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Physico-chemical characterization of surface waters of the west coast of Algeria: Bay of Mostaganem and Cheliff estuary

Fatima Kies[1]& Ahmed Kerkouf[2]

1- Department of the Environment and Earth, University of Milano Bicocca, Italy.

Author for correspondence, email: f.kies@campus.unimib.it

2- Department of Environmental Sciences, Faculty of Natural Sciences and Life, University of Sidi Belabess, Algeria

Abstract

A follow-up in 2013 of the indicators of pollution (temperature, hydrogen potential, salinity, dissolved oxygen, ammonium, nitrites, nitrates, orthophosphates, ortho silicates, biological oxygen demand, chemical oxygen demand, suspended solids) in surface water was performed, in order to estimate the physicochemical quality of the west coast of Algeria. The results obtained revealed the existence of a water contamination by domestic and industrial waste water conveyed to the north by the Cheliff River for discharge into the Bay of Mostaganem, marked by significant space-time variations. In January (24 mg / l), the values of nitrates recorded west of the mouth of Cheliff exceed norms. Ammonium records strong concentrations in January (1.2 mg NH4+/ l) and in February (0.8 mg /l). Nitrites such lagging of high contents in January (NO2- 0.99 mg / l) and February (NO2- 0.59 mg /l), respectively.

The orthophosphates post a maximum concentration in January (6.6mg PO43-/ l). In addition, the organic matter rate measured in surface water is maximum during periods of flooding especially in January (7.51 mg / l) and lowest in the exceptionally dry season in August (2.19 mg / l).
Keywords: Water quality, pollution indicators, Cheliff estuary, bay of Mostaganem, West coast of Algeria.

Résumé

Un suivi en 2013 des indicateurs de pollution (température, potentiel d'hydrogène, salinité, oxygène dissous, ammonium, nitrites, nitrates, ortho phosphates, demande biologique en oxygène, demande chimique en oxygène, matière en suspension) dans les eaux de surface, a été effectué, en vue d'estimer la qualité physico-chimique de la côte Ouest Algérienne. Les résultats obtenus ont révélé l'existence d'une contamination de l'eau par les eaux usées domestiques et industrielles véhiculées vers le nord, par la rivière de Cheliff pour les déverser dans la baie de Mostaganem, est marquée par des variations spatio-temporelles importantes. Au mois de janvier (24 mg/l), les valeurs de nitrates enregistrées à l'ouest de l'embouchure de Cheliff dépassent les normes. L'ammonium enregistre des fortes concentrations en janvier (1.2 mg NH_4^+/ l) et en février (0.8 mg /l). Les nitrites accusent des teneurs élevées notamment en janvier (0.99 mg NO_2^-/l) et en février (0.59 mg NO_2^-/l), respectivement. Les ortho phosphates affichent une concentration maximale en janvier (6.6 mg PO_4^{3-}/ l). Par ailleurs, le taux de matière organique mesurée dans les eaux de surface est maximum pendant les périodes de crues spécialement en janvier (7.51 mg /l) et minimum pendant la saison sèche exceptionnellement en aout (2.19 mg /l).

Mots-clés : Qualité de l'eau, indicateurs de pollution, estuaire de Cheliff, baie de Mostaganem, côte ouest Algérienne.

