ASSESSMENT OF MARINE COASTAL EUTROPHICATION BASED ON SCALING NITRATE CONCENTRATIONS

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The quantitative assessment of eutrophication still remains a problem in spite of the research that has been carried out over the last decades (LIKENS, 1972). Nutrient concentrations are often used in assessing trophic levels (KARYDIS *et al.*, 1983); however, there are problems related to the data analysis since nutrient values deviate from normality and big overlaps between data sets characterising oligotrophic, mesotrophic and eutrophic conditions are observed (IGNATIADES *et al.* 1992). In the present work these shortcomings on the data analysis have been considered and a distribution-free statistical procedure based on scaling nitrate concentrations is proposed as a methodological tool for quantitative assessment of the trophic conditions in marine coastal systems.

Nitrate concentrations from a eutrophic, a mesotrophic and an oligotrophic area, characteristic of Eastern Mediterranean waters (IGNATIADES *et al.* 1992) formed the basis of the scaling system for assessing eutrophication. Each data set was divided into quartiles and in this way a scoring system was developed. Nutrient values ranging from zero to the minimum value of the data set were assigned by the ordinal number 0, between the min. value and lower quartile (LQ) by 1, between LQ and median (M) by 2, between M and the upper quartile (UQ) by 3, between UQ and max. by 4 and finally nitrate concentration values exceeding the max. value of the data set were assigned by the ordinal number 5 (Fig. 1a).

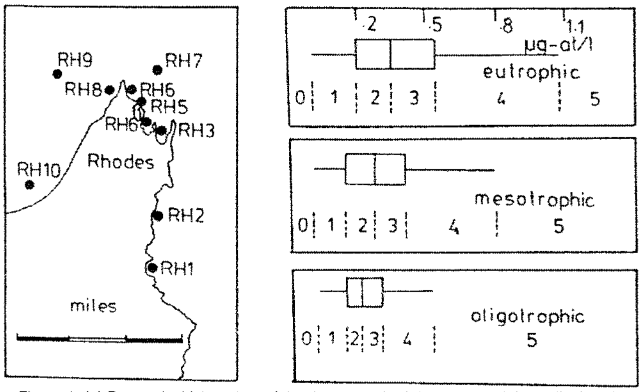

Figure 1. (a) Box-and-whisker plots of the three standard data sets and the ordinal scale described in the text. (b) Station locations

The sum of the scores from the three standard data sets of each data point representing a sampling site an estimate of the trophic level for that particular sampling site. Ten stations (Fig. 1b) spaced along the coastal area of Rhodes, Greece, were used to evaluate the effectiveness of the proposed procedure. It has been found (KARYDIS, 1992) that stations 3, 4 & 5 were eutrophic, 7 & 9 oligotrophic and the remaining sampling sites were mesotrophic. Mean annual values of nitrate concentrations were calculated and their scoring was recorded (Tab. 1)

	RH1	RH2	RH3	RH4	RH5	RH6	RH7	RH8	RH9	RH10
Raw values	0.68	0.45	2.51	6.25	3.00	0.60	0.35	0.42	0.28	0.51
NO3 scaling	13	11	15	15	15	13	9	11	7	11

Table 1 Mean annual values of nitrate concentrations along the coastal area in Rhodes, Greece. Second line of the table: scorine of the trophic leves based on the proposed scaling system

The numerical classification of the ten sampling sites is given in Fig. 2. It was observed that the stations were grouped into eutrophic (3, 4, 5), oligotrophic (7, 9) and mesotrophic (1, 2, 6, 8, 10) states. This grouping was far more pronounced and clear-cut using the results from the scoring system (Fig. 2b) compared to the log transformed raw values (Fig. 2a). This grouping was also statistically confirmed by ANOSIM a non-parametric permutation test (CLARKE, 1993). Further work is being carried out on a number of variables characterizing eutrophication.

