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BIOMEDICAL AND BEHAVIORAL SCIENCE RESEARCH IN ANTARCTICA

Proceedings of the Colloquium

held at

Oklahoma Medical Research Foundation
Oklahoma University Medical Center
Oklahoma City

March 18-19, 1971

Review and Recommendations

by the

PANEL ON BIOLOGICAL AND MEDICAL SCIENCES

of the

COMMITTEE ON POLAR RESEARCH

National Academy of Sciences-National Research Council

Washington, D. C.

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PREFACE

Early in 1970, the National Academy of Sciences published Polar Research: A Survey, in which the several Panels of the Committee on Polar Research appraised recent programs and the status of research in polar regions. The Panel on Biological and Medical Sciences contributed Chapter 9 of this volume, covering material under the following subheadings: Systematics and Biogeography, Terrestrial Ecosystems, Freshwater Ecosystems, Marine Ecosystems, Comparative Physiology, Animal Behavior, Human Biology, Conservation, Logistics, and International Cooperation. The present colloquim is the second of a series planned by the Panel as in-depth interviews with specialists for the purpose of evaluating whether or not we are answering to existing priorities, what directions our research should be encouraged to go for the greatest payoff, and how polar research can best be aided and supported.

The Panel wishes to acknowledge its debt of gratitude to the officers and faculty of the Oklahoma Medical Research Center for giving so liberally of their time and effort to make this colloquim a highly rewarding and pleasant experience. Grateful thanks are due also to the research staff and secretarial staff for looking after the accommodations, communications, and amenities. In particular, the Panel wishes to thank its Vice-Chairman, Dr. Jay T. Shurley, for his planning and supervision of the local arrangements. Dr. Shurley also brought together into draft form a large share of the conference results.

William S. Benninghoff
Chairman
Panel on Biological and Medical Sciences

CONTENTS

SUMMARY OF COLLOQUIUM AND RECOMMENDATIONS

Introduction

The impetus for the organization of this symposium came from three main sources: (1) the completion of over a decade of research on selection criteria for Antarctic personnel by Dr. Gunderson and his colleagues at the U.S. Navy Neuropsychiatric Research Unit (Abstract, p. 19); (2) the completion of a 5-year cycle of field research in biomedicine and behavioral science by Dr. Shurley and co-workers at the University of Oklahoma Medical Center and Veterans Administration (Abstract, p. 18); and (3) the advanced status of planning by the Office of Polar Programs (OPP) for a new South Pole Station, probably to be opened in 1974 (Abstract, p. 17). According to Mr. Philip Smith, the Deputy Director, the plans currently provide better designed for research, and expanded facilities in biomedical and behavioral science research, in addition to support for traditional programs (meteorology, etc.). With inauguration of the new station, the OPP contemplates more emphasis upon joint planning and funding of research programs with other SCAR nations.

Biomedicine is here defined as that branch of biology (especially biochemistry and physiology) specifically concerned with knowledge of the human species, Homo sapiens diurnus varians cultura loco; i.e. human biology. It denotes the basic - as opposed to the clinical - sciences, from whence are derived a major part of the principles and structure for the modern practice of clinical medicine. It is the life science of the human species.

Dr. Rivolier, Chief of Medicine for the French Antarctic Research Program (Abstract, p. 27), spoke of the desire of the French to augment

cooperative efforts with other SCAR nations in psychobiologic research projects such as those described in this colloquium. In addition, he described their research approach: physicians at the four French bases not only attend the health-care needs of station personnel, they conduct the planned biomedical research activities. In their research investigations, an interdisciplinary approach is emphasized. Studies of environmental conditions and physiologic phenomena are closely correlated with psychosocial responses among their personnel.

Current Status of Antarctic Biomedical Research

Since the IGY, the U.S. Antarctic stations have been manned by three major occupational groups: (1) Navy Seabees, who are responsible for construction, maintenance, and logistics tasks; (2) Navy administrative-technical personnel; and (3) a small group of civilian science technicians who gather data. The heterogeneity of these groups, in terms of sociocultural background and personality traits, has posed screening problems; i.e., each requires different sets of screening indicators. Moreover, the disparity in backgrounds has tended to generate group incompatibility over the months of isolation, especially at the smaller stations--taxing group morale and lowering work accomplishment. By their thoroughly documented studies (Abstract, p. 19), Dr. Gunderson and his colleagues have identified three psychosocial components as successful predictors of individual adjustment: (1) task motivation, (2) emotional stability, and (3) social compatibility. More refined field studies should include the effects of the physical environment and the value systems governing the working group. To understand the dynamics of small-group phenomena in

Antarctica, Dr. Gunderson has indicated the following to be essential: (1) the use of multiple behavioral indicators and multivariate analysis, (2) repeated measurements over long periods, (3) maximum use of unobtrusive and nonobtrusive methods of behavior measurement, and (4) a global systems approach to group behavior.

Other nations apparently devote much more research effort (e.g., the Soviet Union) to biomedical programs at their Antarctic stations. While Navy medical and behavioral science studies testify strongly to the human capacity to adapt, they leave unanswered such fundamental questions as how men adapt to stresses, which stresses elicit responses and to what degree, the time required for adaptation to stress, and the physiological as well as psychosocial costs of such efforts. With the expected slowdown in Navy medical activities in Antarctica, the future of their biomedical research is uncertain and the long-range planning essential to significant research yield is compromised.

Special Merits of South Pole Site

The field phase of the biomedical studies of Dr. Shurley and co-workers (Abstract, p. 18) was completed in 1968. This work demonstrated that when Antarctic investigation is conducted at the level of life science and human ecology and is accomplished by psychophysiological techniques, one strikes a rich vein of phenomena regarding the adaptation of man to extreme environments. The Soviet Union and other SCAR nations apparently recognize this, as reflected by their heavy investment in polar biomedical research. The results of the "Oklahoma Sleep Study" showed the South Pole Station to be an ideal site for a broad range of

fundamental research in human adaptation, man-machine interactions, and small-group dynamics. The station is small in size, offers a protracted period of physical and social isolation, maintains excellent radio communications, has minimal environmental pollution, and imposes upon its personnel multiple simultaneous stresses and significant, measurable psychosocial and physiologic alterations. All participants at the colloquium agreed that such conditions of isolated group living simply cannot be simulated in the laboratory.

