the process being again accelerated by the presence of manganese or iron. In alcoholic solution it is possible to replace eosin by chlorophyll or by the methyl and ethyl chlorophyllides. Photo-oxidation again occurs, but is not produced if the non-fluorescent copper compound is used instead of the magnesium-containing chlorophyll compounds, which are fluorescent in alcoholic solution.

Water plants, living or dead, immersed in aqueous solutions of benzidin produce brown oxidation products of benzidin in the neighbourhood of the chloroplasts when exposed to the light. There is no such reaction in the dark, or in dead plant tissue which has been boiled in copper sulphate, so that the fluorescent pigment is replaced by the presumably non-fluorescent copper derivative. Dead green cells, which bleached in a few minutes in a strong light, could be kept green by the addition of neutral sodium sulphite. Noack considers that this is evidence that under certain conditions the photo-oxidative change results in the destruction of the pigment. Dead green tissues in the dark showed no absorption of oxygen in twelve hours, but in a strong light at 10° strong oxygen absorption took place, proportional to the oxygen pressure.

There is an obvious difficulty in associating these photo-oxidative changes with the photo-synthetic reduction of carbonic acid. Noack and Metzner have shown their close connexion with the so-called photo-dynamic action by which species of *Paramœcia*, normally insensitive to light, in the presence of very dilute solutions of fluorescent pigment and oxygen, become photo-tactic in the light, showing positive or negative movements according to the strength of the light or variation in oxygen pressure or pigment concentration whilst under stronger photo-dynamic action, they are killed. Metzner (*Ber. der Deutsch. Bot. Ges.* 41, pp. 268-274, 1923) has even extended this work to root systems growing in dilute solution of fluorescent pigments, which have thus been rendered photo-tropically sensitive, a phenomenon which he describes as induced photo-tropism.

From this point of view, Noack argues that in

normal photo-synthesis the photo-oxidative change must hand energy on to carbonic acid, and he points out the interesting bearing in this connexion of the toxic action of sunlight on leaves, in the absence of carbon dioxide. This phenomenon was reported long ago by Jost. Noack now explains it as a photo-dynamic effect of the fluorescent pigment upon the surrounding protoplasm, produced in the absence of carbon dioxide. He also thus explains the death and bleaching of *Fontinalis* when exposed to sunlight in the presence of phenyl urethane, a substance which, as Warburg has shown, hinders photo-synthesis. Noack also offers a similar explanation of the toxic action of sulphur dioxide upon green tissues; the sulphite hinders photosynthesis and under these conditions photo-dynamic destruction of the protoplasm occurs in the light. This interpretation does not seem quite in harmony with the demonstration of the effect of sulphites in hindering photo-oxidation.

Noack adds some further experiments as to the rôle of the yellow pigments in the leaf plastids. In experiments *in vitro*, these carotinoids were bleached by photo-oxidation in sunlight in less than an hour in the presence of chlorophyll (1 in 100,000); without this trace of chlorophyll they remained unaltered after six hours' exposure.

Stern explains chlorophyll fluorescence as due to its solution in lipoids, but Noack finds that dry leaf tissue from which lipoids and carotinoids have been removed by 24 hours' extraction with petrol ether, still retain their chlorophyll and still show the photo-oxidation of benzidin and bleach as the result of photo-oxidation. These experiments seem in closer agreement with Willstätter's view that chlorophyll is adsorbed on some substance of high molecular weight, although in agreement with Stern's view that the pigment itself is in the fluorescent condition.

It must be admitted that the theoretical interpretation of these experiments of Noack is still far from clear, but they seem well worth consideration as suggesting yet another line of experimental approach to a very fundamental problem, the function of chlorophyll.

Tide-predicting Machines.

