The study of initial motions is intimately connected with the question of the *stability* of a spinning shell at zero yaw. The motion of a shell (or a top) is said to be stable if a small disturbance only produces a small maximum displacement from the position of symmetry, proportional to the disturbance. The condition of stability for small disturbances is the same in the two cases; it must be fulfilled in order that the shell may travel along its trajectory approximately at zero yaw as desired. A knowledge of the disturbing couple enables us to lay down how much spin is required to allow a reasonable margin of stability.

We have said that the usual approximation of motion at zero yaw is inadequate in the case of trajectories of large total curvature. The complete theory indicates that, under the effect of gravity (see (3) above), the yaw tends to attain a sort of equilibrium value which increases along the trajectory, and may reach 20° or more at the end of a sufficiently long arc. A study of initial motions with slightly unstable shells in which such values of the yaw can be realised experimentally will provide the material required for the proper discussion of such trajectories.

The following approximate theory accounting for the drift of a shell has long been known. Owing to the change of direction of motion due to gravity (see (3) above), a shell cannot continue to move steadily at zero yaw. The proper equilibrium state of affairs is attained when the yaw is just such as will enable the axis to keep pace with the changing direction of motion by precession about it. This equilibrium value of the yaw depends on the above-mentioned disturbing couple due to the reaction of the air, which may be determined by a study of the initial oscillations. The resulting yaw in ordinary cases is too small to alter seriously the range at any given time, and does not affect the height because the equilibrium position of the yawed axis lies in a plane which is always very nearly at right angles to the vertical plane containing the original direction of projection. It produces, however, the lateral deviation known as drift. This approximate theory leads to a formula for the drift depending on the ratio of the sideways thrust to the disturbing couple. With the values of this ratio recently roughly determined, the drift has been calculated by this classical theory, and compared with direct observations of the drift of similar shells. The observed and calculated values are in fair agreement, and there is no doubt that the classical theory is substantially correct.

In conclusion, it is perhaps worth mentioning that the interest in such investigations mainly arises from the fact that we can thus study the phenomena of motion through a compressible fluid at velocities both greater and less than the velocity of sound in the fluid. The investigation, however, has scarcely begun, and much work will be required before it is possible to describe adequately the complete reaction on a shell of given shape moving through air.

Obituary

PROF. L. DONCASTER, F.R.S.

LEONARD DONCASTER'S death from sarcoma at the age of forty-two has stopped a career of exceptional distinction. When I lately saw him, apparently in his usual health, presiding over his laboratory as the newly elected Derby professor of zoology at Liverpool, I had comfort in the thought that by his appointment a fresh centre of genetics was safely begun. Doncaster was a natural investigator. From his student days there was never a doubt as to the purpose of his life. The problems of biology were always in his mind. For him the materials were everywhere. Though circumstances led him into academic zoology, he was an excellent field entomologist and botanist, with a fair knowledge also of the domesticated forms. Latterly he became more and more drawn towards cytological methods, but he always kept in touch with the other lines, knowing that the next advance may begin anywhere.

Doncaster started at Naples with experiments on hybridisation of Echinoderm larvæ, which produced evidence of value as to the effects of temperature in modifying dominance; but many aspects of that vexed question remained, and still remain, obscure. He returned to England at the moment when the early struggles of Mendelism were acute. Though constitutionally predisposed to caution, he knew enough of the general course of variation and heredity to be in no doubt of the essential truth of the new doctrines, and undoubtedly his adhesion did much to spread confidence among his contemporaries. He at once joined in breeding work, and at various times experimented with many forms, particularly rats, cats, and pigeons. With insects of several orders he was especially successful. The seemingly more fundamental nature of microscopical work made it very congenial to him, and he always had a mass of cytological material on hand. These studies enabled him to take a prominent part in that comprehensive codification by which the confused and contradictory observations as to the sexes of parthenogenetic and other forms in the Hymenoptera and Hemiptera were ultimately reduced to order.

In the history of biology Doncaster's discovery as to the determination of sex in the currant moth (*Abraxas grossulariata*) will have a permanent place. From the Rev. G. H. Raynor, a fancier of the species, he learnt facts which suggested that the variety *lacticolor* was what we now call "sex-linked," being predominantly associated with females, as colour-blindness in man is with males. After verification and extension this mass of facts provided (1906) the first clear genetic proof of

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sex-determination in the gamete, a discovery of astonishing novelty at that time, though now so familiar to us all that we have forgotten how hard it was to achieve. Being greatly struck with Wilson's cytological proof that many *male* insects are heterozygous for sex, and having himself proved that in Abraxas the female is in this condition, Doncaster devised a scheme in which both sexes are thus represented, dominance being attributed to the female gamete; but he afterwards accepted a simplifying emendation in which the male is taken to be homozygous. After this, finding a curious strain in which half the females produce daughters almost exclusively, Doncaster showed that these females generally had only fifty-five chromosomes instead of the normal fifty-six. By reasoning analogous to that afterwards used by Bridges in his famous paper on "non-disjunction," he attempted a cytological interpretation, though, as he admitted, the solution was imperfect, and the case is still mysterious.