The Special Case of Behavioral Research

In the past, fears have been voiced that behavioral scientists would be rejected by the personnel under observation. These fears have proved to be largely groundless, not only in Antarctica, but in the underseas environment of Tektite I and II described by Dr. Radloff (Abstract, p. 23). For periods of 10 days to 8 weeks, crews in the underwater habitat willingly consented to continuous 24-hour audio and video surveillance. The highly sophisticated methodology used in Tektite II would be applicable, with little modification, to Antarctic studies. The selection of scientific observers, design of the studies, and cooperative approach to the subjects appear to be critical factors in the success of such research.

The problems associated with prolonged social isolation in the nonnative populations of small Arctic and sub-Arctic communities were described by Dr. Smith (Abstract, p. 25). Many parallels emerged between the behavior of Antarctic personnel and that of the men, women, and children who have moved to the inhospitable, remote environment of the North. Withdrawal, depression, diminution in general activity, and other

psychosocial responses were especially striking among women and children, confined to small living spaces. Dr. Smith underscored the need for field research to determine the actual behavior needs of inhabitants, so that the design of living and working facilities can be based upon the data.

Stress on Human Ecology Viewpoint

Dr. Wolf of the Marine Biomedical Institute, drew an analogy between the psychophysiological adaptation of man to the marine environment and that of man living in Antarctica (Abstract, p. 22). Biomedical studies of the responses to various exotic environments (underseas, high altitude, extreme cold, etc.) can yield information which will help elucidate complex human response patterns and physiologic regulatory mechanisms.

To date, U.S. biomedical and behavioral science research in Antarctica has received low priority. Because support has been minimal, the methodology and instrumentation have, of necessity, been simple, Moreover, the studies have tended to remain at elementary levels, such as thermal adaptation and survival. No apparent scientific effort has been invested in studies of human ecology in Antarctica. Yet the Antarctic continent constitutes a peerless, largely unsullied, natural laboratory for the study of man in his environment. Man, after all, is responsible for disturbing many of the delicate ecologic balances of our planet, and he is threatening to disturb them even more. Eventually, he may jeopardize his own survival. Man's activities in the biosphere are largely determined by behavior based upon his beliefs, fears, and sociocultural value systems--the prime subject matter of the behavioral sciences.

The planned construction of a new U.S. South Pole Station offers an unparalleled opportunity for basic biomedical and behavioral science research in Antarctica--both national and international. Such programs promise to provide information of immediate value to the station's operation; e.g., personnel selection, program coordination, individual safety, and group productiveness. However, they also appear to have extensive implications in human ecology around the globe, problems of urban living, clinical medicine, and eventual habitation of exotic environments necessitated by global overcrowding.

Recommendations

Thus, the Panel on Biological and Medical Sciences recommends that:

(1) The behavioral sciences merit at least equal consideration in logistics and funding.

(2) Research interest be stimulated among behavioral scientists in the U.S., with full opportunity offered for collaborative efforts with other SCAR nations.

(3) Support be developed for an international conference on biomedical and behavioral science research in Antarctica, hopefully under SCAR auspices and in the U.S.

(4) A large-scale national conference be held on biomedical, behavioral science, and human ecologic research in the Antarctic, jointly with or separate from a conference on the Arctic region. Its aim would be to examine concepts, methodology, logistics, funding, and research priorities on a realistic and yet imaginative basis.

A PHILOSOPHIC STATEMENT:

RELEVANCE OF ANTARCTIC BIOMEDICAL RESEARCH TO SOCIETY IN THE 70'S

Chester M. Pierce, M.D.
Professor of Psychiatry and Education
Harvard University
Cambridge, Massachusetts

According to demographic predictions, most people will be living in urban areas by the year 2000. Already, the public is awakening to the problems created by population increase. Man feels the stresses of living in cramped quarters with his fellows and recognizes the threat posed to the fabric of his society. What is the relevance of biomedical research in the Antarctic to the problems society faces in the 70's and beyond? What applications do the lessons learned in this extreme, exotic environment offer to humankind in general?

Biomedical research in Antarctica has a unique quality. It is not simulated. The study of men in this environment enjoys the advantages of relatively controlled conditions, ongoing scientific observation in the field as opposed to the laboratory, and a manageable sample size. For the psychophysiologist, the Antarctic community is small enough to be examined carefully, yet large enough to extrapolate the findings beyond the group under study.

In my opinion, three major challenges confront us in the 70's, all stemming from the population explosion. As we shall see, they bear similarity to the challenges faced by the men who live in Antarctica. Assuming that the problem of population growth will not be resolved in the next

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Paper # 5 in a Colloquium on "Biomedical and Behavioral Science Research in Antarctica," Oklahoma City, March 18, 1971.

decade, I see these challenges as: 1) finding new solutions to overcrowding, 2) teaching people to become cosmopolite, and 3) developing an interdisciplinary approach to community problems, in which knowledge is shared for integrated planning.

What effect is overcrowding likely to have in the 70's? The sheer numbers of people who will reach maturity and establish homes in the next decade will probably force us to seek new living sites. Some will be traditional, such as new cities and the growing coalescences of adjacent cities. But some may be exotic environments--places not generally considered habitable. In the 70's, men may migrate to polar climates or even live and work under the sea to find both the living space necessary for their psychic well-being and the physical resources required to support life.

The problem of teaching people to become cosmopolite involves shaping children for their future roles as interplanetary citizens, sensitive to the needs of others. A ride on the subway during rush hour in any large city quickly reveals the effects of overcrowding upon individual behavior. With very little stress, people tend to respond to one another in a swift, hostile manner--a phenomenon seen much less often in sparsely populated areas. Until individuals learn to take a more pluralistic view of society, the "subway syndrome" will only grow worse.

Finally, we must draw people out of their technological or academic compartments and encourage them to become truly interdisciplinary. Knowledge, ideas, and feelings must become communicated and shared. In this way, information can be gathered and synthesized for optimum problem-solving within the human community.

