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## EMBRYOLOGICAL AND CYTOLOGICAL VARIABILITY OF PLANTS IN POLLUTED ENVIRONMENT

edited by  
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#### EMBRYOLOGICAL STRUCTURES AND POLLUTION – FOREWORD

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## THE EFFECT OF SOIL FROM POLLUTED SITES ON REPRODUCTIVE SUCCESS IN *RANUNCULUS REPENS* (RANUNCULACEAE)

ROMANA IZMAIŁOW

**Abstract:** The effects of the stress conditions of polluted environments on the reproductive processes of *Ranunculus repens* L. were studied. The contaminated sites were the slopes and habitat around a post-flotation reservoir containing copper mining wastes (Żelazny Most near Rudna, Legnica-Głogów Copper District, Poland). Several specimens were transplanted from an unpolluted experimental plot to the slope of the reservoir, characterized by very unfavorable chemical, physical and microclimatic conditions. The plants did not survive there to the following year. Other plants were transplanted to the base of the reservoir; they did not enter the flowering phase, did not form stolons through the following year, and finally died. In another experiment, *R. repens* plants from the experimental plot were cultivated in boxes with substrate brought from the reservoir slope and observed for two years. Plants transplanted before the generative phase remained in the vegetative state for weeks, forming stolons, but died after fungal infection. Specimens transplanted at the beginning of flowering grew on polluted substrate for weeks, forming stolons and flowers; flowers were less abundant than in control material grown in unpolluted soil, and pollen viability decreased in the successive flowers from 92% to ca 15% (controls developed 95% viable pollen). Nearly 10% of older ovules showed some atypical features of endosperm development. In flowers from late flowering, ca 80% of the seeds fell prematurely; they contained both endosperm and embryo at early developmental stage. The tissues of some root tips of plants cultivated in polluted substrate had long anomalous intercellular spaces within the ground meristem situated at the exterior of the procambium and near the protomeristem. In some roots the cap and neighbouring meristem degenerated. Achenes harvested from plants growing in the unpolluted plot were germinated in polluted substrate and in standard soil of the plot. In the sample of achenes, germination in polluted substrate was inhibited at early phase and seedlings died. The tested specimens of *R. repens* were not tolerant to the stress conditions.

**Key words:** *Ranunculus repens*, polluted environment, heavy metals, generative and vegetative reproduction in stress conditions, seed germination

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## EMBRYOGENESIS IN *CAPSELLA BURSA-PASTORIS* (BRASSICACEAE) IN POLLUTED AND DISTURBED SITES

ROMANA IZMAIŁOW

**Abstract:** Embryogenesis in *Capsella bursa-pastoris* (L.) Medik. growing in contaminated environments was studied. The examined plants originated from two disturbed and polluted sites: the fly-ash heap of the thermal power station in Skawina near Kraków, and the base of the Żelazny Most post-flotation waste reservoir in the Legnica-Głogów Copper District. The control plants grew as weeds on an experimental field with non-polluted soil in Modlnica near Kraków. The plants from polluted sites showed slightly decreased female fertility than the control, associated

with sporadic degeneration of the egg apparatus or the whole embryo sac. Higher ovule sterility resulting from degenerative processes in young proembryos has not been mentioned in papers on embryogenesis of the species. Degeneration occurred in 12.6% of the analyzed proembryos from Żelazny Most and was observed in the suspensor, in both the embryo and suspensor, or sporadically in the embryo proper alone. Some proembryos showed disturbed structure of the suspensor or atypical embryo proper development, including the hypophysis region. These irregularities were detected in 3.9% of the analyzed proembryos from Skawina and in 2% of those from Żelazny Most. Embryos from heart-shaped to mature stage had normal structure without signs of degeneration. The results suggest that early embryonal stages were particularly sensitive to the polluted conditions in the habitats, and were highly tolerant to stress from the heart-shaped stage to mature embryo.

**Key words:** *Capsella bursa-pastoris*, polluted environment, embryo, embryogenesis, stress conditions

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### EMBRYO DEVELOPMENT AND STRUCTURE IN THE AUTONOMOUS APOMICT *CHONDRILLA JUNCEA* (ASTERACEAE) FROM A POLLUTED AREA

MARIA KOŚCIŃSKA-PAJAŁ

**Abstract:** The effects of environmental stress conditions on embryo development were studied in *Chondrilla juncea* L. growing in the polluted area of Żelazny Most, a post-flotation reservoir of copper mining wastes near Rudna (Silesia, Poland), during two successive vegetative seasons. Plants grown from seeds collected from the contaminated site and cultivated in an unpolluted experimental field were the control. Almost half of the analyzed embryos were in various stages of embryo degeneration, and many of them were abnormal. Ovules showed different kinds of disturbances and degenerative processes such as degeneration of the archesporium, embryo sac, egg apparatus and young embryo. A high percentage of ovules aborted: ca 50% ovules formed viable seeds (54% and 57% in successive seasons) versus 81% in the control.

