The evidence of environmental nutrients absorbed plundering by red tide biology and the feasibility of small satellite monitoring : A case

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Abstract

- The red tide process caused by quick reproduction and multiplication of biology is in fact the one that nutrients in seawater is *absorbed and exhausted plundering by red tide biology*.
- in order to demonstrate and test this deduction,

- During the process of red tide occurred in JiaoZhou Bay, we monitored the yellow substance absorption coefficients and 6 bio-chemical components as well as their indexes at the given sites.

- It is indicated from the analysis of in-situ monitoring data that
  1) the contents of total fats had decreased by 74.25%, equal to 25.75% in its prime,
  2) of amino sugars had been down to 54.3% of that in the red tide's blooming stage,
  3) of carotenes to 53.6%,
  4) of the amino acids to 46%,
  5) of the total sugars to 49.8%;
  6) COD to 46.3%
  7) phenol to 55.2%,

and that the yellow substance coefficients decreases in negative logarithm pattern with the increment of the red tide algal density.

- The small satellite possesses the characteristics of less volume, lighter weight, more flexible launching, shorter developing time, higher specialty and lower cost etc.

- Based on the behavior of yellow substance occurred in the red tide process, it is feasible to develop the special instrument with the characteristic wavelength, which can be loaded on the small satellite platform so as to observe yellow substance in the sea area, to acquire the useful data, to compensate the insufficient of data in this aspect, and to provide a referent index and some data for monitoring and predicting the red tide.

- The related data here provides an in-situ evidence and reference for better understanding the harmfulness of red tide, monitoring the nutrients absorbed plundering by red tide biology，forecasting the red tide process and developing the special instrument loaded on the small satellite to monitor the red tide

Introduction

- The influence of red tide on ecology has attracted extensive attention, which not only damages the normal ecological structure and reproduction of the marine, but also threatens people's life.
- Sea is a complicated ecological system in which biology and environments, biology and biology depend on and also restrain each other in normal conditions, the matter circulation and energy flow of which are comparatively well-organized steady and dynamically balanced. however, the relatively stable state was disturbed when red tide set in.

- **During the primary stage of red tide**, the water body would turn on an phenomenon with high in chal-a, dissolved oxygen, and COD.

- **When in its later stage**, a large quantity of dissolved oxygen is consumed in a process of body dissolution with masses of red tide biology's death, resulting in either serious lack of oxygen in seawater or creating such harmful substances as sulphide etc, which causes the death of marine biology due to lack of oxygen or being poisoned and thus threats to human beings in their heath.

- The change of environmental factors would prevent effective marine biology from normal growth, development and breed, and finally cause certain biology evade or even die as well as disturb their original ecological balance.

- Recently, more results of study on the red tide have been obtained in the in-situ experiments, of course, including the Chinese waters (more data will been showed for you in the paper).

At present, there are more than 150 red tide orientated biological species in Chinese sea areas according to the findings of the primary monitoring.

Besides *Bacillariophyta, Pyrrophyta, Cyanophyta; Chrysopgyta, Chlorophyta, Ciliophora and Echiura* all can also induce red tides. In the sea waters near Yangtze River's estuary, 5 out of 68 red tide biological species once intrigued red tide (Wang J X, 2002).

- In Jiaozhou Bay, it is found that there are 28 genus and 59 species of phytoplankton's among which the advantageous ones are *skeletonemacostatum*, *Chaetoceros Curvisetus* Cleve; *Biddulphia regia* Ostenfeld;*Ceratium breve* Schroder（He w.y et al，2001；Han X.T et al，2004；Zhang Q.Q et al，2004）. The red tide of *Nitzschia* Sp., *Asterionella japonica* Cleve;
- There are many factors that can affect red tide.
- At present, the main researches over their influence factors are meteorology factors like temperature, pressure, wind direction and wind speed, sea case and weather phenomena; oceanographic factors such as water temperature, tides, salinity(He X.Y.et al,2002); biological factors such as phytoplankton; chemical factors like DO, COD, NO3, NO2, NH4, PO4 SciO3, PH values (Wu J.H,2001), the researches of which have led to many constructive achievements.

- Red tide can cause terrible damages to the marine environments by competently consuming nutrients in the seas besides affecting acidity and illumination in the sea body (Qi .Y. Z 2004).
- Now the biological acknowledgements of its effects and disturbance over biological environments where their quantity has not been reported so far.
- Based on the analysis of bio-chemical component evolution during the red tide process from its starts to its development and to its end, some quantitative results were obtained in this research.

