Growth and photosynthetic parameters of the mangrove *Avicennia marina* under different salinity

Daniel Ziche, Barbara Käser, Manfred Forstreuter

Institute of Ecology and Biology

M.Forstreuter@TU-Berlin.de

Introduction

Avicennia marina is one of the most widespread mangroves. It settles not only the northern and southern limits of the extension of mangroves but also in the areas of highest salinity within the mangrove vegetation.

The high salt tolerance of *A. marina* is regarded as a result of a water use efficiency, which balances the relation between carbon gain, water loss and ion uptake with the transpiration stream on a low but constant level [1]. This work compares the relations of growth and photosynthetic capacity to salinity.

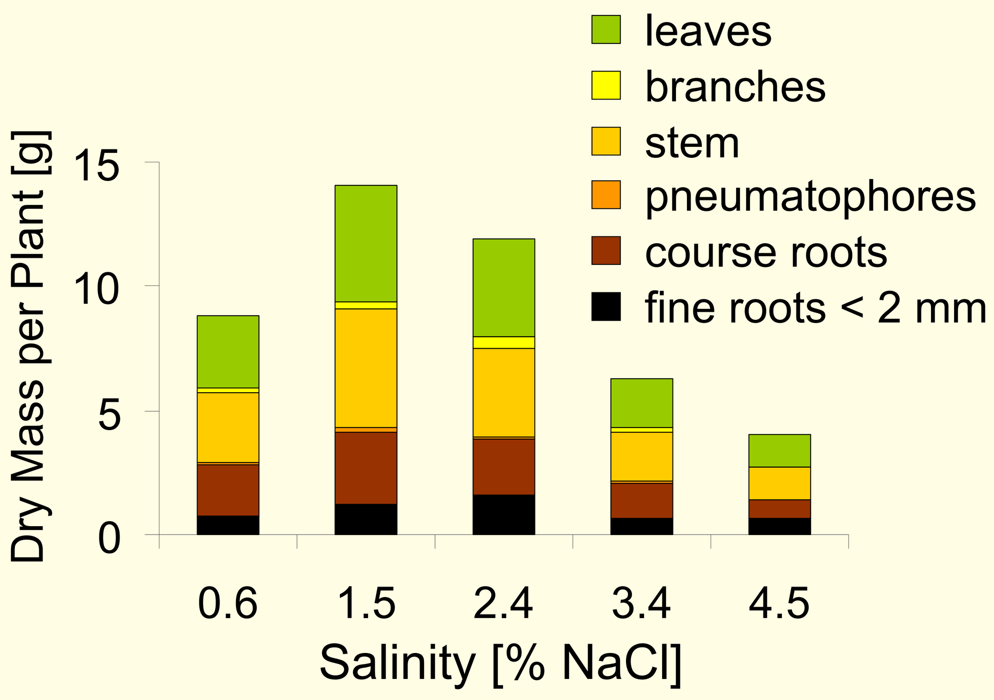

Fig. 2: Mean total dry mass in plant organs at different salinity levels. The ratio between root and shoot dry mass varied not significantly.

Method

Seeds of *Avicennia marina*, collected in the U.A.E. were germinated in a greenhouse under controlled environmental conditions (T_{air}: 20-25°C, *VPD:* ~1.4 kPa, PPFD: 500 µmol m^{-2} $s^{-1,}$ daylenght: 14 hours). They were grown in special plant breeding boxes where the tide was simulated (Fig. 1). After the first three months when the salinity level was 1.5% NaCl the seedlings were divided up into five homogeneous groups and cultivated at five different salinity levels (0.6 %, 1.5%, 2.4%, 3.4% and 4.5% NaCl). After eight month leaf gas-exchange measurements (CO_2 and H_2O) were conducted. Series of A/Ci curves were

Fig. 1: Growing of *Avicennia marina* in plant breeding boxes with simulation of tides. Small picture on the top: roots of *A. marina*, small picture at the bottom: plant breeding box at the installation.

measured with a portable mini-cuvette system (HCM-1000, Walz) under constant environmental conditions (Fig.5). A photosynthesis model (Farquhar model) [2] integrating photosynthesis and stomatal conductance was used to interpret the gas-exchange data. The derived model parameters V_{cmax} and J_{max} (Fig.5) characterise the photosynthetic capacity of the foliage

