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Carbon isotopic variations in species of lichens on an altitude gradient in the South Carpathians and Apuseni Mountains, Romania

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In the present work, the natural isotopic variations of $^{13}C/^{12}C$ in lichens are analyzed in relation to an altitude gradient, to different collection dates, and to different photobiont associations. We have studied the lichens because they are extremely sensitive symbiotic organisms consisting of a fungus (mycobiont) and an algae or cyanobacterium (photobiont) which might react to even slightly polluted air. Lichens are biomonitors with a good accumulation capacity that allow the determination of pollutants deposition in terrestrial ecosystems (Catarino et al., 1991; Nimis et al., 2001).

The lichen species studied were Cladonia., Peltigera canina, Hypogymnia physodes and Pseudovernia furfuraceea. These lichens were collected in Retezat Mountains, Hăşmaşu Mare Mountains and Bihor Mountains, Romania. The colelction of data was performed during 1978, 1987, 1989, 1994 and 2003. The carbon isotope composition ($\delta^{13}C$) in organic material from 56 lichen samples has been measured. The lichen samples were combusted to obtained CO_2 for isotopic analysis. CO_2 was purified on cryogenic traps and then analyzed by a dual-inlet isotope ratio mass spectrometer, model ATLAS designed by Varian. The mean standard deviation is ± 0.3‰.

The results show that the $\delta^{13}C$ values for all studied lichens variy between –21.21‰ and –26.93‰, in the range normally associated with C_3 higher plants (Ehleringer, 1991).

The studied lichens can be separated into two groups on basis of the type of photobiont partner: phycobiont (like Hypogymnia physodes) where the photobiont is a green algae, and cyanobiont (like Peltigera canina) where the photobiont is a cyanobacteria. We have found a difference between $\delta^{13}C$ of the two groups: the Peltigera canina lichens collected in Bihor Mountains in 1978 showed a mean $\delta^{13}C$ value of –23.67 ‰, and the Hypogymnia physodes collected in the same site and the same date showed a mean $\delta^{13}C$ value of –22.71‰. The difference can be explained by the differences in photosynthetic rates (Maguas and Brugnoli, 1996). The lichens possessing different photobiont associations show different water requirements for the activation of photosynthesis. The cyanobiont lichens require liquid water for photosynthetic CO_2 assimilation, while the phycobiont associations can fix CO_2 in the presence of water vapor. Such differences are related to variation in CO_2 diffusion resistance from air to chloroplasts.

We found a variation of the $\delta^{13}C$ values in lichens with altitude. For Hypogymnia physodes lichens this gradient was from –21.21‰ at 1130m to –26.09‰ at 1520m. We have supposed that the lichens along an altitude gradient are exposed to numerous natural and man-made stress factors and react sensitively to any pollution. The stress factors have a direct or indirect effect on photosynthetic apparatus of lichens, and as a result on the $\delta^{13}C$ values.

Also, the $\delta^{13}C$ values of the lichens that were collected at different dates showed a gradient. The Cladonia lichens collected in Big Hasmasu Mountains in 1989 year have $\delta^{13}C$ = -21.52‰ and the Cladonia lichens collected in the same mountains, but in 2003 year, have $\delta^{13}C$ = -24.75‰. The Pseudovernia furfuraceea lichens collected in the same mountains in 1989 have $\delta^{13}C$ = -23.29‰, and the Pseudovernia furfuraceea lichens collected in 2003 have $\delta^{13}C$ = -25.03‰. All these lichens were collected at the same altitude. The ^{13}C content from organic material of these lichens is depleted in the lichens collected in 2003 year in relation to the lichens collected in 1989.

For both species, a decrease in $\delta^{13}C$ values was associated with the change in the $\delta^{13}C$ and CO_2 concentration of the CO_2 atmospheric after a lapse of 14 years. This evidence is relevant for understanding the impact of global change on natural vegetation.

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