2. Hardt, H.D., DeAhna, H.D.: Naturwissenschaften *57*, 244 (1970); Z. anorg. allg. Chem. *387*, 61 (1972)
3. Goher, M.A.S., Drátovský, M.: Coll. Czech. Chem. Commun. *40*, 26 (1975)
4. Goher, M.A.S., Drátovský, M.: Naturwissenschaften *62*, 96 (1975)
5. Goher, M.A.S., Drátovský, M.: J. Inorg. Nucl. Chem. (in press)
6. Goher, M.A.S.: Can. J. Chem. (submitted); Inorg. Nucl. Chem. Lett. (submitted)

Discrimination of Calcium against Strontium in Plants with a Cryptating Agent

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Ions that are closely related chemically, such as K^+ and Rb^+, Ca^{2+} and Sr^{2+}, Cl^- and Br^-, or SO_4^{2-} and SeO_4^{2-}, are usually taken up by plants in similar amounts. However, there is often a reason for discriminating, for instance between the physiologically important Ca and unwanted ^{90}Sr from radioactive fallout of atom bombs. Though chelating agents can cause decreased uptake of divalent cations [1–3], experiments to induce discrimination between Ca and Sr in favor of Ca uptake were unsuccessful because all known chelating agents (e.g. EDTA) form Sr complexes, that are less stable (log $K=8.6$) than the corresponding Ca complexes (log $K=10.6$). In 1969 Dietrich, Lehn and Sauvage [4] found a new type of complexing agent, the so-called cryptating agents (for instance Kryptofix 222=4,7,13,16,21,24-Hexaoxa-1,10-diazabicyclo-8,8,8-hexacosan), the first substances able to chelate Sr (log $K=8.0$) much more strongly than Ca (log $K=4.4$). The chemistry of cryptating agents has been described [5, 6]. Müller [7] was able to decorporate ^{85}Sr with a cryptating agent from animals (rats), but corresponding experiments with plants have so far not been known and are here reported for the first time.

In a climate chamber (22 °C, 70% rel. humidity, light: Osram-L-Fluora) 10-day-old seedlings of bush beans (*Phaseolus vulgaris* L.) were immersed with their roots in an aerated solution of 50 µM/l of each of $^{45}CaCl_2$ and $^{90}SrCl_2$, Kryptofix 222 being added at levels of 0, 12.5, 25, 50, 75, 100 and 150 µM/l. After an uptake period of 24 h the seedlings were dried and analyzed for ^{45}Ca and ^{90}Sr by liquid-scintillation counting (beta or Cerenkov radiation).

The results of this experiment are shown in Fig. 1. In the controls without Kryptofix 222 the Ca and Sr contents of the seedlings were similar: 20.3 and 25.3 nval/mg dry matter, respectively. Even an equimolar addition (100 µM) of the cryptating agent to the $^{45}CaCl_2+{}^{90}SrCl_2$ solution caused the ^{90}Sr content to fall from 25.3 to 12.2 nval/mg and ^{45}Ca content to rise from 20.3 to 25.6 nval/mg. The Ca/Sr ratio in the seedlings thus increased from 0.8 to 2.1; at the level of 150 µM Kryptofix 222/l it was 2.7.

There are two reasons why Kryptofix 222 induces discrimination in favor of Ca against Sr. The direct one is the preferred chelation of Sr rather than Ca by this cryptating agent. Sr cryptate has a larger diameter than the bivalent Sr^{2+} so that less Sr cryptate than Sr^{2+} is taken up by the roots of the seedlings. A consequence of this effect is that Kryptofix 222 has an increasing influence on Ca uptake. This cryptating agent reduces Sr^{2+} concentration in the substrate and hence the (unspecific) competition of Sr^{2+} for Ca^{2+} uptake. This is the indirect reason why Kryptofix 222 is able to increase the Ca/Sr ratio in plants.

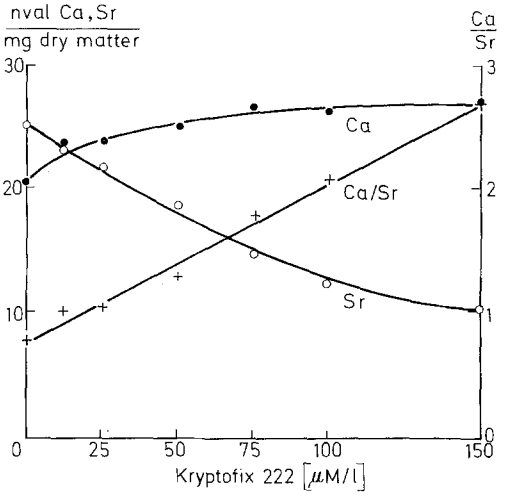

Fig. 1. Influence of a cryptating agent (Kryptofix 222) on Ca and Sr content and the Ca/Sr ratio in bush bean seedlings

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1. De Kock, P.C., Mitchell, R.L.: Soil Sci. *84*, 55 (1957)
2. Wallace, A.: A Decade of Synthetic Chelating Agents in Inorganic Plant Nutrition. Ann Arbor, Michigan 1962
3. Isermann, K.: Z. Pflanzenernähr. Bodenk. *128*, 195 (1971)
4. Dietrich, B., Lehn, J.M., Sauvage, J.P.: Tetrahedron Letters *34*, 2885, 2892 (1969)
5. Truter, M.R., Pedersen, C.J.: Endavour *30*, 142 (1971)
6. Bernabei, D.: Kontakte *2*, 27 (1973)
7. Müller, W.H.: Naturwissenschaften *5*, 248 (1970)

Occurrence and Properties of a Cytokinin in Tissue Cultures of *Daucus carota*

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Carrot callus can be grown in the absence of exogenous cytokinins, because the cultures presumably synthesize sufficient endogenous amounts of these hormones. This is supported by the fact that growth and morphogenesis of carrot-tissue cultures are inhibited by relatively small amounts of cytokinins in the medium [1]. These observations in connection with others on cytokinin synthesis in tissue cultures [2–4] deserve some attention, as cytokinins may be essential for the regulation of growth and morphogenesis, not only in tissue cultures of *Nicotiana* [5] but also in those of other species. Such cultures also provide a closed system, which is excellently suited for the analysis of hormone action at the cellular level. This paper is the first report on the presence of a cell-division factor in carrot-callus tissue.

In all experiments cell cultures of carrots (*Daucus carota* var. Rote Riesen) were used [6]. The cultures were grown on a medium after Murashige and Skoog [7]. The cytokinins were extracted by methanol (80%); the methanol was then evaporated leaving the cytokinins in the aqueous solution. After partitioning between water and ethylacetate at pH 3, the ethyl-