These same problems are faced, in a special way, by the men living in the microenvironment of the U.S. Antarctic research station be it McMurdo, South Pole, Palmer or Plateau. It is noteworthy that the inner city, right here on the North American continent, particularly the ghetto, shares some of the same stresses and elicits some of the same responses from its population. And one of the barometers of the total society is ghetto life, where societal problems appear to germinate and where behavior patterns of the overall culture are reflected in their extremes.

Our personal experience as scientists in Antarctica has dramatically illustrated the crucial factor of depression in a man's adjustment to an exotic, stressful environment. Even before leaving for the field, many men experience a withdrawal of libidinal energy, symptoms of despondency, and anticipatory grief over the life they will leave behind. Anyone who has visited an Antarctic station can testify to the "blunted" responses of the men who have been in residence there for several months. Although individuals vary in the extent of their depression, one can immediately separate the long-term residents from the newcomers by their flaccid facial muscles, flattened voices, and the far-off expression in their eyes (known as the "30-foot stare in the 20-foot room"). Even upon return to the United States, these men tend to retain their blunted responses, shedding them only gradually. This, we believe, represents a kind of despondency within the individual.

In his experiments on sensory deprivation, Shurley found that volunteers "inperience" during the experimental period of isolation; that is, they withdraw into themselves and focus upon self-awareness (as opposed to stimuli drawn from the ambient environment, or "experience"). If, indeed, this occurs before a man leaves for the Antarctic, he may be coping not

only with anticipated separation, grief, and practical problems, but also with doubts and fears arising from this self-awareness and the questions it raises concerning where he is at as an individual in the society. As one incidental finding during our studies at the South Pole Station, we discovered that the dreams as reported by the men were impoverished in content, with depressive overtones. Our research project showed that the electroencephalographic recordings of these men during sleep were characterized by a gradual dropout of the delta rhythm (slow-wave or deep sleep) over their months of residence.

The implications are intriguing. One wonders how loss of slow-wave sleep relates to depression. A correlation between the two phenomena has been noted by clinicians in people severely depressed enough to be hospitalized. Other reported evidence raises the possibility of an endocrinologic influence. Slow-wave sleep disappears in women toward the end of pregnancy. It is also age-related, being high in young children and virtually absent in octogenarians. In addition, delta rhythm tends to drop out in patients with endocrinopathies. One is tempted to speculate further on a relationship to the physiology of catecholamine depletion--opening up a wide range of investigative possibilities.

From a truly psychological standpoint, we are led to reexamine the classical psychiatric concept of depression: i.e., coping with anger by internalizing it. This concept implies that depression represents an excess of emotion, beyond one's ability to handle it consciously, so that the overload is turned inward and hidden from view. Experience in Antarctica has stimulated us to reevaluate this concept and to embrace a broader definition of depression. Depression might wear another face,

representing more simply a lack of hope. Hope disappears when one loses self-confidence, when one sees no prospect of controlling one's destiny, of being free and productive, or of enjoying options in life choices.

Again, the analogy between the polar station and the ghetto comes to mind. However, the scientist at Plateau Station, say, has more basis for hope of escaping his trailer-sized environment and returning to a stimulating, supportive community than the black man has of getting out of Harlem. Both suffer anxiety, too, but the quality differs. The man who departs for 6 months at a polar station usually becomes anxious about leaving his customary environment and risking the hazards ahead. However, seldom does his anxiety reach the terror pitch to which residents of the inner city are often exposed.

We refer to the Antarctic as an exotic environment. This may be only a relative concept. Perhaps the large cities to which we are accustomed, despite their long history and sociologic contributions, are themselves exotic environments--that is, exotic to the inherent nature of man. Perhaps, then, the relevance of biomedical research in polar regions is more direct than one would at first imagine. A Fiji Islander, for example, might find walking through the Holland Tunnel in New York no less exotic than the New Yorker finds walking around the South Pole. Indeed, life in Antarctica and that in segments of the city (suburbia included) may share certain characteristics: physical isolation, restrictiveness, hazardousness, and enforced socialization. The men who work in the Antarctic live in an isolated situation, with a diminished social network, from which one cannot easily escape. But so do many men and women in cloistered suburbs or inner-city ghettos. In both situations, confined individuals can be seen to become withdrawn, hostile, and to

"kill" each other psychologically bit by bit, day by day.

The distinction between the physical and social environments in Antarctica should be drawn carefully. Eight men living in a base the size of a tractor trailer at Plateau Station are spatially isolated, on the one hand, but they are living in forced socialization, on the other. Forced socialization, with its lack of privacy, imposes numerous strains on the individual, documented in scientific literature unrelated to polar research. For one thing, noise interruptions are common around the clock, producing sleep deprivation. Prolonged exposure to such conditions makes human beings irritable, depressed, withdrawn, bored, apathetic, and passive. And they suffer sleep disturbances because of overcrowding.

The toll of similar conditions on children in urban areas (as well as adults) must be enormous. The deleterious effect on general health is a matter of statistical record from public health studies. And it is difficult to visualize a healthy learning climate in two rooms inhabited by five people, no matter how bright and industrious they may be. Moreover, social cohesion is undermined by the irritability of the individuals within the group, their negative feelings about themselves, and their inability to envision their group as integrated and purposeful. In such an environment, an individual cannot assume leadership, cannot follow the leadership of others, and hence cannot develop into the type of planetary citizen we need if humanity is to survive.

Antarctic stations offer fertile ground for the study of group relationships, leadership styles, the skill of following, and the dynamics of group interactions. The methods of study can be telescoped here, because of the closed, controlled environment and the limited group size. As psychophysiologists, we focused our initial research

efforts primarily upon how a man adjusts to this situation and on some mechanisms of psychophysiological adaptation. We know now that he certainly does adjust. The next question is, how does man X adjust compared to man Y?

Our research project on sleep patterns represented a step into the realm of biological rhythms. This area encompasses an enormous range of biological phenomena relevant to society, all the way from problems of aging to the adjustment to increased leisure time. Studies of biological rhythms may tell us, for example, why one child jumps out of bed at 6:30 AM, full of energy, while another can hardly be prodded to the breakfast table at 9:00 AM. Such biological profiles may be important as schools go on to shifts, like factories, to accommodate the increasing number of children. Moreover, behavioral profiles may facilitate the process of group selection for space exploration or undersea work, as well as polar living. In this way, predictable group behavior of the type required for a given job in the environment can be achieved.

