耶鲁大学-南京信息工程大学大气环境中心

Yale-NUIST Center on Atmospheric Environment

Freshwater angiosperm carbon concentrating mechanisms: processes and patterns

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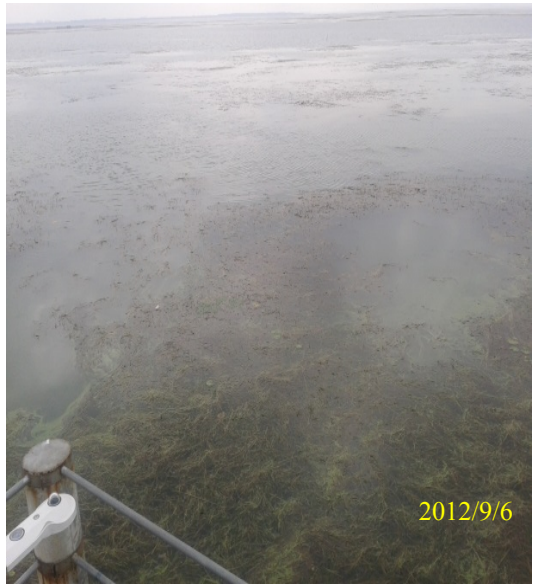
What are these plant carbon concentrating mechanisms?



Outline

- Background
- Objective
- Results
- Structural and morphological features
- Physiological and biochemical features
  (1.CAM 2.C_4 3.HCO_3^-)
- Conclusions
- Discussion

1.Background

CAM plant

Lobelia
HCO_3^-

水网藻
c4

1.Background

- Aquatic angiosperms are derived from terrestrial ancestors and appear to have re-invaded water on many occasions. (Maberly)

- While removing problems of water supply and reducing the need for supporting tissue, freshwaters have a potentially low and fl uctuating supply of CO_2 for photosynthesis, as well as generally low light.

- As we known rates of CO2 diffusion in water are ten thousand times lower than in air, and diffusive transport can be a major limitation of macrophyte photosynthesis (Raven 1970). In many waters, particularly productive lakes, rapid photosynthetic uptake of inorganic carbon can reduce surface concentrations of CO2 close to zero.(Maberly 1996)

2.Objective

- This paper will review published work and present new information on the structural, morphological, physiological, and bioche-mical features of fresh water macrophytes in the context of maximising net carbonuptake, and will discuss how inorganic carbon may influence macrophyte ecology.

3.Results

3.1 Structural and morphological

- Macrophytes in relatively shallow water can obtain co_2 from the atmosphere via aerial or floating leaves

- They possess a cuticle ,stomata and sub-face stomata cavities ,epidermal cells with-out chloroplasts ,and several layers of mesophyll cell with chloroplasts.

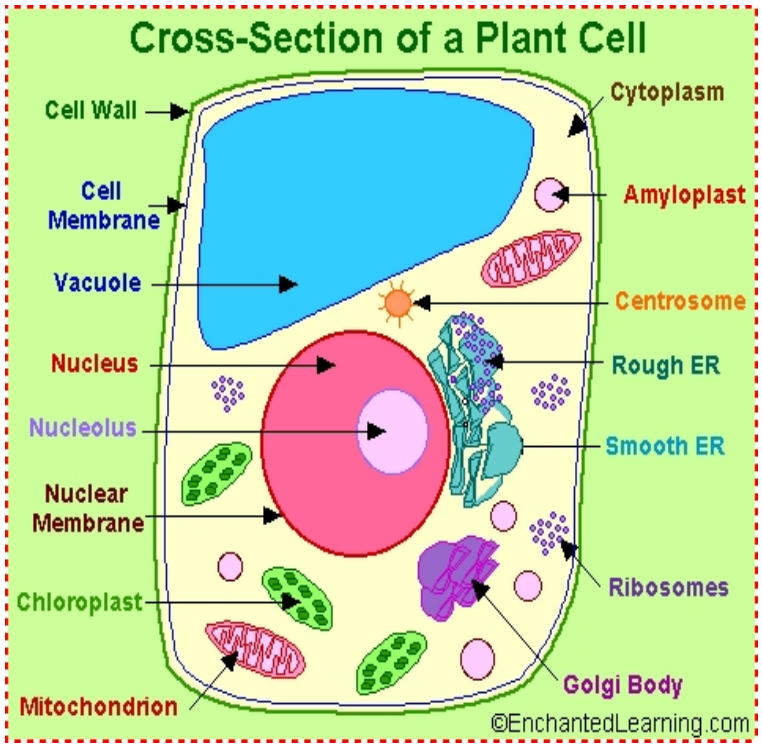
- Possession of roots became necessary by the evolution of ter-restrial homiohydric tracheophytes.