- The followings are the description of samples taken in in-situ and the outline of its analysis.

in-situ samples taken and result analysis

- **1.1 in-situ investigation during red tide**

- A large scale of red tide was found in Jiaozhou Bay on August 12 and 13th 2006,
- the investigations and samples taken from the areas concerned showed that the whole sea areas were seriously affected by the red tide and had been turned into purple.（seen from Fig1）

Fig 1. The in-situ picture for red tide water samples taken in JiaoZhou Bay

1．2 In-situ samples taken and their treatment

- Samples were twice taken in the same site
- **First batch of samples** were taken separately from the most intensive sites like site 2 and the less sparse sites like site 1, 3 and 4 in 13 August, 2006 when the red tide was in its blooming.
- **Second batch** was done after the red tide disappeared. The sites taken samples this time were almost the same as those to have been taken for the first time

- The quantity of sample: The volume of sample taken was 10L/each site.
- The sample pretreatment: completed within 4 hours after samples were taken. including the optical absorption coefficient measurements
- While others were chemically treated by following the relevant <<specification>> .
- The used filter: 0.22um
- The volume of solution for sample measurement: 5ml (for optical measurements)

- **2. To identify red tide algae**

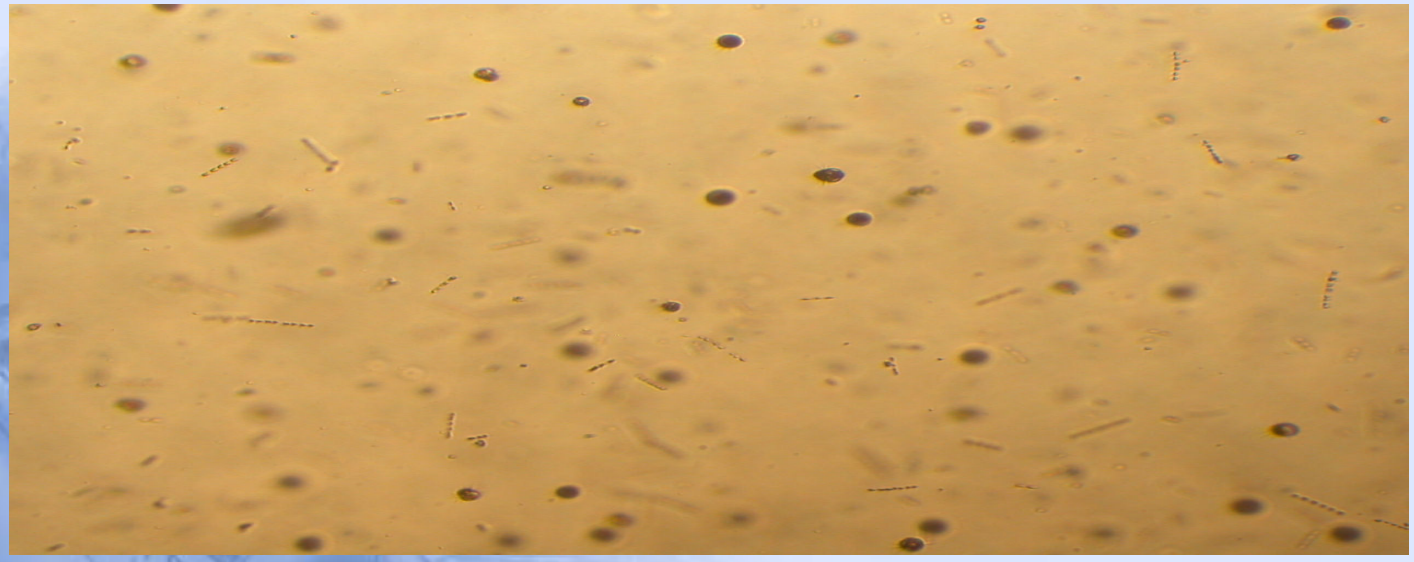
2.1 . Identification of red tide dominant algal species

- Through the biological identification, algae species identified and the calculated red tide density occurred in Jiao Zhou Bay August 13, 2006 were:
- **Location 1**：The population density of *Skeletonema costatum* was 110200 per milliliter (ml), that of *Mesodinium rublum* was 2400 per ml;
- **Location 2**：The population of *Skeletonema costatum* was 58700 per ml, that of *Mesodinium rublum* was 7700 per ml;
- **Location 3**：The population density of *Skeletonema costatum* was 7900 per ml, that of *Mesodinium rublum* was 300 per ml;