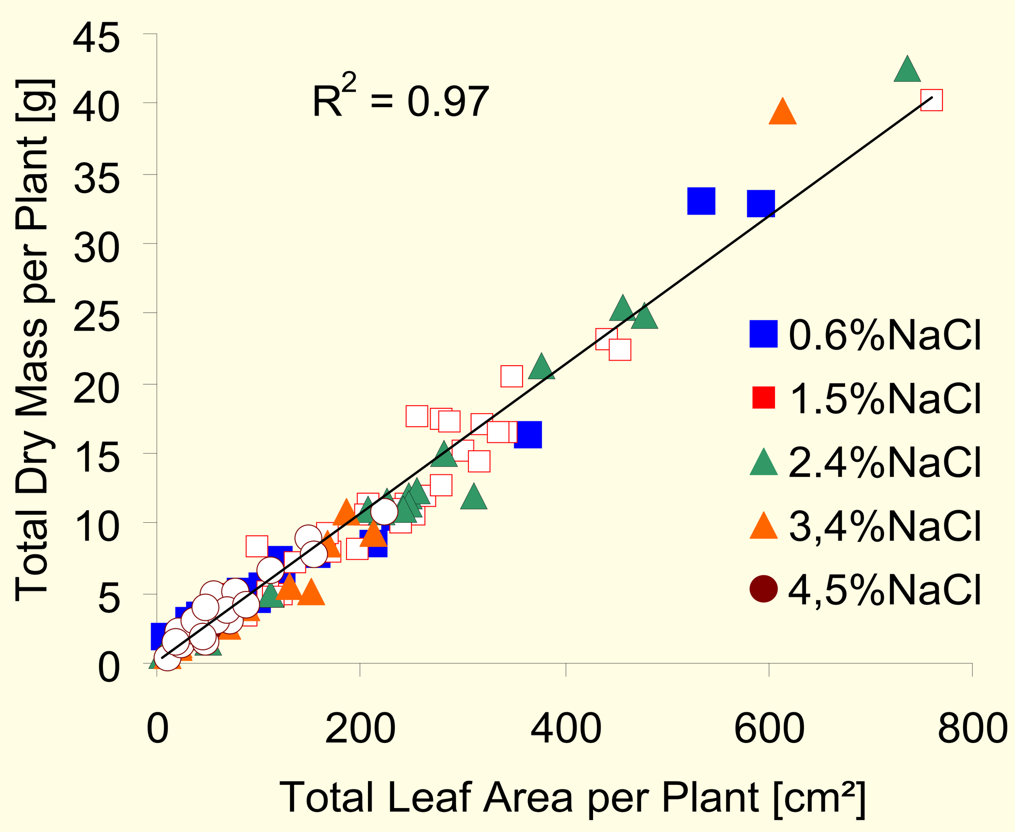

Fig. 3: Correlation between plant dry mass and leaf area (all salinity levels are included).

area. After twelve month the plants were harvested. Growth parameters (dry mass, leaf area, root/shoot ratio, leaf mass area (LMA)) were determined.

Tab. 1: Mean values of measured parameters with standard deviation (SD).

	units	0.6%	SD	1.5%	SD	2.4%	SD	3.4%	SD	4.5%	SD
dry mass	g	8.79	9.48	14.13	9.43	11.92	10.32	6.06	8.57	3.93	2.74
leaf area	cm²	169	173	258	157	232	183	113	134	70	54
root/shoot		0.31	0.15	0.36	0.14	0.35	0.18	0.25	0.16	0.27	0.11
leaf mass area	$g\ m^{-2}$	182.9	19.9	175.5	13.7	175.6	13.5	183.6	16.8	186.8	19.6
transpiration rate	$mmol\ m^{-2}\ s^{-1}$	3.4	0.6	3.2	0.9	3.0	0.5	2.9	0.9	2.5	0.9
net assimilation rate	$\mu mol\ m^{-2}\ s^{-1}$	9.9	1.8	10.0	4.3	8.6	1.9	7.9	2.6	6.6	2.4
stomatal conductance	$mmol\ m^{-2}\ s^{-1}$	84.3	20.1	81.9	29.5	71.1	13.0	67.7	23.0	61.1	27.4
V_{cmax}	$\mu mol\ m^{-2}\ s^{-1}$	80.2	23.2	75.5	34.3	70.9	23.5	68.8	30.8	43.6	18.8
J_{max}	$\mu mol\ m^{-2}\ s^{-1}$	96.1	25.0	99.7	39.7	95.3	29.3	84.7	31.7	47.0	23.4

