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GAS TRANSPORT AND STORAGE PROCESSES IN THE LACUNAR SYSTEM OF *EGERIA DENSA* PLANCH.

By

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ABSTRACT

(500 word limit, PhD Thesis regulations, 1987)

Aquatic macrophytes possess an internal lacunar system of proliferated intercellular airspaces. Lacunar gas exchange processes were investigated in Egeria densa Planch., a submerged freshwater angiosperm.

Investigations of oxygen exchange between Egeria shoot segments and the water revealed that up to 17% of the photosynthetically-produced oxygen is retained within the lacunae. A consequence of this partitioning, which results from the relatively low solubility of oxygen in water, is the development of internal lacunar pressures up to 20 kPa above atmospheric pressure. This storage of oxygen in Egeria casts doubts on oxygen-based measurements of productivity in aquatic macrophytes, unless both internal and external sinks are monitored. Pressurisation also revealed that storage is greater in static water than in flowing water, suggesting that boundary layer limitations to oxygen transfer can also affect partitioning.

Pressures fall to sub-atmospheric values in the dark, due to respiratory consumption of the internal oxygen. The Egeria respiratory gas exchanges in the dark demonstrated a steady concentration gradient between plant and water within an hour of darkening. However, the material steadily consumes approximately 30% of its respired oxygen from the lacunae, rather than the water. This oxygen supply is again due to the low oxygen solubility. The lacunae also assist the radial oxygen supply into the respiring tissue; it was found that the Michaelis-Menten constant for the respiratory response to oxygen tension in Egeria was some two to three times greater in material with infiltrated lacunae than in uninfiltrated material.

Oxygen storage in the stem lacunae resulted in a longitudinal (shoot to root) movement of this gas, which was monitored using a bicompartment apparatus. The root oxygen release rate varied with light intensity and water flow rate in a similar manner to the internal pressure changes. Further experiments, involving measurements of the oxygen flux rates in the Egeria rhizosphere, demonstrated that this root oxygen loss is capable of effecting substantial diurnal oxygen fluctuations in the surrounding sediment. These processes may be interrupted by natural infiltration of the airspaces, but the factors involved here remain uncertain.

The mean internal oxygen transport rate in Egeria (6.28 $\mu l O_2 \ h^{-1}$) was consistent with estimates of lacunar oxygen concentration gradients calculated from Fick's Law, suggesting that diffusion is the oxygen transport mechanism in Egeria. However, by connecting shoots into manometers, internal pressure gradients of some 0.9 kPa m^{-1} were detected. These gradients were 10^3-fold greater than the pressure gradient required to account for oxygen transport in Egeria, but were transient features, as the pressure equilibrated throughout the lacunar system 20 - 30 minutes after a dark/light change. Mass flow was therefore proposed as a transitory, but potentially significant, contribution to oxygen transport.

Root to shoot carbon dioxide transport was measured using $^{14}CO_2$ tracing. The CO_2 uptake (mean internal transport = 4.96 $\mu l CO_2 \ h^{-1}$) represented < 10% of the total carbon fixed; the concentration of root-derived carbon in shoot tissue declined rapidly from the root insertion point.

These results are compared with those of previous studies, and the significance of the Egeria lacunar system assessed.

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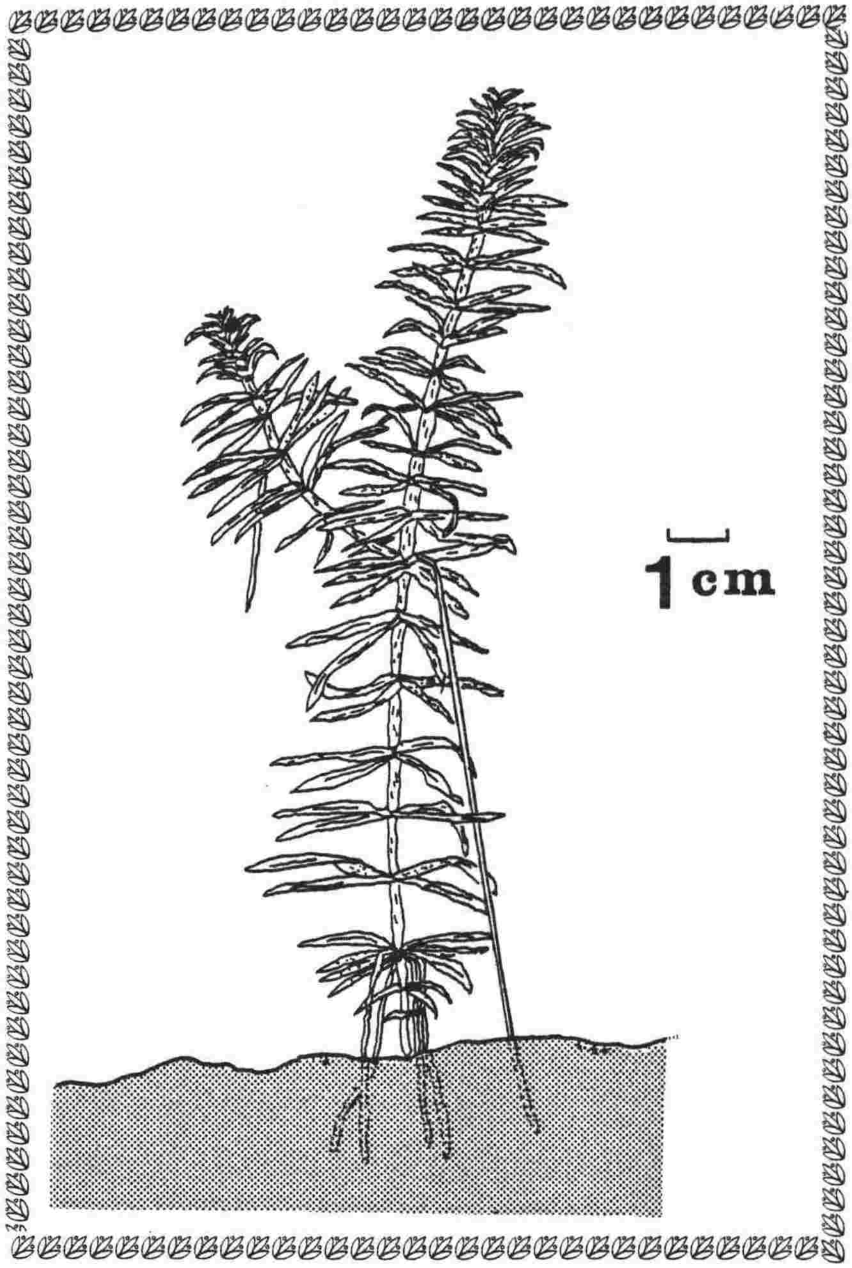

Frontispiece: Drawing of a young Egeria densa Planch. plant, showing general plant form, branching pattern, and adventitious root formation.

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