3.1 Structural and morphological features

- The morphology of submerged leaves often consist of two layers of cells，with chloroplasts in both layers.

- This feature can deficit lack of water, and it also reduces self-shading in a generally low-light environment

- Moreover,this feature can make better use of carbon supply.



(from *Wiki*pedia)

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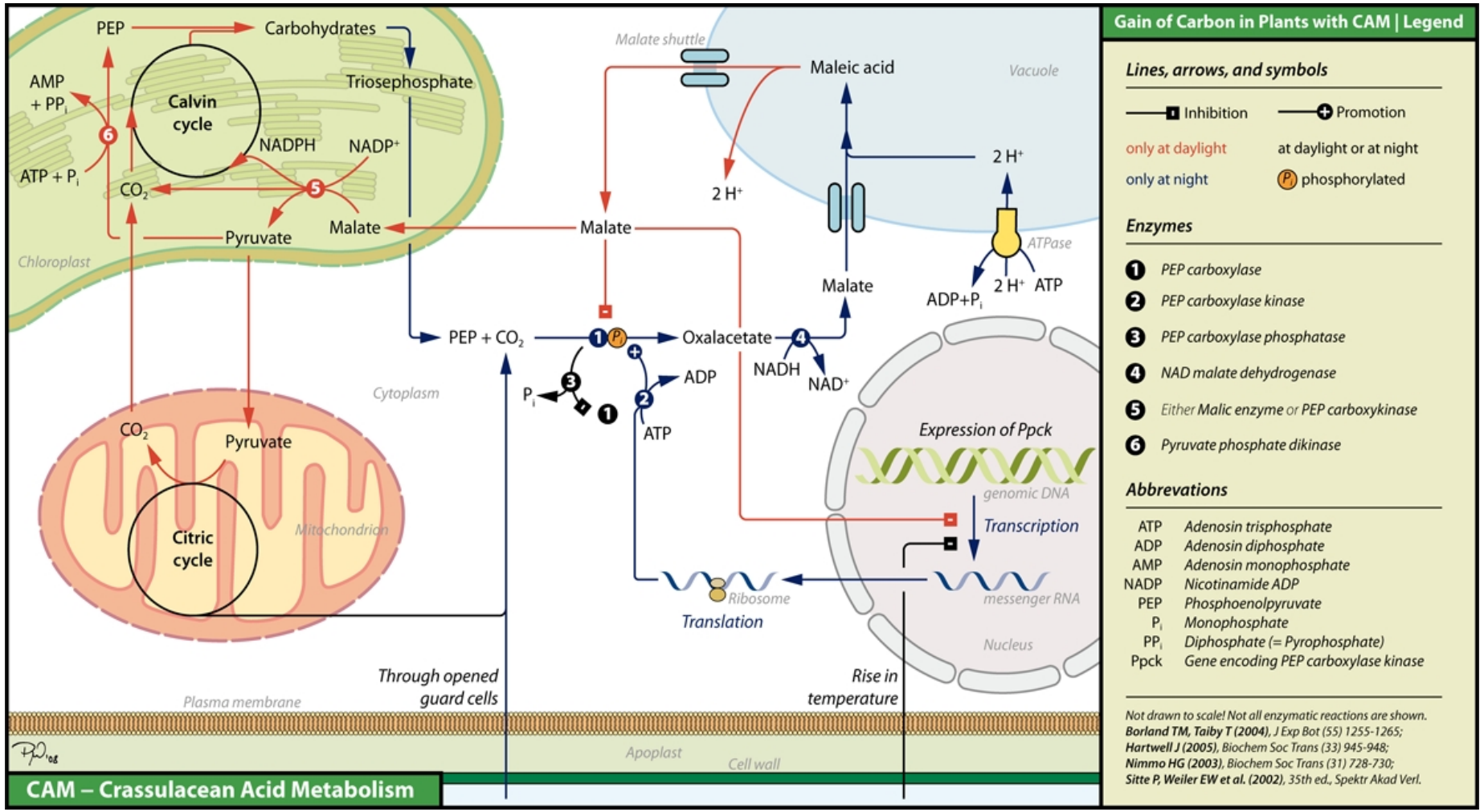
3.2.1 crassulacean acid metabolism

