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Stress, Eutrophy and Related Topics

Abstracts of the papers presented at the 9th meeting of the „Österreichischer Arbeitskreis für Pflanzenphysiologie" (Austrian Association of Plant Physiology) held in Ottenstein (Lower Austria) September 26–29, 1989

By

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1 Light, Photosynthesis, and Stress

1.1 KÖRNER Ch. 1990. Ecological consequences of CO_2 – fertilization. – Phyton (Horn, Austria) 30 (2): 313–314.

The unbalanced experimental evidence of plant CO_2-responses is illustrated by a qualitative analysis of the current literature, which is published in more detail by IIASA-Laxenburg (A. SOLOMON ed.) in 1990. The absence of knowledge regarding CO_2-responses at the ecosystem level, leads to the widespread misuse of physiological response characteristics at the leaf level for prognostic purposes at vegetation level. This is particularly true for photosynthetic CO_2-responses and the temperature responses of respiration, both, however, exhibit strong homoeostatic trends. At present, hierarchical response scenarious including morphotypic and environmental features (more responsive/less responsive) appear to be a useful tool in sensitivity analysis (see LICC proceedings, Biogeography, University of Utrecht 1990).

Provided temperatures will rise in the future, plants from high altitudes may exhibit particularly strong CO_2-responses. In contrast to plants from low altitudes, mountain plants evolved under reduced partial pressures of CO_2. Gas exchange measurements under optimal temperature and light conditions have revealed that the efficiency of CO_2 utilization in mountain plants exceeds that of lowland plants by ca. 30% (Functional Ecology 1 : 179–194, 1987). Results of a global survey of carbon isotope discrimina-

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tion in plants indicate that greater photosynthetic efficiency at high altitudes is a common phenomenon (Oecologia 74: 623–632, 1988), and is associated with greater leaf thickness and higher leaf protein content. Anatomical data from over one hundred herbaceous species further indicate that the increase in atmospheric CO_2-content within the last century has not influenced alpine plants stomatal density so far (Flora 181: 253–257, 1988). In contrast to observations in lowland plants, alpine plants maintain their higher photosynthetic efficiency, when grown under artificially enhanced CO_2-supply. At present, direct temperature limitations of growth probably overrule the direct effects of higher CO_2-supply on photosynthesis. Since it is expected that temperatures will rise in the future, growth responses to the combined influence of increased temperature and CO_2 in alpine taxa are expected to become significant within the next decades. Hence, mountain plants appear to be particularly promising tools for monitoring impacts of climate change.

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1.2 BOLHÀR-NORDENKAMPF H. R. 1990. Light stress. Phyton (Horn, Austria) 30 (2): 314–315.

Light stress can be observed if a surplus of absorbed photons is not deactivated via the normal protective mechanisms. The consequences of high light stress are: 1. compensatory regulations in the electron transport chain and the Calvin cycle; 2. photoinhibition; 3. photooxidation and bleaching; 4. necrosis of leaf tissues. Due to the large variations in light intensities plants have got several mechanisms to be protected against a surplus of absorbed photons. Heliotropic movements of leaves and chloroplasts can alter the absorptivity. The absorbed photons (excitons) drive the electron transport chain and by this generate $NADPH_2$ and ATP, a surplus of photons can be deactivated by heat and fluorescence. If CO_2 becomes limiting (stomata closure) more electrons will be transferred to O_2 and both, heat deactivation and photorespiration will increase. The enhanced heat deactivation causes a remarkable decrease of the quantum yield described as photoinhibition, mostly detected by studying O_2- and CO_2-gas exchange or variations in chlorophyll fluorescence. Photoinhibition is part of the often described 'noon depression' of photosynthesis. High light in combination with chilling temperatures ('photochilling') causes temporary a dramatic loss in quantum yield in crop plants with subtropical origin and in temperate evergreens (e. g spruce). During low light periods or over night the normal quantum yield can be restored. Though the reduction of bioproductivity caused by several photoinhibition periods is not well documented, a combination of photochilling and other stress factors (e. g. drought) lasting over days, causes destruction of thylakoid membranes in the chloroplast. Photodestruction is enhanced if additional stress factors reduce the development of protective adaptations against high light.

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1.3 LECHNER E. G. 1990. High-light induced modifications of the photosynthetic capazity measaured by chlorophyll fluorescence kinetics. – Phyton (Horn, Austria) 30 (2): 315.

A so-called photoinhibition is manifested as a reduction of the photochemical capacity of the PS II. It is still unsolved, whether the primary objective is the PS II-reaction centre or the D_1-protein turn-over. F_v/F_{max} (F_{max}-F_0/F_{max}) is modified diurnal by high light. Nevertheless, the alterations of the absolute values F_{max}, F_0 and T/2 are varying. *Phaseolus vulgaris* shows a significant increase of F_0 during noon time, whereas *Zea mays* is characterised by a reduction of F_{max}. *Helianthus annuus* exhibits non-specific changes of the absolute values. The contradictions of the results are partly due to variations of incident irradiation, to plant types (C_3–C_4) and to sun- and shade adaptations. On the other hand, various mechanisms of damage have to be taken into account. However, the processes occurring are dynamical due to repair mechanisms and structural alterations of the thylakoid membranes. Therefore, it seems likely that a close relationship between PS II-reaction centre and D_1-protein is existing. As a consequence both components are affected by photoinhibition.

