SEASONAL DYNAMICS OF DINOPHYSIS SPP. WHICH CAUSED A DSP OUTBREAK DURING THERMAL STRATIFICATION IN THE GULF OF TRIESTE

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Many recent reports of algal blooms recorded in several inshore waters, including harmful effects provoked by toxic species, suggest that such toxic blooms are becoming more frequent and more wide spread (SMAYDA, 1990).

The outbreak of diarrhetic shellfish poisoning (DSP) in the Gulf of Trieste (Adriatic Sea) was recorded for the first time in September 1989 (SEDMAK & FANUKO, 1991) and was associated with an increased cell density of eight *Dinophysis* species. The highest abundance of *Dinophysis* spp. in September 1989 coincided with the toxicity peak in mussels from two shellfish farms in inshore waters along the Slovenian coast. DSP toxins were again detected in mussels during routine monitoring (mouse assay, YASUMOTO, 1981). High temperatures, a stratified water column and the relative absence of turbulence are conditions known to be favourable for growth and persistence of relative high abundances of dinoflagellates from late spring to early autumn (PAERL, 1988; DELMAS *et al.*, 1992).

In view of these findings and our own data from 1986-1992 revealing the presence of *Dinophysis* spp. from May to October, we followed *Dinophysis* spp. abundance as well as environmental conditions (temperature, salinity, water column stratification), including nutrients during 1993. Sampling was carried out at five depths (subsurface, 5, 10, 15 m and above bottom) in an offshore station in the southern part of the Gulf of Trieste (depth of 20 m) in the vicinity of two shellfish *Mytilus galloprovincialis* farms from May to October 1993, monthly, and approximately biweekly from mid-June to mid-September 1993. From fixed sea water samples (1 l) for phytoplankton counts, subsamples of 100 ml were concentrated in the sedimentation chambers and the entire chamber bottom was examined at 100 x magnification according to UTERMÖHL (1958). Water samples for nutrients (PO_4^{3-}, NO_3^-, NO_2^-, NH_4^+, Si) were analysed using standard colorimetric procedures (GRASSHOFF, 1976). Hydrographic profiles were recorded using a CTD probe. During the investigated period the temperature ranged from 12.6°C (May) to 26°C (end of August). The most pronounced thermal stratification of the water column was observed at the beginning of June (ΔT = 7.85°C; ΔT = temperature between the base of the upper mixed layer and the bottom), while the whole summer period (July and August) was characterised by a thick (10 to 16 m) homogeneous upper layer and a slight decrease of surface temperature (from 26 to 23.2°C). The water column was well mixed in September and October. The pool of inorganic nitrogen ($NO_3^- + NO_2^- + NH_4^+$) was never completely exhausted and the concentrations were always above 1 µmol/l. During the period of thermal stratification the concentrations of phosphate above the thermocline remained low, while below the thermocline they increased. Silicate varied from very low values in July (0.63 µmol/l) to extremely high (11.95 µmol/l) in August after a thunderstorm.

Five *Dinophysis* species were found from May to October : *D. acuminata, D. caudata, D. fortii, D. rotundata* and *D. sacculus. D. caudata* and *D. fortii* were registered over the entire investigated period and *D. rotundata* occurred sporadically almost on every sampling. On the contrary, *D. sacculus* and *D. acuminata* were present in July and from August to September, respectively. Surprisingly, over the period of the most pronounced stratification the cell density of *Dinophysis* spp. was low (up to 40 cells/l below the thermocline). Only at the end of August, when the water column became homogenised, *Dinophysis* spp. cell numbers increased to reach the maximal density of 4460 cells/l, followed by a slight decrease to 1260 cells/l in September and 770 cells/l in October. Only a few specimens of *Dinophysis* spp. were present in water samples in November. In the period of the maximal density the highest concentrations occurred between 10 and 15 m, while above the bottom cell numbers were much lower. The only exception was the sampling on 26 August, when bottom density exceeded 4400 cells/l, and was approximately 50 times higher than densities from the upper water layers. In October *Dinophysis* spp. cells were equally distributed through the water column. No significant correlation was found between cell numbers and nutrient concentrations.

Mouse bioassays on mussels growing in two shellfish farms near the sampling station were carried out from the beginning of July to mid-November. The first positive result for the presence of DSP toxins was recorded at the end of August and lasted till the end of October. In November the mouse test was negative.

These results coincided well with the increased cell density of *Dinophysis* spp. at the end of the summer and the scarcity of toxic species in water samples in November. A distinctive feature was the long persistence of DSP found in wild growing shellfish (mainly *Arca noe*) from different locations in the vicinity of the sampling station. Toxicity was detectable until January 1994, although no *Dinophysis* species were found from December on. One reason is probably the low winter sea temperatures which reduce the metabolic activity of shellfish and thus slow down the detoxification processes (SECHET *et al.*, 1990), but we also have to consider the ecophysiological characteristics that differentiate *Arca noe* from the blue mussel.

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