- CAM(crassulacean acid metabolism)
- CAM is now known in four other genera of aquatic vascular plants: Crassula, Littorella, Sagittaria and Vallisneria.
- CAM isoetids take up inorganic carbon in the dark and fix this to form malate.

CAM process and patterns



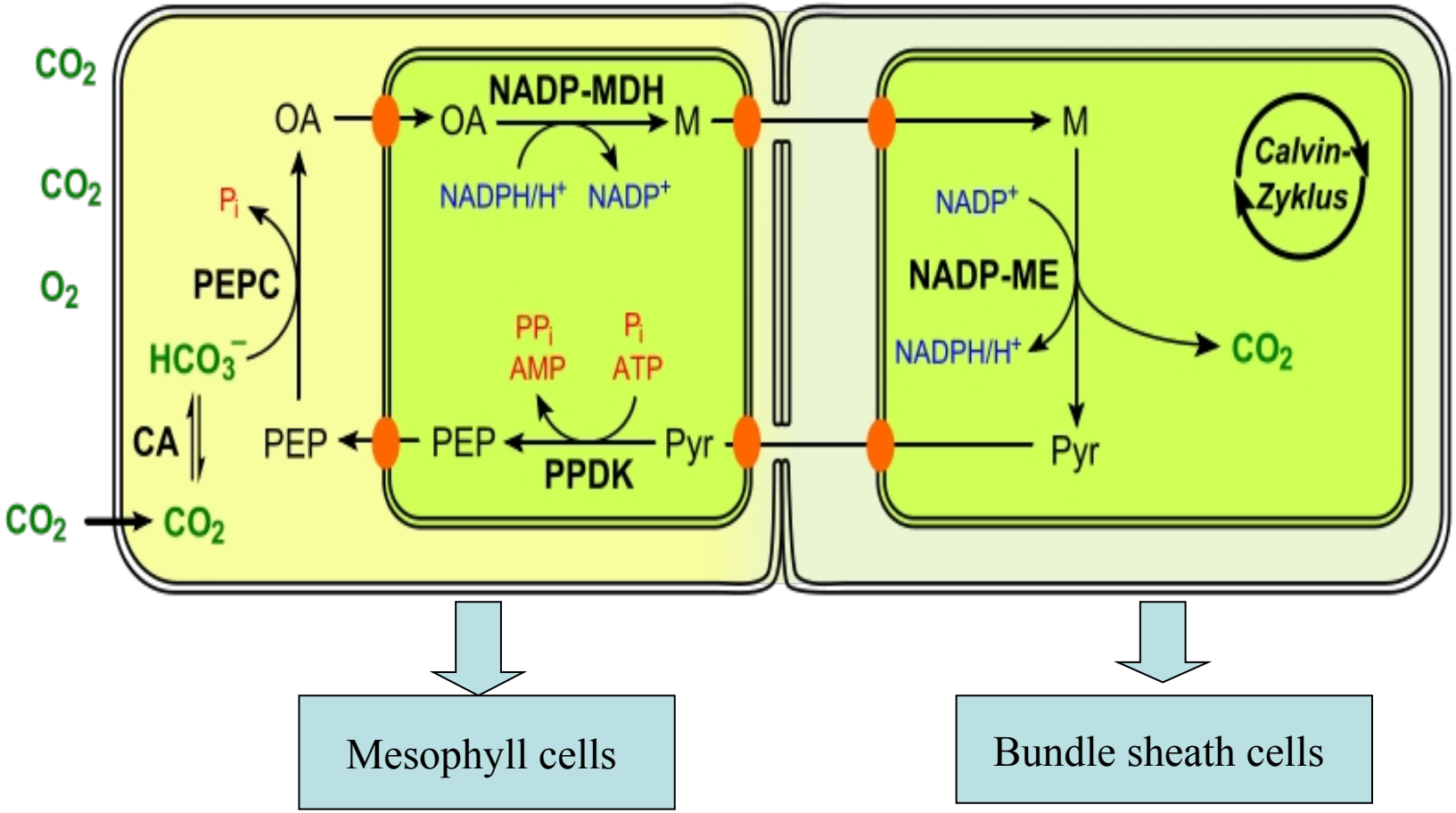
- (Crenim at en.wikipedia)