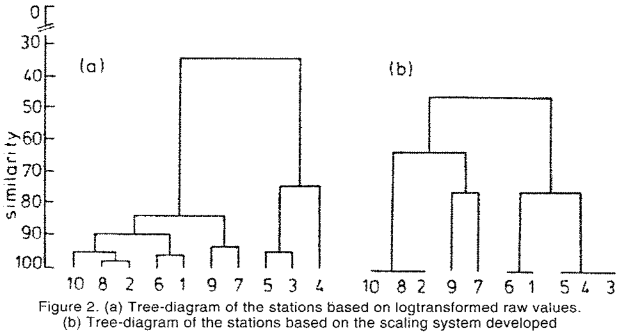

Figure 2. (a) Tree-diagram of the stations based on logtransformed raw values. (b) Tree-diagram of the stations based on the scaling system developed

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UPTAKE OF CADMIUM FROM WATER AND FOOD IN *MUREX TRUNCULUS*

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A previous study aimed to determine Cd concentration in *Murex trunculus* from different areas of North Tyrrhenian coast showed that, also in unpolluted marine waters, this gastropod can reach a high concentration of this metal.

In some marine areas of this coast, Cd is found only in *Murex* and not in other species (*Donax, Venus, Mactra* and *Mytilus*) living in the same environment. Data on Cd levels in *Murex* were obtained by atomic absorption spectrophotometric methods (IL S11 spectrophotometer equipped with a deuterium lamp). The soft parts of *Murex* were first digested overnight in cold 65% nitric acid (Merck Suprapur) and subsequently in boiling acid in distillation vessels. The values of Cd concentrations are expressed in ppm dry weight. Reference standards of lobster hepatopancreas (National Research Council, Canada) were also processed in order to check the analytical accuracy. All the standards gave values inside the 95% range of the mean certified value.

The analytical data, in agreement with other authors (BOUQUEGNEAU, 1988), showed that the digestive gland is the target organ for Cd. From our data, this organ represents about 80% of the total metal body burden whereas a contribution of 2,5% is due to the gills. In order to get a further insigth to the ways Cd is accumulated in *Murex*, two experiments were carried out in the laboratory.

In a first experiment, 16 animals were exposed to 150 µg/l of Cd administered as nitrate in seawater. In a second experiment, 20 animals were fed with mussels previously contaminated through a 6 weeks exposure to 150 µg/l of Cd in seawater. Every animal was fed with one mussel and received a load of about 50 µg of the metal.

In the *Murex* of the first experiment, a fast increase of Cd was observed in the gills whereas in the digestive gland, after 14 days of Cd exposition, the concentration of this metal was not significantly different from uncontaminated animals (Fig.1-2).

The data of the second experiment showed that at the 8th week after predation, the levels of Cd in the digestive gland were yet 10 times higher than the values measured in the controls. Moreover, this time, the loss of the metal from the digestive gland seems very slow. The gills showed an increase with a maximum value at the 3th week after predation to decrease subsequently. Cd accumulation in the gills is probably linked to the transfer of the metal from the digestive gland by the blood.

Therefore the digestive gland of *Murex* seems to take high load of Cd only when present in the food and not when the metal is present in dissolved form in seawater. Cd consumed with the food, on the other hand, is lost speedly by the digestive gland in the first weeks but subsequently the excretion, in agreement with data on other molluscs (VIARENGO, 1989), is very slow. This seems to indicate that the diet is the more important source of cadmium for *Murex trunculus*. An histological study was performed on the digestive gland in order to observe alterations at the subcellular level due to this toxic.

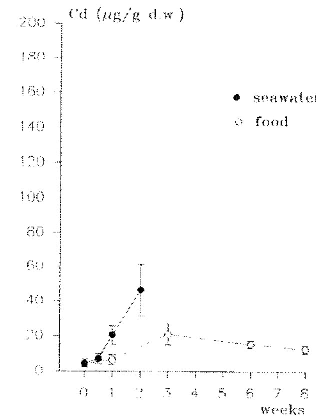

Fig.1. Cd in the gill of *Murex* exposed to contamined sea water or food

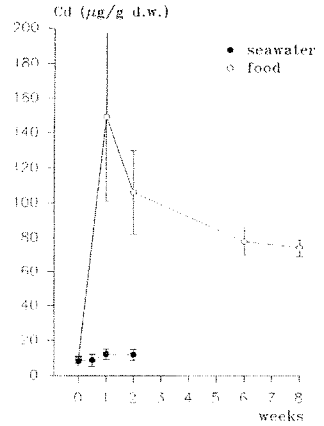

fig.2. Cd in deigestive gland of *Murex* exposed to contamined sea water or food

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