Introduction

For decades, the Cheliff river receives untreated wastewater resulting from industrial, agricultural and urban activities of nine (09) cities of the country that sends to the Sea for discharge at the mouth (Belhadj . 2001, Grimes et al., 2003, Kies & Taibi. 2011,Kies et al.2012). To what extent, these pollutants can they impair the quality of sea water, next to the marine fishing activities in the area? Search for answers to this question is the objective of this research work. It is intended to answer, based on physico-chemical analyzes (Redfield et al. 1963, Nisbet & Verneaux. 1970, Aubert et al. 1973 Aminot & Chausspied. 1983; Rodier. 1996 Sigg et al., 2000, Al-Asadi et al. 2005, Thieu. 2009, Kies et al. 2012), all these analyzes are intended to determine the degree of impact of the Cheliff river on the quality sea water. In addition, pollutants can cause changes in the organoleptic characteristics of water (Aminot & Chausspied. 1983, Rodier. 1996, Belhadj. 2001) as well as toxic phenomena (Bougis. 1974, Belin & Raffin. 1998, Billen & Gargnier. 2007, Kies et al. 2012). That pollution by these excesses is attributed to agricultural, industrial, fisheries or domestic, we found it useful to combine the methods of analysis parameters indicative of "Pollution". Industrial and agricultural wastewater discharges to the Cheliff river in the marine environment of the Bay of Mostaganem, are an important input of organic matter [Biological Oxygen Demand (BOD 5), suspended matter (SPM), etc ...] and mineral (especially nutrients) are the nitrogenous substances, phosphorus and silicate (N, P, Si) (Redfield et al. 1963, Vollenweider. 1971, Bougis. 1974, Belin et al. 2001, Gagneur& Kara. 2001, Al- Asadi et al. 2005c, Billen & Garnier. 2007, Garnier et al. 2008, Garnier et al. 2010, Kies et al. 2012). It is therefore necessary to know the quality and quantity of incoming flow and dissipation of pollution in the liquid part to get a good assessment of the quality of the receiving natural waters (Cheliff River, Cheliff estuary and bay of Mostaganem) and its influence on seawater quality (Conley et al. 1993, Gagneur & Kara. 2001, al-Asadi et al. 2005c, Billen & Garnier. 2007, Kies & Taibi. 2011 Kies et al. 2012).

This research is considered a pioneering study of the western region of Algeria (Bay of Mostaganem). This study focuses on determining the degree of the influence of the Cheliff river variations caused by climate change (Bouras. 2007, Kies & Kerfouf. 2014). Our question is: At what level is there, the level of pollution? And what are the responses of the marine coastal ecosystem Mostaganem deal with stress caused by the degradation of marine water quality? The realization of physico-chemical analysis of the two sites' River Sea "has pushed us to make bio-statistical analyzes under" C "in order to understand the relationship between nutrient intakes of Cheliff river and marine ecosystem of Mostaganem (Kies et al., 2012, Kies & Kerfouf. 2014). Also the analysis of the influence of the Cheliff river on the evolution of the marine water quality, during periods of connectivity and periods of non-connectivity (Kies et al., 2012, Kies & Kerfouf. 2014). Our study is focused on the characterization of the coast of Mostaganem and evaluation of the degree of pollution in this area (Kies & Taibi. 2011 Kies et al. 2012, Kies & Kerfouf. 2014). The objective of this study is to evaluate the physico-chemical quality of surface waters of the bay. Thus, temporal and spatial studies monitor the seasonal change in temperature, pH, dissolved oxygen, ammonium, nitrites, nitrates, ortho phosphates, ortho silicates; suspended solids, BOD in 2013.

Materials and Methods

The excessive increase of nutrients and suspended matter is a form of pollution that has significant negative impact on the marine flora and fauna in 1996 and freshwater (Bougie. 1974, Persson. 1976, Rodier. 1996, Sigget al. 2000, Billen & Garnier. 2007). For this purpose, to evaluate and analyze, we can only measure to quantify (Rodier. 1996, Sigg et al. 2000, Ramade. 2000). This is the reason for using the physico-chemical analysis to identify and characterize the water quality (Nisbet & Verneaux. 1970, Bougis. 1974, Aminot & Chausspied. 1983, Ramade. 2000). The physico-chemical analysis is based on the use of methods, which represent all the techniques to assess the physical characteristics of the water (temperature, hydrodynamismes) and chemical composition of some components (nutrients MY) for a given aquatic habitat. Two of these conventional analytical methods are spectrophotometry and gravimetry (Aminot & Chausspied.1983, Rodier. 1996, Kies & Taibi. 2011).

Selection of sampling sites: samples (Fig. 1) were performed at different stations that have been selected according to their distance from the mouth of the Cheliff River that is to say at a distance from the latter. We have three stations, East (E), the estuary (Emb) And the West station (W).

