sodium cannot perform; but this special function of potassium has not yet been discovered. It is suggested here that organic complexing agents exist in plant tissue which have higher affinities for potassium than for sodium; the resulting co-ordination of chelate compounds of potassium, functioning perhaps as an unknown essential cellular constituent, may account for the essentiality of potassium.

In summary, the cations potassium, calcium and magnesium may exist in plant tissues in one or more of the following forms: (1) simple charged particles, bound ionogenically to particles of opposite charge by normal polar valences; (2) co-ordinated compounds (complexes, chelates) bound by non-ionogenic auxiliary valences; (3) substances of low solubility (for example, phytin, calcium-oxalate, calcium-pectate, etc.).

Assimilation of Micro-elements

Our knowledge of the roles of some of the micro-elements has increased considerably during the past decade or so. Elements like copper, iron, manganese, molybdenum and zinc have been shown to act as nuclei of metalloprotein enzymes or as enzyme activators, and their roles have been reviewed^{13,14}. Chloride ion has been shown to be required in the photo-oxidation of water by isolated chloroplasts³. Boron probably forms sugar borate complexes which are associated with the translocation of sugars⁸. So far, major research emphasis has been placed on the roles of micro-elements in enzyme systems; other roles not now investigated, such as possible effects on membrane structure, cell organization, etc., should also be considered¹⁴. But in spite of increasing awareness of the functions of micro-elements, remarkably little detailed information is available concerning the processes of assimilation of the micronutrients.

With the possible exception of Cl^- , probably very low concentrations of free micro-element ions are present in soils and in plant tissues. The elements copper, iron, manganese and zinc occur in the soil as cations which form insoluble salts with systems such as sulphate, chloride, carbonate, phosphate and many others; boron and molybdenum usually occur as oxy-anions which form insoluble salts of other metals. These metals in soils are locked in the mineral portion of the soil in the form of insoluble inorganic salts; the metals are converted to soluble form by weathering processes, perhaps first involving conversion to bicarbonates of low or intermediate solubility by the action of carbon dioxide dissolved in rain-water, or by attack by natural organic chelating agents produced by micro-organisms or by plant roots, which secrete small amounts of organic anions which tend to solubilize the micro-elements⁶. Inside the plant, micronutrient cations like copper, iron, manganese and zinc may be incorporated into chelate compounds by reaction with cellular metabolites; molybdenum also may form co-ordinated or chelate compounds of biological interest, perhaps involving the binding of the molybdyl ion (MoO_2^+) (ref. 20).

It is becoming increasingly clear that organic substances of various kinds bind metals with greater or lesser tightness. The story of the assimilation of the micro-elements involves numerous interactions of metals with metabolites of various kinds, ranging from those which bind metals so tightly that the metal must be considered not in equilibrium with other substances present which might otherwise interact with the metal, to other binding agents which have low affinities for the metal and in which the metal bonds are labile. The porphyrins bind iron and vitamin B_{12} binds cobalt with extreme tightness; other substances like organic acids, amino-acids, peptides and proteins bind metals less tightly so that the metals remain exchangeable. Purines, pteridines, nucleotides and nucleic acids also have been shown to bind metals, but little work has been done to measure the affinities of these substances for individual metals². Thus, a metal may be carried within the plant as a chelate or co-ordination compound, and may undergo exchanges with other metabolites which form complexes of greater stability. The process of absorption of micronutrients from the external environment by plant roots may involve in part simple replacement at the root surface of one complexing agent for another. Considerable efforts by biochemists and physiologists will be needed to attain detailed knowledge of assimilation of micronutrients.

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OBITUARIES

Prof. A. G. Ginetzinsky

PROF. A. G. GINETZINSKY, head of the Laboratory of the Institute of Evolutionary Physiology in Leningrad and corresponding member of the Academy of Medical Sciences of the U.S.S.R., died on October 20, 1962, at the age of sixty-seven. To many of his colleagues abroad, Ginetzinsky's contributions to physiology became known only comparatively recently, despite the fact that he was the author of a series of important discoveries over the past forty years. He was born at Vologda in 1895. After

graduating at the Medical Institute in Leningrad, he joined the laboratory of the late Academician L. A. Orbeli, whose influence as a teacher continued to guide him in the pursuit of problems in nerve and muscle physiology. After holding for many years the chair of physiology in the Medical Pediatric Institute, Leningrad, Ginetzinsky moved to the Sechenov Institute of Evolutionary Physiology.

Of his many scientific studies, I shall refer to four which have gained international interest and recognition (though

some very belatedly and not until his findings had been rediscovered in other places).

In December 1922, Ginetzinsky gave an important communication at the thirty-seventh Physiological Congress in Petrograd, describing the effect of sympathetic nerve fibres on fatigued muscle. He showed that stimulation of sympathetic nerves can influence and, under certain conditions, restore the force of muscle contraction evoked by motor nerve impulses. The work was done, I believe, at the suggestion of Ginetzinsky's teacher; but there is no doubt from Orbeli's writings that his pupil had played a very prominent part in this discovery, which for some reason is commonly referred to in the non-Russian literature as the 'Orbeli phenomenon'.

In 1935, Ginetzinsky and N. I. Michelson reported that in muscles which had been completely paralysed by curare, a nerve impulse still evokes a small electric response in the region of the nerve-muscle junction. This was the first description of a phenomenon which became known, and intensively studied, several years later under the name of the 'end-plate potential'.

