which a colony consumes in bee production per season and for its own needs before it can show any surplus is on the low side for a really profitable colony.

Miss A. D. Betts has shown that bees can transfer a maximum amount of sugar from a feeder on the hive in a given time when the sugar content of the syrup is about 40 per cent. Thicker syrup is taken too slowly, and thinner syrup carries too little sugar. In the field, the bee spends the larger part of its time travelling to and from the source and from flower to flower. Now if the time occupied in gathering nectar is fixed as part of the whole, Miss Betts' figure is likely to apply; but I infer that for a given strength of nectar the bee will prefer the source in which the nectaries have the larger content, for she will then economize in time of travel. If, however, the sugar content of the nectars varies, it will pay the bee to work at a nectar more dense than that named provided there is more sugar in each nectary; that is, it is the sugar content rather than the nectar content of the nectary that is important and up to limits in excess of 40 per cent. In very dry weather, sugar content far exceeds any figures quoted by Pryce-Jones; indeed, a supersaturated solution is found in very dry weather. In 1942 in Kent and elsewhere, the bees could not work on the limes because the nectar was crystallized.

There is a great deal yet to be done to solve the problems associated with nectar production. No fewer than five theories are quoted and discussed; only one touches upon the relationship of sugar production to soil content; that deals with nitrogen content, but leaves potassium and phosphorus out of account. Pryce-Jones remarks that while the nectary acts as a semi-permeable membrane, holding back the proteins in the sap, no explanation has yet been offered of the diffusion of a dilute solution of sugar in the sap into a more concentrated solution in the nectary.

Pryce-Jones himself has shown that the thixotropy characterizing a very few honeys, notably that from ling and from manuka, is due to the presence of about 1 per cent of a protein. Honey usually contains but a trace of any protein. This particular protein may be extracted and when added to another and liquid honey causes it to become thixotropic. It is difficult to attach much weight to the criticism by Paul 'Espinasse that it has yet to be proved that the protein is of vegetable origin and not added by the bee. Why should all bees add so unfortunate a protein only to those particular nectars, introducing a property which may cause them later to starve in the apparent presence of plenty? It would appear to be far more probable that in these plants a small quantity of a certain protein passes through from the sap. There is room for further investigation of this protein and especially its molecular weight.

In the study of the relationship between the honey crop and the weather, much confusion has been introduced through failure to recognize the large variation of sugar content of nectar when observing changes of hive weight. Certain correlations with weather conditions, however, have been obtained. These indicate that in summer and early autumn, temperatures are generally adequate, but humidity tends to be too low; hence a wide variation in temperature with its wide variation in relative humidity tends to bring the sugar contents within the range for efficient collection for some period of the day, and perhaps to assist in nectar secretion. In the spring, however, temperatures may be inadequate, also hours of sunshine; hence greater importance is attached to temperatures and especially to temperature variation, the latter bringing about periods of suitable temperature and corresponding with periods of intermittent but more adequate sunshine. The conditions are somewhat different as between clay and sandy soils. In studying atmospheric conditions in the summer and autumn, however, there is a correlation factor above 50 per cent outstanding against unknown factors, showing the supreme importance of sources of nectar.

The bee-keeper desires a more continuous succession of adequate sources than he can yet find in any one place; also less unintentional interference by those concerned with agriculture and horticulture. Surely, having regard to the very large contribution to these industries made by the bee-keeper, referred to in the opening paragraph above, it is time that the Ministry of Agriculture assumed official responsibility for bee-keeping, and secured some correlation of the interests of these several industries. A co-operative study, for example, of the benefits to be derived by the several parties by increased use of appropriate sweet clovers. and incidentally of Zofka clover, should provide a very large return for a small expenditure by the Ministry. Any programme should be examined by practical bee-keepers and agriculturists as well as by scientific men if it is to be really effective and profitable. On the practical side, there should be no lack of assistance if only someone in authority would bring the parties together.

# OBITUARIES

## Dr. J. Argyll Campbell

ARGYLL CAMPBELL was a most distinguished student at Edinburgh, gaining very many university prizes and honours. He unfortunately suffered early in his career a catarrhal infection which resulted in deafness, a handicap which he most bravely overcame so far as his output of research was concerned, but which prevented him gaining full recognition of his worth. As professor of physiology at the Government School of Medicine, Singapore, he did valuable work, and in the War of 1914–18 prevented the authorities from substituting an equal weight of sweet potatoes (a watery food) for rice in the workers' ration. As one of a small commission, he was largely instrumental in securing the addition of the province of Trengannu to the Malay States.

Returning to Great Britain, Campbell joined the Department of Applied Physiology at the National Institute of Medical Research, where, until ill-health led to his recent retirement, he carried out very valuable research work. An inquiry with me into the protective effect of water-proof clothing against exposure, such as results from shipwreck, resulted in the adoption by the Ministry of Transport of a suitable suit for merchant seamen in the present War; a quarter of a million such suits have been issued, and high value is given to these as the result of experience.

Campbell developed a simple method of measuring the tension of oxygen and carbon dioxide in tissue spaces, and made the interesting discovery that high pressures of oxygen, such as produce oxygen poisoning, occasion a high tension of carbon dioxide in these spaces. The power of hæmoglobin to combine with and carry carbon dioxide from the tissues is thwarted by its saturation with oxygen. He carried out most

important work on oxygen-want at high altitudes, finding that animals could not continue for long to live at altitudes above 20,000 ft. This degeneration has been fully confirmed for man by the experiences reported by Everest climbers such as Mr. Shipton. Although 27,000 ft. has been reached, the incapacity of the climbers is such that there is little hope of Everest being climbed without use of oxygen-breathing apparatus, and that use is beset with difficulties.