- **Location 4**：The population density of *Skeletonema costatum* was 96400 per ml, that of *Mesodinium rublum* was 2733 per ml.
- Under a general condition, the basic density of cell is used as **the identifying index** such as *>5×106 (ind/dm3) for Skeletonema costtum; >5×105 (ind/ dm3)for Mesodinium rubrum* when red tide was formed by the domain red tide biology.
- So, compared with a case detected this time, it is found that the populations of Skeletonema costatum at other sites were more than that of the identifying index except for the in-situ site 3

- **2.2 The basic biological characteristics of Skeletonemacostatum**

Fig 2: The micro-characteristics of *Skeletonemacostatum* and *Mesodinium rublum* in the water samples (picture)



3. Detected results for each bio-chemical components

- The following results are based on the analysis of in-situ samples taken separately from the given areas mentioned above two processes of red tide

Table 1. The contents of each bio-chemical component in seawater from taking samples

- In the blooming of red tide algae　　After the end of red tide

total fats（mg/L）								
	81.2	188	33.8	20	11. 8	16. 5	46. 5	8. 38
amino sugars（mg/L）								
	0.21	1.59	1.7	0.8	1.7	0.4	0.025	0.21
carotenes (mg/L）	0.05077	0.13357	0.03848	0.03623				
	0.03654	0.02247	0.03232	0.04738				
amino acids (μg/L）	206	576	616	286	176	215	228	156
total sugars（mg/L）	0.3	1.7	2.1	1.2	2.5	1.0	0.03	0.3
COD（mg/L）	3.01	4.17	2.05	3.45	1.81	1.37	1.17	1.53
Phenols（mg/L）	0.0657	0.0747	0.0736	0.0740				
	0.0420	0.0410	0.0370	0.0390				

Analytal results

- 1)Total fats decreased by 74.25% after the red tide, i.e 25.75% of its total content when the red tide algae bloomed.
- 2)When the process of red tide was over, the content of amino sugars in water samples decreased to 54.3% of its total, almost half of that when the red tide algae bloomed)
- 3)When the process of red tide was over, the content of carotenes decreased to 53.6% of its total, nearly half of that when the red tide algae bloomed.)

- 4) when the process of red tide was over, amino acids decreased to 46% of its total, more than half of that when the red tide algae bloomed.)
- 5)When the process of red tide was over, total sugars decreased to 49.8% of its total, almost one half of that when the red tide algae bloomed.)
- 6)When the process of red tide was over, COD decreased to 46.3% of its total, nearly one half of that when the red tide algae bloomed and
- 7) When the process of red tide was over, phenols decreased by 55.2% of its total when the red tide algae bloomed.

4. The statistical results

To find:

yellow substance absroption coefficients vs the density of *Skeletonemacostatum* and that of *Mesodinium rublum* have good relations as following.

Fig 3. The relationship between the densities of *Skeletonemacostatum* and the absorption coefficients of yellow substance

