. You shoot through the head, commonly, because a seal is more likely to sink with a body wound, especially one that lets blood or water into the lungs. In all seasons except summer, 9 killed seals out of 10 will float if shot through the head and perhaps 7 out of 10 even with a body wound. The sinking of a large percentage in summer is probably due not so much to the seals then being less fat, with resulting higher specific gravity, as to the comparative freshness and diminished specific gravity of the surface of the sea, the fresh water of the rains and thaws forming in the quiet spaces among the floes a top layer through which the seals sink to the heavier, saltier water below.

RETRIEVING BY MANAK

If the killed seal floats, and is not more than 20 to 30 yards away, he is secured by the *manak*. This is a ball of wood the size of a grapefruit but pear-shaped. At its equator are three sharp recurved steel hooks and at the small end is a ring to which is attached a long cod line or slender thong. The hunter holds the coiled line cowboy fashion in his left hand and with a fathom of free rope he swings the manak about his head till it whizzes, then throwing it somewhat as the South Americans are said to do the bolas. You throw beyond the seal where he floats like a short log in the water. Before pulling in you try to flip the line over so that as you haul toward you it will drag over the seal. As the manak is about to slide over his back you give a sharp jerk, one of the hooks catches, and you pull the seal to you.

If the seal is too far off to be reached by the manak you convert a tarpaulin and a sledge into a sledboat (as described in Chapter 11) and paddle out to him.

When you come to open water you may see dozens of seals swimming about; another time you may have to wait a day or 2 days before you see the first one. It never happened on the Stefansson expeditions that a seal was not secured within 4 days of watching; but anyway you continue waiting till a seal comes if you need the meat and have no other way of getting it.

If you are on a "water hole," surrounded on all sides by ice that is not broken, you should not wait more than a few hours; for without means of safe travel (opportunity to breathe) no seal may come at all. But if you are on a lead of considerable length it is merely a question of a few days at most till they arrive, for the great leads are their highways. From your camp by a lead you may see no seal Monday and Tuesday where a hundred may pass you Wednesday and Thursday.

UNDER ICE

Each successive summer gale breaks the ice more, and there are no frosts to cement the fragments together before autumn. There is now enough water between the floes so seals can travel freely in all directions; and they do, rising in water patches to breathe. Then comes the autumn with its light frosts, mushy young ice forming everywhere. The seals are reluctant to stop their wanderings and are indeed free to continue them awhile, for a sharp upward bunt of their heads will break ice up to 4 inches thick (young salt water ice is mushy) and give them a chance to breathe.

When a seal travels along a lead covered with young ice he leaves behind a trail of circular fracture spots from a dozen to several dozen yards apart.

Months later, and up to next summer, these fracture spots are your game signs, your index to the former presence of seals. Most of the fracture spots are hidden by the snow in winter, but if you watch as you travel, all day and every day, you will eventually be rewarded by seeing an ice patch swept bare by some wind eddy where there happens to be the characteristic round spot.

THE SEAL'S WINTER RESIDENCE

When the ice thickens beyond 4 inches, and hardens, the seals must stop traveling and take up residence. Here, by industrious gnawing, they keep breathing holes open all winter. At the surface these holes have openings only an inch or two in diameter, but underneath they are enlarged continually until, as the ice thickens to 2 or 4 or even the maximum of 7 feet, they are vertical cigar-shaped chambers of diameter large enough for the seal's body. Each seal may have a half-dozen of these chambers leading to breathing holes that are covered with a few inches or a few feet of snow and thus hidden from the observation of man and from the eye of an animal.

A bear can discover a seal hole by the sense of smell. On young ice as well as in open water they know how to get seals. But far from land the pressures are mild and the ice less often broken by it, so that there are large areas where the skill and strength of the bears do not suffice to get them any seals. Accordingly, bears are rare or absent, which is one of the reasons for the view which was universally held till recently that seals are nonexistent in the deep polar ocean far from land. Actually, when bears are absent it is usually because they lack the ability to get seals rather than because seals are absent.

Man alone would not succeed any better than the bear in securing seals on the large areas of fairly level ice at sea; but man and dog in partnership combine the needed abilities.

The breathing holes of seals are sometimes found on patches of ice swept bare of snow by the wind, but these holes have usually been abandoned. The ones in actual use are generally covered with snow so no eye can see them and no faculty of man detect, and only bear or dog can find them by the sense of smell.

If a man who has no interest in seals, or to whom it has never occurred that any might be near, drives a dog team over snow-covered ice and finds the dogs wanting to stop and sniff the snow, he urges them on impatiently. But if you believe that seals are found here and there all over the polar ocean, you will infer when a dog wants to pause and sniff the snow that a seal's breathing hole is concealed underneath.

DOG RETIRES WHEN SEAL HAS BEEN DISCOVERED

If you allow, the dogs may begin to dig in the snow. You must not permit that, for daylight or a strange smell in the breathing hole will scare the seal. The dogs' usefulness is over when they have scented out the holes. You lead or drive them to a distance of a few score yards where they lie down and sleep while your part of the work is on.

After quieting the dogs you go back, take a long rod like a slender cane and with it poke and prod the snow till the rod slips through into water. Now the hole is exactly located. You withdraw the cane and fill the hole made by it with soft snow to prevent daylight from entering. Then, by scraping with your hunting knife or by cutting blocks, you remove most of the snow from over the hole, leaving a layer of only a few inches. Next you take an ivory "indicator" that much resembles a coarse knitting-needle and stick it down through the snow so that its lower end passes through the breathing hole and is immersed in the water. When the seal rises to breathe his nose will strike this indicator and shove it upwards.

You are now standing motionless above the hole (and perhaps have been for hours, for this hunting method, like most other primitive ways of getting game, requires patience). Your eye should not leave the indicator where it stands upright like a peg in the snow. When the seal rises to breathe you cannot hear him, you cannot see him, and you have no warning till the indicator quivers or moves up. Then you drive your harpoon down alongside the indicator. If you hit the one- or two-inch hole you hit the seal, for his nose is in the hole. He is now harpooned and you hold him by the harpoon line twisted around one leg, or around your waist, while with an ice chisel you enlarge the hole enough to drag him out. One man can do this easily with a common seal (*Phoca hispida*) weighing 150 or 175 pounds, but with a bearded seal (*Erignathus barbatus*) weighing 600 or 800 pounds it is no easy job for two men.

WINTERING HABITS OF SEALS

The reason why you may have to wait for hours and even days for your seal to come up in the breathing hole (though he needs to breathe five or eight times an hour) is that he may have a dozen other breathing holes scattered through several acres of snow-covered ice, and he may be using one of the others temporarily. It is therefore best for several men to work together. When one hole has been located and a hunter stationed there, other hunters should take dogs in leash and lead them around in circles until as many holes have been located as there are available hunters. This greatly increases the chances of getting the seal promptly. Any clumsiness of method at one hole will, furthermore, merely drive the seal to another hole watched by a better hunter.

No one should aim to live by hunting on the sea ice without understanding this manner of sealing, called by the Eskimos the "mauttok" or waiting method; but in actual practice you want it mainly as another string to your bow. Seals are usually secured either by the (among the Eskimos) nameless way first described where a seal is shot in open water, or by the procedure about to be described, called by the Eskimos the "auktok" or crawling method.

At any season of year seals may come up on the ice to lie there and sleep; but they do it chiefly in the spring and summer, from March when it still goes down to —30° or —40° F. to midsummer when much of the surface of the ice is covered with pools of water.

At no time of year is the northern seal unguarded about coming out on the ice from his hole (enlarged by his teeth, or by the thaw, till it will let him up) or from the lead in which he has been swimming. He is always fearful of polar bears. Therefore, when he wants to come up and bask, he spies out the situation by bobbing up from the water as high as he can, lifting his head a foot, two, or even three, above the general level. This he does at intervals for some time—perhaps for hours—until he concludes there are no bears around and ventures to hitch himself out on the ice.

SEALS SLEEP IN SHORT NAPS

Here follows another period of extreme vigilance during which the seal lies beside his hole, ready to dive in again at the slightest alarm. Eventually, however, he begins to take the naps that seemingly were his desire in coming out of the water. But his sleep is restless, through fear of bears. He takes a nap of 30, 40, or 50 seconds or perhaps a minute. Then he raises his head 10 or 15 inches from the ice and spends 5 to 20 seconds in making a complete survey of the horizon before taking another nap. Three minutes is protracted slumber for a seal; although far away from land or in other regions where bears are few or absent, they have been observed to sleep for 5 and 6 minutes.

In rare cases basking seals will be found lying within rifle shot from an ice hummock and can be shot from cover. Ordinarily, however, they select a level expanse of ice. In that case they will see the hunter long before he gets near enough to shoot. An essential of a successful hunt is therefore to convince the seal that you are something that is not dangerous. He may see you move and so you must convince him that you are some harmless animal.

THE HUNTER PLAYS SEAL

There are only three animals with which seals are familar—bears, white foxes, and other seals. It would not serve the hunter to pretend he is a bear, for that is the one thing the seal fears. This consideration shows you must not wear white clothes "for the advantage of protective coloration" on the white ice. For if the seal sees a thing both suspicious and white he will think of a bear and dive instantly. You cannot very well pretend to be a fox, for they are not much larger than cats, are very agile and continually keep hopping around. But if you are dressed in dark clothing and are lying flat on the ice you look at a distance much like a seal, and you will find by trying it that you can imitate his actions closely.

You can learn the auktok method of sealing from an Eskimo if you are among some group who practice it, but there are several groups among whom it is not in use. In any case, you can learn from the seals themselves, for your task is but to imitate them. Take your field glasses with you and spend a few hours or days in watching basking seals from a safe distance, which is 400 or 500 yards. A seal is not likely to see you at much over 300 yards.

Your cue, then, is to begin playing seal when you are about 300 yards away. Up to that point you advance by walking bent while the seal sleeps and dropping on your knees to wait motionless while he is awake. But at less than 300 yards he might notice you bent over or on all fours. Those are not seal-like postures and you must begin to wriggle ahead flat. You must not crawl head-on, for a man in that position is not so convincingly like a seal as he would be in a side view or quartering. You crawl more or less side-on, crawfish style.

You advance while the seal sleeps and you lie motionless while he is awake. Had you been upright or on all fours he might have noticed you near 300 yards but now he does not till you are perhaps 200 yards away. When he first sees you he becomes tense, raises his head a little higher, crawls a foot or two closer to the water to be ready to dive, and then watches you, intent and suspicious. If you remain motionless his suspicions increase at the end of the first minute, and before the third or fourth minute is over he plunges into the water, for he knows that no real seal lies motionless that long. Therefore, before the first minute of his watching is over, you should do something seal-like. You are lying flat on the ice like a boy sleeping on a lawn. The easiest seal-like thing to do is lift your head 10 or 15 inches, spend 10 or 15 seconds looking around, then drop your head on the ice again. By doing this half a dozen times, at irregular intervals each less than a minute, you very likely convince him that you are another seal.

But some seals are skeptical. If yours seems restive and suspicious it is well to increase the verisimilitude of your acting by not only lifting your head at varying intervals but also going through whatever seal-like antics you have observed while watching the real seals through your field glasses.

Seals are lousy—not with our graybacks, of course, but with a variety of their own. Being thus infested, they itch; itching, they are continually rubbing and scratching themselves. They use hind flippers, which are long and flexible and armed with claws admirable for scratching. It is advisable, then, for the hunter to roll about and to flex his legs from the knees frequently, as if scratching with hind flippers. These actions make an impression. In 8 cases out of 10 a good hunter is accepted as a fellow seal that has just come out of his hole to bask and sleep.

Seals that refuse to be convinced may have had a narrow escape from a polar bear recently, or may be hungry and taking occasion for going down to have a feed. That this motive frequently influences seals we judge from the fact that toward midnight a seal usually goes down soon after noticing us. They normally come up on the ice in the early morning or forenoon and go down to feed toward midnight.

If you once get your seal convinced he stays convinced. There is nothing fickle about a seal. He not only does not fear you but even appears to rely on you. It is as if he said to himself: "Over there is a brother seal, and if a bear approaches from that side he will get him before he gets me.

So I can afford to leave that quarter unwatched." As if he held this view, the seal will give you only a casual glance now and then and you can approach with great confidence. You crawl ahead while he sleeps and stop when he wakes up. If he watches you for more than a few moments you reassure him of your sealship by raising and dropping your head, rolling and wriggling as if itchy, and by flexing your legs from the knees as if scratching with hind flippers—all this lying flat on the ice with your side or quarter toward the seal and never allowing him to see your long arms, for a seal's front flippers are short. If you are careful, if the snow is not hard so it crunches, if a moderate wind from the direction of the seal covers any noises there may be, you can crawl as near as you like. Ordinarily an Eskimo throws his harpoon from a distance of from 10 to 20 feet. A man with a rifle would shoot from a distance of 25 to 75 yards.

HARPOONING OR SHOOTING BASKING SEAL

An Eskimo, using his native gear, holds the harpooned seal by the harpoon line. With a rifle only a brain shot will serve; you do not fire at 100 yards because the seal is lying on an incline of ice beside the hole or lead. There are few things so slippery as wet ice and the mere shock of instant death may start him sliding. The seal in most cases has buoyancy enough to float, but in sliding toward the water he acquires momentum enough to take him down diagonally 10 or 20 feet. He then comes up diagonally under the thick ice and you can't get him.

So you drop your rifle the moment you fire and run as hard as you can toward the seal. In some cases he does not slide at all and you slacken speed on getting nearer; in others he is slipping toward the hole, gradually gaining headway, and you slide for him like a player stealing a base. In some cases you will catch the seal by a flipper just as he is disappearing; in others you will be too late and the beast, though stone dead, is lost.

You are a good hunter if you get 60 or 70 percent of the seals you go after. The approach takes, on the average, about 2 hours.

AUKTOK METHOD CONSIDERED BY SEASONS

In the fall, hunting by the auktok method is often dangerous, for the seals are lying on ice so thin and treacherous that you may break through, especially while trying to get the seal after he is killed. In midwinter seals can seldom be secured in this way because they do not come out on the ice. From April to June we kill most of our seals by this approach. From June to September there is so much water on top of the ice that the auktok necessitates wriggling snake-fashion through pools of ice water from a few inches to a foot or more deep. This is disagreeable; the almost unavoidable splashing may scare the seals. Auktok is, therefore, essentially a springtime method.

Basking seals are usually spied first with glasses from some high hummock. The hunter gets them while his companions are making camp; or else there is a pause in the day's march. In that case, the men usually cook a hot lunch for the hunter while waiting. The animal, when secured, is dragged behind the sledge till camp time and then cut up, part fed to the dogs, part cooked for the men, and the rest stowed in the sledge. Three men and six dogs need about two seals a week. Forced wintering on ice means that fat is more necessary than lean, for you will have to depend on it for light and fuel as well as food. Seal blubber at any temperature, even at 30° or 40° below zero, will lessen in weight day by day, the oil trickling out perceptibly. It is therefore necessary to preserve the blubber in bags. This you do by skinning the seal through the mouth, or "casing" his skin, to use the language of the furrier. The skinning is commenced at the lips, the hide is turned back and, as the skinning proceeds, pulled backwards over the head and then back over the neck and body, as one might turn a sock inside out. When the skinning is done in this fashion there are no openings in the hide except the natural ones, which are closed by tying them up. The bag may be used for a seal oil container, or as a float.

HUNTING POLAR BEARS

During some Beaufort Sea off-shore sledge journeys about 10 percent of the food secured was bears. Most of these came to camp, probably not exactly to attack but rather thinking they were going to plunder. It appears that these bears have a sense of fear when on land, doubtless chiefly from their experience with men. At sea they have met but three animals, the seals on which they feed, the foxes which follow them around to pick up leavings, and the seagulls. It seemed, in conformity with this, that whenever a bear identified man or dog as a seal he would stalk or move to attack. When men were shouting and dogs barking, sometimes half a dozen men and 20 or 30 dogs, the bears would walk unconcernedly right toward them, apparently thinking they were yapping foxes that would run or squawking gulls that would fly away.

Bears find a camp on sea ice in one of four ways, which we mention in order of rising frequency. The first requires no discussion—they may hit the camp by pure accident. This accounts for surely less than 1 percent of all cases.

A bear may cross a sledge trail and follow it. Cases have been recorded where a bear has followed a trail through several encampments, these being perhaps 8 to 15 miles apart. At each encampment he has found something that he has eaten—the story being told by post-mortems. There have been instances of glass bottles, tin cans, cartridge shells, paper, bits of rope and other things that have been found when the animal was cut up, whereby is raised an interesting problem which we no more than mention.

There are many known cases where a bear on land has walked by a depot of caribou meat, passing it on the leeward side and necessarily smelling it but without paying any attention. This seems to indicate that he does not recognize the smell of fresh caribou meat as the smell of food. How can that be reconciled with his eating plugs of tobacco, medicine bottles, tin cans, and pieces of rope? It is also possible, of course, that some of these might have had about them a smell of seal oil, or of something recognized by the bear as food; but that can hardly account for all the cases.

When a party is living by hunting they necessarily secure, as we have explained, more blubber than they can use, and must discard some every now and then. The bear naturally cleans up these leavings as he follows the trail.

A bear's third way of finding your camp depends on what we have explained, that he does not succeed in catching seals except along the edge of open water, or through very thin ice that can be broken by a stroke of a bear's paw. It is true, also, that seals may haul out on ice from any open water, and thus become huntable. Obviously, then, a bear finds seals most readily by traveling along the edge of a lead. But sledging parties frequently camp at leads, for several reasons. They may stop there to take a sounding; they may have been delayed by inability to cross the lead; they may have stopped there because it gives them a chance to kill seals for their own food. This intersection of the hunting technique of the bear with the traveling methods of a sledging party brings about frequent meetings at leads. But perhaps half of all the bears that arrive in camp are brought by the sense of smell. It has been established that they can scent a camp 10 miles; likely enough they can detect it even farther. They arrive traveling upwind.

