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Comparative effects of temperature and salinity on growth of four harmful *Chattonella* spp. (Raphidophyceae) from tropical Asian waters

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In Asia, four harmful raphidophyte species, *Chattonella malayana*, *C. marina*, *C. subsalsa*, and *C. tenuiplastida*, coexist in the tropical waters but only *C. marina* was detected in temperate waters. This occurrence pattern pointed to a potentially distinct ecophysiological niche occupancy and possible species dispersion. The growth physiology of these species isolated from tropical Southeast Asia was investigated using unialgal cultures in ten temperatures (13.0–35.5°C) and five salinities (15–35) to better understand the factors driving their distribution. The highest maximum specific growth rates were observed in *C. subsalsa* (0.65 ± 0.01 d^{-1}), followed by *C. malayana* (0.47 ± 0.03 d^{-1}), *C. marina* (0.45 ± 0.02 d^{-1}), and *C. tenuiplastida* (0.39 ± 0.01 d^{-1}). Their optimal temperatures were 28.0, 30.5, 25.5, and 30.5°C, respectively, of which *C. marina* preferred colder water. *C. subsalsa* exhibited a wider growth temperature range (20.5–35.5°C), followed by *C. marina* (20.5–30.5°C), *C. tenuiplastida* (23.0–33.0°C), and *C. malayana* (25.5–33.0°C). Optimal salinities were similar between *C. subsalsa* and *C. malayana* (30), and between *C. marina* and *C. tenuiplastida* (25), but *C. subsalsa* and *C. marina* exhibited a similar growth salinity range of 15–35, while *C. malayana* and *C. tenuiplastida* was 20–35. High values of F_v/F_m were observed in *C. subsalsa* and *C. marina* (> 0.5) in all tested conditions, but F_v/F_m of *C. malayana* and *C. tenuiplastida* were significantly lower at 20.5°C. All four species achieved a maximum cell density of > 10^4 cells mL^{-1} in their optimal conditions. Optimal temperatures in *C. subsalsa* and *C. marina* were identical to previous reports. The high adaptability of *C. subsalsa* in various temperatures and salinities suggests its high competitiveness and bloom potential. The high adaptability of *C. marina* in colder waters compared to other species likely contributes to its wide distribution in the temperate Asian