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Monitoring harmful microalgae in Algerian coastal waters: guidelines and recommendations

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Anthropogenic pressures on Algerian coast water are increasing. The protection of bathers and seafood consumers against toxic microalgae presents a major challenge in Algeria. We present in this paper a criticism of microalgal monitoring in coastal waters. This work describes the key elements of a medium-term strategy that needs to be used. A monitoring network based on toxic phytoplankton must be established in Algeria. Its objective is to detect potential toxin-producing phytoplankton species in water.

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Introduction

The Algerian coast covers a distance of 1200 km from the Mediterranean Basin. But this coast is heavily eutrophic [1-3]. Organic pollution promotes the intensive development of microalgae [4,5]. The proliferation of toxic species is a dreaded phenomenon. Some microalgae can proliferate significantly by forming red waters, brown or green, and thus potentially that affect the ecological balance, other species are directly toxic to bathers and of seafood consumers [6]. Microalgae are poorly studied in Algeria, the current taxonomic knowledge of phytoplankton remains incomplete and data varies according to the sources. Works on phytoplankton in Algeria are generally fragmentary [7]. In Algeria, toxin-producing microalgae in coastal waters are not systematically studied. The lack of a microalgae monitoring plan is the main flaw in the coastal water quality assessment system.

Materials and methods

Phytoplanktons proliferate near the surface. Seawater samples are taken every 15 days at a 0 to1 m depth of near the coast using a Niskin bottle for bathing waters. The sampling procedures are different for surveillance of seafood products and aquaculture farming, which located in the offshore and deep water [8]. Microalgae are identified by the inverted optical microscope by the Utermöhl method [9]. A 4% preservative lugol or formol can be added and the sample is kept away from light and heat.

Results and discussion

Bathing water

In Algeria, the assessment of bathing water quality is based on physico-chemical and bacteriological analyses. This assessment is provided by the National Observatory for the Environment and Sustainable

Development (ONEDD) [11], which has several regional monitoring stations. Bacteriological analyses are made by the Directorate General for Health. Samples are taken during the summer season (Figure 1). Regulatory requirements are specified in particular in the Executive Order No. 93-164 of July 10, 1993, defining the required quality of bathing water and the inter-ministerial decree n ° the 8th of January 17th, 1994, fixing the minimum frequency of sampling, the minimum number of samples and analyses. For example, bathing water is assessed on a scale divided into three classes: poor water quality Class P, acceptable water quality Class A, good water quality Class G.

The main flaw in the current system for monitoring bathing water quality is the lack of an assessment of microalgal blooms. Sometimes algal blooms occur, forming colored waters. Somme species produce toxins dangerous to swimmers [6]. In Algeria, the only organism that regularly monitors the proliferation of microalgae in bathing waters is the Agency for the Promotion and Protection of the Algiers Coastal Region (APPL). Several planktonic blooms were recorded by APPL. During 2013 and 2014 *Noctiluca scintillans* were observed at some beaches of Algiers [12, 13]. On the coast of Chlef, during the start bathing season (May and June 2016), we collected water samples from three bathing sites. The phytoplankton community of the coastal zone of Ténès has been carefully observed under a microscope. The results showed the presence of toxic species at the three sites, such as *Leptocylindrus* sp, and *Pseudo-nitzschia sp* [14]. Therefore, the monitoring of toxic phytoplankton needs to be widespread in the 14 Algerian coastal cities to ensure better health protection for the population.

Tab 1: Triggering threshold for toxin analysis [10]

Target genera	Dinophysis Producers of lipophilic toxins (including diarric toxins)	Alexandrium Producteurs of paralytic toxins	Pseudo-nitzschia *producers of* toxines amnésiantes *amnesiac toxins.* (ASP)
Alarm thresholds	*As soon as there*	Alexandrium catenella/ tamarense : 5000 cells /liter Other lexandrium : 10000 cells /liter	*Groupsofthin*:300000 cells /liter *Groupsoflarge*: 100000 cells /liter

Seafood

As regards toxic micro-algae, given their health impact on consumers of seafood products, It, therefore, a long-term and continuous monitoring of these micro-organisms become necessary. In fact, some toxins, which remain inside algal cells, can accumulate in marine animals that feed on phytoplankton, such as shellfish [15, 16]. Three types of toxic events are currently observed in the Mediterranean, they are linked to three different kinds of micro-algae (Dinophysis, Alexandrium, and Pseudo-nitzschia) producing three different types of toxins which don't have the same risks for the consumer of shellfish (Table 1) [17]. In all cases, the toxins causing diarrhea, paralysis or amnesia, are stable to the heat and the cooking of the shells doesn't therefore decrease their toxicity [18, 19].