A bear that comes in following a trail or up the wind, guided by his sense of smell in either case, will pause every now and then. If he is a trail-follower, he finds occasion to examine some peculiarity in the trail every now and then. If he is coming up the wind there will apparently be, at least during the final half mile, changes in the scent that interest the bear, perhaps through a slight fluctuation of the wind, make him stop and sniff. One that is traveling along a lead discovers fewer things to distract him; he does not know about the camp until he hears or sees it. Such a bear is probably traveling a good deal faster than either of the other two. It may be that the average rate of walking along a lead is 3 miles per hour, and that the averages up the wind or along a trail are 2 miles.

A bear approaching a camp upwind on ice will smell seal meat. He ought to know the difference between dead and live seal; what he smells is dead. He therefore walks toward it without precaution. If he sees motionless dogs outside the camp, he apparently considers them dead seals, for he does not change his approach. However, if a dog stirs, the bear, apparently, begins thinking of the dog as a live seal. He makes himself unbelievably flat on the ice and, with neck and snout touching the snow, advances almost toboggan fashion toward the dogs, stopping dead if one of them moves, advancing again when they become quiet. If there is any unevenness in the ice, he will take cover and advance in its shelter.

The eyesight of polar bears is such that you are not apt to be visible to one until he is within 250 to 300 yards.

In twilight, their yellowish white outlines against white ice are so indistinct that, except for their shiny black noses, they cannot be seen unless they are moving. When bears are on the alert, they move their necks and their whole bodies to peer about, in a peculiar snaky way—giving somewhat the effect of railway men's signal lights being swung on a dark night.

If your dogs notice the bear they start barking. He then loses interest in them, apparently now identifying them as foxes, which he knows he can't catch. However, there is still the dead seal (i. e., seal meat) which he has originally smelled and he therefore resumes his walk toward camp. By that time a shot provides you with bear meat.

AIM FOR THE HEART

For many reasons, one of them to economize ammunition on a long journey, any animal you shoot ought to be killed with one bullet. When a polar bear is walking into camp he is, as said, usually moving ahead as if window shopping, turning this way and that to sniff and look and examine. Wait, then, until he gives you a broadside view and place a soft nose bullet just behind the shoulder in the vicinity of the heart. Don't use hard nose bullets on a polar bear if you have anything else. A beast that large and tenacious of life can carry a half dozen hard bullet wounds, so long as the heart or one of the very large blood vessels is not penetrated or the brain or spinal cord struck.

If a polar bear is charging, the procedure, as with all charging animals, is to aim for the center of your target—for the main consideration is to be sure that every bullet hits somewhere. Taking the center of this target is more important than otherwise because, unless the conditions of light are perfect, you do not perhaps have a clear outline of the body that is moving toward you. For, as explained elsewhere, it is only in the best light that the difference between the yellowish white of the bear and the pure white of the snow is enough to give you a distinct outline of him.

Here, as in all cases that require discriminating sight, you should either wear no glasses or amber glasses. Bare eyes are indicated if the sun is below the horizon. If the sun is above the horizon in a clear sky then any sort of glasses worn for protecting the eyes against snowblindness will do although none of them help you much except the amber ones, which clarify even the clear outline furnished by the perfect lighting. Under diffused light the amber glasses show up to the fullest advantage, giving you sometimes a clear view of the whole bear, including leg movements, when he would be little more than a blur to you without the help of the amber.

In extremely cold weather it may happen that until some moment of excitement, such as a charge of a bear, you have protected your glasses from frosting (as elsewhere described) but that now you forget the precautions and all of a sudden find your sight obscured by a haze on the glasses. The only thing to do, then, is to snatch them off and work with bare eyes till the emergency is over. (Such possible need for casting away glasses is a further reason why each man should carry two or three pairs.)

Do not shoot a large polar bear while he is in the water, as you will find him extremely difficult to haul out. Remember, he may weigh nearly a ton.

If your shot wounds but does not kill a bear, he will likely make for the water. Do not attempt to forestall this by standing between him and the water, for he will then do the only thing left to him—spring at you—and only luck or most effective action can save you.

DO NOT USE DOGS UNLESS YOU HAVE TO

Although Eskimos and some whites permit their dogs to set upon a bear, dogs are too useful to risk in this fashion.

One blow from a bear's paw can injure a dog fatally, or crush his skull, killing him instantly. Your first concern should be to have your dogs tied, for it has frequently happened that if not hurt by the bear they have been injured or killed by stray shots, the bear in some cases walking away unscathed.

If you are in desperate need of food and the bear seems likely to get away you may have to use dogs. In that case, and if you have several dogs, you release first the one that in your opinion will be (scaredest) of the bear—one that will go up to him and bark but keep out of reach. If this first dog does not stop the bear, you will have to release a second. Two dogs together sort of get courage from each other and will both go up closer, increasing the risk of injury but also giving a better chance of stopping or delaying the bear. You may have to release a third or fourth dog. How many you release will always have to be a matter of your judgment—you balance the risk of losing the dogs against the need of getting the bear.

When there are several dogs around a bear you have to shoot very carefully. Ordinarily, however, the bear will every now and then more or less rise on his hind feet; that gives you the chance for a well-placed shot.

When traveling along and in need of a bear you ought to stop every hour or so, climb a prominent hummock and sweep the horizon slowly several times with your binoculars. Doing it once or even twice is not good enough, for if the ice is at all rough even a traveling bear may be obscured by a hummock just when your glasses are passing over his segment of the horizon.

Having located a traveling bear, you watch him a while to get the direction of his movement. He may be following a lead that is not visible to you, although he is. The thing to do, then, is to reach that lead a good long way ahead of him and lie in wait.

A method worth trying—which is the likelier to work the farther you are from land—is to drive your sledge in such a way that the smell from it will strike the bear at a distance of half a mile or a mile. It will depend on that bear's past experience, or perhaps on his temperament, whether he flees or comes up the wind. (The reason why this works better far from land has been explained—that bears have no enemies at sea, but do have land enemies and therefore feel the more at ease the farther they are from shore.)

OTHER SEA ANIMALS, BIRDS, FISH, ETC.

The only animal besides the bear and seal which may be worth considering, from the subsistence point of view, on a journey out on the deep sea northern ice, is the white whale, beluga. The experience of the third Stefansson expedition showed that in spring and summer (and perhaps also in autumn) beluga, singly or in schools, may be seen occasionally even at hundreds of miles from shore, hundreds of miles, too, from where any ship can sail. But there is no use killing them unless you can harpoon them either before or just after the killing, for they sink like stones.

Far out in the pack the belugas travel along leads. You become aware of them, while encamped at a lead, through hearing the noise of their blowing—most commonly through the barking of dogs that have been aroused by the blowing. Like other whales, they usually travel on the surface but a short distance, then go under and come up a little farther ahead. The rate of speed is such that when the ice along the lead is fairly level a man can easily run faster and thus wait for a given beluga. However, since they usually travel in schools this is not necessary—you let the first ones pass and try to get those that come later.

Belugas pass you far out at sea chiefly during the season when seals are numerous, basking here and there on the ice; so that securing one of these whales means no more than your not having to secure at most two or three seals. For if you are traveling you cannot load upon your sledge more meat from even the largest whale than at most the equivalent of two seals—unless, of course, you have a party of several sledges, whereupon an entire beluga could perhaps be utilized. Accordingly, the suggestion is that a small party, say up to 5 men with 2 or 3 sledges and 10 to 15 dogs, are not justified in burdening themselves with a special harpoon equipment for beluga hunting.

About the only thing that would justify carrying beluga equipment is a plan for a large party to camp for a year or more on a drifting floe. If that is contemplated you should take along Eskimo whaling harpoons, or their equivalent, and two or three hundred feet of perhaps quarter-inch braided cotton rope, of the clothesline or window-cord type. Any floats thought necessary for harpoon hunting can be made in the field of sealskins that have been removed by the casing method, which we have described.

WALRUS

Extensive sledge travel on sea ice is seldom practical where there is much open water, so that it is nearly axiomatic that where you do go you don't find walrus. However, if you find them, the killing is so simple that it hardly needs describing. If they are sleeping on ice, you sneak up from behind cover and shoot in a vulnerable spot, that spot determined by your view of each particular beast. Shooting at the base of the skull is preferred if you are using a shotgun, revolver or weak rifle; a powerful modern rifle will reach the brain through any aspect of the skull. You may be able to rush up and kill a walrus with a spear. Certainly you can combine harpooning with shooting, using the harpoon that you carry for getting seals through the ice.

When walrus are swimming you are unlikely to be able to kill one profitably unless you have a boat so that you can harpoon in connection with the shooting. Naturally you cannot carry a boat on a sledge journey. (Nansen tried it and from the hunting point of view it was a failure although the boat served in another connection.) You can, however, convert a sledge into a boat, as described in Chapter 12.

FOXES

Foxes prowl widely and their tracks will follow those of the bears; for they are parasites, feeding on the leavings when a bear has killed a seal. A fox is intermediate in size between a bush rabbit and a hare, is usually skinny and difficult to secure, so that it does not pay to make any provision for securing them to eat; you cannot afford to loiter for skins (furs) if you have serious objectives.

SEAGULLS

There are seagulls all over the polar sea in summer, but it does not pay to carry a shotgun for them nor would it be sane to use up on them your rifle ammunition. Gulls apparently feed mainly on shrimps but no doubt get some fish. They join the fox in cleaning up after polar bears during that part of the spring season when both are out at sea. For details of this see Chapter 5, Section I.

SHRIMPS

In some leads, whether near land or far from it, you will notice shrimps drifting in the water. They were reported by the Papanin expedition from the North Pole's immediate vicinity. They are the food of the seal and usually it pays you better to confine your diet to seal. But you could pick up shrimps by making an emergency dip net, perhaps with a handkerchief.

FISH

There are fish in the sea—we know that from theory, from the occasional appearance of fish remains in seal stomachs along with their main diet of shrimps, and from now and then finding a dead fish on top of the ice. Perhaps it may be all right to do a little fishing with hooks when something prevents you from traveling; certainly it is all right if you have scientific purposes—to find out what kinds of fish there are in the sea. From the subsistence point of view, it is not worth the bother to carry with you fishhooks, nets, or other fishing gear for a journey over sea ice. Even when you get ashore you will probably have no need for fishing equipment.

b. On Land

For Arctic land journeys you place your main dependence on caribou. We therefore consider the technique of finding and securing them. We then discuss the other animals and birds which form supplementary food supply for the land hunter.

ESKIMO METHODS OF HUNTING

Eskimos who have no rifles hunt caribou with bow and arrow. When a band is seen grazing, a council is held and an ambush determined upon toward which the caribou shall be driven. If natural features, such as lakes, will not fully serve, the ambush may be at the angle of two long convergent lines of monuments, *inuksuk* (plural, *inuksuit*), that have been set up from 50 to 150 yards apart, according to the topography. In rocky country the inuksuk (likeness of a man; substitute for a man) is made by putting two or three stones one on top of the other to a height of 1 or 2 feet. If the herd is large and the drive is looked upon as important, the two lines of monuments may be run out each a distance of 5, 6, or even 10 miles, although lines of 2 or 3 miles are more common. The angle between them may be anything from 15° to 45°.

At intervals of perhaps half a mile, men, women, or even children are stationed; there must be at least one person at each extreme of the lines where they are farthest apart. The Eskimos rely on suggestion in having a person every half mile standing in line with the low monuments but moving about (jumping, waving arms, stepping forward and stepping back). Apparently when you convince the caribou that some of the visible uprights are people you get them to believe that they all are people.

The hunters with bows and arrows lie in ambush at the angle of the V while the rest of the men and women form a crescent curve beyond the caribou so as to drive them toward the ambush. A drive is started by men giving long howls, in imitation of wolves, or by inducing leashed dogs to howl. It may happen, too, that the caribou get the wind of the drivers, which has the same effect, starting them to leeward. The drivers gradually close in and the caribou enter the V-shaped area through which they are driven at a speed of from 5 to 8 miles per hour toward the ambush where several of them are shot.

The greatest slaughters of caribou by North American natives, whether forest Indians or Eskimos, are by spearing when they swim rivers or when they cross lakes at narrows. Sometimes the animals are deliberately driven; at other times people can judge from the way the herds are moving where they are likely to cross. In canoes, if they are Athapaskans, in kayaks, if they are Eskimos, the hunters wait out of sight behind a bend or in a clump of willows, being careful that the wind is right so the caribou do not get human or dog scent—or smoke scent, as from a camp fire. The wider the river or the lake, the greater the slaughter, the hunters cannily waiting till the maximum number of animals are swimming. They use spears, of course, though travelers sometimes miscall them harpoons. The dead animals float high in the water, partly or mainly through the buoyancy of the hollow hairs. In rivers they drift downstream, and the hunters follow to pull them ashore one by one, or to pick them up where they have been stranded.

If there are more hunters than boats, perhaps because women share in the hunting, there is a second kill where the caribou survivors scramble out. This is most effective when there are willows or trees. But few wild animals recognize human beings as such when they are motionless, and sometimes the hunters have no other concealment than to stand perfectly still until the caribou are about to pass them.

In a few places in the North it is customary to try to drive caribou to their death over a cliff.

A method of near approach to caribou, used more by the northerly Athapaskans but known to the Eskimos, is for a man to walk hunched forward, as if on all fours, and to carry strapped to his head or shoulders the antlers of a caribou—the hunter thus pretending to be a caribou. A close approach can sometimes be made in this way, the hunter of course moving upwind.

There is only one ordinary trap for caribou, used chiefly by Eskimos of northeastern Canada. This is a deadfall, the animal being speared after it tumbles into a pit. These are made chiefly of snow, but usually have something for reinforcement, perhaps wood or large bull caribou antlers.

HUNTING FOR A LIVING

When a man hunts seriously for a living in the autumn months, say 200 or 300 miles north of the Arctic Circle, he gets up in the dark of night. By dawn at the latest he leaves camp and is 8 or 10 miles away, beyond the area from which game can have been scared by the barking of dogs or the smoke or smell of the camp, by the time that daylight enough for good shooting comes into the southern sky. He then uses to the best advantage the 4 or 5 hours of hunting light, going from high hilltop to high hilltop and examining with his field glasses every exposed hillside or valley. If he does not see game the first day, he hunts similarly the second; and if he finds none the first week, he continues the second week. For it is an essential of hunting that, although game may be abundant in the country as a whole, it may at any time be absent from a given small specific section.

HUNTING INLAND

If on a continental mainland in the fall you decide that caribou have left the coast and that you should go inland for them, the best procedure is to ascend a river as far as possible. The reasons for doing this, instead of striking across country, are mainly two: first, a boat of shallow draft, which you can perhaps improvise if you don't have one, may be taken upstream a considerable distance along most Arctic rivers; second, you expect a river valley to be stocked with a heavy growth of willow suitable for fuel, even in places where spruce trees are not to be found.

HUNTING IN A BLIZZARD

Generally it is only in times of extreme need that one hunts caribou in a blizzard. Not that nine-tenths of the blizzards in the Arctic need keep a healthy man indoors; it is rather that the drifting snow (even when you can see as far as 200 yards) diminishes many times over the chance of your finding game. If you do find it, however, the stronger the gale the better your chance of close approach without being seen; for these animals, though they double their watchfulness in foggy weather, seem to relax it in a blizzard.

STALKING

The main thing in stalking caribou that are not moving is the ability to keep in mind their location accurately while you are circling and winding about so as to approach them from a new direction behind cover of irregular hills and ridges that are unfamiliar to you.

USE OF FIELD GLASSES

Binoculars and a knowledge of their use are about as important as the quality of your rifle and the pair of legs that carry you. It is a difficult thing to teach newcomers the proper use of field glasses. The green man stands erect with his heels together, lifts the glasses jauntily to his eyes and spins slowly around on one heel, taking from half a minute to a minute for a complete survey of the horizon. Then he announces there is no game in sight. The experienced hunter will take some pains to find the best place to sit down, will bring out a piece of flannel that is clean, no matter how dirty he himself and every other item of his outfit may be, and wipe every exposed lens till he is sure there isn't a speck or smudge anywhere. If the landscape is well within the power of his glasses he will probably rest his elbows on his knees. But, if the distance is great or the wind blowing, he will lie down flat with elbows on the ground, or will build up out of stones or any available material a rest for the glasses that cannot be shaken by the wind. If the wind is blowing hard, he may even place a 15- or 20-pound stone on top of his glasses to keep them steady. There is never any pivoting or swinging motion as he brings them to bear upon successive fields of view. If the angle of vision is 6°, as it may be with 6-power glasses, or 3° with 12-power, he examines thoroughly the field disclosed by their first position and then moves them a less number of degrees than they cover, so that the second field of view shall slightly overlap the first.

In calm weather and with an ordinary landscape it takes about 15 minutes for one good look around from a hilltop;

under special conditions it may take twice that long. If, for instance, somewhere near the limit of the power of the glasses is seen a patch that may be a caribou but which may be a stone or a wolf, it can take half an hour of study to make sure. For example:

When there is in the atmosphere that quivering wavy motion which is due to the sun shining on areas of different nature, causing air currents to rise that differ in temperature and humidity, all things have blurred outlines and shapes may appear fantastic. Small stones, round or flat, may look like tall pillars and may even seem to move. If stones or the like simulate motion they will appear to be moving in the same direction, although perhaps reversing it. This may be the case with caribou; but they will hardly keep their relative positions, as immovable bodies seen through a mirage would do.

If you notice six specks, then, they may be caribou or they may be stones. Under conditions when you cannot estimate distance (as, for instance, when you are looking across a range of hills over invisible ice beyond to a second land), they might be white geese. It may take half an hour of watchfulness before one of the bodies moves with reference to the other five. They are then not stones, since one has moved; and not geese, because six geese would not retain their positions unchanged for half an hour. By a process of elimination you will decide they were caribou which had all been lying down until one got up and moved about.

