radioactivity not recovered in the faeces had been absorbed. In forty-four observations on thirty-five control subjects, the radioactivity in the faeces ranged from 9 to 47 per cent and averaged 27.3 ± 1.6 per cent of that present in the oral dose. In twenty-four pernicious anaemia patients, the corresponding average percentage was 92.3 ± 1.3 . When these patients were given intrinsic factor, most of the results were within the limits observed in normal subjects. Achylia and atrophy of the gastric mucosa supported these findings in each of nineteen of the patients who were studied. Sterilization of the bowel with chlortetracycline did not increase the uptake of labelled vitamin B₁₂ in a patient with untreated pernicious anaemia. Studies on megaloblastic anaemia following gastric surgery showed that, after total gastrectomy, little or no labelled vitamin B₁₂ is absorbed unless intrinsic factor is given with it. In five patients with partial gastrectomy, failure of absorption was corrected by intrinsic factor, while in another nine patients in whom no megaloblastic anaemia developed after removal of the distal half of the stomach, there was no permanent impairment of vitamin B₁₂ absorption. In seven patients with idiopathic steatorrhoea and megaloblastic anaemia, absorption was normal in one young patient, slightly impaired in another and negligible in the remaining five. Intrinsic factor seldom caused improvement, even when given in very large doses. In another four patients with idiopathic steatorrhoea, but no megaloblastic anaemia, absorption was normal in three, and only slightly reduced in the fourth. Absorption was unaffected in megaloblastic anaemia of pregnancy or the puerperium and in megaloblastic anaemia associated with epilepsy.

The final paper, by Dr. F. Wokes (Ovaltine Research Laboratories, King's Langley), described anaemia associated with dietary deficiency of vitamin B₁₂ encountered in a group of about a hundred and fifty persons termed 'vegans' who consume no animal food whatever. There was no megaloblastic or macrocytic anaemia, but in rather less than half the subjects there were low serum B₁₂ levels (less than 100 $\mu\text{g}/\text{ml}$.) accompanied by neurological manifestations ranging from slight paraesthesia to subacute combined degeneration of the cord. The wide variation in response was probably not due to variations in dietary intake of the vitamin, which was not found in significant amounts in the foods consumed by the 'vegans'. It was thought to be more likely to be caused by differences in the degree of intestinal synthesis of the vitamin.

Study of the 'vegan' diet showed its vitamin content to be satisfactory, apart from B₁₂ and possibly also D. The average protein intake was rather low (9–11 per cent on the calorie basis), and the large amounts of pulses consumed tended to lead to a deficiency of methionine, which would be aggravated by the deficiency of vitamin B₁₂. This, together with the unusually high intakes of folic acid from green vegetables, may have been responsible for the neurological manifestations.

The part played by vitamin B₁₂ in the *de novo* synthesis of labile methyl groups to convert homocysteine to methionine, and also in the reduction of disulphide to sulphydryl groups, has led to a study in 'vegans' and non-'vegans' of the metabolism of thiocyanate, the sulphur-containing detoxification product of cyanide, in the metabolism of which vitamin B₁₂ in the form of hydroxo- or aquocobalamin appears to be implicated. A sulphur transfer

cycle was described for synthesis of essential sulphur-containing metabolites which might include the methionine deficient in 'vegan' diets. Lack of vitamin B₁₂ might also, by inhibition of a sulphydryl system, lead to abnormal metabolism of tryptophan and tyrosine, with accumulation of toxic products, which might be responsible for the neurological manifestations.

In the subsequent discussion, Dr. C. C. Ungley described scotomata occurring in one of the 'vegans', which were cured by prolonged administration of vitamin B₁₂.

VEGETABLE TANNINS

SYMPOSIUM IN CAMBRIDGE

THE Society of Leather Trades' Chemists held a symposium on "Vegetable Tannins" during April 12–13 in the Chemistry Department, University of Cambridge, at which more than a hundred members and guests participated.

After the symposium had been opened by the president of the Society, Dr. R. G. Mitton (British Leather Manufacturers' Research Association), the chairman, Prof. R. D. Haworth (Chemistry Department, University of Sheffield), briefly referred to Emil Fischer's outstanding contribution to the chemistry of the gallotannins and mentioned how the early optimistic attempts of the 1920's to bring order to the untidy field of tannin chemistry was not realized. The reason for this is that those physical methods, which are now used for the isolation of single substances, were unknown. As a result of recent work, much of which, said Prof. Haworth, has been carried out by those present at the symposium, order and interest have been restored. Considerable academic and technical research is now in progress, and we have learned much concerning the units from which the complex tannins are composed.

