Some Problems of Human Ecology in Polar Regions

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THE PROBLEMS OF MAN IN THE ARCTIC and Antarctic are under examination by many. These are of special interest to the ecologist or environmental physiologist.

The field of interest of the environmental physiologist can be briefly described as the reactions of normal man to the complex of natural and artificial factors of the environment. Physiology is the study of function of living matter. It includes the study of the human organism, an exquisitely integrated mechanism, the behavior of which is essentially the summation of actions and interactions of a mass of living cells, of groups of specialized cells called tissues, of combinations of tissues to make body organs; of body organ systems, of the organism as a whole, and of the interrelation of organisms (men). These reactions and interactions are continually influenced by physical, chemical, and emotional factors of the environment—internal and external.

The environment includes everything, and at the technological level of our present-day culture, with its dependence upon highly complicated machinery, with extremely artificial environments of technical and industrial areas, and with means of transport so rapid that man can be moved within an hour from desert torridity of 135°F. to the frigidness of the stratosphere of 65° below zero, the extreme range of physical impacts which confront man has no counterpart in history.

In spite of our superb machine and engineering developments, man in the final analysis, and man alone, is the focal unit of our functional society. Men, not machines, make our Nation.

The basic interest of the human ecologist is the study and understanding of the responses of the normal man to the multiplex factors of climate, cloister, and clothing, of factory, field, and fairway.

The polar regions are frontiers for investigation of descriptive natural sciences. They are also regions which offer unlimited opportunity for the integration of the man's capabilities and limitations with engineering design and development. The areas demand a continuing concern of man's reactions to the environments by the engineer, the economist, the geographer, and frontiersman; they demand a continuing concern of the geographical parameters of the physical and biological factors by the biologist, the engineer, the community planners.

In March 1946, the Arctic Institute of North America published Bulletin No. 1, entitled, *A program of desirable scientific investigations in Arctic North America*, a statement which was presented in the hope that it might serve as a working agenda and as a guide in planning a comprehensive program of Arctic research in North America. By design, problems related to human biology, including medicine, were omitted.

An outline of a program for similar research, but in the fields of human biology, is presented in this paper in order to invite comment and to indicate directions which the study of man in polar areas may take. A large section of this program applies only to the Arctic; the fundamental differences between the Arctic and Antarctic in regard to the habitability and inhabitation are the essential basis for this orientation.

It should also be noted that investigations are included which deal specifically with physical factors of the environment. The study and understanding of these are essential for the evaluation of man's reactions to the environment. Their inclusion in this biological program emphasizes the need for close integration of all fields of study when an analysis of the polar regions is made.

The first problems which will be considered can be grouped under the heading of *personnel*. These encompass the establishment of criteria for selection of persons to be engaged in polar work (and thereby, of course, the establishment of the validity of selection) and the study of needs and methods for special training and selection.

An approach to the selection requirements upon which to base the choice of personnel for Arctic service can be made through the study of present inhabitants. The motivations, personalities, and adjustments of men and women who have gone into the Arctic, and stayed or returned after a period, can supply a basic amount of generalized data for most types of duties which might be expected in military or civilian colonization of the North. The study of groups such as exist in villages or towns and in mining and lumbering camps can reveal significant comparative information which may be related to selection of personnel for establishing large aerodromes, camps, or colonies. The hunter-trapper personality may suggest standards for the selection of isolated outpost personnel like that needed for radio stations, emergency

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airfields, and ranger posts. The crews of a number of small Arctic trade and cargo vessels which ply the polar fringe seas may be fair sample material for basing selective methods for men to be assigned such duty if the demand becomes greater. A psychological evaluation of the bush pilot, one of the outstanding groups of present-day pioneers, should give an extremely valuable picture which could find ready translation to selection of North country pilots.

It is probable that in many instances the population sample will be inadequate for a complete study; nevertheless, initial directions should evolve from the analysis of present inhabitants. Assuming that the psychosocial study of present non-native Arctic populations reveals the existence of selective characteristics which can be generalized, then the establishment of criteria for selection of personnel for Arctic service (civil and military) will naturally permit a series of validating experiments only if selectees or volunteers for service in the Arctic are available. Government channels, again including military and nonmilitary personnel, will be the potential source.

