velocity of its source. In terms of his operationally defined quantities, the equations are complicated. "This is the price we have to pay," he said, "for equations which tell a complete and unambiguous story in symbols all of which have a definite operational meaning." However, a change of variables does, in fact, yield the standard form of the Lorentz transformation. One takes it that this substitution provides an explicit operational representation of the clock-synchronization, etc., required, but less carefully examined in more familiar treatments. Dr. Ives went on to a careful inspection of the "principle of the constancy of the velocity of light" which, as usually understood, he rejects.

He described also his well-known experimental verification[7] of the time-dilatation using the spectra of canal rays, following a suggestion originally made by J. Stark[8] and employing A. J. Dempster's method of accelerating canal-ray particles.

Dr. G. J. Whitrow (Imperial College of Science and Technology, London) contributed a paper on "The FitzGerald–Lorentz Contraction Phenomenon and the Theories of the Relativity of Galilean Frames". In the author's absence, it was described by Prof. W. H. McCrea. Dr. Whitrow started by quoting Bishop Berkeley's criticism of Newton's introduction of absolute motion into natural philosophy. The dilemma of Newtonian physics was that, while it held good for all Galilean frames in uniform relative motion, the phenomena of rotation seemed to demand an absolute standard of rest. In nineteenth-century physics this was provided by postulating the luminiferous æther. But the Michelson–Morley experiment demonstrated the impossibility of measuring linear motion through the æther. Einstein's formulation of the theory of special relativity again replaced the æther by empty space, but again gave no explanation of rotational phenomena. E. A. Milne's theory of kinematic relativity and world-structure offered a solution of the difficulty. In his view, the whole system of galaxies, or rather the substratum which in the theory represents the smoothed-out system of galaxies, provides at every point of space an absolute standard of rest and non-rotation. But the theory[9] is complicated by a distinction between fundamental and subsidiary Galilean frames. Dr. Whitrow now proposes a modification of Milne's work which restores to it the formalism of special relativity. The consequence of the work of Milne and Whitrow is thus to provide special relativity with a cosmological background. Dr. Whitrow also related the problem to a view of the philosophy of science which he has recently developed[10].

A paper by Prof. W. H. McCrea (Royal Holloway College, University of London) on "The FitzGerald–Lorentz Contraction—some Paradoxes and their Resolution" dealt with the problem of the rigid rod in special relativity theory. According to the theory, the contraction denotes no intrinsic physical change in a moving rod. Nevertheless, an observer can 'trap' the rod in the contracted state and exhibit it as having undergone such a change. If we define a rigid rod as one through which an impulse can travel with maximum permitted speed (that is, the speed of light), then it becomes clear how such a physical change is produced in the process of stopping the rod. If it is stopped at the forward end, then the shortest length momentarily attained is, in fact, less than that given by the FitzGerald factor. It can be shown that the kinetic energy just suffices to supply the energy of compression without dissipation; consequently the 'rigid' rod can be regarded as being also perfectly elastic.

Prof. J. L. Synge (Dublin Institute for Advanced Studies), in his paper on "Effects of Acceleration in the Michelson–Morley Experiment", dealt also, but more generally, with the rigid-body problem. The definition he gave was in a form due to his pupil, Mr. G. H. F. Gardner, and is based upon the concept of a 'drag-point' in the body, together with a condition requiring that any particle of the body responds to the behaviour of the drag-point only with a delay corresponding to the time of travel of light from the point to the particle. This appears to reduce to McCrea's definition in the case of a one-dimensional body. The definition enables one to study the motion of a rigid body in accelerated motion relative to a Galilean frame. As Prof. Synge pointed out, the Michelson–Morley experiment is one upon the behaviour of such a body, the instrument being in accelerated motion on account of the rotation and revolution of the earth. He stated that Gardner's hypothesis predicts a null result for the Michelson–Morley experiment if the interferometer is loosely attached to the earth, as it appears to have been in the latest repetitions of the experiment which have, in fact, given the null result. On the other hand, if the instrument is rigidly attached to the earth, then the hypothesis predicts a definite result about three times that reported by Dayton C. Miller in his particular repetition of the experiment[11]. The provisional interpretation is that Miller's interferometer had sufficient rigid connexion with the earth to show part of the acceleration effect predicted by the new theory. But, as Prof. Synge took care to state, judgment must be suspended until the theory is tested by specially designed experiments.