The philosophy behind the psychophysiologic studies at the Pole was broad and ambitious. The initial research represented a step across the threshold. Along with the sleep experiments, we considered how men used their time. Life, after all, is how one organizes his experiences in time. We have interview material, dream reports, etc. But this is only a start. Such information needs to be more completely and precisely gathered and then correlated with psychological well-being, personal effectiveness, psychophysiological parameters, and biosocial phenomena. For example, we need to relate how people spend their time individually

to their success as community participants. Possibly the most promising line of inquiry in psychiatric research is the study of individual success. Why do some children in a family achieve while others do not? Why does one group succeed while another fails?

At the outset of our studies, we felt that the biosocial phenomena should be linked to the physical data, including those of the earth sciences. Indeed, this has been the case--and it is the special environment of the polar station which makes it possible. A visitor is struck by the fact, for instance, that in some way or other everybody is studying the sun. The scientist in Antarctica enjoys the advantage of having his angularities rubbed off, his tunnel vision removed, by close contacts with scientists in other widely disparate disciplines. The psychophysiologist begins to sense the biological rhythms, the thread of continuity, which tie him to the ionospheric physicist, the marine biologist, and the astronomer.

Specifically, I think that further research into psychophysiological adaptation at the polar stations in the 1970's should move along two lines: 1) the study of physiologic responses, with the data statistically analyzed and correlated to known psychological phenomena, and 2) the study of group interactions by means of more refined observer analyses, involving minimal perturbation of group dynamics. Ideally, such research in the microenvironment of the Antarctic would yield information enabling us to measure biological, psychological, and sociological effects. Then, by learning their impact upon the body and psyche, perhaps we can stimulate an awareness which would bear fruit, in terms of improved human interactions, in the 1980's.

ABSTRACTS*

COLLOQUIUM

ON

BIOMEDICAL AND BEHAVIORAL SCIENCE RESEARCH IN ANTARCTICA

MARCH 18-19, 1971

*Prepared by Barbara Cox and J.T. Shurley, M.D.

Introductory Remarks

Jay T. Shurley, M.D.

In the new (1970) National Academy of Sciences compendium, The Life Sciences, one finds the statement (p. 176): "Biomedical research has come of age. In the intensively managed, highly instrumented clinical research units of our great hospitals, clinical investigation has become a legitimate science. Human biology is being explored with unprecedented vigor and sophistication. This endeavor, the focal activity of university medical centers, is less than two decades old."

In the past five years, we have begun to take biomedical research from the medical center into the field in the remote Antarctic continent.

Since the last meeting of this Panel on Biological and Medical Sciences in June, 1970, the decision has been made by the executive branch of the government to designate the National Science Foundation as the "lead agency" in the conduct of national scientific programs in both the Arctic and the Antarctic. The former Office of Antarctic Programs (OAP) is now the Office of Polar Programs (OPP).

This is the second in a series of meetings designed to allow specialists in the appropriate disciplines to more fully inform the Panel of results and prospects of current programs. The subject of this conference is, "Biomedical and Behavioral Science Research in the Antarctic." In addition to those directly concerned with this topic, presentations will be given, as well, involving three of a number of interfaces in contiguous areas in science; namely, marine biology, man under the sea, and man in the Arctic.

PLANS FOR THE NEW SOUTH POLE STATION

Philip M. Smith
Deputy Director, Office of Polar Programs
National Science Foundation
Washington, D.C.

Much of this colloquium assumes significance for the Office of Polar Programs in the context of our plans for the new South Pole Station--one of three contemplated permanent U.S. Antarctic stations (the other two being McMurdo and Palmar).

The new station buildings are expected to have a functional life of about 10 years, with the following main features: a 160 foot diameter geodesic dome covering three separate, two-story buildings, an 850 foot arch-covered tunnel, and a sky-looking observatory tower and lounge. Construction will begin this coming austral summer, and station occupancy will probably begin for a wintering group in 1974.

Expected station population will be limited to 16 winter and 32 summer personnel, with a top capacity of 45 if the emergency hut is used as summer quarters. There will be space for three or four biomedical personnel.

Programs will include: continued upper atmosphere studies, meteorology, solar-terrestrial physics, biomedicine and behavioral science, a new unmanned geophysical observatory, environmental monitoring "benchmark" activities, and possibly astronomy. Although many aspects of the new station are still under consideration, probable features will include: an on-site desk-size computer for both station-operation monitoring and data processing and storage, much expanded recreational space over that now provided, and accommodations for women investigators. Specific biomedical facilities would include built-in monitoring devices for sleep studies in each bedroom, special quarters for cardiovascular and clinical laboratory studies, and a small laboratory animal facility.

Efforts will be made to expand cooperative programs with other SCAR nations, with joint planning and even joint funding.

RESULTS AND PROSPECTS OF ANTARCTIC BIOMEDICAL RESEARCH

Jay T. Shurley, M.D.
Principal Investigator, Antarctic Project
Oklahoma Medical Research Foundation

A previous report by the Panel on Biological and Medical Sciences (1961) pointed out the possibilities for polar research in medical microbiology, environmental physiology, and psychological and behavioral studies of individual and group adjustment to the stress of prolonged isolation in Antarctica. At the same time, the Panel deplored the low priority and low level of interest that work in this field commanded. In the 10 years since this report, only one biomedical field of study of any scope has been completed in the U.S. Antarctic Research Program--our sleep research project begun in 1966 from the Oklahoma University Medical Center. Some of the results of this investigation will be reviewed in the panel discussion scheduled later in this colloquium.

In contrast, the USSR has undertaken extensive and continuing biomedical programs in Antarctica since the IGY; an impressive amount of their work has just been reported in translation in Issue No. 74 of the Soviet Antarctic Expedition Bulletin. The British, Australians and French also have commendable records for ongoing biomedical research programs.

The Oklahoma Project consisted of a comprehensive behavioral and psychophysiological study of sleep at South Pole Station for two full years. This research stimulated exploration into related areas, leading to studies (and publications) concerning infectious diseases, pulmonary function, and hematological response to altitude hypoxia, as well as group performance and behavior. Although our work raised many more questions than it answered, it demonstrated the feasibility of sophisticated biomedical studies in the field and suggested excellent possibilities for future investigations.

