it can be deduced that there are two basic atomic processes governing breakdown in air—ionization, which sets a minimum electric field for advance (30,000 V/cm in air), and electron capture, which can only be avoided in the pilot channel behind the tip if the field there exceeds 4,000 V/cm. The step process can be interpreted in terms of these fields.

The radius of protection of Franklin's rod has now been explained quantitatively in terms of measured quantities in lightning leaders. In the form of a horizontal earth-wire strung between the tops of power-line towers it is of crucial importance. Recent unexpected failures in such protection, not necessarily involving interruption of electrical supply, but troublesome and connected with increasing heights of towers, require interpretation.

An explanation of the occurrence of ball lightning in the Alps is offered in terms of two features special to this region. The first is the recently discovered powerful ground flash of long duration from the tops of thunderclouds to mountain peaks; the second is the tendency of the ground currents supplying current to the return processes of such flashes to follow the beds of streams in Alpine regions of high rock resistivity. Ball lightning may consist of bubbles of reactive gas occasionally produced by the heavy current in these stream-beds.

CHEMISTRY OF TANNINS

PROF. R. D. HAWORTH, in his presidential address to Section B (Chemistry), reviews the recent progress made in the elucidation of the chemical nature of vegetable tannin extracts which, until the advent of numerous modern techniques of isolation and analysis, has remained a difficult and therefore largely neglected field of study. Although plant extracts may contain more than one type, vegetable tannins are classified as hydrolysable or condensed dependent on their action towards acids and enzymes. The former group is conveniently sub-divided into gallotannins and ellagitannins, which give predominantly gallic acid and ellagic acid respectively on hydrolysis.

The gallotannins, which are amorphous and probably mixtures of isomers and closely related substances, were originally investigated by Emil Fischer and have the general structure of polygalloyl carbohydrate derivatives; the carbohydrate is normally glucose, but several are now known, such as Tara tannin, which is a polygallolyquinic acid, in which the glucose is replaced by other carbohydrates or related substances. The galloyl groups in the gallotannins are of two types, those linked directly to the carbohydrate and those linked depsidically to other galloyl groups, and although recent work has shown accurately how the former are distributed in Chinese, Sumach, Turkish and Tara gallotannins, the arrangement of the latter is probably random and remains unsolved.

Closely related to the gallotannins are the ellagitannins, which are often crystalline, and elegant schemes for their derivation have been suggested. In general the ellagitannins are probably formed by oxidative coupling of adjacent galloyl groups on a simple galloyl glucose and the hexahydroxydiphenoyl group thus produced may then undergo modifications by oxidation, reduction and hydrolysis to give the many novel structures found in this group. Compared with the state of knowledge of the structure of the hydrolysable tannins very little is yet known concerning that of the condensed or flavanoid tannins, which are amorphous and characterized by their conversion with acid to the insoluble highly coloured phlobaphenes. They contain little if any glucose, but are thought to possess a common structural basis and to be derived by postmortal polymerization or polycondensation of the frequently occurring hydroxyflavan-3-ols and hydroxyflavan-3,4-diols. Several dimeric products of these C_6–C_3–C_6 types have been isolated and characterized following acid-catalysed polymerization of the flavan-3-ol catechin, and these, it is suggested, are typical of the initial products formed in the complex process. Other workers have suggested alternative oxidative pathways for the formation of these tannins, but this remains a field of study in which further work is clearly necessary.

The developments made in the chemistry of the vegetable tannins concomitant with an increasing knowledge of the nature of the protein collagen chains in hide indicates the possibility in the near future of a greater insight into the chemical processes involved in the conversion, by the action of tannins, of animal skins into leather.

PHYSICAL BACKGROUND OF BRITAIN IN THE PLEISTOCENE

THE "Physical Background of Britain in the Pleistocene Period" is described by Prof. F. W. Shotton in his presidential address to Section C (Geology).

The fluctuations of climate in Britain during the Pleistocene may well have been more rapid than at any previous time in the country's geological history. Associated with the waxing and waning of the glaciers must have been impressive shifts in the plant and animal populations, fed during the interglacials from the European mainland. The argument is advanced that the Dover isthmus was established very early in the Pleistocene and thereafter remained unbreached until the well-authenticated cutting of the Straits about 7,000 years ago. By contrast, it is suggested that there was no land link between Ireland and the rest of Britain until the last (Würm) glaciation.

There is much evidence available to the geologist by which he can evaluate climate. It is almost certain that when the large ice sheets were established, dominant wind directions were greatly changed by this fact. North-easterlies rather than south-westerlies would dominate. Summers would be colder than now, but winters very much colder. The very existence of glaciers down to the Bristol Channel and Essex demands a lowering of mean annual temperature in excess of 9° C, while the widespread frost structure soils (polygons, stripes, ice-wedges) entail a fall exceeding 7° C. When these structure soils develop on a massive scale—polygons 20–100 ft. across, stripes 20–50 ft. apart—it can be assumed by analogy with the Arctic and Antarctic that 'permafrost' was present, that is, ground frozen winter and summer only a few feet below the surface. One of the most spectacular features of air photography is the frequency with which corn crops, as they ripen in late July, pick out these large-scale patterns. Other evidences of permafrost in Britain are pingoes, ice mounds, the dry valleys of limestone