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The Island of Pantelleria (Sicily Strait, Italy): towards the establishment of a marine protected area. First oceanographic investigations

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Abstract - The Island of Pantelleria, located in the Sicily Strait (Italy), is not yet included on the list of Italian MPAs. A preliminary investigation about the hydrochemistry, at spatial and short-time scales, performed in late-summer 2001, is reported in this paper. Vertical, continuous measurements of temperature and salinity and discrete samplings of nutrients and chlorophyll *a* were carried out at 10 coastal stations. Results showed a strong thermal stratification, while the oligotrophic feature of the water column was pointed out by the low nutrients and chlorophyll *a* concentrations. Short-time T and S variations (every 10 minutes for 5 days) at a selected station, by a self-recording probe moored at a 22 m depth, showed a very dynamic pattern, probably driven by the tide.

1. Introduction

The Island of Pantelleria, located in the middle of the Sicily Strait, 55 nautical miles from Cape Granitola (Italy) and 39 miles from Cape Bon (Tunisia), has an extension of 83 km^3, with a morphology derived mainly from ancient volcanic activities. The central area, with the highest mountain, Muntagna Grande (845 m high), is protected by a Naturally Oriented Reserve, managed by the Azienda Regionale Foreste Demaniali. As regards the marine environment, no Marine Protected Area (MPA) exists along its coasts, although a request was recently made by the local Municipality to the Ministry of the Environment, on November 2001. The few studies on marine biology of Pantelleria are mainly focused on botany: they pointed out the high biodiversity of the marine life, confirming that the coastal habitats of this island have a huge ecological relevance (Giaccone and Sortino, 1974; Calvo and Sortino, 1979; Giaccone et al., 1994; Albertelli et al., 1995). As regards oceanography, all the contributions are focused on the

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Sicily Strait: they deal mainly with the physical circulation (Manzella et al., 1988; Astraldi et al., 1999; Sparnocchia et al., 1999), while some are on the hydrology and chemistry (Budillon et al., 1992; Astraldi et al., 2002) and very few on the biology of the water column (Aguzzi et al., 2003). No research on the biological oceanography of the coastal waters of Pantelleria is on going as yet.

In 2001 the Istituto di Scienze Marine / Biologia del Mare of Venice started in this frame, a preliminary investigation on the hydrology, chemistry and biology of the water column of this island, as a first contribution to the knowledge of the features of its coastal waters, devoted to the establishment of the future MPA. Some preliminary results about the basic oceanographic parameters are reported and discussed in this paper.

2. Materials and methods

The experimental campaign, carried out in late summer (end of August – September 2001), was split into two parts:

1. a study of the spatial distribution of some hydrological and chemical parameters at 10 stations, choosen as the most representative of the coasts of Pantelleria (Fig. 1, circles). This was carried out by means of vertical profiles of temperature and salinity, by probe casts, and discrete samplings of dissolved nutrients and chlorophyll *a* at 5-, 20- and 50- meter depth, by Niskin bottles;
2. a short-time study about hydrology by instrumental recordings (at a frequency of 10 minutes

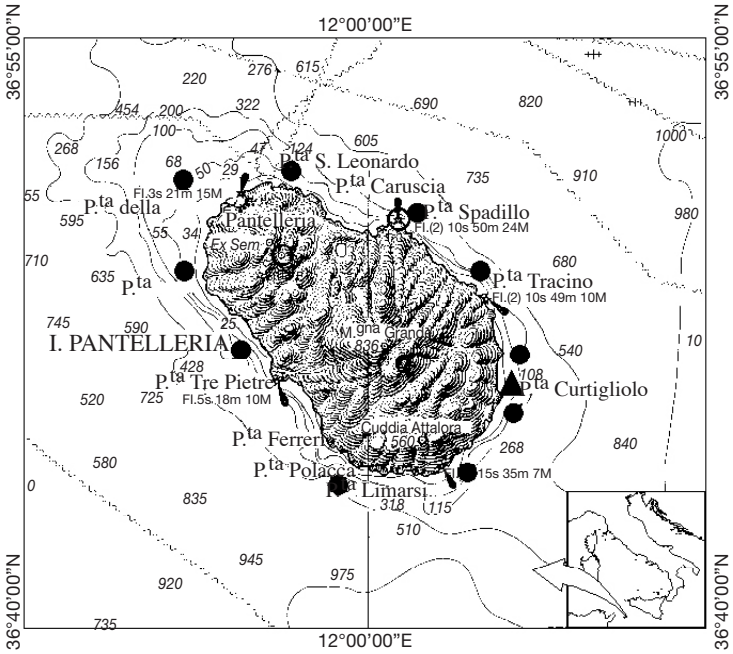

Fig. 1 - Sampling stations. Circles represent 10 coastal stations interested by vertical measurements and discrete samplings. Triangle indicates the selected station (Ficara), where the short-time experiment was carried out.

for a total of 120 hours, with about 700 records acquired) at the bottom of a selected station, the Ficara, close to station n. 6 (Fig. 1, triangle). This site was choosen because located in the area proposed as a totally restricted area in the future MPA, where a wide spread of healthy *Posidonia oceanica* beds can be observed.