On the third Stefansson expedition the sea north of Alaska was explored through several years by sledge parties which, after the first 2 months or so of each journey, depended for food and fuel solely on water game, 90 percent of it seals. Information gained on these journeys has been used in various parts of this Manual. Coming ashore on northern islands, some of which were discoveries of the expedition, the parties changed their dependence to grazing animals, mainly caribou, but in some islands also musk oxen. A statement giving information on caribou and on the manner of hunting them is here taken from Stefansson's *Hunters of the Great North*, pages 250–260:

"When you consider that an experienced hunter is an expert in a very simple task, you will not think it remarkable that we count on being able to secure at least three out of every four caribou we try to get. The same proportion applies to seals and polar bears. This is why we feel no hesitancy in making journeys of hundreds and even thousands of miles in the Arctic regions, depending on hunting entirely for our food. If you read of travelers starving to death up there it will be through some special misfortune, or else because they either did not try to hunt or else did not know well the technique of finding and securing game.

"A common mistake about caribou is to suppose that they are more difficult to hunt in districts where they are frequently hunted by people than in countries where they are never hunted at all. I find there is no such difference. The reason is simple. They have one great enemy, the wolf. On the prairies in the northern half of Canada and on the islands to the north of Canada there are many millions of caribou. Some say there are 10 million all together and some say there are 30 million. In these great herds there must be born every year anything from 2 million to 6 million calves. The number of caribou killed by human beings in all of northern Canada is far less than 1 million per year. Accordingly, the caribou would increase very rapidly were it not for the wolves which kill several times as many as do the human hunters—Indian, Eskimo, and white. Wolves are found wherever caribou are found and the caribou are in continual dread of them. They are, therefore, almost equally harried in countries that are uninhabited by men as in countries that are inhabited. I have, accordingly, found that even in the remote new islands which we discovered in 1915 caribou are about as difficult to approach as in northern Alaska or on the Canadian mainland where they are continually hunted by Eskimos.

"Apart from the islands actually discovered by my expedition there is no known country in the northern hemisphere that has been so little visited as Isachsen Land in north latitude 79°, west longitude 103°. We feel sure that no Eskimos ever saw that island. From the beginning of the world to our time it had been visited only once—by Captain Isachsen in 1901. Isachsen made a hurried sledge trip around the island. The journey took him about a week. In one place he saw some caribou tracks and I think he may have seen some caribou at a distance, but he did not try to hunt them. The next visitors were my sledge party in 1916 and on that occasion we saw no caribou and had to feed ourselves and our dogs entirely on seals.

"My second visit, and the third visit of human beings to the island, was in 1917. We were then on the most dangerous adventure that has ever fallen to our lot. By the road we had to travel we were some 500 miles away from the nearest Eskimos and 600 miles away from our own base camp. Four of us had been on a long journey out on the moving sea ice to the northwest. When we were more than a hundred miles northwest from Isachsen Land, two of my three companions were taken seriously ill. We turned toward shore immediately and it was a hard fight to make land. When we got there after a struggle of 2 weeks we found ourselves with one man so sick that he could not walk, another who could barely walk but was of no use otherwise, and with two teams of dogs that were exhausted with hard work and so thin from short rations during the forced march toward shore that they were little more than skeletons. It had been my pride through many years never to lose a dog. Furthermore, I was exceedingly fond of every one of these dogs for they had worked for me faithfully for years. I was concerned for their safety, and still more concerned for the safety of the sick men. By that time, however, my confidence in our ability to make a living in the Arctic had become so strong through 8 years of experience that I felt more worry for the lives of the men on the score of illness than for fear they might actually die of hunger.

"But the first day on Isachsen Land was a depressing contradiction to my hopes and expectations. The one man in good health and the two men who were sick had to make their way as best they could along the coast while I hunted inland parallel to their course. I walked that day 20 miles across one of the very few stretches of entirely barren land that I have seen in the Arctic. Under foot was gravel without a blade of grass. Much of the land was lightly covered with snow as in other typical arctic lands in winter, and I looked in vain in the snow for track or other sign of any living thing.

"That evening my men were depressed partly because of their illness and also because it looked as if we had at last come into a region as barren as many people think the polar countries generally are. It was clear that if we saw game the next day we would simply have to have it. Where game is plentiful, you may lose one chance and soon get another; but where it is scarce, you must not allow any opportunity to slip through your fingers.

"I am telling this particular hunting story rather than any other to illustrate the principle of how you must hunt caribou in the polar regions if it is essential that you shall get every animal you see. It certainly was essential in this case, for I wanted not only to stave off immediate hunger but to secure meat enough so we could camp in one place for several weeks to give the sick men a chance to become well.

"Our second day on Isachsen Land the men again followed the coast line with the sledges, cutting across the shortest distance from point to point while I walked a much longer course inland. I had gone but a few miles when I came upon the tracks of a band of caribou. You can seldom be sure of the minimum number in a band from the tracks if there are more than 10 animals, for caribou have a way of stepping in each other's footprints. There are always likely to be more animals in a band than you have been able to make out from the tracks.

"The trail showed that these caribou were traveling into the wind as they usually do. There were only light airs and the snow had on it a crust that broke underfoot with a crunching noise. Under such conditions the band were likely to hear me 4 or 5 hundred yards away. The country now was a rolling prairie—not barren gravel as yesterday. It was impossible to tell which ridge might hide the caribou from me, so instead of following the trail ahead I went back along it for about half a mile studying the tracks to see just how fast they had been moving. They had been traveling in a leisurely way and feeding here and there. I estimated their average rate of progress would not be more than 3 or 4 miles per day. I could not rely on this, however, for a wolf may turn up any time and begin a pursuit which takes a band 25 or 50 miles away. Should a wolf pass to windward of them so that they got his smell without his knowing about them, they would be likely to run from 5 to 10 miles.

"When I had made up my mind that these caribou were moving slowly, I went to the top of a nearby hill and through my glasses studied the landscape carefully. With good luck I might have seen some of them on top of some hill and the problem would have become definite. But I watched for half an hour and saw nothing. Clearly they were either feeding in some low place or else they were lying down, for caribou are like cattle in their habit of lying down for long periods. I now commenced a cautious advance, not along the actual trail but crisscrossing it from high hilltop to high hilltop, hoping to get a view of the animals while they were at least half a mile from me and while I was beyond the range of their eyesight, for they cannot see a man under even the most favorable conditions farther off than half a mile. Under ordinary conditions they would not see you much beyond a quarter of a mile.

"Finally I saw the band lying quietly on some flat land. There was no cover to enable me to approach safely within 500 yards and that is too far for good shooting. I thought these might be the only caribou in the whole country. We had 13 hungry dogs and 2 sick men, and now that I had a large band before me it was my business to get enough food at one time to enable us to spend at that place 2 or 3 weeks while the men had a chance to regain their health and the dogs to regain their flesh and strength.

"On a calm day when caribou can hear you farther than you can shoot, there is only one method of hunting. You must study their movements from afar until you make up your mind which direction they are going. Then you must walk in a wide curve around them until you are in the locality toward which they are moving and well beyond earshot. This takes judgment, for they usually travel nearly or quite into the wind and you must not allow them to scent you. You, therefore, have to choose a place which you think is near enough to their course so that they will pass within shooting distance, and still not directly enough in front so that they can smell you.

"On this occasion the glaring light on the snow had been so hard on my eyes that I did not feel they were in perfect condition, and no one can shoot well if his eyes are not right. Unless there is a change of wind caribou are not likely to turn their course back along the trail by which they have come. I accordingly selected a hill across which they had walked that morning and half a mile away from where they now were. On the top of this hill where I could see them, although they could not see me (because my eyes were better than theirs) I lay down, covered my head with a canvas hunting bag to keep the sun away, and went to sleep. Sleeping is the best possible way of passing time, but my object now was not only to pass the time until the caribou began moving but also to get my eyes into perfect condition.

"When you go to sleep at 20 below zero you have in the temperature an automatic alarm clock. My clothes were amply warm enough to keep me comfortable while I was awake, but I knew that when I went to sleep my circulation would slow down. This reduces the body temperature and the same weather that will not chill you when you are awake will chill you enough to wake you from a sleep.

"In this case the chill woke me in about half an hour to an unpleasant situation. A fog had set in and I could not see the caribou, nor had I any means of knowing whether they were still lying down or whether they had started to move. If this had been a good game country, I might have taken chances on advancing through the fog a little, but I was so impressed with the possibility that these were the only animals within a hundred miles that carelessness was not to be considered. At this time of year we had 24 hours of daylight. The fog was bound to lift sooner or later and whenever it did I would commence the hunt over again.

"The fog did lift in about 2 hours and I did have to commence the hunt all over again, for the caribou were gone. I was to the north of them and I felt sure that they had not gone by near me; so they must have gone east, west, or south. I was probably so near them that I could not with safety go on top of any of the adjoining hills, so I went back north half a mile and climbed a high hill there. From that hill I saw nothing and went half a mile to one side to another hill. Then I saw the caribou. They were now feeding half a mile south of where they had been when the fog covered them up. In the meantime the breeze had stiffened enough so that now there was no longer danger of my being heard. I did not, therefore, have to circle them and lie in wait in front but could follow up directly behind.

"Eventually I got within about 300 yards. But I wanted to get within 200, so I lay still and waited for them to move into a more favorable locality. During my wait an exceedingly thick fog bank rolled up, but with it the wind did not slacken. Under cover of this fog I felt safe in crawling ahead a hundred yards, for I knew that I could see through the fog quite as well as the animals and that they could not hear me because of the wind. The reason I had not approached them in the previous fog was that the weather then had been nearly calm and they would have heard me.

"At 200 yards I was just able to make out the outline of the nearest caribou. I did not dare to go closer and, of course, I could not begin shooting with only one or two animals in sight where I wanted to get them all. I had before now counted them carefully. There were 21, which I estimated would be enough to feed our men and dogs between 2 and 3 weeks, giving them a chance to recuperate.

"After about half an hour the fog began gradually to clear and in another half hour I could see all the animals. I was near the top of a hill and they were in a hollow, the nearest of them about 150 yards away and the farthest about 300.

"In winter the ground in any cold country will split in what we call frost cracks. These are cracks in the frozen surface of what in summer is mud. They are ordinarily only half an inch or so wide but I have seen cracks 4 or 5 inches wide. These cracks form when the mercury is dropping and with a noise that resembles a rifle shot. Under the same conditions the ice on the small lakes cracks similarly. These loud noises are so familiar to the caribou and the report of a rifle is so similar that the mere sound of a rifle does not scare them. Of course, we have smokeless powder so they cannot see where the shots come from. What does scare them is the whistle of the bullet and the thud as it strikes the ground. It is instinctive with all animals to run directly away from the source of any noise that frightens them. It is another instinct of caribou when they are alarmed to run towards the center of the herd. A band that has been scattered feeding will bunch up when they take fright. When you know these two principles, it is obvious that the first caribou to kill is the one farthest away from you. On some occasions when I have been unable to get within good shooting distance of a band, I have commenced by firing a few shots into a hill on the other side of them, hoping that the noise of the striking bullets would scare them towards me. Frequently it works. On this occasion, however, I merely took careful aim at an animal about 300 yards away. It dropped so instantaneously that, although the sound of the bullet striking it induced the other caribou to look up, they recognized no sign of real danger. They were, however, alert and when they saw the second caribou fall they ran together into a group and moved somewhat towards me. I now shot animals on the outer margin of the group and as each fell, the others would run a little way from that one. Their retreat in any direction was stopped by killing the foremost animal in the retreat, whereupon the band would turn in the opposite direction.

"It would not have been difficult for me to kill the whole band alone, but I was not shooting alone. From a point somewhat above and behind me I could hear other shots, and some animals I was not aiming at were dropping. Without looking around I knew what this meant. My companions traveling along shore on the ice had seen the caribou and had waited for some time until they began to fear that I might have missed the band. The two sick men had then been left behind in camp while their Eskimo companion had come inland to try to get the caribou. When he got near he saw that I was approaching them and very wisely did not interfere. There is nothing so likely to spoil a caribou hunt as two hunters whose plans conflict. Even when they have a chance to consult at the beginning of the hunt, two men are less likely to be successful than one. For one thing, caribou may see a black dot on the landscape and take no warning from it, but if they see two black dots and later notice that they are either closer together or farther apart than they were a moment before, this makes a danger signal which they understand. That is the main reason why I always hunt alone. If there are two hunters to go out from the same camp on any given day, they should go in opposite directions. That way they double the chance of finding game and each has a fair chance of getting the animals he does find.

"On our journeys we never kill more animals than we need, but in this case we needed the whole twenty-one."

MUSK OXEN

Wild musk oxen are found chiefly on certain islands and then in a small section of the northeastern Canadian mainland—for details see Chapter 5, Section I.

RANGES AND GAME LAWS

There is supposed to be a permanent closed season on all musk oxen under Canadian jurisdiction, whether on mainland or islands; except that naturally anyone, white or native, would be expected to kill a few if it were a matter of life and death. Some of those on the Canadian mainland are in an actual game reserve, on and near the Thelon River. Here the restrictions are theoretically even stricter, but still matters of life and death would control.

The rest of the wild musk oxen are in Greenland. There they have been exterminated from all the west coast, and from all the east coast north to the Scoresby Sound vicinity. From Scoresby they run north along the east coast and around the north coast westward to and through Peary Land. The Danish Government has wanted to discourage killing in this whole region. What they have succeeded in doing is to restrict wanton destruction, which some years ago was almost like the well-known slaughter of the buffalo on the western prairie. Hunters and explorers who go to the region are now supposed not to kill musk oxen except in extreme need.

Peary says: "Presence of musk oxen can be detected very quickly by the patches of luxuriant grass which mark all their rendezvous. * * * A careful examination of these places will soon show whether they have been about, bits of wool and hair shed from their shaggy coats being scattered here and there on the ground, while their tracks show how recent has been their visit." It is only in rugged country, however, that (in Stefansson's experience) you find recent traces without usually being able also to see the herd from some nearby hill.

In clear weather these huge bison or black animals can be seen, whether on a snow field in winter or against a green hillside in summer, as far away with the naked eye as caribou with the best six-power glasses—probably for six or eight miles in summer and ten or twelve in winter. Even in a snowstorm they can be seen three or four times as far as caribou. When seen by hunters they seldom escape.

ESKIMO HUNTING METHOD

The common Eskimo method is to set a few dogs on the herd to hold them in defense formation and then to stab with spears. (See Chapter 5 for description of defense formation of musk oxen.)

A white man's modification is to have men form a circle around the herd at fifty to a hundred yards, shooting at the largest animals first and finishing up with the calves. However, this method is wasteful of ammunition and rarely has workmanlike results. The anatomy of the animal is so well concealed by the tremendous mass of wool on the shoulders that most men do not soon learn how to hit the hearts, and the brain and spinal cord are small targets. As a result, it commonly takes five or more bullets per animal, the wounds are anywhere in the body, and, especially when a shot passes through the intestines, it is hard to make a clean job of butchering.

A better method is to get as close to the animal as possible (approximately ten yards). He will stand with lowered head and the bullet can be placed in the back of the neck at the base of the horns, resulting in instant death and clean butchering.

There is nothing about the killing of musk oxen which has any of the savor of sport. It is about as exciting as killing domestic cattle in a pasture.

If you need a large amount of meat, as for a party spending some months or the winter, it is best to kill an entire herd rather than several out of several herds. The reasons are:

1. The animals stand in such close formation that you can rarely be sure of killing one without wounding others. These would probably later die or become a prey to wolves.

2. If the big animals are killed, the calves and yearlings would probably be unable to defend themselves against wolves.

3. Wolves and bears are continually prowling about and if you have meat depots in many places they cannot all be guarded from theft. But when a large number of musk oxen are killed in one place you can have a man stand on guard until all the meat has been hauled home.

4. You want for your diet animals of different ages because of the varying qualities of the meat. The biggest animals have the best fat, and fat is precious; but their lean is often tough. Yearlings are preferred for beef, or two-year olds. Small calves are about like bob veal and are seldom preferred, but there is no advantage in letting them go and be killed by wolves.

Musk oxen are usually found in bands of from 10 to 40. Stefansson's party of about 15 people and 4 dogs wintering in Melville Island 1916–17 exclusively by hunting, killed as many as 30 musk oxen from a single herd. The number killed depended on the number that could be cut up in a few hours by all hands working together.

BUTCHERING

It is necessary to clean a carcass at once; for, because of the thick skin and deep hair, musk oxen appear to have a fast putrefaction rate even in the coldest weather.

WOLVES

Wolves are found wherever there are caribou. They run to 100 pounds in weight and even beyond. At certain times they are fatter than caribou and therefore more desirable as food. The taste is excellent—like young pig.

It was a rule in the North to shoot wolves because they destroy caribou and because they are good eating. Still, few are secured by parties that live on game—probably not more than one for each hundred caribou. This was because they were so wary and because they move so rapidly and constantly that they cannot be stalked. Trapping is the best way to secure them.

FOXES

As stated earlier in this chapter, it does not pay to shoot foxes for food, nor should you stop to try to secure the skins when making an Arctic journey. However, if you are stationed in a permanent or semi-permanent camp in a locality where foxes are numerous, and if it does not interfere with other work, there is no reason for not trapping them.

TRAPPING

Seton describes one Eskimo method of trapping foxes: "Eskimos use the pitfall. It consists of a circular arched hut, built of stones, with a square opening at the top. Over this opening some thin blades of whalebone are set firmly in the wall at the near end, so as to form an apparently secure footing; at the far end is bait. A sprinkling of snow adds a final deceptive touch. When the animal attempts to get the bait, the whalebone slats over which he must pass bend downward and drop him into the pit below which is deep enough to prevent him from jumping out. The whalebone immediately springs back, and the trap is ready for another victim."

Another method is to cut a shallow hole in the snow, just deep enough for an open steel trap to lie below the level of the surrounding snow. Then a slab of lightly packed snow, just hard enough to lift without cracking, is cut to cover the trap. This slab is laid carefully over the trap, and then shaved and smoothed with great care. The snow slab should be just thick enough to support its own weight, brittle enough to be easily broken when an animal steps on it. A few chips of blubber, fish or meat are shaved off and scattered loosely and carelessly over and around the vicinity of the trap—just enough to give a scent and cause the fox to hunt around until the trap is sprung.

Sometimes a little box-like snowhouse is built over a trap, usually of four blocks of snow, three sides and a roof, leaving one side open to leeward. The bait is placed at the farther end of the house so that the fox must step directly over the trap to get it.

