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1998～1999 年春秋季渤海中部及其邻近海域叶绿素 a 浓度及初级生产力估算

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摘要:根据 1998 年 9 月和 1999 年 4 月两次调查研究表明:1998 年秋季,调查区(37°N～41°N, 117.5°E～122.5°E)表层叶绿素 a 浓度介于 0.046～5.885 mg/m^3,平均为 1.892 mg/m^3;1999 年春季介于 0.170～8.092 mg/m^3,平均为 1.621 mg/m^3。叶绿素 a 的平面分布与历史资料相近月份的分布趋势基本一致,调查区南部是整个调查海区的高值区,而西部及渤海海峡在不同时期出现过高值,中央海区叶绿素 a 的浓度都比较低。叶绿素 a 浓度剖面分布在春季是从调查区西部、渤海中部到渤海海峡依次增高,而秋季刚好相反;从调查区南部、渤海中部到北部的变化趋势在春季和秋季都是依次降低的。在连续站进行的现场测量碳同化数介于 0.263～4.649 mgC/(mgChla·h)之间,平均值为 1.916 mgC/(mgChla·h)。1998 年秋季,调查区水柱初级生产力介于 10.1～458.3 mgC/(m^2·d),平均为 163.6 mgC/(m^2·d),初级生产力的高值区位于海峡口附近。1999 年春季,介于 64.9～740.6 mgC/(m^2·d),平均为 323.7 mgC/(m^2·d),初级生产力的高值区位于海峡口附近和黄河口附近。同历史资料相比,初级生产力有所下降。观测和模型的结果表明,渤海浮游植物生物量的分布与水文条件密切相关,而初级生产力受光照、温度和营养盐的限制。

关键词:浮游植物; 叶绿素; 初级生产力; 渤海

The chlorophyll a concentration and estimating of primary productivity in the Bohai Sea in 1998～1999

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Abstract: Based on the two cruises of ecosystem comprehensive surveys carried out in the Bohai Sea (37°N～41°N, 117.5°E～122.5°E) in September 1998 and April 1999, the distribution of phytoplankton biomass, primary productivity and its relationship with environmental factors were studied.

In every cruise, there were twice station grid surveys. Between these two station grid surveys, five anchor stations and a 3 days drift experiment was carried out. Water samples were taken from 0m, 5m,

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10m, 20, 30m, 40m, and bottom according to the water depth. Chlorophyll samples were filtered on board onto Wateman GF/F filter immediately with carefully shaking before filtering. Chlorophyll a was extracted and measured according to procedures of UNESCO's spectrometer methods under 750nm, 630nm, 647nm and 664nm wavelength. The relative photosynthesis rate and assimilation number was measured at anchor stations by determination the dissolve oxygen changes in black and white incubation bottles, which were placed under water on in situ conditions. Dissolved oxygen was determined by Winkler method. Primary productivity was estimated according to Cadée method. Nutrient, hydrological data and meteorological data were supplied by the workgroups in the campaign.

In autumn 1998, the chlorophyll a concentration of surface layer was between 0.046～5.885 mg/m^3, the mean value was 1.892 mg/m^3. The horizontal distribution pattern of surface chlorophyll a concentration shown that, the chlorophyll a concentration was high in the Laizhou Bay, low in the Central Bohai Sea, and at middle level in the Bohai Bay or Bohai Strait. In spring 1999, the chlorophyll a concentration of surface layer was between 0.170～8.092 mg/m^3, the mean value was 1.621 mg/m^3. The concentration of surface chlorophyll a concentration was high in the Laizhou Bay and the Liaodong Bay, low in the Bohai Strait. The horizontal distribution pattern of chlorophyll a was similar to the history data. The subsurface chlorophyll a maximum (SCM) appeared around the Bohai Strait in the spring cruise, it is correlate to the stability of water mass, this phenomena approved by vertical profiles of stratification cause by temperature accumulation. The vertical profiles of chlorophyll a concentration shown a featured pattern in autumn and spring cruises. The concentration of chlorophyll a became gradually higher across the section of the Bohai Bay, the Central Bohai Sea and the Bohai Strait in spring, and it was in reverse in autumn cruise. It became gradually lower across the section of the Laizhou Bay, the Central Bohai Sea and the Bohai Strait in spring and autumn cruises. The assimilation numbers, that were measured in field in anchor stations, were between 0.263～4.649 $mgC \cdot mgChla^{-1} \cdot hour^{-1}$, and mean value was 1.916 $mgC \cdot mgChla^{-1} \cdot hour^{-1}$. In autumn 1998, the primary productivity in water column was between 10.1～458.3 $mgC \cdot m^{-2} \cdot day^{-1}$, the mean value is 163.6 $mgC \cdot m^{-2} \cdot day^{-1}$; In spring 1999, the primary productivity in water column was between 64.9～740.6 $mgC \cdot m^{-2} \cdot day^{-1}$, the mean value was 323.7 $mgC \cdot m^{-2} \cdot day^{-1}$. The high value of primary productivity lay nearby the Bohai Strait and estuary of the Huanghe River, it is because the nutrient supplement from rive and sediment were plenteous near the Huanghe River estuary, and the euphotic zone was deep around the Bohai Strait. Comparison with seasonal history data, the primary productivity in the Bohai Sea was decreasing.