The investigated parameters were: temperature and salinity by Hydrolab Datasonde4 multiparametric probe, calibrated against a Guildline Autosal laboratory salinometer; dissolved nutrients (ammonia, nitrite, nitrate, orthosilicate, orthophosphate), filtered onto Whatman GF/F fiberglass filters (porosity = 0.7 μm), and analysed with a Systea Autoanalyzer, following the methods generally reported in Strickland and Parsons (1972) and Hansen and Koroleff (1999); chlorophyll *a*, filtered onto Whatman GF/F, extracted in 90% acetone and measured with a Perkin Elmer LS-5B Luminescence Spectrofluorometer, calibrated on commercial pure chlorophyll *a* (Sigma Chemical Co.), according to Holm-Hansen et al. (1965). The total number of samples were 30.

3. Results and discussion

3.1. Vertical distributions at 10 stations

The vertical sections showed the presence of a seasonal thermocline at a 30 – 35 m depth, which separated surface (T around 27 °C) from bottom waters (T range at bottom = 16.6 °C – 18.6 °C; Fig. 2a). The pattern of salinity was very complex (Fig. 2b): average minima were measured at the surface (around 5 m depth) and near the bottom (35 – 50

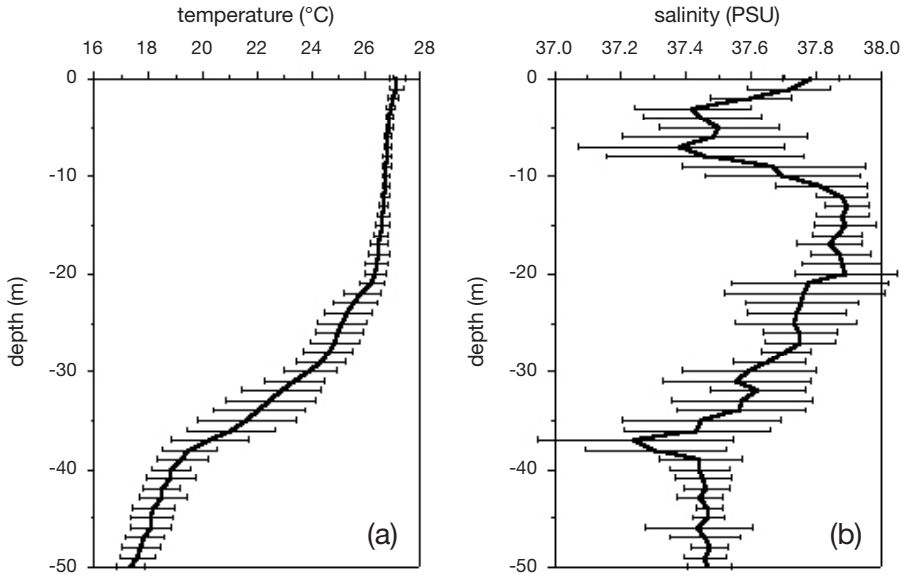

Fig. 2 - Vertical profiles of temperature (a) and salinity (b) by probe casts. Bold line links together the average values calculated at each meter depth, with their respective standard deviations.

m), while a maximum of 38.10 was observed at on intermediate depth (20 m).

It is well known that the upper layer of the Sicily Strait is mainly occupied by the Modified Atlantic Water (MAW), flowing from the Strait of Gibraltar along the Tunisian coasts (Astraldi et al., 1999; Onken and Sellschopp, 2001). In proximity of the shallow coastal area of Pantelleria (50- meter depth), the MAW exhibits a large variability, mainly due to the bottom topography of this region, that exerts a strong influence on the circulation, generating some mesoscale processes, such as eddies, meanders and upwellings (Astraldi et al., 1999, 2002; Robinson et al., 1999). This complexity is highlighted in our TS diagram (Fig. 3), from which: 1) no particular TS cluster was evidenced; 2) only temperature differences discriminated surface from bottom data; 3) slightly saltier waters (S > 37.7 PSU) were found at T > 22 °C.