All these papers will be published in a special number of the *Proceedings of the Royal Dublin Society*, and will be found to contain much more information than there has been space even to mention in this report.

W. H. McCrea

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RABBIT CONTROL IN AUSTRALIA: PROBLEMS AND POSSIBILITIES

THE story of the rabbit in Australia is so well known, so familiar an instance of the spread of an innocent introduction to plague dimensions, that fresh turns in its course must be spectacular to become news. For most of the world beyond Australia, there is the pest, and there are the problems of its control. Even in Australia itself, there has been perhaps a sense of inevitability that this prolific competitor for grazing must embarrass agricultural production, impede attempts to raise both oldoccupied and new land to higher levels of fertility and output, and, in fact, place a heavy burden on farmer and pastoralist to exercise control measures. But there is no complacency among the occupiers of land in Australia; in many areas the rabbit-proof fence has become almost as typical a part of the Australian scene as is the gumtree or the Merino sheep, while in Western Australia the 'rabbit-proof fences', State-erected, State-maintained, and State-patrolled, stretch hundreds of miles across the continent to appear, like the Great Wall of China, a monument to the efforts made to stem the invader.

Always the pest has proved highly resistant to any attempts to confine it to limits of area in which it could be effectively tackled by such techniques as digging out warrens, gassing or poisoning, chasing by dogs and trapping, or even to restrict its numbers by such means. The general problem of its control is so severely practical that until about the late 1920's the possibility of scientific aid appeared almost as remote as that of complete eradication of the pest population. The recognition that the virus disease, myxomatosis, might be an agent in reducing rabbit numbers directly invoked scientific inquiry, and although early investigations carried out by the Division of Animal Health and Production, of the then Council for Scientific and Industrial Research, established that the disease could work, its effectiveness was small because of its very limited powers of spreading naturally through rabbit populations and groups. What did emerge, however, was that the problem, scientifically, had to be regarded as a whole, and that the rabbit and its context were fit material for comprehensive biological study.

During the Second World War and its aftermath, difficulties of labour and increasing costs of material for control measures, among others, gave rise to conditions favouring the rabbit. Also, increasing recognition of the importance of ecological and other biological approaches to such field problems ripened the opportunities for long-term research and encouraged the Commonwealth Scientific and Industrial Research Organization to include review of the rabbit problem in the programme of its Wildlife Section, established in 1949, without at the same time offering any optimism of revolutionary systems of control. The Organization has now issued "The Rabbit Problem—a Survey of Research Needs and Possibilities"*, in which F. N. Ratcliffe, officer-in-charge of the Section, assesses the scope for the different control methods, and presents a valuable, critical appraisement of the complex position to be studied.

In broad terms, Ratcliffe distinguishes qualitative differences in the problem, in three categories of country: "(*a*) the relatively low-value, low-rainfall grazing country (typified in N.S.W. by the Western Division); (*b*) the region of high-value grazing country (sheep to an acre or better, down to, say, one sheep to two acres); and (*c*) the closely settled farming areas". In the first, real control is impracticable, mitigation is possible, but serious infestations are limited by adverse climatic conditions; in the last, good farming practice usually keeps the rabbit under control. In the better pastoral country, which includes much of the land amenable to pasture improvement and the wheat areas, the rabbit problem is most acute and most severe economically, not so much from the direct damage as from the tremendous burden, in labour and expenditure, of measures to curb infestation from attaining catastrophic proportions; here, the real need is "for ways and means of bridging the gap between partial control and eradication".

* The Rabbit Problem: a Survey of Research Needs and Possibilities. Pp. 17. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1951.)