The correlation analysis between chlorophyll a concentration and the other environmental factors in autumn cruise in 1998 shown that, silicate and phosphate concentration had a closed related with chlorophyll a concentration. These indicated the nutrient limitation of phytoplankton growth of these two nutrients in the Bohai Sea during the investigation period. The horizontal distribution of these two nutrient concentrations and N/P ratio (Nitrogen and Phosphate ratio) also support this opinion. The particular or dissolved organic carbon and nitrogen were also correlated to the chlorophyll a concentration, this indicated that phytoplankton was taken an important role in the processes of biogeochemical cycles of carbon and nitrogen in the Bohai Sea during the investigation period. This also indicated that there must be a more important component than phytoplankton (may be bacteria) in the biogeochemical cycle of phosphate in the Bohai Sea during the investigation period. The similar correlation analysis of data of spring cruise in 1999 shown that, phytoplankton growth had a closed relationship with nitrate and nitrite concentrations. This indicated that nitrogen was a limiting factor of phytoplankton growth in spring in the Bohai Sea. Nitrite was mainly contributed by phytoplankton in spring in the Bohai Sea. Turbidity also affected the phytoplankton growth in spring, higher turbidity in this period was mainly caused by the windy disturbance. The particular organic carbon, nitrogen and phosphate and dissolved organic carbon

had a closed relationship with chlorophyll a concentration, this indicated that primary production processes played a very important role in the biogeochemical cycles in spring in the Bohai Sea. Process analysis of modeling showed that the distribution patterns of phytoplankton biomass were correlated closely with hydrodynamic conditions, and the primary productivity in the Bohai Sea was limited by light, temperature and nutrient in ambient waters. The processes of long-term changes of primary production and its relationship with anthropic activity in the Bohai Sea are still mysterious to us.

Key words: phytoplankton; chlorophyll; primary productivity; the Bohai Sea

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浮游植物是海洋生态系统中最主要的初级生产者，在海洋生态系统中扮演极为重要的角色。浮游植物和浮游动物，鱼虾等的产量密切相关。另外，近年来的研究表明浮游植物不但在碳通量上[1]，而且在云反照率(cloud albedo)[2]和海水光通量与热通量[3]上在改变着全球气候，这些都与浮游植物的组成，生物量和生产力的变化是密不可分。因此浮游植物的生物量及生产力的研究是当今海洋生态系统研究的热点[4,5]。

渤海是中国重要的海产品养殖和捕捞场所，渤海生态系统的变化也和中国乃至全球的气候变化密切相关。关于渤海的浮游植物生物量和生产力的研究已有较长历史的研究[6~12]。1958～1959年进行了全国范围内的海洋普查为渤海浮游植物生物量和初级生产的研究奠定了基础。1982～1983年[6~10]以及1992～1993年对渤海渔业和生物资源的调查[12]，为渤海渔业资源的合理化和可持续利用，提供了大量的基础资料。1984～1985年国家海洋局组织进行的渤、黄、东海4个季度月调查，也为渤海浮游植物生物量和初级生产力的研究，提供了大量基础资料[11]。对于渤海浮游植物初级生产的过程，朱明远等[6,11]、吕培顶等[7]、费尊乐等[8~10]和吕瑞华等[12]进行了描述。本文是中德合作项目"渤海生态系统的观测与模拟"所进行的对渤海中部及其临近海域1998年9月和1999年4月两季度月浮游植物生物量和初级生产力调查结果的综合分析。

1　材料和方法

1.1　采样站位和采样进程

于1998年9月24日至10月6日和1999年4月28日至5月11日在渤海中部和渤海海峡及其邻近水域进行了两次水文、气象、化学和生物的综合外业嵌套式调查。站位布设和采样进程如图1。每站位根据不同水深从表层(水下1m)、5m、10m、20m、30m、40m和底层(水底以上1m)进行水样采样。

