A study on the dense bloom of the *Heterosigma akashiwo* in a eutrophic estuary of the Sea of Marmara

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Abstract

A dense bloom of the *Heterosigma akashiwo* (Y.Hada) Y.Hada ex Y.Hara & M.Chihara was investigated by biweekly sampling in relation to environmental parameters in the Golden Horn Estuary (Sea of Marmara, Turkey) from February to late May 2012.

H. akashiwo abundance increased gradually from the lower to the upper estuary and reached to the highest density (10.4×10^6 cells L^{-1}) in the upper part of estuary in late May (20.2°C , 16.4 psu).

A remarkable increase in temperature (4.5°C) and decrease in salinity (2.5 psu) between mid and late May, sufficient nutrient and low water circulation in the upper estuary may have caused the bloom of *H. akashiwo*.

Fish mortality or other harmful effects were not observed during the *H. akashiwo* bloom.

Study area

Golden Horn Estuary (GHE) is 7.5 km long and 700 m wide, with a surface area of 2.6 km^2.

GHE is divided in three parts: Lower (LE), middle (ME) and upper estuary (UE). The depth in LE is 40 m and decreases to 14 m in the ME and 4 m in UE due to the high amount of sedimentation.

The LE is characterized by a two-layered structure. Upper layer has a salinity of ~18 psu originating from Black Sea and lower layer with a salinity of ~38 psu, originating from the Mediterranean Sea.

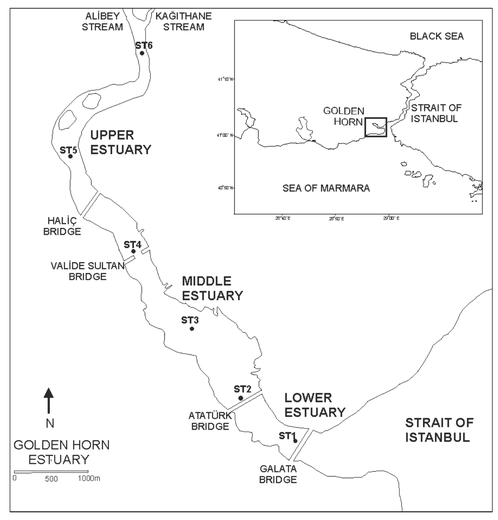

Fig. 1. Study area

Results

- Temperature increased relatively from the LE to the UE, while salinity decrease. Secchi depth decreased towards the UE.
- Nutrient concentrations increased remarkably towards the UE.
- Dissolved oxygen (DO) concentrations were often higher in the LE due to strong interaction with the Strait of Istanbul.

Table 1. Some environmental variables in surface water during the study period

	Lower estuary		Middle estuary		Upper estuary	
Parameters	Mean	Min-Max	Mean	Min-Max	Mean	Min-Max
Temperature (°C)	9.3	4.1-16.8	10.6	4.5-19.3	11.3	5.3-20.7
Salinity (psu)	18.9	18.4-19.5	17.2	15.5-19.1	14.9	6.4-19.0
Secchi depth (m)	7.2	6.0-9.0	2.7	1.0-5.0	1.3	0.5-3.0
NO^3+NO^2-N (µg L^{-1})	5.3	1.8-10.3	11.0	0.3-25.6	11.9	0.1-21.6
PO_4-P (µg L^{-1})	0.6	0.3-1.6	1.7	0.4-5.2	3.1	0.8-11.5
DO (mg L^{-1})	10.9	9.4-13.4	9.1	5.9-11.5	5.2	0.2-11.1
Chl-*a* (µg L^{-1})	1.9	0.6-3.7	9.7	0.5-86.0	8.0	0.6-65.9
pH	7.8	7.3-8.1	7.9	7.3-8.2	8.0	7.7-8.3

- In late May, *H. akashiwo* formed a bloom in the UE (20.2°C, 16.4 psu) and the highest cell density reached to 10.4×10^6 cells L^{-1}.
- During the bloom, NO_3+NO_2-N and PO_4-P values were measured as 5.7 µg L^{-1} and 3.4 µg L^{-1}, respectively.
- DO concentration increased to 11.1 mg L^{-1} and Chl-*a* was measured as 65.9 µg L^{-1}.

