An in vitro analysis of the ecological succession of estuarine protozoa and microalgae

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Abstract

Microalgae are the most abundant populations on Earth and they perform critical ecological services. They play a critical role as primary producers in aquatic food webs, produce half of the atmospheric oxygen, and serve as tremendous carbon sinks. Although microalgae normally fuel productive ecosystems, some can be threatening to other species. The recent high mortality of California sea lions related to domoic acid and a recreational camp closure due to cyanobacterial toxin are examples of harmful algal blooms. To deal with these double-edged sword like organisms, it is critical to have good understanding of their community structures. Although seasonal variations in microalgae are well documented, there is little research on short-time succession and population changes. Moreover, factors regulating species diversity are not well understood for unicellular organisms. This study provides an in vitro analysis of aquatic populations and ecological succession in an estuary over nine weeks. Sediment from Belmont Slough (San Francisco Bay) were transferred to the laboratory. Biodiversity of microalgae and protozoa was analyzed using a Leica DME inverted compound microscope. Population changes over time are reported.

Aim

To examine the diversity of microplankton, their interspecific interactions, and short time ecological succession in an aquatic ecosystem.

Background

- Phytoplankton are primary producers in aquatic food webs (2).
- Microalgae and cyanobacteria produce half of the atmospheric oxygen and play a critical role as a carbon sink (2).
- Blooms of toxic phytoplankton can be harmful to other species (3).
- There may be up to 1 million species of microalgae (5).
- There is little published research on factors regulating microplankton populations and their short-term ecological succession (5, 6).

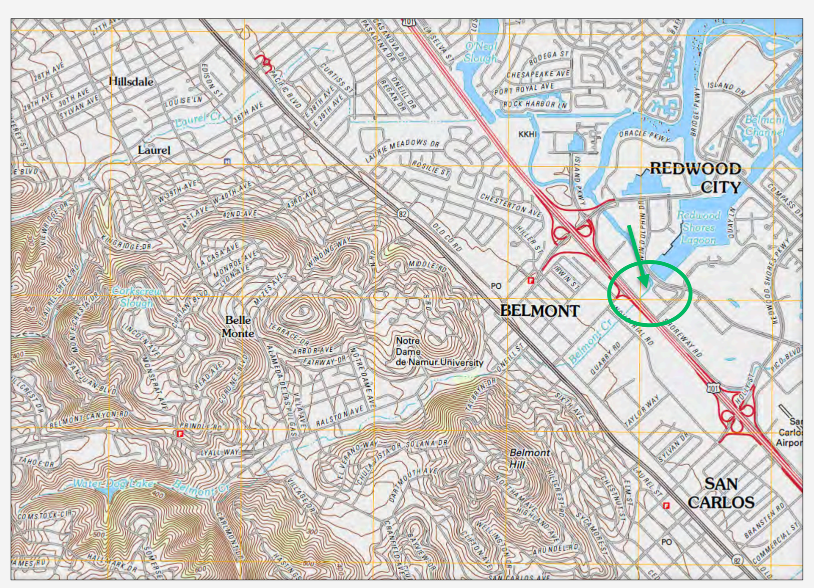

Figure 1. Collection site is on the west side of San Francisco Bay where Belmont Creek mixes with salt water.

Methods

- Water and mud were collected from Belmont Slough (**Figure 1**).
- The collected sample was placed in a microaquarium and incubated at room temperature in an east-facing window (**Figure 2**).
- Daily observations were made using a Leica DME inverted compound microscope. Pictures were taken with an LG G3 smartphone camera.

Figure 2. The microaquarium (Carolina Biological) is 75 × 50 × 4-mm and holds about 5 ml.