1.2　采样和测量方法

于每个测站上各水层用12架rosette系统上的5L干净的Niskin瓶进行采水，浮游植物采样在尽短的时间内(紧接在溶解氧采样后)完成。周转瓶为干净的聚丙烯桶，采水量为2L。抽滤前充分摇匀水样，考虑应尽快抽滤完水样，使用ϕ55mm的Wateman GF/F滤膜，抽滤器为有机玻璃分级过滤设备或聚碳酸酯(Gelman)过滤器。抽滤压力不大于200mmHg，为防止叶绿素降解，抽滤前加入1mL $MgCO_3$悬浊液，滤膜样品快速避光、干燥和冷冻(−40℃)保存。尽量当船测量重要的叶绿素样品。叶绿素含量的测量过程参照Parsons等的程序[13]，于10ml90%丙酮中低温(4℃)黑暗萃取24h，期间震荡样品2～3次以充分萃取。样品经离心后于7230G分光光度计750nm、630nm、647nm和664nm波段处进行测量。对于750nm值大于0.02的样品，重新离心后再测量。叶绿素a含量的计算采用Jeffrey等[14]的改进公式：

$$\text{Chlorophyll}a = 11.85\times(E_{664}-E_{750})-1.54\times(E_{647}-E_{750})-0.08\times(E_{630}-E_{750})$$

初级生产力用各站透明度值，相应光辐射时间，引用温带近海水域平均同化系数3.7 mgC/(mgChla·h)(在$A2$、$A4$、$E3$、$E1$和$B1$进行了现场黑白瓶培养，应用测氧法进行了同化系数的测定[15]，如表1。结果介于0.263～4.649 mgC/(mgChla·h)之间，平均值为1.916 mgC/(mgChla·h))。由于碳同化数的现场测定受环境条件的限制变化很大和测定同化数与温带近海水域平均同化系数3.7 mgC/(mgChla·h)相差不大，同时为与历史资料对比，本研究中还是以3.7为碳同化数进行初级生产力的估算)，依据Cadée[16]所提出的初级生产力简化公式进行估算。

