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Harmful algae

in

Egyptian Mediterranean Sea

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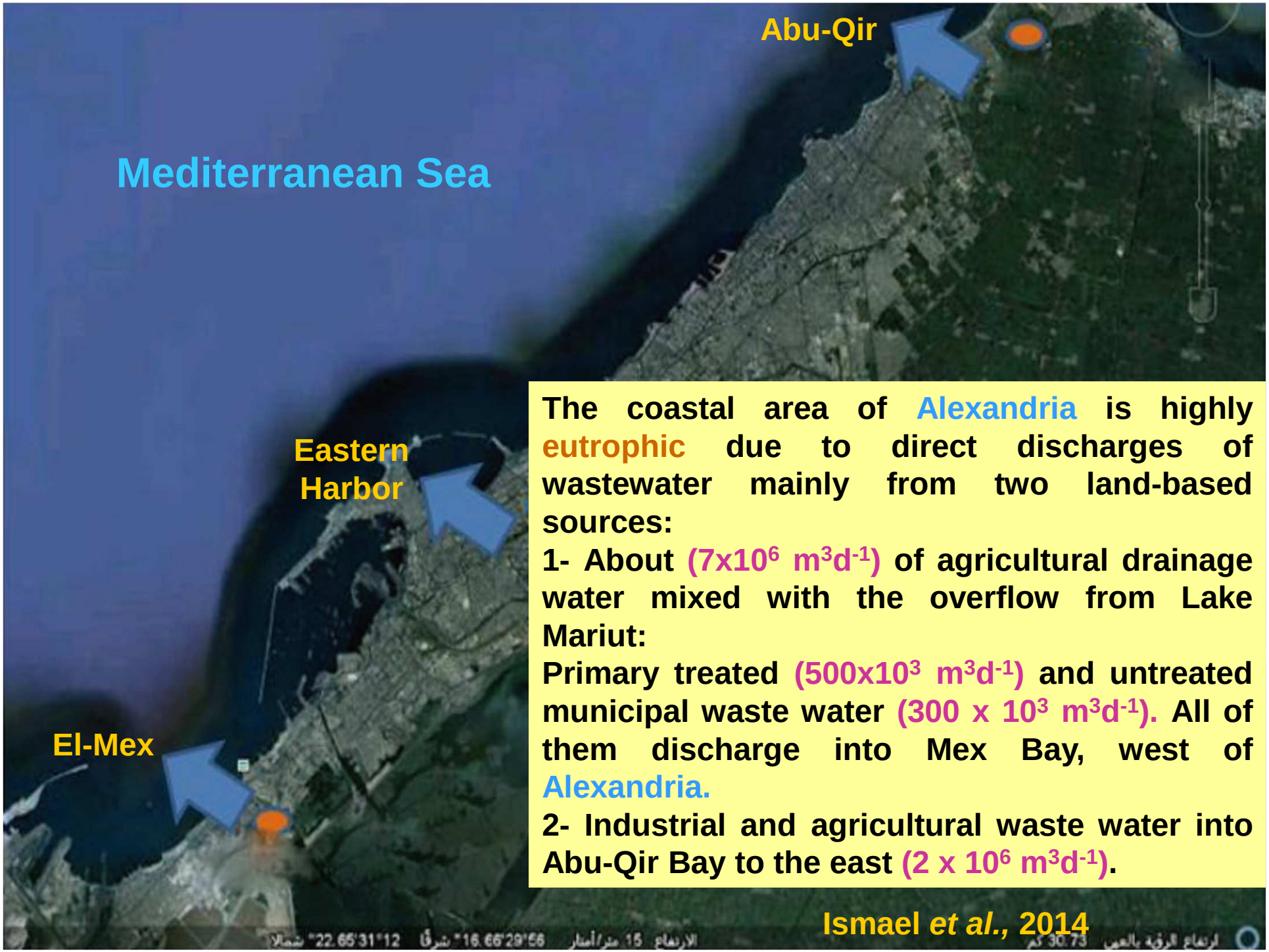
History of Harmful algae in Egypt:

- **Harmful algal blooms are not new phenomena. In the last decades Phytoplankton investigations in Egypt began with the observations of recurrent red tides in the Eastern Harbor of Alexandria since 1960. The red tides were caused by the newly described *Alexandrium minutum*, which was discovered by the Egyptian professor Halim (1960).**

- **The species is one of the at least nine toxic species of the *Alexandrium* genus, known to be responsible for PSP in many parts of the world.**

- **Blooms of this species and other harmful species are generally associated with salinity stratification and local nutrient-rich freshwater inputs.**

The conditions of the coastal area of Alexandria



The coastal area of Alexandria is highly eutrophic due to direct discharges of wastewater mainly from two land-based sources:

1- About ($7x10^6$ m^3d^{-1}) of agricultural drainage water mixed with the overflow from Lake Mariut:

Primary treated ($500x10^3$ m^3d^{-1}) and untreated municipal waste water (300×10^3 m^3d^{-1}). All of them discharge into Mex Bay, west of Alexandria.

2- Industrial and agricultural waste water into Abu-Qir Bay to the east (2×10^6 m^3d^{-1}).

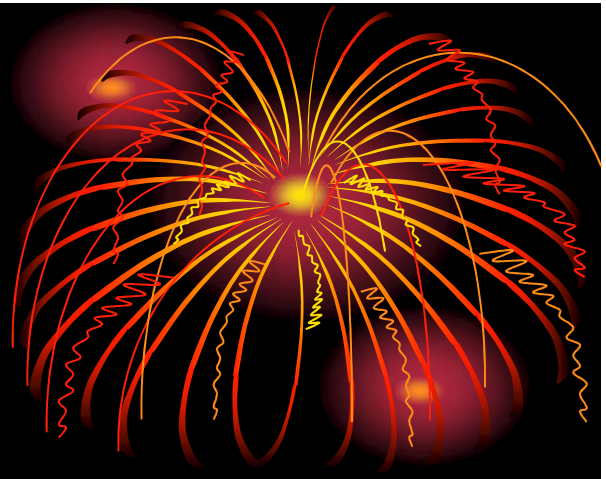
Ismael *et al.*, 2014


Mediterranean Sea
El-Mex Bay
Western Harbor
Eastern Harbor
Nobaria Drain
Alexandria City
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2014 DigitalGlobe
Google earth


Abu Qir Area
Mediterranean Sea
Nelson Island
Abu Qir City
Abu Qir Bay
Tabia Pumping Station
Boughaz El-Maadia
Idku Lake
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2014
Google earth

Eastern Harbor Area

The Eastern Harbor of Alexandria has undergone intense eutrophication in the past decades, resulting from a strong concentration of human activities in its drainage basin. Permanently intense phytoplankton growth occurred (Ismael and Halim, 2007) and the recurrence of cyanoprokaryote blooms (El-Zayat, 2012). The bay has always been the recipient of large volumes of domestic waste water from several point sources. In 1996–1997, however, all outfalls but one were closed. The same volume of waste water now being disposed of through the remaining outfall (El- Masry, 2012).



