

Different outdoor performance of three *Phaeodactylum tricornutum* strains under western Norwegian climate conditions

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Microalgae could provide a sustainable alternative for fish oil as a source for the omega-3 polyunsaturated fatty acids EPA and DHA. However, growing microalgae on a large scale is still more cost intensive than fish oil production, and outdoor productivities vary with reactor type, geographic location, climate conditions and microalgae species or strains. We examined the potential of the climate conditions in Bergen, western Norway for outdoor cultivation and EPA productivity of the diatom *P. tricornutum* in flat panel photobioreactors, and compared three different strains of different origin, to evaluate possible strain specific differences.

Cultivation conditions

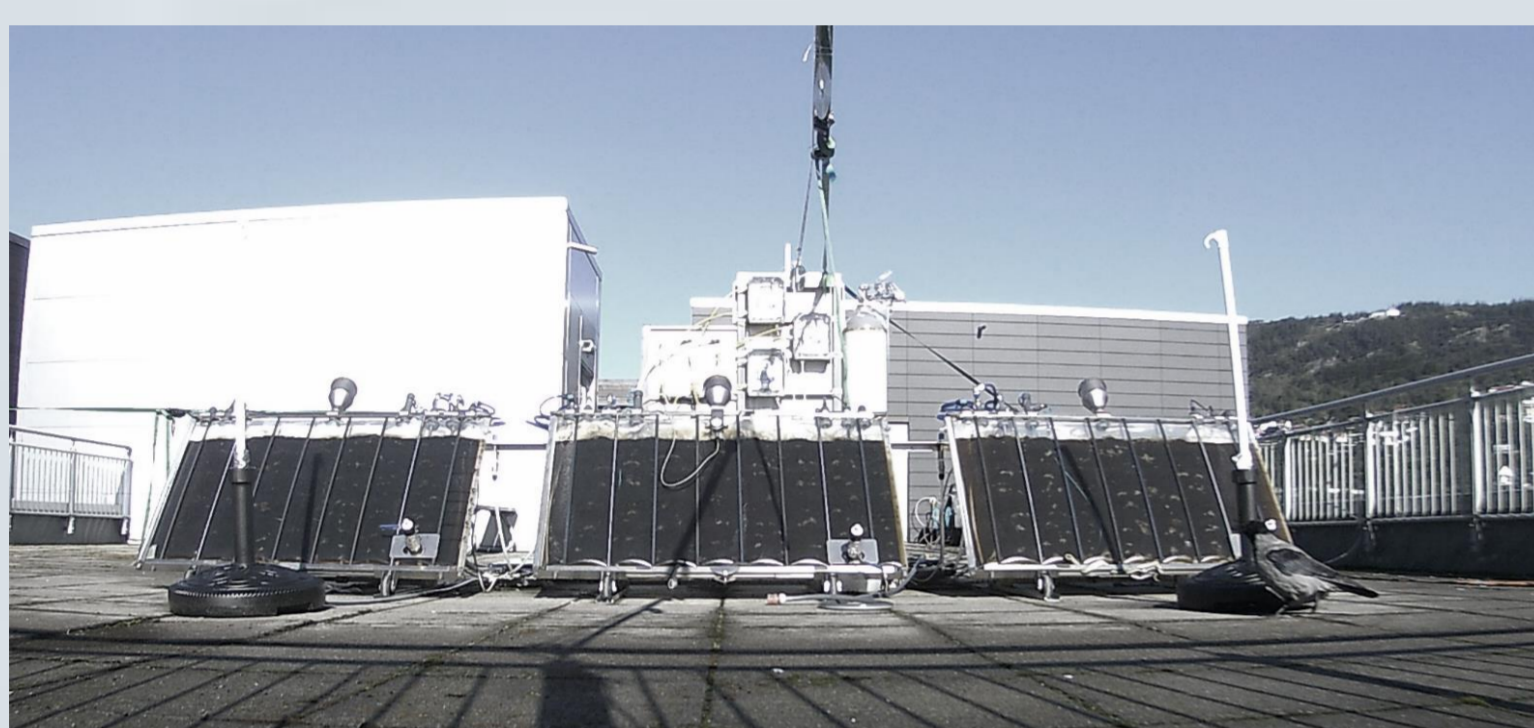
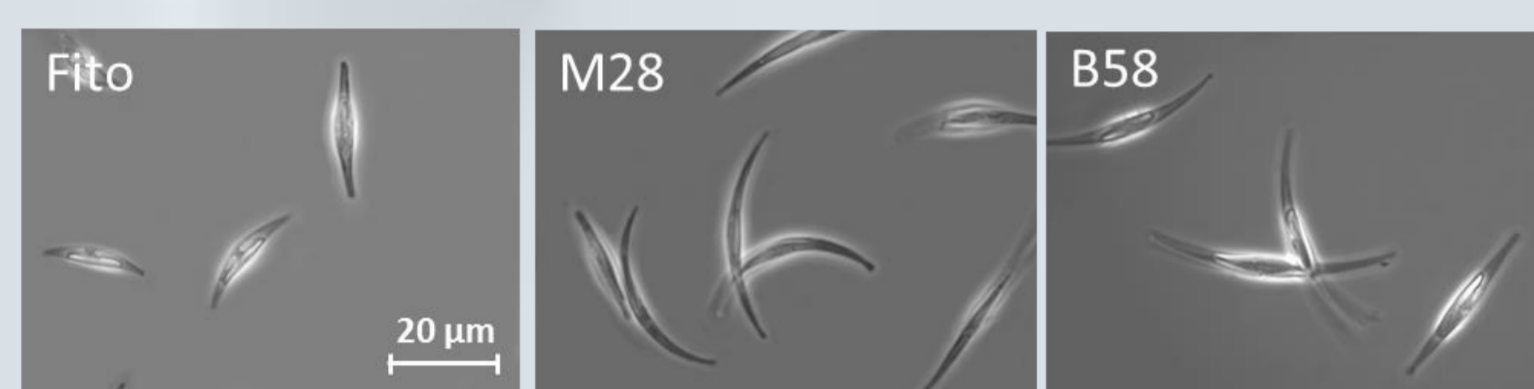