In the course of establishing the need for preselection (and selection) standards and the validation of criteria for selection, a number of important correlations should be explored. The "traditional" emotional disturbance associated with Arctic isolation will demand reexamination. No doubt can be raised regarding the fact that some men cannot tolerate "Arctic isolation," but there is no evidence which clearly associates the development of the instability with the Arctic rather than with the isolation. If both factors are involved, there are as yet no data for assigning relative weights to each.

These broad psychosocial studies should also permit the investigation of two other areas of interest: the relationship of an experiential component of personal history with adjustment to Arctic service, and the relationship of motivation to emotional stability. Many persons who have never seen the Arctic have experienced conditions and situations as severe as, or even more severe than, those encountered in the upper latitudes. How residents of the Dakotas, Montana, Idaho, and some provinces of Canada compare in their adjustment to the Floridian and Californian should be of interest. It must be recalled that many Arctic whaling ships were manned by West Indians, Portuguese, and Mediterranean natives; and of the five men who reached the North Pole with Peary, four were Eskimos and one, Matthew Henson, was a Negro.

As for motivation in relation to adjustment to the Arctic, history is heavy with the achievements against adversity by highly enthusiastic explorers. There is little basis for suspecting factors of the Arctic which might tend to mitigate the forcefulness of motivation in overcoming difficulties, real or imaginary.

The development of methods of training and indoctrination of candidates for Arctic service offers a challenging field for educators who are interested in two rather diverse problems. The simpler is training by methods of simulation (artificially reproduced situations which can be controlled). The evolution of satisfactory methods for simulated training for Arctic jobs, whether engineering, farming, maritime, or community planning, should result in accelerated and economical preparation of men and women for Arctic service. For actual field training to begin with the primer problems is costly and inefficient.

A challenge greater than the simulated training is the indoctrinational program. Few areas of importance have a greater lore of fable than the Arctic, and generally well-informed persons are either uninformed about the Arctic or, even worse, ill informed. A program for indoctrinating people about the Arctic will, perforce, require not only the learning of facts but also the unlearning of fiction. In spite of our inheritance of information, the Arctic Circle does not demark the Arctic, the Arctic is not characterized by six months daylight and six months darkness, the lowest temperatures recorded on the earth are not in the Arctic, and Eskimos do not generally trade wives.

To the educational research in methods for simulated training and for indoctrination should be added research to develop effective survival teaching. Although this may be of primary importance to limited military groups, it should find broad application for transpolar air travelers, crew and passengers alike. Emergency landings in the Arctic are relatively safe compared to those on open seas; nevertheless, a basic understanding of survival methods is essential.

Another large field in need of investigation is related to *factors of the environment.* As indicated earlier, although this is a discussion of a program in human biology, the ecologist must make a critical examination of the physical as well as the biological factors. It will be clear that many physical assays of the environment which are proposed for study in the polar regions are also unknown for temperate zones. In the polar areas, the impact of these factors are so sharp that the biologist must have a clear picture of all the physical factors of the environment. The relation of some of the factors to biological problems will be commented upon in some instances, but a thorough development of this thesis cannot be made here.

The study of meteorological factors is of import; and the relationship to climate is obvious. Polar meteorology for the biologist must be a long-term, continuing study and must be carried out at an adequate network of observatories. In spite of a common tendency to think of polar meteorology as homogeneous, the fact remains that the range is great and the heterogeneity is general.

The physical measurement of solar radiation is essentially a problem of geophysics. But the importance of knowing the spectral range and the intensities of radiant energies in the polar regions warrants an active interest by the physiologist. Such radiant energy is highly com-

plex and variable, for it may originate from direct sunlight and from light that is either diffuse or reflected, or from snow or ice, or it may be refracted from vapor. Polar mirages, sky maps, effects of snow-polarized light, and intensity of total lunar and stellar light for winter activity have to be studied.

Sound and noise levels may be so low that footsteps on the snow several hundred yards away are audible; or they may be of unearthly magnitude when pack ice is breaking up, churning and crashing.

Against quietude, the shrill call of the loon is enervating. Background noises, such as special sound of winds, aircraft, tractors, and the like in the low temperature of polar winters, have not been measured.