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1.4 BOLHÀR-NORDENKAMPF H. R., LECHNER E. G. & HOFER M. 1990. Detection of photoinhibition under natural conditions during ontogenesis of various species as measured by means of chlorophyll fluorescence. – Phyton (Horn, Austria) 30 (2): 315.

The photochemical capacity of sun-exposed and artificially shaded leaves of Phaseolus vulgaris, Zea mays and Helianthus annuus was investigated by means of a Plant Stress Meter (PSM, BioMonitor). During ontogeny flourescence (F_0, F_{max} (absolute), F_v/F_{max}, T/2) was determined at different times of a day. During the day all investigated plants showed a significant decline of F_v/F_{max} as a result of light stress. Photoinhibition, however, could only be observed on Zea mays and Phaseolus vulgaris. This is attributed to a blockage of the Q_B-Protein turn-over and/or a modification of PSII-reaction centers to heat-deactivating centers.

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1.5 Bauer H. 1990. Limitation of photosynthesis yield by extreme temperatures – A review. – Phyton (Horn, Austria) 30 (2): 316.

The well-known response of net photosynthesis (P_n) to temperature is the result of several, partly opposing metabolic processes. In C_3 plants the P_n optimum is reached at rather low temperatures since at higher temperatures photorespiration reduces the photosynthetic yield. Furthermore, alterations in the permeability of thylakoids does not allow the building up of the stromal conditions necessary for activating Calvin cycle enzymes. At still higher temperatures, damage to thylakoids inhibits photophosphorylation and PS II. Their repair requires an intact protein synthesis and may take several weeks.

At suboptimal temperatures P_n is mainly limited by the velocity of enzymatic processes. In chilling-susceptible plants P_n already ceases at temperatures above the freezing point and may remain depressed for several days partly due to stomatal closure and partly to as yet unlocalized impairment of chloroplast function. In chilling-tolerant plants CO_2 uptake is blocked when ice forms in the leaves which apparently hampers CO_2 diffusion. How ice formation impairs chloroplast function is not yet known. If freezing-tolerant leaves have been frozen, recovery of P_n after thawing is usually very slow. In woody plants this is mainly the result of disturbances in the chloroplasts, whereas in herbaceous plants stomatal closure limits the CO_2 supply to the mesophyll. During freezing and also during the recovery phase the photosynthetic apparatus is very susceptible to bright light which causes strong photoinhibition.

Doz. Dr. Helmut Bauer, Institut für Allgemeine Botanik, Universität Innsbruck, Sternwartestraße 15, A-6020 Innsbruck (Austria).

1.6 Gerstenmayer M. 1990. The effect of different daylength and changes in daylength on stomatal aperture of *Phaseolus vulgaris L.* – Phyton (Horn, Austria) 30 (2): 316.

The stomatal pore area of bean plants was determined microphotographically from the abaxial side of leaf discs. 3 weeks of longday conditions (LD: 16 hrs. light) produced significantly smaller pore areas than shortday conditions (SD: 8 hrs. light). This was not true for experiments lasting only for 2 weeks, where LD and SC caused similar values of pore length in SD compared to LD. Adaptation to short-term changes of daylength was more effective than to long-term changes.

Mag. Martin Gerstenmayer, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285,– 1091 Wien (Austria).

1.7 Jakl Th. Photosynthesis and partitioning in *Lupinus albus* for an evaluation of growth analysis. – Phyton (Horn, Austria) 30 (2): 316–317.

As opposed to the CGR (Crop Growth Rate), the course of ULR (Unit Leaf Rate) of Lupinus albus shows several maxima. Since we know that fluctuations in respiration due to temperature regimen and ontogeny alone do not account for this phenomenon, it has been our aim to find an explanation by way of an investigation of assimilate-partitioning and photosynthetic performance. ULR fluctuates disproportionally when compared to average photosynthetic performance, since it does not reflect the sometimes dramatically changing calorific values of the tissues.

Mag. Thomas JAKL, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

1.8 WIENER S. & WIESHOFER I. 1990. Ecophysical aspects of UV B – stress. – Phyton (Horn, Austria) 30 (2): 317.

In the course of earlier studies with bean cultivars in the greenhouse it was noticed that treatment with UV-B of low intensity (0.8 W.m-2) had an impact on the composition of carbohydrates. In most cases an increase of glucose and fructose and a decrease of sucrose could be observed. CO_2-measurements, which were taken at the same time, showed no reduction of photosynthesis, but an increased dark respiration rate. Field studies revealed a changed stomatal behaviour of treated plants. First, the diffusion-rate of irradiatied leaves increased, but in the course of the experiment it decreased significantly. We assume that these effects are due to an altered activity of H^+-ATP-ase.

