RHEOLOGICAL PROPERTIES OF SEAWATER FROM SICILIAN COSTAL AREAS

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Abstract.

A clear positive variation of sea water rheological properties has been observed during phytoplankton blooms (1). Viscosity of filtered and unfiltered seawater samples taken from Sicilian coastal areas where formation of mucilage aggregates are likely to occur, has been measured at 4.00 °C. Monitoring of the development of such secretions is thus made possible by studying the increasing creep resistance of the samples.

Key-words: bathymetry, density, temperature, Adriatic Sea, Tyrrhenian Sea.

Introduction

Seawater rheological properties – It is known that formation of mucilage aggregates is primarily of biological origin and is certainly being initiated by marine meteorological conditions of high temperature and pressure coinciding with conditions of reduced hydrodynamics. However, the features needed to characterize the system from a physical-chemical point of view, have not been yet been studied. A sharp positive variation of sea water rheological properties has been observed during phytoplankton blooms and particularly in cases when effects emerging at the seawater surface occur (Adriatic Sea and North Sea).

Viscosity can be then included within the range of models which are employed to evaluate mucilage phenomena when it is conceived as a parameter to test creep resistance of fluid layers, caused by interaction between different polymer chains and their flexibility (2). If we also consider that sea water is classified as a "weak gel" full of agglomerates which can exceptionally turn into a "strong gel" characterized instead by agglomerates with increased creep resistance (1), it follows that viscosity should have a cyclic occurrence and thus, we should be able to foresee the likely formation of aggregates.

Materials and Methods.

Sampling and sample preservation – A few samples were taken in the Southern Tyrrhenian Sea in areas where phenomena attributed to mucilage aggregates have occurred in the past. Two transects have been chosen along the northern coast of Sicily, one at Isola delle Femmine and one at Capo d'Orlando. Monthly surveys and sampling were made from June 1999 at the stations with bathymetry C = 30 m, D = 40 m, E = 50 m: four samples have been taken for the station C (from the surface and at every 10 m depth) and a sample at –20 m for the D and E stations. We could thus analyse some results following horizontal guide-lines (coast – open sea): $C_2 - D_1 - E_1$ and vertical guide-lines (surface – sea-bottom): $C_0 - C_1 - C_2 - C_3$. (fig 1)

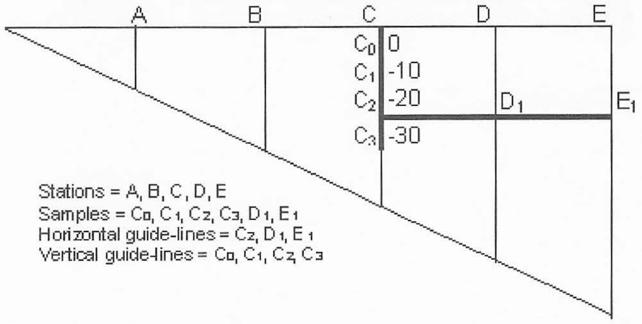

Figure 1. Transect indicating the stations.

Samples are taken and immediately stored at 4 °C in a portable refrigerator. Viscosity is measured at 4.00 ± 0.05 °C in unfiltered seawater (SW) and filtrate (filter GF/F, 7 μm (FSW)) samples. Due to the dimensions of some colloid substances in solution, it was decided to test viscosity of samples using 0.2 μm filters (F_2SW).

Filtering took place within one hour of sampling; samples were stored in a refrigerator at 4 °C and tested within no more than five days maintaining the same temperature.

Preservation and measurement at low temperature, without addition of chemical preservatives, allowed us to evaluate the physical-chemical properties of creep resistance which are caused only by the polymers in solution.

Measurement – Kinematic viscosity was measured at 4.00 ± 0.05 °C by an *Ubbelohde* capillar viscosimeter, Schott-Gerate Macro (0c) connected with AVS 350, an automatic viscosity-measuring instrument, by Schott-Gerate. Kinematic viscosity (ν) converts into absolute viscosity (η) in terms of $\eta = \nu\, d$

where d represents the sample density (3,4). Sea water sample densities result from electrical conductivity readings taken at the same temperature. The accuracy of absolute viscosity was ± 0.001 cp. The ratio between the sample viscosity and the artificial sea water viscosity (ASW: NaCl, $MgSO_4$, $NaHCO_3$) provides the sample's relative viscosity which can be related to the rheological influence of those substances present as solute.

Results and Discussion.

The final outcome of more than one year of study seems to indicate that values obtained for the viscosity of unfiltered seawater show small differences depending on the sampling depths, although not as much as noted during the first three months. The viscosity of filtered seawater, on average, was always slightly lower than that of the unfiltered sample. Little difference was noted between viscosity determined by use of 0.2 μm filters and that using 0.7 μm filters. This is due to the fact that at the moment of sampling, measurements were not affected by substances which were more than 0.2 μm. No major differences were seen with respect to the horizontal guide-lines (coast – open sea): $C_2 - D_1 - E_1$ whilst more marked ones were noted using vertical guide-lines (surface – sea-bottom): $C_0 - C_1 - C_2 - C_3$.

Analysis of recorded values showed that the physical-chemical properties varied according to time (viscosity generally decreased from June 1999 until December 2000), bathymetry, and distance from the coast. Such data apply to both transects in our survey. Figures regarding kinematic and relative viscosity were related to marine meteorological conditions and weather at the time when the of samples were taken.

Therefore is important to continue the viscosity measurements in order to underscore the variations caused by polymers in solution, and in order to link rheological properties with biological and chemical parameters of the samples (i.e. nutrients, chlorophyl and phytoplankton biomass). In this way it will be possible to use viscosity as a predictive parameter of phenomena attributed to the formation of mucilage aggregates.

References

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