HYDROBIOLOGIC OBSERVATIONS IN SYZYGY IN A LATITUDINAL SECTION IN THE MESSINA STRAITS

F. Azzaro *, F. Decembrini, F. Raffa

IAMC-CNR, Messina, Italy - * azzaro@ist.me.cnr.it

Abstract

The effects of tidal streams have been investigated in the Messina Straits during April 1994 in syzygy through significant hydrologic stations, at the same time of the stationary phase (slack waters) between low and high tide phases. Two distinct water masses with different physico-chemical characteristics come from Tyrrhenian and Ionian Seas at different stages of the tide. When the current flows southward, the Ionian water upwelling (highest salinity and nutrients) was most evident along the Calabrian coast, whereas along the Sicilian coast in northward flow. Salinity and nitrate were positively correlated.

Keywords: Hydrology, nitrates, chlorophyl- a, coastal upwelling system, Straits of Messina

Introduction

In the Strait of Messina, upwelling events have been documented since the beginning of this century (1), because their dynamics are determined by the presence of tidal currents (with semi-diurnal phase) and the consequent alternating presence of two water masses. These coditions lead to semidiurnal periodic oscillations of the currents flows, of Tyrrhenian waters into the Ionic basin (southward current) and vice versa (northward current), with a brief slack waters interval. Moreover, coastal geomorphology is responsible for turbulence phenomena as shown by the presence of internal waves. This leads to the upwelling of Ionic waters (Levantine Intermediate Water origin), which are colder, more salty and richer in nutrients in respect to the Tyrrhenian surface waters (Atlantic Water origin).

The distribution of tracing parameters (such as temperature, salinity and nitrates [2]) and the photoautotrophic biomass (standard methods [3]) in a selected west-east section (3 stations: W, C, E) is discussed (Fig. 1). Measurements were carried out (N/O *Urania*, April 1994) in syzygy lunar phases, when the currents reach maximum intensity (>5 knots). The vertical profiles (0-80m) of the cross-sectional flows of current across the transect for the time series at station C were computed with the Hopkins method [4]. Measurements (CTD/rosette) were performed during a 24 hour cycle in correspondence to the 4 stationary phase (with slack waters), this to individuate the upwelling of deep waters. In fact, the maximum chemical-physical differences are manifested when the flowing water has undergone less mixing and better preserves the characteristics of its zone of origin [5].

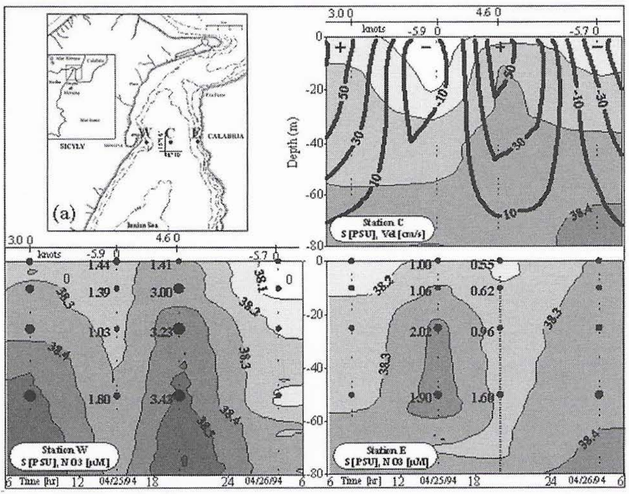

Fig. 1. Location of the stations in the Straits of Messina (a); isohalines distribution in all the stations, for nitrates in stations W-E [•], and for the normal component of the velocity, across the transect at station C [—]. Estimated current speed (Knots) and direction (+=S→N; −=N→S) from «Tavole di Marea I.I.M.M.».

Results and Discussion

The temperature measured in the whole water column showed variation in the order of half degree (14.16±0.29°C), in both slack phases. The salinity better evidenced the change from the southward to the northward current. In the station-W, the distribution of isohalines during a diurnal cycle ranged between 38.3 PSU in upper waters and 38.6 PSU in bottom layer during the stationary phases after northward current (Fig. 1). Since the tide changes, lower halines values were found mainly in the last sampling (38.03 at the surface and 38.32 PSU at the bottom). The distribution of isohalines in the station-E was opposite to station-W, with surface values of 38.3 PSU but in southward current, while in the opposite phase at surface the salinity value was of 38.11 PSU. As shown in figure 1, in station-E there were intruding water bodies able to modify the normal stratification. In the station-C, the distribution of isohalines is similar to station-W, with the saltier water during the two phases of northward flow. The speed of the current at station-C, calculated in slack phases (Fig. 1), introduces a periodic oscillations typical of the alternating of the two tides. The values range between -50 and 70 cm/sec and the isoalines show the prevalence of the northward current in this section.

During the stationary phase after northward current, (Figure 1) an evident dissymmetry between West (2.77±0.80µM) and East coasts (0.93±0.4µM) was observed for nitrate values, with concentration maximum in the western side (3.43µM 50m), perfectly in agreement with salinity values. In the opposite phase, these nutrients were more similar from coast to coast (1.42±0.27µM station-W; 1.50±0.47µM station-E). The nitrates at station-C were not very different for both slack phases (1.84±1.07µM).

The enrichment of nutrients of the euphotic layer at the West coast does not correspond to the same trophic activity. In fact, the values of chlorophyll-*a* were always low for both the tides (0.14±0.05µg-Chla l^{-1} station-W; 0.14±0.05µg-Chla l^{-1} station-C; 0.12±0.02µg-Chla l^{-1} station-E).

Conclusions

The characteristics of the water column, in the Straits of Messina, change quickly between the southward and northward currents. However, the maximum excursions were found for all the parameters examined in northward currents, mainly in the western side in agreement with hydrodynamic factors that result from the coastal relief.

Upwelled waters along the western coast of the Straits were nutrients-rich but plankton-poor (HNLC). Water column instability, due to the turbulence caused by the alternating of the Ionian and Tyrrhenian waters provokes unfavourable conditions for phytoplankton growth as in calmer water.

References

1 - Vercelli F., 1925. Il regime delle correnti e delle maree nello Stretto di Messina. Comm. Inter. del Mediterraneo, Venezia, 1, 209 p.
2 - Strickland J.F.H., Parson T.R. 1972. A pratical handbook of seawater analisys. *Bull. Fish. Res. Ed. Can.*, 167: 311 p.
3 - Lazzara L., Bianchi F., Falcucci M., Hull V., Modigh M., Ribera D'Alcalà' M., 1990. Pigmenti clorofilliani. *Nova Thalassia*, 11: 207-223.
4 - Hopkins T.S., 1999. The thermohaline forcing of the Gibraltar exchange. *J. Mar. Syst.*, 20: 1-31.
5 - Azzaro F., Decembrini F. and Crisafi E., 1995. Continuous survey of upwelling in the Straits of Messina. *Rapp. Comm. Int. Mer Médit.*, 34: 67.