

abundant perithecia resembling organs (evidently true perithecia) which produce long spores. The new infection in the leaves is evidently due to these.

So far as I can judge, there has been, and still is, in Danish waters a high maximum of a fungus in the eelgrass and a wasting disease, connected with in several places a nearly total extinction of this plant. It is therefore suggested that the fungus here is the cause of the disease.

The systematic position of the fungus is not yet clear. The spores are long and flexible and in shape similar to the ascospores of *Ophiobolus*, but they do not seem generally to fall into fragments; also the ascus walls are dissolved very early. It may be *Ophiobolus maritimus* Sacc., but if so, this species should be referred to another genus.

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June 23.

Importance of Carbohydrate Supply in Legume Symbiosis

EXPERIMENTAL evidence, which has been accumulating for a number of years, but especially more recently, emphasises the importance of carbohydrate in nodule development and nitrogen fixation in leguminous plants inoculated with effective bacterial strains. There are, however, certain facts well known to plant physiologists which deserve greater emphasis in this connexion: (a) An abundant supply of nitrogen is conducive to top growth while a wide carbohydrate-nitrogen ratio favours root growth. The carbohydrate-nitrogen relations may be altered by changing the conditions for photosynthesis, by varying the nitrogen additions to the culture medium, and by supplying sugars to the roots. (b) During active photosynthesis a sugar concentration gradient¹, decreasing downward, commonly exists between the leaves and roots of higher plants. These synthesised sugars usually² do not remain long in this form; a considerable portion, 20 per cent or more, is required for respiration, while the remainder is either used for growth or is stored largely as starch.

If these facts, which apply rather generally to higher plants, are borne in mind in connexion with legumes, it is believed that many observations and experimental facts reported in the past in connexion with the nodulation of these plants, may be more satisfactorily explained.

The failure of nodules to develop normally in the presence of an abundance of fixed nitrogen is a good example³. In this case, where the carbohydrate-nitrogen ratio is narrow, most of the photosynthetic carbohydrate is used for top growth and only a small percentage reaches the roots. The condition in this case is similar to that existing in plants grown at low light intensities on soils containing only the usual small quantities of soluble nitrogen. In both cases the carbohydrate supply in the roots is so low that only a limited growth occurs. A high carbohydrate concentration is not essential for bacterial entrance into the root, but abundant nodule development takes place only provided the carbohydrate supply is adequate for good root growth. The frequent observation that root and nodule growth are favoured to a remarkable extent by additions of sugar emphasises the importance of this factor.

Nodule location on plants, uniformly inoculated, may also be closely correlated under many conditions

with available carbohydrate supply in the root at the time of nodule development. Normally, nodules on annual legumes are located chiefly near the upper parts of the main root system, nearest the source of carbohydrate supply. On the other hand, they are usually widely scattered where the plants are grown either in water cultures, or in a nitrogen-free atmosphere, or in the presence of increased carbon dioxide, and when produced by ineffective strains. In all these cases, carbohydrate is usually abundant almost to the root tips.

The limited data dealing with the energy requirements for the chemical process of nitrogen fixation in the nodule, as distinguished from the respiration and growth requirements of the bacteria and host, can now be interpreted with a greater degree of certainty. These fixation requirements appear to be negligible. The bulk of the carbohydrate is consumed in respiration and growth, chiefly of the host.

The intimate relations existing between the nodule bacteria and their hosts now seem less complicated than formerly supposed. In the past, various theories, involving such ideas as immunity and relative vegetative energy of the symbionts, have been advanced. The newer evidence, together with the old, tends to place much greater emphasis on carbohydrate nutrition, so far as effective bacterial strains are concerned. If the carbohydrate supply is adequate, nodules usually develop and nitrogen fixation roughly parallels the growth of the higher plant; if the supply then becomes deficient, the bacteria sometimes remain dormant, or in other cases may attack the tissues of the host to obtain food, as investigators at Rothamsted have repeatedly pointed out.

This communication summarises several of the more important ideas considered more fully in a manuscript entitled, "Carbohydrate Supply as a Primary Factor in Legume Symbiosis", to be published shortly.

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¹ Mason and Maskell, *Ann. Bot.*, 48, 119-141; 1934.

² Arthur, Guthrie and Newell, *Amer. J. Bot.*, 17, 416-432; 1930.

³ Allison and Ludwig, "The Cause of Decreased Nodule Formation on Legumes Supplied with Abundant Combined Nitrogen", *Soil Science*, in Press.

British Association: Aberdeen Meeting, 1934

HAVING been informed that in some quarters it has been stated that the lodging accommodation available for members at the meeting of the British Association in Aberdeen on September 5-12 next is limited, we hasten to take the earliest opportunity of assuring members who propose coming to the meeting that there is ample accommodation available.

While it is true that most of the hotel accommodation, with the exception of some double bedrooms, has already been booked up, the Local General Committee has in hand a large reservation of private lodgings of a suitable type and reasonable tariff.

We may state that the local arrangements are well in hand, and that members of the Association coming to Aberdeen are assured of a cordial welcome and an interesting programme.

E. W. WATT.

H. M. MACDONALD.

Local Hon. Secretaries.

Town House,
Aberdeen.
July 12.