These results imply that the binding sites for oligomycin and carbonyl cyanide trifluoromethoxyphenylhydrazone are on the ATP synthetase. *p*-Chloromercuribenzenesulphonate also inhibits the exchange reaction, which points to the involvement of a thiol group in the exchange reaction. The energy-coupling factor D resolved from the complex is also inhibited by *p*-chloromercuribenzenesulphonate in its activity (stimulating ATP-dependent NAD⁺ reduction by succinate on addition to the urea-depleted submitochondrial particle).

The ATP-P_i exchange activity and 95% of the protein remain in the supernatant fraction when the synthetase is centrifuged at 105000g for 60min in 60mM or higher concentrations of phosphate buffer. In 10mM-phosphate buffer a significant fraction of the protein sediments and the activity in the supernatant liquid is considerably diminished. This

suggests aggregation of the ATP synthetase in solutions of low salt concentration.

The ATP synthetase stimulates the ATP-P_i exchange activity of urea-depleted submitochondrial particles. The specific activity is increased more than tenfold in the presence of urea-depleted submitochondrial particles. This may be due to allosteric activation of the ATP synthetase when it is bound to the membrane or to some necessary component that is provided by the membrane.

The ATP-ADP exchange rate is at least twice the ATP-P_i exchange rate, and this would indicate the formation of X~P as an intermediate in ATP synthesis. These data suggest that the soluble ATP synthetase complex contains X~C. This represents the first report of a soluble ATP-P_i exchange activity related to mitochondrial oxidative phosphorylation.

SYMPOSIUM ON PLANT SCIENCES

The Ecological Significance of 'Unusual' Amino Acids in Plants

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Twenty amino acids are found universally distributed as protein constituents in all living organisms. In addition to these a few others occur frequently as metabolic intermediates. The great majority of natural amino acids are more limited in their distribution, however, and relatively little is known of their metabolism or significance in the organisms that synthesize them.

The higher plants are a rich source of such 'unusual' amino acids: 60 for example have been isolated from or identified in species of one single family, the Leguminosae (Bell, 1971). Certain of the 'unusual' amino acids that have been isolated from this and other plant families are known to be toxic to other species of plants, to micro-organisms, to insects or to animals. Bell & Janzen (1971) have suggested that the high concentrations of L-3,4-dihydroxyphenylalanine (L-dopa) and 5-hydroxy-L-tryptophan that occur in species of *Mucuna* and *Griffonia* may serve to protect the seeds of these species from insect attack. This and other possible roles of 'unusual' amino acids will be discussed.

Bell, E. A. (1971) in *Chemotaxonomy of the Leguminosae* (Harborne, J. B., Boulter, D. & Turner, B. L., eds.), p. 179, Academic Press, London and New York

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Studies on the Metabolism of *sym*-Homospermidine in Sandal (*Santalum album* L.)

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Although the occurrence of polyamines, spermine and spermidine, in the animal kingdom has been established for a long time (Tabor & Tabor, 1964), only limited reports are available on their occurrence in plants (Smith, 1970). A new polyamine, *sym*-homospermidine, has been isolated from sandal leaves and it is present in a free state in high concentrations: 0.5-1.5% of the dry leaves (Kuttan *et al.*, 1971). The present communication deals with the study of the biosynthesis of this polyamine in the sandal plant by using radioactive amino acids as precursors. The procedure for the infiltration of amino acids into the leaves under vacuum has been described previously (Kuttan & Radhakrishnan, 1970). For determination of radioactivity homospermidine was isolated by using a small Dowex 50 (X8; H⁺ form) ion-exchange column and eluting with different concentrations of HCl. With DL-[¹⁴C]ornithine as the precursor nearly 7.5% of the initial radioactivity (assuming only the L-isomer was active) was incorporated into homospermidine. When L-arginine was used nearly 5.5% of the initial radioactivity was in the homospermidine. However, considering the pool sizes of the respective amino acids, arginine was nearly ten times as effective as ornithine. Proline and glutamic acid also served as precursors. With L-[¹⁴C]arginine as the precursor the radioactivity in homospermidine was significantly