on original research of a high order. The research work under this fellowship will be carried on at the New York Hospital and Cornell University Medical College. The fellowship will be available on July 1 at the beginning of the academic year. Applications for the year 1940–41 should be addressed to The Committee of the Lewis Cass Ledyard, Jr., Fellowship, The Society of The New York Hospital, 525 East 68th Street, New York, N. Y., and should be in the hands of the committee by February 15. It is expected that the award will be made by April 1.

SEVERAL grants in support of medical research work have been received recently by the Medical School of the University of Minnesota. A gift of $5,000 has been made by Mrs. John Dwan, of St. Paul, to support the serum center which she had previously started with an endowment. From the John and Mary R. Markle Foundation $1,000 has been granted for work by Dr. Albert V. Stoesser, who is investigating water and electrolyte metabolism in tractable asthma. An annual grant for cancer research, made in the sum of $9,000 three years ago by the Citizens Aid Society of Minneapolis, has been increased to $10,000 a year for the next three-year period. The cancer research is being done by the departments of surgery, pathology and x-ray therapy in University Hospital. Minnesota also has received a fourth fellowship for special graduate training in cancer research from the National Cancer Institute. Another recent grant was that of $16,000 from the Barber Oil Company of Minneapolis to support investigations of the relation of diet and activity to cancer.

DISCUSSION

TWO PARADOXES

IN the archives of the Royal Society there are to be found a number of papers, many of which have never been published, showing that an animated discussion took place in the seventeenth century over the answer to this question: "Is the effect that can be produced by a moving body proportional to the first or to the second power of its velocity?" There were eminent names on both sides of this controversy, the followers of Descartes arguing for the first power, while Leibnitz led the opposition. The discussion was not purely theoretical in character, as each side could cite experimental evidence in support of its contention. An example stated in modern terms will make this clear.

A bullet is fired into a ballistic pendulum. If we focus our attention on the velocity imparted to the pendulum we find this to be proportional to the first power of the velocity of the bullet; but if we regard only the vertical height through which the pendulum is raised, this will be proportional to the second power of the velocity of the bullet.

Simple as this appears to-day, it was a real paradox two centuries ago, for though momentum (or quantity of motion) was a familiar idea to Descartes and Newton, the concepts of work and kinetic energy were yet over a hundred years in the future, and the discussion finally died out without reaching any decision.

It is instructive to note the way in which the nineteenth century finally resolved this paradox. The first step was a clarification of the question and a differentiation of the involved phenomena into two classes—momentum effects and energy effects, the latter class requiring the introduction of a new concept, which was so defined as to be consistent with previously existing mechanical theory. The rather vague ideas of Descartes and of Leibnitz assumed the forms of the conservation of momentum and the conservation of energy.

We have before us to-day a similar paradox dealing with the nature of the electron. Is it a charged particle or a little group of waves? And, as before, there is experimental evidence for both sides of the question. This is well brought out by the diffraction rings obtained by G. P. Thomson,[1] when negative electrons were shot through very thin films of metal. The electron must have a wave aspect, or there would be no interference pattern; it must also have a charged particle aspect, or the whole ring system would not be deflected by a magnet, as it is found to be. Perhaps the solution of this paradox, like that of the seventeenth century, will involve the same elements of clarification, differentiation and the introduction of a new concept.

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OXYGEN RELATIONS IN HYDROPHYTES

IT has been shown by experiments that the roots of willow cuttings obtain oxygen from two separate sources—the atmosphere of the soil and from the shoot.[1] That the roots of herbaceous hydrophytes may also use internal (photosynthetic) oxygen as well as atmospheric oxygen is suggested by certain features of habit and structure.

The root systems of herbaceous hydrophytes are, in a very large number of species, adventitious, arising from some type of underground stem, as rhizomes. Among plants with root systems which are formed

[1] G. P. Thomson, *Proc. Roy. Soc.*, 117: 600, February 1, 1928.

[1] W. A. Cannon, *Plant Physiol.*, 4, 1932.

on rhizomes is *Carex limosa,* or mud sedge, of northern America and Europe. (Other species of sedge which occur in acid-free substrata have similar root systems).

