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Dedication: Reginald Charles Rainey

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Dedication

Dr Reginald Charles Rainey, O.B.E., F.R.S.

These Transactions are dedicated to Dr Reginald Rainey, the Organizer of this Discussion Meeting on Migrant Pests. Reg died on January 18th 1990 after an illness which had severely restricted his physical activities, satisfied, I believe, that his meeting had been successful, lively and well attended, and that every possible action had been taken to ensure that the dead-lines of the Transactions' Editors were being met.

Reg spoke to me as early as January 1987 about his wish to follow the 1977 meeting on Migrant Pests (*Trans. R. Soc. Lond.* B **287**) by a further one to highlight progress, problems and potentialities. This was at a time when his previous robust health was beginning to decline and when he was much engaged with his book, *Migration and Meteorology* (published, happily, before he died and on display at the Meeting). Despite this preoccupation and his deteriorating health, Reg completed heroically all the correspondence relating to the meeting, did more than his fair share of preparing our joint paper, and finalized and proof-read his book, though largely confined to his chair and handicapped by cataracts on both eyes for much of the time. I had many telephone conversations with him during this period and his cheerfulness, clarity of thought and quickness of response disguised from me the seriousness of his condition. It was only towards the end of the year, when Reg's messages were sometimes conveyed by Margaret, his wife, that I became aware that only Reg's determination and dedication had made it possible for all the preparations for the Meeting to be completed.

Reg was a graduate and post-graduate of Imperial College, London, and of the Imperial College of Tropical Agriculture in Trinidad. As a student, he was a keen glider. His first appointment as an Entomologist at the Empire Cotton Growing Corporation's Research Station in Barberton, South Africa, in 1938, engaged him in research into cotton insect pests which were active flyers, and also gave him the opportunity of exploring and publishing accounts of the thermal up-currents by which he was able to soar to heights of over 1300 m from a ridge just outside Pretoria. When the war came, and being rejected as a pilot because of impaired eyesight, Reg joined the South African Air Force as a Meteorologist and served in this capacity throughout the African and Italian campaigns. As a meteorologist, Reg was far more at home with physics than are most biologists. After the war, Dr D. Gunn, then the Senior Scientist at the Anti-Locust Research Centre in London, discovered Reg's dual expertise and Reg needed little persuasion to transfer from cotton pest research to the study of a group of insects, the Acrididae, of some members of which it might be said the air was their habitat. Reg was probably the first to estimate how much time locusts spent in flight and recognize how the air on which they flew determined where they fed, where they reproduced and where they sheltered. The Desert Locust, in particular, fascinated him. This species inhabits a zone from West Africa to eastern India, which can be hostile to all life for months or years on end, and yet populations locate and colonize those parts when the imminence of rain promises to provide the conditions necessary for survival and reproduction. Careful field observations by Reg and his colleagues, accompanied by novel methods, showed that, despite the apparent purposefulness of swarm migration, in fact, flight was usually intermittent and the direction

effectively random. Reg demonstrated that the displacement of such swarms must inevitably be downwind and this would lead to their accumulation in zones of wind-convergence, that is in zones where more air is entering than leaving on the horizontal plane, the excess air being displaced upwards, providing the first requirement for rain. He published his convergence hypothesis in *Nature* in 1951.

The initial major test of the hypothesis was undertaken retrospectively under the auspices of the World Meteorological Organization on all available Desert Locust data from all countries for 1954–55, together with relevant meteorological data. This analysis led to the conclusion that the movements and distribution of Desert Locusts on scales from 10^2 to 10^3 km^2 were not only correlated with, but largely determined by the corresponding low-level wind fields. Desert Locust populations were in almost continuous movement over a total area three times the size of Europe at speeds of up to several thousand kilometres per month, and locusts flew on those winds which, by and large, led to their survival. The second major test of the hypothesis was undertaken using current locust and synoptic data of the whole of the Desert Locust distribution area during 1960–67 to provide interpretations, forecasts and warnings to all countries concerned, in the form of communications of the International Desert Locust Information Service which Reg set up and ran on behalf of the Food and Agricultural Organization of the United Nations. The results were independently assessed by a specialist FAO Committee who recorded 'the very satisfactory results obtained in the verification of the Desert Locust Information Service predictions'.

While the possible limitations of the circumstantial evidence for the convergence hypothesis were fully offset by the number of observations considered, Reg was anxious to secure the smaller-scale direct evidence of the relation of the density and structure of populations of airborne insects and the wind fields in which they flew. It was Reg who initiated the radar studies of the late Dr Glen Schaefer which have been so successfully followed up by Dr J. Riley. This series of radar observations established that wind convergence determined not only the destination of airborne insect populations, but also gave rise to concentrations determining their density and structure. These conclusions could not have been reached without the massive contributions made by Reg. He and his colleague, Miss Margaret Haggis, flew some hundreds of hours in seven countries in Africa and North America in aircraft fitted with Doppler wind-finding equipment, which permitted them to measure quantitatively the convergence which concentrated airborne insects and to locate with unprecedented accuracy the separation of wind-discontinuities, usually only a few kilometres, where insects accumulated and towards which insects, for example moths, moved from both sides with ground speeds much in excess of their own airspeed. This work included studies on the Spruce budworm moth on behalf of the Canadian Forestry Service, on the African armyworm moth on behalf of the East African Agricultural and Forestry Research Organization and on the blackfly vector of Onchocerciasis (river blindness), on behalf of the World Health Organization. They stimulated parallel work in the U.S.A., Australia and China, and established beyond doubt a view previously expressed by many entomologists that we had grossly underestimated the flight activity of most major pests.

Reg's work has profound implications for the understanding of insect population dynamics. It emphasizes that the spatial redistribution of pests which spend much time in flight is often more important than their total numbers and is characteristically dominated by the structured atmospheric systems of winds and weather. Moreover, this redistribution includes not only long

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range displacement of populations but also massive changes in density under the influence of convergent winds. The arrival of such concentrations, if not already at damaging levels, represents an enormous potential increase in birth-rate which may overwhelm locally occurring controlling agents giving rise to pest outbreak. The very important role of flight behaviour in insect population dynamics can be fully appreciated only when sufficient account is taken of the dynamics of the atmospheric environment.

Reg's profound curiosity regarding the interaction of insects and weather was matched only by his concern for his colleagues and co-workers. He was swift to recognize their contributions and to give them every possible help and encouragement. His memory and his work will have a continuing influence on entomological thought.

R. J. V. Joyce
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