Title
Protistan Microzooplankton in the Suisan Bay Food Web: Source or Sink?

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Background

Water pollution, habitat loss and freshwater diversion—all these are possible reasons for declines in some fish species in the San Francisco Bay-Delta. Another less investigated cause for the declines may relate to feeding dynamics among protists—single-celled organisms that include photosynthetic algae and animal-like zooplankton.

Project

Gretchen Rollwagen-Bollens was awarded a CALFED Science Fellowship in 2003 to study protists in Suisun Bay in the San Francisco Estuary, their feeding behaviors and feeding rates—who eats whom, how much and how fast. In particular, she examined dietary habitats of a group of larger zooplankton (mesozooplankton) known as copepods and of smaller zooplankton (microzooplankton) called ciliates.

In the classical model of estuarine food web dynamics, copepods are assumed to eat a whole lot of algae. As such, they are placed in the trophic level above algae, the base of the food chain. Perhaps the most significant discovery of this research has been that copepods in Suisun Bay do not follow this pattern. They seem to be “meat lovers,” feeding more heavily on ciliates, as compared to algae of the same size or smaller. In turn, ciliates not copepods are the ones feeding on algae. To the extent that Suisun Bay is representative, the classical model of the estuarine food chain has been missing a trophic level, namely that between algae and copepods, represented by ciliates and other microzooplankton.

Field Studies and Feeding Experiments

The scientist's research conclusions are based on counts of algae and zooplankton in water samples collected monthly and bimonthly (depending on the season) from various parts of Suisun Bay in 2004–05.

Bottle incubation experiments were also conducted to measure feeding rates of various mesozooplankton: a cladoceran (Daphnia sp.), calanoid copepod (Acartia spp.) and two cyclopoid copepods (Oithona davisae and Limnoithona tetraspina) on plankton less than 200 µm in diameter. Microzooplankton feeding rates on chlorophyll-containing algae were also measured.

Results

Nanoplankton (organisms 2 to 15 µm in size) were 10 to 100 times more abundant than microplankton (15 to 200 µm).

Nonetheless, in every experiment, mesozooplankton (200 to 2000 µm) were found to ingest ciliate carbon at the highest rates (3 to 29 nanograms of carbon per hour).

In 2004 the most common microzooplankton (the source of ciliate carbon) were aloricate ciliates (Strobilidium, Strombidium). Aloricate and tintinnid ciliates (Tintinnopsis, Stenosmella) were most common in 2005.

Both years, populations of ciliates peaked in late spring when phytoplankton (as measured by chlorophyll
exceed energy losses, meaning that microzooplankton could actually be a “source” of carbon.

Rollwagen-Bollens plans to continue to investigate whether microzooplankton are adding to or subtracting from the carbon budget. In either case, microzooplankton, especially ciliates, appear to be an important component of the upper San Francisco Estuary food web. Their dynamics, she said, need to be incorporated into biological models that are used, among other things, to estimate fish stock sizes.

Collaborations
All field collections and experiments were conducted using the facilities (including the RV Questary) of the Romberg Tiburon Center for Environmental Studies, San Francisco State University.

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Presentations

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The CALFED Bay-Delta Program is a collaborative effort of more than 20 state and federal agencies with management or regulatory responsibilities for the San Francisco Bay-Delta system. The CALFED Science Fellows Program has been established to bring world-class science to all program elements to help achieve overall CALFED goals. California Sea Grant administers CALFED research projects towards those ends. This document is available in PDF on the California Sea Grant Web site: www.csgc.ucsd.edu.