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R. MALHOTRA

UNDERSTANDING THE CONCEPT OF ADAPTATION WITH SPECIAL REFERENCE TO PHYSIOLOGICAL ADAPTATION

ABSTRACT. — Study of adaptation and adaptability connotes a lot, in a country like India, spreading over thousands of sq. miles with a vast cultural, biological and ecological diversity. It can be carried at three levels i.e., a) behavioural: the responses are rapid and particularly suitable to temporary fluctuations, b) physiological: here, the responses are activated relatively slowly and are reversible and irreversible in nature, c) genetical: these changes have very slow rate of activation and take several generations.

In the present paper three most relevant ecological factors to the Indian conditions i.e., high altitudes, desert and nutrition, have been discussed, with special reference to physiological responses.

KEY WORDS: Adaptation — Physiological responses — High altitudes — Deserts — Nutrition.

In the present day biological anthropology trend of typological studies has shifted to population studies, with a significant shift of emphasis towards understanding the processes of human adaptation, rather than the products of evolution and adaptation. The biological anthropologists have started concentrating on the processes of micro-evolution and adaptation, using the data on human variation, which was the mainstay of previous studies. The product of these studies provided insights into the very processes which were responsible for these. The underlying factor for such studies is the development of integrated and holistic approaches to evaluate the adaptive processes of human populations. We must understand as much about the cultural basis for adaptation as we do about the environmental stresses and biological mechanism capable of adjusting to them. In a country like India, spreading over thousands of sq.km. with vast cultural, biological and ecological diversities, the problem of adaptation and adaptability occupies an important slot in the total setup of national health and defence programmes.

Adaptation is the process of creating beneficial relationship with environment and it takes place at three levels: a) Behavioural, b) Physiological and c) Genetical demographical (Bateson 1963, Slobodkin 1968). Each level includes several adaptive areas. Quick adjustments to sudden changes in the environment are reflected at the behaviour level. The behavioural responses are rapid and particularly suitable for temporary fluctuations in the environment. Two kinds of behavioural adaptation, i.e. psychological and cultural, are seen. Anthropologists mainly focus on the latter one. The cultural behaviour is patterned, shared and traditional. This can be put in other words also, i.e. changes at technological, organisational and ideological level. These changes help humans to adapt in four ways:

i) by providing the solution to environmental problems,
ii) by improving the effectiveness of these solutions,
iii) by providing adaptability and
iv) by providing awareness or recognition of environmental problems.

The second adaptive level, activated more slowly than behaviour is the reversible and irreversible physiological responses made by the individuals. Acclimatisation is a reversible physiological adjustment to environmental stress, none of the changes is genetically transmitted although potential for these changes may exist. Individual responses to altitude and temperature variation are the best documented examples of acclimatisation in humans. The "Developmental homeostasis" sometimes known as "Plasticity" is an irreversible modification in the individual phenotype due to external environmental stress during the process of growth and development. This can be well explained in the light of recorded data, showing large lung capacity and slow skeletal maturation rate among the individuals living at high altitudes and both these phenomena are results of low oxygen contents at high altitudes. Another classical example are the secular trends, showing larger body size, in the developed countries due to better or "hypercaloric" diet.

The last one is the genetic adaptation. The environmental perturbations continued over the long period of time supplement the behavioural and physiological responses and may result in permanent adaptations. Genetic changes have slow rate of activation and take several generations. These changes affect groups rather than individuals. The genetic structure of the human groups is maintained by high proportions of favourable genes under stable conditions, but a variety of less favourable genes are also maintained as a "buffer" to absorb the shock of unexpected environmental changes. The changes in the gene pool, which take place for improving the fitness of group to a particular environment or in the face of changed or changing environmental conditions are known as "directional selection". This "selection" changes the genetic characteristics of a group increasing the proportion of novel genes at the expence of past favorites. This can be well illustrated by the relationship between temperature and body shape.Heat loss among the human beings is largely through skin, hence the total skin surface area determines the amount of heat loss. It is well known that cylindrical shape has greatest surface area and spherical the smallest for a given volume. The body shape of human beings is an important determinant of heat loss, the selection of body size and shape to climate is well expected — like the prevalance of cylindrical shapes in hot climates. On the basis of these observations two rules have been formulated. The first one is *Allen's rule,* which states that extremities are reduced among populations of cold dwelling endotherms, suggesting thereby, a tendency for shorter legs and arms relative to trunk size in cold climates than would be found among people in relatively tropical areas. The second one is *Bergman's rule,* which stipulates that the body size of endotherms tends to increase as the temperature of the habitat decreases.

In other words as the body size increases the ratio of skin area to volume decreases — so that the heat production which is proportionate to the mass of the individual, is maximized relative to the amount of skin to the air.

With this background in mind we can utilise the results of adaptational studies for better implementation of national health programmes in general and positioning of defence personel in particular, for better efficiency. The main focus of this paper is to highlight the positive aspects of physiological adaptation studies, which can go a long way to help in preparing the blueprints of health programmes and placement of defence personnel. The most relevant climatic conditions in India, for physiological studies are: adaptation to *high altitudes, desert* and *nutrition.* These environmental parameters are discussed individually as under:

ADAPTATION TO HIGH ALTITUDES

There are quite a few studies on the high altitude populations in the Indian subcontinent, but the descriptions of responses, pertaining to newcomers, sojourners or residents have often omitted the ascription of adaptive value and are without any correlation with selective advantage or enhanced performance. The various micro-environmental factors described by Mazess (1975), which affect the man's performance at high altitudes are: a) Hypoxia, b) Cold, c) High winds, d) Rough terrain, e) Limited nutrition, f) High solar radiation.