Harmful algae events in Egyptian Mediterranean waters

Estern Harbor

1- October (1994):

- ***Alexandrium minutum*** **caused massive invertebrate and fish mortality occurred in the Eastern Harbor during October 1994 with evidence of toxicity (IOC news, 2005).**

During (1998-2000):

- **The first occurrence of *Gymnodinium mikimotoi* was during 1998-2000:**

  During August (1999) (0.93 x 10^6 cell l^{-1}).

  During May (2000) (1.8 x10 10^6 cell l^{-1}).

During (1999-2000):

- ***Chattonella antiqua*** **bloomed during (1999- 2000):**

  During July (1999) (0.85 x 10^6 cell l^{-1}).

  During May (2000) (1.14x 10^6 cell l^{-1}) (Mikhail, 2001).

During (2004-2005):

- During (2004) and (2005), incidents of fish and invertebrate mortality occurred accompanying with:

1-Long duration of water discoloration.

2-Marine life on the bottom of the E.H. were severely destroyed:

Dead fish and demersal and pelagic fishes losing their equilibrium, suffering from disorientation and unresponsiveness to human presence.

3-The presence of small crabs found dead on the sand beach or in fishermens nets.

Symptoms of anoxic conditions were also observed in dead fish (IOC News, 2005).

Table (1): Species linked to massive invertebrate and fish mortality in the Eastern Harbor of Alexandria during 2004-2005 (IOC news, 2005)

Species	Year/Maximum Density (M. D)			
	2004	M. D	2005	M.D
Alexandrium ostenfeldii	9 August 14-15 21	$0.11x10^6$ about $0.32x10^6$ $0.51x\ 10^6$	23 – 24-25 July 1 August	$0.13x10^6$, $0.14x10^6$and $0.52x10^6$, respectively $0.082x10^6$
Chattonella antiqua	21 August	$1.26x10^6$	25 July 13-14 August	$0.16x10^6$ $0.33x10^6$ – $0.49x10^6$
Gymnodinium catenatum	7-8 August 15 August 17 21	$2.73x10^6$ $1.53x10^6$ $1.6x10^6$ $0.99x10^6$ $1.34x10^6$	21 July 28 30 3 August 8 10 14	$0.38x10^6$ $0.33x10^6$ $0.56x10^6$ $0.58x10^6$ $0.62x10^6$ $0.78x10^6$ $0.62x10^6$
Gymnodinium mikimotoi	13 August	$0.16x10^6$	30 July 10-11 August 14	$0.06x10^6$ $1.17x10^6$ – $1.92x10^6$ $0.73x10^6$

The consequences of these blooms during (1994-2005) in the Eastern harbor:

- 1- The water characteristics were deeply affected. A reduction in the discharged water is urgently required along the whole coast of Alexandria.
- 2- The severe damage to marine life in the Harbor was due to the occurrence of 6 toxic species.
- 3- High organic matter concentrations could help maintenance of the blooms.
- 5- Recurrent blooms are expected in the following years.
- 6- The rare occurrence of undesirable species such as *Alexandrium minutum*, *Pseudo-nitzschia pungens* and *Heterosigma* sp. could cause damage in the near future.
- 7- A monitoring program must be carried out along the Egyptian Mediterranean coast to evaluate the real situation. Human health is placed at risk, ecosystems are altered, fishing and aquaculture suffer economic losses (Harmful algae news, 2005).

Epiphytic Harmful algae in the Eastern Harbor:

- A survey of the potentially harmful epiphytic microalgae along the coast of Alexandria was initiated since 2005 till 2010 following an incident of mass mortality of the bottom feeding fish, *Siganus rivulatus* in the Eastern Harbor of Alexandria
- Six Cyanobacteria species are recorded:

  Oscillatoria acutissima, Oscillatoria nigroviridis, Oscillatoria limosa, Oscillatoria sp., Lyngbya sp. and Planktothrix c.f. agardhii.

- **Although, there was no toxin analysis during this study, circumstantial evidence lead to conclude that the mass mortality of *S. rivulatus* may be due to microcystins produced by *O. acutissima* (1.07 x 10^6 filaments. g^{-1} wet wt) since it was the only epiphytic Cyanobacteria at this site (Ismael, 2012).**