Campbell pointed out that one of the means of acclimatization to high altitudes was hypertrophy of the heart. His work on oxygen-want led to the contrivance of a simple but effective oxygen-breathing face mask. With the late Dr. Poulton he published a valuable book on "Oxygen and Carbon Dioxide Therapy", a standard work on the subject. Further researches showed him that oxygen-want is better resisted on a certain diet, such as one of carrots, and this inquiry led to possible means of improving the resistance of high flyers. He also found that the effects of oxygen poisoning at high pressures are warded off by a fall in body temperature; animals are more susceptible at high than at low external temperature.

With me he carried out an investigation of the washing out of nitrogen dissolved in the body by the breathing of oxygen, and the amount of nitrogen in the bone marrow of animals exposed to high air pressures—work of interest in regard to compressed-air illness.

Another important line of inquiry carried out by Campbell was on the effect of inhalation of dust on the production of pulmonary cancer. He found that tar-containing dust from roads greatly increased the frequency of such cancer in mice; dust not containing tar did so also, but to much less extent.

Whatever researches Campbell carried out, of which a few have been mentioned, were executed with the greatest accuracy and thoroughness, so that his results stand unquestioned. He was so deaf that one had to communicate with him by writing, and this fact prevented all but a few from realizing his high worth and modest character. LEONARD HILL.

## Mr. E. C. Stuart Baker, C.I.E.

BY the death of Mr. Stuart Baker on April 16 at the age of seventy-nine, ornithology, and especially Indian ornithology, has lost one of its most eminent exponents. He was born in 1864; after being educated at Trinity College, Stratford-on-Avon, he followed his father's career in entering the Indian Police Force in 1883. Nearly all his service was spent in Assam, then, even more so than now, a wild mountainous region peopled by primitive and savage tribes, which offered unbounded opportunities for sport and the observation of wild life, of which he took every advantage. He rose to be officiating inspector of police for the Province in 1910; in 1912 he was selected to reorganize the special police force of the Port of London Authority, a post which he held until he retired in 1925.

On his return to England Stuart Baker settled at Upper Norwood and, taking an interest in local politics, he was elected a councillor of the Croydon Town Council, where he served two terms as mayor during 1937–38.

It was not until about the time of his return from India that Stuart Baker began to publish his numerous works on Indian ornithology. These include volumes on the Indian ducks, doves and game-birds, and finally he was asked to prepare a new edition of the birds for "The Fauna of British India" series, issued under the authority of the Secretary of State for India in Council. The first edition by E. W. Oates and W. T. Blanford was in four volumes. Stuart Baker expanded these into eight, published during 1922–30, and practically rewrote the whole. It has since become the standard work on the subject. As he felt he had not done justice, for want of space, to nesting and other habits, he prepared four more volumes, "The Nidification of Birds of the Indian Empire", which appeared during 1932–35.

Perhaps Stuart Baker's most valuable work was on the cuckoo problem. Always deeply interested in the study of birds' eggs, of which he amassed a very large collection, he paid special attention to the cuckoos, especially those of the many Indian and Asiatic species. The results of these observations and reflexions appeared in 1942 under the title of "Cuckoo Problems", in which he discussed such questions as adaptation of cuckoo's eggs to those of the fosterers, how far the 'survival of the fittest' has been concerned in the evolution and adaptation of the eggs, and such lesser questions as the method by which the cuckoo egg has been introduced into the nest of the fosterer and the ejection of fosterers' eggs from the nest by the young cuckoo. The value of this work was greatly enhanced because Baker had at his disposal much evidence from the many Indian species and did not confine himself to the European cuckoo, which had been the case with most previous writers.

Stuart Baker received the C.I.E. in 1932. He was a fellow of the Linnean and Zoological Societies and a member of the British Ornithologists' Union, of which he was honorary secretary and treasurer from 1913 until 1936.

He married in 1897 Ethel May Roffey, who survives him together with four daughters. W. L. SCLATER.

## Mr. J. W. Bullerwell

JOHN WILLIAM BULLERWELL began teaching (two years before he entered college) as an assistant master at the Orphan House School, Newcastle, where he had previously been a student. While an undergraduate at Armstrong College, he taught mathematics and mechanics in Newcastle School Board evening schools, and after graduating in 1896 he became science master at St. Cuthbert's Grammar School and part-time lecturer in mathematics at Armstrong College. In 1901 he became lecturer in mathematics at Hartley College, Southampton, a post which he held only for a short time, before returning to Newcastle as lecturer in physics in 1902, becoming senior lecturer in 1919. He retired in 1938, but returned to duty again until 1942.

Two or three generations of students will remember Bullerwell for his novel and well-thought-out methods of presenting his subject. He was above all other things a teacher, whose every desire was to help and advise his students. He had no grudges against anyone, and he was always ready to rejoice in the promotions and successes of others. With his six feet four inches he commanded discipline with ease, but it was always a parental rather than a dictatorial discipline.

Bullerwell was appointed secretary of the University of Durham Schools Examination Board in 1932, and he carried out the duties with efficiency until