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Effect of lead compounds on regeneration of mosses *Atrichum undulatum* (Hedw.) Beauv. and *Plagiomnium cuspidatum* (Hedw.) Kop.

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Abstract

The influence of various lead compounds concentrations on the regeneration of green and brown *Atrichum undulatum* and *Plagiomnium cuspidatum* shoot fragments was studied. Both these species are highly tolerant to the lead content in the substrate. *A. undulatum* is more susceptible than the other species. Concentrations of 120 ppm $PbCl_2$ and 240 ppm $Pb(NO_3)_2$ inhibit and lower concentrations stimulate shoot regeneration.

INTRODUCTION

The latest investigations point to the possibility of utilizing vegetative reproduction of cryptogamous plants as monitoring agents for determination of environment pollution (Margot, Romain, 1976; Margot, 1977). Bryophytes have a high regeneration ability. New plants can grow from dying fragments of shoots (Misiura, 1964; Lepiarz-Wittner, 1975; Sobotka, 1976).

MATERIAL AND METHODS

Atrichum undulatum and *Plagiomnium cuspidatum* (mosses common in urban environment) were cultured in Petri dishes on Knop's medium with agar. Lead chloride, lead nitrate and lead tetraethyl in concentrations of 15, 30, 60, 120, 240, 480 ppm were used. The methods of lead tetraethyl preparation have been described in an earlier paper (Krupińska, 1976). Each sample consisted of 20 green or brown fragments of shoots 6-7 mm long (in 3 replications). The cultures were kept at 22°C under 8000 lux/12 h/day.

RESULTS AND DISCUSSION

The regeneration ability of green and brown shoot fragments of *Atrichum undulatum* and *Plagiomnium cuspidatum* was investigated. The number of regenerating plant fragments is shown in Table 1. The moss species tested exhibit a high tolerance to lead content in the substrate. Particularly *P. cuspidatum* has a high regeneration power. Green and brown fragments of shoots regenerate in nearly 100 per cent in 15-120 ppm $PbCl_2$ and $Pb(C_2H_5)_4$ or 240 ppm $Pb(NO_3)_2$ (Table 1). This is also confirmed by the number of arising gametophore buds (Fig. 1).

Table 1

Effect of contamination with lead compounds on the regeneration of *Atrichum undulatum* and *Plagiomnium cuspidatum* shoot fragments

Compound	Conc. of comp. ppm	No. of regenerating fragments			
		Plagiomnium cusp.		*Atrichum undulatum*	
		green shoots	brown shoots	green shoots	brown shoots
Control	0	20.0±0*	19.3±0.7	12.0±1.0	9.3±1.5
$Pb(NO_3)_2$	15	20.0±0	19.3±0.7	16.0±1.0	11.3±1.5
	30	20.0±0	19.0±1.0	14.3±1.3	9.3±1.5
	60	20.0±0	18.3±0.7	9.6±1.5	10.3±0.5
	120	20.0±0	18.6±1.5	3.3±0.5	4.0±1.0
	240	20.0±0	19.0±1.0	2.0±2.0	1.0±1.0
	480	0.6±0.5	0.6±0.5	0	0
$PbCl_2$	15	20.0±0	19.0±1.0	15.3±1.5	12.3±2.5
	30	20.0±0	19.3±0.7	15.0±0	10.0±1.0
	60	20.0±0	19.0±1.0	12.0±0	7.3±0.6
	120	20.0±0	19.0±0	1.0±1.0	4.0±2.0
	240	0	3.0±1.7	2.0±2.0	0.6±0.6
	480	0	0	0	0
$Pb(C_2H_5)_4$	15	20.0±0	18.6±0.7	17.0±2.0	16.0±2.0
	30	20.0±0	19.6±0.7	15.6±1.5	17.3±2.5
	60	20.0±0	19.0±0	16.0±0	14.6±1.5
	120	20.0±0	16.3±0.6	16.0±1.0	12.6±0.6
	240	13.0±2.0	10.3±1.4	10.0±1.0	7.0±1.0
	480	2.0±1.0	1.3±0.6	3.3±1.5	0.6±0.6

* — Standard deviation of mean.
Each result in table corresponds to mean from 3 samples, each composed of 20 fragments.

The phenomenon of stimulation occurs in the process of regeneration of mosses cultured on a substrate containing lead compounds. This stimulation is stronger in the case of *P. cuspidatum* and is active in a wider range of concentrations. The stimulating effect of low lead salt concentrations in the substrate has already been reported (Meinck

et al., 1975; M a k s i m o w, 1974). Green fragments regenerate somewhat better, as regards the number of forming gametophores and the percentage of regenerating control shoots cultured on polluted medium. Similar regeneration abilities are exhibited by the shoots of *Polytrichum commune* (M i c k i e w i c z, 1975).