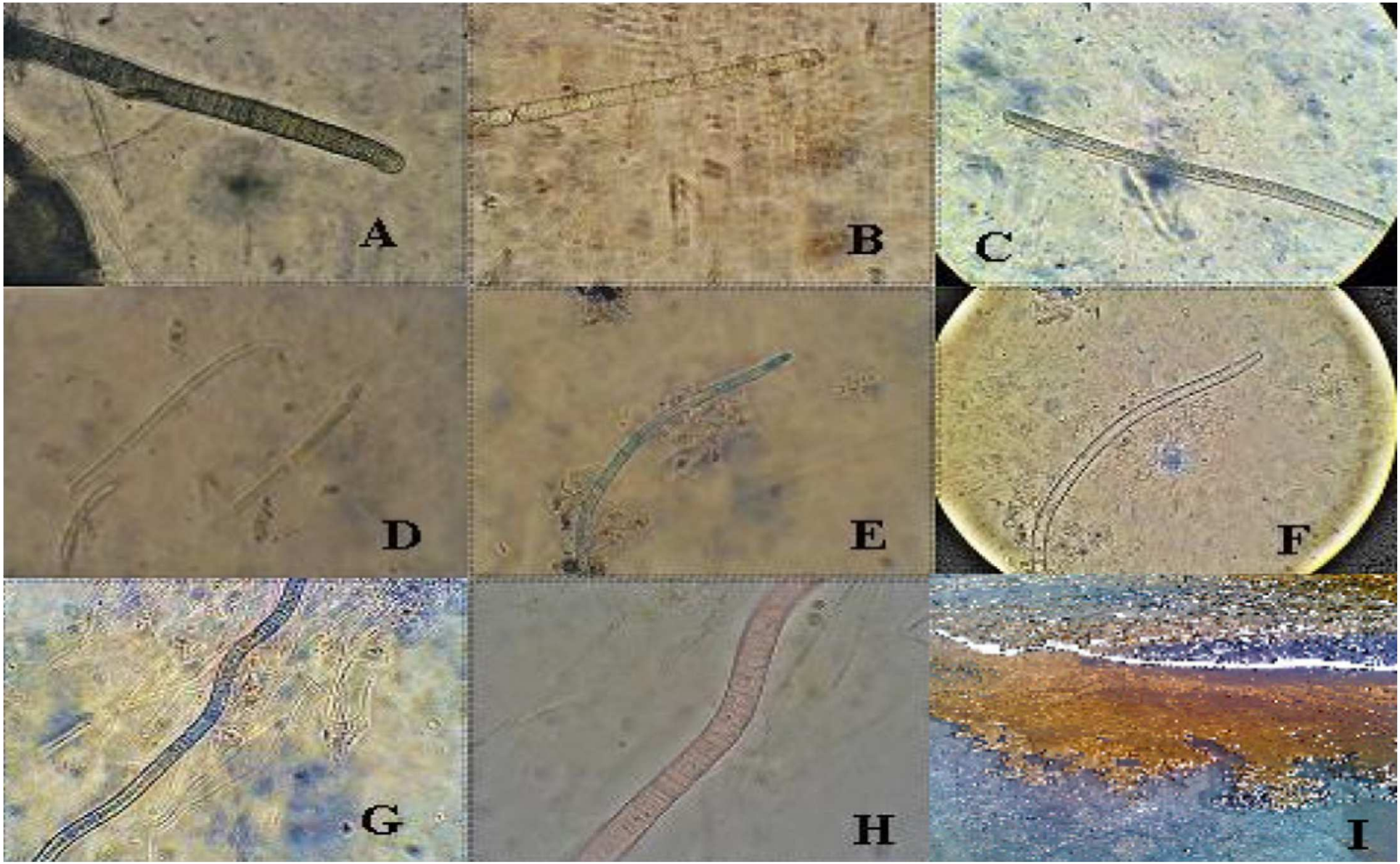


Fig.(1): Species recorded from the Eastern Harbor and Abu Qir area. (A) *Oscillatoria nigroviridis,* (B) *Oscillatoria spp.,* (C) *Planktothrix c.f. agardhii,* (D) *O. acutissima*, (E and F) *O. limosa*, (G and H) *Lyngba sp.* and (I) large mat of *O. acutissima* in the Eastern Harbor (Ismael, 2012).

Harmful algae in Abu-Qir

- The phytoplankton community in the stressed part of Abu Qir Bay was studied from April 1998 to March 1999.
- The phytoplankton count was low (0.01-12.5 x 10^3 unit/L) all the year round, except high density in September (55.6 x 10^3 units/L), due to the bloom of the diatomate *Nitzchia pungens* (Shams El Din and Dorgham, 2007) .

Epiphytic Harmful algae in Abu-Qir Bay:

- ***Ostreopsis* spp.** have been reported for the first time from the Egyptian Mediterranean waters (from June 2005 to December 2007), from the rocks at Abu Qir.
- Populations of two ***Ostreopsis* morphotypes** were found to occur in Abu-Qir, ***O.* cf *ovata*** Fukuyo and ***Ostreopsis* morph1 (Ismael, and Halim, 2012).

