STRATIFICATION IN BIG LAGOON, CALIFORNIA AND ITS EFFECT ON COPEPOD POPULATIONS

BY

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INTRODUCTION

Along the northern California coast are located two brackish water lagoons, Big Lagoon and Stone Lagoon, which are fed by small streams and separated from the ocean by unstable sand bars. Following periods of heavy fresh water runoff, these bars breach allowing sea water to enter the lagoons. During a part of the year, pronounced stratification occurs at least in one of these lagoons, Big Lagoon, which has an area of approximately 1,470 acres and a maximum depth which varies from seven to ten meters. Two important species of anadromous fish, silver salmon and steelhead trout, utilize Big Lagoon, and the chemical, physical and biological characteristics of the lagoon may greatly affect the quality of the lagoon as a rearing area for these species. The thermohaline characteristics of Big Lagoon have been described (Joseph, 1958), but no detailed studies of stratification have been published. The zooplankton of Big Lagoon, which has not been studied previously, is restricted much of the year to estuarine forms, dominant of which are Acartia clausi Giesbrecht, 1889 and Eurytemora affinis (Poppe, 1880).

Concentrations of zooplankton have often been found associated with temperature and salinity discontinuities; and a laboratory study of the effects of temperature, salinity and density on the vertical distribution of zooplankton has been made (Harder, 1968). Big Lagoon, because of the lack of mixing due to tidal currents and because of the steepness of the salinity and density gradients, is an excellent environment in which to study in detail the response of estuarine copepods to these gradients.

METHODS

Plankton and dissolved oxygen samples were collected using an electrically triggered two-liter water bottle composed of a tube of PVC with valves on both ends. In order to sample as narrow a band of water as possible, the sampler was triggered in a horizontal position. Oxygen samples were analyzed using the Winkler method of titration. Salinity and temperature readings were taken with an in situ induction salinometer which has an accuracy of ± 0.3%/o and ± 0.5°C.

Samples were collected six times over a period of eight weeks in the deepest
part of the lagoon where, during the period of the sampling, the depth varied from 7 to 9 m. Water samples, salinity, and temperature readings were taken at varying depths, but always at 0.3 m intervals through the halocline. While collecting animals, the sampler was held at depth for three minutes before triggering. The two-liter samples were strained on gauze, and counts were made of all late stage copepodites and adult copepods in the samples.

STRATIFICATION

Salinity profiles (fig. 1) throughout the study were similar and exhibited: (1) low salinities, generally 2 to 30/00 above the halocline, (2) a pronounced halocline with a salinity gradient of at least 20/00 over a depth range of 1 to 1.5 m, (3) a region below the halocline with salinities from 20 to 26/00. The most noticeable change in the salinity profiles from the first to the last sampling date was the shift upward of the halocline.

Temperature stratification (fig. 1) was less pronounced than that of salinity, but the thermocline became better established by the end of the sampling period when a temperature gradient of 5.5 °C was recorded. A gradual warming, particularly above the thermocline, took place during the study.

Density values (fig. 2) indicate a strong pycnocline which shifted upward in depth during the study primarily in response to salinity changes.

Dissolved oxygen concentrations (fig. 1) varied markedly with depth. Above the halocline oxygen concentrations were close to saturation, but were greatly reduced below the halocline, in many cases reaching zero. The steep oxygen gradient was in all cases within the halocline.

PLANKTON

Copepod densities for both species (figs. 3 and 4) were greatest within the region of the maximum salinity, temperature, density and oxygen gradients, i.e. within the halocline. The numbers of copepods above and below the halocline were markedly lower than in the halocline in all cases. Where there are gaps in the data (above the halocline on the last four sampling dates) towed nets substantiated the sharp reduction in copepod numbers. Below the halocline, copepod numbers were low on all sampling dates. The depth of maximum copepod concentration (figs. 3 and 4) shifted upward slightly with time, and the numbers within this layer of maximum concentration decreased until on May 22, 1968 there was no apparent layer of concentration. Distinct differences existed between the vertical distributions of the two copepod species, although the depth of maximum concentration was the same for both. On the first four sampling dates, *Eurytemora affinis* was more abundant above and below the halocline, except in the upper layer on April 7, 1968, than *Acartia clausi*. On the first two sampling dates, the numbers of copepods within the dense layer were very similar for both species; but on April 24 *A. clausi* was in much lower concentration within the halocline and by May 13 this species was absent from the samples.