Compliance Level of the Mollusc Waters Quality in the Black Sea According to the EU Legislation *(Daniela Roşioru, Luminița Lazăr, Andra Oros, Valentina Coatu, Elena Stoica)*	**"Cercetări Marine" Issue no. 43** **Pages 232-240**	**2013**

COMPLIANCE LEVEL OF THE MOLLUSC WATERS QUALITY IN THE BLACK SEA ACCORDING TO THE EU LEGISLATION

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ABSTRACT

The paper presents the evaluation of the quality of the marine environment and of marine molluscs which was carried-out in year 2011 in the four designated areas by the EU Shellfish Waters Directive 2006/113/EC, for the growth and commercial exploitation at the Romania Black Sea coast.

The main species monitored were the mussel *Mytilus galloprovincialis* (Lamark, 1819) and the rapa whelk *Rapana venosa* (Lamark, 1819).

Water and sediment quality along the Romanian coastline in 2011 was, overall, in conformity with the Shellfish Waters Directive 2006/113/EC.

The level of conformity for salinity was 50% in Areas 1 and 2 from the northern part of the Romanian coastline, which are influenced by the Danube River freshwater input (95% required).

The level of conformity for lead in seawater was 66.70% in Area 1, 60% in Area 3 and 85.7% in Area 4 (100% required). For chrome in sediments, the level of conformity which was achieved was 66.67% in Area 2 and 75% in Area 3 (100% required).

The level of all parameters analyzed in mussels were in conformity with the EU Directive requirements.

KEYWORDS: EU Directive 2006/113/EC, seawater, marine sediment, molluscs, Black Sea

AIMS AND BACKGROUND

The EU Shellfish Waters Directive no. 97/923 was implemented in Romania based on Government Decision no. 201/2002 (*GD no. 201/2002*), supplemented and amended by Government Decision no. 467/2006 (*GD no 467/2006*) consisting of technical methods regarding the water quality for molluscs (Roşioru and Dumitrescu, 2010; Roşioru, 2012; Roşioru et al. 2012). The initial Directive is repealed and now Directive 2006/113/EC, with its amendments (*Directive No 2006/113/EC*), is adopted and applied.

In their environmental policy agenda, European maritime states have outlined the protection of species and habitats and the need to maintain quality standards in coastal and offshore waters as a priority (Orth et al.2006).

The Water Framework Directive and Marine Strategy Framework Directive call for the definition and application of biological quality elements and the development of early-warning approaches for environmental health assessment and monitoring.

Molluscs make-up 25% of the total production of marine organisms in Europe (FAO 2012). *Mytilus galloprovincialis* (mussel) is the most important mollusc in the Romanian marine area, known as mass species and marine bio-resource potentially exploitable for human consumption (Abaza et al., 2010).

Rapana venosa is an invasive species originated from the Sea of Japan. *R. venosa* has become a valuable commercial resource: its meat is exported to Japan for food and it has recently also been included in the diet of those native to the Black Sea area (Sahin et al., 2009).

The potential food safety problem associated with the consumption of bivalve shellfish is well recognized. The risk to consumers is potentiated by the fact that bivalves are minimally processed and consumed raw or slightly cooked, with viscera included.

The suitability of shoreline areas for growing and harvesting shellfish is influenced by several factors, but none more vital than water quality. A primary concern in these areas is the contamination from human and animal faeces and the related public health risks associated with the consumption of contaminated seafood. Because molluscs are filter feeders, they concentrate contaminants to a much higher concentrations than the surrounding seawater (Benttencourt et al., 2012).

The existence of appropriate legislation minimizes the probability of contamination in bivalves. In determining the public health suitability of bivalve molluscs must be considered the chemical and microbial contaminants and the physic-chemical environmental factors.

In Europe, the Directive 2006/113 EC is an important guideline for the regulation of shellfish areas. Legal requirements for live bivalve molluscs intended for direct human consumption must be accomplished in order to safeguard public health (Benttencourt et al., 2012).

MATERIAL AND METHODS

The assesment of the quality of the marine environment and of marine molluscs was carried-out in 2011 in the four designated areas for the growth and commercial exploitation (Table 1).

Table 1 - The location, area and sampling sites along transects in each of the four designated areas for shellfish growth and commercial exploitation

Areas	**Geographic limits**	**Area (nautical miles)**	**Sampling transects (location and isobath)**
Area 1	Sulina and Sfântu Gheorghe	142 Nm^2	Mila 9 45°01'N 29°39'E (5 m depth) 45°01'N 29°44'E (20 m depth) 45°01'N 29°51'E (30 m depth)
Area 2	Perişor and Chituc	215 Nm^2	Portiţa 44°40'N 29°00'E (5 m depth) 44°38'N 29°12'E (20 m depth) 44°37'N 29°20'E (30 m depth)
Area 3	Năvodari and Constanţa Harbor	109 Nm^2	Casino-Mamaia 44°14'50''N 28°38'50''E (5 m depth) 44°14'50''N 28°42'50''E (20 m depth) 44°14'50''N 28°51'E (30 m depth) Constanţa Nord 44°13'N 28°39'E (5 m depth) 44°13'N 28°42'E (20 m depth)
Area 4	Agigea and Mangalia	101 Nm^2	Eforie South 44°02'N 28°39'E (5 m depth) 44°02'N 28°40'E (20 m depth) Costineşti 43°56'N 28°39'E (5 m depth) 43°56'N 28°41'E (20 m depth) 43°56'N 28°45'E (30 m depth) Mangalia 43°50'N 28°36'E (5 m depth) 43°50'N 28°41'E (20 m depth)