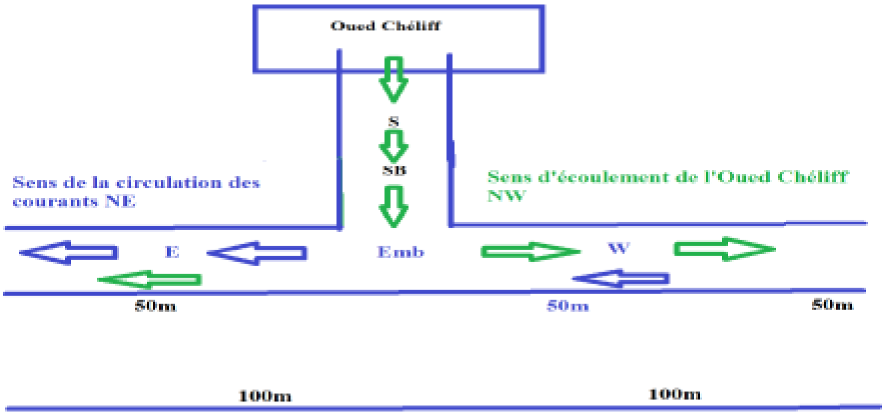

Figure 1: Points of the liquid phase samples for physico-chemical analyzes (Kies et al.2012).

The water samples sea for physico-chemical analyzes were performed at different times of the year 2013 (Fig. 2).

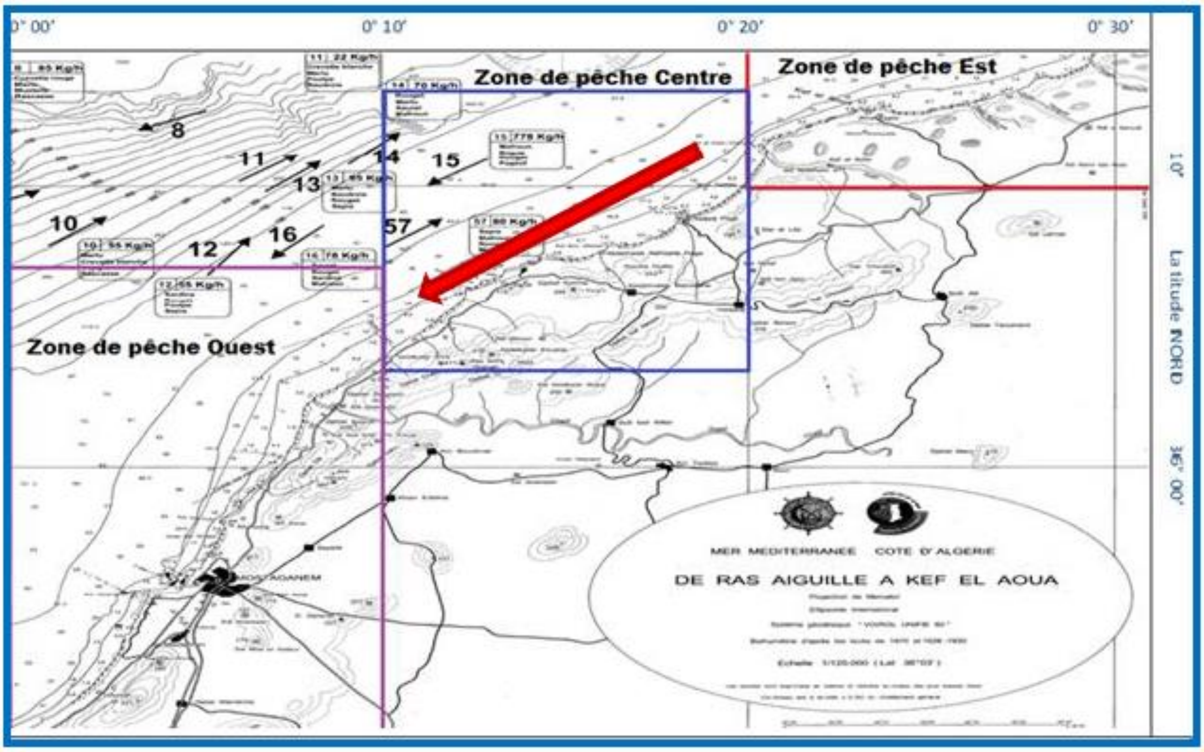

Figure 2: Map of location of the study area (Kies et al.2012, modified).

Packaging and transportation of samples: packaging and transportation of samples is in a portable cooler with a sufficient reserve of cold, especially during warm periods and this to avoid any chemical reaction and alteration of the initial value of the parameters to be measured (Rodier. 1996). So, a temperature of 4 ° C is suitable for short-term storage; beyond, it is preferable to use the freeze. We can keep the samples in the refrigerator at 4 ° C if analysis should take place later.