Dr. Susanne WIENER, Dr. Isabel WIESHOFER, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

2 Other stresses

2.1 LUDLOW M. M. 1990. Osmotic adjustment in cereals. – Phyton (Horn, Austria) 30 (2): 317–318.

Osmotic adjustment is a process that assists in the maintenance of cell volume and turgor as organisms loose water to their environment. The process has been known in animals and algae for many years, but it has only been recognised in higher plants for less than twenty years. It has been found to occur in many species of higher plants, and it is likely that it occurs in all higher plants to a greater or lesser extent. Variation in osmotic adjustment among genotypes of the same species has been also shown in many species, including cereals such as wheat, barley, rice, sorghum and maize. As a process it has many potentially-beneficial effects for growth and survival of higher plants during water stress. While osmotic adjustment can potentially assist growth and photosynthesis during water stress,, continued water loss is an inevitable consequence and death by dehydration a possibility. However, osmotic adjustment can also promote root growth and extraction of soil water. Furthermore, it increases the capacity of leaves to tolerate dehydration. Both these responses enhance the capacity to avoid death by dehydration. Thus while osmotic adjustment assists growth and yield during water stress, its effect on survival depends on the balance of positive and negative tendencies.

Osmotic adjustment has been shown to enhance the yield of wheat by up to 50% during water stress. It has also been shown to enhance the yield of grain sorghum by 33% and 24%, respectively, when plants are subjected to pre- and post-anthesis water stress. Consequently, there appears to be a good opportunity to increase the yield of genotypes of cereals that have low levels of osmotic adjustment by selecting genotypes that have higher levels of adjustment.

Prof. Dr. Mervin M. LUDLOW, CSIRO, St. Lucia, QLD 4067 (Australia).

2.2 SOJA G., SOJA A. M., ZARGHAMI R. & PICHLMAYER F. 1990. Screening of faba beans varieties (*Vicia faba* L.) for drought resistance. – Phyton (Horn, Austria) 30 (2): 318.

Faba bean varieties were exposed to osmotic stress in nutrient solution with polyethylene glycol-6000. Stress treatments in nutrient solution affected the plants in a similar way as drought periods in the field without irrigation. Stress indices (% reduction) of dry matter production and leaf photosynthesis in nutrient solution were positively correlated to stress indices of grain yield in the field (r = 0.71 and 0.81, resp.). ^{13}C-discrimination due to drought stress differed from −24 to −26‰ among varieties but was constant for irrigated plants (−26‰) in the field. Higher yielding varieties under drought showed less differences between drought and irrigation treatments in δ_{13C} (r = 0.92).

Dipl.-Ing. Dr. Gerhard SOJA, Dipl.-Ing. Dr. Anna M. SOJA, Reza ZARGHAMI, Dr. Friedrich PICHLMAYER, Abteilung für Landwirtschaft, Österreichisches Forschungszentrum Seibersdorf, A-2444 Seibersdorf (Austria).

2.3 NOWOTNY G. 1990. Investigations on moisture tensions in the rhizosphere and their influence on the water regime of horse chestnut trees (*Aesculus hippocastanum* L.) in the city of Salzburg (Austria) – Phyton (Horn, Austria) 30 (2): 318.

During the vegetation periods 1986 and 1987 investigations on the water regime of a deicing salt affected roadside tree and a park tree were carried out. Using an Eijkelkamp pF-equipment pF-curves for the diverse soillayers were gained. The sandy, condensed soils of the roadside tree was affected by lower water potentials than the park tree. Serious water deficiency did not appear in both sites.

Mag. Günther NOWOTNY, A-5741 Neukirchen/Großvenediger 169.

2.4 ULLAH S. M., SOJA G. & GERZABEK M. H. 1990. Nutrient uptake, gas exchange and water relations of salt stressed faba bean (*Vicia faba* L.). – Phyton (Horn, Austria) 30 (2): 319.

Faba bean responded to salt stress (0, 45, 90 and 150 mM, NaCL : MgCl : $MgSO_4$ = 20 : 1 : 1) with yield reductions (grain: 69 to 90%, straw 50 to 76%) and increasing concentrations of Na and Mg (up to 18fold) and Ca, Mn and P (2 to 3fold). Na depressed K concentration. Plants under simultaneous water and salt stress were able to maintain gas exchange for a longer time at a higher level than plants without salt influence. Combined stresses decreased leaf water potential to -14.10^5 Pa. Osmotic potential diminished by about 5.10^5 Pa due to salt stress.

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2.5 WIELANDER B. & PUNZ W. 1990. Possible effects of urban stress on plant energy content. – Phyton (Horn, Austria) 30 (2): 319.