Fig. 1. Three *P. tricornutum* strains (Fito, M28 and B58) were grown in flat panel outdoor bioreactors (GWP-III, F&M S.r.l, Florence, Italy) in Bergen, western Norway (60°22'49.7"N, 5°19'54.3"E) for six month (April-October) in 2016.

- *P. tricornutum* strains Fito, M28 and B58 were grown in flat-panel outdoor photobioreactors in Bergen, Norway (Fig. 1).
- Strains M28 and B58 were isolated from local fjords, strain Fito was obtained from Spain.
- Altogether 15 repeated batches were conducted during spring, summer and autumn 2016 (Fig. 2A).
- Dry weights and fatty acids were analyzed every 2. or 3. day.
- Weather was sunny in spring & autumn but rainy & cloudy during summer, with strong changes in day length (Fig. 2B).
- Irradiance and temperature fluctuated significantly (Fig. 2B&C).

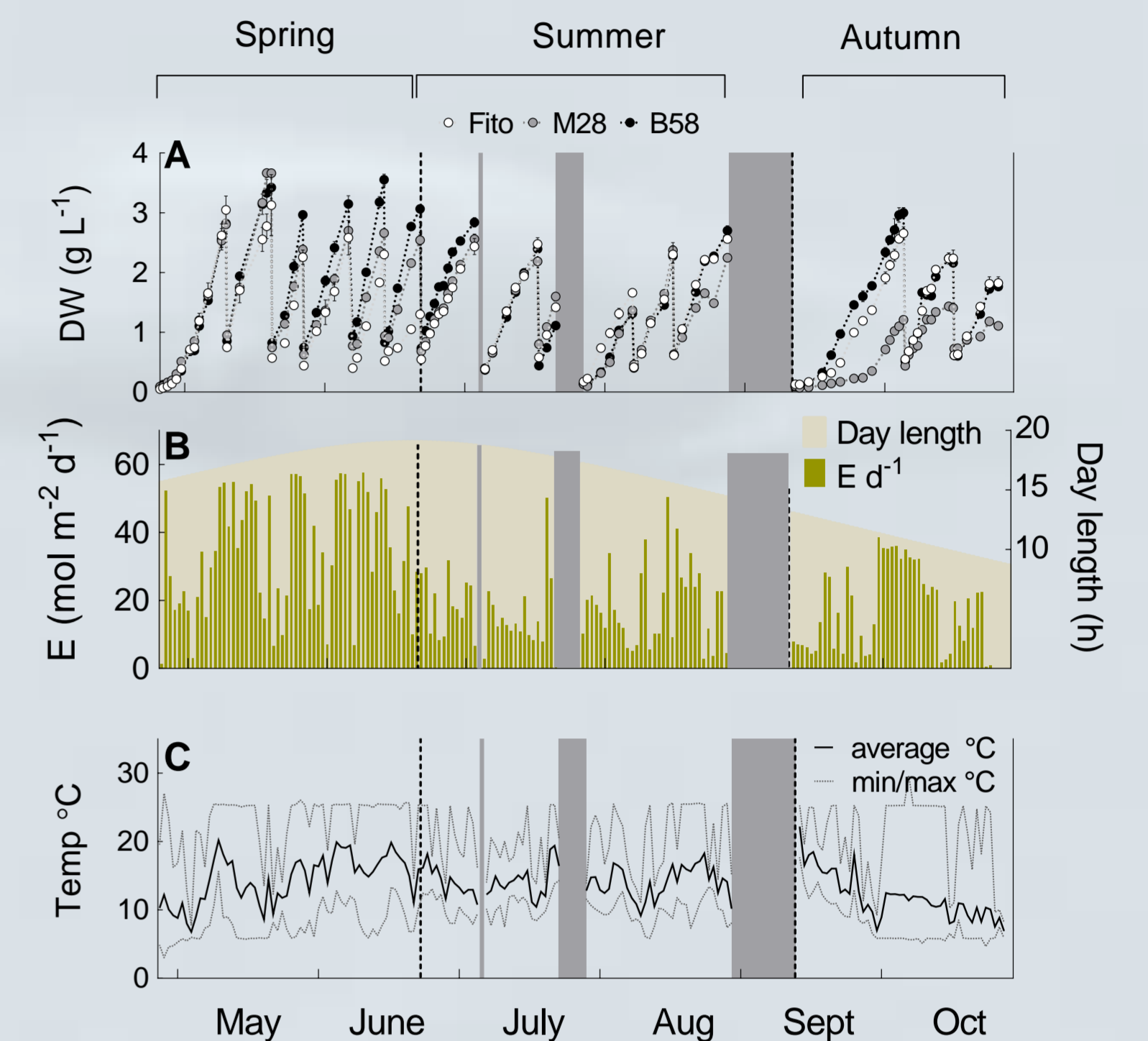


Fig. 2. A: Dry weight (DW) concentrations of repeated batches of the three *P. tricornutum* strains Fito, M28 and B58. B: Daily-integrated irradiance (E) and day length. C: Daily temperature inside the cultures. Grey bars: interruptions of the cultivation.