Laboratory measures: the suspended solids (TSS), dissolved oxygen (DO), nitrite (NO2), nitrate (NO3), ammonium (NH4 +), ortho-phosphates (PO43-) orthosilicate (SiO2), and the biochemical oxygen demand (BOD) were determined by the methods mentioned or approved by AFNOR by Rodier. (1996).

Results and Discussion

Much of the data is presented in graphical form as a function of time and space, covering the period from 2013 to the physico-chemical parameters (Figs. 3 and 4).

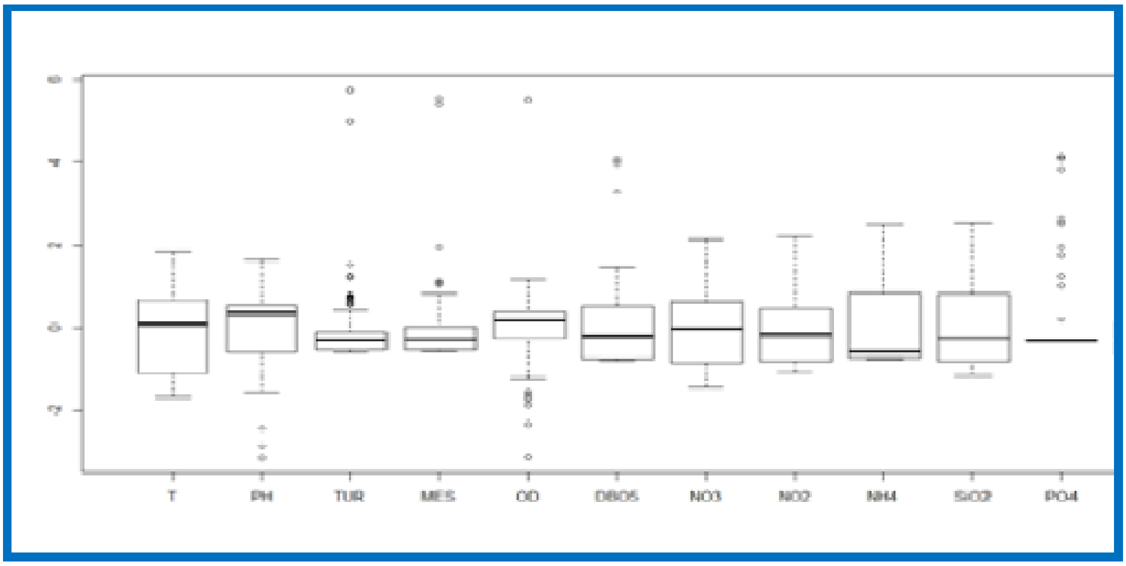

Figure 3: Variability of physico-chemical parameters during the year 2013 in different stations of Cheliff river and sea water of Mostaganem (during the periods of connectivity: river-sea).

The temperature of the study area is between 10 and 25 ° C Cheliff the river and is in the range of 11.5 to 24.4 ° C sea water on the coast of Mostaganem. Throughout the sampling period, the average temperature obtained in the marine waters of Mostaganem is about de16.8 ° C during periods of connectivity (Fig.03) and 20.9 ° C for periods not connectivity (Fig. 4). This variation is normal, with the exception of December 2013, have a temperature of 17 ° C, whereas the latter should normally be less than this value. These variations are probably due to climate change undergone by the earth.

pH measurement gives approximately the same value for all sampling points and it is between 7.4 and 8.3 in water Cheliff River and is from 7.1 to 8.4 in sea water coast Mostaganem. Mean Ocean Water is 7.8 during periods of connectivity River-Sea (Fig. 3) and 8.0 during periods of non-connectivity (Fig. 04). An alkaline pH is Duala presence of basic elements transported by Cheliff River. For aquatic life possible freshwater medium pH should be between 7 and 8. Sea water, pH favorable to life is 8.2 to 8.3, which corresponds to normal values.