There is no humane way of killing foxes by steel traps and the only thing is to visit the trap lines often. A fox will frequently gnaw one leg off to get free. If two feet are caught, he may be frozen to death by morning.

DEADFALL TRAPS

The nearest thing to a humane trap is a deadfall. You lift up one end of a heavy log, or one end of a long slab of stone, and prop it up with a stick which supports it so insecurely that a little tugging or pushing will displace it and permit the weight to drop. If around the log or slab you build a kind of house of sticks or stones that is shaped just the right way you can probably arrange it so that the heaviest pressure of the weight will strike the fox just back of the shoulders, whereupon death may come almost instantly.

BIRDS

It is probably never worth while to take a shotgun on a long journey, and birds should be hunted with a rifle only in extreme emergencies (because you get so little food for each shot, because you are so likely to miss, and because of the mutilation of a small animal by a high-power bullet). But it is worth while to keep in mind that birds can be used in certain localities and under certain conditions.

There are large sections of the Arctic, including most or all of the islands in the first tier north of Canada, where geese moult by the tens of thousands. The Eskimos at the moulting season make a camp in one of the moulting districts and go out, different days in different directions, round up the geese, perhaps several hundred at a time, drive them slowly to camp and butcher them there, cutting them up immediately so as to hang up or spread out the meat to dry.

The moulting districts may or may not be nesting districts—sometimes the moulting geese are exclusively males.

Where you have nesting regions the geese may be of some consequence as food.

It is one of the curious facts of the Arctic that in some of the best nesting regions eggs were not eaten by the natives. An example is the Richardson Island section of the Mackenzie delta, which apparently was one of the greatest nesting districts of Arctic Canada. The local people made no use of the eggs until after the American whalers began to winter at Herschel Island, following 1889. They brought with them Alaska Eskimos used to feeding on eggs who introduced the custom. However, even as late as 1912 little use was made of the eggs. When an egging party went out to Richard Island it was even then usual that the foray was led by or instigated by an Alaska Eskimo.

STRATEGIC SPOTS FOR SECURING MIGRATING BIRDS

There is in the Arctic here and there strategic topography for the killing of ducks and geese, particularly ducks. Ordinarily these birds migrate along river courses or along a coast line. While great multitudes come down the Mackenzie River, there is apparently no place of the sort we have in mind on that stream, so that most or all are on seacoasts. A typical place is the Shooting Station, one of the best known, about halfway between Barrow Post Office and Point Barrow, Alaska. The ducks are migrating along the coast. When they come to the narrow land and the lagoons at Shooting Station they apparently realize that they have arrived at a turn in the coast and they cross the isthmus, practically speaking all of them in one place, all in a belt half a mile or a mile in width. Nowadays people wait at the Shooting Station with shotguns and kill the ducks by the hundreds.

But it is possible for those who do not have shotguns to utilize the migration controls of the topography by using a hunting device on the principle of the South American bolas, with the differences that the Eskimos use six or more balls instead of two and that they do not hold on to it by a line but let go as if, in using a slingshot, you were to throw the sling as well as the shot.

The bird bolas is of six, seven or eight balls, each the size of a walnut but more almond-shaped or pear-shaped, and made by the Eskimos of bone or ivory. The string on each is from 30 to 40 incres long and there is a handle of feathers or of a bundle of the strings where they come together. Grasping this handle you swing the bolas around your head, lasso fashion, and let fly towards a coming flock of birds, perhaps at an upward angle of 45°. The strings spread out like the ribs of an umbrella. The balls are probably visible to the keen-eyed ducks; but not the strings, or perhaps the strings are not understood by the ducks—at any rate, they sometimes fly into the bolas when you would think they had a chance to avoid it. If strings get properly obstructed by the bird, they and the rest wrap themselves around and bring her to the ground, usually so tangled that she cannot move fast. It happens, however, that either in the air or on the ground she gets so freed that she can fly, with the bolas trailing. For that and other reasons it is well for each hunter to provide himself with half a dozen sets each morning.

There are not many places in the Arctic where there are bird cliffs. Some are found in northeastern Siberia and a great many around Greenland. The birds, of the little auk or puffin type, may there be secured with the bolas or, as is the local custom in Greenland, with a net on a pole used on the principle of a butterfly net.

There are certain Arctic birds, notably the ptarmigan, that can be netted in large numbers by an ordinary fish net or by a net that you make up, no matter how carelessly, out of any sort of string. You prop up the net on edge in any place frequented by ptarmigan. Then you watch until a flock is in the neighborhood, go round to the proper side and approach very slowly. Upon a man's slow approach these birds usually run away instead of flying. They will then walk into the net, which should be tilted in their direction in such a way and so loosely that it falls on top of them.

Ptarmigan as well as rabbits can be snared in brush. You will find almost anywhere in the northern fringe of the Arctic forest, but more especially among the thick willows of the river flats that both ptarmigan and rabbits have trails along which they walk or run. By watching a few birds you soon discover the proper height at which to suspend snares. This is somewhat lower for ptarmigan than for rabbits, except in places where a rabbit has to sort of stoop down to go under a bough or a fallen tree.

SECTION III

FISHING METHODS

We have said that on journeys over the polar sea it is probably not worth while to carry any sort of fishing gear, even though you may be expecting to spend some time on an uninhabited land after coming ashore. For when you are doing two things at the same time, traveling and living by hunting, you cannot afford either the time required for small game or the carrying of the paraphernalia that would enable you to utilize these minor resources.

The argument changes, however, if your plan is to spend a long time in a given place, and particularly if there is a considerable number of men. Even so, fishing would not pay from a camp on a drifting floe, but it may very well pay on any of several of the larger Arctic islands, and it will pay handsomely in certain districts of the mainland.

For a permanent or long-continued establishment in Alaska, or in a similar country, all you need to know with regard to fishing is that the natives are experts at it, that they will sell you quantities of fish if you provide them with a market, and that they will show you their technique if you want to learn from them. We consider, therefore, chiefly methods to be used where there are few natives or where there are natives not expert in or well equipped for fishing.

Fish nets are on the whole the best of human inventions in this field. White men are the world's greatest experts in the making and the use of nets. Most of the forest Indians of North America did have nets before the Europeans came, and nets seem old, too, in Siberia. Eskimos did not have them till recently, when they were introduced either by whites or by non-Eskimo natives. It may be 300 years ago since the net was first used on Bering Sea; it is not much more than a hundred since it reached Point Barrow; it reached the Mackenzie district so late that there were still living in 1906 a number of people who remembered when they had seen the first fish net. The practice of using nets did not get east beyond Cape Parry until following 1910. At that time nets were not in use from Parry to somewhere near King William Island, but east and south of that they were again found. Today they are in use in all Eskimo countries.

In an emergency a net has to be made almost necessarily from twine, although this can be secured by unraveling cloth if no netting twine is obtainable. Of native materials, only two have been found moderately good for nets—whale bone (baleen) and the bark of certain trees. There may not now be living anyone who knows how to make bark nets, although the practice was continued on the lower Mackenzie into the present century—one bark net was secured near Slave Lake in 1906 for the American Museum of Natural History of New York. There may be Eskimos living around Point Barrow or Point Hope who have made whale-bone nets, but this is unlikely. However, baleen can be split by anyone by just common-sense methods and can be knotted as a cord.

The thing to do is to take nets with you. If you do not know the country you expect to traverse, you might perhaps carry meshes of 2-inch, 3-inch, and 4-inch stretch.

There are two most important things about the use of fish nets on journeys, one of these peculiar to the Arctic.

You must be very careful to keep your fish net dry when it is not in use—you must never let it stay wet long enough to decay. This would appear so elementary as not to need stating; but it is a fact (or is commonly believed to be) that an editor of an American sportsmen's journal, who had been giving advice to sportsmen for years on matters of hunting, fishing, and travel, lost his life on a journey he made in Labrador because he neglected drying his nets when they got wet from rain or from canoe upsets. When, through a combination of accident and other circumstances, it became important for him to use the nets for fishing they were already so rotten as not to hold the fish.

The special thing about the use of nets in the Arctic is setting them through ice. If you are spending the winter in a set place you will naturally begin fishing soon after the ice is strong enough to bear a man—when it is, say, 4 or 5 inches thick (although it will bear a man when somewhat thinner). You make holes in the ice, perhaps 10 feet from each other, for a distance equal to the full length of your net. You take a pole that is more than 10 feet long, fasten a string to one end of it, push the pole all the way down through the hole and let go of it so that its buoyancy will bring it up flush against the ice. Then you maneuver it so that it is visible to a man looking down through your second hole. From that it is shoved along to the third, fourth, and other holes, until at the last it is brought up out of the water.

Now you fasten each end of your net to an end of the string, so as to have an endless-chain effect, and then pull through so that the net is all in the water and the string all on top of the ice. You must weight your net so that nowhere does it touch the ice. It will probably be best to suspend it so that it is at approximately the same depth through its whole length, say ten or fifteen inches below the under surface of the ice. You manage this by fishing down through your holes, get hold of the upper edge of the net and attach a string which suspends it at that point. The reason why your net must not touch the ice is that the ice is growing thicker by freezing at its lower side. If the net touches the ice its upper edge will be embedded in the ice tomorrow morning and you will not be able to get it out except by chopping up all the ice.

If you have to chop your net out, do not try by careful chiseling to free it from the hundreds of pounds of ice that will be clinging to it. Make a large round hole in the ice somewhere and lower your net, ice and all, into the water. If you stand by a while, gently working the ice and net around by poking with a pole, the chunks will thaw off and the net will be free—there will be no damage unless you have cut some threads when you were chopping the net loose in the first place. For it is only water immediately in touch with the ice and in process of freezing that is at the freezing point of fresh water—all the rest, farther down, is a little above freezing.

In winter there are places where you can set a net in water that is open no matter how cold the weather. The best of such places are where rivers originate in large lakes. There your method of fishing during winter is just the same as it would be in open water during summer.

When you are taking fish out of a net at temperatures well below zero you will probably want to work with bare hands—most northern fishermen do. The water in the hole from which you have pulled the net is, of course, unfrozen. If the air is 40 below zero it is more than 70 degrees colder than the water. The best way, therefore, to warm your hand is to stick it every now and then down into the water. This warming in ice water ought to be enough to enable you to take the fish out of one net at a time. If you find your hand growing numb, the best way is to shake the water off it as best you can and then stick it somewhere inside of your clothes. Handiest is to wear a coat and shirt wholly of fur and cut Eskimo style as described in this Manual's section on clothing. Then you can slip both arms, if desired, out of the sleeves and hold them on your bare breast until they are warm.

Taking fish out of a net with bare hands at 50 below zero demonstrates what we said in the clothing discussion, that if the rest of your body is warm as toast you can stand almost any amount of cold on your hands. It is men who are badly clad whose hands get numb under such conditions.

It is possible to use waterproof mittens in taking fish out of nets although among northern fishers, at least among the Eskimos, you are considered rather a sissy if you do—or else the excuse is made for you that naturally your hands get numb because your clothes are so poor. The mittens, when used, are of seal skin, the same material and sewing as for the upper of a seal skin water boot, and they are cut gauntlet style. It may be that rubber gloves or mittens would be good, perhaps the kind used by surgeons. However, there is not much protection from cold in the surgeon type of rubber glove; there would be more from a rubber mitt, since all four fingers would be touching and warming each other, and you could slip your thumb occasionally into your bare palm to warm it.

It is important when taking fish out of a net in very cold weather to do you handling on top of snow, not on top of glare ice. For if a wet piece of the net touches glare ice it will freeze fast and there will be danger of breaking the threads. However, if this occurs, you chip the net loose with your hunting knife or a pickaxe, not minding if chunks of ice cling to the netting. For they will melt and drop off when you put the net back into the water again and set it.

FISHING FROM THE BEACH

Along certain Arctic coasts people are more successful than you would believe in setting nets from the beach. West of the Mackenzie at Shingle Point, for instance, Stefansson took part in fishing with two-inch mesh, the nets about 30 feet long and 18 inches wide. Logs were split and the splinters lashed together so as to make poles 60 or 70 feet long. With these the nets were shoved out from the beach, buoyed so as to float just below the surface. Half a dozen people could be kept busy with four nets. You shove out all four from the beach, about 100 yards apart. After pushing the last out you go back to the first, pull it in, and find anything from 10 to 30 or 40 fish. Shove that net out and take in your second net, and so on, rotating all day or until you are tired.

LENGTH OF RUNS

Fishing of this kind could in some cases go on for a week or ten days at a time when there was a run. Even when there was no run you would probably get something, although in that case you might not find it worth while to pull in the nets more than three or four times a day.

USE OF SWEEP NETS

Fishing from shore with sweep nets depends on local knowledge although you may discover a shoal of fish by accident any time. You must have at a minimum one boat. Your net should be fairly long and wide and of a rather small mesh. When you know there is a run you fasten one end of the net to the shore by a long line, go out with the other end, attach it to your boat and paddle around in a semi-circle, coming back to shore. In this way great quantities of "herring" are captured at various points on the north coast of Canada, particularly at the Baillie Islands (near Cape Bathurst). Some of these are real herring similar to the Norwegian. On August 3, 1911 (August being there the month of runs—especially late August) Dr. R. M. Anderson drew in about 3,000 California herring (*Clupea pallasi*) with one sweep of a 200-foot net that had an end fastened to the beach at the Cape Bathurst sandspit.

The Eskimos have a way of using hooks which at least in cold weather is a great deal better than our method. The body of the hook is made of ivory or bone, and shaped like a small fish so as to be its own bait. A very good material for a point to this sort of hook is a shingle nail, or for larger fish a 6-penny or 8-penny nail, which you pass through a hole bored in the head of your ivory fish at right angles to the long axis of its body and then bend up L-fashion, or a little more, perhaps U-shape.

To use these hooks you make a hole in the ice 12 to 18 inches in diameter, so that it will let in a good deal of light. You sit beside the hole and keep jiggling the ivory fish at various depths, always being ready to pull in the moment you feel something on the hook. You pull in straight and fast; then your fish will not get off the hook. As he comes out of the water you throw him, with a continuation of the same motion, upon the snow beside you—you have no bother taking him off the hook as you would if it had been barbed.

It was the experience of a party using this method in the delta of the Mackenzie River that an ivory fish the size of your index finger and with an 8-penny nail was rather on the big side. More likely it should be the size of your little finger or somewhere in between the two. With an ivory or bone body of this intermediate size they caught fish of many species and ranging in weight from less than a pound to connies that weighed more than 50 pounds.

LAKE FISHING

It is not easy for a stranger to tell in advance what are going to be the better fishing localities in a lake. You might try setting your net off a promontory. If you have several nets you better set them in different parts of the lake under different conditions. After some of this experience you will be a better judge than any wise fisherman, white or native, who does not know that particular lake.

There are perhaps only two important northern ways of using hooks that are different from the ordinary. The Dogrib and other Athapaskans who travel on Great Bear Lake carry hooks of the codhook type. These they bait by wrapping a piece of fish, a piece of bacon, or something of that sort, around the shank and drop them into the water so weighted that there is a noticeable strain on the line as you pay it out. You keep on letting out the line until you feel the hooks strike bottom. Then you pull it back so that the hook will be suspended a foot or two feet from the bottom. This is said to be the best way to catch the Bear Lake trout, a fish numerous in the 15 to 20-pound weights, not very rare up to 35 pounds and said to attain top sizes of 50 or more pounds.

SPEARING FISH

At the foot of a waterfall there may be an opportunity nearly throughout the year for spearing fish, although the best opportunities are when there is a run, or an attempted run. Bloody Falls on the Coppermine is an instance. Eskimos will crouch around on rock ledges with fish forks that have handles which are short at 10 feet and may run to 20 feet or more. They hold the spear motionless, or nearly so, in the water, until a fish swims within reach, when they give a little push. These are two-pronged spears with a barb on either side.

In shoal water Eskimos use very short fishing spears with a handle only three or four feet long and usually with three prongs. You just wait around till you see a fish near you and jab at him.

FISH TRAPS

When fish are running up or down a stream, or when for any reason they are numerous, you can sometimes divert and catch them with fences where the water is shallow. Eskimos build these more or less like the caribou drives we have been describing, except the boulders have to be close together to form a wall. Sometimes a number of people beating the water will drive fish along one of these walls into a pound which usually is not of rocks but of sticks that have been driven into the river bottom. There are also indiscriminate ways of building what are practically mazes for the fish, consisting of any number of separate compartments—square, triangular or any other shape. When a lot of fish have been tangled in these mazes the Eskimos go wading around and spearing them, usually with the three-pointed spear.

SECTION IV

GAME LAWS

ALASKA AND CANADA

Each person who intends to hunt land animals, apart from emergencies of the trail, should be provided with a copy of the game and hunting laws and regulations published by the Alaska Game Commission, U. S. Department of Agriculture, and of the corresponding laws and regulations for Canada obtainable from the Department of Mines and Resources, Ottawa. There is no point in trying to summarize these laws and regulations, for they change from time to time.

GREENLAND

By Danish law, Greenland is a closed country, more so than Tibet. If you get there at all it will be either with permission to hunt or in such extreme emergency that you would take the law into your own hands.

Your application to visit Greenland, as a private person, should be transmitted by the State Department of the U. S. to the Danish Government through its representative at Copenhagen. The American Minister will make an attempt to secure your permit from the administration of Greenland (Grönlands Styrelse). He will have to make a case that you are not a tourist. It is theoretically impossible for a mere tourist to visit Greenland. However, the Greenland administration will accept most any "serious" plan. You are a musician and you want to study the music of the Eskimos. You are a painter and specialize in glaciers or mountain scenery. You are a botanist and desire first-hand experience with Greenland vegetation. In all such cases it is better to be able to show that you are connected with some organization, or at least that your findings and collections are to be used by a learned society or at least a public institution—your music will be studied by a specialist on primitive music at Yale; your botanical collections are going into the Gray Herbarium at Harvard, or something of the sort.

SVALBARD

Norwegians have not been so strict and formal about the Spitsbergen group and Bear Island as the Danes have been about Greenland. The basic reason for this is considered to be that the Danish regulations are intended in the main for quarantine—to protect Greenland Eskimos against white men's epidemic and other diseases. The population of the Svalbard Islands is wholly either Norwegian or Russian and therefore possessed of about the same immunities as the rest of us; so that our diseases are no more dangerous to them in Svalbard than they would be in Oslo or Moscow.

