when the last crop of wheat was removed on December 8.

An interesting case is that of the two pine seedlings. During the growth of the first crop one of these died, and the pot with the dead seedling left intact was carried on in the set and treated in the same way as the other cultures. The greater yield in this pot over that in the pot containing the live pine is clearly evident.

Another feature is the variation in yield obtained in the pots with different species of trees. It would appear that the cherry was least active in checking growth of wheat, the dogwood next, followed by the tulip, then maple, and most of all, live pine, although it would not be safe to assume this same order would obtain in the field.

It should be mentioned that in replanting the wheat, the soil was disturbed only enough to accomplish this, so the organic matter left by the wheat roots would act as a light application of green manure, although it is well known that wheat is not very effective as green manure. This would perhaps help slightly to counteract the deleterious effect of the tree roots on the wheat, but the aim was to leave the soil undisturbed.

Summarizing the foregoing, we find that seedling trees of tulip, dogwood, maple, cherry, and pine retard growth of wheat when the latter is grown under conditions making it necessary for the wheat roots to be in close physical relation with the tree roots. That this retarding effect differs with different species of tree seedlings, that the checking of wheat growth is greatest during the season when the tree seedlings are most active physiologically, and this checking effect becomes less as the season of physiological inactivity of the trees is approached. That in the case of pine, at least, the live pine is much more detrimental to wheat growth than the dead pine.

This injurious effect of trees on wheat appears to be due to the excretion of substances by the trees, toxic to wheat growth.

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NOTES ON ORGANIC CHEMISTRY

FORMATION OF FUSEL OIL

The production of fusel oil during the course of the ordinary alcoholic fermentation involves grave practical difficulties to the manufacturer of distilled spirituous beverages, because the removal of this constituent entails a considerable expense. To the pure chemist also, this formation of fusel oil is of importance because it, apparently, complicates the chemical changes involved in the course of fermentation. The conversion of grape sugar, $C_6H_{12}O_6$, into alcohol, $2C_2H_6O$, and carbon dioxide, $2CO_2$, is very simple, but to account for the production of small, variable amounts of amyl alcohol and similar substances compels the use of quite complicated equations. The difficulties of both the brewer and the chemist will be lessened, or wholly removed by some highly interesting work which Felix Ehrlich[1] has carried out in the Berlin Institution of Sugar Industry. He has fermented pure sugar solutions with pure yeast cultures and obtained, on an average, about 0.4 per cent. of fusel oil. The addition of *l*-leucine,

$$\begin{matrix}CH_3\\CH_3\end{matrix}{>}CHCH_2CH(NH_2)CO_2H,$$

or of *d*-isoleucine,

$$\begin{matrix}CH_3\\C_2H_5\end{matrix}{>}CHCH(NH_2)CO_2H,$$

to the fermenting material immediately raised the content of fusel oil to 3 per cent. The former compound gave inactive amyl alcohol,

$$\begin{matrix}CH_3\\CH_3\end{matrix}{>}CHCH_2CH_2OH,$$

and the latter, optically active, dextro-rotatory amyl alcohol,

$$\begin{matrix}CH_3\\C_2H_5\end{matrix}{>}CHCH_2OH.$$

On comparing the formulæ it will be observed that the alcohols can be formed from the leucines by the addition of the elements of water and the elimination of ammonia and carbon dioxide.

The latter substance is, of course, evolved, and the question arises as to the fate of the ammonia. Special experiments showed that the fermenting liquid and the gases issuing from it were free from ammonia and nitrogen,

[1] *Ber. d. chem. Ges.*, **40**, 1027 (1907).

and that the amount of amyl alcohol formed was equivalent to the quantity of leucine which disappeared in the course of the reaction. It follows, therefore, that the ammonia must be absorbed by the yeast as rapidly as it is produced and be converted into insoluble albuminoid material.

Evidently the formation of fusel oil is dependent on the assimilation of nitrogen by the yeast and it was found, by further experiments, that the addition of asparagine, $H_2NCOCH(NH_2)CH_2CO_2H$, or of certain ammonium salts such as the carbonate or sulphate, all of which liberate ammonia far more readily than the amino-acids, such as the leucines, almost completely prevents the formation of fusel oil. The results were the same irrespective of the kind of yeast employed and of the presence or absence of leucine from the mixture. Solutions of ordinary molasses behaved like those of pure sugar. The formation of fusel oil under industrial conditions appears, therefore, to be due essentially to the presence of amino acids in the mash, and not to those which the yeast contains. It is also obvious that the removal of these acids is not necessary for the prevention of the formation of fusel oil.

The same chemist has also carried out a number of experiments on the production of certain higher and more complicated alcohols from amino acids, in the presence of fermenting sugar. He finds that the action is a general one and that it appears to resemble certain activities in plants. Thus, from phenylalanine, $C_6H_5CH_2CH(NH_2)CO_2H$, he obtained phenylethyl alcohol, $C_6H_5CH_2CH_2OH$, which is the chief constituent of the odoriferous material of the rose.

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BOTANICAL NOTES

HOW TO STUDY THE FUNGI

GEORGE MASSEE, the well-known mycologist of Kew, has brought out a useful 'Text-book of Fungi' (Duckworth and Company, London), which is intended to serve as an introduction to those new lines of research included in the morphology, biology and physiology of the fungi, 'and also to indicate where fuller information may be obtained.' The reader will observe that the book is not, like some of its English predecessors, a book of *information*, only, but it is intended to foster investigation and research, in accordance with present-day ideas as to the proper function of a text-book for advanced students. For it must be remembered that this is no elementary presentation of the subject for children in the secondary schools, or others who have not had a good preliminary training in the 'general botany' courses in the college or university. It is, on the contrary, a book for the college or university student who has already acquired a good general notion of the fungi, and their relations to other members of the vegetable kingdom, and who is now ready to take up their particular study.

The book is roughly divided into three parts: I., Morphology, Physiology, Biology, etc. (195 pages); II., Pathology (36 pages); III., Classification (183 pages). In the first, such topics as the cell, anatomy of fungi, formation of spores, sexual reproduction, asexual reproduction, effect of light, effect of low temperature, respiration, transpiration, enzymes, parasitism, symbiosis, heteroecism, mycoplasm, chemotaxis, geographical distribution, ecology, phylogeny, etc., are taken up at greater or less length, and it is safe to say that any properly prepared student who carefully goes over this part of the book will do so with great profit, and will get a very good modern understanding of these plants. In the second part the student finds helpful discussions of the diseases caused by fungi, the spread of disease by means of hybernating mycelium, legislation against disease-producing fungi, etc. The third part opens with a discussion of the classifications of the fungi, followed by a systematic account of the orders and families. The author arranges all fungi under six orders, namely; Phycomycetes, Hemiascomycetes, Ascomycetes, Hemibasidiomycetes, Basidiomycetes, Deuteromycetes. The text is illustrated with 141 figures, which add much to the usefulness of the book.