The most important physiological criterion, of course, is hypoxia, which is characterised by high altitudes. The other factors are present to some degrees also in other geographical zones. The low barometric pressure at high altitudes results in low oxygen tension. This hypoxic condition at high altitudes is pervasive and cover present stress, which can be ameliorated only slightly by altering behavioural patterns and developing altitude technologies. Most of the organ systems and physiological functions are adversely affected by hypoxia. The responses of newcomers, sojourners and residents provide a general framework for evaluation of biological adaptation and this can be assessed at various levels like physical performance, nervous system functioning, growth and development, nutrition, reproduction, health, so on and so forth. Mazess (1975) sums up the effects of hypoxic conditions result in "homeostasis", i.e., hyperventilation and increased tissue capillarity. The physical performance, the nervous system and growth and development, all appear to deteriorate, but under longer exposure the physical performance increases. Caloric and protein utilization is adversly affected by hypoxia. The high carbohydrate and low protein diet has been found to be most suitable. The subnormal fetal growth and survival rate may reflect on reproduction rather than fecundity. Since hypoxia is a major stressor besides numerous environmental variables at high altitudes, it will be interesting to study it in combination with other factors to understand the adaptive responses.

ADAPTATION TO DESERTS

The Thar desert in the Indian subcontinent is distinguished, particularly, by extreme aridity and often very high temperature with marked diurnal and nocturnal thermal means. Nevertheless, this singularly inhospitable region has been inhabited since long before the dawn of history by a large, though widely scattered populations. It is disconcerting that there is still no major study available to tell us just what the effects of the environment may have been on the physiology of native Thar people and sojourners.

The regulation of human responses to excessive heat of deserts depends mainly upon air temperature, excessive sunlight, solar radiation, ground radiation, aridity and humidity wind speed, water resources, mineral contents of water, rate of dehydration etc.

It will also be interesting to record the water requirements of the human body, salt loss and how to make up the deficit, body built, weight, surface — volume ratio, age, skin colour and toxemia. Thar groups have yet to be studied on ways that could yield results that would be of much use to us. Observations have revealed that more active individuals are relatively lean and sinewy, but there are indications also that there is nothing genotypic about this (Briggs, 1975). Similarly Coon et al. 1950, Coon 1965 and Garn 1965 are of the opinion that there is no clearcut evidence that any major race of mankind is better adapted to desert than any other, in terms of overall genotypic composition, although there are suggestions that some subraces may have become better adapted as a result of natural selection, over very long period of time.

NUTRITIONAL ADAPTATION

Human biologists have been rather slow in recognising the tremendous importance of nutrition as a key environamental factor, affecting man's evolution and contributing to variability. In fact the importance of this aspect was highlighted through "plasticity" studies conducted by Boas in 1911, which strongly suggested that post-natal growth and maturation along with adult morphology were strongly influenced by diet.

The nutritional adaptation not only depends on the resources available but also on the mode and degree of their utilization. The utilization of food resources to some extent, is a culturally determined matter. A meagre supply of food (hypocaloric diet) often occurs in the very environments, the tropics, where soils are leached of minerals and foods of animal origin are scarce. Thus the increase in weight from tropics to frigid zones noted earlier, under consideration of Bergman's rule, may be a response to nutritional stress as well as adaptation to cold and heat.

The effects of nutritional inadequacies upon health and quality of life, can be studied right from the fetal stage itself. These inadequacies affect the individuals at various stages and many of them may result in fetal retardation, slow growth and development during childhood, delayed adolescence and affected adult body morphology. Furthemore, the basal metabolic rate (BMR) seems to be inherently low in poorly nourished populations. Thomas (1971) has shown that energy flow (caloric consumption) in the Andean human ecology, is low and frequently disrupted which in turn results in slow growth and might operate to maintain small size of individuals. A similar observation has been made by Malhotra (1966) by conforming that a clear increase of mean male stature with increased caloric and protein intake from south to the central and then to the northern parts of India, is observed. There are probably differences in the body proportions, as well. In that taller and probably better-fed people are relatively longer in the region of lower extremities, but generally, the body size is considerably more ecosensitive than body proportions.

Besides, by now it is well established that body size of adults and newborns show clear socio-economic gradients, irrespective of ethnic affinities. The rate of survival during the first five years among the young children born in poverty is much lower.

It has been seen that the parts of the body most affected by the nutritional deprivation are those programmed to grow most rapidly at that time. Apparently, full catch up, upon dietary rescue, seems to occur after the deprivation phase is over — in the developed countries, but is difficult in the underdeveloped ones, where such rescue is rare,

The importance of physiological adaptational studies, well envisaged from the foregoing account, can be further utilized for identification of high risk groups (persons with sickle cell anaemia, carriers of hepatitis), in the designing of clothing, equipment and work space, surveys of nutritional level and etiology of disease in diverse populations as well as within a population. All this has been well proved by the leading role played by physiological anthropologists in the current International Biological Programme. Presently, when man is increasingly beset by man made environmental problems and diseases of civilization — at least some solutions can come from anthropologists.

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R. Malhotra
Anthropological Survey
of India, 16/5 Madhuban,
UDAIPUR 313001
INDIA