There is a permanently closed season on reindeer, which are native, and on musk oxen, which have been introduced and which are really domestic animals. There are no restrictions on sea game, including polar bear.

U. S. S. R.

Things are very special in the U. S. S. R.; but they have been appreciative of and readily helpful to travelers and explorers in peacetime. In 1940 scientists of the U. S. Government (Smithsonian Institution) and of American universities were welcomed and given every facility—consult, for instance, Dr. Ales Hrdlička of the National Museum, who has much recent experience of travel off the beaten tourist track in the U. S. S. R. Permits have to be secured in advance for private travelers, whether scientists or not. The arrangements would be made either through the Soviet Embassy in Washington or the American Embassy in Moscow.

SECTION V

CACHES, DEPOTS, AND BEACONS

On the polar sea, caches and depots of all sorts are out of the question unless for a very few days. To leave something behind on the pack during an outward journey and expect to pick it up on your return would be like detaching a dory on an eastward voyage across the Atlantic and expecting to pick it up coming back. Besides, there is no known emergency way of caching things to be safe from the first two of the three serious things which may occur—the floe may tip on edge and spill your belongings into the water; the floe may crumble and bury them under a mountain of broken ice; a polar bear may come along.

On landfast ice, one sort of depot may be bear-proof. You sink a pit into the thick shore ice, as if you were digging a grave so large that it would contain what you desire and still be filled only to within three or four feet of the surface. You now cover your belongings with something waterproof, perhaps the hides of animals. Then you shovel in a little snow and pour in some sea water. Before the mush has hardened you drop in chunks of ice so that they will freeze as in a matrix. Putting in more snow, more ice, more water, you obtain a conglomerate through which you can work easily with pickaxes when you want to open the cache but through which even a polar bear would find it difficult to penetrate.

More valuable than knowledge of how to cache things from polar bears is an understanding of what it is they recognize as food and will eat. Fresh seal is their staff of life. They can smell it from 10 to 12 miles to leeward and they will get at it in spite of practically anything. All decayed meats apparently smell alike to all carnivorous animals so that caribou, musk ox, or the meat of a fellow bear will be just as much like food as if it were seal. But in his whole experience the bear has never eaten bear and he has never eaten caribou. If these meats are fresh, the smell of them apparently means nothing in the way of food. Travelers have reported bears so hungry that they followed a sledge trail to pick up refuse but nevertheless walked a few yards to leeward of a depot of caribou meat and paid no attention to it.

Polar bears get to be very old and they travel far. There is, accordingly, no guarantee that an old and experienced bear may not have learned through some accident that caribou is food, so you cannot swear they would never touch that sort of depot. Certainly the rule is that they will not. But, remember, if there is even a slight decaying smell, caribou, like any other meat becomes food to their nostrils.

TRAPS ARE DANGEROUS

Against bears, as other animals, you can employ such devices as a loaded gun which shoots when a bait is pulled. This is so dangerous that it should be used only in extreme need. Even one of your own men, through forgetfulness or accident, might be the victim, let alone strange men or your own dogs. The same objection applies to the setting of very powerful steel traps. Anything strong enough to hold a bear is likely to break a man's leg if he steps into it, and will certainly ruin a dog.

With the grizzly bear you have about the same trouble as with the polar, since they, too, are powerful. However, they are largely vegetarian, are few even where they are found, and are absent from large portions of the Arctic territory. We need not discuss caches against grizzlies except as some which are developed in other connections may happen to be more or less effective against them, too.

Protection from wolves and foxes is easy. Pile up stones around a heap of meat and, if they are heavy, these beasts will not disturb. If the stones are small, you can fix them in a matrix of slushy snow. Logs piled over meat are similarly effective and so are box caches built log-cabin style.

But there is one animal hard to outwit or repel, the wolverine. He is clever in his depredations; he is mischievous as well, for he will carry off things that are of no possible use to him—such as watches or scientific instruments.

By the ancient Greek principle of natural history, that an animal has intelligence in proportion to the physical organs it possesses for dealing with the outside world, the wolverine ought to be intelligent. His paws, next after apes and their near relations, are most like human hands. His teeth are powerful. He is indefatigable, and he has either intelligence or a persistence which frequently amounts to the same thing. We give some examples:

Climb a tree and hang a bundle of meat from a limb by a rope. Any animal might bite this line if it were rawhide or if it smelt like food, as through being greasy. A wolverine will bite the line whatever it is and however it smells.

If you suspend by a wire which the wolverine cannot bite, he grasps the wire as if with arms and slides down it to the bundle. This author has never seen a wolverine actually doing that, but he has numerous testimonials that they do somehow arrive at the bundle and cling to it while they tear it to pieces, perhaps eating some of its contents there and the rest after they fall to the ground.

Through a cache of log cabin type, wolverines will eat their way no matter how big the logs. Apparently time means nothing to them. If they don't get through in a day of gnawing, they will get through in a week.

What seems to be the most ingenious of possible animal stories about cache rifling is vouched for by Stefansson through his own observation and that of his companions. A pit was made for caribou meat; on top of it were placed round stones, the biggest about the size of your head, and these were fixed in a matrix of ice derived from snow slush. The ground was hard as concrete so the beast could not burrow through it. It could not chew through the stones. What the wolverine did was to lie on the stones until the body heat melted one loose from its matrix, whereupon he rolled it out. He then gnawed away what ice he could, and lay down again to do some more melting. Finally, doubtless after several days, he got to the meat.

It has been suggested that this story shows no real intelligence—that what happened was merely that the beast knew where the meat was located, wanted to be as near as he could be, and so lay down on top of it. Every little while, moved by blind instinct, he would try to get nearer the meat.

At last he would find that a stone was loose which he then rolled away.

Some of the best arguments for the intelligence of a wolverine are not from his cache-breaking but from his direct stealing. The biggest of them, proportioned like skunks, will not run over 40 pounds. Stefansson had killed and butchered a caribou in such a way that most of its body was still in one piece. This was unwieldy, several times bigger than the wolverine as well as heavier, yet he carried it off as a man will drag a log through snow—lifting and carrying one end on his back, dragging the other.

A man on guard is the only real protection against the rifling of caches by wolverines. However, if you smoke-dry your meat, it has the advantage that you can leave it for a few days with tolerable safety (or you can cache anything else you like in the smoke house) for the smoke smell, while fresh, will keep beasts of prey at a distance. Eventually, of course (in about a fortnight) some wolverine will become contemptuous of the fire smell, which he at first dreaded, and venture into the deserted house.

DEPOTS

Hunters take advantage of frozen ground for temporary storage of meat. If you kill a caribou and leave the meat exposed to the sun it will be fly-blown in no time, for blue bottles are numerous even in islands well north of the continental limit of America. So when you butcher an animal you scoop out a hollow in the ground, protect the meat by skins under and over, and then cover with earth. These excavations are down to frost, which may be anything from a few inches in a swamp to say two feet on a sandy southward slope. The meat is safe from flies and decay is slowed.

Sometimes large depots require little or no protection from animals by the nature of what they contain. For instance, when Captain Kellett left 288 days' provisions for 66 men on the south shore of Melville Island, he deposited such things as flour in barrels, bread in casks, sugar and currants in kegs, chocolate in cartwheels resembling grindstones, quantities of woolen clothes, tools, etc. These supplies Stefansson found more than half a century later to be some of them in good condition and few if any of them disturbed by animals, though polar bears, wolves, and foxes must have visited the locality frequently.

Certain of the things most important to cache in the Arctic are by their nature perfectly safe, as, for instance, gasoline in large drums, ammunition in factory packing. Biscuits are safe from anything but mice, for they would not be recognized as food by the Arctic animals even when the packages are open.

The Stone Age Eskimos did not recognize such things as food either. For instance, those Victoria Islanders who found on Banks Island McClure's abandoned ship and the considerable stores of food, both on it and ashore, used none of the European edibles but did use the packing cases and other related materials, such as nails, hoops, and wires.

So far as the Eskimo people are concerned, depots in the Arctic are safer than they would be in most other countries. If it is known whose property they are and what they are intended for, they are likely to be respected unless there is a special enmity with the group involved. This respect for caches is a matter of honor and custom. In addition, it may happen that an Eskimo is afraid to touch a depot for reasons of taboo.

There are, however, no sure ways of instilling effective taboo dread by any sign which you can put on a cache or place near it. Most often an Eskimo taboo, if applied, will be the idea of some shaman or will be connected with a folklore story which is current locally (as gospel). In a few places special things might work; as, for instance, putting a human skull on top of the depot. You would have to know your locality before trying this dodge, or take a chance on it. For there is diametric variance among uncivilized Eskimos as to their attitude toward human remains. In some districts anybody would be frightened by a skull, or would have a taboo feeling, while in another place a man equally free from European influence might pick up the skull and hand it to his children to play with.

BEACONS

Where records are being deposited, the best way is that which has been commonest in polar exploration, to erect, out of things of no value to the Eskimos, a beacon which will be seen from a distance. Then at a prearranged distance and direction from this, and in a prearranged manner, you bury or otherwise hide the record. You will have to be pretty ingenious about hiding traces of your burial, but that would be accomplished exactly as if you were hiding something from European inquisitiveness.

It is probably not true anywhere of the Eskimos of Canada or Alaska, but in the U. S. S. R. the icebreaker *Sibiriakov* found on her 1932 voyage that identification marks on the Chukchi shore had been destroyed by the Chukchis because they believe such marks scare away seals.

PRESERVATION OF RECORDS

How to preserve a record for years or centuries is everywhere a problem, but not quite so much in the Arctic as elsewhere. For instance, Stefansson found in an open cylinder which had been filled with wet sand for more than half a century, thawing every summer and freezing every winter, the record of McClure's discovery of the Northwest Passage. It was written on ordinary paper and still legible except in a few spots that had "rotted" away.

In old records that have been recovered in the North, the preservation of pencil writing has usually been better than that of ink. In some records where both were used, nearly all the pencilling was legible, nearly all the pen writing undecipherable.

The early explorers usually put records into whatever they happened to have with them, though some carried special contrivances. Since rust is slow in the Arctic, an ordinary water-tight tin can, such as those which hold casein or malted milk, is likely to keep a record safe for a quarter or half century. Within their natural limits bottles are excellent, or glass jars with screw tops. A brass shotgun shell, corked, would be good (except that this Manual counsels against shotguns being carried at all on long and difficult journeys).

CHAPTER 14

MECHANIZED TRANSPORT

SECTION I

DIRIGIBLES

This chapter on the use of dirigibles, airplanes and motorized land vehicles does not aim to be a complete discussion of the problems but merely an application to them of certain geographic, oceanographic, and meteorological peculiarities of the Arctic. We are discussing the application of certain elements of polarcraft to mechanized transport.

The voyages of the *Norge, Italia,* and *Graf Zeppelin* brought no surprises except that there is still a mystery, and seemingly always will be, as to why the *Italia* crashed.

As brought out in our discussion of climate, the weather is on the average stable and the winds on the average not strong when you get into the Arctic basin away from the shores of the polar sea. The only condition seriously hostile is the formation of ice upon the envelope and other parts of the craft. This may be less serious with a dirigible than an airplane when the cause is of the nature of spicule fog (discussed in Chapter 3, Section V). It is quite as serious as with planes when the cause is damp snow or sleet.

We summarize what is developed in our climate discussion about the seasonal distribution of Arctic fogs and sleet:

FOG

Except near the margins of the pack, fogs that might form ice are practically absent during four months, December to March, inclusive. They are rare in November and April;

well within the pack they are rare also in May. In May near the edges of the pack, and anywhere in the polar basin during June, July, and August, fogs are bad. Near the center of the pack September becomes a clear month; but fogs are prevalent through October out by the margins of the ice and along the continental Arctic shore.

SLEET

The seasons for sleet and snow soft enough to cling are similar to but not identical with those of the fogs.

The records of polar expeditions show that there is no winter month anywhere in the Arctic, except perhaps on the Greenland ice cap, when a sleet storm may not strike. However, it is not likely to happen in any one year that sleet occurs near the center of the Arctic pack during the four-month space December–March; nor is sleet likely even towards the margins of the pack in November or April. The month of May will have little soft snow near the center of the pack but may have it occasionally near the margins. June, July, and August are the sleet months. However, it is not probable that even on the Arctic fringes, except perhaps where the Gulf Stream waters intrude to the north and northeast of the Atlantic, that sleet would be as bad during the worst four months as it is during the worst four over the Newfoundland Banks.

One difficulty with icing peculiar to the dirigible is that when it forms on struts and wires, and continues forming, there will come a time when it begins to break off in chunks. Some of these will get into the slip stream and hit the propeller, which bats them so they fly almost like bullets, some of them striking the envelope. This came near being serious with the *Norge*. Once appreciated, the difficulty can be avoided, as by a suitable placing of wire netting. (This statement, derived chiefly from the experience of the *Norge*, is not so applicable to later dirigibles which avoid exposed struts and wires.)

As with airplanes, dirigibles have found in the Arctic that they can usually control the formation of ice by rising and dropping to levels of different temperatures.

We mentioned under climate the average lowness of Arctic fogs, pointing out as a commonplace of the Yankee whaling fleet to the north of Alaska in summer that when the men on the decks could see no indication of neighboring ships the captains at the mastheads could see each other clearly, the blanket of fog being then a hundred feet or less in thickness.

There are not over the polar sea, although there may be over polar lands, those sudden down drafts that are so risky for a dirigible flying low in rugged or mountainous country.

CASE HISTORY OF ITALIA

A case history may bring out certain things about northern aviation clearly and with more force than possible in an abstract statement. We use that of the *Italia*.

Umberto Nobile had built the airship with which Amundsen and Ellsworth crossed the Arctic in 1926, and had been its navigator. In 1928 he was in the Arctic again, with the dirigible *Italia*, operating from a hangar at King's Bay, Spitsbergen. He had already made a good exploratory voyage to the east when, on May 24, he flew from Spitsbergen westerly to the northeast corner of Greenland, crossing an unexplored part of the sea. Then he continued from Greenland to the North Pole by a route unexplored because it was far more easterly than the Peary journeys.

From the Pole, Nobile was returning to Spitsbergen, and was a little to the northeast of that island group, when, on May 25, he was overtaken by a cataclysm that has many explanations, each conflicting with one or more of the others, and none conclusive. All we can state beyond argument is that suddenly the airship was found to be dropping rapidly.

It seems that by a quick change of rudders, or in some other way, Nobile had tilted the ship upward before she struck the ice, so that her tail dragged. Two of the three gondolas were torn away. Ten men, with goods and wreckage, were dumped on the ice. Freed of their weight and that of the gondolas and cargo, the dirigible rose swiftly and drifted off before the wind. Men who had not been stunned by the shock got to their feet and watched it soar away.

They are in reasonable agreement that when the *Italia* was something like 5 miles off she exploded. The six men aboard her in the forward gondola must have been lost.

One of the marooned men, Pomella, was killed as the gondola was being torn loose from the airship; two had broken hips and legs, Nobile and Cecioni; Malmgren suffered a fractured shoulder and, as it proved later, his kidneys had been torn loose so that he eventually died from this cause.

RELIANCE UPON RADIO

If there had been no radio, the Nobile party would have started moving toward shore. Such a 20- or 30-mile walk would have been a mere commonplace in the history of exploration—in fact, several exploring parties have walked ashore on this and near-by groups of islands during the last few centuries, some of them covering several hundred miles. Even with the cripples, the Nobile party could have double-tripped ashore, probably in a week or two.

RADIO SUCCEEDS IN 9 DAYS

But, since they had a radio, Nobile was correct in staying where he was. It took them some days to get the radio in proper working order and it was not until after 9 days (June 3) that an operator in Archangel got and properly interpreted their signals. Days more elapsed before, on June 7, they were in contact with their base ship, the *Città di Milano.* Ten days later they saw the first two planes, Norwegian, piloted by Riiser-Larsen and Lützow Holm, which turned back because of engine trouble shortly before reaching the party. In succeeding days an Italian plane circled near them, and the Norwegians twice approached and then disappeared from view, each time without sighting the Nobile camp.

Finally, on June 20, an Italian plane, working from the base ship, sighted the party, but did not land. It dropped equipment, much of which was broken in the fall. Two days later Italian planes dropped provisions and further supplies. June 22 two Swedish planes flew over, dropping provisions and a note with instructions for marking out a landing place on the ice.

The next day, June 23, almost a month after the disaster, Lieutenant Einar Paal Lundborg descended with his Swedish plane on the pack about 500 feet from the camp. Hopping from cake to cake, he and his mechanic arrived at the camp to find Nobile demanding, in the best grand-opera tradition, that all others should be saved first and he himself be removed last. Lundborg replied (personal communication to Stefansson; see also his book narrative) that this was no grand opera; that he was in command, and that the rescue would be conducted as seemed best to him and his associates.

Nobile was skin and bones from worry, and he is small-boned to begin with. Cecioni, the other cripple, was always large and had put on an extra 50 pounds lying there in the tent, eating much and worrying little since the accident. Lundborg, glancing at the two men, decided that the plane could not carry Cecioni in addition to himself and his mechanic, but that it would carry Nobile. So, taking Nobile under one arm, he and the mechanic hopped from cake to cake again, returned to the plane and flew to the Swedish base on Foyne Island. A few hours later another Swedish plane delivered Nobile to the Città di Milano.

LAST OF MEN RESCUED IN 49 DAYS

Meantime, leaving the mechanic behind at the Swedish base so as to be able to carry the big and fat Cecioni, Lundborg returned alone. Engine failure compelled him to glide for a landing. He fell short by a yard or two, so that his skis, instead of planting themselves on the floe, stubbed their toes against the edge of it and the plane turned on its back, without, however, injuring the pilot. So the fat man had to remain to get still fatter until the Soviet steamer *Krassin* arrived to pick up the entire party of seven on July 12, a month and a half after their descent. (Lundborg had been taken off the floe a few days earlier by a small Swedish plane.)

This case history of Nobile has brought out things both applicable to dirigibles and airplanes. We mention some points not touched upon that concern the dirigible.