In an introductory paper, on the scope of vegetable tannin chemistry, Dr. T. White (Forestral Central Laboratories) treated historically the chemistry of the tannin and related polyphenol constituents of the principal vegetable tannin extracts. He dealt with the previously proposed classification of tannin extracts, defined a tannin (as opposed to a polyphenol) and directed attention to tannin action. New work on the degradation of the major constituent of commercial gallotannin was outlined. The preliminary results can be interpreted in terms of a trisaccharide formula which is reminiscent of the tetrasaccharide formula proposed this year for sumach gallotannin by Grassmann and co-workers. Dr. White stressed that the condensed tannins cannot now be considered as a single class of compound. His paper included a review of the physical chemistry of gross tannin extracts, and a provocative account of the physiological function of tannins in the intact plant, notably as inactivating agents for vector-transmitted virus proteins.

Mr. H. G. C. King (also of the Forestral Central Laboratories) and Dr. White then gave a paper on quantitative determination of specific nuclei and components of vegetable tannin extracts. In the same way that paper chromatograms may be used for the separation of tannin constituents, they may also form the basis for the estimation of these substances, when used in conjunction with specific

reagents and reflectance spectrophotometry. Examples of catechol, monosaccharide, phloroglucinol, pyrogallol and resorcinol estimations were included.

In a paper on gallotannins and ellagitannins, Prof. D. Burton and Dr. H. E. Nursten (University of Leeds) outlined the work of the Leather Industries Department at Leeds under the successive administration of Profs. Atkin and Burton, both of whom had applied electrometric titration methods to gross tannin extracts and their dialysates, plant acids and their salts being found in the dialysate. By means of cation-exchangers, the salt content was estimated before and after dialysis. Application of these methods to the types of extract under consideration has afforded analyses of use to the industry.

Prof. O. Th. Schmidt (Chemical Institute of the University of Heidelberg) then gave a paper on the constitution of chebulinic acid. A Diels-Alder adduct of dimethyl fumarate and 1-acetoxybutadiene was formed, and the configuration of the separate racemates was unambiguously determined. Treatment of the *trans-trans*-tetrahydrophthalic acid dimethyl ester with ozone and hydrogen peroxide successively gave a cleavage product, the antipodes of which were resolved with brucine. One antipode was identical with the butanol tetracarboxylic acid lactone, derived from chebulic acid. Hence, both these substances have the racemoido-racemoido-configuration. Addition of the elements of water to chebulinic acid gave *neochebulinic* acid, which afforded chebulic acid and a trigalloylglucose on hydrolysis. The latter proved to be identical with 1 β :3:6-trigalloyl-D-glucose, which was synthesized from triacetyl-L-glucosan. Application of the new results suggests a constitutional formula for chebulinic acid.

In his exploratory study of the polyphenols and polyphenolase of tobacco, Mr. W. W. Reid (Research Department, Carreras, Ltd.) fractionated tobacco extracts by lead acetate precipitation and solvent extraction. These fractions were further subdivided as band chromatograms on thick paper, and homogeneous fractions were estimated by modern scanning techniques. Cellulose columns were also employed, and the enzymic oxidation of the resulting polyphenols by tobacco polyphenolase was studied.

In a contribution on paper chromatography as an aid to the elucidation of the structure of polyphenols occurring in tea, Dr. E. A. H. Roberts (Indian Tea Association Chemical Laboratory) exemplified the technique by the separation of (+)- and (-)-catechin and of *cis*- and *trans*-cinnamic acids. Accordingly, (+)-catechin, (-)-epicatechin, (+)-gallocatechin, (-)-epigallocatechin, and *cis*- and *trans*-chlorogenic and *neochlorogenic* acids were identified, theogallin was shown to be a galloyl ester of quinic acid, and chromatographic evidence for the occurrence of both *p*-coumarylquinic acids and myricetin glycosides was advanced. The possibility of the production of benzotropolones in tea fermentation was tentatively considered.