The South Pole appears to be an ideal site for several areas of investigation, among them biomedicine. The latter, we believe, offers particular research promise in this environment and therefore should rank among those disciplines which receive program emphasis. Possibly, a year-round international program, undertaken on an interdisciplinary basis, could be based at this site in order to investigate various aspects of the effect of Antarctic life upon men engaged in work pursuits. Beyond these immediate objectives lies the probability that the data obtained on young men adapting to the long, unbroken isolation of wintering-over at the South Pole will have relevance for biomedical and psychosocial problems in the Arctic, in space and under the sea, as well as here at home.

RESULTS AND PROSPECTS OF OPERATIONAL PSYCHIATRY IN ANTARCTICA

E.K. Eric Gunderson, Ph.D.
Chief, Operational Psychiatry Division
Navy Medical Neuropsychiatric Research Unit
San Diego, California

During the IGY, the Navy Bureau of Medicine and Surgery devised attitude and symptom questionnaires, supervisor ratings, sociometric tests, etc., which were administered to several wintering groups in Antarctica in order to formulate a consistent program of data collection over several years. Our prime objective was the successful medical and psychiatric screening of men who would adjust to the polar environment. Of the psychosocial components, three seemed most important: (1) task motivation, (2) emotional stability, and (3) social compatibility. In the next stage of research, data were collected from about 20 wintering-over parties at several stations, by means of subjective ratings by group leaders and sociometric tests. The striking degree of agreement on the three personality components made possible the development of criteria and hence measures of prediction for screening.

Recently, an overall evaluation of the selection problem has been completed for the three major occupational groups at the polar stations: (1) Navy Seabees (construction workers), (2) Navy administrative-technical personnel, and (3) civilian scientists. Studies have revealed that multiple sets of screening indicators will be necessary because of the basic differences in these groups. Hence, one set is seldom relevant to all three categories of men. For example, criteria of prediction for job satisfaction have proved valid for scientists but not for Navy personnel. The disparate responses among the groups reflect fundamental differences in sociocultural backgrounds, psychological traits, etc. The small work party at a polar station is extremely heterogeneous. As one might expect, group morale, compatibility, and accomplishment were lower at smaller stations.

To date, valid studies of small groups are limited. Laboratory experiments simply lack the realism and duration to merit serious consideration. Several important principles of behavior measurement seemed to emerge from our survey of small groups under isolated, stressful conditions: (1) multivariate analysis and use of multiple behavioral indicators are essential (i.e., one must employ more than one technique to measure a particular aspect of behavior, and many aspects must be studied simultaneously to evaluate their interrelationship); (2) longitudinal studies must be conducted, with sufficient numbers of observations over long periods to detect significant changes in a given system; (3) unobtrusive and nonobtrusive methods of measurement should be given maximum usage so that normal operations and behavior continue uninterrupted; and (4) a systems approach to group behavior must be emphasized (i.e., group interactions are not only important, but environmental influences and transactions, as well).

All possible factors in such an environment should be identified and evaluated: (1) objectives and goals of the group, (2) philosophical and value systems governing the group, (3) personnel composition, (4) organization structure and authority patterns, (5) technology and its effect upon the group, and (6) physical environment.

RESULTS AND PROSPECTS OF NAVY MEDICAL OPERATIONAL RESEARCH IN ANTARCTICA

Captain Samuel A. Youngman (MC) USN
U.S. Navy Support Force, Antarctica
Washington, D.C.

In the past, U.S. Navy Antarctic research has been limited by six factors: (1) little long-range planning, funding, or coordination, (2) logistic problems, (3) young, inexperienced doctors in charge, with little prior time in the U.S. to plan projects and obtain equipment before deploying to the Antarctic, (4) the requirement that feasible programs have a Naval application, (5) highly limited resources for conducting the programs, and (6) the questionable statistical significance of studies based upon the small human sample-size available at Antarctic stations.

To date, most research has been designed to determine the limits of human tolerance and adaptability to environmental stresses, both physiological and psychological. All evidence gathered thus far underscores the ability of man to adapt. Specific areas of study have included: personnel selection, psychiatric effects of Antarctic station life, aspects of spatially confined small-group life (e.g., eight men at the small Plateau Station), response to high-altitude exposure and early detection of related pulmonary edema, symptoms of mountain sickness, long-term dental study of oral acidogenic bacteria, nutritional survey, determination of basic physiologic data to serve as baselines, and clinical evaluation of the effects of sedatives on the insomnia produced by prolonged isolation.

Navy medical activity is expected to slow down at the polar stations, although personnel may still take part in civilian studies (with permission of the Navy), and Navy physicians may participate in these research programs when they have time from their primary mission. The prospects for biomedical investigation at the Antarctic stations are most promising, but only under the conditions of long-range planning, which is essential for efficient research activity in these remote regions--and hence for maximum yield of valid data.

LESSONS FROM THE SEA FOR BIOMEDICINE

Stewart G. Wolf, M.D.
Director, Marine Biomedical Institute
University of Texas and Texas A & M University
Galveston, Texas

There are many lessons to be learned from the sea, whether from a warm coral reef off the coast of Texas or in the cold polar waters of Antarctica. The importance of the ocean for all living things cannot be overestimated, nor can the knowledge it offers us--not just about food, weather, etc., but about social arrangements and behavior. The sea is an older, more productive community than the land. It produces adequate food for its enormous population; it controls population without eliminating species; and it represents a continuing society in social equilibrium.

At the Marine Biomedical Institute in Galveston, faced with so many fertile areas of investigation, we recognize the pitfalls of fragmenting our research efforts in too many different directions. Our focus, therefore, lies in two areas: (1) psychophysiologic adaptation of man to a marine environment (analogous, in fundamental ways, to polar biomedical studies), and (2) comparative neurobiology. Comparative biological studies between man and simpler animals constitute a rich source of information, because when nature produces a good design form (e.g., neurons, cilia), the design persists through the ages and is shared by many species. Variations which occur during the evolution of higher animals are merely elaborations.