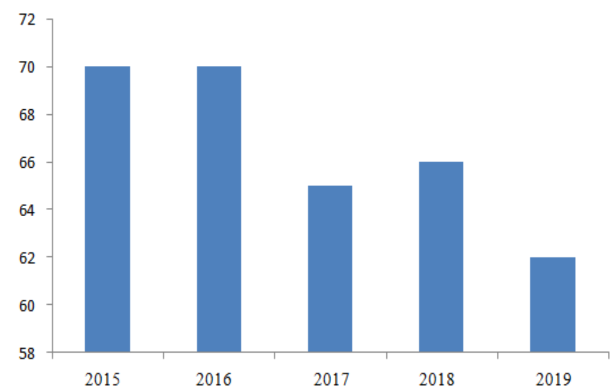

Figure 1. Number of authorized bathing sites in Algiers

In Algeria, several research institutions such as the National Centre for Fisheries and Aquaculture Research and Development (CNRDPA) have made efforts to monitor toxic phytoplankton and zooplankton in fishing and aquaculture production areas, but the results are insufficient (Table 2). To monitoring the health status of shellfish areas and their classification, Minister of Agriculture and Fisheries launched a pilot project in the City of Chlef which consists of a microbiological and physicochemical checks of aquaculture production areas to classify them into three categories (A, B, C) [20].

But there is a lack of time series data on the composition and abundance of microalgae along the Algerian coast. Effective monitoring of toxin-producing microalgae likely to accumulate in seafood must be carried out in the 14 coastal cities by a specialized public establishment, forming a monitoring network for toxic phytoplankton. The results obtained on the toxic species must be used for the start of shellfish and fish sampling for toxin analysis. In addition, the results obtained can be used to assess and classify bathing water quality. The National Observatory for the Environment and Sustainable Development must use this monitoring network to assess the state of bathing water. The aim of this monitoring network is to evaluate the biomass, abundance and composition of marine phytoplankton in coastal and lagoon waters. Coastal water sampling should be conducted the year round with a high frequency (once every fortnight).

Tab 2: Plankton biodiversity in Algeria [7]

	Year 2000	Year 2016
Phytoplankton	209	303
Toxic phytoplankton	Unknown	22
Zooplankton	80	94

Organic Pollution

In the coastal zone of Algeria, anthropogenic disturbances of many origins result in chronic pollution. It is stated that around 1000 companies have operations in the areas of building materials; petrochemistry; pharmaceutical, mechanical, electrical and electronic engineering industries; and food and paper production factories discharged into the rivers and Algiers coastline [21, 22]. The bays are also exposed to strong demographic expansion and coastal development and harbor the main Algerian port facilities.

Some other scientific studies confirmed that seawater quality is seriously degraded in the area. The information from satellites was combined to characterize seawater pollution by hydrocarbons along the Algerian coast and confirmed that sea water is mainly contaminated by pollution from various sources and is subjected to several types of urban, industrial and oil wastes[23].

The COD and BOD5 values in the Bay of Arzew were frequently above the national standard thresholds 120 mg/l, and 40 mg/l, respectively, mainly due to the presence of organic matter in the effluent, caused by dysfunction or lack of wastewater treatment, and de-oiling plants [24].

Several, sometimes severe, cases of eutrophication are evident, especially in enclosed coastal bays which receive elevated nutrient loads from rivers, together with direct discharges of untreated domestic and industrial waste. Land-based activities (urbanisation, industry and agriculture) represent the main source of pollution into the Mediterranean Sea. In the case of urban and industrial pollution, the main problem is the rapid population growth along the southern coasts of the Mediterranean, where there are fewer legal instruments and lesser environmental infrastructure investments. It should also be known that one third of the Mediterranean population is currently concentrated in the coastal regions.

Two rivers flow into the Bay of Algiers, El Hamiz and El Harrach (970 km^2; 6 m^3/h); the latter drains the domestic and industrial wastewaters of the city of Algiers itself, and only some of the wastewater discharged into the is[25]. The greatest pollutant flow along the Algerian coasts (100 000 t/year of organic chemical compounds, 175 000 t/year of suspended matter, 1500 t/year of nitrogen, and 4000 t/year of phosphorus) is discharged into the marine area impacted by the Algiers metropolis [22, 25].

Analysis of sea water samples carried out every season showed presence of important pollution in the gulf of Arzew and coastal waters [26]. It was found that some of wastewater is still discharged into the sea without any prior treatment with the absence of treatment systems. Due to pollution level, 213 of 487 beaches on the Algerian coast were prohibited to bathing. In recent years, several industries have been active in Arzew. There are mainly chemical and petrochemical industries. These industries, like all human activities, produce various effluents and waste. Not only untreated effluent but also petrochemicals presented along the coast also caused adverse effects on marine fauna and flora. Estimated quantities of more than 20,000 tons of petrochemicals are illegally dumped by oil and LNG tankers into the waters. It was put forward that more than 300,000 tons of oil are lost or discharged annually into the Mediterranean Sea [24]. The analysis of sea water samples taken at different locations [26] and pollution level are summarized in the Table 3. It is seen that very high concentrations were obtained and the mean values exceed permissible standards.

Table 3. Results of the sea water analysis (as mg/L), summarized from [26].

Parameter	Range of analysis result	Average value	National standard
SS	294 - 3062	-	35
COD	460 - 4944	1600	120
BOD_5	208 - 2002	583	40

Conclusions

Microalgae are very sensitive to a variety of organic and inorganic toxicants. A monitoring network for toxic microalgae should cover the 14 coastal cities. In order to succeed in setting up this network, it is necessary to include the main bodies which monitor bathing water quality and phytoplankton proliferation. The organization and tasks of the monitoring network for toxic microalgae must be specified by regulation. The existence of regulations specifying sampling frequency, the analysis protocol and toxicity thresholds for microalgae are essential to the proper functioning of the monitoring network.

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