Effects of environmental changes on plant growth and vegetation in coastal region — Ecophysiological approaches on referrence to leaf water status of mangrove plants

Kuni ISHIHARA*, Tadashi HIRASAWA** and Taiichiro OOKAWA**

* Faculty of Agriculure, Utsunomiya University

** Faculty of Agriculture, Tokyo University of Agriculture and Technology

As the study program on the effects of environmental changes in coastal region on plant growth and vegetation, leaf water status was examined in mangroves in the area from sea water along the coast to brackish water in the mouth of the river.

Leaf water and osmotic potentials of *Bruguiera gymnorrhiza* (L.) Lank., *Rhizophora stylosa* Griff. and *Avecennia marina* (Forsk.) Vierh., and sea or brackish water potential were measured with the thermocouple psychrometer. The leaf water potentials of these mangroves, with low transpiration in the cloudy days, were lower than the potentials of brackish water sampled in the places where these mangroves grow. Their leaf pressure potentials, caliculated from the leaf water and osmotic potentials, were kept higher than 0.9MPa usually found in the leaves of plants under sufficient soil water conditions. It is also of interest to note that the leaf water potentials of the mangroves growing in sea water area along the coast were higher than the sea water potential, but their leaf pressure potentials were higher than 1.0MPa.

Furthermore, the leaf water potentials were measured in three plants of *R. stylosa* of different size and age growing in sea water area. The leaf water potentials of large and medium size mangroves were higher than the sea water potentials. On the contrary, the leaf water potential of the small size and one or two year old mangrove was lower than sea water potential and its leaf pressure potential was very low.

These results indicate that *R. stylosa* growing in sea water area along the coast are probably using water with lower water potential than that of sea water. It appears that the sea water is diluted lower than the leaf water potential with fresh undergruond water and that the small and young mangrove, with low leaf water and pressure potentials, uses sea water directly because its root system is not yet developed enough to penetrate deeper layer to use sea water that is diluted with fresh underground water flowing into the sea from the land. Therefore, the mangrove would suffer from water stress under intense transpiration condition on a fine day.

We examined the leaf water status of mangrove plants growing in sea water along the coast in Bali Island, Indonesia and near Komi and Yubujima of Iriomotejima to ascertain the results and suggestions mentioned above. The leaf water potentials of the mangrove plants in both Indonesia and Iriomotejima were higher than the water potential of the sea water around these plants at the time just before sunset and just after sunrise when transpiration was very low. In the plants with high transpiration rate at the daytime of the fine day the leaf water potential reduced to the water potential almost equal to the sea water potential around the plants. However, the reduction in the leaf pressure potential was not so remarkable compared with that of the leaf water potential because the reduction in the osmotic potential was larger than that of the leaf water potential. Thus the leaf pressure potential was maintained at the level of 0.6 to 0.7 MPa. As a result leaf diffusive conductance and photosynthetic rate were maintained high during the daytime. The maximum of the leaf photosynthesis was higher than 20 μ molCO_2 · m^{-2} · sec^{-1}. But in the small plant leaf diffusive conductance and photosynthetic rate reduced significantly in the afternoon of a fine day.

These results could generalize the suggestion that water in the soil where roots of mangrove plants are growing should be diluted with the fresh underground water from the land and, therefore, they could sufficiently absorb water with far higher water potential than that of sea water under intense transpiration conditions.

To examine the suggestions mentioned above, we tried to determine ^{18}O / ^{16}O ratio of the xylem water in the stem of *R. stylosa* comparing with the ratio of sea water and fresh water in the river with Dr. N. Tanaka, Graduate School of Environmental Sciences, Hokkaido University. The very close relation was found between ^{18}O / ^{16}O ratio and salt concentration of water. The value of ^{18}O / ^{16}O ratio of sea water and fresh water was 0.2 and − 4.5, respectively. The values of the xylem water of the plants growing in sea water were − 1.1 to − 1.5. The salt concentration of water with − 1.1 to 1.5 ^{18}O / ^{16}O ratio was 2.2 to 2.3 % from the relation between ^{18}O / ^{16}O ratio and salt concentration. Thus we concluded that *R. stylosa* growing in sea water was absorbing a 2 to 1 mixture of sea water and fresh water.

The conclusion indicates that the underground fresh water flowing out directly from the land is essential for the development and / or recovery of mangrove vegetation in the sea along the coastal region.