It is possible that the tension which causes these contractions of the leaf-cells at the same time acts as a stimulus to increase the permeability of the plasmatic membranes of the cells; and so one might imagine that the development of a certain tension would automatically release organic substances from the cells and draw them through the tracheæ downwards. Direct experiment on this point presents difficulties, but it may be worth recording that when the internal osmotic pressure of the leaf-cells was overbalanced by an external gas-pressure, the water pressed from the cells and forced out of the tracheæ of the supporting stem was found to be practically pure, and if it contained carbohydrates they were in such small quantities that no reduction could be detected with Benedict's solution either before or after inversion. This experiment was repeated several times with branches of *Sambucus nigra* and *Tilia americana*. The cut branch, well supplied with water, was first exposed for several hours to conditions favourable to photosynthesis, and then either immediately or after a sojourn in darkness subjected to the gas-pressure. A pressure of thirteen atmospheres was found sufficient to drive water back from the leaves out of the stem.

Of course the conditions of this experiment are not those obtaining in the normal plant, where during transpiration the volume of a leaf, or part of a leaf, changes. In the transpiring plant we can also imagine the accumulation of a substance or an ion which would give rise to an alteration of the permeability of the plasmatic membranes of the leaves.

When, in order to imitate these conditions, the cells of the leaves in the foregoing experiment are rendered permeable by the introduction of a little toluene into the pressure-chamber, the application of a smaller pressure is sufficient to press the cell-contents into the water-channels and liquid emerges from the base of the stem which readily reduces Benedict's solution.

In the same way, if a pinna of *Sambucus nigra* is surrounded with toluene vapour, transpiration from the adjacent pinnæ draws back the cell-contents of the toluened pinna, and afterwards their track in the wood of the vascular bundles of the rachis may be traced by the browning of this tissue.

Another possibility presented itself, namely, that the direction of the current might act as a stimulus regulating the permeability of the cells in contact with the tracheæ. To test this, short lengths of stem set in their normal position were supplied, first through their lower and afterwards through their upper end, with distilled water. In neither case could carbohydrates be detected in the issuing stream.

The foregoing short consideration of some recent physiological work leads us, then, to the following conclusions:

The transport of the organic substances needed in the distal growing regions is effected through the tracheæ of the wood. The substances travel dissolved in the water filling these channels, which is moved by transpiration, expansion of the growing cells, or root pressure.

Physical considerations forbid us admitting that sufficiently rapid transport can be afforded by the bast either for the observed upward or downward distribution of organic substance.

The existence of downward as well as upward movement of water in the tracheæ of the wood may be demonstrated by suitable experimental means, and may be inferred by the transport of hormones in the wood.

The occurrence of local contractions in leaves suggests that local increases of permeability supply dissolved organic substances to the distal ends of certain of the filaments of tracheæ. The tension developed by the transpiration of other regions draws these along downward as well as upward channels in the wood.

In thus ruling out the participation of the bast in the longitudinal transport of organic substances in plants one naturally is forced to speculate on its probable function. Its distribution and conformation are such that, while it possesses a very small cross-section, it appears with the other living elements of the vascular bundles, medullary rays, wood-parenchyma, etc., to present a maximum surface to the tracheæ.

This large surface may find explanation in the necessity of interchange between the living cells and dead conduits. The colloidal contents of the former render this process slow, hence the necessity for the large surface of interchange to enable sufficient quantities of organic substances to be abstracted from and introduced into the tracheæ to meet the needs of the plant.

Before concluding I would like to add that the experimental work carried out on this matter would have been quite impossible for me were it not for the assistance and ingenuity of Mr. N. G. Ball. He also has contributed materially by his criticisms and suggestions.

Obituary.

COLONEL E. H. GROVE-HILLS, C.B.E., C.M.G., F.R.S.

COLONEL EDMOND HERBERT GROVE-HILLS, whose death occurred on October 2 at his residence at Campden Hill, W., was the son of Herbert A. Hills of High Head Castle, Cumberland. Born on August 1, 1864, he was educated at Winchester, whence in 1882 he passed into the Royal Military Academy, Woolwich. There his abilities were recognised as giving promise of a distinguished career, and he passed out as the senior cadet of his term, receiving a commission in the Royal Engineers in 1884.

Scientific subjects specially interested him, and in 1893 he was elected a fellow of the Royal Astronomical Society; in the following year a paper by him on the photographs of the spectrum of the eclipsed sun taken at the solar eclipse of April 1893 was communicated to the Royal Society. The study of solar physics strongly attracted him, and he also took part in the eclipse expeditions of 1896 to Japan, of 1898 to India, and in that of 1914 to Kieff, whence he was recalled on the outbreak of war to military service. In 1898 he took up the appointment of instructor in chemistry and photography at the School of Military

Engineering, but he had only held this for a year when he was transferred to the Topographical Section of the General Staff at the War Office. Here his scientific inclinations found full scope in the organisation of survey work in all parts of the world. During his tenure of the post he raised the standard of this work in a very notable degree, which was recognised by the C.M.G. being conferred on him in 1902. His work here brought him into contact with many problems in geodesy, in which he took a keen and lasting interest. At this time Sir David Gill was actively promoting the geodetic triangulation in South Africa, and to this Grove-Hills gave his whole-hearted support.