The oligotrophic feature was pointed out by low chlorophyll *a* (about 0.1 - 0.2 μg dm^{-3} on

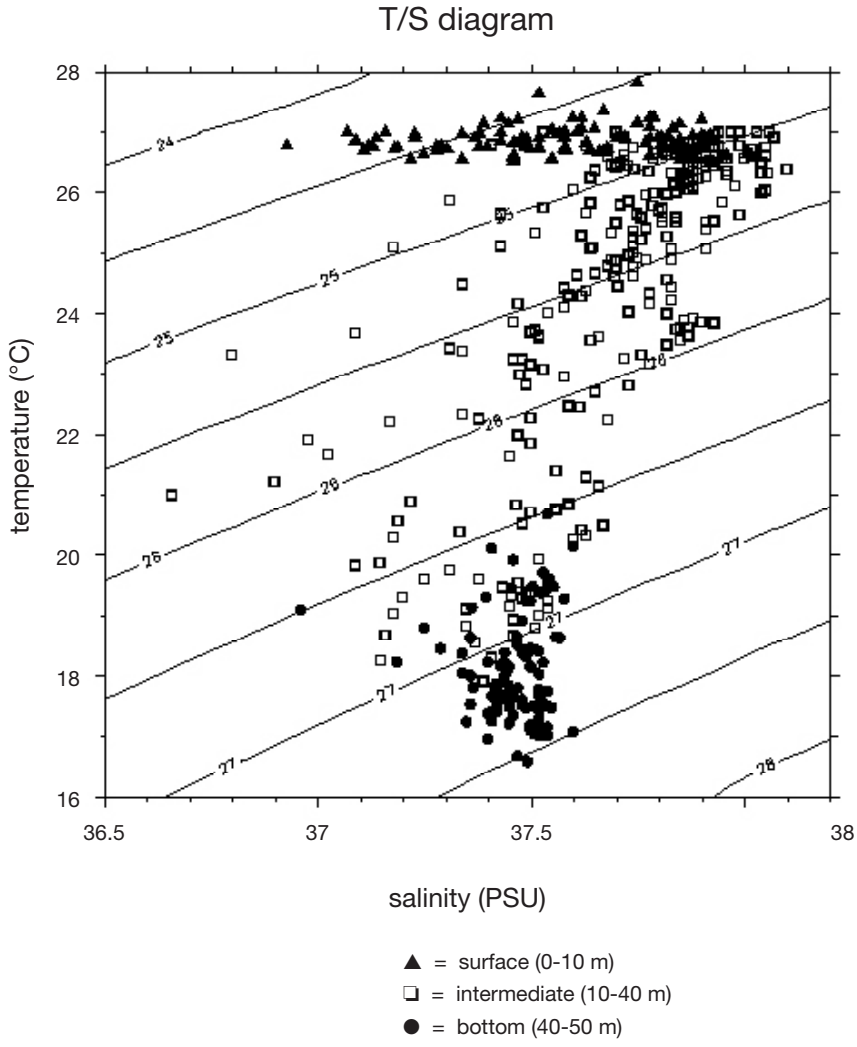

Fig. 3 - T/S diagram related to all data. Clusters related to different levels are evidenced (see legend).

the whole water column) and dissolved nutrient concentrations, with averages of dissolved inorganic nitrogen (DIN), orthosilicate and orthophosphate respectively of 0.31 μM (sd = 0.13), 1.04 μM (sd = 0.14) and 0.05 μM (sd = 0.02). DIN was mainly represented by ammonia (average = 74%), which increased its percentage from surface to bottom (respectively from 64 to 81%), while the more oxidised form, nitrate, acted inversely, decreasing from 34% at the surface to 16% at the bottom. The chlorophyll *a* / phaeopigment ratios (ratios between active and inactive chlorophyll), decreased from averages of 2.2 - at a 5 m depth - to 0.6 at a 50 m depth. These distributions were signatures of a low photosynthetic activity by phytoplankton along the water column, as well as the presence of grazing and regenerative processes that took place mainly near the bottom.