One of the difficulties of dirigible operation in tropics or temperate zone is that its gas tends to expand in the daytime when the sun shines and then to contract at night, giving unequal carrying power and tending to the waste of gas. During summer there are in the Arctic long periods of continuous sunshine so that, if you are able to keep above the usually low fog, you have a uniformity of gas buoyancy for weeks and even months at a time—since for weeks near the margin of the polar area and for months near its center the sun is constantly above the horizon. There are similar reciprocal periods of uniform buoyancy in winter due to the absence of the sun.

THUNDERSTORMS RARE

If it be true that the *Hindenburg* and similar disasters resulted from accumulation of electricity under a thunderstorm condition, then in this respect the Arctic is one of the safest of flying regions. There are thunderstorms in the Arctic, but they are extremely rare and probably occur chiefly on its margins. (It seems, by the way, that lightning in the Arctic, and in some other northerly lands, is more likely to occur in winter than in summer. In Iceland, for instance, it is recognized that the severest thunderstorms come in winter.)

SUMMARY

Generally speaking, then, the dirigible is well adapted to Arctic work. Its safest time begins for the main area of the pack in September and ends in May. For the margin of the pack it begins in October and ends in April. For half the year conditions are about the best in the world; for no month of the year are they worse than the worst month on the Newfoundland Banks.

SECTION II

AIRPLANES

Before considering the more specific points we take up the comparative safeties of airplane operation over liquid and ice-clad seas. We turn first to how they compare for safety in forced landing:

Most early flyers who came down on liquid seas far from land and beyond sight of a vessel were lost. All were lost who made forced descents beyond sight of rescuers in a gale.

Before 1937 there had been perhaps a dozen forced landings on the frozen sea. Some were in good weather, some in falling snow, some in blizzards, and one in a combination of gale and the darkness of night. All these had been safe descents—no lives had been lost and there had been only minor injuries to planes. The flyers were always saved in one of three ways: they made repairs and flew again; they were rescued, by plane or ship; or they abandoned their plane and walked ashore.

Take specifically for the North Atlantic the entire period from its first crossing by the United States Navy airplanes in 1919 to the beginning of survey flights by Pan American Airways and Imperial Airways in 1937. During this period at least 19 ocean descents were made in all weathers from calm to gale. Nine planes were lost. The people saved were mostly those who had specially good luck, as coming down in fairly good weather either within sight of a ship or after being able to communicate to a nearby ship through radio the approximate position where they were about to descend.

During the same period more than 90,000 miles were flown over the polar sea. There were at least 56 voluntary and forced descents in all weather from calm to gale (not all Soviet figures are available). No lives were lost from any of these descents.

The safety of the polar sea, as compared with the deadliness of the North Atlantic, is the result of frost. If water is liquid, the best you can hope for is to swim awhile before sinking. When water is solid you behave upon it as if it were land. You are warmer on the ice at —50° than you are in the water at 50°, for water gets to your skin but cold air is held at bay by your clothing. In a 50-mile storm on a liquid sea the waves break over your plane and toss it about until it sinks. In a 50-mile wind on the pack ice you can lash down your plane as if it were on land. Then you can construct a windbreak of snow blocks and tent behind it. You can build a dwelling of snow in which, by Eskimo technique, you can have a warmth of 50° when the thermometer outside reads —50°. If your airplane is beyond repair your radio may not be, and you have time and comfort for getting it into shape.

We can focus the broad contrasts between liquid and frozen seas best with case histories. We need not describe those of the liquid oceans, for they are so clearly in mind; all we need to do is refer to them. There was, for instance, the loss of Charles Kingsford-Smith, Australian, in 1935, and of Amelia Earhart, American, in 1937—these are remembered not merely in themselves but as typical of what so often happens with tropical or temperate zone ocean descents, whether in stormy weather as with Kingsford-Smith, or in good weather as with Miss Earhart. Our need is for the case histories of those who have descended on frozen seas.

FROZEN SEA CASES

The first land plane descent upon sea ice far from shore was made with a ski plane on March 29, 1927, by Hubert Wilkins and Ben Eielson. They took off from Point Barrow, Alaska, with the thermometer around −40°. They planned to fly northwestward for about 6 hours, to the vicinity of latitude 80° north, longitude 180° west, where they would descend and take soundings. They would then fly south for 2 or 3 hours, and thence return to Barrow on a southeasterly course.

A hundred miles from shore the plane was already beyond the previously known region, for they had crossed the track of the *Karluk*, a ship with which Wilkins had once been connected temporarily. They continued for 400 miles beyond the *Karluk* exploration, when they had engine trouble, which necessitated not only a forced descent but also the first ski or wheel descent ever attempted on the pack far from shore.

Wilkins selected a landing spot he thought favorable, depending, as he has said, on the experience he had gained when traveling over pack ice afoot during the years 1913–16 when he was a member of the Canadian Arctic Expedition of 1913–18. Eielson, schooled by North Dakotan and Alaskan winters, brought the plane down to a perfect landing. This was in clear and nearly calm weather 500 miles from shore. A sounding, which Wilkins took while Eielson was repairing the engine, gave more than 16,000 feet, so that they were above the deepest place yet found in the polar sea. During the repairs, the sky had clouded over and snow was beginning to fall.

After a take-off from pack that was made difficult by the softness and depth of new-fallen snow, they flew eastward a little way, had engine trouble again, and made their second descent in a snowstorm. They were still approximately 500 miles from land.

Upon the second take-off the plane headed back toward Alaska and fought this wind through the afternoon. Planes were not so fast in 1927 as they are now, and speed was cut to something like 50 or 60 miles. They continued through the daylight of the late afternoon. In this latitude at this time of year, and with clouds in the sky, it is practically dark at seven o'clock. At nine o'clock, flying a mile high, the plane's engine stopped for the third time, now for want of gas.

The only thing to do was to keep straight against the wind and to bring the plane down as gradually as possible.

Here was a test of a theory in practice. During a previous expedition Wilkins had arrived at the belief that you seldom have to go more than 5 miles, and probably never more than 25, on the northern sea in winter before you find a patch of ice level enough and large enough for an airplane descent and take-off. These patches, then, are scattered; certainly 80 percent of the ice is too rough for a plane, perhaps 95 percent. Even in the coldest weather there is open water here and there; for the ice is continually breaking under the stress of the currents. The chances were, then, at least 10 to 1 that in the darkness and blinding storm the plane would be injured; perhaps 1 chance in 20 that it would come down in open water. What happened, however, was that it descended on a fairly level patch. There was not even a severe jolt. Only the fabric of one wing was slightly injured, torn by a snag of ice. This last, however, was immaterial; for the plane, lacking gas, would have to be abandoned. (There were not in 1927 such facilities as now for rescue operations from the shores of the polar sea.)

In the blizzard and darkness, Wilkins and Eielson, able to get only a limited idea of where they were and how situated, went to sleep in the cabin of the plane and had a fairly good night. Morning found them drifting on a floe some square miles in area, surrounded by leads and patches of open water. The weather was still cloudy and there was not much frost, so that new ice did not form rapidly upon the open water and the floes were comparatively free to move in a drift which appeared to be southeastward, parallel to the north coast of Alaska. An astronomical observation later showed that they were about 75 miles northwest of Point Barrow.

In 7 days the floe, with the camp on it, drifted about 200 miles in an easterly direction. Then the skies cleared and the weather became cold so that new ice formed, binding the floes together. Wilkins and Eielson now took their bedding, camp gear, rifles and ammunition on their backs and started walking toward shore. They averaged 10 miles a day and made it in 10 days.

In the Wilkins story everything went according to plan—they had counted on the possibility of forced landing, on perhaps having to leave their plane, and they had figured the chance that they might have to walk as much as 500 miles to shore. Since it is not possible for men to carry on their backs food enough for that much of a walk over drifting ice, Wilkins had provisions only for about 20 days—in other words, emergency rations. The main plan for subsistence was through hunting equipment which would provide food and fuel in the manner to which Wilkins had become accustomed between 1913 and 1916 on the third Stefansson expedition.

An even more striking contrast between safeties of liquid and ice-clad seas we have from two forced descents where one man was the central character of both. For Roald Amundsen had two forced landings, the first on the pack to the north of the Franz Josef Islands, the second in the never-frozen Gulf Stream (warm North Atlantic drift) just north of Norway.

CASE OF AMUNDSEN

Amundsen and Ellsworth, with four companions, flew north in two airplanes, pontoon-equipped. They started from Spitsbergen May 21, 1925, and were within 100 miles of the North Pole when engine trouble forced both planes down within 3 miles of each other. Pontoons can in an emergency serve as skis upon snow or upon level earth, but the Amundsen planes found open water and descended into leads. These leads soon closed through ice movement, but the party saved one of the planes from being crushed between the floes by hauling it up on the ice.

PONTOON TAKE-OFF FROM ICE

The ice surface was rough, as it usually is in the vicinity of leads, and the men had to work for days to smooth out a runway—a particularly difficult task because they had not brought along tools suitable for this work. With makeshift gear they did level off a runway. One plane was able to carry the men of both, and, using the pontoons for skis, they took off on June 15, flying back to Spitsbergen.

We have discussed the Nobile predicament of 1928. Amundsen was one of those who wanted to come to his help. As a passenger in a French seaplane piloted by a French naval officer, Captain Guilbaud, Amundsen flew from Tromsö, Norway, June 18th, bound for King's Bay, Spitsbergen. There was also a French crew of three and Dietrichson, a Norwegian who had piloted one of Amundsen's planes during the 1925 work. The weather was neither calm nor stormy but halfway between.

The world listened to the plane's radio. When the signals stopped, we knew there had been a forced landing. Ships began to cruise back and forth over the vicinity where the party must have descended but only wreckage of the plane was found—eventually.

Because Amundsen perished several hundred miles north of the Arctic Circle, it was repeated through the press frequently and with variations that he, the great conqueror of the Arctic, had finally been conquered by the Arctic; that the temporary master of the ice and snow had been mastered permanently by these inexorable forces. But not during thousands of years, probably not since the last Scandinavian Ice Age, has there been a floe or any piece of ice in the waters where Amundsen was lost.

Amundsen's descent was several hundred miles short of that ice pack which, at the very moment of his death, was keeping safe Nobile and the rest of the men whom the famous Norwegian explorer meant to help.

The contrast between a frozen and a liquid sea is basic. The pack gives you the amenities of land. You do not sink because ice is firm; you do not thirst, for sea ice is fresh if it is more than 9 months old and there is fresh snow on much of it in any case (or fresh rain and thaw water in summer); your clothes keep you warm and dry, for they have been designed to repel air and rain; there are no waves and spray, for the hard surface is not stirred by the wind.

It is of course ideal that a pilot should have both a theoretical and practical knowledge of the various kinds of Arctic ice described in this Manual before coming down upon any of them for the first time. However, he can take courage from remembering what we have said elsewhere, that on the first 50 descents made upon the northern pack no life was lost and no pilot suffered serious injury; and surely at least a third of these landings must have been the first upon sea ice for the pilot concerned.

COMMON SENSE WAY TO JUDGE ICE

Common sense does the trick. No matter how inexperienced you are you can tell water from ice. With an almost elementary knowledge you realize that the youngest ice looks darkest, almost as dark as water, in comparison with the whiteness of the snow and of the level and strong this year's ice; and that if it looks green, blue, or anything darker than a rather light grey, you must not come down upon it if you can possibly help yourself. You will see, like rivers turned boulevards, the winding and forking ramifications of the leads, most of which were as level as a floor when the ice was formed and some of which are still practically that level even when the ice has become many times stronger than required for the biggest airplane that is coming down for a proper landing.

JUDGING ICE SAFETY FROM AIR

Previous weather must always be taken into consideration in judging landing conditions from the air. However, color is, as we have said, the main thing. Not only is black ice (blue or green under certain light conditions and angles) unsafe, but so are the various shades of grey—the safer the lighter the grey. If it has not been snowing since the pressure that broke the ice and produced the lead upon which you want to land, then the lead may be strong enough though greyish in color.

Here we should keep in mind what was said about young ice in Chapter 11, Section III, particularly the discussion of comparative strength at different temperatures. We said there that 8-inch ice with an air temperature of −40° might be as strong as 10-inch ice at 20°. That was probably an understatement, if we think of both the 8-inch ice and the 10-inch ice subject to a blow, as if a man were to jump on it from a height; likely, the 10-inch ice at 20° would give way more easily than the 8-inch ice at −40°.

Another thing the flyer must keep in mind about ice of the 8- to 14-inch range of thickness is what we said in Chapter 2, Section III, about slush. The essence of it is, from the point of view of judging ice strength, that even with no snow blanketing its surface a thaw is taking place at an air chill of 20°; for that temperature is not low enough for freezing brine of such concentration as you get on top of young ice through the elimination of (shoving upward of) salt that was farther down. The slush formation will produce a darkening of the ice, so that a true appreciation of the color of the surface really gives a better indication of the strength than you would receive from a thickness measurement.

An important thing to remember about salt water ice, in comparing it with experience you may have had with fresh ice, is that salt ice bends more readily than fresh. If on a lake your plane gradually comes to a half and finally stops, without any sign thus far that the ice is going to break, you are all right permanently, but you are not necessarily all right at sea. If there is any doubt, keep your engine turning and lean out, or somehow manage to see the ice around your skis. If you notice it beginning to change color, becoming a little darker, and, of course, if you see that a saucer hollow is gradually forming either around each ski or around the plane as a whole, then you better start moving. You need not necessarily take off, for you have already found that the ice is strong enough to support your plane while in motion. Taxi to an ice area that for one reason or another looks to you safer, and try again standing still.

We describe later a risky but sometimes advisable experiment, flying along ice and letting your skis touch it occasionally, an observer watching the marks both to see how black they are immediately and also to detect a gradual later darkening, during the next second or two. A part of the observer's background for interpreting these signs is that there are two things, or if you like three, that are involved in the darkening. It may be that your ski bent the ice and that the darkening noticed is produced by a seepage of sea water from below. Or it may be that you have merely pressed down into a slush on top of the ice a white covering which has one or two origins: It may be a very thin layer of hoarfrost produced by a condensation of that fog from young ice which we discussed under the head of "water smoke" in Chapter 3, Section V; or it may be that you have pressed down into slush a snow covering.

If the edges of the heavy ice bordering the lead are rounded off (filled in) with old snowdrifts, then the lead should be considered safe. You may happen to know how long ago it was the wind blew that made these drifts, and how cold it has been in the interval, which knowledge is most important if there is only one direction of drift. If you see that drifts are in two or more directions, you have additional evidence that the ice is not so very new—it has been there through as many different strong blows as there are different directions of drifts.

Whether the strength of comparatively thin ice is going to be sufficient depends, of course, on other factors besides its own strength, among them the weight of your plane, the length and width of your skis, and the angle and speed at which the skis hit the ice.

You may be down on a lead that is surrounded by comparatively thin older ice (for instance, you are on 10-inch lead ice with 4-foot ice forming either shore). In that case the difference in level between the lead and the older ice is so small that you can without difficulty taxi up on the old ice and rest there till the lead is safe, knowing pretty well that ice which bends only slightly under your weight now will be strong enough not to bend at all a few hours hence. Or if there has been a wind since the lead froze over, there are drifts from the old ice out upon the new, and you can perhaps use one of them in taxiing off the lead for safety—if the difference in level between the lead and its shore is too much for your skis to take otherwise.

Again assuming that your lead ice is bending only slightly under your plane, there is the third possibility, that a man who is with you in the plane can jump out with a miner's pickax and go along to some place where, with a few dozen blows, he is able to slope off the edge of the old ice so that you can climb onto it from the new.

If you are planning to stop so long that your engine will cool off it is well not to have your plane standing on a lead even though the ice may be 2 or 3 feet thick and a hundred times the necessary strength for your plane. For you can never tell anywhere in the Arctic (although the danger is greater the nearer you are to land) when ice pressure may start. Under stress at the right angle and of the required power any ice will crack, even that which has been brought to a thickness of more than a hundred feet by crushing, overlapping and freezing. Still, the chances of breakage are greatest with the thinnest ice. So if you are going to spend the night, or longer, you had better move your plane to the heaviest ice you can practicably reach by taxiing from the lead.

So far as ice breakage is concerned, there is no need for a man to stand watch over a plane while the others sleep, if they make camp on the ice and sleep with their ears close to the ice or snow. For even if your ear is separated from the floor of your camp by 2 or 3 thicknesses of caribou skins and then by something you are using for a pillow—even so you will hear through the ice the sound of ice breaking though it be miles off. However, if the men sleep in the cabin of the plane it may be necessary to stand watch; for apparently there is no testimony available as to whether the sound of breaking ice is transmitted through the structure of the machine to the interior of the cabin—probably it is not. Or at least it would probably not be loud enough there to wake an ordinary sleeper.

However, we must qualify this by what is said in our Chapter 7 on the difference between snow-house camps and tent camps. In a tent you hear the noise of breaking ice only when there is no wind, for a flapping of the canvas or other fabric may drown out the noise; in a snow house you hear the noise of breaking ice equally far whether there is a gale or a calm. Indeed, men inside of a snow house will hear noises transmitted through the ice that would not be heard by a sentry standing guard outside.

PROCEDURE WHEN ICE IS BREAKING

Upon finding out that ice is breaking not many miles away, you prepare for taxiing rather than for a take-off—unless, indeed, you have served the purpose of your stop and are ready to travel. While you warm up the engine you station men on hummocks, perhaps with field glasses, looking for signs as to where the ice is breaking. This can perhaps be seen by the gradual elevation of a snag of ice against the horizon. For it is likely to happen, especially near the start of a crush, that individual flat cakes of some dimension are gradually tilted, one edge down in the water and the other up in the air. Sometimes you see them rising 10, 20 or more feet before they topple over, broken either by their own weight or by a thrust.

Possibly at the start, but more likely after half an hour or so of pressure, you see ridges building up here and there. It was Stefansson's practice with dog sledges, and the like could be done with airplanes, to get everything ready for the start and to move, if there is pressure all around you, into the center of the floe that you are on.