THE simplicity of the harmonic methods of analysis and prediction of tides is very fascinating, and the invention of the tide-predicting machine by Lord Kelvin almost ensured the success of the methods. A predicting machine sums a number of harmonic variations, transmitted vertically to pulleys, round which passes a wire or chain which is fixed at one end and carries a recording pen at the free end. For the majority of ports the harmonic method of analysis is unrivalled in accuracy and cheapness; consequently we find machines in active use in the following countries: Great Britain (one at Broadstairs and one at Bidston Observatory), France, Germany, Portugal, United States, Argentina, Brazil, India, and Japan (2). In addition to these, three machines are no longer used: one was destroyed at Tokyo, and the Brazilian machine is being replaced by a model under construction at the present time. It is noteworthy that since the War five machines have been built at Glasgow by Messrs. Kelvin, Bottomley, and Baird.

The number of harmonic variations utilised by the machines varies from ten to thirty-seven, and much ingenuity has been practised, especially in connexion with devices to reduce the cost of predictions. Considering that a port cannot do business without tide predictions, it is remarkable that 10*l.*-20*l.* should be considered excessive cost, and that too often accuracy is subordinated to price. For the more important

ports, however, accuracy is increasingly demanded. Considering only prediction, accuracy depends upon the number of constituents incorporated in the machine, and also upon the performance of the machine. For some ports, especially those situated in estuaries, a machine with, say, eighty constituents would be required; the initial cost would be very great and the difficulties of operation enormously increased.

The present writer has had actual experience with five of the latest machines; he has carried out tests on two others, and has witnessed the performance of another one. There is no possible doubt but that the principal source of error in performance is that of friction. A change in tension of 1 per cent. at each pulley means a considerable average change over of tension throughout the wire under certain conditions. This leads either to stretching with a soft wire or to 'bowing' from the vertical with a resilient wire, and it seems impossible to find a wire of circular cross-section that will satisfy all conditions. A chain is used on two machines (United States and Germany), and a flexible tape of relatively large cross-section is used on the Liverpool Tidal Institute machine at Bidston. The machine now under construction for Brazil is being fitted with ball-bearings for each pulley.

Even if a perfect machine, with a large number of

constituents, could be built, it is still doubtful whether the harmonic method can be adequately used for the direct prediction of tides for estuary ports; part of the difficulty has to do with the validity of the resolution into harmonic constituents at such places. It is possible, however, to apply adequate corrections to the machine predictions, and such corrections may be 'non-harmonic' (functions of the range of tide) or 'harmonic'; in the latter case the machine may be used with a special time-scale to run off a separate curve for the corrections. Even this method is not without its difficulties. The harmonic method has thus had to confront many serious hindrances to universal adoption, especially in the case of the most important ports where its defects are most apparent; there is no doubt, however, that the harmonic method of prediction and the use of predicting machines will increase, but perhaps with some loss of apparent simplicity of operation.

Various details of the machines hitherto constructed are brought together in Special Publication, No. 13, issued by the International Hydrographic Bureau of Monaco, entitled "Tide Predicting Machines." Most of the remarks appear to have been culled from official accounts of the machines. The whole volume would have been more useful if it had been subjected to more helpful criticism. Appendix II. and the tables of astronomical arguments for ten constituents are of no value to any one likely to be using a machine and are out of place in the volume. Certain formulæ on p. 81 are inconsistent, and the table on p. 83 cannot be understood unless certain symbols, x and y , are explained.

A. T. DOODSON.

University and Educational Intelligence.

CAMBRIDGE.—An offer has been made of 25,000l. by the Empire Marketing Board, through the Committee of the Privy Council for Scientific and Industrial Research, for the building and equipping of an extension of the Low Temperature Research Station.

Sir Josiah Stamp has been appointed Rede lecturer, Dr. C. Hose has been elected to an honorary fellowship at Jesus College, and C. Rimington, Emmanuel College, has been elected Benn W. Levy student in bio-chemistry. The Raymond Horton-Smith Prize has been awarded to Dr. A. J. Copeland, Pembroke College, for his thesis on "The Cocaine Substitutes, with Special Reference to Borocaines"; *proxime accessit*, Dr. T. A. Butcher, Queen's College, for a thesis on "The Normal Gastric Secretion as Determined by the Fractional Test Meal."