Dr. D. E. Hathway (British Leather Manufacturers' Research Association), in a communication on some approaches to aromatic biosynthesis leading to polyphenols and tannins, described the separation and identification of ellagic acid in plant extracts, and the separation of a plant acid fraction from myrobalans by means of ion-exchange chromatography. Related cyclohexanecarboxylic acids were identified by paper chromatography, and they were separated by extended ion-exchange methods. The chromato-

gram of the polyphenols and tannins of myrobalans was elucidated. On account of Davis's microbial studies, and the presence of cyclohexanecarboxylic acids concomitant with simple polyphenols and tannins in myrobalans, Hathway suggested that they may also be precursors of aromatic amino-acids, polyphenols and tannins in the plant. The occurrence of cyclohexanecarboxylic acids in other plants was mentioned, and the question of the ubiquity of shikimic acid was raised. The use of radioactive tracers in lignin biosynthesis was cited, and the emergence of C₇-C₉ plant compounds, including gallic acid, from the cyclohexanecarboxylic acid sequence was discussed.

On the second day the conference was continued under the chairmanship of Dr. F. E. King (Research Department, British Celanese, Ltd.). In their review of the leuco-anthocyanins, Drs. T. Swain and E. C. Bate-Smith (Low Temperature Research Station, Cambridge) have divided these substances into a category requiring oxygen for the transformation into anthocyanidin, and a category which does not require it. Little is known of the chemical structure of many of these substances. King and Bottomley (1953) isolated a leuco-anthocyanin, however, which they proved had a flavan-3:4-diol structure (7:8:3':4'-tetrahydroxyflavan-3:4-diol), the tetramethyl ether of which was afterwards synthesized by King and Clark-Lewis. Meanwhile, Swain had synthesized the 5:7:3':4'-isomer by hydride reduction of taxifolin. This new leuco-anthocyanin does not occur in Nature, it being different from that in apple and cacao. Two decades earlier, Robinson and co-workers provided considerable evidence for the structure of cyanomac lurin and peltogynol, neither of which belongs to the flavan-3:4-diol type. Leuco-anthocyanins are sometimes mobile on paper chromatograms, and this is a behaviour consistent with comparatively simple structures. A stationary class may be due to chemically unidentified polymers.

Mr. W. E. Hillis (Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, Australia), in a communication on leuco-anthocyanins as the possible precursors of tannins, showed that the leuco-anthocyanin content of vegetable tannin materials follows the intensity of red colour imparted to leather. In regions of active growth, such as the leaf tips and cambium during spring, there is a relatively high accumulation of leuco-anthocyanins. Mr. Hillis presented evidence that in eucalypts these substances originate in the leaves and move down the phloem across the cambium into the wood. Leuco-anthocyanins may be transformed into 'tannins' at the sapwood-heartwood boundary.

Dr. W. Mayer (Chemical Institute of the University of Heidelberg), in a paper on catechins from the bark of oak and sweet chestnut, described the isolation of (+)-catechin and (+)-gallocatechin from these plant tissues. (+)-Gallocatechin proved identical with Oshima's casuarin. Reduction of the pentamethyl ether with sodium and alcohol invoked desmethoxylation, and the resulting diphenylpropane was also obtained from pentamethyl (-)-epigallocatechin and was synthesized via the chalcone. The similar desmethoxylation of O-trimethylpyrogallol was encountered by Kostanecki.

In a communication on the occurrence and properties of dihydroflavonols (4-oxocatechins), Dr. J. E. Gowan, Mrs. E. M. Philbin and Prof. T. S. Wheeler (Chemistry Department, University College, Dublin)

reviewed the occurrence of the eight dihydroflavonols in the plant kingdom: dihydro-kæmpferol and -myricetin occur most frequently. Dihydroflavonols have been synthesized by six methods: oxidation of 2'-hydroxychalcones and flavanones; bromination of flavanone, followed by nucleophilic replacement of halogen; ring-closure of 2'-hydroxy- α -methoxychalcones; treatment of 2'-acetoxychalcone dibromides with silver acetate or alkali; dithionite reduction of flavonols; and reaction of aromatic aldehydes with 2-hydroxyphenacyl chlorides. Under the influence of alkali, dihydroflavonol disproportionates into the flavonol and flavanone, or affords the corresponding 2-benzyl-2-hydroxycoumaran-3-one.