With dogs you might wait till the level piece around you is but a few square acres before you begin trying to cross a ridge and escape, as described in Chapter 11, Section III. With an airplane you would noturally want to take off while your runway is long enough. It may, then, be the safest—when you are good and ready and are convinced that your neighborhood is really in for a bad pressure—to take the air and circle around for a while till you have determined upon an area that is not being crushed; whereupon you would land again and make a second camp.

A description of ice crushing may over-impress a reader; those used to it do not ordinarily get excited by it, nor worry much. It will not be, whether with dogs or airplanes, nearly as dangerous as a lot of other situations to which you are so used that they do not worry you.

The circumstances under which pressure is dangerous is that of darkness or really thick weather. There are no rules; you have to rely upon your own judgment or upon a hunch, which is perhaps the same thing. It may be that if you remain still the pressure will cease before anything happens in your immediate neighborhood. On the other hand your neighborhood may break up, and then a take-off is no longer possible. However, the crushing that destroys or immobilizes your plane is probably not otherwise dangerous to the men. If your plane radio is still functioning you can send an SOS; if not, you take your portable radio equipment to a place of safety and send out messages at leisure.

It is possible that ice may not only crush but also bury a plane; for slabs that resemble brick walls three or four stories high may tumble upon it. Much more likely, however, your damaged plane will still serve a number of purposes, such as use of radio or employment as living quarters. Likely, too, there will be ample time for dismembering it and taking away anything you need if you have to retreat.

CASE HISTORIES OF CRUSHED PLANES

Of all the scores of planes that have stood for longer or shorter periods on the Arctic ice none, so far as we know, have yet been crushed in the manner described. The nearest thing was that during one of the Ellsworth-Wilkins Antarctic expeditions a machine was standing on level ice when a crack opened so as to let down one ski, the ice thereupon closing and pinching the ski and its fastenings enough so that the plane had to be brought out for repairs. This was a winter type of situation. A like thing happened in summer during the Levanevsky search when a pontoon craft belonging to the Soviet Government came down alongside an ice breaker in the sea to the north of Alaska. Some time later drift ice closed in and broke up the plane before it was possible to hoist it aboard the ship.

TESTING WEAK ICE

Under a number of conditions, among them rescue operations, it may be necessary for you to descend in a given locality where the indications for a safe descent are few. There may be, for instance, a lead with ice of such color that you feel pretty sure it is not safe. A skillful flyer can make a preliminary test that is valuable if he has with him an observer who is a sound judge of conditions. The operation we are about to describe is so risky that it should be attempted only with a powerful motive and good visibility conditions, as well as the skillful pilot and competent observer.

You come down with the machine in full control, touch the ice lightly with your skis and rise again. Your observer watches the color of the marks that are made on the ice. If the ice is too weak they will not only be dark at first but they will continue darkening for a few moments. This is a darkening possibility of snow that was on the lead; if not proper snow it is a darkening of snow-like rime that has accumulated on the surface of the young ice through its "sweating"—the condition we described when discussing water smoke in Chapter 3.

The hypothetical situation of desire to land within a small radius of a given spot may occur where there is not merely an absence of all good types of landing places which you would ordinarily use but also not even a dangerous looking lead. That situation fortunately is not likely to be found in winter except in a region of paleocrystic ice. The description of this ice in Chapter 2, Section III, and elsewhere, will indicate that it is not desirable for ski landings, and even worse for wheels. Superficially the unevenness may not be greater than that of the snowdrifts among which Canadians land in their winter prairie flying. But the situation is nevertheless worse, for the snow is likely to be soft in the hollows between the rounded hummocks of glare ice. However it is the opinion of Wilkins, the only really expert flyer who has as yet traveled on foot extensively over the Arctic pack, that where there is a large field of paleocrystic ice you can almost always find a level area of considerable size which was a fresh water lake the previous summer and upon which you descend and accomplish such a slowing up of your speed that by the time you have slid across the level patch into the hummocky district the jars need not be enough to break or upset your machine.

A serious difficulty with this type of paleocrystic ice landing is in taking off. Almost certainly you could not make it. However, it is likely that you could taxi from where you came down to some old lead or other level field and take off there. The taxiing may of course require stopping occasionally and getting out with pickaxes to cut away snags of ice; for even among the heavy paleocrystic floes breakage and crushing take place, particularly in summer. You may find 20 successive miles of this kind of ice without snags; but it is not likely you can leave your paleocrystic field for a level one adjoining without crossing either a low pressure ridge or an area that has snags sticking up here and there.

ESTABLISHING A LARGE "PERMANENT" CAMP WITH FREIGHTING PLANES

A situation the opposite of a rescue, which demands your coming down right by, is one that requires you to scout a broad region to find a good spot where it is intended that a number of planes shall come down later; as for instance, to establish a scientific base camp on drifting floes. Such a camp was established at 90° North by the Administration of the Northern Sea Route when they delivered to that locality a Soviet scientific expedition with its four members and 10 tons of supplies. But while the case we have in mind is like theirs we cannot use their actual procedure for a guide; rather we would do what they planned to do but did not. They sent one or more observers who did visit the immediate North Pole vicinity but who had such bad luck with the weather that no observations of value could be made. These weather difficulties were due to the lateness of the season. It was already May, and the 4- or 5-month season of practically no fogs comes to an end during April. As May advanced the weather was constantly getting thicker and foggier so that delay was not permissible.

What the Northern Sea Route planes did, therefor, was to arrive in a group of four the third week of May. A pilot, considered to be their best judge of sea conditions as viewed from the air, circled a likely spot two or three times and then came down. The others stayed aloft. The crew of the first plane scampered around the neighborhood, picked out the best landing field and made their customery T-symbol to indicate the direction of wind and the one in which the other three planes were to land.

BEST SEASON TO ESTABLISH CAMP IS MARCH

If parties are to be landed on sea ice, and if you can choose your time for doing it, then the preferred month is March. Your scouting party should arrive at the desired locality either early in the morning or later than midafternoon; for although the Arctic sun is never high still it is higher at noon (except right at the North Pole) than at other times and consequently the shadows will not be so conspicuous and clear. Probably you should travel at first at 3,000 or 3,500 feet until you have picked out two or three likely spots. You will give each of these a more thorough examination by flying around them at an elevation of 200 or 300 feet.

ANCHORING PLANES IN SNOW

Since men can camp anywhere, with a few exceptions as outlined elsewhere in this Manual, the first consideration of a survey party landing away from a base is for the plane. The camp site should be selected in the relation of obstructions in the terrain to the prevailing wind—you want a lee for your plane though you do not want a lee for your camp otherwise. The direction of the prevailing winds, or at least that of the last strong wind, can be determined from aloft by the furrows in the snow (sastrugi) which are parallel with the direction of the wind, with the wider and more rounded ends to leeward.

If your camp site looks as good to you after you have landed as it did from aloft, you next choose a place where it is possible to dig a trench into which the plane can be taxied and secured, facing into the prevailing wind. (See below for exception to facing the plane into the wind.) Secure the plane by digging the trench wide enough for the skis, and about 2 or 3 feet deep, according to the size of the plane. It will stay with tail high and wings nearly parallel with the ground. For a low-wing monoplane a snow wall could be built around wings and fuselage, thereby preventing the wind from getting any lifting hold under the plane. Deadmen should be put in front and under each wing tip, buried about 3 feet deep, and snow packed hard on top. If these don't break loose the first half hour while the snow is setting, they will not come out later; for, as we explained in relation to snow house building, snow, after being packed in, sets and hardens in a way that reminds one of concrete (of course a soft concrete).

When it is necessary to tie down an airplane for short periods on ice a satisfactory method is to dig two holes in the ice at locations near the end of each wing, connecting the two holes under the ice by means of a tunnel. A line is then tied to one wing, passed down through the tunnel and made fast to the end of the other wing.

When an airplane is left in the open where it may be subject to high winds, it is important to tie the controls so that the flippers and rudder will not lash back and forth. There are wooden gadgets made on the order of a clamp which can be fastened on to the flippers and the rudder to prevent movement in highest winds.

In connection with making a plane fast it has been learned that a plane faced into a strong wind will be harder to keep fast than one which is broadside to the wind. A 60-mile wind blowing against the plane when it is facing the wind causes tremendous lift, as the wing design intended. Apparently this is an important rule to keep in mind whenever the trench and wind-break method, described above, is not employed. However, winds over 50 m. p. h. seldom if ever blow on the Arctic pack if you are more than 50 miles from land, at least in winter—or so have testified De Long, Nansen, and Stefansson, among others. Gales of 60 m. p. h. therefore occur only on or near land in the Arctic—but possibly farther within the pack north of Iceland and north of western Europe where the warm currents from the Gulf Stream may create a special condition.

A difficulty in operating with skis is that the skis "freeze" to the ice or snow if the plane is left standing for any length of time. If timber is available, it is a good thing to put one small log in front of each ski and then taxi the plane up on the logs, thus preventing the skis from sticking to the snow or ice.

The preceding is, of course, a rule for all ski landings on snow anywhere. That a ski "freezes" to the snow is a special application of a general principle we have mentioned several times. But perhaps we had better make it doubly clear in this connection.

When snow falls gently upon the ground and remains there, it settles or subsides gradually, being perhaps eventually subject to the transformation into granular snow, a form we discuss under several relations; but never does snow that lies undisturbed where it fell undergo the process spoken of as resembling the hardening of concrete.

When snow is pounded into drifts by a strong wind there is an intermediate result. This snow is hard enough to cut into blocks, as for snow houses, but still (at least superficially) the process is not the one we think of as turning to concrete.

The concrete-like process will result if you take soft new-fallen snow, or the powdered results from crushing a block of drifted snow, and subjected to pressure. When you are building a snow house, for instance, you rub the originally soft or the pulverized snow into a crevice in the wall. If you test it immediately it is still soft. Test it in 5 minutes and it has undergone a noticeable hardening. Test it in half an hour and it is much harder than even snow that has been pounded into a drift by a gale. This is the process spoken of as hardening like concrete.

Now when a heavy thing, like a loaded sledge or an airplane on skis, stands with a plane surface heavily pressed down on snow the "concrete" process takes place. Accordingly, when you land an airplane the first thing to do, or at least a thing to be done within 5 minutes, is to place blocks of wood, blocks of ice, or something of that sort, underneath the skis so as to keep them off the snow.

If skis have been allowed to "freeze" to the snow you will have to loosen the plane first by some such process as shaking it or by prying up the skis with levers. Then you will have to raise the skis so that you can get at their under sides and scrape them free of the snow that sticks to them.

Snow will stick in this fashion apparently to any ski or runner. Certainly it sticks to steel, iron, and wood. There is, probably, a difference in how tenaciously it sticks. For instance, it is said to rub very easily off ivory sledge runners.

So it may be worth while to make experiments with soft metals, such as german silver or copper, to see if they have a special value in "concrete" snow sticking less to them.

We have suggested that the age of a lead can be inferred from snowdrifts that extend out upon it in the lee of hummocks that are on the old ice at its margins, and that you can be still more certain the lead is strong if you note drifts crossing each other that have been made by successive winds. This brings up a discussion of snowdrifts both as a help and as a hindrance.

The snowdrifts are an obvious hindrance in that they constitute a roughening of the surface. This will not be worse than what Canadian flyers deal with constantly on their prairies.

In discussing snowdrifts as a compass, we explained that in diffused light, when they are not visible, the man on foot can still use them through the sense of touch. Obviously a flyer cannot use them that way—cannot use them in diffused daylight or in twilight. But if the sun is clear, and low in the sky, as it is bound to be, since it is the Arctic, the shadows cast by the drifts will be clear and a pilot can use them not only to indicate how rough the surface is but also, within the limitations discussed in Chapter 11, Section II, he can make some use of them as a compass.

DETERIORATION OF ICE LANDING FIELDS IN SUMMER

But all this discussion has been on the assumption that you are flying in winter, or at least not during the season of thaws. We have dwelt on the summer being the worst time of year for sleet and fog, conditions that may produce emergency landings; it is also the worst for making safe descents upon the sea ice.

It was with reference to winter we quoted Wilkins as saying that usually there is a fit landing spot every 5 miles and almost certainly at least one in 25. In saying that he counts not only upon the leads that are flat, and upon certain fields of ice that formed level in the autumn and have never been crushed, but also upon the paleocrystic ice where the surface of rounded hummocks is like a miniature rolling prairie and where snow has filled in most of the hollows so that the glare knobs do not constitute much more of an unevenness that snowdrifts frequently do.

All this is different in summer. A lead or stretch of other flat ice that might accommodate a thousand planes in April, or even in May, will begin in late May or early June a slow deterioration. First the snowdrifts become so soft and granular that you will have to be very careful when you come down not to nose over—your skis may sink where you expect them to slide. A little later there is slush pretty well all over the level field. This is not quite so bad a stage as the granular snow one just before; but the next that follows is worse.

JULY AND AUGUST ICE CUT BY CHANNELS AND PITTED WITH LAKES

For somewhere in the neighborhood, perhaps half a mile or 2 miles away, there is a crack in the ice made through pressure or a hole cut by a seal. The buoyancy of ice is greater than that of water and the thaw water flows off into these openings. Gradually here and there currents develop, and they cut channels for themselves. By early June near the margin of the pack, and late in June towards its center, you have the ice crisscrossed by these channels that have become ditches, some of them 2, 3, and even 4 feet in depth, with perpendicular or overhanging sides and of a width ranging from 1 to several yards. The channels connect lakes, some of an area of a few square yards, others as big as several acres; lakes that are from 1 foot to 3 or 4 feet deep.

PALEOCRYSTIC ICE NOW WORST OF ALL

If this is perhaps a slight overstatement for an ice field that was perfectly level it is an understatement for those fields that had unevenness here and there. In particular it is now suicide to come down on paleocrystic ice, where the lakes are everywhere, with some at least of the formerly rounded hummocks now shaped more like anvils or mushrooms.

If you have to come down with a land plane under these conditions the situation is, however, not quite hopeless. You try to find some open lead and come down parallel to it. Perhaps you can find on the shore of one of the leads a stretch as much as half a mile or a mile long and a score or more of yards in width that has no big channels, water courses, emptying into the lead—the only channels may be tiny ones that your skis would hardly notice as you cross them at right angles, sliding along parallel to the lead and as near to it as you can trust yourself to steer safely.

When the freeze-up starts you are not at once through with these difficulties. Some of the lakes and water courses will be more or less empty and they will fill with such soft snow that there will be a deceptive levelness of the surface—you come gliding along after your skis are on the ice and may strike one of these soft patches that will either stop you and nose you over through the mere softness of the snow or, more likely, will permit the skis to sink in so much that they stub their toes against the far side. Then it also happens that the lakes we have described, some of which are nearly or quite large enough for a landing, will be covered with soft snow. For some time after the freeze-up this blanket of snow may keep the ice from thickening so long that even when you feel sure that everything must be frozen solid you find you have come down upon snow-covered ice so weak that it lets you through into the water.

Assuming the quoted estimate right, that there is a landing place on an average every 5 miles for the best time of winter (which, from the landing point of view, would be March or April) we might say that the good landing spots are in October only one-tenth that many and in December only half that many. When we consider also the poor light of October—the short days, the prevalent cloudiness, and occasional fogs—it appears that the fewest possible sea landings should be attempted before November. Thereafter with the light of moon, stars, and aurora, with the absence of fog and the rareness of clouds, you have a much improved condition.

There is no time of year when a descent upon the Arctic pack does not give you a better chance of safety than do the other oceans on the average.

WATER DESCENTS POSSIBLE IN WINTER

In summer, pontoons and flying boats are preferable over the Arctic pack to landplanes. It is probable that even in February, the coldest month of the year, you would find open water of sufficient extent for coming down with water gear on an average once every two or three hundred miles—probably oftener. You might make the descent safely, but you could hardly take off again; for the very splash as you strike the water will fasten a lot of ice on your craft. You should be able to taxi up to the edge of the lead and, with block and tackle, to haul the plane up so that it does not freeze fast. Here pontoons are better than a flying boat; for, as said, you can use them as skis on the ice and take off with them.

In summer you will find a great deal of open water at the North Pole (Lat. 90° N.) and even at the center of the pack, which is reckoned to be about 400 miles from the Pole in the direction towards Bering Strait. However, it is difficult to see from aloft whether there are floating around small chunks of ice. Ones plenty big enough to puncture your hull will be almost the same color as the water and practically flush with it. Still it would be at least a 50-50 gamble, and perhaps with the odds as much as 4 or 5 to 1 in your favor, that you would make a safe landing followed by a safe take-off after repairs.

AUTUMN CHANGE FROM SEAPLANE TO LANDPLANE

In the 1937 search for Levanevsky, Wilkins used a civilian model of the Consolidated flying boat then in use for long-range bombers by the Navy, and flew in it about 10,000 miles over the pack before the middle of September. By that time he considered that the formation of young ice on most of the open water had made flying boats more dangerous than a landplane. This statement is, however, for the central pack only; seaplane operation could have been carried out along the Alaska and Canada shores some 2 weeks longer.

When Wilkins resumed flying in October with a Lockheed, operation by landplane was still hazardous, for the season of sticky snow was not quite over and landing conditions were bad. However, there was in practice no difficulty; he never had to land for he was able to get rid of icing by changing his levels of flight. Operating conditions improved rapidly and were good by late November. As mentioned elsewhere the total flying of this landplane was about 10,000 miles before the middle of March, the longest flights (up to 2,700 miles) by moonlight.

In our discussion of ground ice we have brought out that over half of Canada, two-thirds of Alaska, and an area in the Soviet Union as big as the United States, lakes account for 50 percent to 60 percent of the surface, except in districts which are mountainous. These lakes are a great safety factor. In summer you use pontoons or a flying boat and come down on the liquid water. In winter you use skis and wheels and come down on the level ice. When flying a mile high you usually have within gliding range a choice between several good emergency landing places.

There is, however, a transition period during which in the autumn a given lake has too much of a skin of new ice upon it to permit descents with flying boat or pontoons and not enough of an ice-platform to allow ski or wheel landings.