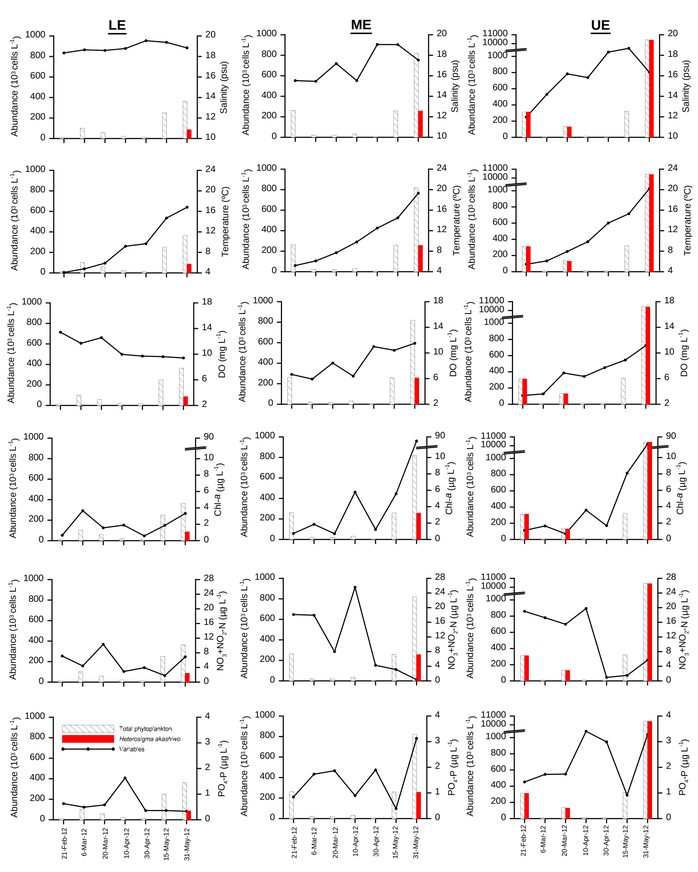

Fig. 2. Relationships between *H. akashiwo* abundances and environmental factors

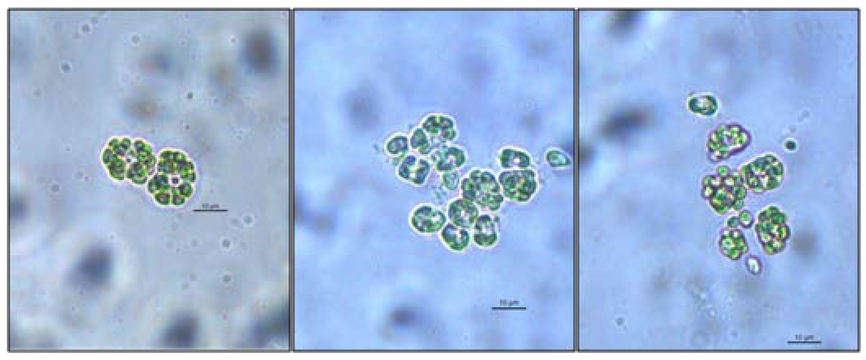

Fig. 3. Light micrographs of *H. akashiwo* cells in water samples collected during the bloom

Discussion

- Bloom of *Heterosigma akashiwo* occurred following the diatom increase as reported by Rensel et al. (2010).
- Bloom was observed almost at the same time in the UE similar to the previous study carried out in the GHE (Tas & Yilmaz, 2012).
- There was a significant positive relationship between temperature and bloom formation of *H. akashiwo.*
- A rapid temperature rise (15.7 to 20.2°C) in late May may have caused the bloom as stated by Taylor & Haigh (1993). Thus, one of the most important factors causing the *H. akashiwo* bloom is temperature rise.
- *H. akashiwo* is euryhaline (Rensel et al., 2010) and its bloom occurred at a salinity of 16.4 psu in the GHE, in agreement with the tolerance of this species to low salinities reported by Branco et al. (2014).
- High temperature, low salinity, sufficient nutrient and low water circulation in the UE may have caused the *H. akashiwo* bloom in late May.
- Although no fish mortality or other harmful effects were observed during the bloom in the GHE, *H. akashiwo* may cause a potential harmful risk in the future.

References

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Acknowledgements

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