medullated nerve are different from those of medullated; for these experiments Holmes used the nerves of crabs. The free carbohydrate, and especially the glycogen content, is very much higher; the latter may form 20 per cent of the total solids. Under anaerobic conditions at rest, the glycogen decreases, with a coincident increase in the free carbohydrate and lactic acid; in oxygen the fall in glycogen and the rise in free sugar are considerably less, and there is no increase in lactic acid, although preformed lactic acid is not removed. In the nerve-ganglia the presence of a polysaccharide was detected.

J. Pryde and R. W. Humphreys (*Biochem. Jour.*, vol. 20, p. 825; 1926) have shown that the oxidic bridge of the galactose in the cerebrosides of ox brain is of the stable amylene type.

The carbohydrate metabolism of cancer cells differs from that of most normal tissues in that aerobic glycolysis is a prominent feature, whilst the oxidative removal of lactic acid is a relatively slow process. B. E. Holmes (*Biochem. Jour.*, vol. 20, p. 812; 1926) has shown that certain tumour tissues contain very little reduced glutathione and have only a slight activity in reducing the oxidised form when added. H. G. Crabtree (*ibid.*, vol. 22, p. 1289; 1928) has found that certain pathological overgrowths, aroused by different viruses, behave like malignant tissue in their carbohydrate metabolism; this change from the normal was not seen when the virus failed to produce hyperplasia.

F. Dickens and F. Šimer (*Lancet*, vol. 2, p. 10; 1930) have recently shown that the respiratory quotient of normal tissues runs parallel with their power of anaerobic glycolysis; tumours have a low respiratory quotient, indicating a poor ability to oxidise carbohydrate, although actively glycolytic. The inability to oxidise lactic acid is peculiar, since tumours, like normal tissues, oxidise pyruvic acid.

S. T. Harrison and E. Mellanby (*Biochem. Jour.*, vol. 24, p. 141; 1930) have investigated the inhibitory action of pancreatic and other extracts upon the formation of lactic acid in cancer and muscle. It has been known for some time that pancreatic extracts inhibit acid production by muscle hash. D. R. McCullagh (*ibid.*, vol. 22, p. 402; 1928) confirmed this for muscle extract; he also showed that the former prevented the disappearance of carbohydrate, but caused an increase in the free phosphate content instead of a decrease. In the presence of sodium fluoride, pancreatic extract prevented the formation of hexose phosphate, and the author considers that this is the cause of the failure to produce lactic acid. In a later paper, working with E. M. Case, it was found that the inhibition was probably due to the amylase present in the pancreatic extract (*ibid.*, p. 1060).

The properties of the unknown factor and the enzyme are very similar: inhibition is observed when malt or taka diastase replaces the pancreatic extract, or when glycogen is used as substrate instead of starch; and the formation of lactic acid from activated glucose by muscle extract is not inhibited. Harrison and Mellanby confirmed the inhibition when starch is used as the source of the lactic acid, and the failure of inhibition with glucose; they also found, however, that inhibition occurs with hexose diphosphate but not with hexose monophosphate. They therefore consider that the pancreatic extract does not act by inhibiting the esterification of hexose but by forming maltose, which is only slightly acted upon by the muscle system with the production of lactic acid. They agree that the inhibition is due to amylase; the inhibition of lactic acid formation from hexose diphosphate, however, cannot yet be explained. The same authors have also shown that various preparations of amylase inhibit the glycolysis, anaerobic and aerobic, of tumour tissue; the latter cannot form lactic acid from hexose di- or mono-phosphate or from starch to any appreciable extent, so that in this case also the inhibition cannot be due to inhibition of ester formation.

Pancreatic extracts have also been reported to contain an antiglyoxalase. Phenylglyoxal is converted to mandelic acid by liver extract; pancreatic extract inhibits the reaction. J. O. Giršavičius (*Biochem. Jour.*, vol. 24, p. 446; 1930) has found that pancreatic extract itself produces acid from phenylglyoxal; a reaction appears to occur between the phenylglyoxal and diamino-acids and polypeptides in the extract with production of an orange substance. It does not appear that this reaction can be responsible for the antiglyoxalase activity of pancreatic extracts, since the substances involved are thermostable and dialysable.

