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Marine Environmental
Quality Committee

REPORT OF THE STUDY GROUP ON POLLUTION AFFECTING SHELLFISH IN AQUACULTURE AND NATURAL POPULATIONS.

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I. MEMBERS OF THE STUDY GROUP

In La Rochelle (october 1991) the following recommendations of consultative committee approved by the delegates meeting for this study group were :

"Attention was drawn to the fact that the study group on Pollution Affecting Shellfish in Aquaculture and Natural Populations (C.Res. 1991/2 : 45) was one of the council's first attempts to investigate the effect of pollution on fisheries. Delegates were encouraged to ensure a better representation of proper experts at the 1992 meeting since the 1991 meeting had been poorly attended."

The recommendations from the Shellfish Committee were adopted by the council as C.Res. 1992/2 : 45 jointly with MEQC, Mariculture and ACMP.

Despite these recommendations no new country had nominated expert to this study group ; only Canada, the United Kingdom, Germany and France have members. With only 5 people included the chairman it was obviously not enough to constitute a good study group where collective reflection could bring more than a litterature study. Furthermore the majority of members of the group are all biologists not specialised on the pollutants or ecotoxicology.

For this reason despite the large interest for the council to have an expertise on the subject the chairman of the study with the agreement of the chairman of the shellfish committee and of the ICES President decided to withdraw the meeting which was previously expected in Nantes (France) from 1-3 July 1992.

The members of the study group are :

M. HERAL, R. MEIXNER, R. PENNEY, J.C. SMITH, B.N. SPENCER.

II. TERMS OF REFERENCE

The council resolution 1991/2 : 45 precised : the study group on Pollution Affecting Shellfish in Aquaculture and Natural Populations will meet in Nantes (France) from 1-3 July 1992 to :

a) specify the substances and activites most commonly involved in pollution incidences affecting shellfish (in order of severity of impact if possible),

b) continue the compilation of information on the types, extent and sources of pollution (chemical and biological) affecting shellfish in the ICES area and their marketability,

c) in conjonction with the working group on Biological Effects of Contaminants, identify relationships between pollutants and disease susceptibility in shellfish.

III. WORK IN THE PERIOD 1992

No work has been done by the study group in 1992 because of the too low number of persons involved in the study group and as we previously said no specialists of pollutants have joined the group.

Despite this the chairman proposes some reflections about the terms of reference.

a) Substances and activities involved in pollution affecting shellfish in order of sensivity of impact

In the previous report a panel of the different types of pollution affecting shellfish has been presented including successively :

- Salinity stresses caused by the modification of the fresh water regime in estuaries by building dams for competition for other uses of the fresh water,
- Destruction of habitats mainly by dredging activities as extraction of agregates, and dredging in the channel,
- Destruction of the shellfish habitat caused by commercial fishing mainly due to dredge and demersal trawling actions.

The consequences of eutrophication with macroalgae proliferation and decomposition have been examinated as well as anoxic conditions which occured after the phytoplankton bloom. Some phytoplankton species can also directly produce toxins which cause deletorious effect on the benthos.

For the direct action of pollutants the effects of high input by oil tanker on benthic fauna have been examinated as well as the toxic impact of heavy metals and their salts with the tributyltin story.

Different other impacts have been noticed like organic waste, nutrients and pesticids used by intensive agriculture.

To sort out these anthropogenic modifications function of severity impact is not an easy task because toxicity of products will be function of "assimilative capacity" of ecosystems which receive the effluent at certain levels of discharges without suffering of deleterious effects on a global scale. This capacity is function of hydrographic processes which dilute and disperse the pollutants but also the sedimentation erosion processes which can change the form of the products as well as PH, temperature and salinity. Another criteria to sort the pollution incidences is to fix the level of organisation where the impact must be evaluated (fig. 1). Of course for this ICES study group it is the impact at a population level which is dominant.

