Seasonal change in Elefsis Bay, Greece

by

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Elefsis Bay represents a case of a poorly flushed Mediterranean water body. It is small and is exposed at opposite ends by two shallow channels that lead to different portions of the Saronikos Gulf, which in turn, is a semi-enclosed continental shelf embayment. The Bay receives industrial pollution along its northern shore and domestic wastes through the east channel from the metropolitan Athens sewage effluent. These exposures generate severe ecological stresses on the Bay, the most acute being the summer anoxic condition in the lower layer, and motivate scientific research and civic concern in the area. The topographical setting and typical station locations are shown in Fig. 1.

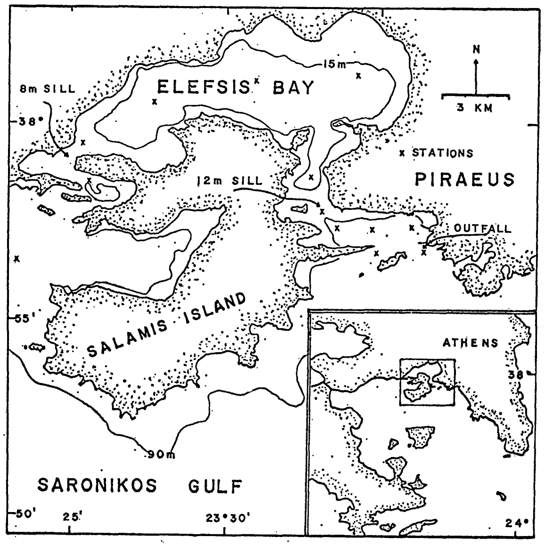

FIG. 1. — Topographical area of Elefsis Bay showing typical stations.

The water in Elefsis Bay was found to be well mixed during the winter, a condition resulting from surface heavy water formation and mechanical mixing. The greatest variations were found at the east and west ends where advective fluxes of warmer outside water generated gradients. Within the Bay the vertical and horizontal variations were of similar magnitude, that is, perhaps not more than 2° C in temperature and 0.4 ‰ in salinity.

Rapp. Comm. int. Mer Médit., **23**, 5, pp. 77-80, 3 figs (1976).

During the summer surface heating and reduced mechanical mixing permit the development of a strong stratification which effectively isolates the lower layer from anything but small diffusive exchanges with the upper layer. A vertical diffusion coefficient of 10^{-2} cm^2/sec was estimated for this period. Horizontal variations in the respective layers are less than in the winter. A comparison of typical summer and winter vertical structures are shown in Fig. 2.

The cycling from winter to spring differed for the two periods observed. The water of the 1972-3 season cycled clockwise on the T-S diagram (Fig. 3), that is, the water became cooler and fresher during the winter and then saltier and warmer during the spring. However, the water of the 1973-4 season became cooler and saltier during the winter and then warmer (with little change in salt content) during the spring. This variation in seasonal response was due to a different salinity cycling. During the early spring of 1973 the surface water first freshened through precipitation, and then during the late spring it increased in salinity through evaporation. The spring of 1974, on the other hand, experienced no dramatic freshening in the surface layer so that the vertical diffusion between the two layers could maintain an isohaline condition for a longer time.

An important consequence of this seasonal cycling is the length of time that the lower layer is convectively isolated and hence more susceptible to oxygen depletion. This condition began to develop during mid-March in 1973, while not until mid-April in 1974. The termination of this condition depends mostly on the atmospheric cooling and the mechanical mixing available. The 1974 summer higher salinity condition of the bottom layer (0.3 ‰ higher than 1973) also could prolong the breakdown of stratification, particularly when accompanied by high runoff or low evaporation during the fall season.

An evaporative heat loss of 200ly/day for 1973 was estimated from heat budget calculations. This corresponds to an annual evaporation of 124 cm/yr, which is less than the Mediterranean average of 145 cm/yr but more than that at the comparable oceanic latitude of 110 cm/yr, SVERDRUP *et al*, [1942]. The

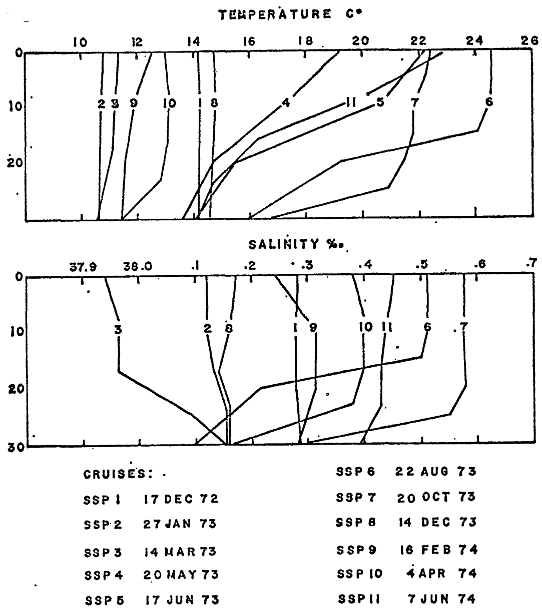

FIG. 2. — Mean vertical distributions of temperature and salinity in Elefsis Bay for the different Saronikos Systems Project cruises.

