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### Homoserine and its Lactone in Pea Seedlings

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The presence of L-homoserine in the pea plant was demonstrated in this laboratory in 1953 when its lactone,  $\alpha$ -amino- $\gamma$ -butyrolactone, was isolated as the hydrochloride in crystalline form from an ethanol extract of pea plants.<sup>1</sup> The extract was boiled first under reflux with 1 N hydrochloric acid for 3 h. Subsequently the unusually vigorous formation of L-homo-

serine in germinating pea seeds was found<sup>2</sup> and the presence of this amino acid in many different plants established.<sup>3</sup> It was always found in pea seedlings as the free amino acid, and not as the lactone, when the amino acids in the neutral ethanol extract were separated on an Amberlite-IR 120 column and then eluted with ammonia. Also on some paper chromatograms prepared directly from the ethanol extract of the bleeding sap of pea plant only the spot of homoserine but not of its lactone could be observed.

Staron *et al.*<sup>4</sup> have recently published a study according to which the lactone of homoserine is the natural compound in germinating pea seeds and not homoserine itself. This is not in accordance with the findings in this laboratory. In order to elucidate the reason for the different results we have performed the following experiment. Pea seeds ("Thursday II") partially sterilized by sublimate solution ( $\text{HgCl}_2$ ) were germinated in the light at room temperature for five days. The germination was slower than usual. The shoots (about 2.5 cm), with small roots attached, were separated from the cotyledons and 5 g was extracted four times with 90 % ethanol (80, 30, 30, 30 ml). The extract was taken to dryness *in vacuo* at about 35° and the residue was dissolved in 12 ml 40 % ethanol. A two-dimensional paper chromatogram (butanol-acetic acid-water and phenol-water) was run, using a volume of solution corresponding to 25 mg

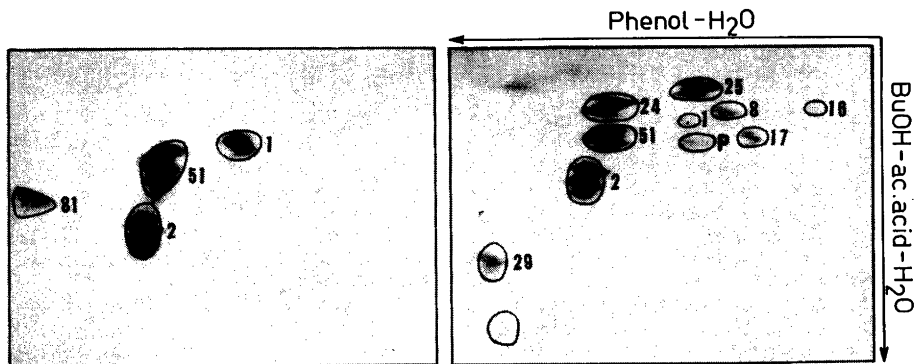


Fig. 1. 2-Dimensional chromatograms of the free amino acids extracted from pea seedlings (minus cotyledones)

left: Control with homoserine 51, its lactone 81, glycine 1 and alanine 2 added

right: Ethanol extract of the seedlings: homoserine 51, gly 1, ala 2, glu  $\text{NH}_2$  24, glu 17, asp  $\text{NH}_2$  25, asp 16, serine 8,  $\gamma$ - $\text{NH}_2$ -butyric acid 29.

of shoots (Fig. 1 right). A control chromatogram of alanine, glycine, homoserine, and its lactone was prepared also. (Fig. 1 left).

Because no spot of the lactone of homoserine is found on the chromatogram (Fig. 1 right) it is clear that homoserine is present mainly as the amino acid and not as the lactone in pea seedlings. As the free amino acids had been extracted from the seedlings with ethanol solution without the addition of acid, which causes lactone formation, and without allowing the amino acids at any stage of the separation to be subject to alkaline conditions which may cause the cleavage of the lactone ring, the result is conclusive. The result obtained by Staron *et al.* is possibly due, at least in part, to the fact that during the separation of the amino acids they have acidified the concentrated solution, after the evaporation of ethanol, to pH 2.3. The purification of the acid solution with Permutit 50 may have contributed further to the formation of lactone. However, quantitative lactone formation cannot even then be expected.

One interesting observation is found in the report of Staron *et al.* They state that the pea seedling has an antifungal effect on yeast (*Sacch. cerevisiae*) and believe that this is due to the lactone of homoserine. They followed the lactone formation during the germination by determining the inhibition of the growth of the yeast. As homoserine is, however, found mainly as the free amino acid in germinating pea seeds, its lactone can hardly be the antifungal factor in question. In germinating seeds of different plants many various antimicrobial substances are formed.

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## Scandium Manganese(III) Oxide, a Compound Isotypic with LuMnO<sub>3</sub>

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A new type of structure of ferroelectric  $ABO_3$  compounds has been reported by Yakel, Koehler, Bertaut, and Forrat,<sup>1</sup> when *B* is trivalent manganese and *A* is a trivalent ion of the set yttrium, holmium, erbium, thulium, ytterbium, and lutetium. The ferroelectric properties of these compounds have been investigated by Bertaut, Forrat, and Fang.<sup>2</sup> The structure is hexagonal (probable space group  $P6_3cm$ ) and the unit-cell parameters are, *e.g.* for LuMnO<sub>3</sub>,  $a = 6.042 \text{ \AA}$  and  $c = 11.37 \text{ \AA}$ .

In order to investigate if this structure type is stable even for a smaller trivalent ion than lutetium, a solution in nitric acid of scandium and manganese, with the molar ratio 1:1, was evaporated and the residue was heated at 800°C in air (*cf.* Ref. 1). X-Ray powder photographs were taken in a Guinier focusing camera using  $CuK\alpha_1$  radiation. The powder pattern could be interpreted assuming a hexagonal unit cell with the unit-cell parameters  $a = 5.830 \pm 0.001 \text{ \AA}$  and  $c = 11.179 \pm 0.002 \text{ \AA}$ .

Single crystals were made, according to Yakel *et al.*,<sup>1</sup> by heating a mixture of scandium oxide and manganese(III) oxide, with the molar ratio of 1:1, in a bismuth oxide flux at approximately 1100°C in air. Rotation and Weissenberg photographs were taken, using  $CuK\alpha$  radiation, for a crystal rotated around [001] and [110] of the hexagonal cell. The unit-cell parameters of the single crystal, obtained from rotation photographs, were  $a = 5.84 \text{ \AA}$  and  $c = 11.17 \text{ \AA}$ . By comparing the structure factors, derived from the observed intensities, with those calculated from the parameters for LuMnO<sub>3</sub>, as given by Yakel *et al.*, it was seen that the compound formed is isotypic with LuMnO<sub>3</sub>.

In the least-squares refinement of the structure of LuMnO<sub>3</sub>, Yakel *et al.* obtained physically unacceptable values for some components of the temperature factors of the oxygen atoms. According to Yakel *et al.*, the cause for these anomalies may be, *inter alia*, an incorrect anomalous-dispersion correction or an incorrect assignment of the