Glacier Lassitude.

THE effects of glacier lassitude, ' a peculiar sapping of energy, a weakness of the legs, and a disinclination to move . . . not a breathlessness due to exertion, but a loss of muscular power . . . a profuse sweating . . . something like the oppression experienced when marching through a hot, moist jungle in the rains,' described by Major Hingston (' A. J.' **37,** 22 *seq.*) as one of the physiological difficulties experienced upon the 1924 Everest Expedition, have been investigated and simulated for experimental purposes by Professor Leonard Hill and Dr. Argyll Campbell at the Medical Research Council's National Institute for Medical Research at Hampstead. Their results appeared in the *Lancet,* May 2, 1925, p. 939 (in the A.C. Library). Major Hingston's further statement, that ' the lassitude appeared immediately after stepping on to the glacier ' and ' was quickly relieved on again reaching rock or moraine,' shows that the symptoms were such that the possibility of their being encountered should not be lost sight of whenever a climbing expedition affords a choice in route or camp site. The question appears to affect route rather than camp site, unless the camp is to be inhabited by day, as Major Hingston remarks that the lassitude was only noticeable during the middle part of the day. The question is one which does not appear to be confined to high altitudes or glaciers, for, as every climber knows, it is easier to climb a hill by a ridge than by a corrie ; and the difference can scarcely be attributed entirely to the psychological effect of the more varied views obtainable from the former. The experiments, which will now be described, appear to bear this out.

Professor Hill and Dr. Campbell, after stating that Major Hingston does not give the pulse rates of those suffering from glacier lassitude, continue : ' We know already that ordinary discomfort due to overheating is accompanied by an increase in pulse rate ; in fact, it is generally agreed that pulse rate is the best indicator of discomfort due to overheating. . . . Altitude itself, as is well known, increases the pulse rate while at muscular work. Here again pulse rate is considered a good indicator of distress.' They commence their investigations with this

knowledge to start with. Experiments, with consistent results, were made upon two subjects, viz. :

'D. S.,' who was in good training for football, and wearing ordinary winter clothing.

'C. P.,' a healthy, active person not of athletic habit, who was lightly clad.

An altitude of about 18,000 or 20,000 ft. was simulated by making the subjects breathe air only containing about half the normal amount of oxygen.

Conditions tending towards glacier lassitude were simulated by making the subjects work in a room heated to 68° F., in which the cooling power of the air, measured by dry kata-thermometer, was 5 millicalories per sq. cm. per sec. Opposite or bracing conditions, with which the effect of the relaxing ones was compared, were satisfied by making the subjects work in a wind tunnel at 46° or 50° F., and ventilated with a large fan, the cooling power in this case being about 32.

Work was done on a work-measuring machine of the bicycle type at the rate of 2170 ft.-lb. (300 kgm.) per min. at 70 r.p.m. ; or by walking on a revolving platform at 4 or 5 miles an hour. Each method gave similar results. In order to convey some idea of the work done by bicycle it may be mentioned that the net output of a man, weighing with his equipment 180 lb., would theoretically be equivalent to 2170 ft.-lb. per min. if he were climbing at the modest rate of 725 ft. per hour. It may incidentally be noted that quite a lot of investigation of the circumstances of mountain sickness is being carried out both in this country and in America by means of work-measuring bicycles [1] ; and much information of interest from the climbing point of view could be obtained if the data necessary for converting the rate of output of work into terms of feet climbed per hour were determined. These data would have to be found experimentally, as the efficiency of the human body as a climbing engine may be different from its efficiency when driving a cycle.

All the experiments were carried out about 3 hours after breakfast. The duration of work was adjusted so as to give definite evidence of mountain sickness—faintness, giddiness, headache. D. S. worked for only 10 minutes., while C. P. worked for two periods of 10 minutes separated by a resting interval of 12 minutes. In each experiment the pulse rate was measured for the last minute of work.

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[1] See for example *American J. of Physiology*, Oct. 1925.

Both sets of high altitude experiments—those under bracing and those under relaxing conditions—were repeated under sea-level conditions ; that is, while normal air containing 20·9 per cent. of oxygen was breathed. Thus there were four distinct sets of conditions, dependent upon the state of the air breathed and the air surrounding the body, under which the observations were taken :

1. Sea level—bracing.
2. Sea level—relaxing.
3. High altitude—bracing.
4. High altitude—relaxing.

Normal pulse rate would be at sea level—resting. The effect of work would be to increase this pulse rate. Such increase would be least under combination 1, and any further increase would be due to high altitude or relaxing conditions, or to the two combined. This further increase was determined by comparing the pulse rates between five of the six possible pairs of 1, 2, 3, and 4 ; and the average results worked out as follows :

Sets Compared	With	To Determine the Effect of	Average Increase in Pulse Rate D. S.	C. P.
1 & 2 3 & 4	High oxygen supply. Low do.	Relaxing conditions do.	12	24
1 & 3 2 & 4	High cooling power. Low do.	High altitude . do.	14	11
1 & 4	—	Relaxing conditions and high altitude together .	23	36

It will be noticed that the two observed values in the bottom line are approximately equal to the sum of those above, as they should be theoretically.

The conclusion arrived at is that under conditions such ' as glacier lassitude as experienced on Mt. Everest, produced by combined effects of overheating of the body and of breathing oxygen at low tension during light muscular work, the heart beat is markedly increased in rate owing merely to summation of the effects of each factor upon the heart. The pulse rate is an excellent guide to discomfort and distress of the heart during such conditions, a rate of 140 per minute being considered the limit of safety in the subjects under the conditions specified.' P. J. H. U.