muscle with motor supply intact, we might expect reflex contraction. Not only is there none, but further, the muscle, if reflexly contracting at the time, is thrown out of contraction. Instead of reflex contraction, there is therefore reflex inhibition. Evidently the muscle is provided with more than one kind of receptor; it possesses certainly two kinds with diametrically opposed functional effect. Like the heart, it has two opposed nerves, one of augmentor function, one of inhibitory function—only in the case of our skeletal muscle these two opposed nerves are afferent and not efferent.

The significance of this is at present obscure. The "lengthening reaction," it is true, may involve a reflex inhibition and is certainly proprioceptive. We must also not forget that muscles can give rise to pain. Cramp, rheumatism, muscular fibrositis, and neuritis evidence this only too commonly. Even a small partial rupture of a muscle makes it a seat of pain when it contracts. In all such cases the treatment that the physician's experience enjoins is rest; that is the treatment that Nature herself seems to aim at, for she enforces it, in the last resort prescribing pain, if rest be departed from. Existence of these inhibitory afferents from muscle suggests she enjoins involuntary desistence from contraction by reflex inhibition. Some involuntary, as well as voluntary, restraint from use of his lumbar muscles restricts the lumbago patient in rising from his chair. But the problem of the proprioceptive nerve, which inhibits its own muscles, certainly cannot be satisfied wholly in this way. Among such proprioceptives are some which, while reflexly inhibiting their own muscle, excite contraction of the antagonist, thus causing for their own muscles a stretch scarcely likely to be soothing to inflammation. Moreover, there are muscles which seem not to possess proprioceptors inhibitory of themselves.

The microscope likewise separates the receptors of muscle into species of more than one kind, well-differentiated forms, muscle-spindles, Golgi tendon-organs, basket-endings, tendril-terminals, Pacinian corpuscles, and so on. It is unlikely that for all these the adequate stimulus can be the same, or the functions identical. In perception of postures and movements there seem traceable, as underlying data, degrees of muscle-length on one hand and, on the other, degrees of muscle-tension. Some muscle-receptors may be length-recorders, others tension-recorders; one would suppose the Golgi tendon-organs among these latter. As to the "muscle-spindles," the muscle fibres they enfold, though differing within the spindle from those outside, yet receive motor-terminals; one would suppose active contraction to supply their stimulus. Through them and through other receptive endings which clasp muscular fibres, the active contraction of the muscle might be expected to evoke reflex reactions, and to furnish a "contraction" datum for perception of active postures and movements.

At present, however, there seems little evidence that active contraction *per se* excites receptors in the muscle itself. Using that delicate index, the electric action-current of the nerve, and in the uncut nerve of the muscle, Forbes and Gregg and Forbes and Adrian have shown that the action-current in a reflex excited by a single shock is practically as brief lasting as in the direct reaction of the cut motor-nerve itself. No proprioceptive reverberation seems to ensue. Again, Cooper and Adrian, with the action-currents of the muscle in reflex tetanus, find secondary waves following the primary ones of the response. In view of the likelihood that these secondary waves might be a proprioceptive repercussion set up by the primary contractions, they paralysed these receptors, but only to find the secondary waves still persist. Germane to the general negative result with reflexes seems that unexpected feature of the "muscular-sense," revealed by perceptual examination of movements and postures, namely, that the fineness and accuracy of our perception of these when they are passively performed, *e.g.* by external means applied to a limb itself passive and inactive, is practically no less delicate than when they are performed by muscles themselves actively contracting. This would seem to suggest that the receptors of muscles are functionally merely on the same plane as are the receptors of the joints.

Muscular receptivity offers a wide field, and our view of it has perforce been but a glimpse. That glimpse, however, may have served to show that through their own nervous arcs the muscles have a voice in their own management and co-ordination, and they are, moreover, not motor machines only but sense-organs as well. Only by fuller study of them in these aspects can we know how best to use them. Should this short account serve to attract recruits to that study, it will have been of good augury for progress in the problems of muscular receptivity.

Obituary.

DR. R. M. WALMSLEY.

WE regret to announce that Dr. Robert Mullineux Walmsley died on June 15, after a street accident which happened two days previously when he was knocked down by a motor vehicle immediately after getting out of a tram-car. Every attention was given to him at the hospital, but he never regained consciousness.

As Principal of the Northampton Polytechnic Institute in Clerkenwell, Dr. Walmsley was very well known in connexion with engineering training. In 1901 he started day courses in that college in electrical and mechanical engineering. In 1903 the governing body sent him to the United States and Canada to study the methods adopted in engineering training. The results he deduced from this tour were communicated to the Institution of Electrical Engineers in a lengthy paper read in February 1904. This paper gave rise to considerable discussion. He was of opinion that employers in Great Britain should be educated to the advantages of taking technically trained men. The system which he adopted at the Northampton Institute was a modified "sandwich" course, unsuitable men being gradually weeded out by examination.

Dr. Walmsley was born near Liverpool seventy years

ago, and was connected with technical education practically all his life. He matriculated at the University of London in 1879, obtaining the degrees of B.Sc. and D.Sc. in 1882 and 1886 respectively. He was appointed senior demonstrator in electrical engineering at the Finsbury Technical College in 1883. He went to India in 1887 as Principal of the Sind Arts College of the University of Bombay. Returning to England a year later, he became the first professor of electrical engineering and applied physics at the Heriot-Watt College, Edinburgh. In 1896 he was appointed Principal of Northampton Institute, a post which he held until his death.