The rhizome of *C. limosa* is long, branched and has long internodes.[2] It is superficially placed in the substratum. The most striking structural feature is the internodal development of large chambers, which, in effect, are storage chambers for gases, especially for oxygen.

The adventitious root system is dimorphic, consisting of adventitious or main roots which are relatively slender and much branched, and main roots which are relatively thick and which may or may not bear laterals. There are, thus, really two kinds of thick roots, branched and not branched. The slender and thicker main roots have unlike origins. The slender roots arise at the base of flower shoots; the thicker roots are formed at the base of leafy shoots.

Root hairs occur abundantly on nearly all the roots. The thicker main roots have aerating tissue composed of 10 to 15 rows of intercellular spaces, arranged radially.

It has been observed (Metsävainio) that the roots with prominent intercellular spaces may penetrate deeply; those without it are usually superficial. The crucial structural difference between the two is evidently the presence or the absence of aerating tissue.

It will be recalled that other herbaceous hydrophytes also have well-developed intercellular spaces or chambers, for example, Elodea and Equisetum. Those of the former may, when the plants are in sunshine, contain much oxygen, derived from carbon assimilation. And, in certain scouring rushes the air chambers are the most prominent features both of the shoot and of the rhizome. It is because of this that the rhizome, as in *E. fuviatale,* may penetrate deeply in a wet, or saturated substratum. An analogous condition appears to obtain in some sedges which have aerating tissue not only in the rhizomes but also in the thicker main roots, and the origin of these roots at the base of the leafy shoots has, from this point of view, great significance. They may also be storage organs for oxygen, especially oxygen of internal origin.

From these and other considerations it is concluded that the slender and much branched main roots, without prominent intercellular spaces, and which are shallowly placed, derive the oxygen they require from the well-aerated soil atmosphere immediately around them. It, in fact, is because of this readily obtainable oxygen that these roots have laterals. The thicker main roots, on the other hand, which have aerenchyma, develop and live where the oxygen supply is limited, but they are able to secure the necessary amount from the rhizome and/or chlorophyll-bearing shoot. It is because of this that they live under poor conditions of aeration in spite of the relatively small water-absorbing and *oxygen*-absorbing surface.

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[2] K. Metsävainio, *Ann. Bot. Soc. Zoolog.-Bot. Fennicae Vanamo,* 1. Helsinki. 1931.

HARDINESS OF THE PAPER-MULBERRY TREE

A TREE that supplies paper to part of Asia and materials for clothing to many Pacific islanders was formerly much planted in the United States.

This curious tree *Broussonetia papyrifera* Vert. is said to be hardy up to New York City and also to sometimes escape and spread, naturally, though the sexes are in separate trees. "Is the female of the species more tender than the male"? was a question not to be answered by the Arnold Arboretum, as outside the climatic limit of this tree. Possibly some reader of SCIENCE may know the answer.

In Baltimore, Md., many of these trees flourished in yards, being introduced by Jesuit Fathers, it is said. But as far as known all the trees here are staminate or male and not capable of colonizing new localities. Yet in North Carolina one sees the strange flowers and the mulberry-like fruit that might spread seed to new regions. In Florida also female trees are found.

When, on different occasions, little female trees from Florida were planted in Baltimore, they flourished exceedingly all summer, but failed to survive the winter, as the male trees do.

It may be that this tree is exceptional and that both sexes are not equally hardy and thus the limits of its natural distribution would be set by one sex while artificially by man the other sex may be grown over a wider area. Is there such a physiological difference?

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THE GALTON LABORATORY

YOU were good enough (November 10) to reprint for the information of readers of SCIENCE, the letter of protest which I wrote to the London *Times* on the obstacles placed in the way of the Galton Laboratory continuing its researches. It is now possible to give a somewhat fuller view of the situation.

Many of the constituent institutions of London University are again active. The London School of Hygiene and Tropical Medicine, for example, situated only a few hundred yards from University College, along Gower Street, has its library and main departments open. I have been unable to ascertain, even if undergraduate teaching is supposed to be safer elsewhere, why research departments should be forbidden to continue at University College, which now stands nearly empty.

The Galton Laboratory has established its right to continued existence, though it has been forced to leave London. Sir John Russell was kind enough to find it