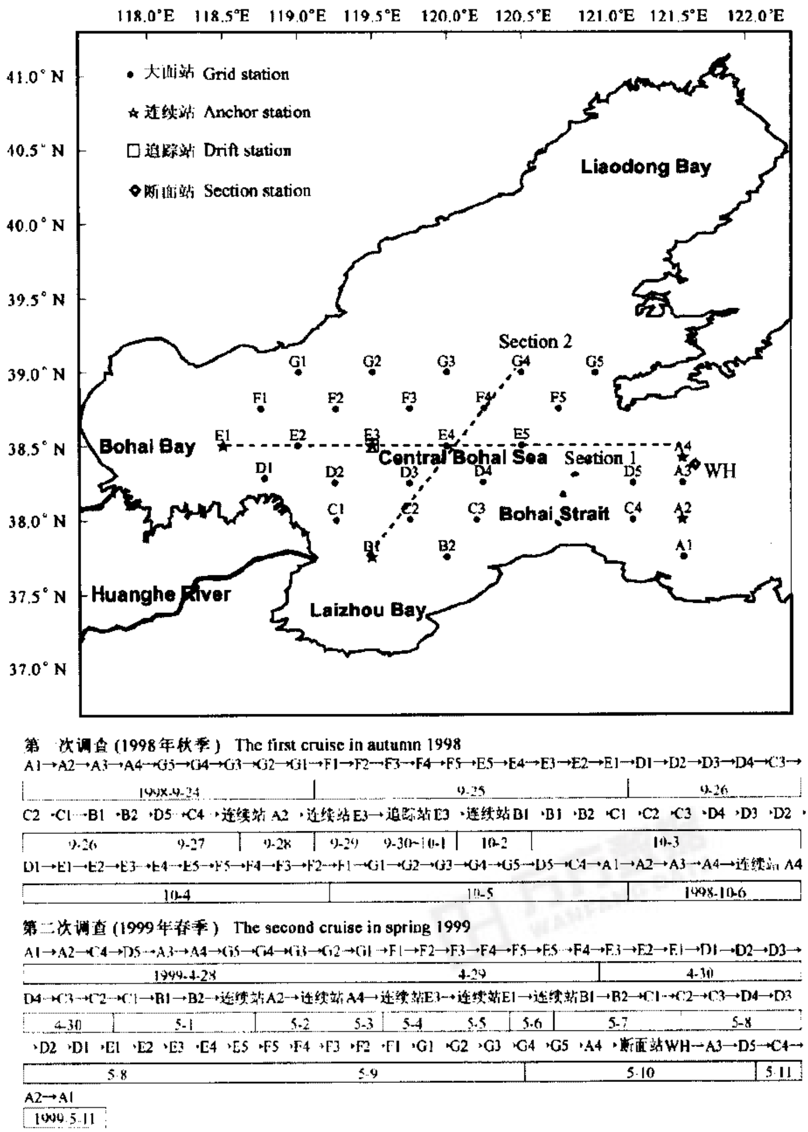

图 1 调查站位图及采样过程

Fig. 1 The sampling stations and sampling procedure

2 结果与讨论

2.1 表层叶绿素 a 浓度和初级生产力的平面分布

表层叶绿素 a 的浓度(考虑初级生产力是由表层叶绿素估算的,所以没有用水柱叶绿素 a 浓度表示)的平面分布如图 2。1998 年秋季,叶绿素 a 浓度介于 0.046～5.885 mg/m^3,平均为 1.892 mg/m^3,两遍大面站调查结果相似,浮游植物叶绿素高值区分布于调查区的南部和西北部,而中央海区的生物量明显低于边缘海区。秋季,渤海浮游植物的生长主要是受营养盐分布的影响。在边缘海区由于水浅,营养盐可以较快地由底部沉积物中得到补充,所以边缘海区的叶绿素浓度比渤海中部为高。此次调查中,两遍大面站之间有一

次大风事件,使营养盐在浅水区域得到了适当补充,所以第二遍大面站叶绿素浓度在这些区域有所增加。1999 年春季,叶绿素 a 浓度介于 0.170～8.092 mg/m^3,平均为 1.621 mg/m^3,此次两遍大面站调查结果稍有不同,但都是在黄河口附近出现叶绿素高值区,在海峡口附近和渤海湾附近是叶绿素的低值区。两航次叶绿素 a 的平均值都比历史同期的资料[6～8, 11, 12]略高,这和使用 GF/F 滤膜,取样体积大及当船测量有关。叶绿素 a 的平面分布与历史资料相近月份的分布趋势基本一致。调查区南部是整个调查海区的高值区,而调查区西部和渤海海峡在不同时期出现过高值。但中央海区叶绿素 a 的浓度都比较低。

表 1　调查区光合作用相对速率和碳同化数

Table 1　The relative photosynthesis rate and assimilation numbers in survey area

调查时间 Time		碳同化数 Assimilation number (mgC/(mgChla·h))						光合作用相对速率 Relative photosynthesis rate (mgC/(mgChla·h))					
		A2	A4	B1	E1	E3	平均 Mean	A2	A4	B1	E1	E3	平均 Mean
站位 Stations	1998-09	1.473	0.953	0.636	3.057	1.174	1.459	2.209	1.939	1.299	5.580	2.179	2.641
	1999-04	4.649	1.794	0.263	4.310	0.851	2.373	8.135	4.306	0.525	5.747	1.701	4.083

初级生产力的平面分布如图 3 所示。1998 年秋季,调查区水柱初级生产力介于 10.1～458.3 mgC/(m^2·d),平均为 163.6 mgC/(m^2·d),高值区位于海峡口附近。1999 年春季,介于 64.9～740.6 mgC/(m^2·d),平均为 323.7 mgC/(m^2·d),高值区位于海峡口附近和黄河口附近。水柱初级生产力在海峡口有高值,和此区透明度高及水体深有关。由于没有历史同期资料可直接对比,同时叶绿素 a 浓度测定和初级生产力估算方法与历史资料略有差异,所以与历史资料的对比存在一定困难,但本研究调查时期是浮游植物春季和秋季水华时期附近[17],调查结果比历史资料略低[12],所以可以初步断定初级生产力比历史同期有所下降,如表 2。与其它同纬度地区海域初级生产力相比也是较低的。很多资料推测这和近几十年来环渤海经济圈的发展有关,但有待于进一步证实。

