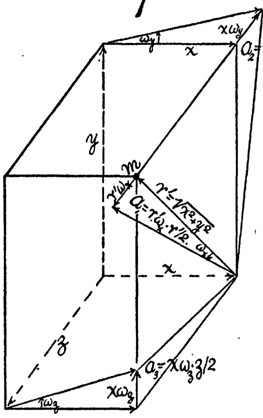
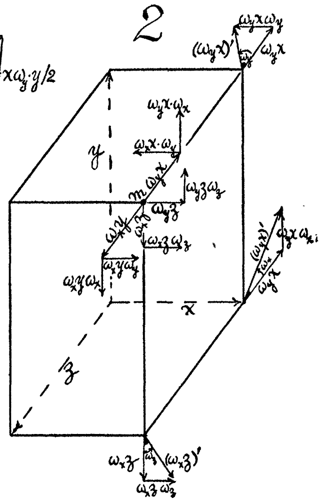
1



2



momentum couples per unit of $m$ $2a_1 = r' \omega_x \cdot r'$, $2a_2 = - x\omega_y \cdot y$, $2a_3 = - x\omega_z \cdot z$, where $r' = \sqrt{y^2 + z^2}$ so far as displacements in a plane normal to $x$ are concerned. If therefore we make the summation for all the mass points $m$ of the body, w being constant, we obtain the coefficients $A - F - E$ of the first row of the tensor and the component moment of momentum about the $x$ axis, $A\omega_x - F\omega_y - E\omega_z$. The forces normal to $y$ and normal to $z$ contribute the other two, in turn.

H.W.—If this angular momentum about $x$ be construed as linear momentum relative to a radius 1 and if it be multiplied by the angular velocity $\omega_x$ also regarded as linear for the same unit radius, the product $(A\omega_x - F\omega_y - E\omega_z)\omega_x$ is twice the kinetic energy of the body, so far as rotation about $x$ is concerned. The other two axes make the corresponding contributions. The expression is interesting in showing how square product terms arise in the equation for kinetic energy.

H × w—In contrast to the preceding, the equation for the torque of the centrifugal forces is astonishingly complicated. I have analyzed it in Figure 2, to be interpreted in the same way as Figure 1, but referring to the torque about the $z$ axis. Centripetal force is generated by the rotation of a tangential velocity about a non-parallel axis (a few examples at the corners of Figure 2) and acts at $m$ with the appropriate lever arm here either $x$ or $y$. The tangential velocities $\omega_z y$ and $\omega_z x$ may be discarded; for either they are not rotated ($\omega_z y \cdot \omega_x$, $\omega_z x \cdot \omega_y$), or they generate pulls along $z$, $\omega_z y \cdot \omega_y$, $\omega_z x \cdot \omega_x$), while the torques $\omega_z x \cdot \omega_z \cdot y$ and $- \omega_z y \cdot \omega_z \cdot x$ balance. Since $\omega_x x$, $\omega_y y$, $\omega_z z$ have no meaning, there remain so far as $m$ alone is concerned, the tangential velocities (see Figure 2)

$$\omega_y x, \ \omega_x y, \ \omega_y z, \ \omega_x z$$

The per second rotation of these produce the centripetal forces per gram of $m$ (see figure)

$$- \omega_y x \cdot \omega_x + \omega_x y \cdot \omega_x - \omega_y z \cdot \omega_z$$
$$- \omega_y x \cdot \omega_y + \omega_x y \cdot \omega_y + \omega_x z \cdot \omega_z$$

which operate respectively with the lever arms $x$ and $y$, so that the full torque about $z$ is

$$m\,(- \omega_y x \cdot \omega_x + \omega_x y \cdot \omega_x - \omega_y z \cdot \omega_z)\, x -$$
$$m\,(- \omega_y x \cdot \omega_y + \omega_x y \cdot \omega_y + \omega_x z \cdot \omega_z) y$$

To convert it into torque of centrifugal forces, these must be reversed. For symmetry $m\omega_y \omega_x z^2$ is to be added and subtracted, to match the terms in $x^2$ and $y^2$. Finally the summation is to be made for all the points $m$ of the body. The result (after arrangement) is for the axis $z$,

$$(A - B)\omega_x\omega_y + F(\omega_x^2 - \omega_y^2) + (D\omega_x - E\omega_y)\omega_z$$

with corresponding expressions for the $x$ and $y$ axis. Altogether therefore there are 18 deputy torturers engaged in their nefarious practices. Naturally if $D$, $E$, $F$, vanish, the treatment by the same method is simple.