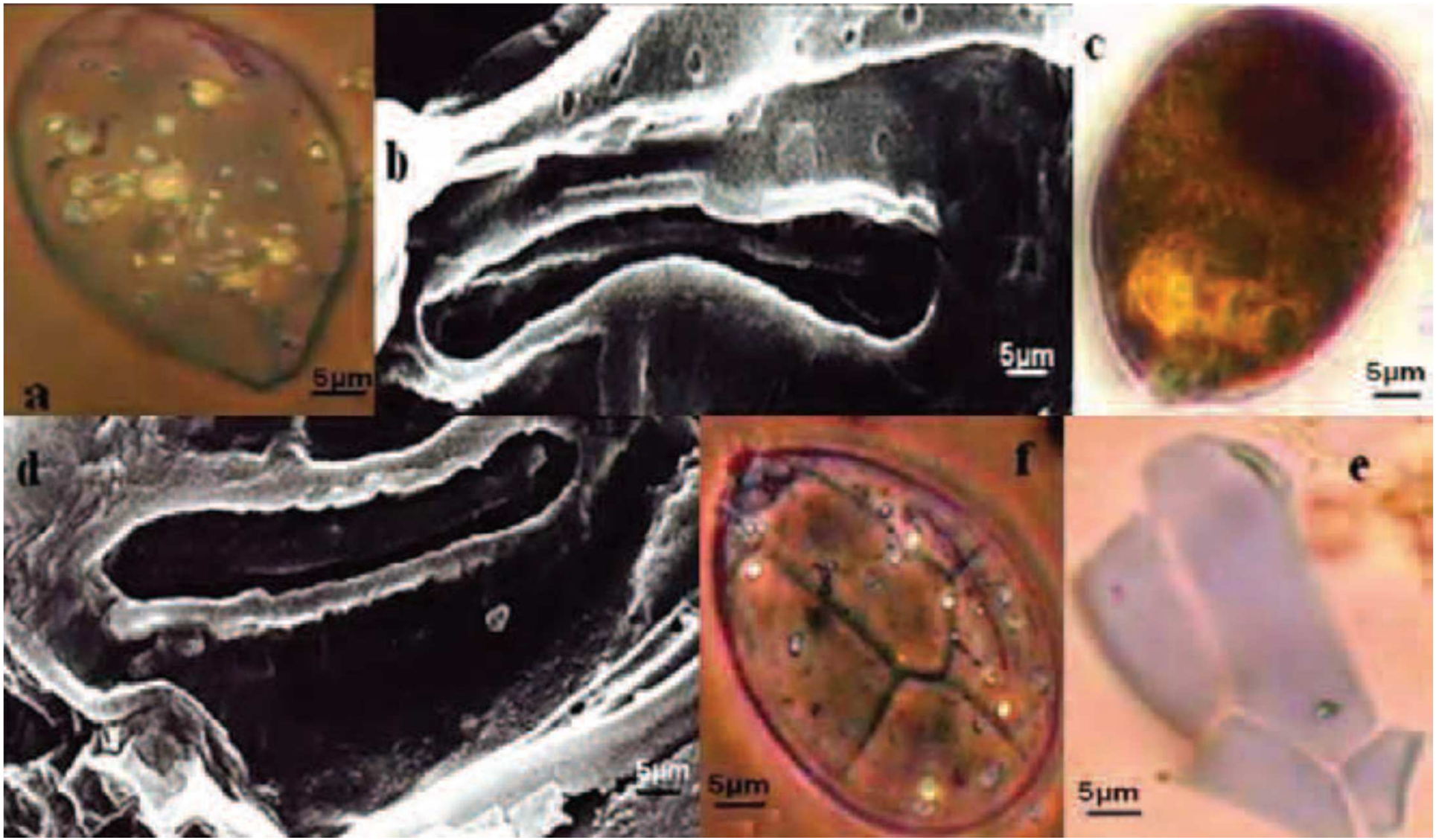


Fig. (2): LM of *Ostreopsis* cf. *ovata* (a), SEM of thecal surface showing thecal pores (b), LM of *Ostreopsis* cf. *ovata* with red pigmented vacuoles (c), SEM of Po (d), LM of plates 1', 2'and 3' with Po (e), LM of hypothecal view (f) (Ismael and Halim, 2012).

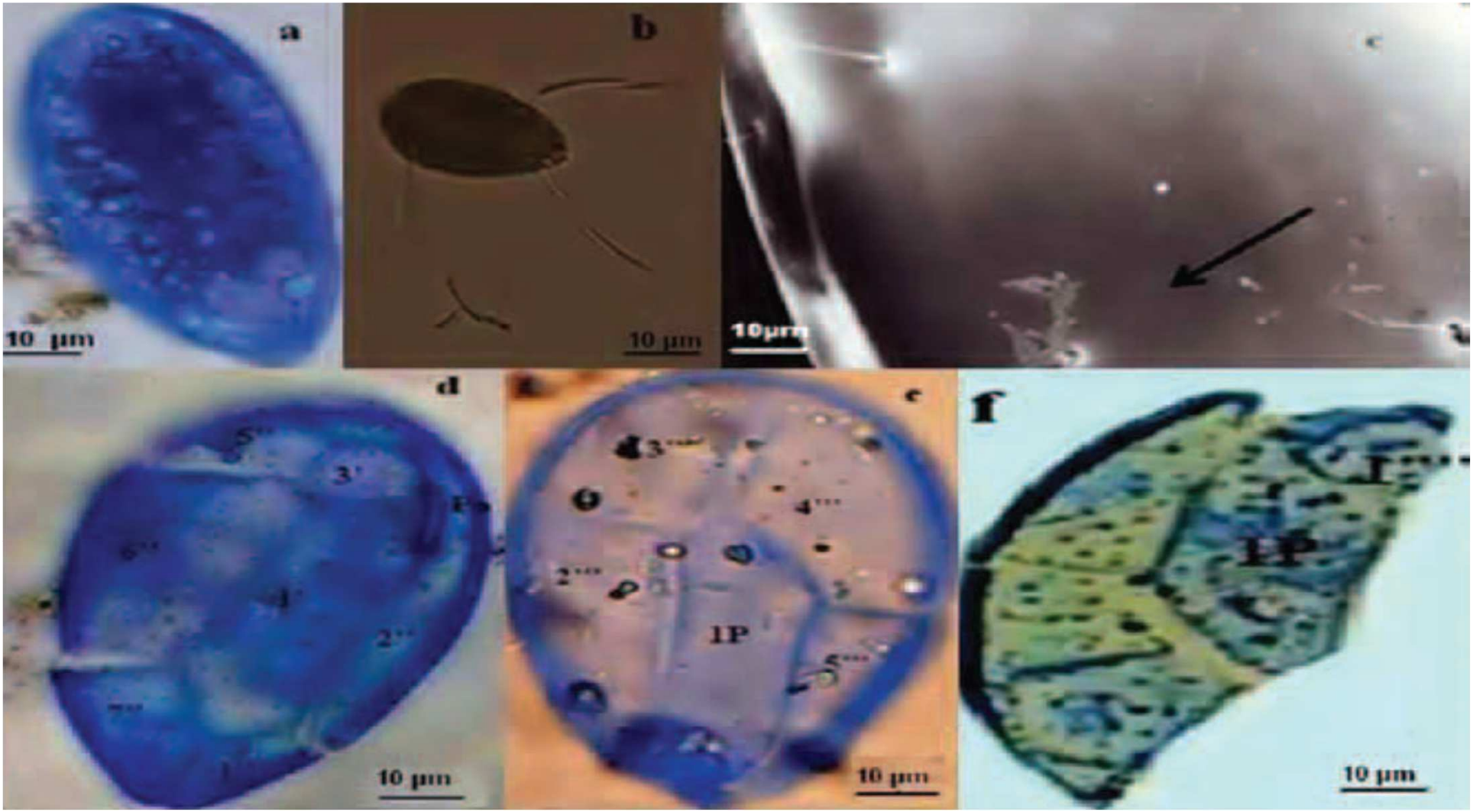


Fig. (3): LM of *Ostreopsis* morph 1 with trypan blue staining (a), LM of thecal surface with pores (b), SEM of thecal plates surface with ejected trichocysts (c), LM of epithecal view of *Ostreopsis* morph 1 (d), hypothecal plates (e), the posterior intercalary plate (f) (Ismael and Halim, 2012).

- **However, the morphological features of the dominant morph, *Ostreopsis* morph 1, do not match any of the *Ostreopsis* species described before.**
- **The species recorded during this study bears some similarity to *O. ovata* and *O. siamensis*, but four characters distinguish it from the other two.**

These features are:

- a) the size of the apical pore plate (Po)
- b) the shape of the suture between plate 1’ and plate 3’.
- c) the thecal pore size
- d) the ratio DV/AP.