Dr. W. B. Whalley (Organic Chemistry Department, University of Liverpool), discussing the stereochemistry of the chromans and related compounds, dealt with a stimulating application of conformational analysis. In common with King, Dr. Whalley agrees with the assignment to catechin and epicatechin of *trans*- and *cis*-structures, respectively, but he produced evidence in favour of fresh conformations with 3(*a*)-hydroxyl groups for both substances. Conformational analysis has been extended to the 3-hydroxyflavanones, 2-hydroxyisoflavanones and flavan-3:4-diols, and it is evident that Dr. Whalley will elucidate the conformation of the complicated O-ring heterocyclics by application of stereo-specific reactions.

The Society will publish the symposium lectures and discussions in book form, and this should interest all those whose work brings them into contact with polyphenols, tannins and vegetable tannin materials.

D. E. HATHWAY

EAST AFRICAN INDUSTRIAL RESEARCH ORGANIZATION

REPORT FOR 1954-55

THE East African Industrial Research Organization, which incorporates the East African Industrial Research Board, came into existence on April 1, 1955, and its first annual report* is a progress report covering the period January 1, 1954-June 30, 1955. The new Organization absorbs the staff of the previous Board, and provision is made for a 50 per cent increase during the next two years. The British Government is contributing, from Colonial Development and Welfare Funds, 75 per cent of the capital expenditure for offices and laboratories and housing, and half the recurrent expenditure during the next two years. The Organization will be responsible to a board, on which the East African Government and the East African High Commission are represented.

The present report summarizes the work in the production of hecogenin from sisal waste, the plant for which has operated successfully since it was officially opened in June 1954. A preliminary report has been issued on the investigation of coffee processing which indicates that there are three stages in drying fermented coffee and that it is desirable to dry-wash the fermented coffee initially as quickly as possible, without using too high a temperature. When the coffee is dry enough to be safe from deterioration, the remaining process may be a slower

* East African High Commission. East African Industrial Research Organization: Annual Report 1954-55. Pp. ii+17. (Nairobi: East African Industrial Research Organization, 1955.)

removal of moisture in a conditioning bin. Work with dual-fuel engines, using oil and indigenous wood, has shown that producer gas can replace diesel oil in a diesel engine and is utilized as efficiently thermally as the oil. Satisfactory ignition of the gas-air mixture can be achieved with a low proportion of the full-load consumption of oil; at least 70 per cent of the full-load rating of a coupled diesel engine and alternator can be carried on gas, while the governor retains full control of speed, and existing engines can be modified economically on the site.

Chemical engineering research has been concerned with the utilization of natural steam, the production of salt and lime burning; in ceramics a refractory grog has been produced by calcining fine kyanite, bonded into pellets with molasses in a rotary kiln, and also a porous grog by grinding raw kyanite with charcoal, pelleting with molasses and calcining in the laboratory at 1650° C. Other work has been concerned with the production of phosphatic fertilizers and the pelletizing of cetyl alcohol for use in retarding the evaporation of water from dams. For this latter purpose, following work by A. F. C. Cole, who died during the period, apparatus has been devised by which an output of 20 lb. a day has been achieved. The apparatus is described and illustrated in the report.

CURRENTS THROUGH THE STRAITS OF DOVER

NEARLY a hundred and twenty-five years ago Faraday predicted that electrical potential differences would be set up in sea water, a conducting fluid, by its motion in the Earth's magnetic field. His predictions were verified by measurement of voltages induced on submarine cables. During recent years, oceanographers have begun to use measurements of the voltage differences in sea water as a useful method of studying water transport. In a recent paper (*Phil. Trans. Roy. Soc., A*, 248, 953; 1956) K. F. Bowden has demonstrated the value of the method in his study of the flow through the Straits of Dover. He has taken as his raw material fifteen months of continuous observations of the voltage fluctuations induced on a cable crossing the Straits of Dover, together with four months of similar observations on a cable crossing the southwestern portion of the North Sea. Regular voltage fluctuations, about one volt in amplitude, produced by the tidal currents are a dominant feature of his records. These fluctuations, while serving a useful purpose for calibrating the voltage in terms of the mean flow through the Straits, have to be eliminated to study the more interesting residual currents. The calibration, which depends on the conductivity of the sea bed as well as the sea water, is done empirically. Shorter-period fluctuations produced by magnetic disturbances are eliminated by filters in the measuring equipment and by smoothing of the graphical records.

Prof. Bowden shows that the residual currents, which sometimes run with speeds as high as one and a half knots in either direction, are highly correlated with the local winds and the slope of the sea surface along the Straits. The correlation is also high with the wind system over the southern part of the North Sea and the English Channel, indicating that the surface slope along the Straits is largely a consequence