Mosses as Epiphytes.*

WISNIEWSKI has surveyed parts of the virgin forest of Białowieza, with special reference to the epiphytic Bryophyta. His results and the discussion of their significance bring out several points of interest bearing on the nature of epiphytism in this group. He recognises four associations of mosses on the trees, the first two of which appear to be true epiphytes, whilst the other two are more closely related to the vegetation of the ground flora.

The two epiphytic associations are:

(1) On broad-leaved trees (except *Betula* spp.): *Leucodon sciuroides* (chiefly on *Carpinus betulus*) and *Anomodon viticulosus* (chiefly on *Acer platanoides* and *Fraxinus excelsior*).

(2) On coniferous trees and *Betula* spp.: *Drepanium* (*Hypnum*) *cupressiforme*, var. *filiforme* and *Orthodicranum montanum*.

The other two associations under consideration are: (3) In damper situations on any type of tree: *Eurhynchium striatum*.

(4) In drier situations on any type of tree: *Pleurozium Schreberi*.

Considering possible factors influencing the ability of mosses to grow in different situations, it is clear that neither light nor temperature is a limiting factor. The light intensity lies well within the limits at which at least some of the species under consideration have been found to flourish, according to the work of Zmuda and Malta, and the same applies to the temperature range. The question of water supply is, however, a vital one for mosses as their method of water absorption is entirely different from that of root-bearing plants. It is clear from the work of Schimper and others that the rhizoids of a moss are ineffective in the uptake of water, for even if the lower parts of a moss plant are actually in water, the upper parts may be seen to wilt. The chief method of water absorption seems to be imbibition by the walls over the whole surface of the plant, whether dead or living, as is illustrated by the rapid recovery of form on moistening dry specimens. Wisniewski found an interesting difference in this respect between the epiphytic mosses and those of the ground flora, for whilst the dry plants of the former group

* Wisniewski, T. "Les associations des Muscinées (Bryophyta) épiphytes de la Pologne, en particulier celles de la forêt vierge de Białowieza." (*Bull. Internat. de l'Acad. Polonaise des Sci. et des Lettres*, pp. 293-342; 1929.)

recovered either instantaneously or at most after a few seconds on moistening, those of the latter took 40-50 sec., or often longer.

Müller points out that mosses cease to condense atmospheric moisture when the tension of water vapour is lower in the air than in the cells, so that this method is of significance to the moss only at times when the atmosphere approaches saturation. In the forest, the saturation deficit of the atmosphere increases with the distance from the ground level, and the rate of this increase depends chiefly upon the permeability of the soil and the type of forest (that is, broad-leaved or coniferous). Partly as a result of this, the moss life of the *Leucodon* and *Anomodon* type in the broad-leaved forest extends up the trees to a height of 20 m., whilst the *Drepanium* and *Orthodicranum* type in the coniferous forest only extends 3-4 m. The heights to which the mosses can extend is evidently controlled to some extent also by properties of the mosses themselves, since only certain species—the epiphytic species—can extend up the tree more than about 30-50 cm.; below this level one finds some of the species characteristic of the ground flora, for example, *Eurhynchium striatum*, *Pleurozium Schreberi*, along with certain Phanerogams, such as *Oxalis acetosella* and *Geranium Robertianum*.

The general occurrence of certain epiphytes on broad-leaved and others on coniferous trees might be explained to some extent by the humidity of the type of forest formed by such trees, a factor which is seen to influence the flora of the undergrowth and tree bases. There is, however, something more than this obvious relationship between the true epiphytic mosses and their hosts, for one finds that trees of a particular kind, for example, *Pinus sylvestris*, have their characteristic epiphytic mosses whether growing in a typical pine association or occurring as an isolated example in an association consisting typically of broad-leaved trees, and vice versa. Further, one finds that within an association, a particular moss may show a preference for a particular kind of tree, for example, *Leucodon* for *Carpinus betulus* and *Anomodon* for *Acer platanoides* and *Fraxinus excelsior*—a curious fact which future investigation may show to be associated with the type of bark (fissured or scale) and the consequent difference in the rate at which water flows away.