Along the shore of Alexandria:

- Since 2000 many artificial lagoons were established along Alexandria coast for swimming and recreation, which became a suitable environment for Algal Blooms.
- 27 species were reported as potentially harmful species (2007) .
- The most important bloom was during mid-August caused by *Micromonas sp*., forming green tide, accompanied by the bloom of *P. quinquecorne*. Although there is no sign for fish or invertebrate mortality, this bloom caused economical losses for internal tourism (Ismael, 2009).

During (2005-2010):

- The distribution and abundance of epiphytic and planktonic *Coolia monotis* along the Alexandria coast were studied from 2005 to 2010 at four sites: Abu Qir Beach, Stanly, Eastern Harbour and Mex Beach.

- **The species was most abundant as planktonic form in the E.H., reaching 15.2 x10^{3} cell. L-1 during summer 2010. The epiphytic forms showed lower density, with a maximum of 454 cell. g^{-1} fwm (Ismael, 2014).**

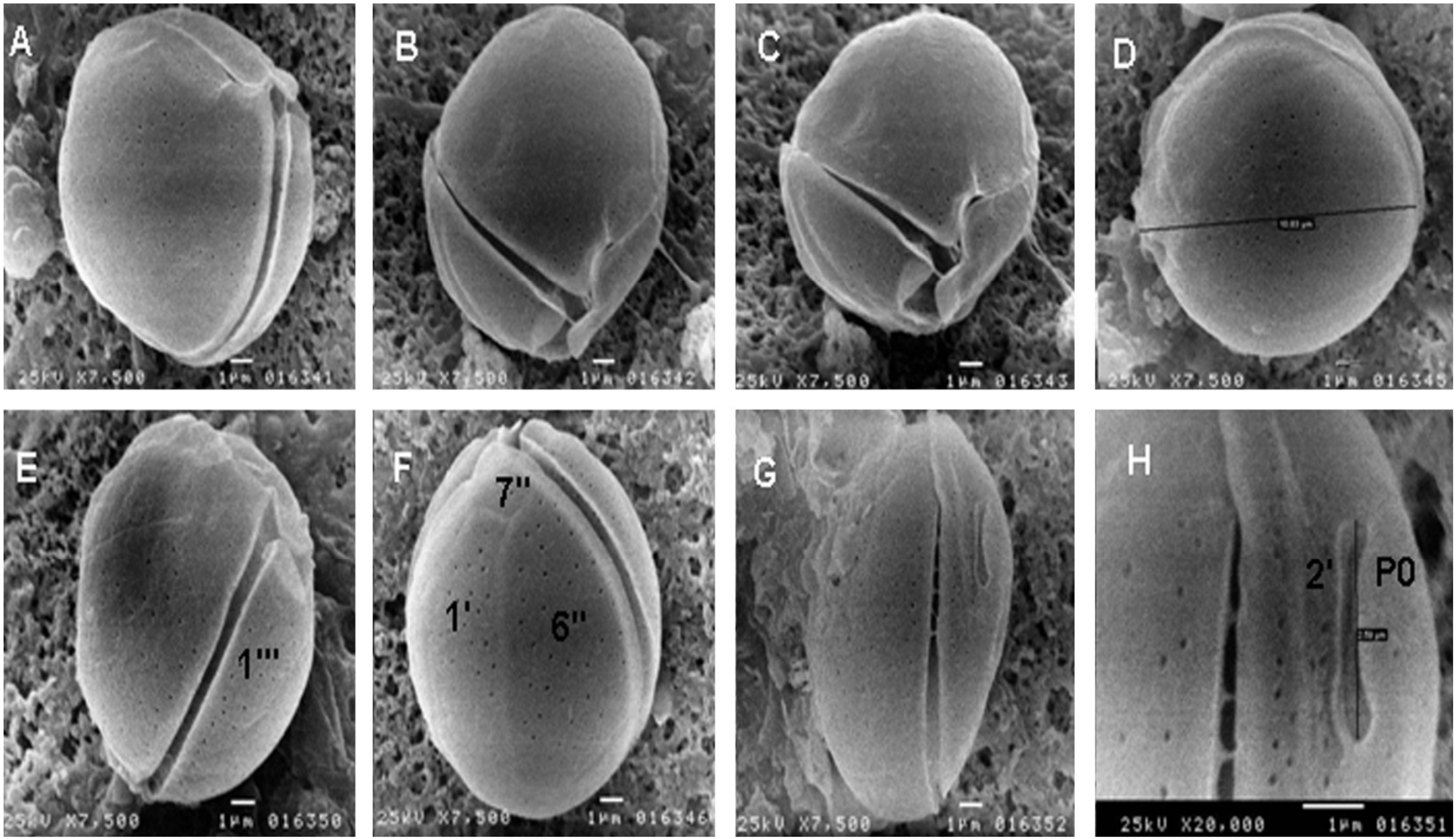


Plate 1: SEM of *Coolia monotis* from the Eastern Harbor. (A–C) Cingulum with lists, (D) plates 1', 6'', 7'', 1''' of C. monotis, (E–F) Trans-diameter of *C. monotis* and (G–H) P0 with plate 2' (Ismael, 2014).