Physical phenomena, such as cosmic rays, aurora, and geomagnetism, are of significant interest to the geophysicist. His findings may be worth the attention of the physiologist, but the field is unexplored.

Humidity, fog, icing conditions, winds, water currents, ice, snow, topography, terrain, barometric pressure, and similar factors influence biological behavior. The study of the effects of these conditions on the organism cannot be logically pursued until the values of the factor are ascertained. Again, one must warn against assuming or expecting uniformity throughout polar regions. Not only are the Arctic and Antarctic very different in many respects, notably with respect to mean altitude of land surfaces, but also various parts of the Arctic may differ in almost all regards, except for the few or even for the single character chosen to define the entire polar region.

The assay of biological factors of polar environment will find its greatest share of interest in the Arctic since, except for fringe waters, the Antarctic, like the Greenland Ice Cap, is quite devoid of life. The first phase of a bioassay of polar regions by the ecologist should be a climatological analysis. Systematic study of climatic factors for the various polar areas is being pursued, but on far too modest a scale to allow a clearly defined presentation of Arctic and Antarctic climates.

The strict study of flora and fauna, which may fall more clearly to the plant and animal biologist, has had a share of attention, but, as indicated in the program of the Arctic Institute of North America (Bulletin No. 1), a great deal is yet to be investigated. The study of animal and plant life in the polar regions having environmental impact on man can be carried on almost without limit.

Bacteriological aspects of these geographical areas present a challenging opportunity. It is known that bacterial processes are retarded, but whether this is due entirely to temperature factors is not clear. Surveys of the bacterial content of the air, soil, snow, ice, inland waters, and sea should be conducted. The metabolism of the bacteria which are indigenous in the polar regions, their culture characteristics, and their pathogenicity (or nonpathogenicity) offer the field-minded bacteriologist and the human ecologist an intriguing problem.

The study of the extent, behavior, growth, and reproduction characteristics of the insect populations in the Arctic will afford valuable information for the control of the pestiferous insects like the Arctic mosquito and sand flies, but even more, it may offer a field for studying basic biological processes under special natural environments. A fundamental approach to relation of environment to genetic changes is being carried on by a study of the *Colias* in the Arctic by W. Hovanitz (personal communication).

Although an exhaustive search of the literature has not been made, the writer believes that no virological survey of the Arctic has been conducted. The environmental physiologist will be interested in such investigations.

Both the botanist and the ornithologist have been in the field, and of all the special phases of biology these two have carried out the most work; the greatest share of this has been descriptive, however, and there is, as with animal forms, a potential wealth of information regarding the physiology of polar plant life.

The rewards to the human ecologist for interest in Arctic vegetation can be found in regard to nutritional value of the vegetation, toxins, fuel utilization, cultivative potential, and even pharmaceuticals.

Mammals have been of economic interest, mostly for pelts and in some few instances for food. Scientific inventory and population analysis on a large scale should be of interest with respect to food, fur, domestication, pack and work use (dogs, reindeer, ponies), species balance, and basic animal ecology. It is interesting to note in passing that animal trails or runs across permafrost (permanently frozen ground) influence the permafrost character by the wearing off of the top insulating grasses.

It should be emphasized that the comments regarding plant and animal life are made with reference to the biological status of the polar regions to the extent that they constitute a series of factors of man's environment. The natural habits of the mosquito in the Arctic are of intrinsic interest, but the mosquito problem, as pest or potential disease vector or for control and irradication, is the one posed in this paper. The behavior of bacteria in Arctic regions is a challenging study, but the problem herein presented is mainly bacteria (pathogenic and nonpathogenic) as they constitute a factor of the environment.

A third general field in need of investigation in polar regions is *health and sickness*. Most of this work is pointed to the upper latitudes, since human inhabitation of the Antarctic continent is limited to explorers. The study of health of the native and the long-time white resident (trader, missionary, bush pilot, trapper, and civil servant) has been touched but very slightly. Medicoethnological studies have been conducted in limited phases, chiefly dental, general dietary, and some infectious diseases, but a critical and extensive examination of the historical aspects of the health status has yet to be made. The medical observations incorporated in the writings of early

explorers and travelers have not been assimilated in a single body of information.