Attempts to use pathogenic micro-organisms in the control of mammal pests have not generally been promising, but there were indications that the use of myxomatosis might give a cheaper method than others of checking rabbit numbers *in the higher-value country*; accordingly, trials were begun to introduce the virus into warrens in this category of land. But the first attempts failed to induce an effective spread of infection.

The survey records the position of other control methods in use, of which fumigation is probably now the most important. Gas is either blown through a burrow system, or is laid to form a zone of lethal concentration at the burrow mouth; carbon monoxide, 'Cyanogas' and carbon disulphide are used for blowing, 'Cyanogas' and chloropicrin are used as barrier zone fumigants. Neither method gives 100 per cent kill owing to the difficult natural conditions under which the fumigants are called upon to operate in the burrows; the choice of compounds possible for use is small, and the only hope appears to be improvement of the standard materials, especially chloropicrin. No effective 'persistent' fumigant has so far been found. Mechanical treatment of warrens by digging out formed a major control method in better-class country, and is now largely superseded by tractor ripping; while this loses effectiveness on stony or hilly land and among tree roots, its potential contribution to control is high when used as part of a planned campaign. Poisoning can kill large numbers of the pest, and its most effective use in reducing infestations is achieved by specialists who have accurate knowledge of the ecology of rabbit populations. The idea of using lures to poisoned baits is popularly attractive, but the evidence is that their effectiveness depends upon prevailing conditions rather than on any special attributes of the odour employed. "Of all the methods of rabbit destruction available, poisoning stands most in need of scientific study and clarification."

No particular promising line of inquiry which might lead to revolutionary new control methods emerges from the survey. There are possible minor improvements in fumigants and fumigation; probable major developments in efficiency of poisoning, but only after prolonged investigations; and a clear need for detailed ecological studies, on the results of which a sound national policy can be planned and put into effect. The report concludes by proposing a scheme for an "experimental area-control campaign" to determine the conditions under which the various control methods can best be integrated to meet local expressions of the problem; for example, to elucidate the conditions under which the target of local eradication must be replaced by that of mitigation and control. But in any such campaign, experimental or as a widely applied policy, the provision of rabbit-proof netting is seen to be essential to separate the areas in which eradication is practicable from those in which it is not.

Thus this report. But as it was prepared, a spectacular development occurred in the development of myxomatosis epidemics. It was known that the disease could be spread from sick to healthy rabbits by certain mosquitoes. As mentioned above, the first attempts to establish the disease in experimental sites were unsuccessful, but by continuing the introduction into warren colonies in the Murray River valley into the summer months of 1950–51, conditions favourable to success were encountered and mosquitoes rapidly spread the disease, so that by February 1951 the disease was reported widely in the Murray River system and its incidence had extended northwards along the Murrumbridgee, the Lachlan, and the Darling Rivers, almost up to the Queensland border, but with a slower spread south of the Murray.

Most effective transmission and high rabbit mortality were largely restricted to narrow zones of river frontages and to swampy areas where the dusk-biting *Culex annulirostris* was prevalent ; but it was soon evident that 'jumps' of infestation were attributable to the day-biting *Aedes*, which are more widely distributed over open country. Local recessions of the epidemic occurred as the autumn season advanced. The Commonwealth Scientific and Industrial Research Organization had issued recommendations to graziers as to how to set up fresh loci of infection by moving infected rabbits ; but by June it had announced that the first great epidemic had passed, leaving a probable toll of millions of rabbits killed and a vast saving of expenditure on control measures and of valuable fodder, over an area "about half the size of the continent of Europe". While the mosquitoes had been the main agents in spreading the epidemic, it was soon recognized that the small black fly *Simulium* was also involved and, later, that the smaller 'true' sandflies are important carriers, especially in parts of Queensland.