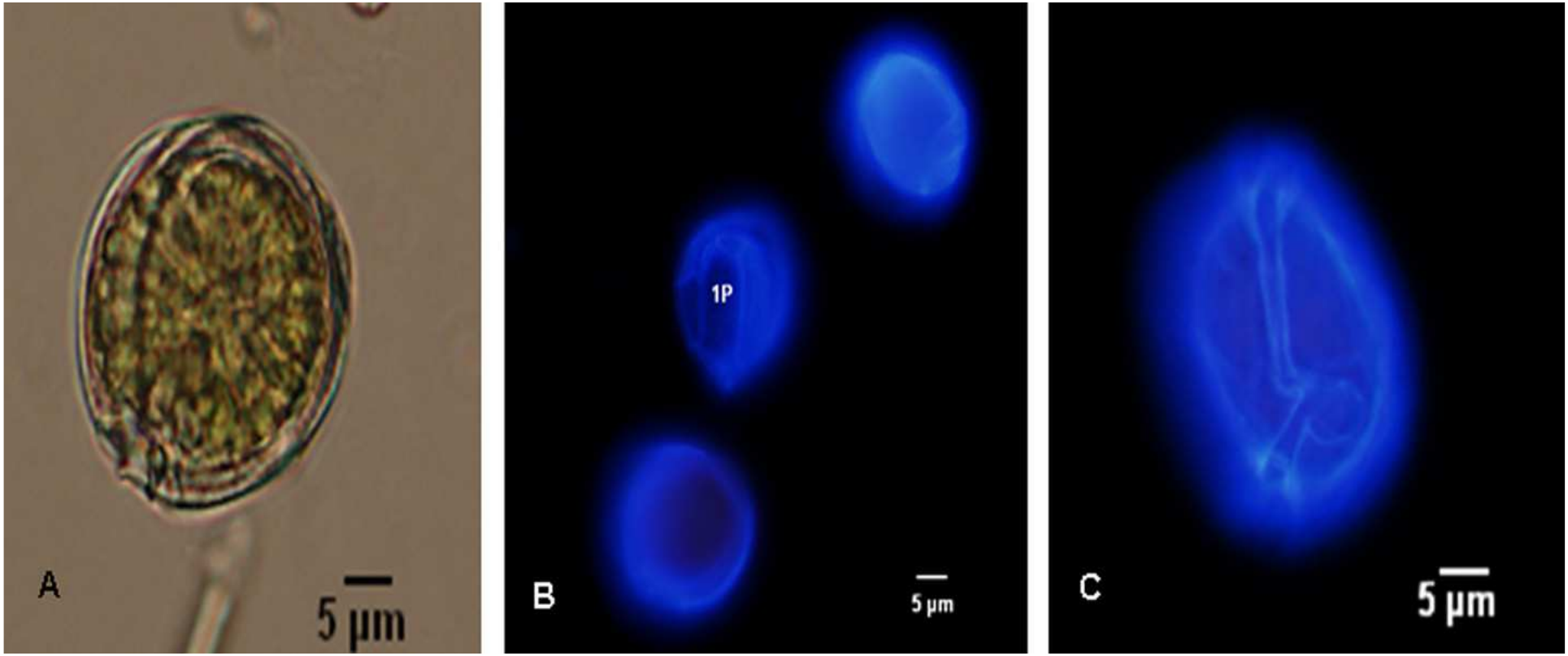


Plate (2): *Coolia monotis* from Mex Beach. (A) Light microscope and (B–C) epifluorescence microscope showing 1P, sulcus and cingulum with lists.

Table (2): The main events of HABs in Egypt recorded by the researchers of the National Institute of Oceanography and Fisheries (Gharib, 2006).

Time	Location	HAB species	Cell/Lx10^6	Source
Sept-1990	Eastern harbor	*Anabena sp.*	21.1	Zaghloul, 1996
May, 1987	Eastern harbor	*Alexandrium minutum*	15	Zaghloul, 1995
April, 1992	Eastern harbor	*Prorocentrum triestinum*	75	Zaghloul, 1995
Oct. 1994	Eastern harbor	*Alexandrium minutum*	24	Halim&Labib, 1996
Sept. 1998	Eastern harbor	*Chattonella antiqua*	0.54	Mikhail, 2001
July, 1999	Eastern harbor	*Chattonella antiqua*	0.85	Mikhail, 2001
May, 2000	Eastern harbor	*Chattonella antiqua*	1.14	Mikhail, 2001
Sept, 2000	Eastern harbor	*Chattonella antiqua*	0.65	Mikhail, 2001
Oct. 2000	Eastern harbor	*Chattonella antiqua*	0.31	Mikhail, 2001
Sept. 1998	Eastern harbor	*Gymnodinium mikimotoi*	0.50	Mikhail, 2001
Oct. 1998	Eastern harbor	*Gymnodinium mikimotoi*	0.13	Mikhail, 2001
Aug. 1999	Eastern harbor	*Gymnodinium mikimotoi*	0.93	Mikhail, 2001
May, 1999	Eastern harbor	*Gymnodinium mikimotoi*	1.8	Mikhail, 2001
Oct. 2000	Eastern harbor	*Gymnodinium mikimotoi*	0.42	Mikhail, 2001
21Aug. 2004	Eastern harbor	*Chattonella antiqua*	1.26	Mikhail *et al.,* 2005
7 Aug. 2004	Eastern harbor	*Gymnodinium catenatum*	2.73	Mikhail *et al.,* 2005
13Aug. 2004	Eastern harbor	*Gymnodinium mikimotoi*	0.16	Mikhail *et al.,* 2005
2005-2010	Eastern harbor	*Oscillatoria acutissima*		Ismael, 2012
Feb. 1990	Western harbor	*Prorocentrum cordatum*	2	Zaghloul, 1996
Oct. 1990	Western harbor	*Pseudo-nitzschia delicatissima*	5	Zaghloul, 1996
July, 1999	Western harbor	*Alexandrium minutum*	10.6	Gharib&Dorgham 2006
July, 1999	Western harbor	*Prorocentrum triestinum*	6.8	Gharib&Dorgham 2006
April, 1992	El-Mex Bay	*Prorocentrum triestinum*	63.5	Mikhail, 1997
June, 1992	El-Mex Bay	*Scrippsiella trochoida*	6.11	Mikhail, 1997
September, 1998	Abu-Qir Bay	*Nitzschia pungens*	55.6x10^3	Shams El Din and Dorgham, 2007
2005-2007	Abu-Qir Bay	*Ostreopsis sp.*		Ismael and Halim, 2011
2005-2010	Alexandria Shores	*Coolia monotis*	15.2 x10^3	Ismael, 2014

Recommendations:

- 1- New methodologies and modeling for nutrient and HAB monitoring.
- 2- Study of Taxonomy and distribution of harmful algal species and their habitat:
- 3- Identify the mechanisms by which HABs harm higher trophic levels, and develop techniques to protect shellfish and fish aquaculture.
- 4- Purification and structure determination of algal toxins.
- 5- Introduce the most developed analytical methods for toxins.
- 6- Remote detection of harmful algae.

7- Awareness of the impact of harmful algae, especially in developing countries.

8- Introduction of new techniques that treat ballast water to remove or destroy the living organisms being carried.

9- Undertake many precautions for improvement of diagnosis of public health impacts.

10-Public education and awareness to control eutrophication and the release of other pollutants into the water bodies and the control of harmful algae.