Productivities

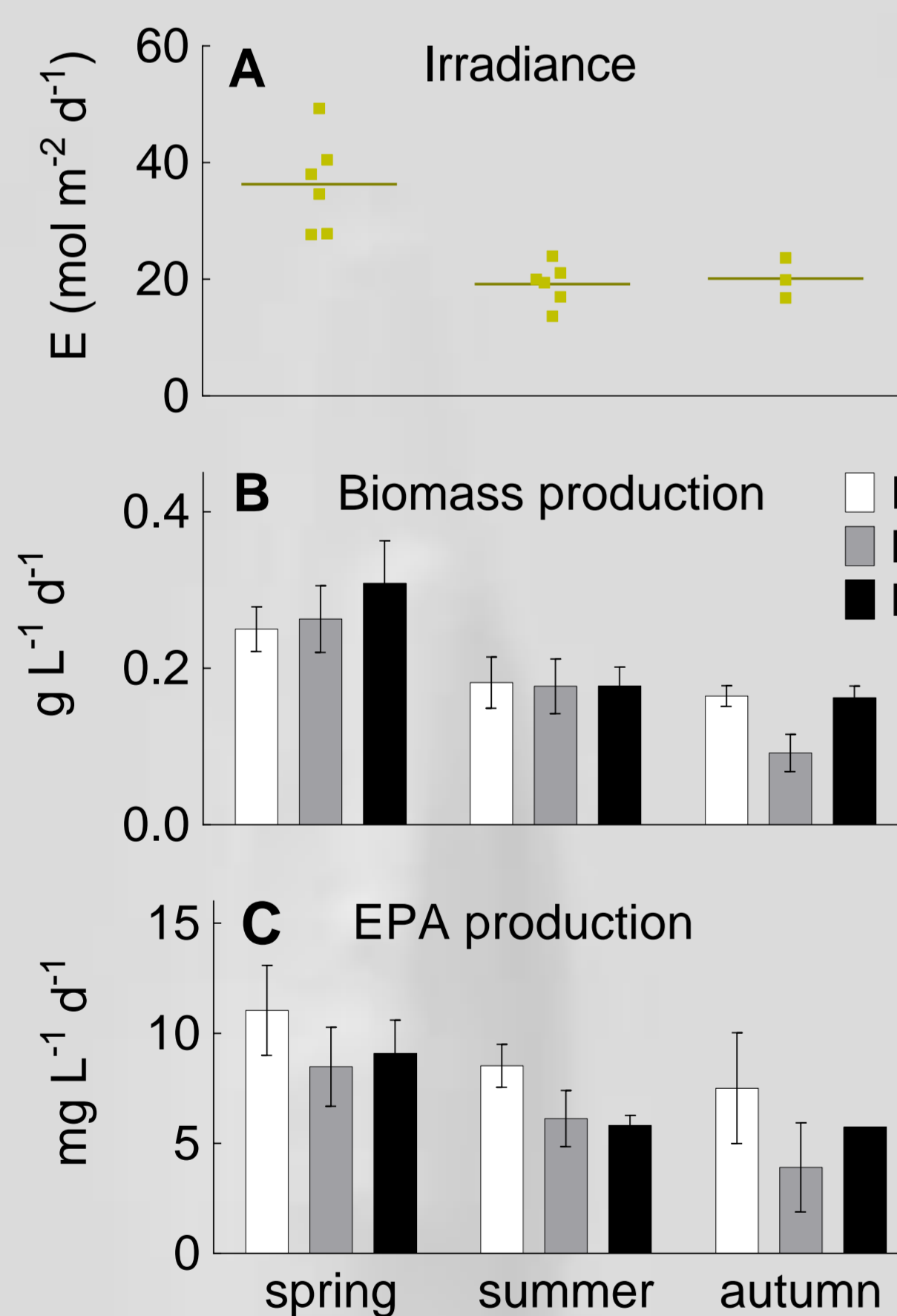


Fig. 3. A: Dots display average daily irradiance during a batch and lines the mean value of the seasons. Values for biomass (B) and EPA production (C) are average and standard deviation from the respective batches of each season.

Differences between seasons:

- Irradiances were higher in spring, resulting in higher biomass and EPA productivities than in summer & autumn.

Differences between strains:

- Strains possessed similar biomass productivities in spring and summer, but M28 had lower productivities in autumn.
- Strain Fito had higher EPA productivity than M28 and B58 in all seasons.