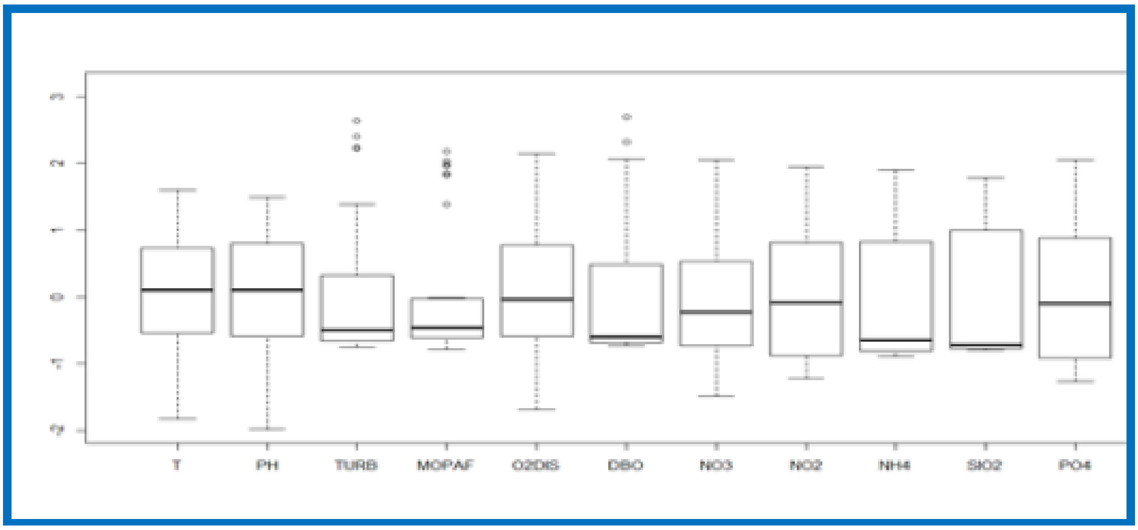

Figure 4: Variability of physico-chemical parameters during the year 2013 in different stations of Cheliff river and sea water of Mostaganem (during the periods of non-connectivity: river-sea).

Intakes of nitrate (Fig. 3) are very high. The recorded values exceed the standard (0.003 mg / l) and suggest that this is the leaching of soil that led to the enrichment of river nitrate Cheliff especially in the month of February 2013 (22 mg / l). In December 2013, the concentration is 28 mg / l at the mouth, 24 mg / l in the west of the mouth and 11 mg / l in the east of the mouth. Therefore, we can say that the use of nitrogen as nitrate is turned towards the East than to the West and, throughout the study period.

The measured concentration of nitrite is between a minimum of 0 mg / l and a maximum of 0.99 mg / l in sea water while it is between 0 and 1.51 mg / l in water of Cheliff River. This variation is due to the richness of the area nitrogenous materials from farmland adjacent industrial activities located near the Cheliff River. Nitrites from fertilizers used to fertilize farmland. When the land is washed away by the action of rainwater runoff, nitrites are transported by the river to the Sea. According to Figures 03 and 04, we can deduce that the rate of nitrites increases when the rate of ammonia decreases in periods of non-connectivity (Fig. 4). This is due to the conversion of ammonia into nitrites. It be noted that depletion during periods of connectivity nitrite (Fig 3) Is due to the evolution of nitrogen compounds (ammonification: $NO2 + NH4$); therefore, it can be deduced that it represents an index of pollution.

The ammonium concentration determined in samples is between 0.3 mg / l and 0.9 mg / l (threshold value exceeding the standard 0.003 mg / l) in periods of non-connectivity (Fig. 04) while that during periods of connectivity (Fig. 3) is limited between 0 mg / l and 6.6 mg / l. As nitrite of the Cheliff River that is carries nitrogen compounds from agricultural activities, estimated to average 0.43 mg / l in sea water during periods of non-connectivity but are very high during periods of connectivity river-sea (flood periods) and evaluated at 1.2 mg / l. This is due to that, organic and nitrogen substances are diluted and are distributed in the marine environment by the vertical and horizontal currents, leading to a decrease in their concentration.

Changes in phosphates concentration during the study period is shown in Figures 03 and 04. The recorded values are high and very variable. They range from 0 to 6.6 mg / l, thus exceeding the standard (0.06 mg / l) to the Sea during periods of connectivity, between 0- and 0.85 mg / l for periods of non-connectivity River-Sea.