**Key words:** *Chondrilla juncea*, embryo, ovule, degeneration, reproduction, pollution, heavy metals

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### VARIABILITY OF ANTIPODAL APPARATUS IN *CIRSIMUM ARVENSE* (ASTERACEAE) IN POLLUTED AND UNPOLLUTED ENVIRONMENTS

ROMANA CZAPIK & KATARZYNA KAŻMIERSKA

**Abstract:** Mature antipodal complexes of *Cirsium arvense* (L.) Scop. in plants from four localities were compared. The plants grew on the following sites: (1) an ecologically undisturbed

experimental field in Modlnica near Kraków; (2) waste heaps of the former Solvay soda factory in Kraków; (3) ashes of the power station in Skawina near Kraków; and (4) the surroundings of Żelazny Most, a post-flotation reservoir of the copper mine near Rudna (Głogów-Legnica Copper District, Silesia, Poland). A two-celled antipodal apparatus typical for the genus and species prevailed in the plants from all localities. It consisted of a micropylar binucleate cell and a uninucleate chalazal cell. During secondary differentiation additional mitoses might occur, followed or not by cytokinesis and fusion of two nuclei. One of the two nuclei in a coenocytic antipodal showed signs of degeneration first; however, the polluting factor(s) did not influence normal degenerative processes. About 11 types of antipodal complexes occurred with various frequencies in the examined plants. Comparison of the material from particular localities suggests that some unknown factor(s) are implicated in, for example, the inhibition of mitoses and wall formation in the samples from Żelazny Most and Solvay, and the increased number of three-celled antipodal complexes in Skawina. The polluting factor(s) influencing the variation in individual plants cannot be specified. Some of the morphological response from the antipodals in *C. arvense in situ* seem due to pollution, and mixed with a degree of genetically conditioned plasticity.

**Key words:** *Cirsium arvense*, antipodals, embryological variability, pollution

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## DEVELOPMENTAL DISTURBANCES AND DEGENERATION OF PLANT EMBRYO IN POLLUTED ENVIRONMENT

ROMANA CZAPIK, ROMANA IZMAIŁOW & MARIA KOŚCIŃSKA-PAJAŁ

**Abstract:** Degeneration of young embryos and disturbances of embryogenesis were observed in *Capsella bursa-pastoris* (L.) Medik., *Vicia cracca* L., *Chondrilla juncea* L. and *Cirsium arvense* (L.) Scop. growing in the polluted environment of the base of the copper mine post-flotation waste reservoir (Żelazny Most near Rudna in Silesia, Poland). In addition, embryos of the following species from two contaminated localities were investigated: *Capsella bursa-pastoris* and *Cirsium arvense* from the fly-ash heap at the power station in Skawina near Kraków, and *C. arvense* from waste heaps of the former Solvay soda factory in Kraków. The plants had higher seed sterility; the responsible factors seemed to be abortion of young seeds and to a lesser degree abortion of young ovules and/or generative tissues inside the ovules. The young embryos degenerated surrounded by regular-looking endosperm (in all species), or the embryo and endosperm degenerated simultaneously (*Vicia*, *Chondrilla*, *Cirsium*). Very rarely, degenerated nuclear endosperm which surrounded the resting egg cell (*Cirsium*). In some ovules the pattern of regular embryogenesis was disturbed, leading to an irregularly shaped embryo and/or suspensor (*Capsella*, *Vicia*, *Chondrilla*). An extremely rare deviation, namely young coenocytic embryos surrounded by degenerating nuclear endosperm, was found in two embryo sacs of *Chondrilla juncea* and in one of *Cirsium arvense*. Three conclusions were drawn: (1) young stages of embryo development are more sensitive than older ones; their degeneration may also be the result of the prolonged action of unknown factor(s) expressed at some early sensitive stages; (2) endosperm seems less sensitive than embryo; (3) an unspecified pollutant or mixture of pollutants inhibited cytokinesis in the first divisions of the egg cell, associated with early degeneration of free endosperm nuclei.

**Key words:** Embryo, embryogenesis, endosperm, seed, sterility, heavy metals, pollution

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### IMMUNOFLUORESCENCE OF MICROTUBULAR CYTOSKELETON DURING MICROSPOROGENESIS OF *CHONDRILLA JUNCEA* (ASTERACEAE) IN A POLLUTED ENVIRONMENT

MARIA KOŚCIŃSKA-PAJĄK

**Abstract:** A high degree of degeneration during microsporogenesis was observed in triploid apomictic plants of *Chondrilla juncea* L. growing in contaminated soil at the base of the Żelazny Most post-flotation waste reservoir near Rudna (Legnica-Głogów Copper District, Silesia, Poland). The question was whether triploidy, apomixis or the environment influenced the cytoskeletal configuration in the microsporogenesis of this cytotype and the changes in the spatial organization of the microtubules during cell division and nuclear movements. The cytoskeletal configurations were observed to be typical of regular meiotic division. The nuclear domain was visible in binucleate cells that had not undergone meiosis. The patterns of distribution of organelles were atypical. Plastids and mitochondria did not form the equatorial plate observed in many other taxa during cytokinesis but were dispersed randomly in the central and peripheral cytoplasm.

**Key words:** *Chondrilla juncea*, immunofluorescence, microsporogenesis, microtubular cytoskeleton, pollution

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### COMPARISON OF C-MITOTIC EFFECTS OF AMBUSH 25EC INSECTICIDE (PERMETHRIN) AND COLCHICINE ON ROOT MERISTEM CELLS OF *PISUM SATIVUM* (FABACEAE)

MARIA KLEIN & LUCYNA SAMEK

**Abstract:** C-mitotic effects of colchicine and the insecticide Ambush 25EC (permethrin) in pea root meristems were compared. The examined compounds were applied in concentrations of 0.02% and 0.2% for 4 and 8 h at 10°C. Ambush 25EC, similarly to colchicine, caused metaphases to accumulate, while the number of anaphases and telophases decreased but to a lesser extent. Colchicine elicited 'ball-type' metaphases with significantly shortened chromosomes located in the center of the cell. Chromosomes in Ambush 25EC-treated cells were scattered in the cytoplasm. The number of c-mitotic disturbances increased with the concentration and duration of insecticide treatment. The compounds only slightly disturbed the mitotic activity of pea root meristem cells.

**Key words:** *Pisum sativum*, Ambush 25EC insecticide (permethrin), colchicine, c-mitosis

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