Progress was also made with the paradox of tortoiseshell cats, known by fanciers to be almost exclusively females. Doncaster proved that tortoiseshell is the female heterozygote of orange and black, the corresponding male being orange; and in the course of wide inquiries he discovered the new fact that the rare tortoiseshell tom is often *sterile*. In his last paper he conjectured, not without probability, that, in view of Lillie's extraordinary discovery as to the free-martins of cattle, these males may owe their peculiarities to the intra-uterine influence of other embryos. Most of these subjects are discussed in his text-book, "The Determination of Sex," 1914. Just before his death Doncaster published an admirable "Introduction to the Study of Cytology," in which he declared himself with reservation a convert to the views of Morgan—a judgment which, from so critical an observer, must carry great weight.

His death will be cruelly felt. At a time when cytology is becoming a subject of primary importance, the loss first of R. P. Gregory and now of Doncaster leaves us bereft indeed.

Doncaster was one of the clearest-headed men I have known, and, being full of both enthusiasm and knowledge, he taught extraordinarily well. In Cambridge he served in various capacities, and was for four years in the University of Birmingham. As Prof. Herdman has written, his death is "nothing less than a calamity to Liverpool University." Doncaster was slight in figure and of a nervous temperament, feeling and thinking of everything with intensity, though nevertheless a fluent speaker. He came of a Quaker family, being the son of Samuel Doncaster, manufacturer, of Sheffield, in whose beautiful garden he developed his love of plants. Educated at the Friends' School at Leighton Park, Reading, he went up as a scholar to King's College, Cambridge, of which he afterwards became a fellow. He married in 1908 Dora, daughter of Walter Priestman, of Birmingham, and leaves three children.

We did not speak of such matters, but it was known to his friends that Doncaster had religious instincts strongly developed. The years of the war were to him more hateful even than to most thoughtful men. He held the Friends' attitude of the unlawfulness of war, but, feeling that alternative service was a duty, he gave up his researches and qualified as a bacteriologist, working in the 1st Eastern Hospital, Cambridge, and afterwards in the Friends' Ambulance Unit at Dunkirk.

W. BATESON.

MR. JOHN W. HYATT, of Newark, New Jersey, whose death is reported at the age of eighty-two, was the inventor of celluloid. He was a printer by trade, and was using collodion in the course of his work when he accidentally overturned a bottle, and the idea of celluloid came to him from watching the collodion solidify. He took out 250 patents in all, a large majority of which had an important bearing on manufactures. They included a billiard-ball composition, a roller bearing, a system of purifying water for domestic use, a sewing machine capable of sewing fifty rows of lock-stitches at once, a machine for extracting juice from sugar cane, and a new method of solidifying American hardwoods. In 1914 Mr. Hyatt was awarded the Perkin medal of the New York Society of Chemical Industry.

WE much regret to see the announcement in the *Times* that PROF. AUGUSTO RIGHI, For. Mem. R.S., died suddenly at Bologna on June 8 at seventy years of age.

Notes.

THE list of honours conferred in celebration of the King's Birthday includes the following names of men associated with scientific work:—*Irish Privy Councillor:* Mr. H. T. Barrie, Vice-President, Irish Department of Agriculture. *K.C.B.:* Sir A. W. Watson, president of the Institute of Actuaries. *C.B.:* Mr. A. W. Flux, Assistant Secretary, Board of Trade. *Baronet:* Mr. P. J. Mackie, who financed the Mackie Anthropological Expedition to Uganda and other expeditions. *Knights:* Prof. F. W. Andrewes, F.R.S., pathologist at St. Bartholomew's Hospital; Capt. D. Wilson-Barker, captain-superintendent of the training-ship *Worcester*, and past-president of the Royal Meteorological Society; Dr. J. C. Beattie, Principal of the University of the Cape of Good Hope; Mr. W. B. M. Bird, founder of the Salters' Institute of Industrial Chemistry; Dr. H. H. Hayden, Director of the Geological Survey of India; and Prof. J. B. Henderson, professor of applied mechanics, Royal Naval College, Greenwich. *C.I.E.:* Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, and Mr. R. S. Pearson, Forest Economist, Research Institute, Dehra Dun. *K.B.E.:* Dr. J. Dundas-Grant, eminent aural specialist; Dr. J. C. Stamp, distinguished economist; and Col. W. Taylor, ex-president of the Royal College of Surgeons in Ireland. *Companions of the Imperial Service Order:* Mr. R. B.

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