Carbon isotope fractionation during photosynthesis in submerged moss and aquatic plants

Andreja Sironić, Nada Horvatinčić, Jadranka Barešić, Ines Krajcar Bronić
Ruder Bošković Institute, Zagreb, Croatia
andreja.sironic@irb.hr

Radiocarbon activity ($^{14}\text{C}$) and ratio of stable isotopes $^{13}\text{C}/^{12}\text{C}$ (δ$^{13}$C values) were measured in plant samples collected 2011-2012 in the natural habitat of the Plitvice Lakes, Croatia: terrestrial moss, water submerged moss, marsh and aquatic plants. All collected samples are C3 photosynthetic cycle plants. The $^{14}\text{C}$ and δ$^{13}$C values of the plant tissue were compared with values of carbon reservoirs the plants use in photosynthesis: atmospheric CO$_2$ and/or dissolved inorganic carbon (DIC) as well as with the carbon isotope composition of plants measured 30 years ago [1]. The fraction of each carbon reservoir in plants was determined and the 13C fractionation factor between DIC and organic tissue of a plant was calculated. Since there were no systematic paired measurements for $^{14}\text{C}_{\text{DIC}}$ and $^{14}\text{C}$ of plants at some locations in the old data set, we approximated the missing $^{14}\text{C}_{\text{DIC}}$ values by the values taken from [2]. There is a very good correlation between $^{14}\text{C}$ and δ$^{13}$C of moss plant tissue in both periods which is a result of variation of the ratio of atmospheric and dissolved inorganic carbon in moss. The fraction of atmospheric carbon in submerged mosses ranges from 8 to 66%. Calculated 13C fractionation factor between DIC and organic tissue of moss is 41 ± 3 %. Aquatic plants (algae, submerged species) sampled from ~30 cm depth show higher fraction of atmospheric carbon (~20 %) than a sample from 14 m depth (~0 %). Floating plants have 15 - 20 % of atmospheric carbon, while emersed plants have 90 – 100 % of atmospheric carbon (marsh plants, sedge, grasses). Calculated 13C fractionation factor between DIC and plant tissue for submerged and floating plants is -22 ± 3 %, which is the same as the 13C fractionation factor between the atmospheric CO$_2$ and plant tissue for C3 plants. Emerged samples have higher dispersion in 13C fractionation factor values (from -9 % to -147 %). The difference between the determined 13C fractionation factors for mosses and for aquatic plants (algae and floating plants) could be a result of different plant adjustment to photosynthesis of HCO$_3^-$ (aq) and CO$_3^{2-}$ (aq) molecules from DIC. Mosses are known to be adjusted to photosynthetic assimilation of CO$_2$ there is probably an extra step of transformation of HCO$_3^-$ (aq) and CO$_3^{2-}$ (aq) to CO$_2$ resulting in a larger 13C fractionation factor between DIC and plant tissue for mosses than for aquatic plants.