Leaf and wood samples of *Acer pseudoplatanus* L., *Aesculus hippocastanum* L. and *Fagus sylvatica* L. in the area of Vienna were collected and analyzed for their content of sulfate, lead, copper, manganese, and energy. In most cases no relationship between sulphur and energy content (for *Acer, Aesculus, Fagus)* could be observed, with the exception of *Aesculus* (wood) in the Prater Hauptallee, where also a (negative) correlation between lead and energy content was found, the latter relation being less good for the sampling all over Vienna (*Acer, Aesculus*). No correlation of copper and manganese with energy content could be discerned. Leaves from chronically salt-exposed trees *(Aesculus)* showed decreased energy content. There seems to be a weak negative relation between pollutant zones given in literature and energy content. Most part of the plant energy content was due to their fat content; nevertheless, leaves in polluted areas showed cuticle thickening (avoidance?).

Dr. Barbara WIELÄNDER, Mag. Dr. Wolfgang PUNZ, Institut für Pflanzenphysiologie Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

2.6 BODNER M. & LARCHER W. 1990. Chilling susceptibility of wild *Saintpaulia* species of different altitudinal origin. – Phyton (Horn, Austria) 30 (2): 319–320.

The chilling susceptibility of 7 wild species of *Saintpaulia* was determined by measuring fluorescence during cooling and by estimation of visual injuries. As a rule, visual and functional ratings were in agreement, with the exception of *S. shumensis* with only little visual injury but great reduction in fluorescence coefficients. The correlation usually observed between less chilling susceptibility and higher altitude of origin was not in any case clear, probably because below 1500 m in tropical regions temperatures are not low enough to be selective for chilling resistance.

Dr. Maria BODNER, Prof.. Dr. Walter LARCHER, Institut für Allgemeine Botanik, Universität Innsbruck, Sternwartestraße 15, A-6020 Innsbruck (Austria).

2.7 NAGELE M., MAIR M., GALLER V. & BAUER H. 1990. Effects of frost hardening on photosynthetic activity. – Phyton (Horn, Austria) 30 (2): 320.

Various herbaceous and woody plants were frost hardened under natural or artificial conditions and the changes in their net photosynthetic rate (P_n) and chlorophyll fluorescence were recorded under optimal conditions. The development of frost tolerance was associated with a reduction in P_n which, depending on plant type and hardening stage, was mainly due to disturbed chloroplast function or to stomatal closure. Complete recovery of P_n could only be observed in herbaceous plants.

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3 Nutrients, Heavy Metals

3.1 ALBERT R., HÜBLER K.-M. & PESCOLLER G. 1990. Ionic patterns of forest trees – natural and anthropogenic variations. – Phyton (Horn, Austria) 30 (2): 320–321.

The patterns of dissolved ions within the cell saps of higher plants show taxonomic pecularities and reflect the physiological status of the individual. Variations are due to different nitrogen-forms, unbalanced mineral nutrition, and may occur under the influence of gaseous atmospheric pollutants with ionic character (SO_2, NO_x), and of high deposition rates. Some examples are summarized:

Sulfate is accumulated strongly in spruce needles in classical "Rauchschadensgebieten" Judenburg, Styria. It becomes the dominant anion in 4 years old needles, representing about 70% of total anions, associated with a heigh potassium demand to compensate for the anion excess. On the other hand, the organic anions Shikimate and Quinate diminish more rapidly as in spruce needles of clean air areas.

Cell saps in needles from extremely acidified and impoverished sites (Schöneben, Böhmerwald) are characterized by ionic concentrations being lower by a factor of 1.5 to 3 lower as in needles from "average" sites.

Beech leaves under the influence of caloric power plants in the "Vienna Wood" show a certain SO_2-accumulation (about 25% of total anions). In high polluted areas, neither spruce nor beech leaves show tendencies of NO_3-storage.

The beech leaves and twigs from dolomitic or calcareous soils show very low levels of P, Mn, Fe, Zn, and Cu.

The relation of water soluble Ca, Mg and Mn within the leaf cell sap of both tree species shows striking variations among habitats. On calcareous sites, Ca and Mg exceeds Mn by a factor of about 100; on acidic soils, Mn may be higher then Ca and Mg. The possibility of "relative mineral deficiency" is discussed.

Prof. Dr. Roland ALBERT, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

3.2 PESCOLLER G. 1990 The mineral metabolism and ionic patterns of beeches. – Phyton (Horn, Austria) 30 (2): 321.

The mineral metabolism and the ionic pattern of beeches in the vicinity of Vienna, in the Vienna Wood that is partially strongly influenced by industrial immissions and in several Austrian woods with negligible immissions, have been investigated. The beeches of the Vienna Wood were well supplied with K, Mg and Ca, while in some areas signs of anthropogenous immissions could be found: the insufficient supply with K and Mg resulting out of leaching processes, the mobilization of Mn in the soil and its storage in leaves, SO_4-accumulation that did not affect the acid pattern as well as significantly enhanced N-contents.

