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Potential Harmful Dinoflagellates of Iraqi Coastal Marine Waters

Ibrahem H.F. ✉, Al-Shawi I.J.M.
Marine Science Center, University of Basrah, Iraq
✉ Corresponding author email: feryal07@yahoo.com
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Abstract Ecological scientists in many countries routinely monitor their coastal waters for potential harmful algae in order to prevent harvesting of contaminated sea food, but this is not the cause for Iraq The present work is the first attempt to recognize the potential harmful algae in the coastal waters of Iraq. Samples were collected from different locations along Shatt Al-Arab estuary and coastal line of Iraq for two years from February 2013 to December 2014. The water temperature during sampling period ranging between (26.67℃-31.84℃) at all stations. The salinity were fluctuated between (15-45.7)‰, N:P ratio were (3-26). In this study (16) species of potential harmful algae were recorded during this period some of these are toxic. The dominate species were *Ceratium furca*, *Dinophysis caudata*, *Dinophysis mile*, *Noctiluca scintillans*, *Prorocentrum micans*, *Protoperidinium divergens*, *P. despressum*. Four species were recorded for first time in Iraqi costal waters including *C. declinatum*, *Dinophysis acuminatum*, *Protoperidinium steini* and *P. subinerme*.
Keywords: HABs; Iraqi coastal marine water; toxic algae; dinoflagellates

Introduction

There is a growing belief that harmful algal blooms (HABs) are increasingly spreading to all the oceans of the world, coastal seas, estuaries and lagoons(Ajuzie and Houvenaghel, 2009).These toxins may harm wildlife and humans when ingested or inhaled. Other algal blooms may negatively affect aquatic organisms by reducing oxygen in the water, resulting in significant fih kills (Al-Ansi et al., 2002). but they do not produce toxins and are not considered HABs.

Dinoflagellates are a part of the major HABs organisms. They belong to the diverse group of unicellular eukaryotes which are motile and largely photosynthetic (Leander & Keeling, 2004),. Some are mixotrophic, exhibiting both autotrophic and phagotrophic mode of feeding (Sherr and Sherr, 2002). They are a major group of primary producers that constitute the basic source of energy in aquatic food webs. Some dinoflagellates are, however, harmful to other aquatic biota, and to man who relies heavily on the aquatic environment for food and recreation (Ajuzie 2002, 2008). Despite HABs have grave consequences on the environmental public health and local economy there is no attention was given so far to monitor them in our coastal water. There are many factors that increasing HABs Such as warm surface water temperatures, reduced grazing by predators, sunlight, increases nutrients, low flow conditions, Still water, Calm weather, Release of nutrients from sediments and Low salinity (Sheppard et al., 2009). Our work is an attempt to study the HABs species in our coastal water for the first time to prepare a guide for these algae species and put a base for more future studies.

Harmful Algal Blooms in the Gulf and Iraqi Coastal Waters

A rise in nutrients levels around mariculture and discharge of untreated sewage water into Kuwait Bay led to a HAB incident that affected the caged, as well as the wild fish and causing a massive fish kill in 1999(Al-Yamani et al., 2000). The HABs incidences have been also reported from Abu Dhabi, Dubai, Ajman Fujairah, Iran and Oman(Sheppard et al., 2009).

There is one study on dinoflagellates in Iraqi coastal area (Al-Handal and Abdullaah,1995). They were recorded 36 species of dinoflagellates and pointed out that most of these species recorded were distributed to the marine environment by currents which play an important role in the transfer of these species from different regions of the Gulf to the study area.

Al-Aarajy (2001) studid the fish kills that have occurred in the waters of Khor Abdullah during June 1999 and linked it to some types of dinoflagellate *Prymensium parvum*, *Prorocentrum micans* and *Peridinium* sp. Al-Shawi(2010) observed HABs during September 2008 in Khor Al-Zubair lagoon and recoded 10 species of dinoflagellates, the dominant species were *Ceratium furca* and *Dinophysis caudata*. Thangaraja et al. (2007) summarized the documented information on the HABs and red tide phenomena of Gulf of Oman and outer Arabian Sea ROPME Sea Area (RSA) 1987, the HABs species showed geographical distribution, spatial and temporal occurrence and their impacts in Omani waters were described and discussed.