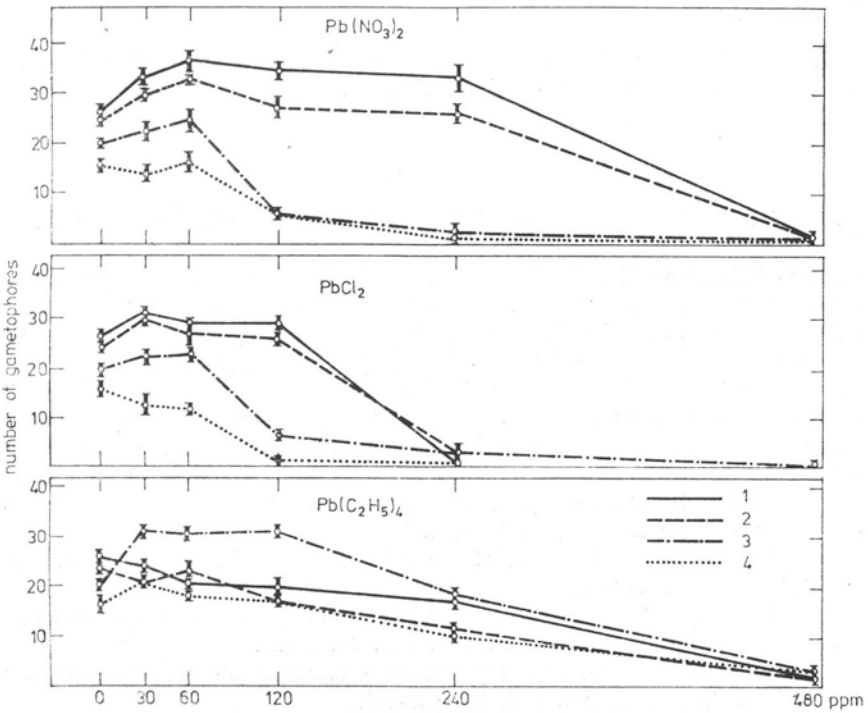

Fig. 1. Effect of lead compounds on the number of gametophores formed by *Atrichum undulatum* and *Plagiomnium cuspidatum*
1 — green shoots of *P. cuspidatum*, 2 — brown shoots of the same, 3 — green shoots of *A. undulatum*, 4 — brown shoots of the same

The lead compounds used show a similar action, lead chloride being most toxic. The influence of this compound and of lead nitrate on higher plants is similar (M e i n c k et al., 1975). Lower concentrations of lead compounds (15-120 ppm) do not produce noticeable morphological changes in the newly forming gametophytes. At concentrations of 240 and 480 ppm the regenerating shoots sometimes form morula-like buds which after some time die or else grow into many-branched bushy forms differing widely from the controls in their appearance. It would seem that these disturbances may be due to the action of lead on mitotic division in connection with the accumulation of this element in the cell nucleus (S k a a r, O p h u s, 1973). Similar dwarfed, bushy, profusely branched forms have been observed in the development of *Funaria hygrometrica* protonema and *Marchantia polymorpha* gemmulae cultured on substrate containing lead compounds (K r u p i ń s k a, 1976).

It should be stressed once more that both the studied moss species are highly tolerant to lead content in the substrate and, owing to this and their ability of accumulating this element they may be considered as playing an important role in the process of biological decontamination of the environment.

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Wpływ związków ołowiu na regenerację mchów Atrichum undulatum (Hedw.) Beauv. i Plagiomnium cuspidatum (Hedw.) Kop.

Streszczenie

Zbadano wpływ różnych koncentracji chlorku, azotanu i czteroetylku ołowiu na regenerację mchów *Atrichum undulatum* i *Plagiomnium cuspidatum*. Badane gatunki mchów wykazują dużą tolerancję na zawartość ołowiu w podłożu, przy czym bardziej wrażliwym gatunkiem jest *Atrichum undulatum*. Duże zdolności do regeneracji łodyg ma *Plagiomnium cuspidatum*, gdzie prawie wszystkie zielone i brązowe fragmenty regenerują na podłożu ze związkami ołowiu w stężeniach 15-120 lub 15-240 ppm. W procesie regeneracji mchów hodowanych na podłożu zawierającym związki ołowiu zachodzi zjawisko stymulacji. U *Plagiomnium cuspidatum* jest ono silniejsze i obejmuje szerszy zakres stężeń.