Dr. Gertrud PESCOLLER, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

3.3 SPOHN U., ALBERT R. & GRABHERR G. 1990. Studies on the nutrient regimes in beech forest ecosystems in Lower Austria. – Phyton (Horn, Austria) 30 (2): 321.

In the diagnostics of new types of forest decline in beech forest ecosystems the question arises whether different nutrient levels in the ecosystems influence the foliar concentration of mineral ions and the leaf size. Herb and tree layer of several associations of Fagetalia sylvaticae under different nutrient regimes and generally low atmospheric deposition rate have been investigated. In the herb layer, species use the nutrients of the soil quite differently. Only a few species transpose the available nutrients to build up new biomass. In contrast the plants of the tree layer show a wide range of individual variation without any significant correlation to the nutrient level of the forest.

Ulrike SPOHN, Prof. Dr. Roland ALBERT, Prof. Dr. Georg GRABHERR, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

3.4 HORAK O. 1990. Examples of micronutrient deficiency and its different causes of origin. – Phyton (Horn, Austria) 30 (2): 321–322.

The present paper gives some examples of micronutrient deficiency, and its different nature of origin.

Deficiency of manganese can be observed frequently on soils rich in carbonate and organic matter. Leaf Mn contents of concerned plants (wheat, raspberry, white cedar, black pine) were found mostly in a range far below 20 ppm/dry matter.

Zinc deficiency in apple was found to be induced by an excess of phosphorus in soil. Zn contents of 15 ppm/dm and a P/Zn ratio of > 200 were characteristic for chlorotic leaves with necrotic margins.

Another example represents a site where the soil was contaminated with copper (average: 180 ppm) by long term application of fungicide sprays. As a consequence of the antagonistic action of Cu, peach, morello cherry, and strawberry show heavy deficiency of Mn, Fe, and Zn.

Doz. Dr. Othmar Horak, Abteilung für Landwirtschaft, Österreichisches Forschungszentrum Seibersdorf, A-2444 Seibersdorf (Austria).

3.5 Bachmann G. 1990. Ecological importance of soil physiological investigations. – Phyton (Horn, Austria) 30 (2): 322.

The rhizosphere soil resulting out of combinations of six different plant species and four different types of soil was analysed in order to gain informations regarding the concentration of organic metabolites and their origin in the rhizosphere. Amino acids, sugars, carbon dioxide evolution and some enzyme activities have been measured with quantifying methods. It turned out that the concentrations and the activities of the metabolites behaved in an interdependent way reminiscent of the metabolical regulations in living organisms. Usually, the soil dominates the combination and sometimes the plant is predominant, while some combinations suggest a very special symbiosis of the involved organisms.

Dr. Gert Bachmann, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

3.6 Peer Th. & Rücker Th. 1990. Higher fungi as monitor organisms for heavy metal contents in terrestrial ecosystems. – Phyton (Horn, Austria) 30 (2): 322–323.

On investigating the fruitbody collections of 34 fungal species on the "Stubnerkogel" (Gastein valley, Austria) the metal contents viz. copper, zinc, lead and cadmium have been determined. There are significant differences between the contents of heavy metals in different ecosystems: the levels in terricol species are generally higher than in lignicol species; in some mycorrhizal fungi elementspecific accumulations are concerned (esp. Cd and Zn). The comparison of metal levels of 8 selected fungal species on the Stubnerkogel with results from other parts of Salzburg shows a striking lead and a weak cadmium pollution of this area; these results are confirmed by the recorded soil data.

Doz. Dr. Thomas PEER, Dr. THOMAS RÜCKER, Institut für Pflanzenphysiologie, Universität Salzburg, Hellbrunnerstraße 34, A-5020 Salzburg (Austria).

3.7 NIEL W. 1990. The effect of manuring with grapes draff compost on *Vitis vinifera* compared with inorganic fertilization. – Phyton (Horn, Austria) 30 (2): 323.

Plants treated with compost showed lower production of biomass, less content of chlorophyll and nitrogen, and a lower peroxidase activity than the fertilized plants. The higher peroxidase activity in vine leaves of the latter group could be interpreted as a stress reaction due to the higher salt concentration in soil. On the other hand a high nitrogen level is known to increase biosynthesis of cytokinins, which are supposed to enhance peroxidase activity. The compost showed positive effects on the content of humus, Ca, Mg, P and K. Because of the deficiency of available nitrogen the importance of this compost for viniculture is curtailed.

Dr. Waltraud NIEL, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

3.8 HOLZER H., BOLHÀR-NORDENKAMPF H. R. & POSTL W. 1990. Relation between growth and nitrate accumulation of lettuce (*Lactuca sativa* cv. Ravel) during a cultivation period in autumn. – Phyton (Horn, Austria) 30 (2): 323.

Due to the decrease of irradiation nitrate accumulation is a specific problem of cultivation of lettuce. An additional light source alters the microclimate and influences nitrate content, which was related to the results of a classical growth-analysis. A plant's nitrogen-content is determined by the photosynthetic nitrate-reduction, soil nitrogen content as well as growth and transpiration rates. Consequently, the synergistic effects of all factors have to be known.