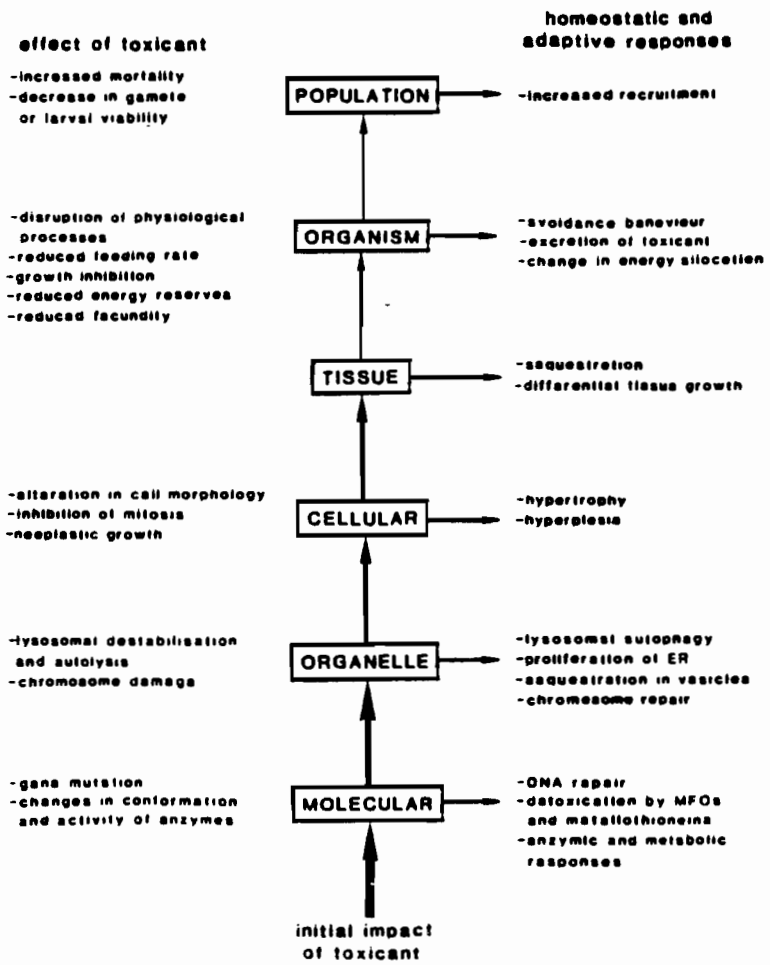

Figure 1 : A hypothetical scheme suggesting how the impact of a toxicant upon an organism might pass through, and be dissipated by, its hierarchical organisation. Some effects of toxicants that we have considered, and adaptive responses to counteract those effect, are listes (from Stebbing, 1985 in Bayne et al., 1985).

Pollutants are acting at different stages of animal life ; for the highest concentration they cause adult mortalities. At lower level of contamination modifications of the ethology and physiology will depress growth rate and reproductive effort. At these levels and lower, recruitment is the first function which is declining as larval viability and post larval stages are most sensitive to environmental conditions (pollutants but also temperature and salinity regime).

The impacts of pollutants on the environmental degradation with consequences on the population dynamic of shellfish are not well documented in the litterature. It is always difficult to prove that a lack of recruitment is due to a pollutant or to variation of hydroclimatic or physical conditions (Troadec and Alzieu, 1985). In the same way, increase of mortality due to direct effect of pollutant or to disease related to pollutants could not be neglected in stock assessment calculation even if published information on the topic are scarce, reflecting the difficulty in obtaining good observations as the working group on pathology and disease of marine organisms precised in 1991.

Obviously the major impacts of environment modification population dynamic have been caused by :

1°) TBT : In all the countries at the vicinity of recreative harbours the antifouling paints with tributiltin (TBT) have been used causing inhibition of reproduction, of the larval survival rate, increase of the mortality rate and decrease of the growth rate of different populations of molluscs particularly the cultivated japanese oyster *Crassostrea gigas* but also wild species like *Nucella lapillus* or *Litorrina littorea.*

2°) Hydrocarbons : Grounding of oil tankers such as a Torrey Canyon, Amoco-Cadiz in French Brittany, Exon Valdey in Alaska, Gulf War, caused massive destruction of the shellfish mainly benthos, it has been estimated that an average number of 10 serious accidents occur each year in the world with a fleet of nearly 1 400 boats which carry hydrocarbons and chemical products.

3°) Management of fresh water : Building of large dams for use of fresh water for development of intensive agriculture or for human needs can cause large ecological changes. It is well known for Aral sea in Uzbekskaja, in Egypt with Assouan dam on the Nile, in Persian Gulf with decrease of recruitment of Peneid shrimps correlated with the decrease of fresh water. In France, for other

example buildings of dams in estuaries have modified salinity regime but also sedimentary and hydrodynamical conditions which became no favourable for mussels recruitment and breeding (Troadec and Alzieu, 1985).