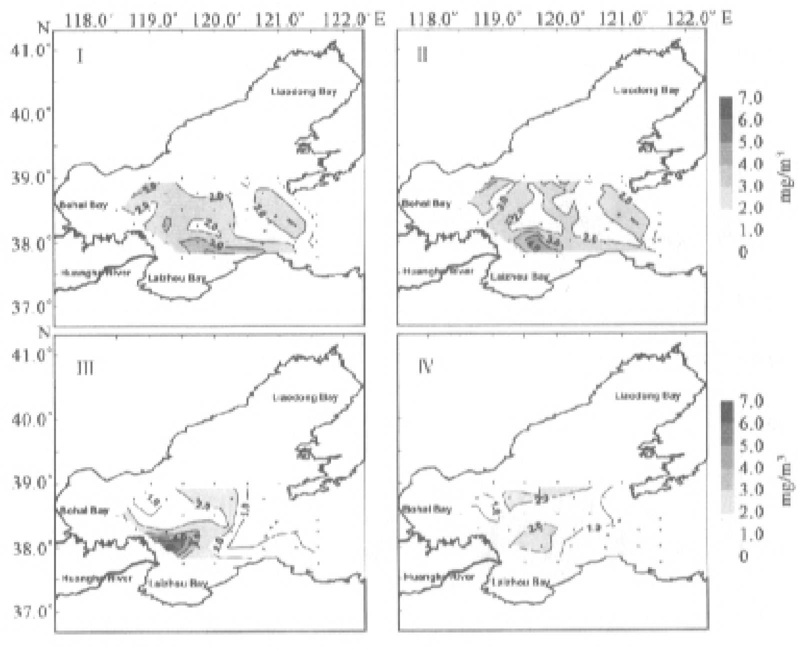

图 2　调查区表层叶绿素 a 浓度平面分布(mg /m^3)

Fig. 2　The horizontal distribution of chlorophyll a concentration of surface layer in survey area

Ⅰ. 1998 年 9 月第一次大面调查 First station grid survey in September 1998; Ⅱ. 1998 年 10 月第二次大面调查 Second station grid survey in October 1998; Ⅲ. 1999 年 4 月第一次大面调查 First station grid survey in April 1999; Ⅳ. 1999 年 5 月第二次大面调查 Second station grid survey in May 1999); 下图同 the same below

表 2 渤海水域初级生产力的数年际变化和与其他海区初级生产力的比较

Table 2 The decades comparison of primary productivity in the Bohai Sea and the other Seas

海区 Area （调查年份）	初级生产力 Primary productivity (mgC/(m^2·d))	初级生产力 Primary productivity (mgC/(m^2·a))	资料来源 Source
渤海(1982～1983) the Bohai Sea	312 年平均 Mean of a year	114	费尊乐等[9] Fei *et al*. 1998[9]
渤海(1992～1993) the Bohai Sea	216 年平均 Mean of a year	79	吕瑞华等[12] Lu *et al*. 1999[12]
渤海(1998～1999) the Bohai Sea	244 春季和秋季水华期平均 Mean of spring and autumn	89	本研究 This study
胶州湾(1984) the Jiaozhou Bay	422	154	郭玉洁等[18] Guo *et al*.
东海 the East China Sea	178	65	青山恒雄[18] Guo *et al*.
南海 the South China Sea	110	40	Lursinsap *et al*.
台湾海峡(1994～1995) the Taiwan Strait	120～360		洪华生等[20] Hong *et al*.
日本近海(1973) the Japanese Seas	438	160	有贺祐腾[18] Guo *et al*. [18]
欧洲北海 the North Sea	100～1000		Raymont[21]
一般温带海域 Temperate Seas	300	110	Menzel *et al*. [22]
亚热带海域 Subtropic Seas	100～200	60	Menzel *et al*. [22]
热带海域 Tropic Seas	50～150		Menzel *et al*. [20]
南极海域 the Southern Ocean	10～150		Menzel *et al*. [22]
北极海域 the Arctic Ocean	10～20		Mezel *et al*. [20]
南极普里兹湾(1992～1993) the Prydz Bay	251	92	宁修仁等[23] Ning *et al*.