In 1942, Ginetzinsky and N. M. Shamarina published a most interesting paper the main findings of which were rediscovered seventeen years later in Sweden and in Great Britain. It confirmed the well-known fact that 'adult' skeletal muscle fibres are not very sensitive to acetylcholine except in a narrow region around their nerve-muscle junctions. The authors proceeded to show that, a few days after birth, the whole length of the muscle fibre reacts to low concentrations of acetylcholine, and that the final state, of a locally restricted sensitivity, is not attained until later. Furthermore, when adult muscles are deprived of their nerve supply, their acetylcholine sensitivity again begins to spread, from the nerve-muscle junction along the whole length of the muscle fibres.

During the last years of his life, Ginetzinsky's principal interests had turned to problems of kidney physiology, especially the control of water excretion and the mechanism of action of the anti-diuretic hormone. In 1958, he published a note in *Nature* (182, 1218; 1958) in which he put forward a new theory, namely that the re-absorption of water in the renal tubules is controlled by a local release of hyaluronidase which causes a temporary breakdown of the intercellular 'cement substance' in the wall of the distal and collecting tubules and so opens up channels for osmotic water flow. His evidence indicated that a hyaluronidase is released from the kidney cells under the influence of anti-diuretic hormone, and that the action of the free enzyme raises the water permeability of the tubular wall. This novel hypothesis has aroused much interest and some controversy; but its main features have been greatly strengthened by subsequent work done in Britain and by Ginetzinsky himself.

I had the pleasure and privilege of meeting Prof. Ginetzinsky in Moscow in 1961 and, like many of our colleagues, I was greatly looking forward to his intended visit to Britain in 1963, when he was to have given a series of lectures in the University of London. Ginetzinsky's contributions to physiology took a considerable time to cross the language barrier: if recognition outside his own country was belated, it fortunately did not come too late, and I like to think that he derived a good deal of satisfaction from it during the last years of his life.

BERNARD KATZ

Academician A. V. Topchiev

ACADEMICIAN A. V. TOPCHIEV, a noted organic chemist, a skilful administrator and a clever 'cultur' diplomat, died in Moscow on December 27.

Born in 1907, Alexander Vasilievich Topchiev graduated at the Moscow Institute of Chemical Technology in 1930. After his graduation he made rapid progress and soon achieved eminence as a scientist and as a specialist in the field of petroleum chemistry. His numerous papers, a

number of them dealing with petroleum hydrocarbons, earned him world-wide recognition. He also played an important part in the creation and development of the Soviet petroleum, chemical and polymer industry. Among his publications one may single out a few of the more outstanding ones, such as one on the nitration of hydrocarbons, another on boric fluoride as a catalyst and one on radioactive isotopes, the last paper being presented at the Congress on the Peaceful Uses of Atomic Energy held in Geneva in 1958.

In 1947-49 he acted as deputy Minister of Higher Education. In 1949 he was elected a member of the Soviet Academy of Sciences, and eventually he was entrusted with the key post of scientific secretary of the Academy. He was also director of the Institute of Petroleum-Chemical Synthesis. He received the Stalin Prize and the Order of Lenin for his work. As a very active member of the Communist Party, he was a deputy in the Supreme Soviet of the Russian Federation. His abilities as an administrator and a diplomat ensured his election to a number of committees and he was often sent abroad.

Topchiev was a frequent visitor to England, since his first visit in 1955 when he came to London as the leader of a group of Russian scientists attending a conference on nuclear energy. At this meeting he spoke with much feeling of the desire of the Russian scientists to restrict nuclear energy to peaceful uses. In 1956 he again led a party of Russian scientists attending the opening of Calder Hall. He was known as a most active fighter for peace and international scientific co-operation, and he was one of the founder members of the Pugwash peace movement at its first conference in 1957. At a scientific gathering in the United States in 1961, Topchiev again spoke eloquently about problems of peace and international co-operation. He was also a frequent and eloquent expositor of the Russian space programme, a circumstance which suggests that he had an important part to play in this.

To sum up, one may say that Topchiev was an outstanding scientist, an outstanding administrator, an organizer of international scientific and cultural co-operation and a most popular ambassador of his country, greatly admired by his fellow delegates and by his hosts for his frankness of speech, sincerity of purpose and good humour.

S. I. TOMKEIEFF

Dr. J. Howard Dellinger

DR. J. HOWARD DELLINGER, formerly chief of the Central Radio Propagation Laboratory at the National Bureau of Standards, U.S. Department of Commerce, died on December 28.

Dr. Dellinger, who initiated radio research at the Bureau in 1911, was also known for his work at national and international conferences on radio problems. He is credited with the discovery of the simultaneous occurrence of solar eruptions and radio effects (the Dellinger effect). He also investigated the ionosphere and high-frequency radio propagation and supervised the development of many basic radio aids to air navigation, and the initiation of the U.S. standard frequency broadcast service (WWV).

After retiring from the Bureau in 1948, Dr. Dellinger continued his work as a radio consultant and adviser.

Dr. Dellinger joined the staff of the National Bureau of Standards in 1907. He began working on the determination of the conductivity of copper for a few years. He was appointed chief of the Radio Section in 1919.

During the Second World War, Dr. Dellinger was selected by the Armed Services Joint Communications Board to direct the work of the Interservice Radio Propagation Laboratory. It was the task of this group to draw together accumulated research knowledge and data from which to make radio propagation predictions for the Armed Services. In 1946 this organization became