11- Additional educational activities

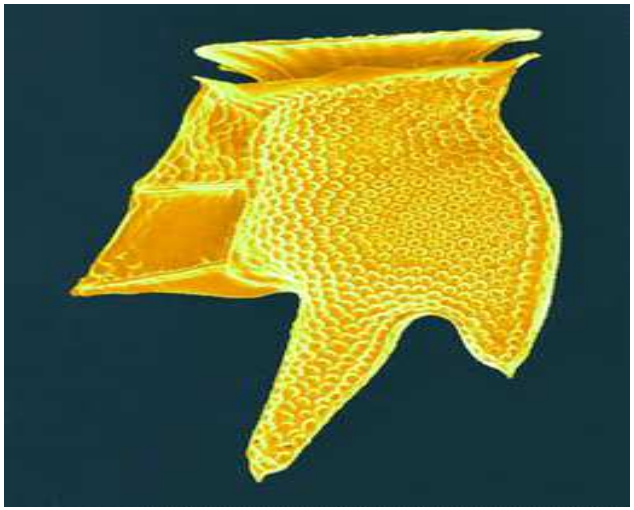
HANA

- However, HANA, or Harmful Algae in North Africa, is a network initiated in North Africa. HANA was endorsed by IOC in 2005 as one of its regional networks for HABs to discuss HAB problems in the HANA region.
- The Professor Youssef Halim the Chair of the organization and the coordinator in Egypt Amani Ismail Abdel Hamid connect with the other Northern African countries and has put goals concerning harmful algae:
- (i) Improve scientific knowledge of the physical, biogeochemical and physiological factors governing HABs.
- (ii) Establish a database relative to the incidence of HABs in the region
- (iii) Establish a directory of the personnel involved in HABs, their area of specialization and their level of expertise as a contribution to the HAB-DIR.
- (iv) Compile an inventory of regional publications relevant to HABs;
- (v) Promote the exchange of information through regular working groups, workshops etc….
- (vi) Promote capacity building for scientists and managers involved in HABs.
- (vii) Develop an identification guidebook for harmful species from the region.

Harmful Algae in Egypt according to HANA (Harmful Algae in North Africa, Working Group).

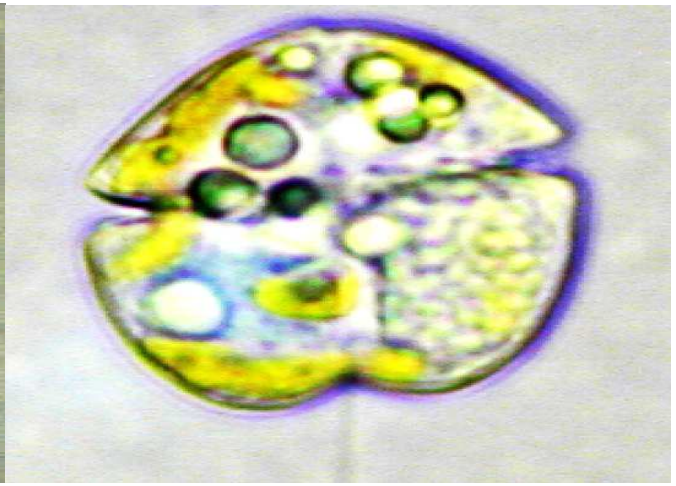
Alexandrium catenella
Eastern Harbor

Alexandrium minutum
Eastern Harbor

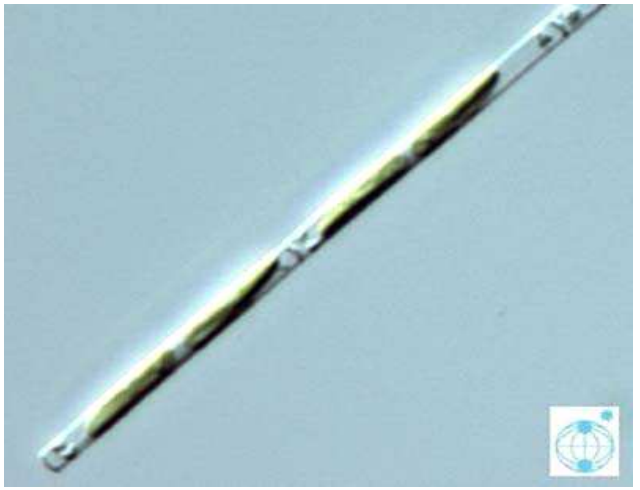


Dinophysis caudata
Eastern Harbor

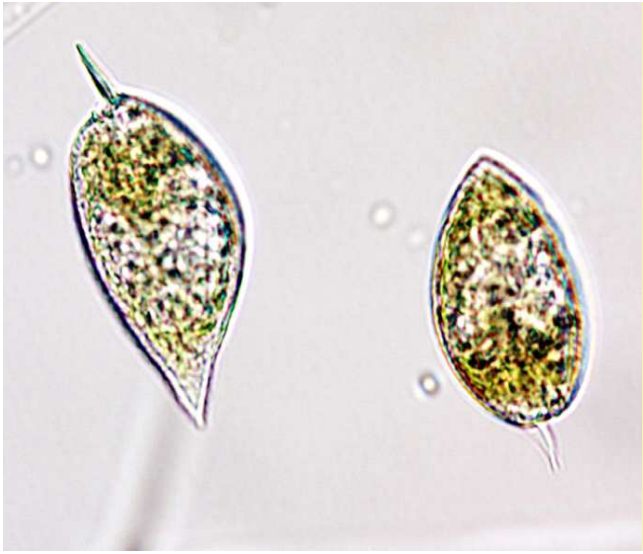
Cylindrotheca clostrium
Eastern Harbor& Mex Bay