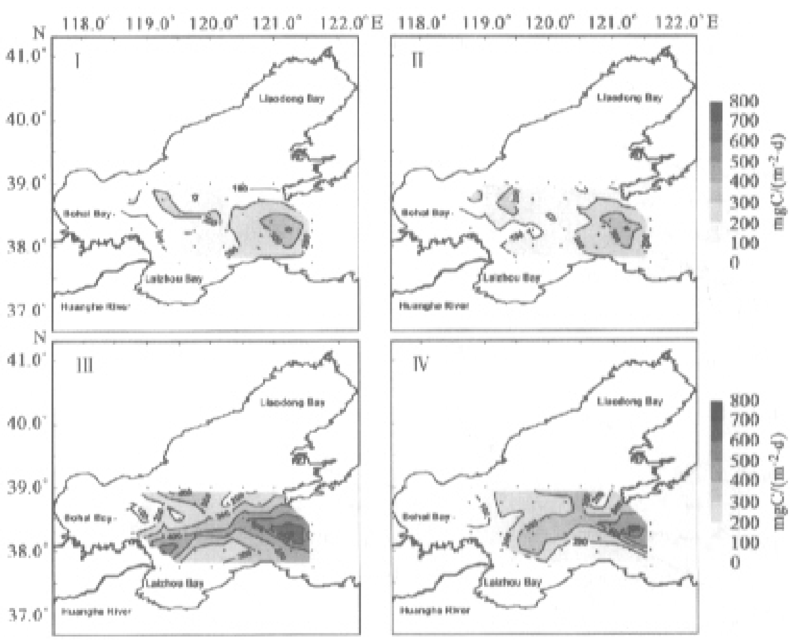

图 3 调查区初级生产力平面分布(mgC/(m^2·d))

Fig. 3 The horizontal distribution of primary productivity in survey area

2.2 叶绿素a浓度的剖面分布

在调查区选取典型的断面 1 和断面 2(图 1)，分别代表调查区西部→渤海中部→渤海海峡和调查区南

部→渤海中部→辽东湾的叶绿素 a 浓度剖面分布(图 4)。1998 年秋季，调查区西部的叶绿素 a 浓度要比渤海中部和渤海海峡依次为高，调查区南部的叶绿素 a 浓度比渤海中部和调查区北部依次为高，表明此调查期渤海浮游植物的生长旺盛的区域主要分布在渤海的内部边缘海区。营养盐的分布也有同样趋势，这些都表明此期黄河、海河和滦河的渤海周边河流对渤海生态系统的影响。1999 年春季，调查区西部的叶绿素 a 浓度要比渤海中部和渤海海峡依次为低，调查区南部的叶绿素 a 浓度比渤海中部和调查区北部依次为高，

