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# Plant-Mediated Rhizosphere Oxygenation in the Native Invasive Salt Marsh Grass *Elymus athericus*

Ketil Koop-Jakobsen[1], Robert J. Meier[2] and Peter Mueller[3]
[1]Wadden Sea Station, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), List/Sylt, Germany
[2]PreSens Precision Sensing GmbH, Regensburg, Germany
[3]Institute of Soil Science, Center for Earth System Research and Sustainability, University of Hamburg, Germany

**Abstract:**

In the last decades, the spread of *Elymus athericus* has caused significant changes to the plant community composition and ecosystem services of European marshes. The distribution of *E. athericus* was typically limited by soil conditions characteristic for high marshes, such as low flooding frequency and high soil aeration. However, recently the spread of *E. athericus* has begun to also include low-marsh environments. A high-marsh ecotype and a low-marsh ecotype of *E. athericus* have been described, where the latter possess habitat-specific phenotypic traits facilitating a better adaption for inhabiting low-marsh areas. In this study, planar optodes were applied to investigate plant-mediated sediment oxygenation in *E. athericus*, which is a characteristic trait for marsh plants inhabiting frequently flooded environments. Under waterlogged conditions, oxygen ($O_2$) was translocated from aboveground sources to the roots, where it leaked out into the surrounding sediment generating oxic root zones below the sediment surface. Oxic root zones were clearly visible in the optode images, and no differences were found in the $O_2$-leaking capacity between ecotypes. Concentration profiles measured perpendicular to the roots revealed that the radius of the oxic root zones ranged from 0.5 to 2.6 mm measured from the root surface to the bulk anoxic sediment. The variation of oxic root zones was monitored over three consecutive light–dark cycles (12 h/12 h). The $O_2$ concentration of the oxic root zones was markedly reduced in darkness, yet the sediment still remained oxic in the immediate vicinity of the roots. Increased stomatal conductance improving the access to atmospheric $O_2$ as well as photosynthetic $O_2$ production are likely factors facilitating the improved rhizosphere oxygenation during light exposure of the aboveground biomass. *E. athericus'* capacity to oxygenate its rhizosphere is an inheritable trait that may facilitate its spread into low-marsh areas. Furthermore, this trait makes *E. athericus* a highly competitive species in marshes facing the effects of accelerated sea-level rise, where waterlogged sediment conditions could become increasingly pronounced.

Keywords: tidal wetland, plant-soil interaction, sediment oxygenation, ROL, wetland plants, aerenchyma, planar optode, imaging