In 1905 he completed his period of service as head of the topographical department of the War Office, and then retired from the army. In the following year he contested Portsmouth in the Conservative interest unsuccessfully, and afterwards occupied himself mainly with scientific investigations. At the British Association in 1906 he raised the question whether the triangulation of this country was of the accuracy required by modern geodesy, and a few years later the Ordnance Survey undertook the re-observation of certain triangles in Scotland to determine this point. In the same year he and Sir Joseph Larmor discussed the movement of the pole in an important communication to the Royal Astronomical Society.

Col. Grove-Hills was president of Section E at the British Association meeting in 1908, where he discussed the surveys of the British Empire in an important address. He had before this been invited to report on the Canadian surveys and wrote a valuable and instructive report on them. In 1911 he was elected a Fellow of the Royal Society, and from 1913 to 1915 he was president of the Royal Astronomical Society. He was also latterly Secretary of the Royal Institution. Keenly interested in astronomy, he designed the suspended zenith instrument at Durham Observatory, of which institution he was Honorary Director up to the time of his death. While on his way to Kieff with the eclipse expedition of 1914 he was recalled to take his part in the Great War, and was appointed Assistant Chief Engineer of the Eastern Command, being gazetted Brigadier-General in 1918. His services in this responsible post were recognised by the award of the C.B.E. in 1919.

Endowed with very great natural ability, and a keen interest in all scientific questions, Grove-Hills combined with these great administrative ability and sound common sense. He was always ready to assist by his advice and active co-operation in any well-planned scheme of scientific work, and in his death astronomy and geodesy have suffered a severe loss.

H. G. L.

MAJOR-GENERAL J. WATERHOUSE.

MAJOR-GENERAL JAMES WATERHOUSE, who was eighty years of age, died on September 28. As a youth he joined the Royal Bengal Artillery, and after seven years was made Assistant Surveyor-General in charge of the photography section in the Surveyor-General's Office in Calcutta. He retired in 1897. His official duties necessitated the study of photography and photo-mechanical methods of reproduction, and this he did with a keen eye for any possible improvement, and a skilful hand which enabled him to test the practical value of any new introduction. He made an extended continental tour during his term of office that he might become acquainted with the methods employed in foreign photographic laboratories. A considerable number of improvements were introduced by Waterhouse in photolithography and allied processes, as well as in collotype, sometimes varying methods in use elsewhere to render them suitable for a tropical climate. His knowledge of these methods in all their minutiæ was very extensive, and in 1882–1885 he contributed to the *Photographic News* a series of fifty chapters on photolithography.

In 1873, when Vogel published his discovery that the sensitiveness of plates to green and red could be enhanced from a negligible to a practically useful amount by the use of certain dyes, Waterhouse was one of the very first to confirm the observation and to find other effective dyes. In 1890 he found that by the addition of thiourea to the developer the reversal of the image was so much facilitated that a very little, if any, increase of exposure was necessary. He took part in the observation of the total eclipses of 1871 and 1875, and in the transit of Venus in 1874.

On his retirement, Waterhouse studied the early history of the camera obscura, and of the action of light on silver salts, correcting some false and incomplete ideas that were current. He was president of the Royal Photographic Society from 1905 to 1907, honorary secretary of the Calcutta Zoological Gardens from 1894 to 1897, president of the Asiatic Society of Bengal from 1888 to 1890, and trustee and twice chairman of the Indian Museum at Calcutta. The value of his scientific work in connexion with photography was acknowledged by the award to him of the Progress Medal of the Royal Photographic Society, and the Voigtländer Medal of the Vienna Photographic Society.

WE regret to record the death of Prof. J. K. A. Wertheim Salomonson. He was born in 1864, passed his medical studies at the University of Leyden, and in 1899 became professor in neurology and radiology in the University of Amsterdam. His contributions to these two subjects were of considerable importance, for his range of knowledge of medicine and physics was supplemented by a perfection of skill in instrumental design. He was a frequent visitor to this country and only last year he demonstrated to the Ophthalmological Section of the Royal Society of Medicine a method for the photography of the structure of the eye. He was responsible for improvements in the electro-cardiograph and in many instruments designed for radiological purposes. A man of engaging personality, his loss will be felt over the wide circle which his scientific interests served. He was a Knight of the Order of the Lion of the Netherlands and an honorary member of the Röntgen Society. At the time of his death he held the office of rector magnificus at the University of Amsterdam.