

at the latter point firm unbroken land-ice was met with, which could not be passed either by the ship or with boats. The *Hekla* therefore returned northwards, and got out of the ice on August 18th in 68° 25' N., 19° 25' W. A short visit was made to Iceland for the purpose of coaling and taking in provisions; and on August 29th the *Hekla* again left for Greenland, the intention being to try to reach the coast at Cape Grinel and follow it southward to Angmagsalik, but constant easterly storms and packed ice made this impossible. On September 10th the coast was reached at Angmagsalik (65° 40' N.), the wintering place of Captain Holm. While the ship was anchored in a bay here the expedition made boat excursions northward to 66° N. The ice, here lying packed close to the land, prevented further progress, and it was too late in the season to await a spreading of the ice. All the inhabited places in the district were visited. During the eight years that had elapsed since the visit of Captain Holm the population had decreased from 400 to 300 souls. A very large collection of dresses, weapons, and utensils was purchased from the Eskimo.

On the 26th of September the *Hekla* left the harbour, and after a fine voyage arrived at Copenhagen on October 12th.

PHYSIOLOGICAL EFFECTS OF HIGH ALTITUDES.

By CLINTON DENT, F.R.C.S.

MR. CLINTON DENT, F.R.C.S., sends the following communication, which is a summary of an article published in the *Nineteenth Century* for September last, with additions suggested by Mr. W. M. Conway's recent experiences in the Karakoram:—
“Mountaineering as a special branch of travel has developed so much within the last thirty years, that the oft-discussed question as to the possibility of ascending the highest points of the Earth on foot has assumed a new phase. Probably, as far as practical skill is concerned, mountaineers of the present day are fully qualified to make the experiment. The question is whether the feat is a physiological possibility. The intrinsic ‘mountaineering’ difficulties are not likely to be insuperable. Assuming that Gaurisankar is really the highest point, it is probable that on the north side the snow slopes will be tolerably gentle. Days must occur, though they might be exceptional, when the snow would be in good order, and not powdery or granular. At the same time, the extremes of heat and cold experienced render it likely that extensive ice-slopes will be met with. Time would prevent any great length of ascent by step-cutting, and success would only be possible when snow overlying the ice was yet

adherent, and in good order for walking. It is tolerably clear that the use of climbing-irons may be essential. Although Mr. Conway's guide, Zurbriggen, cut an immense series of steps, they were not fully fashioned, as would be necessary if no climbing-irons were employed. 'A stroke or two' sufficed. Mr. Whymper's observations are of great interest and importance, but the Andes is not the most favourable field for testing the upward limit of mountaineering. A long sea voyage is necessary; the climate is trying, and the weather abominable. Experience seems to show that great heights can be reached in the Himalaya with less distress than in the Andes. Apparently also they can be reached with less difficulty in Sikkim than in Central Asia. Professor Bert and Mr. Whymper have demonstrated irrefutably that mountain sickness is a real affection. Professor Bert sees in the deficiency of oxygen at great heights the explanation of all the symptoms. Mr. Whymper does not share this opinion, and shows conclusively that Bert's suggested remedy, the inhalation of oxygen, is not practically possible on the mountain-side. Mr. Conway's experience at a height of 23,000 feet (?) seems entirely opposed to Professor Bert's theory. Mr. Whymper regards the expansion of the air or gas within the body and the consequent pressure upon the internal organs, as an important factor; but considers that this may be minimised, or even entirely avoided, by gradual ascent. In the writer's opinion, the mechanical effects of such expansion of air or gas are unlikely to prove at all a serious obstacle. A far more important factor is the effect of diminished pressure on the portion of the spinal cord concerned with the nutrition of the lower limbs. This effect is brought about through interference with the local blood-vessels. Greatly increased pressure also produces much the same symptoms. The circulation of the blood is much impeded through the portion of the spinal cord where it is most demanded while the lower limbs are being exerted. The result is, that the action of walking, which should be almost 'automatic,' at great heights demands a powerful effort. Hence follows fatigue. Recovery can take place, but only very gradually. Mr. Conway took sphygmographic tracings of his own and his guide's pulse at the greatest height he reached. These tracings will probably bear out what has often been noticed before, that the blood has great difficulty in reaching the extremities. Presumably the tracings were of the pulse at the wrist. Comparative tracings of the pulse in an artery such as the carotid in the neck would have been of great value, and such may have been taken. For the turbulent action of the heart and consequent distress might then be shown to be due to efforts to overcome the peripheral resistance rather than to any affection of the heart itself. Certain blood-vessels have to enlarge, and this is a slow process. The increased frequency of the heart's action is due to peripheral resistance. It would appear, as regards the effects due to expansion within the body of gases

as well as to the nutrition effects, that complete recovery and entire habituation to low pressure can take place. Mr. Whympers dictum, that, in the endeavour to ascend to the greatest heights, 'from the effects of respiration none can escape,' is discussed in the article referred to. Inspiration being a muscular act, the question is, how far the special muscles involved may be trained to extreme and protracted exertion. Actual experiment can alone furnish the full answer. Physiological considerations seem to indicate that in exceptional men the required increase of sustained muscular power could be fully met. In men and animals who remain for some time under conditions of greatly reduced pressure the number of coloured blood corpuscles, the essential oxygen-carriers, increases prodigiously. It is thus apparent that the oxidations of the body may be carried on after a time effectively at great heights. Those who would attempt the experiment must be physically qualified. Anæmic persons are unsuitable. Tolerably full-blooded men, of spare habit, with relatively large bones, will probably suit best. The experience of the workmen recently engaged in the construction of a railway tunnel in Peru, at a height of 15,645 feet, shows that in a period to be measured by weeks, occasionally months, acclimatisation becomes so complete that the individuals are capable of doing full work. The climatic conditions are so much more unfavourable in Peru than in the Himalaya, that it is not unfair to assume that work at a height of 20,000 feet in the latter would not demand greater exertion than at a height of 16,000 in the former. Neither on mountaineering nor on physiological grounds does the possibility of ascending Gaurisankar appear hopeless. To some extent a question of men, it is largely a question of money. Selected men will have to work for a year or more with the one definite object before them if they desire to ascend 6000 or 7000 feet higher than has yet been reached on foot. The attempt would be costly, long, laborious, and not free from risk; but it is possible. The cold due to the diminished circulation through the lower limbs appears to be a more serious factor than has hitherto been imagined. Although the heat of the sun was terrible in Mr. Conway's recent ascent of the Pioneer Peak, 'the cold ground seemed to suck the warmth out of our feet' (*Proceedings*, 1892, p. 763), and the party narrowly escaped frost-bite. Wearing metal climbing irons may have conducted to loss of heat; but it is plain that the best covering for the feet and legs for very high ascents requires special and further consideration. The experience of Arctic travellers will be of value; but it must be remembered that Arctic travellers are not subject to the same interference with the circulation due to the diminished pressure. Certain drugs have the power of relaxing the smaller blood-vessels, and it is possible that these might be of use."