This concentration results from agricultural fertilizer, which in this case are composed mainly of nitrogen, phosphate and potassium (NKP). During the months of October, November and December, the phosphates concentration is high due to the swell which causes an increase of the material in suspension rich on minerals such us phosphates. This period is characterized by a large intake of nutrients (N, P, Si) for the development of phytoplankton species during warm periods (February, March, April and May) which results in decreased concentrations of phosphates.

Silica varies throughout the sampling region between 0 and 19.5 mg / l, this value exceeds the standard set at 0.14 mg / l. The high rate of silica resulting from the massive presence of siliceous components in the coastal rock leached and transported by the river to the Sea. The maximum concentration was measured in samples taken at the mouth in March 2013, these high levels of silica were confirmed by the identification of phytoplankton species in siliceous tests, such as diatoms (Kies & Taibi. 2011 Kies et al.2012). The dissolved inorganic nitrogen and silicate annual flow is significantly higher during the period of monitoring the flow of river in 2013, showing the importance of soil leaching for these two nutrients. The flow of phosphate, however, has remained relatively stable.

Outside flood periods, the suspended matter content is almost always less than 50 mg / l (from April to September 2013). Stations located in Sea water, it reaches 3985 mg / l in February 2013 in the West, because of horizontal ocean currents that go mainly to the west (Fig. 03 & 04) .So, the solid particles may have an inhibitory action on the fish species directly compromising the development of their eggs (asphyxia), or reducing the stock of available food. The absence of remains of macro - plants on the coast suggests that the seabed in the area is devoid of flore. This limiting factor for both the installation and development of wildlife and especially of benthic fauna as daylight accessed easily in this kind of habitat (Kies & Taibi. 2011 Kies et al. 2012) .In addition, the suspended material is a good medium for bacteria that are usually responsible for the partial or total destruction of organs tract of fish species (Kies & Taibi. 2011 Kies et al. 2012).

BOD5 values exceeding the norms, for flood periods or connectivity river-sea. For sea water, the value of the DBO5 is high than 10 mg / l. The values of the DBO5 are about (992 mg / l) in October 2013 to the west of the mouth of the Cheliff River, and (442 mg / l) to the east of it. What could thus correspond to poor water quality? The increased load of biodegradable material (BOD) increases bacteria that are heterotrophic and Cyanophyceae, which means they require organic matter for growth. It is also noteworthy that biodegradability is activated mainly from the mouth or with the same concentration as is the case in April 2013 (360 mg / l at the mouth, 368 mg / l to West and 331 mg / l in the East). Or with different concentrations up to the West in December 2013 (991 mg / l) and the values of 422 mg / l in the east and 118 mg / l at the mouth (Figs. 3 &4). Minimum values are observed during periods of non-connectivity (River-Sea) in February 2013 (5.9 mg / l at the mouth) and August 2013 (19 mg / l at the mouth).

Conclusion

The results of physico-chemical analyzes of water from the river, the sea and the estuary during flood periods showed that Cheliff pours a considerable amount of pollutants in the river mouth area. The study revealed the presence of nitrogen, phosphorus and sulfur substances; suspended matter (organic and inorganic) is considerable. According to scientific studies realizes par Kies&Taibi (2011), Kies et al.(2012) and this work (2013), pollutants detected have a negative impact on the marine fauna and flora of the Bay of Mostaganem, particularly in the area of the mouth of Cheliff. Because of winds east coasts and ocean currents that result, polluted water head in flood periods to coast. Les huge amounts of solid particles in the water prevent the penetration of sunlight for this; the development of the flora is reduced to a minimum in the area of the mouth as confirmed by the observation of the marine benthos immersions. In addition, it is likely that the plant can't be built in the study area because of the strong horizontal currents and the nature of the substrate (sandy bottom mixed with clay). This vegetable poverty therefore implies a very low diversity of wildlife. Companies' cities upstream of the river minimize their production costs by discharging waste that creates damage in city of Mostaganem (downstream). So, according to Prud'Homme (1980) the problem of pollution, by Cheliff (Taibi & Kies. 2011, Kies et al.2012) river is not a matter of "*all or nothing*" is rather a matter of "*more or less*". This is explained by the fact that the consequences of pollution increases with the degree of contamination and the cost of non-pollution decreases with it. This research has highlighted the influence of the Cheliff River on the marine ecosystem, including the sharp deterioration of the water quality marked by increased pollution indicators.

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