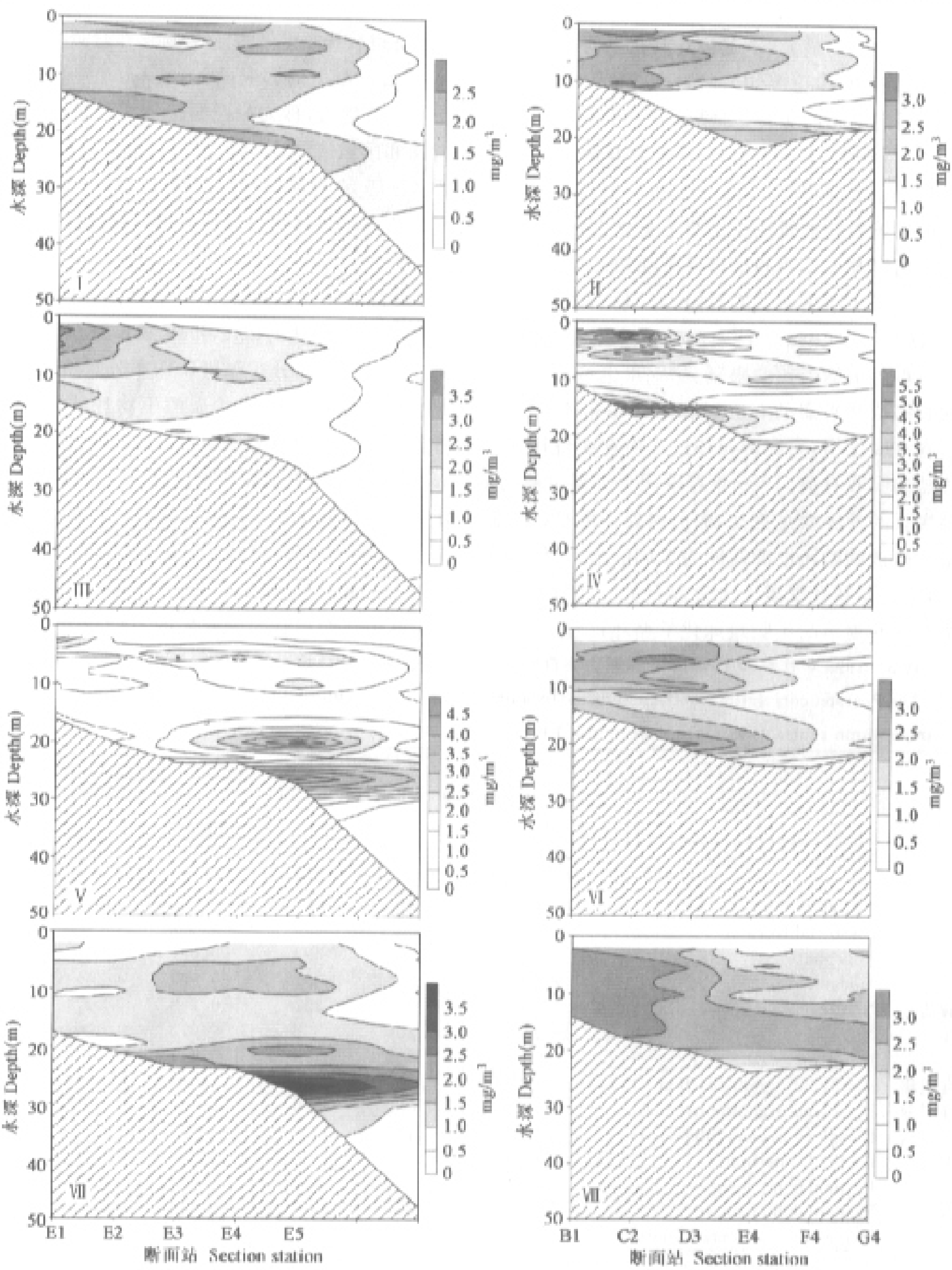

图 4　断面 1 和 2 的叶绿素 a 浓度剖面分布

Fig. 4　The vertical profiles of chlorophyll a concentration in section 1 and 2 during the investigation (mg/m³)

表明调查期渤海海峡口以内的浮游植物生物量比海峡以外的黄海水域要低，而此期调查区南部的生物量还是比调查区北部要高。此期，在渤海海峡口靠近渤海中部处，出现了叶绿素 a 浓度的次表层最大值，说明此时渤海光线充足，此区出现了明显的水体稳定情况，调查航次报告中此区出现的温跃层也印证了这一点[24]。

2.3 影响生物量和初级生产力分布的因素

浮游植物的生物量分布和初级生产力一般受物理、化学和生物等环境因子的限制[25, 26]。物理因子中以光照和温度的影响最大，平流输运和扰动对生物量的分布影响也较大。化学因子中以营养盐浓度和一些痕量的无机元素如铁、铜等的影响较大，称为对浮游植物生长的由下至上的影响(bottom to up effect)。生物因子中以浮游动物的摄食，对浮游植物生物量和初级生产力影响最大，称为对浮游植物生长的由上至下的影响(top to down effect)。以上对各种因素，在渤海不同时期和区域或多或少地在限制着浮游植物的生长。费尊乐等[10]和吕瑞华等[12]对渤海初级生产力过程进行了初步研究，他们的结果表明渤海的初级生产力受光照的影响较大。本研究在观测的基础上，发现除了光照对渤海浮游植物生长影响较大外，在冬季和早春温度的影响以及在夏季和秋季浮游动物的影响也是不容忽视的[17]。

对叶绿素 a 浓度和其它环境因子的相关分析见表 3(营养盐和水文数据来自中德双方各课题组，以下同)。从表中可知 1998 年秋季调查区浮游植物的生长与磷酸盐和硅酸盐的浓度相关，预示着在渤海这两种营养盐对浮游植物生长的限制。这一点也可从调查区营养盐浓度的平面分布和氮磷比率分布看出[27]。生物量与溶解态或颗粒态的有机碳和氮密切相关，说明此时期浮游植物在这两种物质的生物地球化学循环过程中起着重要作用，而在磷循环过程中存在着比浮游植物参与的过程更重要的其它过程，这也许是和细菌对磷酸盐的吸收有关。1999 年春季调查区浮游植物的生长与硝酸盐和亚硝酸盐浓度相关，说明此时限制浮游植物生长的营养盐是氮盐，而此时亚硝酸盐的来源主要和浮游植物的生长有关，也即浮游植物吸收到体内的硝酸盐被硝酸还原酶还原为亚硝酸盐，从细胞中渗漏出来。浊度(光限制)在一定程度上影响着浮游植物生长，这主要和春季多大风过程有关。溶解有机碳和颗粒态的碳氮磷都与浮游植物生物量相关，说明浮游植物在这些物质的生物地球化学循环过程中起重要作用，其中浮游植物对颗粒氮的贡献较大。