Mag. Hiltrud HOLZER, Prof. Dr. Harald R. BOLHÀR-NORDENKAMPF, Dr. Wolfgang POSTL, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

3.9 ULRICH S. M. 1990. Comparative studies on metal tolerance and metal uptake in *Silene vulgaris*. – Phyton (Horn, Austria) 30 (2): 323–324.

8 different populations of *Silene vulgaris* (MOENCH) GARCKE originating from Austrian normal soils, serpentine soils, and Cu- and Zn/Pb- mine wastes were investigated. Metal tolerance was defined in short-term experiments by determination of the cytoplasmic tolerance to copper and zinc (HÖFLER 1932). The Zn-populations showed a high Zn-tolerance of the

cytoplasm, compared to normal populations, correlating with the metal contamination of the soil. The Cu- and serpentine ecotypes also showed a marked cytoplasmic Zn-tolerance. A significantly enhanced tolerance of the cytoplasm to Cu could not be detected in any population, not even in copper plants.

The pattern of metal uptake and distribution varied considerably even in plants growing on sites of similar metal contamination. This indicates different machanisms of tolerance and detoxification.

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4 Methodical papers

4.1 HEINRICH G. 1990. Use of the laser microscope mass analyzer (LAMMA) in biology. – Phyton (Horn, Austria) 30 (2): 324.

LAMMA permits the analysis of microscopically small volumes of matter. The instrument works as follows: A high-power laser is focused onto the sample by means of an optical microscope objective, which also serves for visualising the sample to be analysed. The ions resulting from a laser pulse are analysed with a time-of-flight mass spectrometer, recording the complete mass spectrum of each single laser shot. The lateral resolution with a diameter of 1 um and detection limits in the range of 0.1–10 ppm permit to analyse inorganic ions and organic compounds within the cell compartments. To give an impression of the obtainable results, typical spectra of inorganic ions are reported, such as fingerprints of trapping slimes of carnivorous plants, latices of fungi and of higher plants, nectary fluids ad ion spectra of different fresh-water organisms, showing iron and/ or manganese mineralisation. Besides it is shown that LAMMA mass spectra make it possible to demonstrate the intracellular distribution of lead and other metals in semithin sections of plant tissue and to identify organic substances in different samples.

Prof. Dr. Georg HEINRICH, Institut für Pflanzenphysiologie, Karl-Franzens-Universität Graz, Schubertstraße 51, A-8010 Graz (Austria).

4.2 BERMADINGER E. 1990. Unwanted artefacts in the SEM-investigations of spruce needles. – Phyton (Horn, Austria) 30 (2): 324–325.

Though the scanning electron microscopic (SEM) investigation of the needle waxes of conifers seems to be rather simple unwanted artefacts may lead to false conclusions. The wax tubes of spruce are rather sensitive. A too dense layer of needles or a careless touch with fingers or tweezers results in mechanical damage. Overheating occuring during transport (intense solar radiation) or preparation (sputtering) damages the wax tubes since the melting point is in the range of 40–60° C. Contact with organic solvents (making, mounting) should be avoided. As a consequence of all these influences the crystalline structure of the tubes in destroyed and the needle surface may reveal alterations as do surfaces highly damaged by air pollutants.

Dr. Edith BERMADINGER, Institut für Pflanzenphysiologie, Karl-Franzens-Universität Graz, Schubertstraße 51, A-8010 Graz (Austria).

4.3 POLONYI S. 1990. Cryosubstitution and electron microscopy of lichens. – Phyton (Horn, Austria) 30 (2): 325.

Within the framework of an ecological investigation the ultrastructure of lichen thalli, growing in an area with less influence by gaseous immisions were compared with those growing in a heavily polluted site in the town of Salzburg. Freezefixation and a following kryosubstitution shortens the fixation time to a minimum. Therefore the specimen appear in a nearly native state in electronoptical images. This method enabled a very good preparation of fungus hyphae and algal cells of the genus *Trebouxia,* both lacking vacuoles within their cells.

Mag. Sven POLONYI, Institut für Pflanzenphysiologie, Universität Salzburg, Hellbrunnerstraße 34, A-5020 Salzburg (Austria).

4.4 SEVCIK G., GUTTENBERGER H. & GRILL D. 1990. A temperature regulated perfusion chamber for light microscopy. – Phyton (Horn, Austria) 30 (2): 325.

Perfusion chambers enable the exchange and constant flow of plasmolytics. Nevertheless deviations of temperature may cause troubles. Our new chamber contains another circulation to control temperature with an external thermostat. An integrated thermocouple allows to record the object temperature by computer interface. The glass built chamber with the compact dimensions 75 × 35 × 3 mm provides good optical quality and is compatible to every type of microscope.

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5 Miscellanea

5.1 RÜCKER W.*) & MAIER R.**) 1990. Changes in the peroxidase patterns of tobacco calli caused by lead, cadmium, parathion or maleic acid hydrazide. – Phyton (Horn, Austria) 30 (2): 325–326.