Physical, chemical and biological factors of the marine environment (water and sediment) in living molluscs (water temperature, salinity, dissolved oxygen, total hydrocarbons, organohalogenated substances, heavy metals, faecal coliforms) were analyzed by the analytical methods set out in the Annex to Directive no. 2006/113/EC and Government Order no. 201/2002.

The mussels were sampled from the sea bottom at different depths using the dredge with 60 cm and 100 cm opening on board of the research vessel "Steaua de Mare 1", belonging to the National Institute for Marine Research and Development "Grigore Antipa" Constanța.

The main species monitored were the mussel *M. galloprovincialis* and the rapa whelk *R. venosa*. The quality of economically important molluscs in terms of heavy metal contamination, pesticides and microbial load was assessed within each of the 4 delimited areas.

RESULTS AND DISCUSSION

For the implementation of the EU Directives in Romania, the following steps were accomplished: (i) the delimitation of four favourable areas for the development and exploitation of molluscs in the Romanian Black Sea coastal area *(Order no. 1950/2007);* (ii) developing a monitoring system of the marine environment in the designated areas; (iii) establishment of the maximal allowed limits of organohalogenated substances and heavy metals in water, sediments and marine molluscs (*Order no. 1888/2007*).

The National Institute for Marine Research and Development (NIMRD) "Grigore Antipa" Constanța has implemented a monitoring system of littoral waters, sediments and molluscs according to the requirements of the EU Directive no. 2006/113/EC and of national requirements, and a set of mitigation measures towards the reduction of pollution and water quality required by EU legislation.

The reporting to the European Commission (EC) and the European Environmental Agency (EEA) regarding the conformity to the quality goals required by the Directive were done annually based on the data obtained during 2005-2011.

The implementation of the Shellfish Waters Directive in Romania will not only protect mollusc populations in the coastal waters from the detrimental effects of pollution and thus improve the quality of molluscs for human consumption, but will allow the export of molluscs to other EU countries (Dumitrescu et al., 2003, 2005).

This paper presents the reported data to EC and EEA, the conformity to the EU Directive no. 2006/113/EC in 2011, along the Romanian Black Sea coast (Table 2).

Table 2 -The level of compliance in 2011 for quality parameters of shellfish waters with the objectives set by Directive no. 2006/113/EC and GD no. 201/2002.

Parameter	**Level of compliance resulted in shellfish areas**				**Required level of compliance**
Area	Area 1	Area 2	Area 3	Area 4	
pH	100	100	100	100	(MA)** - 75
Salinity (g‰)	50*	50*	100	100	(MA and MR)** -95
Dissolved oxygen (% saturation)	100	100	100	100	(MA and MR)** -95
Petroleum hydrocarbons	100	100	100	100	(MA)** - without film
Organochlorinated substances a. water (µg/l)					(MA)** - 100
HCB	100	100	100	100	
Lindane	100	100	100	100	
Aldrin	100	100	100	100	
Dieldrin	100	100	100	100	
Endrin	100	100	100	100	
DDT total	100	100	100	100	
b. sediments (µg/g)					
HCB	100	100	100	100	
Lindane	100	100	100	100	
Aldrin	100	100	100	100	
Dieldrin	100	100	100	100	
Endrin	100	100	100	100	
DDT total	100	100	100	100	
c. molluscs (µg/g)					(MR)** - 100
HCB	100	100	100	100	
Lindane	100	100	100	100	
Aldrin	100	100	100	100	
Dieldrin	100	100	100	100	
Endrin	100	100	100	100	
DDT total	100	100	100	100	
Metals					
a. water (µg/l)					(MA)** - 100
Cu	100	100	100	100	
Cd	100	100	100	100	
Pb	66.70	100	60	85.70	
Ni	100	100	100	100	
Cr	100	100	100	100	

b. sediments (µg/g)					
Cu	100	100	100	100	
Cd	100	100	100	100	
Pb	100	100	100	100	
Ni	100	100	100	100	
Cr	100	66.67	75	100	
c. molluscs (µg/g)					(MR)** - 100
Cu	100	100	100	100	
Cd	100	100	100	100	
Pb	100	100	100	100	
Ni	100	100	100	100	
Cr	100	100	100	100	
Faecal coliforms (no./100 ml)	100	100	100	100	(MR)** - 75