3.2.1 crassulacean acid metabolism

- CAM features

- CAM isoetids take up inorganic carbon in the dark
- CAM photosynthetic rate is very low
- CAM is strong ability to adapt to the environment

3.2.2 C_4 process and patterns



- (by Yikrazuul)

3.2.2 C_4 process and patterns

- C_4 process

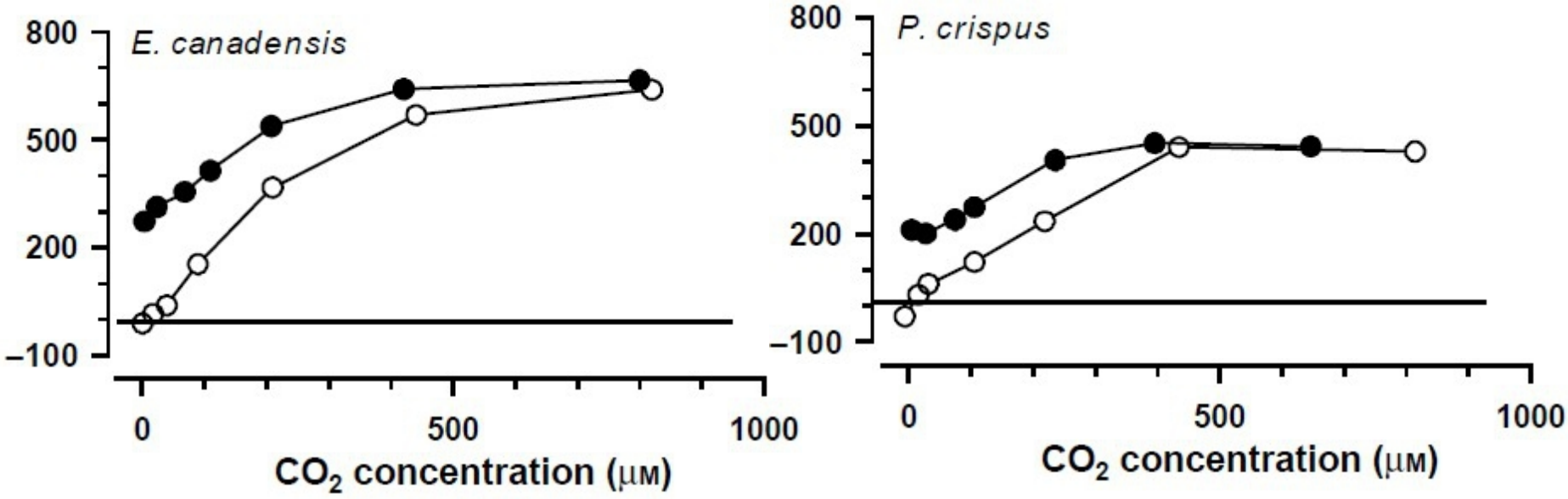
1. Carboxylation reactions
2. Reduction reactions
3. Decarboxylation reactions

- Features

1. low rate of photorespiration
2. low CO2 compensation point
3. High CO2 Saturation point
4. High rates of photosynthesisi

3.2.3 Physiological and biochemical features to maximise net carbon gain

- HCO_3^- use
- Among the CCMs found in aquatic macrophytes, the ability to use HCO_3^- in photosynthesis is by far the most widespread in both marine and freshwater habitats.



