Discussion. The different range of growth variability and antagonistic nature of saprophytic fungi in competition with the test pathogens on agar plates may be commonly ascribed to production of antibiotics or general mycostatic staling growth substances by interacting fungi. However, the possibility of occurrence of competition for nutritions, change in pH, nutrient imbalance, mechanical obstructions and hyperparasitic interactions cannot be ruled out during colony interactions. Several factors such as equal competitive and resistance capacity of interacting fungi to offset the effect of staling products, production of metabolic substances of same biological nature and equal growth rate, may play an operative role in intermingling growth (grade 1) of interacting fungi. Overdominating capacity of one fungal colony on another one (grade 3 or 2) primarily depends upon higher growth rate and tolerance to antagonism. Complete growth inhibition of a fungus may be due to diffusion of active staling growth substances by the resistance fungus which would have proved lethal before the establishment of the sensitive one.

Microscopic examination after 10 days of growth showed lysis and loss of permeability in most of the interacting hyphae. In some cases, swelling and attenuation of hyphal diameter were also noticed. However, when such hyphae were transferred again on fresh agar, normal growth was resumed. Hence abnormality due to mycotoxic substances or change in pH of nutrient broth produced the alteration in the morphological nature of interacting fungi but apparently failed to develop any genetic effect. Park[10] also demonstrated that staling growth substance of *Fusarium oxysporum* was inhibitory to apical growth of several fungal hyphae.

The discrepancy between the ability to inhibit the growth of a fungus in vitro by another one cannot be exactly compared with antagonistic interactions occurring in the actual root system, due to involvement of certain ecological factors in vivo. However, antagonistic effect on microbial colonization in vitro study should be considered as indication of potential antagonistic property of a fungus in vivo.

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3 J. Heuvel, Willis Commelin Scholten *84*, 1 (1970).
4 N.J. Fokkema, Physiol. Pl. Path. *3*, 195 (1973).
5 A.M. Skidmore and C.H. Dickinson, Trans. Br. mycol. Soc. *66*, 57 (1976).
6 N.J. Gibbs, Ann. Bot. *31*, 744 (1967).
7 A.M. Skidmore, Microbiology of aerial plant surface, p. 507. Academic Press (1976).
8 C.L. Porter, Am. J. Bot. *11*, 168 (1924).
9 D.K. Arora and R.K. Upadhyay, Pl. Soil *49*, 685 (1978).
10 D. Park, Trans. Br. mycol. Soc. *44*, 377 (1961).

Nuclear degeneration induced by chlortetracycline

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Summary. After application of chlortetracycline to plants, a degeneration of nuclei, manifested by dilatation and vacuolation of the nuclear membrane, occurs in the mesophyll cells of the sunflower plant.

The tetracycline antibiotics inhibit plant growth and negatively influence the formation of chlorophyll[1-6]. After application of chlortetracycline (CTC) to plants, a marked disturbance of the differentiation of the membranes of chloroplasts occurs and results in their complete degeneration[7]. It follows from the hitherto published cytological studies that tetracycline antibiotics inhibit the course of mitotic division in the cells of the root tip of the broad bean (*Vicia faba* L.)[1] and that especially CTC provokes various disorders of chromosomes[8]. It was therefore interesting to determine how the effect of CTC was manifested in the structure of the nucleus. The results obtained are presented in the paper.

The sunflower plant, *Helianthus annuus* L., cv. Armavirskij 3497 served as experimental material. The achenes of the plants were soused for 12 h in a solution of chlortetracycline hydrochloride of a concentration of 10^{-4}M at 25 °C. The plants were cultivated in a cultivating chamber at a temperature of 25±1 °C, with 14 h of light and 10 h of dark, and using Richter's nutrient solution of half concentration. Material for observation was withdrawn after 7 days, fixed in 5% glutaraldehyde and 2% OsO_4, embedded into Durcupan ACM (Fluka) and examined under the electron microscope Tesla BS 613.

One of the symptoms of beginning degeneration of nuclei in the mesophyll cells of the sunflower plant is the development of protrusions from the nuclear membrane towards cytoplasm (figure 1), of which shapes and sizes vary. Another typical manifestation of degeneration of the nucleus is an occurrence of invaginations in the nuclear membrane (figure 2). These are of oval shape and develop by gradual dilatation of the nuclear membrane. Both outer and inner parts of the nuclear membrane participate in the formation of these structures. Inside these invaginations, which are found around the whole periphery of the nucleus, there are globular particles whose shape, size and density resemble lipidic globules in the cytoplasm. Some invaginations merge with each other, which results in a formation resembling a vacuole in which 2 lipid-like globules are present. Chromatin of degenerating nuclei is considerably condensed and arranged in electrondense clusters located in the peripheral parts of the nucleus (figures 1 and 2). In the period when the nuclear membrane is formed by numerous invaginations, extensive degeneration is observed also in other cellular organelles.