* - % No samples with values outside the maximum allowable (MA) and/or recommended (MR)

** - % No samples with values below the maximum allowable (MA) and/or recommended (MR)

The parameters measured and the minimal/maximal values accepted were those included in the Annex of the Directive: pH, with values between 7 and 9, color that must not vary with more than 10 mgPt/l; suspended solids that must not register values higher than 30% compared to unaffected waters, salinity with values between 12-38‰, dissolved oxygen with values higher than 70%, petroleum hydrocarbons and their derivatives that must not form films, total number of faecal coliforms below 300/l00 ml (*Directive no.* 2006/113/EC). All analyses were done according to the methods included in the Annex of the Directive no. 2006/113/EC and the Government Order no. 201/2002.

The pH was ranged between 7 and 9. The total suspended solids had overall low values without impact on water quality. Water temperature was not influenced by point discharges. Salinity often evinced values below the minimal recommended threshold of 12‰. Dissolved oxygen complied well with the requirements in all four areas. The presence of petroleum hydrocarbon films was visually assessed, but was not reported within the investigated areas. Organohalogenated substances were identified in both water and sediments, but within concentrations allowed by the Ministerial Order no. 1888/2007

The level of conformity for salinity was 50% in Areas 1 and 2 from the northern part of the Romanian coastline, which are influenced by the Danube River freshwater (95% required).

The level of conformity for lead in seawater was 66.70% in Area 1, 60% in Area 3 and 85.7% in Area 4 (100% required). For chrome, in sediments, the level of conformity which was achieved was 66.67% in Area 2 and 75% in Area 3 (100% required).

Overall, organohalogenated substance and heavy metal contamination was extremely low and their concentration in mollusc meat did not present a threat for human consumption. Faecal coliforms were present in molluscs at concentrations below the threshold.

The levels of all parameters analyzed in mussels were in conformity with the EU Directive requirements.

The mussel populations in the Black Sea have drastically declined and degraded, therefore the study of adverse anthropogenic effects on natural mussel population is of prime importance.

Salinity is one of the most important environmental factors. Being relatively constant in open sea, it varies considerably in intertidal zones, estuaries and other biotopes. The ability to exist at varying salinity, euryhalinity, depends on different adaptations. Marine molluscs may live in a wide range of salinity from 4-5 up to 75-80%. They possess numerous salinity adaptations investigated to a much lesser extent than those of osmoregulators (Berger 1997). Salinity dropping below 10% has negative influence on Black Sea mussel populations. It substantially reduces filtering activity and can influence the growth, sexual maturation, survival and structure of mollusc population. Changes occurring in the size, age, sex and phenotypic structure of mussel population can be considered adaptive strategies (Shurova 2001). The optimal salinity for the development of Black Sea mussels is 15%, whereas a high mortality of embryos begins to occur at 12% (Shtyrkina, 1996).

Marine molluscs may exist in a wide salinity range without hermetization of their mantle cavity. Exposure to extremely diluted or concentrated seawater initiates an isolating reflex, firstly in the more sensitive individuals and then in all experimental animals. In addition to burrowing into bottom sediments, actively choosing the environmental and escaping from unfavourable conditions, marine molluscs may close their shells at abnormal salinity (Shurova 2001).

The most common reaction of marine mollusks to salinity change is the decrease of functional activity (the respiration rate decreases). The ability of mollusks to restore the functional activity under long-term exposure to water of changed salinity is also manifested in locomotion and byssus production rate (Berger 1986, Berger et. al., 1985).

Based on the monitoring results, the following measures for the complete fulfillment of the requirements of the Shellfish Waters Directive no. 2006/113/EC are recommended: (i) limiting the inputs of nutrients carried by the Danube; (ii) improving the ability to treat wastewater along the coastline; (iii) a rigorous control of ballast water, wastewater and garbage disposal related to shipping; (iv) limit and control the use of fertilizers and pesticides on agriculture fields close to the coastline; (v) increase awareness of the public regarding the risks of consumption of contaminated molluscs and on the needs for environmental quality (Roşioru and Dumitrescu, 2010; Roşioru, 2012; Roşioru et al., 2012).

CONCLUSIONS

1. Water and sediment quality along the Romanian coastline in 2011 was, overall, in compliance with the Shellfish Waters Directive.
2. The only parameter under the minimal value was salinity in the northern part of the Romanian coastline, due to the freshwater transported by the Danube River. The conformity was: 50% for Area 1 and Area 2, 100% for Area 3 and Area 4.
3. For marine water, the compliance level for lead was: Area 1 - 66.7%, Area 3 - 60%, Area 4 - 85.7% (concentrations above the threshold).
4. For marine sediments, the compliance level for chrome was: Area 2 - 66.67%, Area 3 - 75% (concentrations above the threshold).
5. Organochlorinated substance, metal and faecal coliform content in mussels in 2011 were at concentrations below the threshold and in compiance with the EU Directives.

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