4°) Eutrophication : It is caused by an increase of effluents (urban and agricultural) had deletorious local effects due to anoxic conditions. It is the case for example in Chesapeake Bay under the depth of 6 meters or in Baltic sea in Kattegat and Skagerrak where the benthic fauna disapeared. But on the contrary, eutrophication as well as change of salinity related to dam building, will modify the structure of the benthic community. The change has not always deleterious effects : for example the increase of the population of the blue crab in Chesapeake Bay (Rothschild and Staag, in press) or the increase of the landings of mussels, cockles, but also brown shrimps in the Dutch Wadden sea during the fifties and the sixties (Boddeke and Hagel, 1991). So the reaction of the biota to these phenomena is an increase of the productivity in the well aerated zones. It is not possible now to judge the balance between the decrease of the biomasses in anaerobic areas and the increase in other sectors.

Of course several other pollutants as heavy metals, pecticides had some effects on larval survival rate and the growth rate of the adults (mussels, oysters, shrimps). This allows to use the larval test or the mollusc scope for growth measurements to estimate the quality of the water or sediment and to estimate biological effects of contaminants. But in the test, concentrations which caused mortalities of shellfish or high depress in scope for growth are very seldom found. It generally occured only in coastal zone, at the direct vicinity of waste, where no dilution is possible.

b) Identification of the relationships between pollutants and disease susceptibility in shellfish

As for fish evaluating impact of pollutants on disease is not an easy task. Epidemiology alone cannot establish causality since relationships in space and time with contaminants are only achieved by correlation. The proof can undoutedly only be established by experiment. But in nature there is a mixing of pollutant factors and environmental conditions which can increase by synergy the stress on the shellfish. Sinderman (1989) did a good review on these topics, he noted that during the past decade, for shellfish, important new findings have added significantly to information about pollution on disease.

1°) Shell disease and associated "black gill disease" have been found on crustaceans with higher prevalences in polluted habitats but the cause and the relationships between pollutants and disease have not been demonstrated. This disease also called "exoskeletal disease" or shell erosion presents the same pattern that fin erosion of fish encountered in degraded estuarine and coastal waters. A recent review of this disease in crustaceans of commercial importance in the US led to the conclusion that (Anonymous, 1989) :

"Evidence exists for an association of shell disease with habitat degradation. Prevalances show trends similar to those of the black gill syndrome which also has a statistical association with extent of pollution. Experimental exposures of crustaceans to contaminated sediments, heavy metals, biocides, petroleum and petroleum derivatives can result in the appearance of the black gill syndrome often accompanying shell disease".

Nevertheless to understand thoroughly the relationship between these diseases and pollutant, further experimental studies are necessary to evaluate more undoubtedly what and how substances modify the cuticular synthesis.

2°) Kidney concretions : In habitats with high levels of pollutants (heavy metals, hydrocarbons...) pathological changes were examined in the kidneys of bivalve molluscs, clams and scallops develop concretion of calcium phosphate which may occlude the entire kidney. The concretions in clams from polluted sites were more numerous and larger than those from animals from reference sites.

3°) Susceptibility to disease : It has been demonstrated that pollutant exposure affects phagocytosis in hard clams but on the contrary in japanese oyster and american oyster pollutants, may affect cellular defense in a positive way by increasing phagocytic activity of oyster hemocytes.

On the contrary, some authors suggested that chronic pollution may put a stress on the animal which could be manifested in increased parasitism.

In conclusion because complex mixtures of chemical contaminants occur in coastal waters, specific pathology in shellfish due to one contaminant is very difficult to demonstrate. Except for the shell deformation of oysters and the shell disease in crustaceans where these abnormalities have been induced in

laboratory to identify contaminants better, for the other case the problem has been stated precisely by Dethlefsen (1988).

"Given the present knowledge of ecosystems interactions it is unrealistic to expect that marine or aquatic science will be able in the near future to produce results that unequivocally document a connection between specific dysfunctions and specific pollutants. Such causal relationships can be demonstrated only for substances that are tested under controlled laboratory conditions. Whenever this proof has been required or expected for a complex ecosystem, the results have always been debated in the scientific community and therefore have been of no use in a pollution management context."

CONCLUSION

If we refer to the ICES paper CM 1991/Del : 11 ref A "Enhancing the interdisciplinary role of ICES" we understand quite well that it is a new challenge for ICES to have good environmental expertises particularly on their effects of exploited populations. To achieve that goal we need the key people and particularly in this study group. If it is impossible (people not free or not concerned by the subject), it will be better to decide to put an end to this study group.

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