Dilatation of the nuclear membrane in the course of the process of degeneration of nuclei is probably related to the lytic process in the cytoplasm, plastids and mitochondria. This hypothesis seems to be confirmed by the fact that in the nucleus the presence and activity of hydrolytic enzymes[9,10] was found. A similar type of nuclear degeneration combined with vacuolation of the nuclear membrane was observed also in *Myxomycetes*[9], in the microspores of *Tradescantia paludosa*[11], after the application of the herbi-

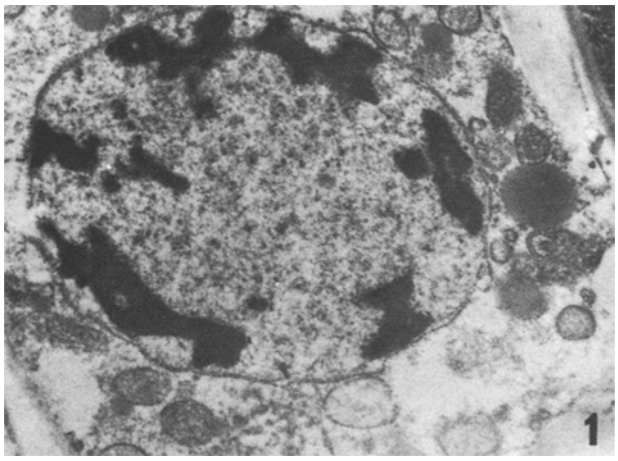

Fig. 1. The origin of protrusion from the nuclear membranes after the application of CTC. × 20,000.

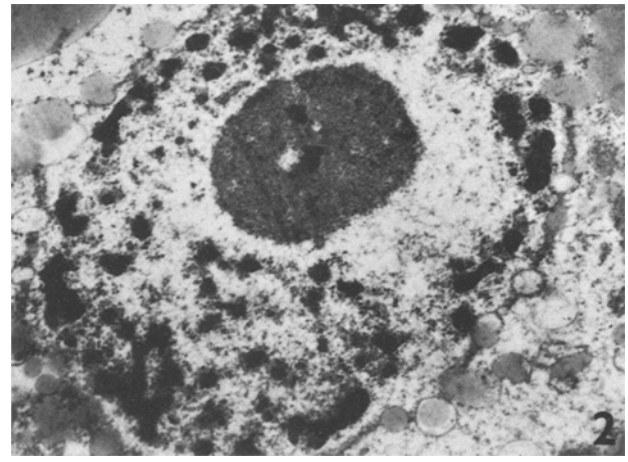

Fig. 2. Vacuolation of nuclear membrane after the treatment of CTC. × 30,000.

cide trifluraline on the cells of the root tips of the broad bean (*Vicia faba* L.)[12] and in the ageing of the mesophyll cells of tobacco leaves[13].

The changes described in the submicroscopic structure of the nucleus result from total degeneration of cells induced by the effect of CTC.

1 J. Baloun, Thesis, Comenius University, Bratislava 1970.
2 H. v. Euler and M.L. Stein, Experientia *11*, 108 (1955).
3 J. Lacharme, Thesis, University of Lyon, Lyon 1961.
4 G. Netien, P. Hutinel and O. Sotty, C.r. Soc. Biol. *146*, 1337 (1952).
5 G. Netien and J. Lacharme, Bull. Soc. Chim. biol. *37*, 643 (1955).
6 G. Netien and J. Lacharme, Bull. Soc. linn. Lyon *28*, 12 (1959).
7 J. Baloun, Thesis, Charles University, Hradec Králové 1978.
8 A.K. Sharma and G.N. Bhattacharyya, Acta biol. hung. *18*, 67 (1967).
9 D.M. Bechtl, Protoplasma *90*, 179 (1976).
10 Ph. Matile, in: Lytic compartment of plant cells, p.22, Ed. M. Alfert. 1975.
11 Z. Nazakava and T. Niki, Bot. Mag., Tokyo *88*, 157 (1975).
12 M. Bobák, Thesis, Comenius University, Bratislava 1975.
13 H.W. Ragetli, M. Weintrub and E. Lo, Can. J. Bot. *48*, 1913 (1970).

Changes in IAA oxidase activity in rooting hypocotyl cuttings of *Phaseolus mungo* L.[1]

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Summary. IAA oxidase activity increased concomitant with root initiation during 16–52 h, in all cultures, thus showing the necessity of an active IAA oxidase for root initiation in *Phaseolus mungo* hypocotyl cuttings. The increase being very sharp in IAA alone, but less in all other cultures. The role of sucrose in root initiation via IAA oxidase activity has been discussed.

The allosteric nature of IAA oxidase was put forth in an earlier communication[2], to explain the dual behaviour of this enzyme [3–9]. Gurumurti et al.[10] implicated the oxidation products to explain the synergistic action of sodium metabisulfite with IAA in root initiation in *P. mungo* hypocotyl cuttings. To further strengthen this postulate, experiments were conducted to study the changes in IAA oxidase activity at periodic intervals to correlate it with root initiation in *P. mungo* hypocotyl cuttings. The results obtained show an interesting relationship between root initiation and IAA oxidase activity and constitute the subject matter of this paper.

Seedlings of *P. mungo* were raised as described earlier[10]. 1100 hypocotyl cuttings were divided into 4 equal groups of 275 cuttings each to be cultured in water, IAA (5 mg/l), sucrose (1%) and IAA (5 mg/l) + sucrose (1%), respectively. 50 hypocotyl cuttings at the beginning of the experiment (0 h) and later on from each group were removed from the culture media after 16, 28, 40, 52 and 64 h and 3.0-cm portions below the hypocotyl node were used for the assay of IAA oxidase as is described elsewhere[11]. The enzyme extract was prepared at pH 4.0. The reaction mixtures each time comprised of 4 ml of enzyme extract + 4 ml IAA solution + 1 ml H_2O_2 + 1 ml H_2O. The reaction mixtures were incubated for 30 min and the amount of IAA that was left unoxidized was estimated as described elsewhere[11]. The enzyme activity was expressed as µg IAA oxidized per mg protein and presented in the figure. Protein content was estimated by the method of Lowry et al.[12].

Records were also maintained of the time that was taken for initiation of roots. The number of rooted cuttings and the roots were also recorded after 7 days and presented in the table. The experiment was repeated 3 times with essentially similar results.