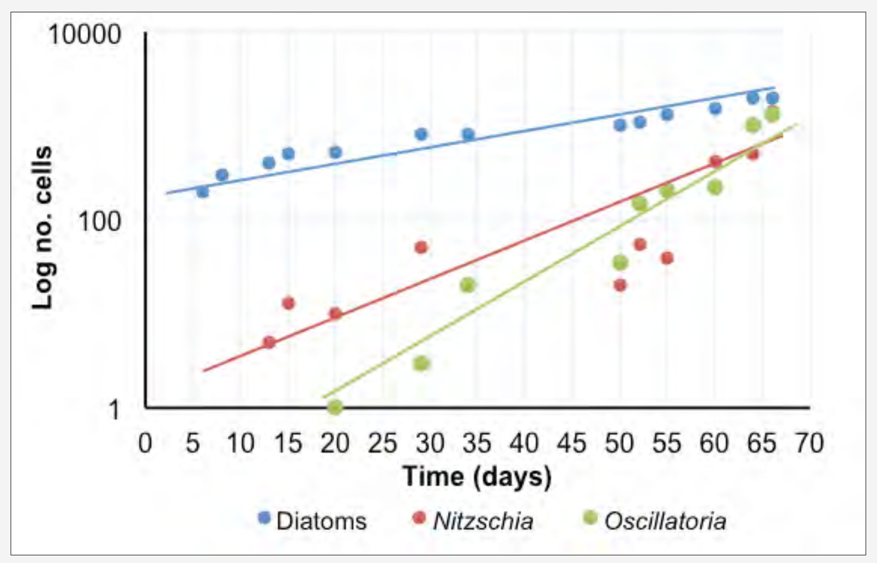

Figure 3. At the beginning, the most abundant phytoplankton were diatoms, primarily *Diploneis*. During week 4, *Nitzschia* and *Oscillatoria* started thriving. Their population became parallel to the total population of other diatoms at the end of week 9.

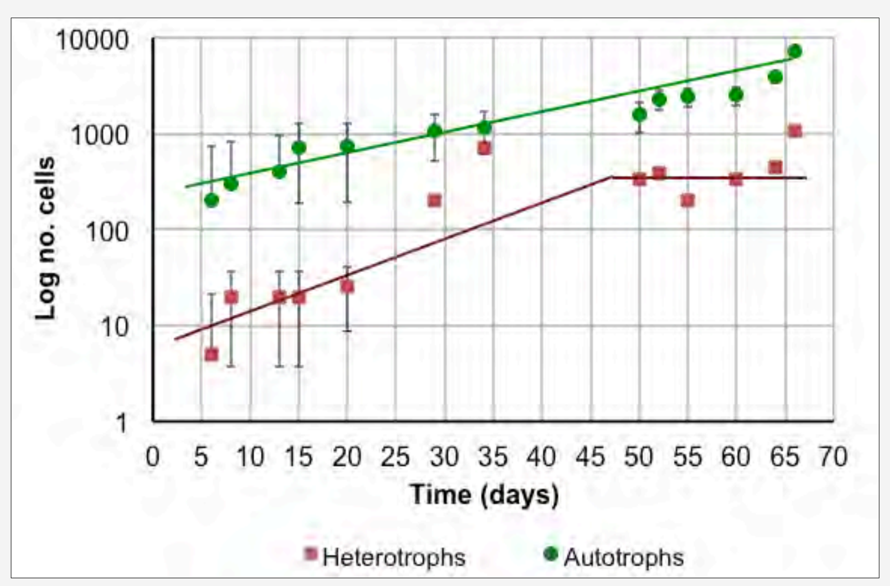

Figure 4. Autotroph and heterotroph population growth over 9 weeks. Error bars = 1 S.D.

Results

- Diatoms and cyanobacteria grew first. *Nitzschia* and *Oscillatoria* were the dominant autotrophs (**Figure 3**).
- The producer population was higher than heterotrophs' over 9 weeks (**Figure 4**).
- Dominant protozoa were *Colpidium, Coleps*, and testate amoeba (**Figure 5**).
- Testate amoeba and *Nitzschia* became the most abundant species after nine weeks (**Figure 6**).