Fatty acid profile

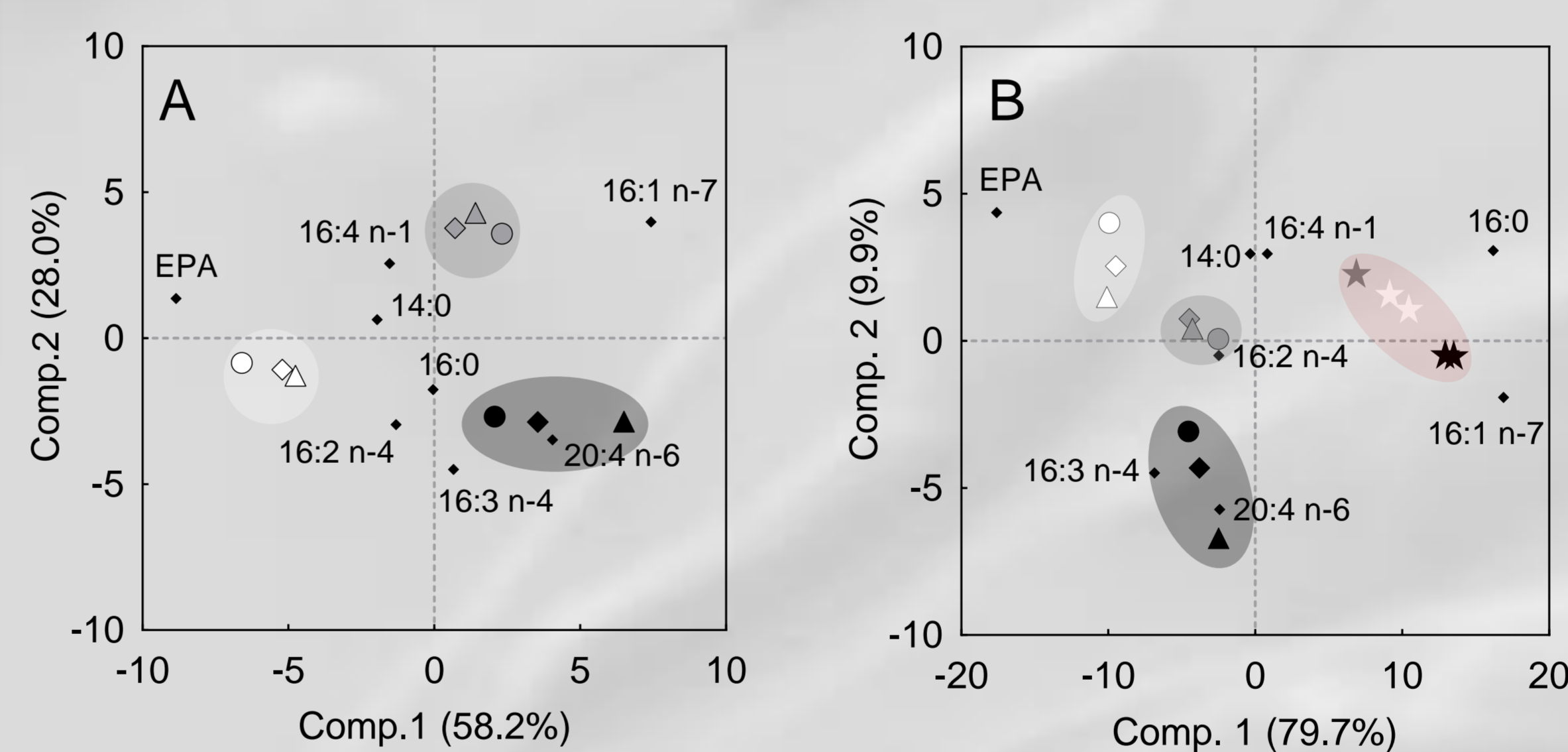


Fig. 4. Principal component analysis of the relative fatty acid composition (%TFA) for three *P. tricornutum* strains. A: Nine objects representing the three strains at the three seasons, and eight variables representing the fatty acids with highest impact on the distribution. B: Same variables and objects as in A, but including additional data from laboratory experiments for each strain.

- PCA of the average seasonal fatty acids composition (%TFA) revealed strain-specific fatty acid profiles and only little influence of the season on the fatty acid composition (Fig 4 A).
- Including data from laboratory experiments revealed significantly different fatty acid profiles between indoor and outdoor grown cultures, and higher EPA content for the outdoor cultures.

Conclusion

- Despite the similar biomass productivities, the Spanish strain (Fito) revealed higher EPA productivities than the local strains M28 and B58, due to an increased EPA content of the biomass. However, this was only apparent with growth under outdoor conditions.
- Total fatty acid profiles were specific for each strain under outdoor conditions, and varied only slightly between the seasons, but changed significantly from indoor to outdoor conditions.