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## THE SEAT OF FORMATION OF AMINO ACIDS IN PYRUS MALUS L.[1]

ALTHOUGH it has been established that nitrates can be reduced to nitrites in the roots and stems of plants, the possibility that the reduction of nitrites to form α-amino acids as an intermediate stage in the synthesis of proteins in plants could also take place in the cells of the roots and stems has not generally been accepted. Emmerling[2] indicated that in certain soils amino acids might be formed from nitrates in the roots and stems of some plants. However, Sachs (1865), Sorokin (1870), Pagnourd (1879) and Schimper[3] (1885) supported the photochemical theory of the formation of amino acids and proteins. They considered the chloroplast of the cells of the leaves maintained with a continuous supply of carbohydrates as being specially adapted to carry on the synthesis of proteins from ammonium salts and nitrates supplied to them by the conducting cells. Moreover, the rapid consumption of nitrates in the leaves is offered as the reason for the lower nitrate content in these tissues than in the roots and stems of some plants.

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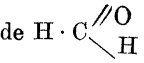
[1] Published by permission of the Director of the Agricultural Experiment Station as Technical Paper No. 425. Contribution No. 28 of the Department of Agricultural and Biological Chemistry.

[2] Emmerling, A., numerous papers in Landw. Ver. Stat. (1880–1898).

[3] See Czapek, F., Biochem. der Pflanzen 2: pp. 296–301 (1920) for a résumé.

This view that the synthesis of amino acids can take place in the leaves only has been especially emphasized more recently by Baly and his colleagues[4] from their experiments on the reduction of nitrates *in vitro*. It is maintained by these investigators that the activated formaldehyde  $H\cdot C\begin{smallmatrix}//O\\ \diagdown H\end{smallmatrix}$ produced photosynthetically in the living chloroplast cells reacts upon the first product of reduction (the nitrous acid salt—$KNO_2$) giving rise to formhydroxamic acid  $\begin{matrix}H—C—OH\\ \ \ |\\ \ \ NH\end{matrix}$, the formation of which was first established by Baudisch[5] by exposing a solution $KNO_2$ and methyl alcohol to ultra-violet light. This latter is assumed by Baly and his colleagues to react with another molecule of activated formaldehyde, giving rise to numerous nitrogen compounds such as, for example, the α-amino acid—glycine. It follows, they claim, that the synthesis of nitrogen compounds *must* be restricted to the leaves. Although these papers have attracted considerable attention, plant physiologists have necessarily been cautious in accepting the conclusions drawn.

Thus, Dr. Eckerson[6] has shown that the hypothesis propounded by Baly *et al* that nitrates are reduced in the light by activated formaldehyde in green leaves is inapplicable to the results of her experiments on tomato plants having a high C:N ratio, since, in this case, when nitrates are fed, it is the fructose and glucose that are oxidized, accompanied by an hydrolysis of starch as the hexoses are used up in the formation of amino acids and a portion possibly in increased respiration. Suzuki[7] also obtained strong nitrate tests with barley plants fed nitrate only, the nitrate disappearing when sugar was added. The nature of the active material is unknown. Anderson[8] has postulated the presence of a reducing substance resembling the atite of Haas and Hill.[9]

During the investigations of the writer, extending over the past four years, on the nitrogen metabolism of Pyrus Malus, in which the partition of nitrogen has been studied in the various parts throughout a year's cycle, positive tests were found for nitrates (or nitrites) in one tissue only and this at just one period of the year, *viz.*, in the leaf buds just as they were opening. This work was carried out on mature and seedling apple trees receiving heavy applications of sodium nitrate at regular intervals throughout the vegetative period, by means of microchemical tests on sections of the leaves, tips of stems and one and two-year old branches with diphenylamine reagent,[10] "G" salt,[11] and the Griess-Ilosvay Reagent,[10] and also numerous *quantitative* tests[12,13,14] on both the dialyzed and undialyzed sap, preserved under toluene, and on aqueous alcoholic extracts of various tissues during the vegetative cycle. The fine roots gave nitrate reactions throughout the season; whereas in the main roots the reaction was much feebler and, as already stated, the tests were negative in the aerial parts except in the buds as they were opening. Correspondingly, quantitative tests for amino acids were always higher in the roots than in the aerial parts.

These results are in accord with the recent work of Dr. Eckerson,[15] who found that the reducing power of extracts from various parts of apple trees collected last September and November showed decided differences. The fine roots were very high in reducing activity, the buds less active and the bark of first and second year twigs had very little reducing power.

From the foregoing, it can scarcely be doubted that in this species the reduction of nitrates to amino acids takes place for the most part in the roots. Although experiments *in vitro* may be valuable in suggesting types of reactions that may occur in the cells of plants or animals, the extension of the results of such experiments as indicating the actual conditions existing to the processes *in vivo* should be made with caution. The internal conditions existing in the plant at any one time may bring about unlike chemical reactions to accomplish the synthesis of α-amino acids and the different plant species may not carry out these syntheses in the same way. These investigations do not throw any light on the mechanism of the formation of amino acids in this plant and any suggestions offered at present would be purely hypothetical.

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[5] Baudisch, Oskar, Ber. der Deut. Chem. Ges. 44: pp. 1009–1013 (1911).

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[15] Eckerson, Sophia. Private communication.