involving the discriminant) to ascertain when cubic equations had imaginary roots.

Chas. Baskerville,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ECOLOGY.

To the Editor of Science: I read with much interest Professor Fernow's article, bearing the above caption, in Science, April 17, an article attractively written and containing many valuable suggestions.

I do not propose to enter into the general discussion outlined by the author, but shall confine myself to the paragraphs on the soil. It would not be right to allow so misleading a statement as 'it is first of all to be considered that chemical constitution [of the soil] plays probably only a small part or practically none; the reliance of tree growth on mineral constituents being relatively small' to go without protest.

The chief fact that is adduced in support of this dictum rests on the small percentage of ash in the grown tree and its greater abundance in the leaves and younger growth.

The growth of a tree is as absolutely conditioned by 'mineral constituents' as by any other fundamental factor of the environment. Vines says: 'Thus the inorganic substances absorbed by the roots pass into the cells of the leaves where they are concerned in the processes of constructive metabolism which are in operation in those organs.'

It is apparent that without this 'constructive metabolism' the materials of which the chief part of the plant is composed, mostly carbohydrates, could never be provided.

One of the functions of the absorption of water as such by plants is to secure the translation of these mineral elements from the soil to the parts of the organism where their constructive work is to be done.

Vines says: 'Only very dilute solutions of salts can be taken up by the roots; as a consequence, it is necessary that relatively large quantities of water should be absorbed in order that the plant may be supplied with the salts which are important in nutrition.'

The tree, during the whole period of its growth, does not use from without a single organic product. It gets its nitrogen in the form of nitric acid, its carbon in the form of carbon dioxid, its phosphorus in the form of phosphoric acid, its hydrogen in the form of water, and so on to the end of the nutrients. The fact that mineral matters are exuded in the leaves is no proof that they have not performed or assisted in performing the most important physiological functions. The excretion of a 'mineral constituent' may even be a proof of its importance in metabolism, as is the case with a great part of the phosphorus that is excreted from the body. Nature is careful to provide a superabundance of the most important substances. Because a tree may take up only one millionth part of the carbon dioxid which comes to it in the air during its period of growth, is no reason for saying that this constituent of the air is of little consequence in biodendry.

Mineral substances not only are useful and necessary in plant growth because of their part in forming tissues, but also because they stimulate by their presence the functional activity of the vegetative cells. In other words, they are condimental or katalytic as well as constitutional. Although potash is not a constituent of starch, it is thoroughly established by indubitable evidence that in the absence of potash in the plant blood starch granules are not formed.

The ions of mineral matter taken from the soil and coursing through the circulating apparatus of the tree perform useful and necessary functions from the time they enter the waiting mouth of the rootlet until they congregate in the extremest tip of the reddening leaf.

The 'mineral hunger' of plants is as well known and recognized by physiologists as that of animals, and the welfare of the growing tree is undoubtedly as profoundly affected by the soil element of its environment as by any other. Experiments have shown the minimum of any given mineral element of the soil which will permit normal development, but such a minimum only does so in case other mineral

elements are in excess. If the minima of all mineral elements are presented to the plant at the same time, normal growth can not take place.

In the experiments of Wolff it was conclusively shown that in such cases flowering and fruiting are practically prevented. The plant has, therefore, need of an excess of mineral matter, and this is secured from other mineral substances if one of the essential minerals is present in a minimum quantity. Thus some mineral foods may, temporarily at least, act as substitutes to a certain degree for others. Strange to say, however, sodium, which is so near potassium in its general properties, has but slight, if any, suitability as a substitute therefor. It is a mistake, therefore, to look upon the constitutional assimilation of mineral matters as their chief utility. The fact that both potash and phosphorus are always associated with the functions of the living cell is not to be forgotten. The absence of either of these minerals makes vegetable growth impossible. Especially are these two substances the katalytic agents whereby the living cell converts the other mineral foods of plants into starch, sugar, cellulose, oil and protein, of which the organic parts of plants are chiefly composed. These elements reach the tree solely through the soil, and the greater or less abundance of them in the soil can not fail to affect profoundly forest growth, perhaps to a greater extent than almost any other factor of the environment.

The soil has, therefore, marked ecological as well as physiological influences on forest growth. The soil of the forest is nature's own handiwork and will never be modified by man. When man begins his work the forest ends and the park begins. We all know how the soil alone has, in many instances, determined the character of tree growth. It is not wholly accidental that the sands are covered by pines and the mountains by oaks. The virgin forests in many localities were indexes whereby the early settlers selected their entries of land. They did not need to be told that the maple, the walnut and the tulip grew on the richer, and the beech, the gum and the oak on the poorer soils. The first forests that fell before the ax were those of the first-named trees. Thus the nature of the soil has often determined the original distribution of forest growth. Nature seems to know the edaphic principle in ecology better than man.

It is to be regretted that at this late day we should be told by such an eminent authority: 'Moreover, the total amount of mineral constituents in a tree is not only very small, but by far the largest portion is found in the leaves and young parts, suggesting again their merely fortuitous presence as a residue of the transpiration current, and mostly not required.'

I need hardly add the observation that the presence of mineral substances, both as such and as salts of the organic acids, profoundly modifies osmotic pressure, and without the aid of these substances the 'transpiration current' would never reach the tips of the trees, but, like the vanishing stream of the desert, be forever lost. The incidental fact of peripheral accumulation of mineral matter due to transpiration seems to have no bearing on the previous utility of the accumulated material during its passage through the cellular substance of the tree.

H. W. WILEY.

ARE STAMENS AND PISTILS SEXUAL ORGANS?

IN SCIENCE, XVII., 652, Professor W. F. Ganong suggests that stamens and pistils are sexual organs, and gives some interesting reasons for this conclusion. In brief, he proposes to abandon the morphological point of view and adopt one purely physiological. It must be admitted that a genuine argument is presented here, but it is still open to question whether such a use of terms conduces to clearness. If the stamens are male organs, I suppose their product, the pollen spores, must be regarded as male cells. And if the pistil is a female organ, I suppose the scattering of pollen spores upon the stigma must, if one is consistent, be considered as a sexual act and, in that case, may be termed, as Mueller did, 'Befruchtung.' But to the mind of a morphologist this confusion of the processes of pollination and fecundation is extremely ob-