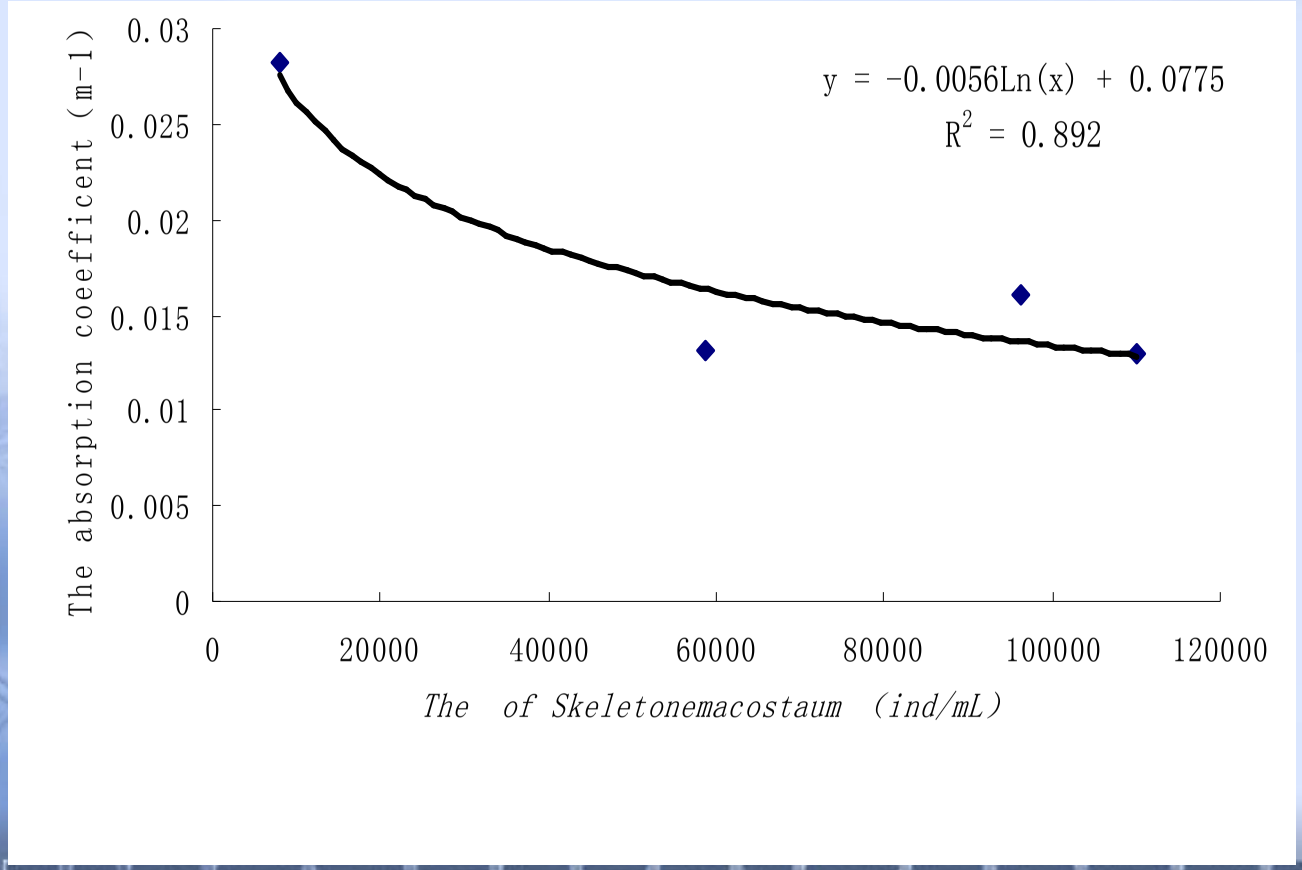
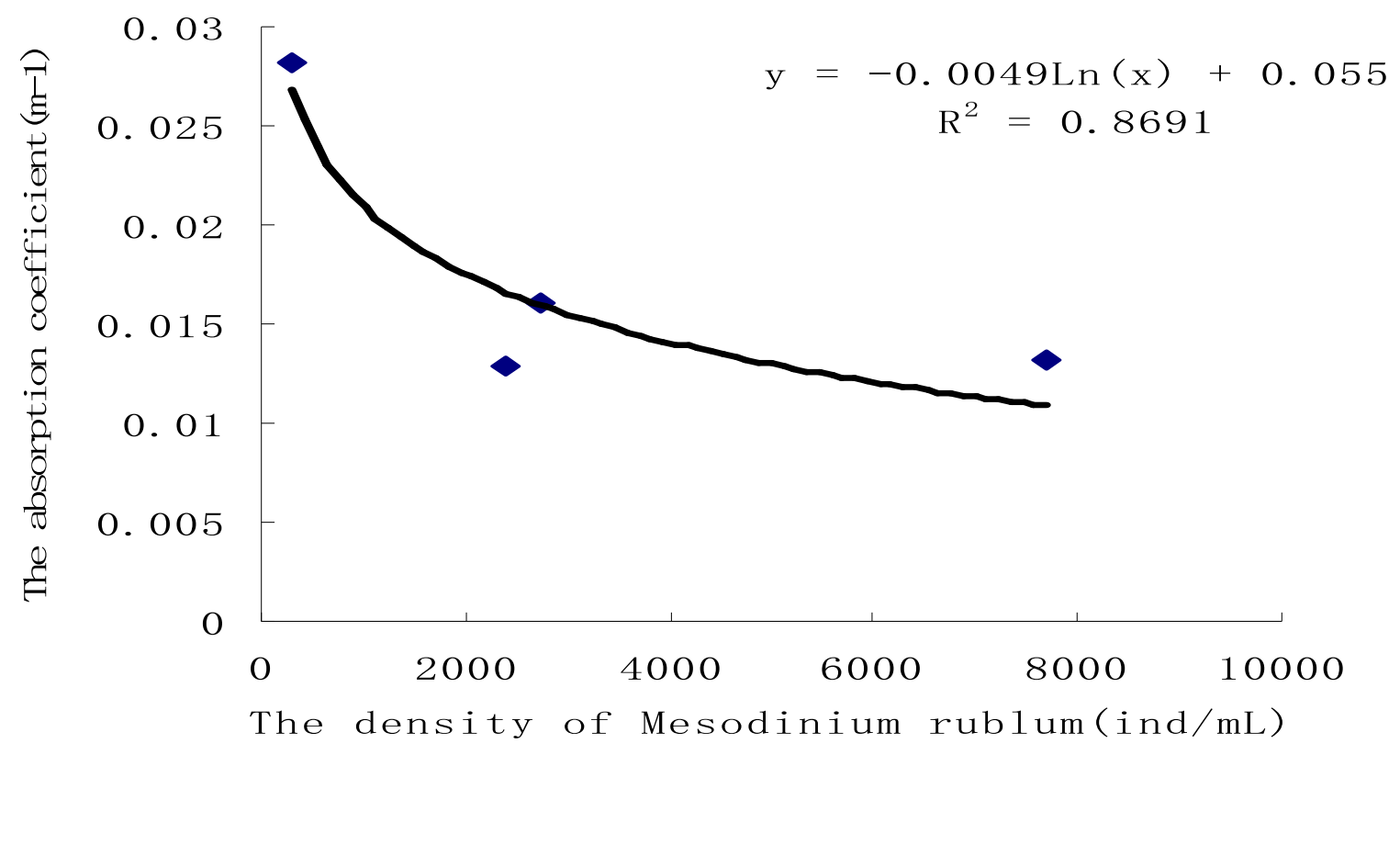