Materials and Methods

Description of Study Area

The Gulf is a semi-enclosed water body its area about (226000) km^2 and the length ranges between (990-1000) km while the width (56-338) km. Because of the shallowness of its waters and high temperatures is a marked increase in evaporation rates and an increase in the values of salinity range between (40-50) part per thousand in the coastal areas (Michel et al., 1986; Ismail et al., 2007). The length of the Iraqi coast about 64 km, which is short compared with the Kuwaiti coast, ranging in length from 170-200 km, and Iran's coast up to 2000 km (Al-Yamani et al., 2004; Al-Nafisi, 2009).The north –west part of Gulf received major input through the Shatt Al-Arab estuary, Tigris and Euphrates rivers join near Garmatt Ali and form Shatt Al-Arab which turns to estuary at the end parts and enter the Gulf. Four stations were selected to collected phytoplankton samples and to investigated potential harmful species The first station was located at the Shatt Al-Arab estuary near Faw city and the second in the outer bar of the Shatt Al-Arab estuary near Kreen Area while the third located close to the Basra terminal oil port and the fourth selected at Khor Abdulla. All the stations are shown in the Figure 1.

Field and lab work

Present work were obtained along the Shatt Al-Arab estuary and north west Arabian Gulf for four stations from February 2013 to December 2014 (Fig.1). Water quality measured in the field by using (YSA) multimeter made in USA. Phytoplankton collected by net and kept in 1L plastic bottles after preserved by adding drops of lugol solution. Phytoplankton samples were examined by using light microscope. The microphotographs of phytoplankton species were taken by employing a camera that fixed at the top of microscope various references were used to identified the studied phytoplankton including: Dodge(1982), Dodge (1985), Taylor (1987), and Perry (2003).

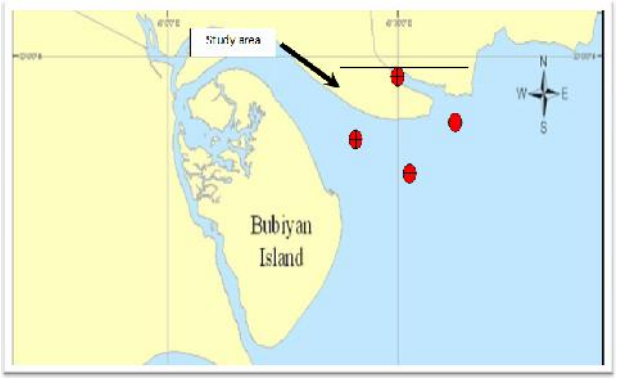

Figure 1 Sampling Area in the north west Arabian Gulf

Results

Environmental Factors

Water temperature, pH, salinity, Turbidity, and dissolved oxygen and N:P ratios ranges in all stations during study period are represented in the Table(1). The water temperature during sampling period ranging between (26.67-31.84)℃ at all stations. The salinity were lowest at station (1) ranging between (15-17) ptu and highest in the other stations (43.8-45.7) ptu. Turbidity were increasing in the station(4) while the lowest value recorded at station(2) and (3). The highest values of dissolved oxygen represented at station(3) and (2) respectively while the lowest recorded at stations(1) and (2) respectively. N:P two stations respectively while the lowest recoded at station (1) and (3).

Dinoglagellates

A total of sixteen potentially harmful dinoflgellates were recorded in Iraqi coastal waters during this study. They including specie belonging to fife genra *Ceratium*, *Dinophysis*, *Noctiluca*, *Prorocentrum*, *Protoperidinium*. Some of these organisms are potentially toxic and others blooms forming flagellates Table 2. Four species were recorded for first time in Iraqi coastal water *C. declinatum* (Karsten) Fig.2(15), *Dinophysis acuminate* Fig.2(3), *Protoperidinium steini* (Balech) Fig.2(4). *P. subinerme* Fig.2(6).

Table 1 Ranges of some environmental factors during study period.

Factors	Station(1)	Station(2)	Station(3)	Station(4)
Water Temperature(℃)	26.67-28.0	30.11-31.0	31.13-31.84	30.-31.3
pH	8.03-8.08	7.3-8.4	8.36-9.04	8.52-8.53
Salinity(g/l)	15.4-17.1	44.5-45.4	43.8-44.5	32.6-45.7
Turbidity(NTU)	23.6	0.6-5.0	0.00-1.4	121-205
Dissolved Oxygen(mg/l)	6.64-8.46	5.73-10.16	8.77-11.73	7.57-9.39
N:P ratio	6-8	10-21	3-12	8-26

Table 2 Occurrence of the Some Harmful Algae identified at NW Arabian Gulf during study period.