More attention is now being directed by governmental agencies to medical studies associated with Arctic and sub-Arctic regions, e.g. by the Interior Department in Alaska, by the Department of Mines and Resources in Canada, by the Danish Government in Greenland, and by the Northern Sea Route Administration in the Arctic and sub-Arctic USSR. The data, however, are still meager and sporadic. Public health surveys have concentrated heavily on tuberculosis; but the field is open for thorough and extensive disease surveys and control, medical requirements, and medical climatology and geomedicine.

From the purely medical viewpoint, the Arctic offers an extremely fertile field of inquiry regarding epidemiology, incidence, mortality, and morbidity of many diseases. The nutritional aspects of the Arctic population and the study of contagious diseases, endemic and epidemic, of diseases and natural growth of childhood and adolescence, of cancer, and, of course, longevity constitute a small share of the problems still unsolved. Hypertension, and cardiovascular disease in general, has reportedly a very low incidence, but precise data are not readily available. Most specialties of medicine such as dermatology, internal medicine, endocrinology, ophthalmology, gynecology, and urology will find interesting data when the native and the long-time immigrant population is studied. The responses of newcomers to the Arctic should reveal data pertinent, not alone to the specific disease groups, but also to the general aspects of physiological adjustment.

Some specific diseases which may be of interest to the field of Arctic or polar medicine will include pneumonia, tuberculosis, typhoid fever, rheumatic fever, allergy, arthritis, nephrosis, myositis, chilblain, frostbite, and snow blindness.

Because of the relatively limited population and the capacity to isolate whole villages, the work of the Public Health doctor, especially in Greenland, has been effective and instructive and, when accepted as an example to indicate potential fields of inquiry, is most stimulating.

We pass now from our consideration of the general medical and health status evaluations of the peoples of the Arctic to more specific *physiological problems* which are in need of investigation. First are those related to the assessment of health in the polar regions. Longitudinal studies—that is, long-term studies conducted on individuals over a significant part of their growth or longevity periods, rather than short-term studies of many persons of different age groups—will be revealing, especially in regard to the growth and development of the native. The physiologist interested in the child and adolescent has an opportunity to study not only growth in relation to nutrition (of different quality than temperate zones) and to special seasonal and climatic conditions, but also psychophysiological developments within a cultural group which treats its children with a real acceptance of the child as a person.

The physiology of adaptation or adjustment, or somatic learning, or even acclimatization is indeed a challenging problem, whether the process be real or imagined. The reactions of the organism, as a whole or as separate parts (as, for example, the peripheral vascular bed of weather-exposed parts of the body), to polar climatic factors have not been measured. The processes of wounding and wound healing, of disease susceptibility and recuperance, appear to be altered in polar regions. Critical evaluations have as yet to be made. It may be added that, although many physiological changes associated with lowered environmental temperature have been investigated, there are many factors of the polar environment in addition to temperature which may play significant roles. Actually as for temperature, indoor temperatures in the upper latitudes are usually maintained much higher than farther south; and outdoor clothing is usually adequate to keep northern residents more comfortable in below-zero weather than Eastern Seaboard inhabitants are likely to be in ordinary street clothing in above-zero winter weather.

An intriguing psychosomatic problem of Arctic life is the general acceptance of reality as a basis for behavior. Rigid schedules are not maintained, the elements of weather are not combatted, and, all in all, the pace shifts with the environmental factors. One should point out that this is a pattern of the native and long-time inhabitants and not necessarily true for the newcomer.

Some more specific physiological problems which present themselves include the effects of solar radiation (of polar intensity, range, and duration) on the eyes, skin, and body-temperature regulation; nutritional requirements for the low temperature and strenuous activity that are encountered on the trail; water balance among natives and white man; mineral balance, especially in the light of low salt contents; calcium source (in growing children); vitamin requirements; and the fat, protein, and carbohydrate relationships. In the case of these last problems the fish and meat-eating Eskimos of King William Island region offer a valuable source of information. In addition, postural gait and orthopedic studies in general will be interesting, for leather-arch supporting shoes are not used either by the natives or by the white man on the trail.