表 3 1998 年秋季和 1999 年春季航次调查区叶绿素 a 浓度同其它环境因子的积矩 Pearson 相关系数

Table 3 The Pearson correlation coefficient of environmental factors and chlorophyll a concentration in waters of survey area during autumn cruise 1998 and spring cruise 1999

		1998 年秋季 Autumn cruise 1999			1999 年秋季 Spring cruise 1999		
		Pearson	t	n	Pearson	t	n
盐度	Salinity	−0.180**	0.000	392	—	—	—
pH 值	pH	0.372**	0.000	381	−0.071	0.118	490
浊度	Turbidity	0.121**	0.017	389	0.203**	0.000	493
溶解氧	Dissolved oxygen	0.284**	0.000	386	0.012	0.791	481
磷酸盐	Phosphate	−0.226**	0.000	392	−0.061	0.174	493
硅酸盐	Silicate	−0.187**	0.000	392	0.052	0.246	493
亚硝酸盐	Nitrite	0.127*	0.012	392	0.243**	0.000	493
硝酸盐	Nitrate	−0.052	0.306	392	0.373**	0.000	493
氨	Ammonia	0.084	0.098	392	0.011	0.810	493
溶解有机碳	Dissolved organic carbon	0.247**	0.000	273	0.404**	0.000	259
溶解有机氮	Dissolved organic nitrogen	0.187**	0.000	389	—	—	—
溶解有机磷	Dissolved organic phosphate	0.041	0.418	389	—	—	—
颗粒碳	Particular carbon	0.514**	0.000	390	0.230**	0.000	493
颗粒氮	Particular nitrogen	0.542**	0.000	390	0.401**	0.000	259
颗粒磷	Particular phosphate	0.382**	0.000	388	0.214**	0.000	489
悬浮物	Suspended particulate matter	0.179**	0.001	327	0.166**	0.000	493

表中 Pearson 为 Pearson 相关系数；t 为双尾 t 检验；n 为检测样品数；—为缺乏数据 Pearson is the Pearson's correlation coefficient; t is paired-samples t test; n is number of the samples or cases; —is absent of the data ** 表示相关置信度水平小于 0.01，* 表示相关置信度水平小于 0.05，其它为不相关 ** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.01 level, the others is no obvious correlated

Falkowski[28]认为,浮游植物的初级生产主要受光照条件的影响,而生物量的分布多受物理作用驱动的营养盐分布的影响,但单纯的光限制模式和营养盐限制模式很难对初级生产的过程进行描述,所以现在对于初级生产过程的模型和过程研究将重点放在将光限制模型和营养盐限制模型进行数学的耦合上来。应用模型来进行初级生产力过程的研究是当今初级生产力研究的一个热点之一[29, 30]。由于欧洲北海和中国的渤海具有相似的水文环境,应用北海三维生态模型(Ecological Model System, Hamburg (ECOHAM))[31]进行渤海初级生产的模拟,发现光照是决定初级生产力的主要因素,同时温度的影响也是巨大的。应用磷限制进行模拟的结果基本上与历史观测结果相符合,但赵亮等模拟结果表明,如再耦合氮限制模型,其结果会更好。模型研究的结果表明渤海浮游植物的初级生产过程主要受光照条件和营养盐浓度的限制。

3 结论

调查结果表明,渤海中部及其临近海域叶绿素 a 的分布与水文和营养盐条件有关。调查区南部的叶绿素 a 浓度在调查期都是高的,而渤海中部的叶绿素 a 浓度就较低,调查区西部和渤海海峡有时会出现较高值。叶绿素 a 浓度的平面分布同历史资料的相近月份比较,表明分布趋势是相似的。每次进行的两遍大面站调查平面分布的结果趋势相同。叶绿素 a 浓度剖面分布在春季是渤海湾→渤海中部→渤海海峡依次增高,而秋季刚好相反;调查区南部→渤海中部→辽东湾的变化趋势在春季和秋季都是依次降低的。水柱初级生产力在渤海海峡口较高,同此区透明度高及水体深有关。同历史资料比较发现,渤海初级生产力有下降的趋势,是否与人为的活动有关,需进一步证实。相关分析表明调查区的叶绿素 a 浓度与磷酸盐和硅酸盐浓度密切相关。模型研究的结果表明光、温度和营养盐是限制渤海初级生产力的主要因素。关于渤海初级生产力的模式及过程还需要今后更深入的研究,同时模型和实时资料获取技术的发展也是今后渤海初级生产力研究的重要方面之一。

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