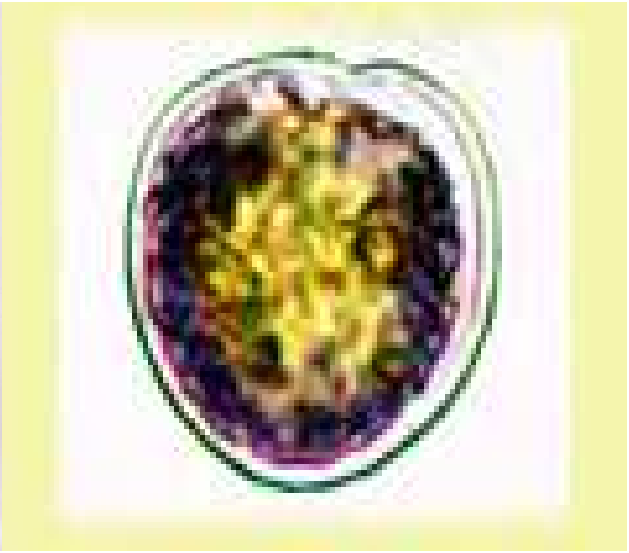
Karenia mikimotoi
Eastern Harbor



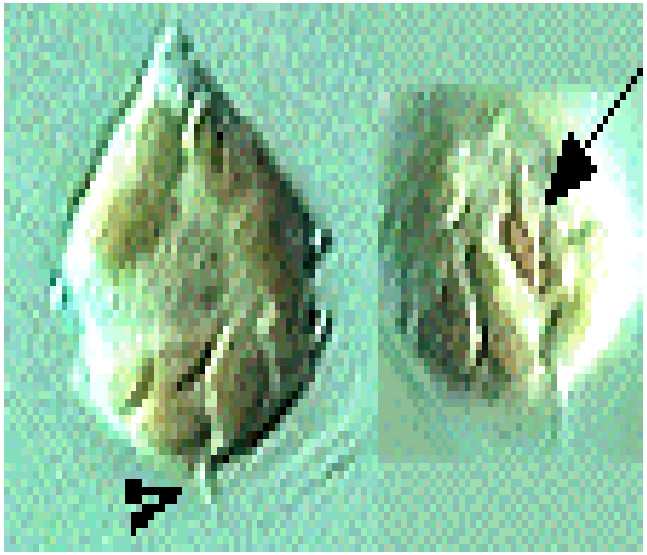
Leptocylidrus minimus
Eastern Harbor



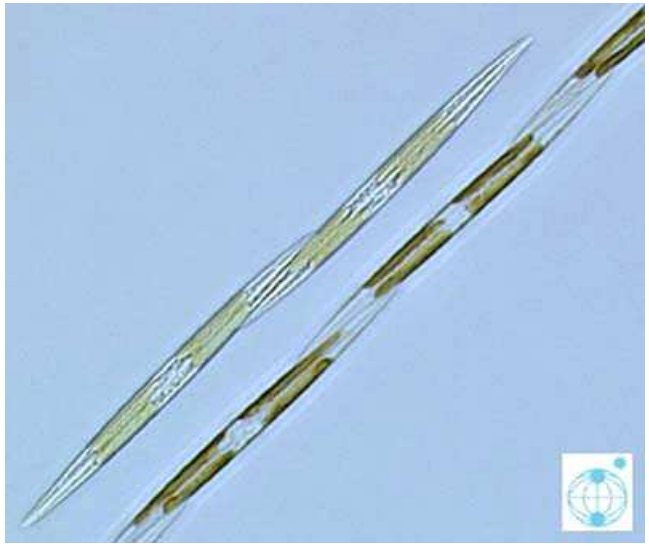
Prorocentrum micans
Eastern Harbor& *El Dekhaila*



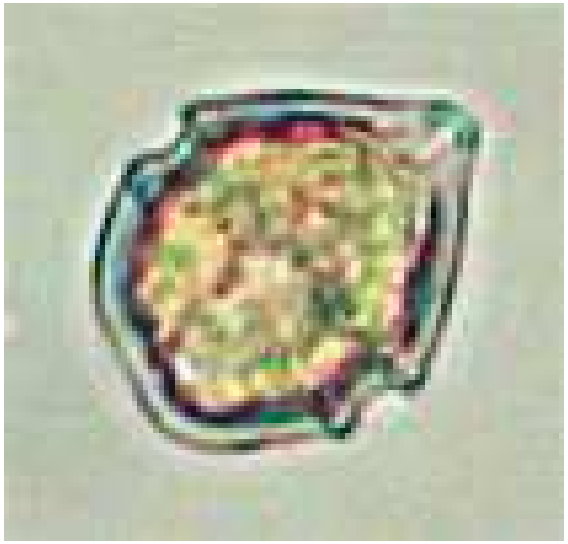
Prorocentrum minimum
Eastern Harbor& *El Dekhaila*



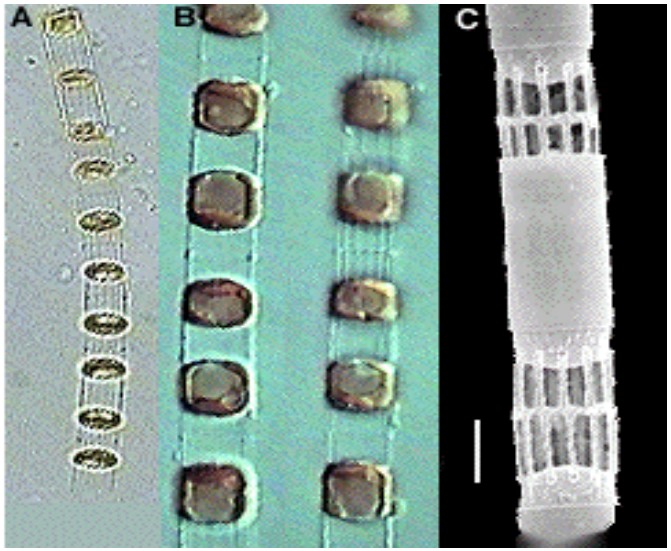
Protoperidinium quinquecorne
Eastern Harbor



Pseudo-nitzschia pungens
Eastern Harbor



Scrippsiella trochoidea
Eastern Harbor, Mex Bay & El Dekhaila



Skeletonema costatum
Eastern Harbor, Mex Bay& Damietta

The Role of National Institute of Oceanography and Fisheries

- **The national Institute of Oceanography and Fisheries (NIOF), which is one of research institutions affiliated to the Ministry of State for Scientific Research of Egypt has set many objectives that take into consideration:**
- **1-Promotion and conservation of the water environments and their natural resources.**

2- To solve many encountered problems of water environment by :

a- providing data information about the Egyptian aquatic areas.

b- studying and monitoring the physical, chemical biological changes in the Egyptian waters.

c-investigating possible hazardous phenomena such as, coastal erosion and the sudden increase of the sea water level, harmful algal bloom ... etc.

- **However, NIOF is always in connection with IOC and followed the developed technologies dealing with harmful algal bloom and the prediction of these blooms and how to control the events and try to link with the governorate and provide it with information and data needed in this domain.**


Thank You
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