An unexpected feature that is without any explanation is that, as regards epiphytic moss vegetation, *Betula* spp. are classed with the conifers—a fact which is further supported by the distribution of epiphytic lichens by Räsenen in Finland.

The connexion between an epiphytic moss and its host cannot be regarded as strict, by any means. Wisniewski points out that, although the types he regards as epiphytic are rarely found in other habitats, there are very few of them which have not been recorded as growing on rock or stone as well. The marked preference for the epiphytic habit is further emphasised by the fact that very few of them are recorded from altitudes or latitudes beyond the tree zone. A study of the literature on moss distribution brings out the fact that the majority of the epiphytic forms—48 per cent—of the Białowieza forest are holoarctic in distribution, extending across Europe to North Asia and China on one side, and to North America on the other. It is curious to find that of the twelve species of trees serving as the commonest hosts for epiphytic mosses in the Białowieza forest, none occurs in North America, so that evidently the same species of mosses in the latter continent must have transferred to other hosts.

World Geometry in its Time Relations.

PROF. R. C. TOLMAN, of the Norman Bridge Laboratory of Physics, Pasadena, has published, in recent issues of the *Proceedings* of the U.S. National Academy of Sciences, a series of papers on world geometry in its time relations. The subject is the same as that of recent papers by Lemaître, de Sitter, and Eddington, namely, the existence of non-static solutions of Einstein's gravitational equations. Prof. Tolman's papers are admirably concrete and free from paradox, and will appeal to those who are attracted by a certain definiteness of point of view.

After discussing the recognised weaknesses of the Einstein line-element (full, static universe) and the de Sitter line-element (empty universe), Prof. Tolman proceeds to determine a line-element on the basis of five assumptions: (1) spatial spherical symmetry; (2) symmetry with respect to past and future time; (3) a criterion of stability; (4) and (5) conditions of isotropy with respect to the volume defined by a system of nebulæ and with respect to the average density of matter. These conditions are shown to determine the form of the line element uniquely save for a certain function of time only, which occurs as a multiplier in the space part of the line element. As a first approximation, Prof. Tolman takes this to be a linear function of the time, and reduces its determination to the ascertaining of the numerical value of a single parameter, which must be a physical constant. This constant can be interpreted in terms of the time-interval between the sending out of two light-impulses by a nebula and the time-interval between their receptions. If these are not equal, the nebula will appear to be in motion in the line of sight, and the lines in its spectrum will be displaced with red or violet. The discrepancy between the two intervals will increase with the distance of the nebula, and Prof. Tolman deduces a proportionality between distance and line-displacement. This is in agreement with the empirically found relation between red-shift and distance for nebulæ, and, using the observed numerical values, the author infers the values of the constant in his formula for the line-element.

Prof. Tolman then shows that owing to the presence of this time-factor in the line-element, the mass enclosed within a given volume must be changing, and he identifies this change with the transformation of matter into radiation—that is, he identifies the reduction in measured mass with the mass disappearing from the volume in the form of radiation. The value of the time-constant deduced from the observed recession of nebulæ should thus be connected with the rate of evolution of energy per gram by the stars. From the nebular recession, Tolman finds $k = 5 \cdot 1 \times 10^{-10}$ (years)$^{-1}$, whilst the values of k deduced from the observed masses and luminosities of the stars as tabulated by him vary from $1 \cdot 7 \times 10^{-10}$ down to $2 \cdot 3 \times 10^{-16}$.

In a later paper of the series Prof. Tolman shows that the addition of higher terms to his linear approximation for his undetermined function of time may seriously modify the values of k deduced from the observed rate of annihilation of matter, and concludes that the discrepancy is not fatal. One is naturally tempted to make the criticism that the rate of annihilation of matter must be governed by the physics of the energy-generating process in stars, and so is surely a different physical phenomenon from the recession of the nebulæ, implied by such considerations as those of stability and symmetry in the universe. This, however, is not incompatible with the view that the transformation of matter is the