Dr. Walmsley was chairman of Convocation and a senator of the University of London, and for many years he played a prominent part on many committees. He was for fifteen years chairman of the University Extension Board. In 1909 he was chairman of the council of the Association of Technical Institutions, and in 1912 he was chairman of the Optical Convention. He had also served on the council of the Royal Aeronautical Society, and was a member of the Institution of Electrical Engineers and a fellow of the Institute of Physics and of the Physical Society. He re-wrote and greatly extended Dr. Urbanitzky's "Electricity in the Service of Man," and was the author of other educational works.

MR. F. MERRIFIELD.

BY the death at Brighton on May 28 of Frederic Merrifield, at the venerable age of ninety-three years, British entomology loses one of its best known and most highly esteemed representatives. Mr. Merrifield was the son of a barrister of the Middle Temple, and was himself called to the Bar so long ago as November 1853. His mother, Mary Philadelphia Merrifield, was a lady of high scientific attainments, who quite late in life acquired a knowledge of the Norwegian language in order to correspond with Prof. Agardh on the subject of Algae, on which she was a recognised authority. Up to her death in 1888 at an advanced age, she was a frequent contributor to NATURE, and there can be no doubt that her son derived from her that wide interest and devotion to natural science which marked the whole of his long life.

In the intervals of leisure afforded by a strenuous public career at Brighton, where for many years he was Clerk of the Peace, besides serving on the County Councils of East and West Sussex, Mr. Merrifield became proficient in more than one branch of natural history. The study of the Order Lepidoptera, however, chiefly engaged his attention, and his masterly series of researches on the effects of various conditions of temperature in the early stages of certain butterflies and moths, on the resulting perfect insects, are familiar to all entomologists. These experiments were carried out between the years 1887 and 1896, and were in the first instance undertaken on behalf of the late Francis Galton in order to obtain data for the revision and extension of a general theory of simple heredity. The memoirs on these researches appeared in the Transactions of the Entomological Society of London, and are of high interest, especially with reference to experiments of a similar nature conducted independently by Standfuss, Weismann, and other investigators. An excellent detailed summary of these papers, by Dr. F. A. Dixey, was given in NATURE, Vol. 57, of December 23, 1897, pp. 184-188.

Mr. Merrifield, who was elected a fellow of the Entomological Society in 1887, served as one of the secretaries in 1887 and 1898, and occupied the presidential chair of the Society with distinction in 1905-6. His genial address and kindly nature endeared him to all, and although an invalid for a good many of his later years, his mental powers and his keen appreciation of the beauties of Nature remained unabated to the very close of his long life. The collections of Lepidoptera which embody the results of his experiments will find a permanent and appropriate resting-place in the Oxford University Museum. J. J. W.

CAPT. W. F. CABORNE.

THE sudden death of Capt. Warren Frederick Caborne occurred from acute peritonitis on June 14 at Loppington Hall, near Wem, Shropshire. He was nearly seventy-five years of age, being born in July 1849. At the age of sixteen Caborne joined the mercantile marine and served for some time under Capt. Henry Toynbee, who was the first marine superintendent in the Meteorological Office. He joined the R.N.R. in 1879, and became a lieutenant in 1882. He was in command of the transport *Adowa* during the Burma Expedition. Caborne retired from the R.N.R. in 1894 with the rank of Commander; he was a Nautical Assessor from 1898 until 1914, and served in the same capacity to the Court of Appeal from 1903 to 1908, and to the Privy Council. He was a fellow of the Royal Geographical Society, the Royal Astronomical Society, and of the Royal Meteorological Society. For many years he served on the council of the latter; he was also a vice-president, and for some time honorary secretary. He was the author of numerous papers dealing with the naval reserve and marine subjects.

In later years Caborne was a member of the council of the Royal United Service Institution, and he also gave active support to the Smoke Abatement Society. Offering his service to the Government during the War, he was employed under the Director of Naval Ordnance, and for his service was promoted to Captain on the R.N.R. retired list in 1918.

WE regret to announce the following deaths:

Dr. W. J. Beal, for forty years professor of botany in the Michigan Agricultural College, on May 12, aged ninety-one.

Sir James J. Dobbie, lately Government Chemist and formerly Director of the Royal Scottish Museum, Edinburgh, aged seventy-one.

Dr. R. H. Jude, for many years head of the Mathematical and Physical Departments of Rutherford College, Newcastle-on-Tyne, on June 1, aged seventy-one.

Prof. J. G. Longbottom, professor of mechanics in the Royal Technical College, Glasgow, aged fifty-four.

Charles Oberthür, naturalist and printer of Rennes, aged seventy-eight.

Mr. E. P. Rathbone, a foundation member and member of council of the Institution of Mining and Metallurgy, on June 14, aged sixty-seven.

Sir Adolphus William Ward, Master of Peterhouse, Cambridge, and Vice-Chancellor of the University of Cambridge 1901–2, on June 19, aged eighty-six.