If you assume that you cannot fly over a given region with water gear unless all waters are liquid nor with land gear unless there is safe ice on all the lakes, then planes would have to be idle over vast areas of the Soviet Union and considerable ones in Canada and Alaska for perhaps 6 weeks in fall and another 6 in spring. However, it is usually possible to play the lakes off one against the other so that this transition period is nearly or quite eliminated.

In the fall two lakes perhaps only a mile apart may freeze a good 6 weeks apart. There are a number of such cases around Great Bear Lake, where shallow ponds will usually freeze before the end of September, while bays of the lake itself may not freeze until November. You use the frozen or the open lake according to the landing gear that you carry.

In the spring the situation is reversed. The small lakes thaw much sooner than the large and deep ones, so that you can find on the same day, near a good many places in the North, safe ice for ski or wheel descents and safe and perfectly clear water for pontoons or flying boats. Sometimes you can even get these conditions on different arms of the same lake. A well-known instance of this from Great Bear Lake is that landings have been made around the 7th and 10th of June with pontoons on Cameron Bay while tractors were still operating on the larger Echo Bay, of which Cameron is a branch.

A frequent northern situation gives you both ice and water facilities on the same spring day even in a small lake if it is deep. Because there is such a large quantity of cold water in the lake, and because so much of the sun's light has been reflected from the lake's surface without being converted into heat, three-quarters of its surface will still be firm enough for airplane landings when several square miles of wholly ice-free water have developed at one side, where enters the current of a river that has gathered warmth from hundreds or thousands of square miles of snow-free land which it drains.

As we described in Chapter 11, Section II, there is, or may be, open water throughout the winter where a river leaves a large lake. This, however, will be used during cold weather only in an extreme emergency, for you will get your plane all iced up.

In taxiing or landing on frozen surfaces of rivers or lakes, particularly during the transition period, precautions should be observed for special conditions: In lakes, for instance in the Liard section of northwestern Canada and in some parts of Alaska there are occasional soft spots caused by hot springs. In rivers, the ice is frequently very thin in certain locations when that nearby may be several feet thick. It is a local northern belief that this is sometimes caused by whirlpools in the river which wear the ice thin, due to the sand in the bottom of the river being constantly thrown against the under side of the ice. More likely it is caused as described in Chapter 11, Section II.

As described in the Chapter 11 section just cited, rivers may flood at any time of winter. There is an obvious danger hardly needing comment in descending either upon snow that is seen to be wet or upon a watery section of the ice surface. A danger not obvious is that sometimes the ice of a river is covered with 1, 2, or even 3 feet of very soft snow when the flooding starts, and the water may seep along for a mile or two, soaking the lower few inches of this snow but seldom or never coming to the surface so as to show a dark spot. It is hard to tell a flyer how to guard against the danger of coming down on this kind of snow, except that he should look as far as he can ahead (upstream) and not come down on snow, no matter how white it looks, if half a mile or so ahead he can see a darkening that indicates water.

The trouble is that if your plane sinks through snow into slush you will get ice frozen on your skis in such a way that the situation is going to be very difficult to manage. Most likely you will freeze in right where you are and have to chop your plane out eventually. This can be done the sooner by beating or tramping down the snow in the vicinity of your plane, so that it will all have a chance to freeze quickly.

DANGER SPOTS IN WINTER LAKE ICE

On lakes there are the dangers for planes which will be inferred from our description of the danger to men on foot and in sledging parties described in Section II, Chapter 11, where we tell about how ice may be eaten away from under snow, leaving either a surface consisting exclusively of snow or of snow with only a skin of ice underneath.

In connection with what was said above about coming down on lake ice during the spring transition period, one should have in mind the discussion of needle ice in Section III, Chapter 11. The main things from that discussion for the aviator to remember are that he better not come down near the meeting place of the lake's ice with its open water; and that he should come down, if possible, where there is a certain amount of snow on top of the ice, for there it is not likely to have disintegrated yet into the needle formation.

DESCENTS ON GLASSY WATER

A problem not special to the North but more serious there than the average is that of descents on glassy water.

When you are doing salt water flying, whether deep sea or coastal, you have the water glassy much oftener than in other latitudes because floating ice prevents wave action. Even if less than a quarter of the surface has ice upon it the water will be without a ripple in a way that seems strange to southerners. The coastal lagoons, in the early spring, also have cakes of ice floating about.

The small ice fragments detached from larger ones are a danger which we have discussed already. What we deal with here is the glassiness which results from their presence.

Arctic lakes are frequently glassy although after a manner not differing from what you find in more southerly districts.

If you have a shore line by which to judge height, there is no danger in landing on glassy water. Come as close to the shore line as practical, bring the machine to an ordinary glide, 100 or 200 feet in the air, place it in landing position and allow it to sink until it bounces—i. e., come down in a power glide in normal landing position.

You will be reluctant to use these tactics among ice, for detached chunks are more likely to injure your plane if you come down near a considerable floe. It may be well, then, to throw overboard such things as cushions (whatever you have that will float) and strike the water close to them.

SEASONAL AND GEOGRAPHIC VARIATION OF ARCTIC FLYING

We have said that generally speaking Arctic flying weather is best in winter and next best in summer. Of the two bad seasons, it is debatable whether spring or fall is the worse. Spring has the drawbacks of most fogs and most sticky snow and sleet; but it has daylight for nearly or quite all the 24 hours. The autumn has a good deal of fog and sticky snow, though not nearly as much as spring; but autumn daylight is limited and moon, stars, and aurora do not cooperate with the flyer very well when skies are cloudy.

Such exceptions as there are to the above rules occur where the conditions are special. The most special region is to the north and northeast of the Atlantic, where Gulf Stream and iced waters meet. Next most special is the vicinity of Greenland, because of the relation of a high and chill plateau to surrounding open seas. The third and perhaps least important group of exceptions is around Bering Strait and Bering Sea. The Strait is, or may be, kept open by a strong current. The ice is mobile in Bering Sea and there is some interference by warm Pacific waters. These and similar things which make flying conditions worse have been discussed elsewhere and are merely referred to here, as a résumé.

But it seems worth while to bring out, more fully than was done in our discussion of climate, certain weather features that have a special relation to flying.

With the exception of the Gulf Stream waters, the Greenland neighborhood, and Bering Strait and Sea, it is generally true for Arctic and sub-Arctic that you can pass from the good flying conditions on the continental lands to the good flying conditions of the interior pack ice without having much trouble with the bad coastal weather if you cross between land and pack at right angles to the coast, thus spending the least possible time in the worst belt. However, coastal weather does not differ much from pack and inland weathers during winter or early spring.

AVOID COASTWISE FLYING

From late spring through the summer and into the hard freezing of the autumn you get, on the whole, the worst possible flying conditions if you follow a coast line. Airways should therefore be so laid out, and sporadic flying should be so planned, that if you have to fly in the same direction as the coast runs then you do so parallel to the coast, preferably 50 to 100 miles inland. All approaches to a coast from the interior of the continents, or from the central region of the pack ice, should be as nearly as possible at right angles to the coast.

Two sub-Arctic lines of flight are, from the weather point of view, through much of the year extremely bad, about the worst in the northern hemisphere. They are following or approximately following the Aleutian chain in the Pacific and following in the North Atlantic the line or belt where the south and southwest flowing East Greenland and Labrador currents brush against the northward and northeastward flowing Gulf Stream.

SAMPLE CASE OF AIRLINE ROUTING

We illustrate through the geographically and climatologically best all-the-year route from New York to some such point in Asia as Peking or Irkutsk. This would keep at least 100 miles west of Hudson Bay, would cross the Rocky Mountains where they practically disappear abreast of Fort Macpherson (between latitudes 67° and 68° N.), and proceed down the Yukon to what should be the most northwesterly important base of this line, near Nulato.

Taking off from Nulato, the plane should acquire a considerable height, whereupon it can pass over without being troubled by most of the weather that makes the Bering coastal areas of Alaska and Siberia, and the sea between them, so bad in winter.

According to Soviet reports, Bering Sea weather extends somewhat farther inland in Siberia than Alaska, so that Anadir is perhaps a little too easterly for the Siberian main base of the suggested line. It should probably be at Krasnino, which is about 100 miles upstream from Anadir, or at some intermediate point.

An extensive correspondence with Canadian and Alaskan Arctic and sub-Arctic flyers has brought out some further points which we summarize:

WINTER FLYING

It is the experience of northern flyers that "you can't hurry the weather." If you take your time, camp in case of blizzards or too much ground drifting, it is not more dangerous to fly in the Canadian Arctic and sub-Arctic, or in central and northern Alaska, than farther south.

In northern Canadian flying little time is lost in winter because of weather—not more than 4 or 5 days a season. Conditions of visibility are usually good, in the interior, and snow doesn't freeze on the wings. Interior Alaska estimates for time lost are higher—about 25 percent of the days are considered unsuitable for flying. This difference in favor of Canada may well be not personal with flyers or due to equipment but due to the weather, and other natural flying conditions, really averaging better in Canada than Alaska.

SUMMER AND WINTER FLYING

An important factor in Arctic commercial aviation is the distribution of light and darkness—short periods of daylight each day in the winter and long periods of daylight in summer. (We have discussed this under Light in the Polar Regions.)

NIGHT FLYING

In connection with night flying a situation has developed which makes Canadian Arctic flyers nervous about giving out information. Government regulations say that you may fly only from half an hour before sunrise to half an hour after sunset; but no provision covers the period (several weeks in certain active flying districts) in winter when the sun does not rise. These Canadian flyers have mail contracts which they must carry through, and yet they cannot get a ruling which will permit them to do it legally. The testimony of some of the best Canadian aviators is, therefore, elaborately hedged around with qualifications, such as "I don't do it myself because it is against the regulations, but I know that * * *."

If a flyer knows the country, Arctic night flying with a moon in a clear sky is less dangerous than flying on a dull day (day of diffused light); you get, on the average, better flying weather at night. Full moon flying, and some say down to half moon, is perfectly safe. There is no glare on the snow in moonlight and the shadows are clean cut.

When several Alaskan and several northern Canadian flyers were consulted on the adequacy of moonlight for night landings on snow, and when the results were tabulated, it was found that the Canadians average a considerable more favorable attitude toward relying on the moon than did the Alaskans. In some cases of approximately equal ability and experience, Canadian testimony would give almost twice as many days as the Alaskan, per lunar month, for the time during which night landings by moon and stars are safe. Almost certainly this marked difference between the two groups is not in any large part of the result of personal equation or of equipment, but is in chief due to the greater reflection of moonlight by snow in northern Canada.

For the Canadian flyers were thinking mainly of the section north of Great Bear Lake, and of the northern treeless plains in general, while the Alaska flyers were doubtless thinking of the middle third of their territory, the Yukon basin. The Canadians were, then, speaking of a terrain that is mainly prairie or lakes and is from 90 percent to 100 percent covered by a snow blanket that reflects whatever light comes to it, while the Alaskans were thinking of land that is half, three-quarters, or in some cases seven-eighths covered with forest. Also, in the part of Alaska most familiar to these flyers are mountains so high, valleys so steep, and precipices so abrupt that they cast extensive shadows. Such topography is rare in Arctic Canada (except in the Yukon, with which district many of the Canadian flyers questioned had little familiarity).

Doubtless because of considerations such as these, the Alaska estimates for safe landings at night by natural light on snow range from 4 to 8 days per month; the Canadian estimates were nearly double that—as high as 16 nights of the 28-day lunar month.

GLACIER LANDINGS IN SUMMER

During both winter and summer, places for emergency landings are few in Arctic mountains; but they are even fewer in summer, for snow fields that can be used in winter are now gone. However, there are some Arctic mountain glaciers, with great glaciers in sub-Arctic mountains, as in those of southern Alaska.

All flyers new to the Arctic who may have occasion for crossing mountains should be instructed that most glaciers will furnish a safe landing. Their seaward ends, the ones downward in the valleys, will be heavily crevassed, and so dangerous. Follow a glacier up its slope and, a long time before you reach its head, you may come to a stretch where crevasses are few. In any case, there is pretty certain to be a snow area near the very head where there are few or no crevasses.

GLACIER LANDINGS IN WINTER

Although, as said, winter landing places in Arctic mountains are more numerous than those of summer, still you may need to use glaciers even then. You can, of course; but with this difference of conditions: Crevasses are fewer in winter, and in that sense the glacier is more serviceable. But such crevasses as there are will be camouflaged by snow, so that you cannot be so sure from aloft whether you are coming down in a good place. However, the very head of the glacier is pretty safe at any season.

Apart from the great number of lakes in all nonmountainous Arctic and sub-Arctic countries, there appears little about northerly summer flying in lowlands that requires further special comment. On the continents of both New and Old Worlds are found June, July, and August temperatures that resemble those of the States, running up to and even above 100° in the shade. They have thunderstorms, but no worse than those of the States; and so on for various other comparisons.

SECTION III

TRACTORS

We discuss the northern geographic setting for the use of tractors and then sketch their recent development in Alaska.

In connection with ground frost we have given in chapter 2, section I, the reason why half or more of the surface of northern flat lands is covered with lakes and we have discussed these lakes from the point of view of the aviator in the present chapter. For mechanized ground operation, dependent on tractors and other motor vehicles, the "eternal" frost is at least as important as it is for aviation.

SUMMER USE OF TRACTORS HANDICAPPED BY LAKES AND SWAMPS

Lakes on flat land are likely to be connected by sluggish streams. In rolling and hilly country northern lakes are somewhat more likely to be connected by streams than those farther south, because of the lack of underground drainage. In summer, even if the ground were hard between the lakes, this network of them and their connecting streams would prevent the use of tractors. Summer use of them is doubly impractical because the ground between the lakes is mostly swamp.

WINTER USE FACILITATED

But in autumn the situation changes. The swamp becomes as hard as concrete; every lake and every sluggish stream gets a hard and smooth surface which, 3 or 4 weeks after the beginning of the freeze-up, will support tractors of practically any burden, giving them boulevard conditions for travel.

ARCTIC AND SUB-ARCTIC HAVE OVER 5,000,000 SQUARE MILES NEARLY IDEAL FOR WINTER TRACTOR OPERATIONS

Accordingly, there are few natural terrains in the world across which a mechanized land force could move so readily as across the northern prairie—traversing the lakes, following the winding streams, crossing the isthmuses between lakes that are usually low. In those parts where the land is forested the advantage to the tractor is similar, except that now and then it will be necessary to chop down trees that grow on the isthmuses between lakes that are not connected by suitable rivers. The ground being as hard as concrete, all you need to do is cut the trees off flush with surface. That gives you a hard and nearly level road.

In advancing, a force will be directed in one of three ways, by local guides, by maps, or by airplanes circling above and telephoning directions to the ground.

RIVERS ARE WINTER BOULEVARDS TO THE HEART OF A COUNTRY

Not only does practically all of the nonmountainous Arctic and sub-Arctic, a total area equal to nearly double that of the forty-eight States, become a ready highway for tractors in winter through the lakes; every river is also a boulevard reaching from the sea toward the heart of a country. The Yukon penetrates Alaska, and the Mackenzie Canada, each for 2,000 miles. There are at least three equally large Siberian rivers, each giving a road 2,000 miles toward the center of Asia. There are three or four other Soviet rivers comparable in size to the Missouri, each giving a thousand miles of access. There is a still greater number of sizes like the Kushkokwim, Kowak, Noatak, and Colville of Alaska, rivers that furnish roads of several hundred miles.

DEFENSE FACILITATED BY THE NATURE OF ARCTIC LANDS

This is not a work on military procedure. Still we point out that while an Arctic territory is perhaps more easily invaded than any other by a mechanized army of combined land and air forces, it is also nearly or quite the easiest, terrain in the world to defend. Through the very fact of mechanization, the advancing land force must follow lakes and rivers. It has to cross isthmuses between lakes where they are low and narrow. Therefore, you can forecast more easily than in most countries just about what way the invading army will have to take through an Arctic land.

Even where there is prairie this gives considerable advantage to the defenders. But remember that of the land covered by lakes because the subsoil is frozen more than 3,000,000 square miles is an evergreen forest, with trees in many places growing close together and 50, 80, or even 100 feet high. They come down nearly or quite to the water's edge both on lakes and rivers. These forests are often so dense that even a scouting plane cannot see down through between the trees to determine with even fair accuracy the force that may be there. Machine guns and other guns will find admirable willow and evergreen cover all around most lakes and along most stretches of river bank.

An invading army knows that there will be ambush here and there and may try to advance in snowstorms and during the dark of night. Here, too, there is advantage to the defense forces in being on lake or river shores; for guns can be sighted in daylight to be much more effective during darkness on those even surfaces than they could possibly be if the land were rolling or in any degree uneven.

The most striking difference between the utilization of the results of ground frost by plane and tractor is that the planes can use the resulting lakes the year round. The tractors are blocked by them in summer and aided by them in winter.

Because tractors operate only in winter in such countries as northern Finland, the northern third of the Soviet Union, and large sections of northern Canada and Alaska, movements that depend on tractors are of necessity winter operations.

In Alaska, Canada, and the Soviet Union, there has been in recent years a rapid growth in the use of tractors for commercial purposes.

ALASKA USE OF TRACTORS

Crawler or track-type tractors became popular in placer mining with the development of the bulldozer, and they now take a considerable part in this industry. During the operating season tractors equipped with bulldozers are used principally for stripping off the overburden—shoving the waste gravel to one side of the cut, pushing the gravel up to the sluice box, and also for stacking tailings at the end of the sluice box.

Previous to their use in placer mining, tractors were used primarily for winter freighting, when the marshes and rivers are frozen over, and for the building of such roads as the Alaska Road Commission has constructed throughout the Territory. There is also a limited number used in farming, both in clearing land and in pulling farm equipment. Their Alaska use for this purpose was up to 1940 chiefly confined to the Matanuska Colony and to the Tanana valley around Fairbanks.

Due to the saving in fuel, it is estimated that at least 95 percent of the tractors operated in the Territory during the last few years have been powered with diesel engines.

Since the price of gold increased, following 1932, and more modern methods were developed in placer mining, the Alaska use of the crawler tractor has no doubt increased 300 percent to 400 percent. It is estimated that in 1940 there were between 400 and 600 crawler tractors in the Territory, between 60 and 75 per year having been shipped in during the period 1937–40.

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