Thus, exploration of exotic environments yields data which help not only to unravel complex biological systems, but also to test man's capability to accommodate to environmental changes. The latter would appear to be a powerful tool for the future elucidation of human regulatory mechanisms. In fact, Haldane has said that progress in medicine depends upon our ability to understand how man adapts to changes in his environment.

BEHAVIORAL STUDIES IN AN ISOLATED UNDERSEAS HABITAT (TEKTITE II): POSSIBLE APPLICATIONS TO THE ANTARCTIC ENVIRONMENT

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Group phenomena in underseas habitats and at polar stations are in many ways analogous; thus, cross-fertilization of ideas among the scientists involved might be valuable. Simulated experiments on isolation performed in the laboratory are unrealistic, especially regarding task motivation and social interaction.

Tektite II was an underseas operation 50 feet below the surface of the warm waters of Lameshur Bay, the Virgin Islands, where marine studies were conducted April-October, 1970 (186 days). Ten consecutive crews (9 all-male, 1 all-female) occupied the habitat at ambient pressure for 14-20 days each. Each crew consisted of four marine scientists and one engineer. They lived and worked in four compartments (not counting the sea): (1) a wet lab, (2) engine room, (3) bridge area, and (4) crew quarters, containing bunks, stove, table, chairs, etc.

For our behavioral studies, a closed-circuit TV was installed in each compartment, as well as a microphone, to permit continual monitoring of personnel activities in the habitat. In the "topside" command van, two men were always on duty to collect data at regular, predetermined intervals. This process consisted of recording simple events every six minutes according to pre-coded categories by punching with a stylus the appropriate holes on a 40-column IBM card. Thus, about 240 cards were collected per person per day, ready for direct computer processing.

By this and other methods of study, records were kept of habitat utilization (how much time a man spent where), time utilization, territorial behavior, diving behavior, mealtime behavior, communications with surface personnel, mood, diurnal cycles, effects of perturbations (storms, illness, etc.), social dominance, gregariousness, and specific leisure activities. Each crew was given permission to turn off the TV monitor or microphone when they felt the need to escape constant observation. Interestingly, previous experience with the four men confined for 60 consecutive days in Tektite I suggested that individuals need more privacy from being overheard than from being viewed; the open microphones were turned off 60 times and the cameras only 6 times during the two months.

In our efforts to predict performance and behavior, we have eschewed traditional personality tests, because whatever their worth in the laboratory and clinic, we believe they lack validity in operational settings. We developed, instead, a life-history questionnaire, which takes biographical inventory of 32 major variables for each of 19 years of a man's

life. From this emerges a picture not only of overall adjustment, but of changes and rates of changes. Variables were arranged in three categories: (1) environment (e.g., school size), (2) individual behavior (e.g., athletic activities), and (3) change of situation (e.g., serious illness in childhood). The statistical correlation to marine science performance has been quite encouraging, and some cross-validation has been obtained with a (different) population of divers.

Our work and the research experience gained by others at the polar stations (both objective and subjective) suggest some additional possibilities for assessing individual and group performance in Antarctica--for example, the number of radio as well as telephone contacts with the outside, weight gains and losses (group norm and individual departures from it), housekeeping habits, alcohol consumption, gross motor activity (measured by a pedometer), time spent outside the station (measured by a light-sensitive indicator attached to the clothing), and gregariousness (with interpersonal contacts measured by a receiver). Such data could be computer-scored or perhaps even transmitted back to the U.S. via satellite. The value of participant observers should not be underestimated, but a very special kind of person, trained for this dual role, is required. Delayed group interviews of medical officers from various stations at various times, long after their polar residence, should also be productive.

HUMAN ECOLOGY IN THE POLAR REGIONS

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The characteristic irritability, withdrawal, and inability of men to "mobilize" after several months of residence in Antarctic stations is a chronic problem in other isolated environments as well. Although my own experience in Antarctica has been separated by several years from recent work in the Arctic and sub-Arctic, I am struck by the similarity of responses shared by Antarctic personnel and the non-native white residents of small Arctic communities. (The latter accept jobs there, ostensibly for the high pay, but seldom stay more than 2 years.) Social interactions, after a period of time, drop off precipitously, remaining at a low level. The incidence of mental disturbances is high, as is the divorce rate (reflecting, one might infer, a breakdown of interpersonal relationships). The per capita alcohol consumption is about 9 1/2 times that in the continental United States. The children in these white settlements show a lack of affect (i.e., blunted emotional responses) and a low level of physical activity; they rarely play outdoors as do the native children. And when the non-native children return "home", many are apparently unable to cope with peer groups.

Evidence indicates that these psychosocial problems are at least partly related to the design of living quarters and community facilities. For example, no room is set aside in the home for children's active play, and thus boisterous activity is not tolerated by the parents. Places for general socialization are generally limited or absent in these communities, leaving families without outside behavior supports and nowhere to turn but inward. In effect, residential and community design has been based upon intuition and tradition, and not upon actual behavioral needs as determined by field research.

Clearly, living spaces should be designed to meet the demands of the environment, to accommodate work requirements, but also to promote the psychosocial welfare of the inhabitants--and this applies to Antarctica. Although man can adapt, the damage to him may be too great to allow present mistakes to continue. I believe that detailed behavioral studies of polar personnel should be undertaken to determine day-to-day patterns and frequencies of activities throughout each man's period of stay. These data then should be compared with analogous data collected in the normal, back-home environment. (Sleep studies are a step in this direction). Polar station design should be reexamined in terms of how the inhabitants use its various parts and spaces.

Moreover, Antarctica, with its limited, easily studied population, provides an ideal situation for developing valid measures of group processes--e.g., how a group structures itself and other interpersonal phenomena. I suspect that such research, while it will require time and money, will provide answers directly translatable to problems of our urban areas, the magnitude of which we are just beginning to realize.

BIOMEDICAL RESEARCH IN THE FRENCH ANTARCTIC PROGRAM

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France now has four Antarctic bases, each with one or two physicians in residence. Their duties are not only to attend the health-care needs of station personnel, but to conduct biomedical research. These physicians (usually drawn from the military) are prepared for their technical and research functions for 4-5 months before deployment to Antarctica, and they are retained 4-6 months after their return to complete the research.

