Acclimatization to Cold in Antarctica as shown by Rectal Temperature Response to a Standard Cold Stress

Animals acclimatized to cold have been shown to maintain their deep body temperature at normal levels under conditions cold enough to induce hypothermia in unacclimatized animals[1,2]. Similar studies on men presumed to be acclimatized have given conflicting results. Some investigations[3,4] have suggested that there is an improved ability to maintain rectal temperature, others[5,6] have shown no change, while yet another[7] has shown a diminished ability to maintain rectal temperature. Such conflicting findings have led some workers to the conclusion that man does not acclimatize to cold, possibly for the reason that he is rarely exposed to sufficient cold stress to induce acclimatization. It was therefore thought desirable to investigate the effect of residence in the seasonally varying but always cold climate of Antarctica on men's responses to a test cold exposure.

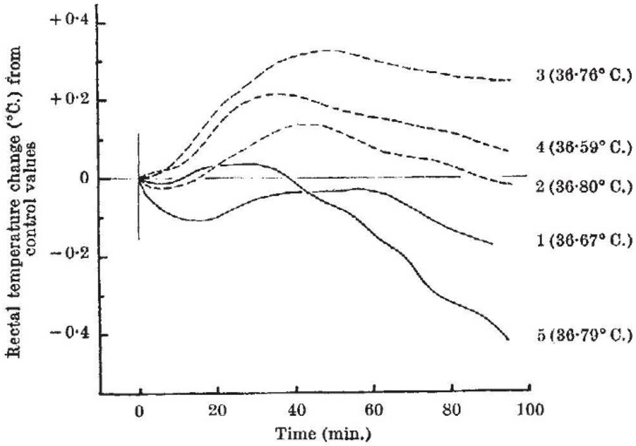

Fig. 1. Rectal temperature response to a standard cold stress in Australia (continuous lines) and Antarctica (broken lines). Each curve represents the mean of the eight exposures in the series identified by the adjacent number, and the value in brackets after each number signifies the control value (mean pre-exposure rectal temperature) in that series

Four members of the 1958–60 party of the Australian National Antarctic Research Expedition to Mawson (lat. 67° 36′ S., long. 62° 53′ E.) were exposed to a standard cold stress before, during and after a year in the antarctic. The standard cold stress consisted of a 95-min. exposure to an air temperature of 50° F. while the subject rested naked on a nylon-mesh mattress. During this exposure, and during the last ½ hr. of a 1-hr. control period under blankets that preceded it, the skin temperature at five sites and the rectal temperature were measured every 5 min., and the metabolic rate was determined every 15 min. The time of day, and food and exercise preceding the exposure, were standardized. The ambient conditions to which the subject was exposed (air temperature, humidity, air movement and mean radiant temperature of the surroundings) were measured during every exposure.

Five series of these tests were carried out, and in every series the same four subjects were exposed twice, making eight exposures per series and forty exposures for the whole study. Series 1 was done in Melbourne in December (summer) 1958 immediately before sailing for the antarctic; series 2, 3 and 4 were done at Mawson in 1959, in autumn, spring and summer respectively; and series 5 was done a week after returning to Melbourne in March (autumn) 1960, one month after the expedition ship had left antarctic waters.

Fig. 1 shows the average rectal temperature change from the control (pre-exposure) values in response to the cold exposure in each of the five series. It can be seen that in series 1, in Melbourne, the cold exposure caused a fall in rectal temperature (− 0·15° C. at the end of the exposure). In the antarctic, instead of falling, the rectal temperature rose in response to the cold exposure, the rise being earliest, highest and most sustained (+ 0·25° C. at the end of the exposure) in series 3, which was done in the spring at the coldest time of the year. This rising response weakened as climatic conditions afterwards became milder, until in series 5, in Melbourne once more, a slight early rise occurred but was not sustained, and thereafter the rectal temperature fell steeply to a lower level (− 0·42° C.) than in series 1. Analysis of variance of the rectal temperature changes after 90 min. in the cold showed that the differences between series were highly significant ($P < 0{\cdot}001$).

These findings cannot be explained in terms of experimental error, changes in body-weight or changes in physical fitness, and it is concluded that they are due to general acclimatization to cold, for they show a close relation to the degree of climatic stress experienced by the subjects. The results appear to indicate that acclimatization to cold in man, as in other animals, enhances the ability to maintain deep body temperature. The contrast between series 1 and series 5 suggests that the recent loss of acclimatization leaves the subject less able to maintain his deep body temperature than he was before acclimatization was first achieved.

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1 Hart, J. S., *Rev. Canad. Biol.*, **16**, 133 (1957).
2 Blair, J. R., Dimitroff, J. M., and Hingeley, J. E., *Fed. Proc.*, **10**, 15 (1951).
3 Glickman, N., Keeton, R. W., Mitchell, H. H., and Fahnestock M. A., *Amer. J. Physiol.*, **146**, 538 (1946).
4 Glaser, E. M., *J. Physiol.*, **110**, 330 (1950).
5 Horvath, S. M., Freedman, A., and Golden, H., *Amer. J. Physiol.*, **150**, 99 (1947).
6 Rennie, D. W., in *Cold Injury*; *Trans. Fifth Conf.*, 1957, edit. by Ferrer, I., 253 (Macy, New York, 1958).
7 LeBlanc, J., *J. App. Physiol.*, **9**, 395 (1956).