NATURE

SATURDAY, OCTOBER 10, 1925.

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

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NO. 2919, VOL. 116]

Physiology and Athletics.

PROF. HILL'S address on "The Physiological Basis of Athletic Records," an abridgment of which appears elsewhere in this issue, affords another instance of the value of laboratory work and its application to practical problems. The investigations of the functions of the isolated frog's muscle which were almost notorious for their supposed uselessness, have laid the foundation of the later work on muscular exercises. Prof. Hill does not claim that physiology can teach us how to win races, or, what is more important to certain sections of the public, "how to spot winners." The physiologist can aid, however, in the selection of men and women who are likely to become successful in the field of athletics.

The measurement of the gaseous exchanges of the body have been used for some time as a means of investigating certain functions of the body. In the hands of workers such as Haldane, Douglas and Krogh, among others, these methods have yielded results which have led to an understanding of the functions of the circulatory and respiratory systems. Benedict and Cathcart, by direct and indirect calorimetry, showed how the metabolism of the body and the physiological cost of work might be studied. Prof. Hill, by measuring (*a*) the maximum oxygen intake (income) and (*b*) the maximum oxygen debt, has extended the scope of these investigations. The measurements afford a means of investigating not only the metabolic changes during exercise, but also of studying the recovery process in the tissues after exercise is over.

It is clear that the measurement of the oxygen used will enable us to estimate the physiological cost of work, but movement to be physiologically efficient must be carried out in a skilful manner. The athlete who is able to go into debt heavily for oxygen is not necessarily the most skilful. The degree of skill which is shown will depend on factors such as posture, co-ordination of muscles, and the integrative action of the nervous system. Even the most simple movements of the body will on analysis be found to be exceedingly complex, many factors being harmonised to bring about the unity of motion. The work of Marey and the Webers demonstrated, many years ago, that the mere act of walking involved not only movements of flexion and extension of the lower limbs, but also accompanying movements of the shoulders, arms, head and hips. At each step, oscillations of the hips, shoulders and head occur. The leg that is moving forward is accompanied by a forward movement of the hips and a backward movement of the shoulders, that is, a slight twist of the trunk around a vertical axis. This torsion may be so exaggerated as to become very

apparent, but it is manifest to a slight extent even in normal walking, especially in women with a large pelvis. The torsion of the trunk and active oscillations of the upper limbs which balance the body increase on rapid walking. These accessory movements, unless reduced to a minimum, will lessen the efficiency of the movement and increase the physiological cost.

The muscular system which controls voluntary movement may be divided into three parts: (1) the prime movers, (2) the antagonists, and (3) the synergic group of muscles. Flexion of a limb is brought about by the contraction of one set of muscles, the flexors, and relaxation of the opposing set or extensor muscles, the two groups working in harmony. This dual action is essential and is found in every voluntary movement. To allow the third group, the synergic muscles, to function in a co-ordinated manner with the prime movers and antagonists, the limb or body must adopt the correct position. The action of the muscles, as pointed out by Magnus, depends on the posture. Bedale and Cathcart have recently investigated the physiological cost of work, by indirect calorimetry, in different types of weight-carrying, and their results show that the cost of work varies with the same load according to the posture adopted.

The body controls the movements of muscles and the posture of the part by the action of the nervous system. The regulating mechanism involved has been termed by Sherrington "the proprioceptive system," and includes nerve fibres from the muscles, tendons and joints, the internal part of the ear, and the external muscles of the eye connected through the various regions of the brain. In maintaining balance and posture each organ plays a definite part, regulating position, judgment of distance and the co-ordination of movement. The interaction and co-ordinated mechanism of these systems can be demonstrated by any skilled act, as, for example, movements of the expert skater in cutting a figure on the ice. It is impossible at the present time to express these various factors in measurable terms, but the investigations of the oxygen consumption correlated with the speed of movement gives a basis for discussion. It must be clear that a first-class athlete who is capable of breaking records does possess a high degree of skill in his movements. A man who is capable of establishing a large oxygen debt may become a record-breaker if he can be taught how to use his limbs to the best advantage. The elimination of unnecessary movements is receiving attention in the fields of athletics and industry. Slow motion photography and motion study are means by which the movements may be studied and faults corrected.

There still remains a factor of which we have little knowledge, namely, the determination to win. How often is form upset on the racing track through a man losing his will to win at the psychological moment. This faculty, vague and indefinite as it may be, undoubtedly plays an important part in athletic life.

The comparisons drawn between men and women will be hotly contested, and Prof. Hill is a brave man to express the female performer as a fraction of a man. Certain anatomical differences in structure of men and women are known and probably militate against the female athlete. The flat female pelvis allows greater torsion of the trunk on exercise, and accessory movements of this nature will interfere with speed of action. Again, it is not clear that women up to the present have given as much time and attention to sport as men, and improvement is likely to be made by training and physical culture. Prof. Hill has arranged to carry out further work on this subject, and the results will be awaited with interest.

Fossil Insects of the Carboniferous Period.

A Monograph of the Fossil Insects of the British Coal Measures. By Dr. Herbert Bolton. Part 1. Pp. 80 + 4 plates. Part 2. Pp. viii + 81-156 + plates 5-10. (London: Palæontographical Society, 1921-1922.)

PALÆONTOLOGISTS are now aware that, at the epoch when the coal beds of the Carboniferous Period were deposited, the arthropods were the first of all living creatures to gain the conquest of the air—these insects bore sway in that silent domain which as yet the birds did not dispute with them. This most ancient world of insects has been revealed by the progress of study as of so special a character that it cannot be brought within the narrow limits of the zoological classifications of the present day.

British palæontologists possessed the honourable record, with regard to fossil insects, of having first discovered, early in the last century (1833), an impression of an insect in these carboniferous strata (*Lithosialis brongniarti* Mantell, 1854). They have now added to their list of successes a record which is still more glorious because it is due, not to chance, but to the sustained effort of one of their number—to-day the insect fauna of the British Coal Measures must be regarded as the best known of all those brought to light from all the Carboniferous basins of the world, thanks to the scrupulous and patient work which Dr. Herbert Bolton, director of the Bristol Museum, has carried out during close on twenty years.

The following figures will speak for themselves: in 1908, when Dr. Bolton began his investigations, only