The psychosocial effects of life in Antarctica--one of our initial areas of polar research--were originally studied in the interests of personnel selection. Since then, the work has been continued also for its wider relevance to society. In the last 6-8 years, our investigative efforts have expanded to include biology and physiopathology, along with environmental factors. Because we believe that psychosocial responses are intimately related to physiologic phenomena and environmental conditions, an interdisciplinary approach is emphasized in the French polar program. Thus, accurate environmental measurements are considered equally as important as accurate measurement of physiologic parameters, if the two are to be correlated.

We welcome cooperative efforts with the other SCAR nations--in shared research programs, for example, or exchange of personnel between stations. With our improved economic situation in respect to polar research, we hope to become more active in the international community represented in Antarctica. The experience of attending this 2-day colloquium strengthens my hope for future cooperation with the U.S. in psychobiologic research of the type described by the participants here.

ABSTRACTS

Panel Discussion:

Biomedical Adaptation of South Pole Station Personnel to Wintering: Results of the USARP - Oklahoma Project, 1966-70

ORIGINS OF THE USARP-OKLAHOMA RESEARCH PROGRAM

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In the years following the IGY, the general research thrust in the Department of Psychiatry and Behavioral Sciences, at Oklahoma University Medical Center, involved studies of various phases of consciousness in man and animals. Jay Shurley was studying isolation and sensory deprivation; my work focused on sleep disturbances; others were examining consciousness phenomena in animals. At the same time, U.S. Navy investigators were concerned with similar problems, especially as they related to life in Antarctica. The efforts of these men to solicit more interest from their civilian colleagues, along with our own cordial contacts at the Naval Medical Neuropsychiatric Research Laboratories in San Diego, and at the Bethesda Naval Medical Center, constituted the initial stimulus of the USARP-Oklahoma Research Program. Subsequent contacts with Dr. George Llano of the National Science Foundation gave the project its real impetus.

In 1963, we made our first on-site inspection of the South Pole Station in order to see, in person, the actual working conditions, facilities, and problems likely to be encountered (among them, the acceptance of psychiatrists by station personnel). This environment seemed an ideal place for field study of psychophysiological adaptation to stress, confinement, and various deprivations. It was well known, for example, that sleep disturbances were rife among the men in this isolated environment. We were impressed not only with the research possibilities, however, but with the importance of selecting investigators with special qualities, necessary for effective work among the men in the polar station. Subsequently, much thought and study went into the experimental design of the program we planned to launch. Finally, with the freely given cooperation of the National Science Foundation and the Navy, and the cheerful forbearance of our superiors and coworkers at OUMC, the project entered the field in 1966.

PSYCHOPHYSIOLOGY OF POLAR SLEEP

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The Oklahoma Sleep Project, a study of the sleeping and waking behavior of South Pole Station personnel, took several directions. A 7-channel polygraph recorded on magnetic tape the psychophysiology of sleep patterns of about 10 unpaid volunteers during each of two consecutive years. Baseline and follow-up studies revealed that all men entered the station environment with normal proportions of slow-wave sleep (i.e., delta rhythm), that it underwent a profound decrease over the year in residence, and that the low levels persisted as long as 18 months after return to the U.S. The significance of these data is unknown at present, but we assume they represent a response to chronic stress.

In addition, sleep and activity patterns of large (or total) samples of Antarctic personnel wintering-over at Pole, Byrd, McMurdo, Scott, and Vostok stations were examined. In 1967 and 1968, participants recorded data daily on self-report cards; the results are currently being analyzed. Finally, a short-term sleep study was conducted on two new arrivals at South Pole, revealing a marked change in sleep patterns--including total loss of slow-wave sleep. This was thought to be associated with the acute hypoxic state. In general, there is an unusually high incidence of periodic, severe insomnia among station personnel through the dark period. Some men "free-cycled" their sleep and waking periods throughout the year. None showed untoward clinical effects upon return to the U.S.

Clearly, much remains to be elucidated, and further, more detailed studies are strongly indicated.

IMMUNOLOGIC AND PHYSIOLOGIC RESPONSES OF MEN TO THE "GERM-FREE" ENVIRONMENT OF ANTARCTICA

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Carl Puckett Professor of Chest Disease
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University of Oklahoma School of Medicine

As an infectious-disease-oriented physician, I was at first ill-disposed to study a group of hale, hearty young men at an isolated polar station. Then it occurred to me that these men might, in their relatively germ-free environment, serve as "mirrors" (i.e., reverse images) of the sick state. Indeed, we found that men at Plateau Station uniformly had white blood cell (WBC) counts below 500/cu. mm. whereas 5000-10,000 is considered the clinically normal range. After the men landed in New Zealand on the way back to the U.S., these counts quickly returned to the normal range. Antibody activity in Antarctic personnel, measured by immunoglobulin levels, dropped so low that it was undetectable by currently available techniques. Consistent with these laboratory findings, respiratory infections were virtually absent after a short period of residence at polar stations, while 70% of the men have reported their occurrence upon return to the U.S. The Russians have made similar observations. Experimental animals introduced into a germ-free environment respond in much the same way to the decrease of microbial insult: WBC count falls, the lymph nodes and spleen shrink, and immunoglobulins decrease.

Thus, what clinicians consider a normal WBC count is only relative, representing a degree of wellness (or of sickness, depending on one's point of view). Cut off from the ordinary pool of antigen, as in Antarctica, man manifests an entirely altered "normal" range. This has clinical implications for many kinds of group living--from the crowded urban situation to long space flights, in which antigen assaults and antigen deprivation affect health status.

CARDIOPULMONARY AND METABOLIC CHANGES AT SOUTH POLE

Clarence A. Guenter, M.D.
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The South Pole Station, though it is situated 9,280 feet above sea level, has an effective pressure altitude of about 11,500 feet, and hence its marked physiologic effect upon man. This was confirmed by direct measurements of blood gases, pulmonary function, and erythropoeitin and cellular responses of the blood--determined on volunteers among station personnel at several intervals during their year of residence. Early incomplete adaptation to hypoxia was apparent from the data, but this phenomenon paradoxically reversed itself about midway through the year, until it was completely lost. It remained absent thereafter. Body temperature (measured orally) also decreased significantly during the year. These pilot studies indicate that further, much more sophisticated studies of cardiopulmonary function are strongly warranted in station personnel who reside at South Pole Station for a year.