The peroxidase patterns can be employed as an indicator for growth substance effects in the cells; there exist groups of multiple enzyme forms

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which react to auxin/gibberellin in the medium or to cytokinin respectively. All substances tested cause decreasing callus growth with increasing concentrations; low lead concentrations show a preliminary stimulation of growth. Inhibition and stimulation are conformed to attenuation or accentuation respectively of the auxin/gibberellin sensitive zones. The intensity of the cytokinin sensitive multiple forms is mostly increased. Therefore an influence of noxious substances onto phytohormones may be deduced.

5.2 Guttenberger H. 1990. Nuclear DNA-content of dissimilar specialized plant cells. – Phyton (Horn, Austria) 30 (2): 326.

An important fact of differentiation in higher plants is the quantitative change of the nuclear (= nuc)-DNA-content. Not only endopolyploidy, but also DNA-amplification and -underreplication occur. This leads to specific nuc-DNA-contents in cells of different tissues and specialized cells. For example guard cells often have DNA-contents of 2 C and 4 C (1 C = DNA content of telo-half-phases in meristems). Synthetic active cells show in most cases higher nuc-DNA-contents and/or often specific cell cycles. For example most of the nuclei of mucilage excreting head cells of the trichomes of *Zebrina pendula* have a DNA-content of 4 C, some of them 2 C, other nuclei have reached 8 C and more. In many nuclei DNA-contents are not associated with determined C values. The stringing hairs and pearl glands of *Urtica* have extremly high nuc-DNA-contents (up to 512 C). In the investigated guard cells of different plant species chloroplast number and cell size are correlated, but both, cell size and nuc-DNA-content, and nuc-DNA-content and chloroplast number are not correlated in the guard cells investigated.

Mag. Dr. Helmut Guttenberger, Institut für Pflanzenphysiologie, Karl-Franzens-Universität Graz, Schubertstraße 51, A-8010 Graz (Austria).

5.3 Foissner I. 1990. Ca^{2+}-induced formation of wall appositions in characean internodal cells. – Phyton (Horn, Austria) 30 (2): 326.

Ionophore A 23187 and chlortetracycline induce exocytosis which results in the formation of granular callose plugs within 1 to 6 hours. Ca^{2+} is taken up from the medium and deposited in the plug. No net uptake of Ca^{2+}-induced plugs ($>10^{-2}$ M). These wall appositions are fibrillar, contain cellulose but only small amounts of callose and Ca^{2+}. $CaCl_2$-induced plug formation lasts about 24 hours. The rapid formation of callose plugs seems to be an effective mechanism to prevent Ca^{2+} from entering the cytoplasm. Less Ca^{2+} is probably involved in the formation of cellulose plugs.

Dr. Ilse Foissner, Institut für Pflanzenphysiologie, Universität Salzburg, Hellbrunnerstr. 34, A-5020 Salzburg.

5.4 HÖFTBERGER M. 1990. Light- and electronmicroscopical investigations in *Xanthidium armatum*. – Phyton (Horn, Austria) 30 (2): 327.

On the contrary to other so far ultrastructurally investigated desmids, cell development of *Xanthidium armatum* starts with primary wall formation between the two semicells. Mitosis and septum formation do not happen until this new growing part of the cell has reached a distinct thickness. During the following pattern formation the nucleus first moves into the young half cell and later back to the isthmus region. Subsequently the nucleus migrates along the cell wall ring of the isthmus. After numerous of these circular motions the nucleus moves back to the centre of the cell, where it is situated until next cytokinesis.

Mag. Margit HÖFTBERGER, Institut für Pflanzenphysiologie, Universität Salzburg, Hellbrunnerstr. 34, A-5020 Salzburg (Austria).

5.5 JAROSCH R. 1990. Fundamentals of a hydrodynamics for the plant cells. – Phyton (Horn, Austria) 30 (2): 327.

Most phenomena of cell motility, from the motion of bacteria to muscular contraction, are explained and simulated by the "filament rotation model". In addition to the longitudinal effects ("sliding", "shearing") rotating helical filaments generate lateral hydrodynamic effects which can be investigated in an aquarium filled with honey. The main effects are far reaching lateral streams and localized negative pressure adjacent a wall. Freely movable filaments can "roll" on a wall. Pairs of counterrotating filaments are stabilized. When rotating components of the cytoskeleton (microtubules and actin filaments) generate these lateral effects many hitherto mysterious features as positioning of organelles, textures of wall microfibrils, pattern formation and the morphogenesis of plant cells become comprehensible. Different streaming patterns can move and shape the nucleus and other organelles and bring them in appropriate positions. Time dependent reversal of the rotational directions are required for the transformation of the patterns.

Prof. Dr. Robert JAROSCH, Institut für Pflanzenphysiologie, Universität Salzburg, Hellbrunnerstraße 34, A-5020 Salzburg (Austria).