EDINBURGH.—At the meeting of the University Court on November 15, Prof. Baldwin Brown was appointed Munro lecturer for the current academical year. He will deliver a course of ten lectures in the summer term on "Activities of Prehistoric Man in their Relation to the Origin of the Arts."

Mr. J. A. V. Butler was appointed a lecturer in the Department of Chemistry.

LEEDS.—The following appointments have been made in the Cancer Research laboratories: Mr. J. S. Young to be lecturer in experimental pathology and assistant director of cancer research; Mr. Young has held appointments as resident assistant physician at the Western Infirmary, Glasgow, as University assistant to Prof. Muir, and, for the past two years, as assistant pathologist at the Western Infirmary; Mr. H. J. Channon to be bio-chemist in the Department of Experimental Pathology; Mr. Channon held a Beit Memorial Fellowship for Medical Research

under Prof. J. C. Drummond, University College, London; Cancer Research fellowships to Dr. Georgiana M. Duthie, who has been a demonstrator in the Pathology Department of the University since January 1925; and to Mr. G. A. Collinson, who during the same period has acted as research assistant to Sir Berkeley Moynihan.

LONDON.—The following free public lectures are announced:—"The Present Position of the Logic of Induction," Dr. C. D. Broad, at King's College, at 5.30, on December 1; "Colour Vision," Prof. H. E. Roaf, at University College, at 5, on December 1 and 8; "Nervous Affections of the (Esophagus)" (The Semon Lecture), Dr. A. Brown Kelly, at the Royal Society of Medicine, at 5, on December 2; and "Influence of Environment on Bacteria," Mr. F. W. Twort, at the Royal College of Surgeons of England, at 4, on December 6, 7, 9, 13, and 14.

The following doctorates have been conferred: *D.Sc. in Physiology* on Prof. D. T. Harris (University College) for a thesis entitled "Biological Action of Light"; *D.Sc. (Engineering)* on Mr. H. E. Merritt (West Ham Municipal College) for a thesis entitled "Generated Gear Teeth."; *D.Sc. in Physics* on Mr. C. E. P. Brooks, for a thesis entitled "The Variations of Pressure from Month to Month in the Region of the British Isles," and on Mr. Wilfred Jevons for a thesis entitled "(1) A Band Spectrum of Tin Monochloride exhibiting Isotope Effects; (2) The More Refrangible Band System of Cyanogen as developed in Active Nitrogen."

MANCHESTER.—The honorary degree of D.Sc. has been conferred upon Mr. S. L. Pierce, formerly manager of the Manchester Corporation electricity undertaking and an Electricity Commissioner; Prof. A. C. Seward, professor of botany in the University of Cambridge; Dr. A. E. H. Tutton, formerly H.M. Inspector of Schools (Technological Branch).

THE date of the second biennial conference of the World Federation of Education Associations, to be held at Toronto, Canada, in 1927, is to be August 7-12 instead of some days earlier. The secretary of the Federation is Charles H. Williams, 101 Jesse Hall, Columbia, Missouri, U.S.A.

ACCORDING to a note in the October issue of the *Scientific American*, Princeton University is appealing to the public of the United States for an endowment of two million dollars in order to strengthen and enlarge its research work in the fundamental sciences. A further one million dollars will be granted by the General Education Board if the public subscribes the two million. The note directs attention to the large amount of research in science which has been carried out at Princeton during the past twenty-five years without an adequate endowment, and repeats Secretary Hoover's warning that the United States is falling behind in research in pure science. Several other universities of the United States are making similar appeals for endowment.

MR. W. R. BOWER, Head of the Department of Physics and Electrical Engineering at the Huddersfield Technical College and a past president of the Association of Teachers in Technical Institutions, is retiring at the end of the current term after holding his present post for thirty years. The College authorities are now creating separate departments of physics and electrical engineering. The new head of the Physics Department will be Mr. H. Lowery, lecturer in physics at the Bradford Technical College and formerly assistant lecturer in physics in the