Literature

[1] Ball, M.C. 1988. Salinity Tolerance in the Mangrove *Aegericas corniculatum* and *Avicennia marina*. Water Use in Relation to Growth, Carbon Partioning, and Salt Balance. *Aust. J. Plant Physiol.* 15: 447-464

[2] Farquhar, G. D., von Caemmerer, S., Berry, J. A. 1980. A biochemical modell of CO_2 fixation of C3 Species. *Planta* 149: 178-190

[3] Munns, R. 1993. Physiological processes limiting plant growth in saline soils: some dogmas and hypothesis. *Plant Cell Environm.* 16: 15-24

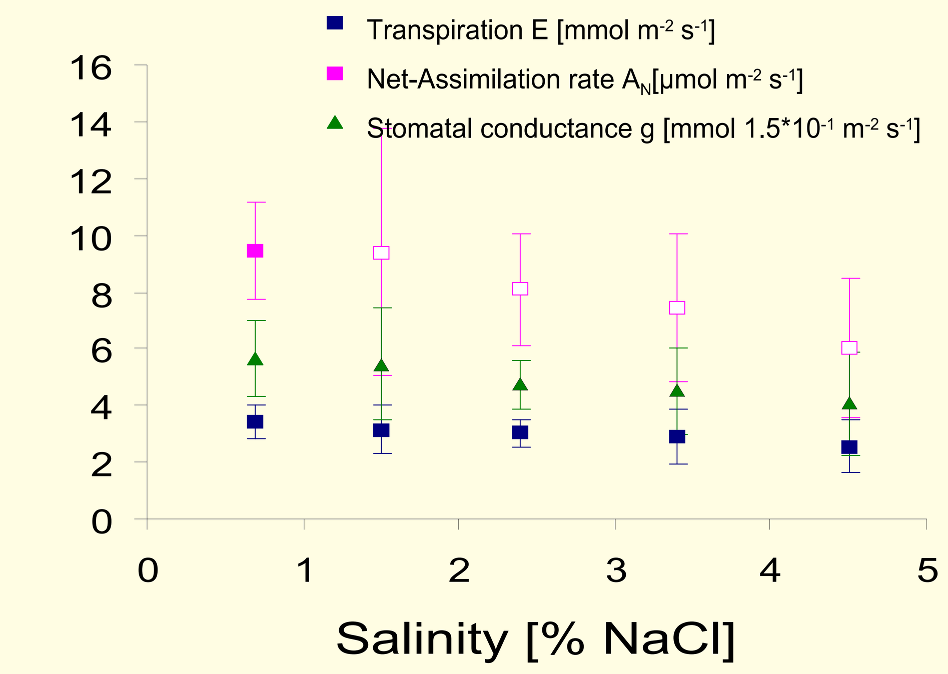

Fig. 4: Mean values of gas exchange parameters (net-assimilation rate, transpiration and stomatal conductance) at ambient CO2-concentration (350ppm) of *Avicennia marina* at different salinity levels (PPFD>1400µmol m^{-2} s^{-1}, T_{Cuv}=25°C, VPD=1,8kPa).

Results and Discussion

The plants showed optimum growth at a salinity of 1.5% NaCl. A significant decrease in dry mass was found at 0.6% and 4.5% NaCl (Fig.2). The relation between plant dry mass and total leaf area stayed constant in all treat-