Species	S(1)	S(2)	S(3)	S(4)
Ceratium furca	+	+++	+++	++
Ceratium trichoceros	-	++	++	++
C. tripos	-	++	++	++
Ceratium horridum	-	+	+	+
Ceratium fusus	-	+++	+++	+++
C. declinatum (Karsten)	-	++	++	++
Ceratium macroceros	_	+	+	+
Dinophysis caudata Sav.-Kent	+	+++	+++	+++
Dinophysis acuminate	_	+	+	+
Dinophysis miles		++	++	++
Noctiluca scintillans (Macartnei) Kofoid et Swezy 1921	+	++	+++	++
Prorocentrum micans	+	+++	+++	+++
Protoperidinium steini (Balech)	-	+	+	+
P. divergens (Ehr.)	-	+	+	+
P. despressum (Balech)	-	+	+	+
P. subinerme	-	+	+	+

Note: (-) Absent, (+) Present, (++) Abunda, (+++) Commen

Discussion

This work was basically designed to provide a qualitative account of potentially harmful algae in the Iraqi coastal waters. The low salinity values recorded in station one due to the effect of freshwater of Shatt Al-Arab, while other stations(marine) are less diluted by fresh water inputs. The temperature followed the seasonal pattern of Iraqi climate. The turbidity were highest at stations (4) compared with other staions due to high current speed in the mouth of Khor Abdulla. The N:P ratios were increasing in the stations (2 and 4) while decreasing at station one.

This is a very first attempt to investigate the prescience of HABs dinoflagellates in Iraq coastal waters. It is expected to mark the beginning of HABs monitoring in the country small account of the dinofagellates were observes in station one Shatt Al-Arab estuary because this station has fast flowing waters which may have been responsible for the absence of potential harmful dinoflagellates, and may be due to lowest values of N:P ratio that is limiting factor for several species of dinoflagellates (Faus, 2000)

There are many researcher who studied the diatoms of this area among them(Al-Handal, 1988; Al-Handal er al, 199; Al-Handal and Al-Rekabi,1994; Al-Handal, 2009), but none of them were focusing on harmful dinoflagellates. The most important and dominant genus observed during this study are genus *Ceratium*, this genuse is wide distributed in our region, (7) species were recorded were dominant at stations (2,3 and 4) The high density and occurrence is ***Ceratium furca*** which is a high salinity tolerant species, tends to prefer conditions where nitrogen (N) rather phosphorus (P) serves as the growth-limiting nutrient. *C. furca* is non-toxic, but it has the potentials to form