3.2.3 Physiological and biochemical features to maximise net carbon gain

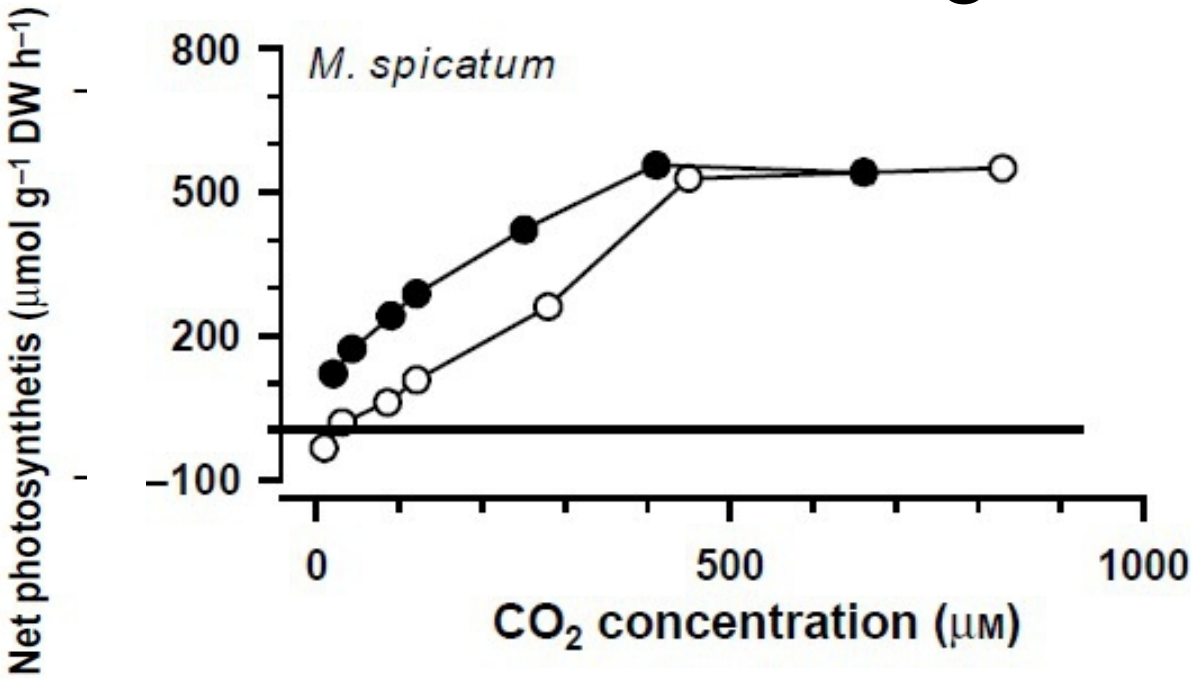
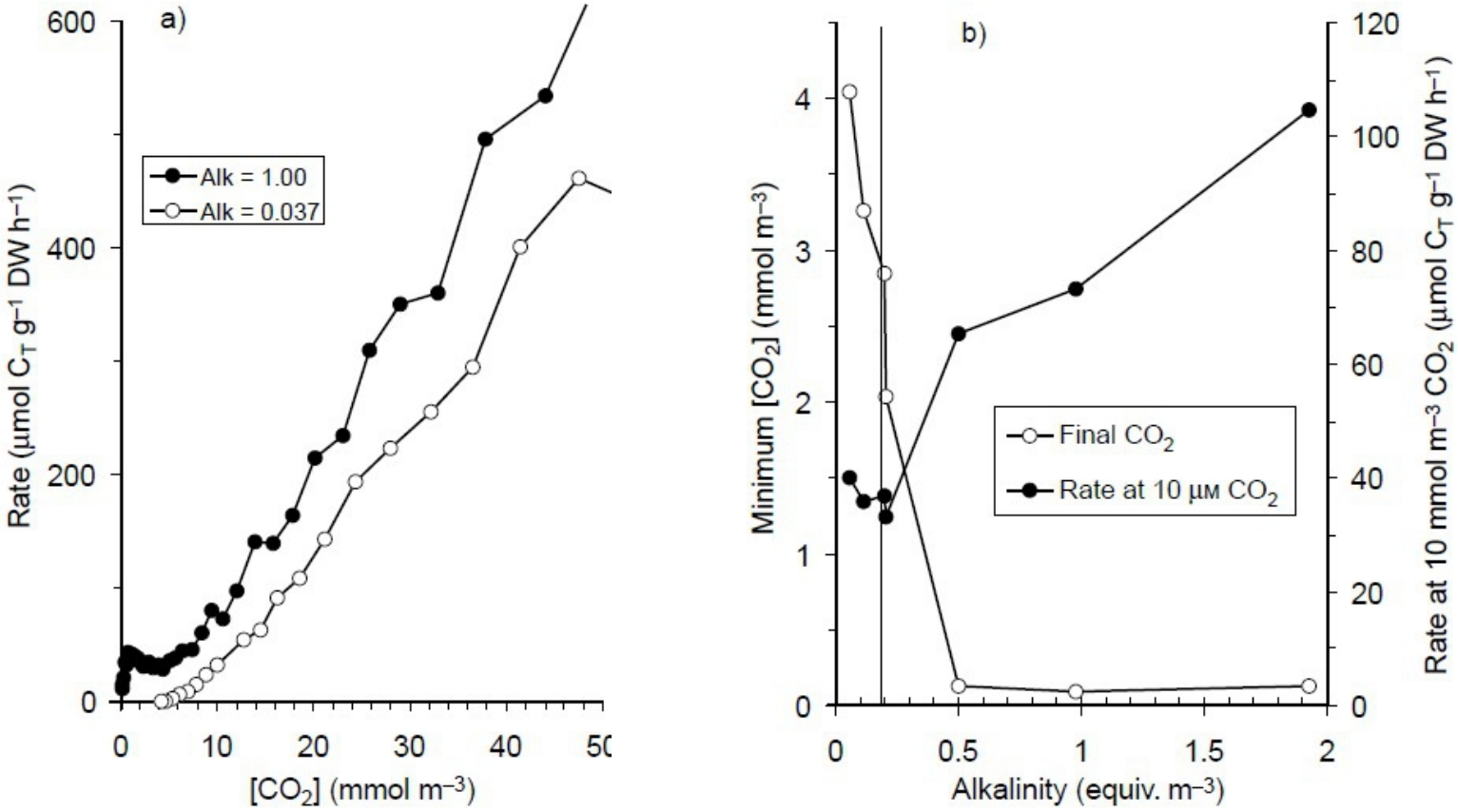