The cardiovascular balance of the polar inhabitants, kidney function, neuromuscular reactions, fitness in general, and psychomotor and sensory responses appear to warrant closer examination. It is not unreasonable to expect productive results from almost all phases of human physiological investigation which may be conducted on the inhabitants of the Arctic regions.

A very practical broad field of inquiry which involves the physiologist is that related to engineering, especially engineering in regard to man's employment of machine,

or machines for man. In this area fall the problems of food, hygiene and sanitation, clothing, transportation, and community planning.

The *engineer-physiologist problems* regarding food (exclusive of the production of food that would be the province of the agricultural engineer) are related to food storage, processing for Arctic use, preparation, packaging, messing facilities, and special rations (pemmican and others) for emergency use. Problems in hygiene and sanitation include water supply, sewage disposal, housing (heating, ventilating, humidity control), laundry requirements, and the like. Humidity control in the dry, cold climates is an important problem, for in the usual condition which exists in northern houses the heated dry air causes the upper respiratory passages to become dehydrated. Not only is this very annoying, but it also makes one more sensitive to invasion of infectious agents when these agents happen.

The engineer-physiologist team must also attack problems of devising and improving transportation vehicles from the standpoints of operation design, maintenance convenience, and human factors in the vehicle design—heating, vibration control (for riding over rough tundra, sastrugi, and ice), noise elimination, removal of noxious gases, comfort, and safety aspects. The design and development of the best clothing for over-all use also demand the cooperation of the engineer and the physiologist.

Finally, for community planning, whether the community be a mining camp, an aerodrome, or a sizable village, the problems demand a combined attack by the human ecologist, the engineer, and the geographer.

To the writer, the essential and demanding requirement that the various disciplines of science and technology work together is one of the most exciting aspects of research in polar regions.

A System of Nomenclature for Isotopic Compounds

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THE RAPIDLY INCREASING AVAILABILITY of isotopes of the common elements, both iradioactive and stable, makes it a certainty that research studies will soon involve the synthesis and utilization of many compounds containing abnormal concentrations of isotopes, usually in definite positions in the molecules. At the present time there is no general system of nomenclature for such compounds (with the exception of those containing deuterium), and therefore they are identified by structural formulas and by textual description.

Deuterium compounds are named in this country by the modified Boughton system, this convention having been established by the American Chemical Society in cooperation with representatives of the American Physical Society (E. J. Crane. *Science*, July 27, 1934, pp. 86–89). Under this system of nomenclature the position and number of deuterium atoms in the molecule are indicated in the name itself by the suffix -m,n, . . .-d_r, where m and n are the positional numbers of deuterium atoms in the molecule or portion of the molecule and r is the number of deuterium atoms per molecule.

Several considerations seem pertinent concerning the establishment of a general system of nomenclature for isotopic compounds:

(1) The system of nomenclature should be applicable to all isotopes.

(2) For indexing purposes, as well as for clarity and convenience, the name of the isotopic compound should be very similar to that of the normal one.

(3) The position or positions in the molecule of the isotopes present in abnormal concentration should be indicated.

(4) Compounds containing isotopes in any abnormal concentration should be named by this system, rather than only those containing isotopes in essentially 100 per cent concentration, since for tracer purposes radioactive isotopes or stable isotopes in relatively small concentrations may be used.

The importance of point 4 is considerable. It is unlikely that isotopes other then deuterium will soon be available in high purity. Moreover, the ratios of isotopic masses of other elements are much smaller than the ratio of those of hydrogen. Any differences in physical properties or chemical reactivity between normal compounds and those containing pure isotopes of other elements would therefore be much less marked than the differences obtainable with hydrogen isotopes. As a consequence, interest in pure isotopes other than deuterium should be small. Yet the synthesis and use of isotopic compounds involve very specialized problems whether the compounds contain an isotope in 100 per cent purity or not, and convenient reference and indexing in all such cases will be important.

These ideas were probably considered by the American Chemical Society Committee on Nomenclature, Spelling, and Pronunciation, for in its report on nomenclature of deuterium compounds (E. J. Crane. *Ind. eng. Chem.* (News ed.) 1935, **13**, 200) this statement is made: "If compounds of tritium are eventually made, they can readily be named in like manner, 't' being used as is 'd'