

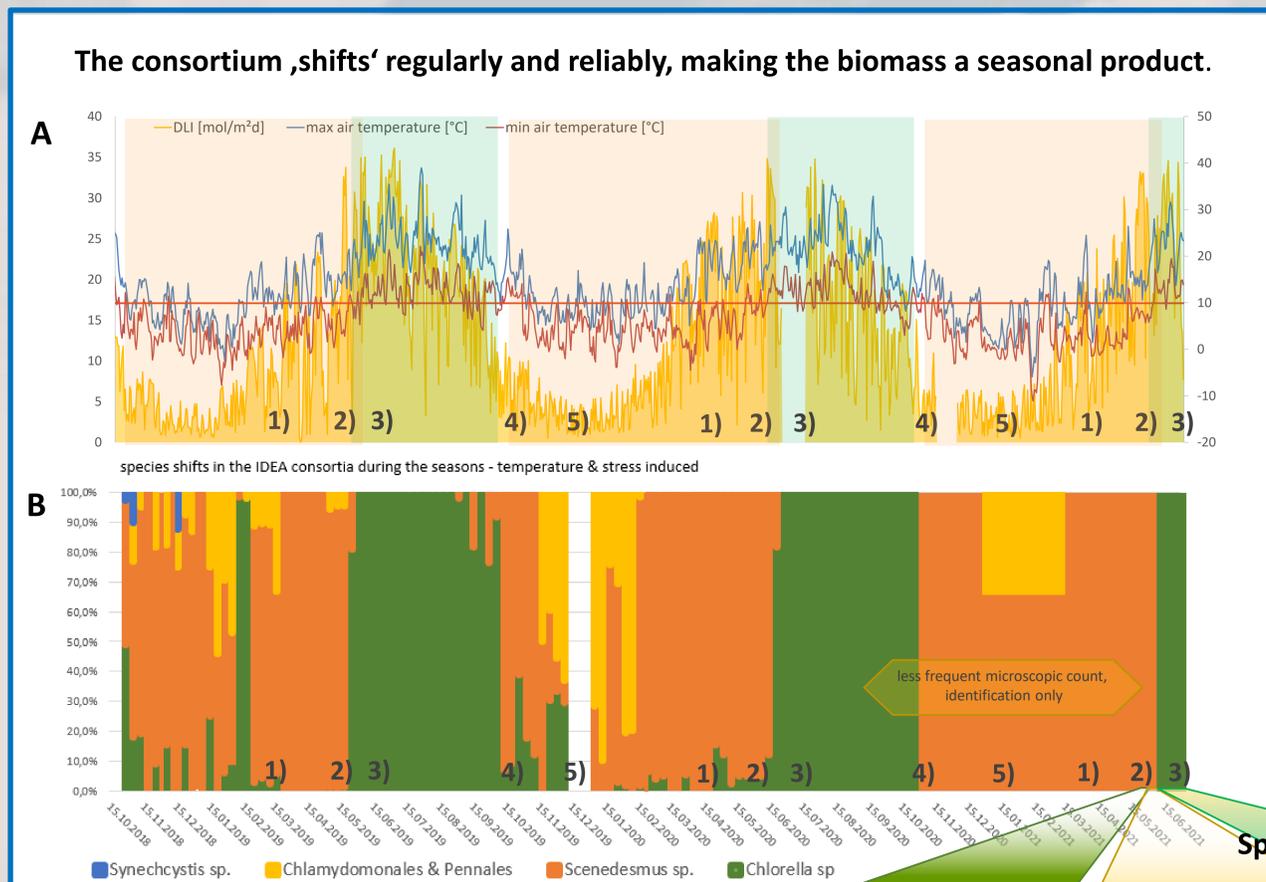
# ALGAE BIOMASS AS A SEASONAL PRODUCT - YEAR-ROUND PHOTOTROPHIC ALGAE PRODUCTION IN NWE

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This consortium proposed and tested for a year-round production consists mainly of *Scenedesmus* sp., *Chlorella* sp., and *Chlamydomonales*, *Synechocystis* and Pennales like *Nitzschia*; and the accompanying bacteria. It has developed a high biological buffer capacity and can deal with stressful situations (aka German weather in a non-airconditioned greenhouse and outdoors), by promoting the respective strongest contributor.

After a first year (2018) of monitoring reliable growth, 2019 started with regular harvesting (e.g. remove 90% of the culture upon reaching a density OD<sub>735</sub> of 2, then replenish with medium). This resulted in the same reliable growth, but purer cultures, since the faster growing species are favoured then; and a strongly increased productivity.