REFLECTIONS ON BIOMEDICAL RESEARCH NEEDS AT THE SMALL POLAR STATION

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In 1967, I was the Navy Medical Officer and Officer-in-Charge of an eight-man U.S. Antarctic station. Consistent with the report of Dr. Muchmore, hematologic studies of the men at Plateau Station revealed a significant decline in white blood cell counts. These and other routine physiological measurements at Plateau yielded equally interesting data. Yet, I became convinced during my 12-month stay that a more important aspect of this biomedical work was its psychosocial effect on the group. Participation in systematic examinations and cooperation in the laboratory work required the integrated efforts of all station members. My observations of our eight-man team (including myself) lead me to urge further investigation, in the Antarctic and elsewhere, of group phenomena--such as general lack of interpersonal and environmental familiarity, the conditional feeling of closeness generated by environmental hazards, and the common hope of successful completion (or sometimes, simply escape) of the tour of duty. Studies of this nature may not only enhance operational effectiveness at the polar stations; they may give us more basic knowledge of isolated group function.

INFORMATION PROCESSING PARADIGM IN EXOTIC ENVIRONMENTS

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Department of Psychiatry and Behavioral Sciences
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The small groups who reside and function in the isolated, stressful, closed environment open only in summer each year offer a unique challenge and opportunity to study cognitive functioning in the field. It is obvious from the reports of Shurley and his colleagues that interesting and significant alterations do occur, which have heretofore received no attention.

However, tested methods do exist which could be utilized at the new South Pole Station for monitoring cognitive functioning quantitatively and qualitatively in terms of information processing and decision making. Studies here in Shurley's laboratory, using Pishkin's auditory Concept Identification procedures, and medical student volunteers reveal conclusively that even brief (30, 60 and 120 minute) exposures to profound sensory and perceptual isolation result in highly significant facilitation and inhibition of information processing rates and accuracy, in a characteristic time course. The method could well be used to study any other exotic environment. Furthermore, social input variables as well as stimulus variables can be studied objectively by this method.

The effects of multiple stressors, of hypoxia, drugs, and other stressors on highest level cortical functions, judgment, and decision making, and their critical role in human performance, thus become open to objective assessment. It is strongly felt that this kind of information would have many significant implications for polar operations, as well as other exotic environments.

THE SOUTH POLE AS A SOCIOCULTURAL LABORATORY

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Many situations exist in which individuals are separated from their accustomed microculture; e.g., students in college dormitories, missionaries in remote regions, Peace Corps volunteers, etc. In such instances, the influence of the new environment upon the individual is very difficult to study. In the laboratory represented by the Antarctic station, the socialization process of the wintering group has known boundaries. We still cannot control the variables, but they are greatly diminished--and with proper instruments of observation, their psychophysiologic effects may be evaluated.

A closed social environment exists for eight months annually at the South Pole; the men in the party are spatially isolated and removed from the direct influence of their native culture. There is little privacy, and the individual is forced to socialize with an extremely heterogeneous group. Before three months in isolation have passed, the jokes and stories have become stale, the store of movies has been shown, and the men find themselves burdened with leisure time. Consequently, they find themselves turning inward to contemplate themselves as individuals, their past, and their future. Common responses to this situation are: (1) depression, loss of hope, and social withdrawal (characterized by a refusal to try to understand the environment and one's reactions to it), and just "waiting out" one's stay; (2) subjective exaggeration of the group heterogeneity, polarization into groups based upon unresolved opinion differences, and deterioration of the party into several hostile cliques; and (3) an initial period of intense, personal social comparison, followed by the evolution of a microculture adapted to this special environment (with the degree of success depending upon the composition, and often size, of the party). All "successful" wintering parties at small stations appear to have attained some degree of group homogeneity based upon sociocultural reorganization.

PERSONAL IMPRESSIONS OF THE POSSIBILITIES AND LIMITATIONS OF BIOPSYCHOLOGIC RESEARCH IN ANTARCTICA

Albert Joern
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After a year of work at the South Pole, I left with ambivalent feelings. The seemingly inexhaustible research possibilities in biomedicine made my involvement in our project exciting, but the feeling that I had only scratched the surface gave me a profound sense of failure.

An area of physiologic study which should be pursued is the puzzling response of pulmonary physiology in man to long-term exposure to the hypobaric environment at South Pole Station. According to the textbooks, one would expect greater efficiency of ventilation and oxygen transport. Indeed, this appeared to be the case initially, but by the end of the year our subjects had actually reverted to the unacclimatized state. Unfortunately, the measurements used to measure these parameters lacked optimum precision, the sample size was small, and this finding cannot be presented except as an empirical observation.

Another rich area of investigation is the psychosocial interactions at the small, isolated stations. They offer conditions in group living that cannot be duplicated in the laboratory. Participant observation is complicated and difficult, however. Not only must the biopsychologist develop refined, standardized measurement techniques which will be feasible to use in the remote, rugged environment of Antarctica, but he may also be faced with major problems of nonacceptance (due to irrational fears and suspicions of his psychiatric connections) by some of the subjects needed to participate in the studies.

NOTICE

The study reported herein was undertaken under the aegis of the National Academy of Sciences with the express approval of the Council of the Academy of the NRC. Such approval indicated that the Council considered that the problem is of national significance; that elucidation and/or solution of the problem required scientific or technical competence and that the resources of NAS were particularly suitable to the conduct of the project. The institutional responsibilities of the Academy were then discharged in the following manner:

The members of the study committee were selected for their individual scholarly competence and judgment with due consideration for the balance and breadth of disciplines. Responsibility for all aspects of this report rests with the study committee, to whom we express our sincere appreciation.

Although the reports of our study committees are not submitted for approval to the Academy membership nor to the Council, each report is reviewed by a second group of scientists according to procedures established and monitored by the Academy's Report Review Committee. Such reviews are intended to determine, inter alia, whether the major questions and relevant points of view have been addressed and whether the reported findings, conclusions and recommendations arose from the available data and information. Distribution of the report is permitted only after satisfactory completion of this review process.