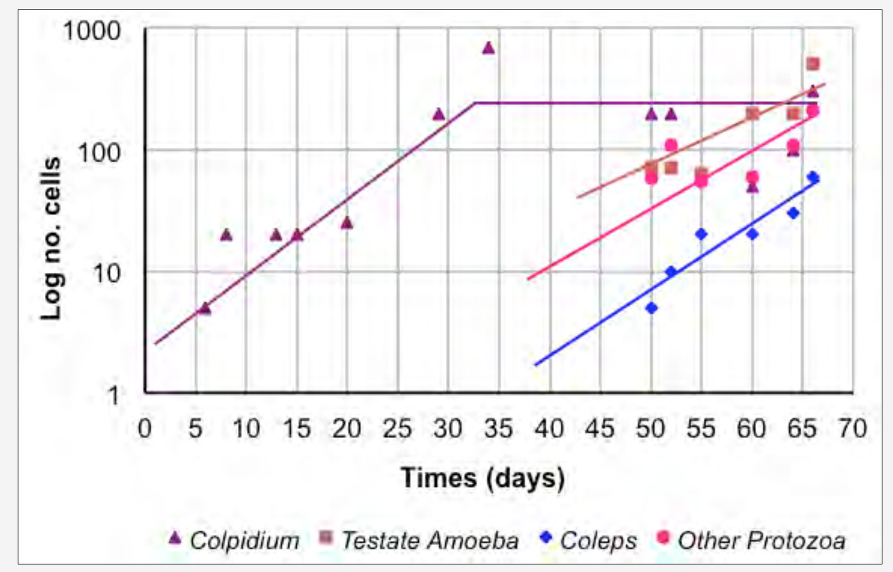

Figure 5. *Colpidium* started growing in the first week. When the population reached stationary phase in week 5, predatory protozoa, *Coleps* and testate amoeba, appeared. Testate amoeba became the highest population on day 66.

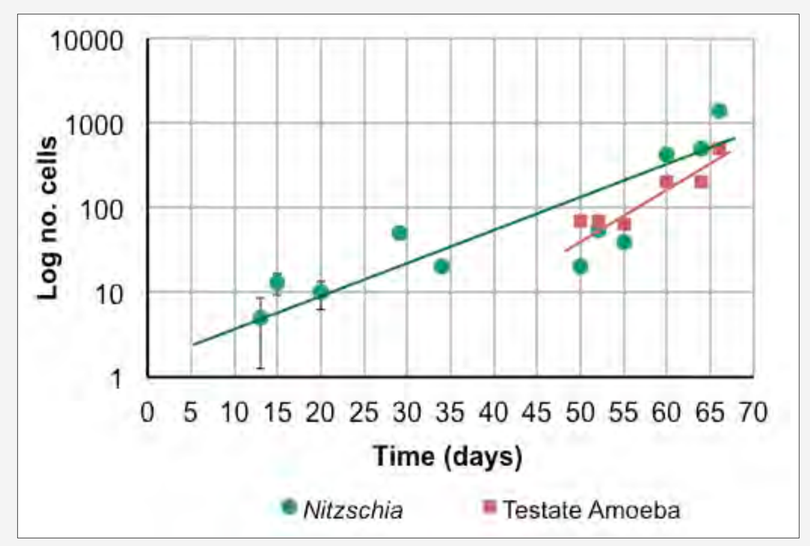

Figure 6. *Nitzschia* grew steadily at about 6.5 cells per day. Testate amoeba began growing at day 39 and continued through day 66, at 5.6 cells per day. Error bars = 1 S.D.

Future Studies

- *Nitzschia* includes several species of diatoms known to produce domoic acid neurotoxin (3). The interrelation between testate amoeba, *Nitzschia* and *Colpidium* can be further studied.
- Do testate amoebae prefer *Nitzschia* over *Colpidium*?
- How will a decrease in *Nitzschia* population affect testate amoeba and *Colpidium* populations?
- How will absence of *Nitzschia* affect testate amoeba population?
- More research should be done on *Nitzschia* species identification, factors regulating its growth and toxin production as well.

Discussion & Conclusion

- Over nine-week observation, producers: diatoms, cyanobacteria and microalgae, grew steadily.
- Consumers or heterotrophs started growing after autotrophs and reached stationary phase at week 6.
- Despite its significant growth rate in early weeks, the *Colpidium* population abruptly reached stationary phase once other protozoa, mainly its predators; *Coleps* and testate amoebae, appeared.
- Among protozoa, testate amoeba became the most dominant species.
- Testate amoeba appears to be favored by fast and continuous growth of its food, *Nitzschia*. As it is also predatory on *Colpidium*, its boom must be a factor of *Colpidium* growth decline.
- *Nitzschia* and testate amoeba were beneficial to each other; the presence of testate amoeba maintained the *Nitzschia* population below the carrying capacity and *Nitzschia* provided food for testate amoebae. This pair became the most abundant species over nine weeks.

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