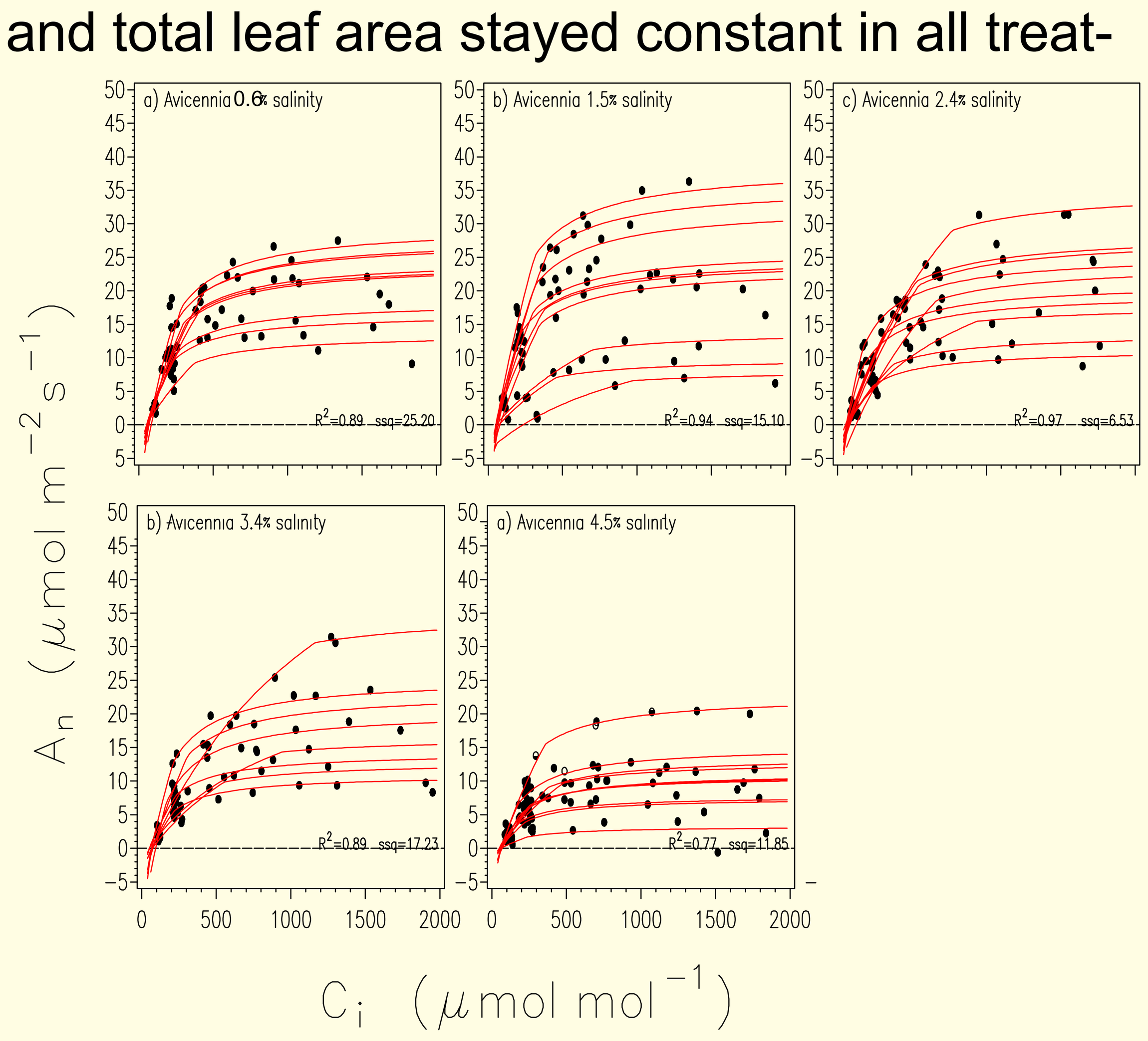

Fig. 5: A/Ci curves measured at different salinity levels (PPFD>1400µmol m^{-2} s^{-1}, T_{Cuv}=25°C, VPD=1,8kPa). The maximum rate of carboxylation (V_{cmax}) and the maximum rate of elektron transport (J_{max}) were calculated by the parameters of the curves

ments (Fig.3) LMA changed not significant. Apart from a significant increase in fine root mass at highest salinity it was found no significant differences in the relations between plant organs. At ambient CO2-concentration the rates of net-assimilation and transpiration changed not significant between the treatments, also there was a tendency in decreasing at high salinity. This was caused by a decline of stomatal conductance (Fig.4). At 4.5% NaCl V_{cmax} was hardly affected but J_{max} declined significantly. It can be concluded, that the reduction in growth at high salinity is not caused by reduction in photosynthetic capacity. This is in agreement with other results [3, and see literaure cited there]. As a result of acclimatisation to higher salinity the "leaf area efficiency" remained constant.