monthly trend of the excess of evaporation over precipitation (E-P) is smooth, for example producing a maximum of 175 cm/yr in July and a minimum of 10 cm/yr in November. However, the sudden precipitation or evaporative events occurring on the order of days are quite irregular and no doubt significantly alter the water structure history. The advent of 6 cm of rain around the 10th of March 1973 probably set up the spring salinity cycling as described above.

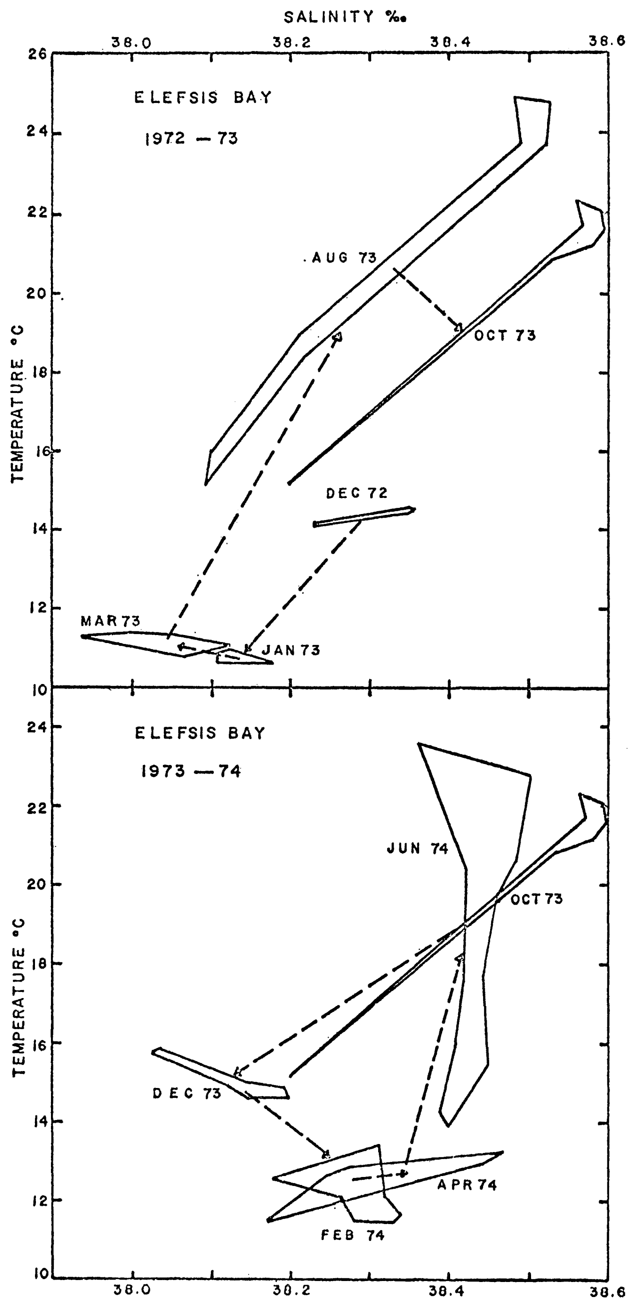

FIG. 3. — T-S diagrams showing the seasonal progression of water masses in Elefsis Bay.

Since the Bay has open channels at either end it can sustain a net transport. The two major causes are from pressure differentials on either side of Salamis Island and from thermohaline density gradients. The former has shorter time scales linked to the local winds and is similar in effect to that of a sporadic tidal flow. A longer time scale thermohaline flow is also possible. During the winter the Bay produces bottom water as the inside densities increase above those outside. The restricted channels preclude any large effect on the Saronikos water mass structure but the associated transport of Elefsis bio-chemical properties can be significant. The flow through the upper layer of the system was estimated by assuming that the property distribution, was steady over the sampling period (1 day) and therefore that horizontal advection and horizontal diffusion balanced. The transports thus obtained ranged from 240 m^3/sec from west to east during January 1973 to 450 m^3/sec from east to west during June 1973.

Acknowledgments

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Reference

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