Fig 4. The relationship between the densities of *Mesodinium rublum* and the absorption coefficients of yellow substance



4. The feasible deduction of the small satellite monitoring red tide

- comparing with other routine operational satellites such as Landsats, NOAA Series, SPOT, and ERS series etc, the main characteristics and superiority that the small satellite possesses are
- smaller volume,
- lighter weight,
- more flexible launching,
- shorter developing time,
- higher specialty and lower cost et al.

- There is no instrument specially developed for monitoring yellow substance and each components of yellow substance in seawater at present.
- Once the acting mechanisms of marine yellow substance on the red tide process is understood, the behavior of yellow substance occurred in the red tide process and physical characteristics can be used to develop the special instrument with the characteristic wavelength, which can be loaded on the small satellite platform to realize the routine observation of yellow substance in the sea area involved, acquiring the useful data, compensating the insufficient of data and thus providing a referent index and some data for monitoring and predicting the red tide.

- The main basis are as follows.
- **On the physical feasibility:** Three problems below have been verified
- 1)the marine yellow substance really contains the plentiful nutrients;
- 2) yellow substance in seawater provides an essential nutrient supply for the growth of red tide algae, their exhaustion will lead to the end of red tide process;
- 3) the present satellite retrieving model of yellow substance can provide a technical support and data for studying and predicating the red tide process.

- **On the supplement to the sea color satellite data:** Up to now, no special sea color satellite can be used to monitor yellow substance. For example,
- the observing wavelengths of SeaWIFS (USA) are from 412nm to 765nm, which obviously is difficult to satisfy the requirement of monitoring yellow substance because an effective wavelength used for monitoring yellow substance is at ultra-waveband. As to the time effectiveness, the possessing value of SeaWIFS data has be strictly restricted as the received data are permitted sent to users outside the USA long after one mouth.

- Besides, HaiYang (HY)-1, the sea color satellite of China, has the same weakness as SeaWIFS in the observing wavelengths and algorithm and can't also provide the observing data for the routine yellow substance monitoring now.
- the small satellite carrying the special instrument used for observing yellow substance can acquire an useful data so as to compensate the insufficient of data in this aspect.

- Therefore, it is capable of setting up the special useful satellite observing networks. used for monitoring yellow substance so as to realize the routine observation of yellow substance in the sea area, and to provide a referent index and some data for monitoring and predicting the red tide.

5. Conclusions

- The in-situ experiment reveals the following facts
- that happening of red tide is closely affected by the concentration of yellow substance in seawater, in which the organized bio-chemical components in yellow substance is one of critical elements that trigger the red tide algae to grow and reproduce.

- To find that:

  1)75% of total fats in the seawater has been consumed during the whole process from its starting to its bloom and finally fading

  2) 6 bio-chemical components contained in the yellow substance as well as their indexes are reduced to 50% of amino sugars, carotenes, amino acids, total sugars, COD, and phenols.

- The yellow substance absorption coefficients decreases by negative logarithm with the increment of the red tide algae （*Skeletonemacostatum* and *Mesodinium rublum*） density .

- The data of “the deserted-waters” of nutrients in seawater will serve as a strong evidence that nutrient components in the seawater were exhausted plundering by the red tide algae, which undoubtedly will provide a better evidence and in-situ data for understanding the red tide process, do in-situ base for developing of future small satellite systems carrying the special instrument used to observe the red tide.

Thanks you very much

- Welcome to Qingdao China for watching sailing competition Olympic games 2008