

reflecting serious oxidative stress in *B. juncea*.

Due to the short-term Zn stress, SOD and APX showed higher activities in the roots of *B. juncea* keeping the amount of superoxide anion ( $O_2^{\cdot-}$ ) and  $H_2O_2$  at a control-like or lower level. Contrary, NO and ONOO $^{\cdot-}$  showed significant accumulation as the effect of Zn exposure. Despite the elevation of ONOO $^{\cdot-}$  levels, there was no detectable lipid peroxidation, which may indicate that it has a role in stress tolerance in *B. juncea* roots.

In the background of the serious growth inhibition and the viability loss of *B. napus* roots severe oxidative stress was observed: despite the elevated SOD activity  $O_2^{\cdot-}$  accumulated, while the cells failed to eliminate the formed  $H_2O_2$  because of the reduced APX activity. Moreover, a remarkable lipid peroxidation was visualized in the roots.

Long-term Zn excess caused oxidative and nitrosative stress in both species and despite their higher level in *B. juncea* root tips, it proved to be more tolerant according to the growth parameters.

Based on the morphological and physiological results, I conclude that *B. napus* tolerates Cu excess better than *B. juncea*. In contrast, *B. juncea* possesses elevated Zn tolerance compared to the other species. My results support the species-specificity of metal tolerance.

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## Study of cuckoo-host relationships on a great reed warbler population in Hungary

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The brood parasitic common cuckoo (*Cuculus canorus*) lays its eggs to nests of other bird species, where the foster parents incubate, hatch and feed the cuckoo. A typical host species is the great reed warbler (*Acrocephalus arundinaceus*), breeds in wetland areas in Hungary, and builds open nest in reed beds. The modal clutch size of great reed warblers is 5 eggs and incubation time is about 11-12 days. We investigated several aspects of ecological relationships between common cuckoos and great reed warblers, including behavioural and evolutionary adaptations. However, we also applied microbiological and molecular methods.

In our first study, we examined bacterial loads on the eggshells of common cuckoos and great reed warblers. During our field work we collected samples from the eggshell surface of both cuckoo and great reed warbler eggs, either from parasitized and non-parasitized clutches to compare bacteria of the eggshells. We hypothesize that cuckoos, as nest visitors, may influence on the hygiene of nests of great reed warblers by changing bacteria loads. Previous studies showed that environmental factors, such as temperature and humidity, may affect bacterial loads on the eggshells in cavity nesting birds. We hypothesized that these environmental factors also affected the hygiene of open nests of great reed warblers. From these factors we measured ambient light conditions, both in the visible and UV spectra.

Keeping eggs dry in avian nests during the incubation period may reduce bacteria load on the eggshells, so it may protect the eggs from bacterial infections. A few previous studies have already showed the antimicrobial effects of incubation in cavity nesting birds, but, in the first time, we studied these effects under more variable environmental conditions, on an open-nesting bird species.

During the co-evolution arms race between common cuckoos and great reed warblers both the brood parasites and hosts developed ecological adaptations. The adaptations developed by the brood parasite help successful parasitism (e.g. "mimetic eggs"), but the adaptations by the hosts are against the brood parasites ("antiparasite adaptations", e.g. egg discrimination). We evaluated the changes of eggshell spottiness of common cuckoos and great reed warblers in time. Previously, we photographed parasitized clutches of host eggs held in museum collections ( Natural History Museum, Tring, Mátra Museum, Gyöngyös, and Hungarian Natural History Museum, Budapest), and we also took digital photos during our field work. All eggs were collected from Hungary. We had four treatments from the years of 1900s, 1930s, 1960s, and 2000s. For analysing images we used ImageJ and Matlab programs. We wanted to reveal how spottiness changed in common cuckoos and great reed warblers. We analysed these changes by statistical pattern analysis on eggs from the last hundred years, focusing on cuckoo egg mimicry to host eggs.

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