Fig. 1. Rates of photosynthesis in *Elodea canadensis*, *Potamogeton crispus* and *Myriophyllum spicatum* as a function of CO_2 concentration at 0.1 mol m^{-3} HCO_3^- (○) and 1.0 mol m^{-3} HCO_3^- (●). Photosynthesis was measured as oxygen exchange at 15°C and an irradiance of 600 μmol photon m^{-2} s^{-1} (400–700 nm).

3.3 Plasticity of morphological and physiological response in relation to carbon supply

- Response of Myriophyllum alterniflorum at low ALK sites to HCO_3^- at 20℃ and 500 umol photon $m^{-2}s^{-1}$



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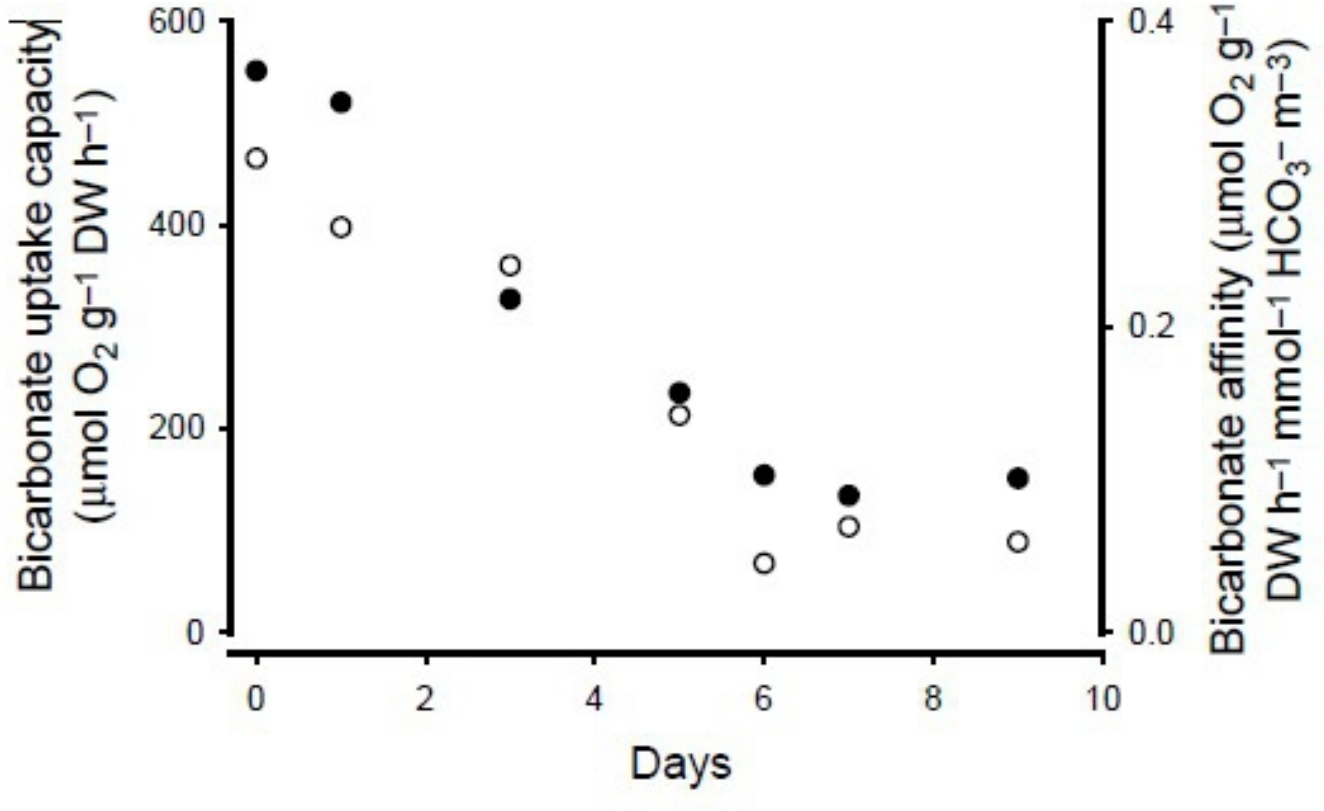

Fig. 3. Response of HCO_3^- affinity (o) and HCO_3^- uptake capacity () for *Potamogeton crispus* to changes in CO2 availability.

3.3 Plasticity of morphological and physiological response in relation to carbon supply

- Plants show marked allocation plasticity or acclimation in response to growth conditions.

- Plasticity is believed to be a response that maximizes resource capture and optimizes resource allocation within the plants

- Within a species, plasticity in carbon affinity in response to environmental conditions is a common phenomenon resulting in changes in all key photosynthetic traits

4.Conclusions

- Freshwater angiosperm access to atmospheric co_2 , obtaining co_2 from the sediment via roots or near the sediment surface.

- The strategies adopted varies with ecological conditions,and as a result there is a link between the distribution of macrophyte species and carbon availability at a site.

- Angiosperms suggests that many of the carbon acquisition features have evolved more than once.

5.Discussion

- What is the influence of the freshwater angiosperm carbon concentrating mechanisms to the lake ecosystem.

- Angiosperms death have what kind of impack on the lake ecosystem.

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Thanks !