Extraordinary local differences in infestation occurred, but there is little doubt that the general direction and vastness of spread were affected by the unusual distribution of conditions that had obtained. Many parts of Victoria had suffered from drought, and there was little spread of the disease south of the Murray valley ; to the north, the season had been wetter and wetter, and in parts of northern New South Wales and Queensland the widths of the effective killing zones had become greater, to give almost a general epidemic. The region in which the disease had its most profound effects, namely, those areas west of the foothills of the dividing range watered by the upper tributaries of the Darling River, had experienced some of its worst flooding on record.

Obviously, many questions remain for scientific workers and graziers to answer regarding the potentialities of the disease as an agent, and the conditions under which it can be expected to exert its contribution to a general campaign of control. Plans have been made for future distribution of the virus ; but it is emphasized that there are many areas, such as high-value hilly country, where the rabbit is a serious pest, in which it can have little effect, and other measures of control must be pursued. Moreover, recovered animals have been found in some areas, possibly due to the appearance of virus strains of lower virulence ; this opens up further questions for study, although in practice any acquired immunity, or variations in virulence, would only have temporary or local effects against the influence of fresh inoculations of the lethal strain.

Among notable instances of biological control, Australia has already provided the case of the pricklypear ; it may be that this further chapter in the story of the rabbit in that continent will introduce a record of an achievement of equal or higher rank in the annals of its pastoral and agricultural development. For the moment, it is appropriate that this chapter should end by noting (*vide The Times*, October 18, 1951) that three of the scientific men who had taken leading parts in the programme, Dr. I. Clunies Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Sir Macfarlane Burnett, director of the Walter and Eliza Hall Institute, and Prof. F. J. Fenner, head of the Department of Microbiology in the Australian National University, themselves were inoculated with myxomatosis to allay doubts as to possible effects of the virus on man.

J. E. Nichols

RECENT RESEARCH AND ADDITIONS TO THE BRITISH FLORA

THE flora of the British Isles is probably better known than that of any other area of comparable size, and yet important discoveries can still be made. The annual exhibition meetings of the Botanical Society of the British Isles afford opportunities for bringing new plants, and the results of recent research, to the notice of botanists, and the one held in the lecture room of the British Museum (Natural History), South Kensington, on October 20 provided ample evidence that field and herbarium work in 1951 had been exceptionally productive.

The outstanding discovery of the year was that of *Diapensia lapponica* L. on a Scotch mountain, thus adding a new family—the Diapensiaceæ—to the British flora. This arctic-polar species, forming dense cushion-like tufts with crowded, imbricated, cartilaginous leaves, and with peduncles some 2 cm. tall bearing solitary white flowers 1·5–2 cm. across, was discovered very locally by C. F. Tebbutt, an ornithologist, on a mountain top in Westerness. It was represented at the exhibition meeting by a fine series of photographs by J. E. Raven and by the specimen sent by the discoverer to the Royal Botanic Gardens, Kew, for identification.

Mr. Raven also exhibited photographs of *Kœnigia islandica* L., a small annual member of the Polygonaceæ, with a circumboreal distribution extending as far south as the Himalayas in Central Asia. This was recently detected at Kew from specimens collected in Skye in 1934 [1] and was re-found in June this year by Miss M. McCullum Webster. Mr. Raven's photographs showed that in Skye it grows in open damp places and that it is often gregarious. His observations and pictures indicate that it extends over a much wider area than could be deduced from the notes on the labels of the Kew specimens.

Two exhibits showed species originally recorded by G. Don (1764–1814), whose "reputed discoveries" have caused so much controversy among British botanists. Of these, the most surprising was *Homogyne alpina* (L.) Cass., found by A. A. P. Slack in 1951 in "the parish of Cortachy and Clova", Angus, and shown by B. W. Ribbons. Don said it occurred in the mountains of Clova "as on a rock called Garrybarns"[2] ; but hitherto no other botanist has succeeded in re-finding it. The exhibitor is anxious to obtain evidence which will help in identifying "Garrybarns". *H. alpina*, formerly known as *Tussilago alpina*, is widespread in the mountains of Europe but