5.6 GÄTZ N. & SCHAGERL M. 1990. On the ecology of *Peridiniopsis borgei* LEMM. – Phyton (Horn, Austria) 30 (2): 327–328.

The dinoflagellate *P. borgei*, new for Austria, was found in 10 out of 19 investigated clay pits in Vienna and Lower Austria. It only occurs in ponds with a pH > 8 and a conductivity > 1000 μS/cm. Thecal morphology was studied by REM-technique. Cell dimensions: 37–50 μm long, 29–44 μm wide, 29–37 µm thick. Population development starts in May. Highest cell densities (several hundred individuals/ml) are reached in late summer. Vegetative cells disappeared from the plankton with the beginning of vertical mixing in October, but cysts (globose, diameter of 36–40 µm) could be observed.

Mag. Norbert GÄTZ, Mag. Michael SCHAGERL, Institut für Pflanzenphysiologie, Universität Wien, Althanstr. 14 / Postfach 285, A-1091 Wien (Austria).

5.7 KANDELER R. 1990. Sink activity of the flower primordium. – Phyton (Horn, Austria) 30 (2): 328.

When fluorescein-Na (1 : 100000) is supplied to floating plants of *Lemna gibba* or *L. aequinoctialis,* the dye accumulates in the flower primordia to a higher degree than in frond primordia of the same age. This effect can be suppressed by arsenate (10^{-4}–5.10^{-4}M). Furthermore, fluorescein uptake in *L. aequinoctialis* is accompanied by a depolarization of membrane potential in a similar way as in the case of nitrate (LÖPPERT, pers. comm.). It may be supposed that fluorescein accumulation needs phosphorylation energy and comes about by a proton co-transport. Therefore, the distribution of the dye within the plant may be used as an indicator for the relative sink activity of growth centres.

Prof. Dr. Riklef KANDELER, Botanisches Institut, Universität für Bodenkultur, Gregor Mendel-Straße 33, A-1180 Wien (Austria).

5.8 ZELLNIG G., 1990. Permeability experiments on nectary hairs of *Abutilon.* – Phyton (Horn, Austria) 30 (2): 328.

The uptake, spreading and localisation of two different substances were investigated in nectary hairs of *Abutilon striatum* var. *thompsonii (Malvaceae)* by means of light- and electron microscopy.

Infiltration of buds with the fluorochrome Lucifer Yellow (LYCH) and / or diaminobenzidine (DAB) lead to an apoplastic uptake of LYCH and DAB up to the tip cell of the nectary trichomes. In addition LYCH also entered the symplast of the nectary trichomes. Till now it has been assumed, that apoplastic transport of nectar towards the tip cell is restricted by an apoplastic barrier of lipidic material in the lateral walls of the stalk cells.

When LYCH was microinjected into the tip cell, the dye spread towards the stalk cell. Electron microscopical investigations revealed ultrastructural changes in the nectary cells (e. g. increase in the number of vesicles) even at very low concentrations of the injected dye (2 mM).

Dr. Günther ZELLNIG, Institut für Pflanzenphysiologie, Karl-Franzens-Universität Graz; Schubertstr. 51, A-8010 Graz (Austria).

5.9 ARTNER CH. 1990. ^{137}Cs-distribution in some selected plant communities of Styria (Austria) after the fallout of Tschernobyl. – Phyton (Horn, Austria) 30 (2): 329.

In the first and second vegetation period after the radioactive fallout ^{137}Cs was used to describe the distribution of artificial radioactivity in different styrian plant communities.

The activity concentration in leaves of selected trees was observed during seven months and showed characteristic seasonal variabilities. These were explained by stretching growth in spring, reabsorption in automn and other phenomenons. In forest ecosystems, mosses and mushrooms contained 10–20 times more ^{137}Cs than comparable grass-samples from the same sites. While no ^{137}Cs was detectable in the most samples of saprophytic and parasitic mushrooms, symbiotic species contained higher amounts of ^{137}Cs per dry weight than mosses. High amounts were also found in barks and seemed to be accumulated there in water – insoluble form.

Christian ARTNER, Institut für Pflanzenphysiologie, Karl-Franzens-Universität Graz, Schubertstraße 51, A-8010 Graz (Austria).

5.10 CHIZZOLA R. 1990. Pyrrolizidine alcaloids in medical plants. – Phyton (Horn, Austria) 30 (2): 329.

Highly toxic pyrrolizidine alkaloids (PA) occur in trace amount in some medicinal plants. Although it is controverial if they present a health risk, the Federal Health Office (Bundesgesundheitsamt) in the FRG suggests to retire medicinal plants and plant extracts containing more than 0,1 ppm PA.

To avoid PA in plant extracts we investigate the variability in PA content and select for PA-free chemotypes of Petasites hybridus, a species building up PA ordinary.

Methods: After reduction of the N-oxides with an oxygen absorber resin and purification with a strong cation exchanger column the PA were analysed by capillary GC or an ELISA.

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