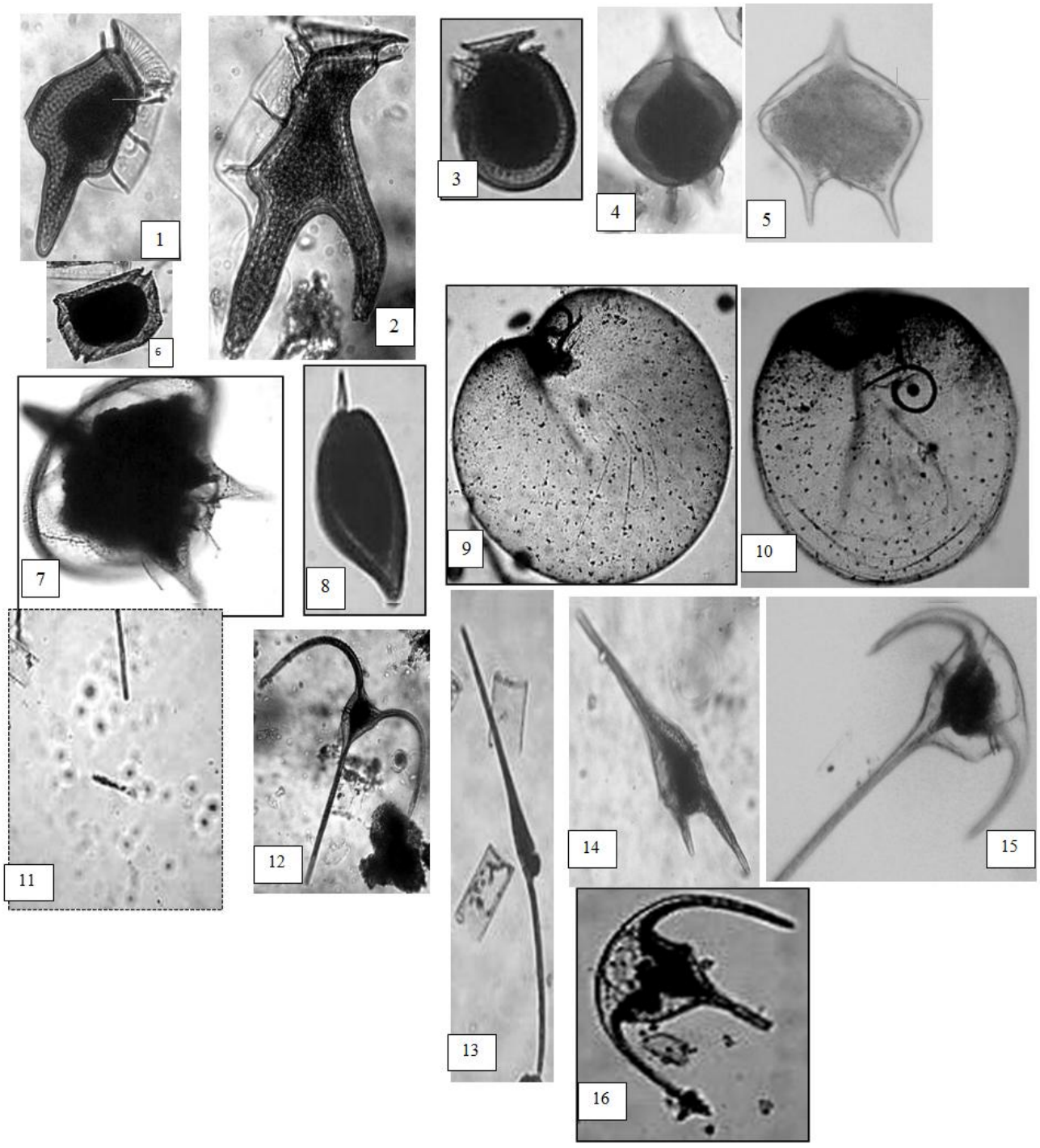

Figure 2 Images of Some Potential Harmful Algae from Iraqi Costal Waters: (1) *Dinophysis caudata* (2) *D. miles* (3) *D. acuminate* (4) *Protoperidinium steini* (5) *P. divergens* (6) *P. subinerme* (7) *P. despressu* (8) *Prorocentrum micans* (9-10) *Noctiluca scintillans* (11) *Ceratium horridum* (12) *C. trichoceros* (13) *C. fusus* (14) *C. furca* (15) *C. declinatum* (16) *C tripos.*

massive blooms (Faust, 2000). Such blooms are capable of killing aquatic biota. In 2001 *C. furca* blooms killed 100s to 1000s of gilthead sea bream (*Sparus auratus*) in aquaculture net pens in the Kuwait Bay (Glibert et al 2002). ***Ceratium fusus*** tolerates a wider range of salinity both N and P are equally growth limiting nutrients for *C. fusus*. In the less saline waters P is expected to be the growth-limiting nutrient, while in the more saline waters N is expected to control its growth. *C. fusus* is non toxic (Taylor et al.,1995). However, it is a fish killer, kills aquatic animals by depleting water oxygen

content during high biomass blooms. The anther important genus is ***Dinophysis*** species recorded here *D. caudate*, *D. acuminate* and *D. miles*, *D. caudata* appears to tolerate a wider range of salinity (21-34 ‰). The apparent growth-limiting nutrient for the *Dinophysis* species is N (Singh et al.,2014). These species are all potentially toxic. It is well established that several *Dinophysis* species produce both dinophysistoxins and okadaic acid, all of which cause DSP (Diariatic Shellfish Poisoning) (Bravo et al., 2001). ***Prorocentrum micans*** these species was present in water samples collected from marine environments N is apparently the growth-limiting nutrient for the species. *P. micans* is a toxic dinoflagellate, toxicity in this species has not been demonstrated. However, blooms of *P. micans* have been reported to kill aquatic biota. A bloom of this species alongside that of *C. furca* caused fish mortalities in Iraqi coastal waters in 1999 when they caused anoxic conditions that resulted in the suffocation of the fishes (Al-Aarajy, 2001).

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