Species shift follows microclimate patterns:

- 1) *Chlorella* is generally more competitive than *Scenedesmus* at higher temperatures – but outdoor min temperature below 10 and insufficient light keeps them from taking over.
- 2) Conditions need to be stressful for *Scenedesmus* to yield: high light and high temperature precede the shift.
- 3) *Chlorella* takes over, bacteria and grazer load rises with *Scenedesmus* retreat. *Chlorella* makes up for grazer pressure with higher growth rates in summer
- 4) Receding light (DLI<15) and falling temperatures hamper *Chlorella* and promote *Scenedesmus* again.
- 5) Winter sees *Chlamydomonales* when *Scenedesmus* growth is lowest.

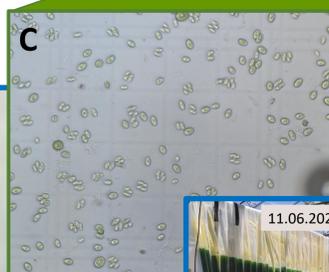
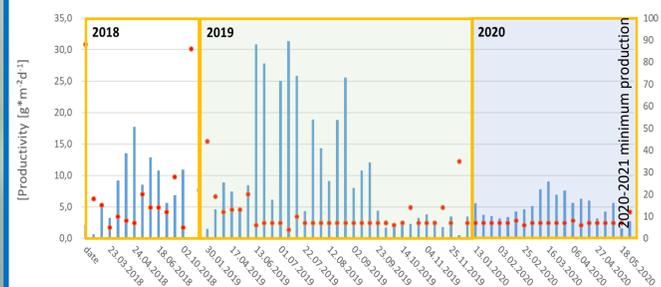
Fig. 1: climate data (A) and species composition as determined via microscopy analysis (B) C-D-E: culture during a species shift in June 2021. Scenedesmus dominated culture (C), bleached culture with dead scenedesmus cells, grazers and few Chlorellas (D), and the emerging Chlorella culture (E).

More possible and feasible uses of thus-derived biomass need to be determined!

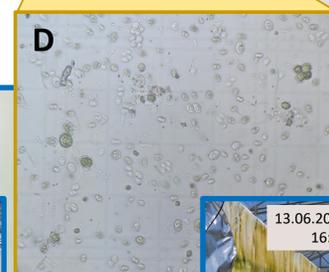
Productivity averaged over 2018-19 (incl. winter) to **13 g/m<sup>2</sup>d**.

The summer months May-September averaged over all cultures between **25 and 32g/m<sup>2</sup>d** with peak values of **60 g/m<sup>2</sup>d**.

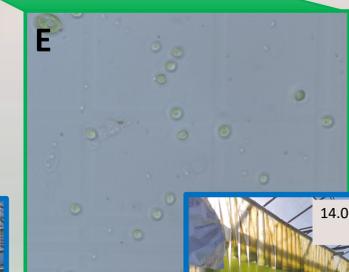
Over **June 2021** the culture average productivity was **100.4 g/m<sup>2</sup>d** (prolonged perfect weather period and improved pH-regulating CO<sub>2</sub> supply).



11.06.2021  
Night min temp goes back down to under 10°  
Day temp can go as far up as 42°C in the culture medium;  
Additional light stress then promotes *Chlorella* takeover.



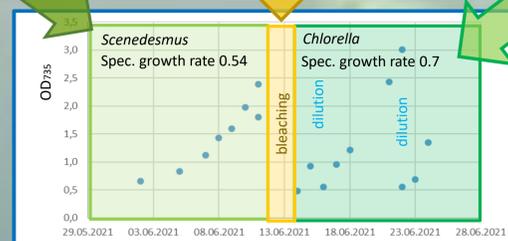
13.06.2021 16:00  
Dead *Scenedesmus* cells, bacteria and the occasional *Chlorella*; at >42°C water temp (50°C peak air temp) and high light, the algae are completely bleached.



14.06.2021 11:00  
Only several hours later *Chlorella* starts into its exponential growth phase. After a dilution step, an almost pure *Chlorella* culture continues.

Avg spec. growth rate 06/2021:  
*Scenedesmus* 0.307  
*Chlorella* 0.337.  
Max spec growth rate 06/2021:  
*Scenedesmus* 0,909  
*Chlorella* 0,987.

Rates were measured at different days, at a DLI of 23 resp. 25, and a max outdoor temp of 21,8°C resp. 21,9°C  
→ the shift requires a stress event.  
→ The local *Scenedesmus* is very heat/light tolerant.



The biomass was supplied to the project partners for further processing; the very same algal consortium culture since 2017 is still in use today.