3.2. Short-time measurements at a selected station

The dynamics of the water masses has been evidenced by instrumental acquisitions at the bottom (22- meter depth) of a selected station (Ficara), where strong excursions of temperature (up to 5 °C) and salinity (about 1 PSU) took place in a few hours, with a cyclic trend (Fig. 4). Recorded temperature and salinity ranges were: T minima = 20.4 – 23.5 °C, T maxima = 25.3 – 26.7 °C; S minima = 37.2 – 37.6 PSU, S maxima = 37.6 – 38.0 PSU. In the vertical T and S sections of Fig. 2, these two classes may be recognised respectively at a 15 – 25 m (T and S maxima) and a 30 – 37 m depth (T and S minima). Lacking further information about the dynamics of the water masses, in this preliminary overview, only hypotheses can be

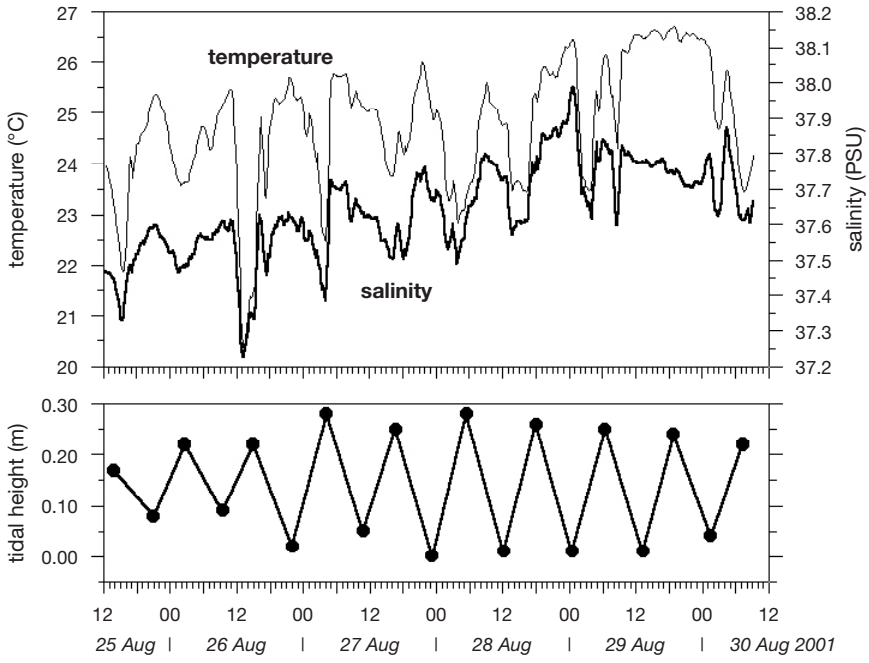

Fig. 4 - Instrumental acquisitions at the selected station (Ficara, 22 m depth). Temperature (thin) and salinity (bold) are shown, as running average calculated on 5 values. Predicted tide is shown at the bottom.

formulated. The short-time trends appeared to be constant in time, with a periodicity of about 12 hours (with the exception of the last days, August 29 and 30), resembling that of a semidiurnal tidal height. To correlate T and S versus tide, because of the lack of tide data at Pantelleria, we utilised the data reported in the NOAA tide prevision table (NOAA, 1982; Fig. 4 bottom): although these represent only the astronomical component, our opinion is that this was very close to the real tide, because during our experiment of 120 hours the meteorological situation was almost stable, with high atmospheric pressure (between 1013 and 1018 hPa), moderate winds (max wind speed = 14 knots) and state of the sea up to Beaufort 4 (ECMWF and local Coast Guard data).

Correlations calculated from predicted tide (min and max level) vs. temperature and density were statistically significant (both $r = 0.530$, $n = 19$, $p \leq 0.05$) showing that tidal height, although of a limited amplitude (foreseen range = 28 cm), could contribute to the periodic advection of deeper waters, characterised by lower temperature and salinity. Driven to tide, these waters may periodically move up and down, following the depth contour, and influencing in this way the shallow coastal area.

4. Preliminary conclusions

This very preliminary study on the coastal waters of the Island of Pantelleria pointed out the following remarks:

1. the experimental strategy we adopted to investigate the hydrology and chemistry of the water column could be suitable to environmental monitoring, to be utilised in the future MPA;
2. our observations highlighted the importance of coupling vertical measurements and samplings on the water column with short time-series at the seabed;
3. our hypothesis about the influence of tide on T and S short-time trends should be validated by measurements about the dynamics of the water masses, such as current field and tidal height;
4. these preliminary results, together with the data acquired in the frame of future programs about the establishment of the MPA of Pantelleria, will be utilised in some oceanographic models about the circulation of the Mediterranean Sea, such as the new MFSTEP, with an improved resolution of 6 x 6 km, suitable to represent processes at a coastal scale (Demirov, pers. comm.).

In the near future, this study will be integrated with information on the biology of the water column, such as the distribution and taxonomy of the phyto- and zooplankton communities.

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