碱族、碱土族元素对衣藻细胞生长分裂的影响*

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近年来，微量元素对生物的影响，越来越广泛地受到重视。综观生物微量元素与周期律之间的关系，我们曾以梨形四膜虫为实验材料，探讨了元素周期表中若干元素对它的营养促进和毒性抑制作用，并作了初步的报道[1,2]。此外，还做过锗[3]和稀土元素[4]对梨形四膜虫生长分裂的影响。本文以绿藻门中的衣藻细胞为材料，研究了碱族、碱土族元素对衣藻生长分裂的影响，探索其作用的规律性。

一、实验方法和结果

将武汉水生生物研究所提供的莱哈衣藻（*chla mydomonas reinhardtii*）引入无机盐的水溶液中进行无菌培养[5]。用日光灯持续照射。实验用 40W 日光灯管 2 支，距离 40 cm。温度为 25℃。将每个元素分别以不同浓度加入到培养液中，每隔一定时间定量取出培养液，滴加 Lugol 液杀死细胞后，用白血球计数法测得细胞数 N，设起始时刻细胞数为 N_0，将 N/N_0 值与生长时间 T 作图。从所得衣藻细胞群体生长曲线，可看出元素对衣藻生长分裂的影响。所用试剂都是分析纯，试剂溶液和培养液都经严格高温灭菌。培养液配方见表 1。

以碱金属族中锂为例，将 LiCl 水溶液定量移入培养液中，使锂离子的浓度按元素计分别为 0，1，5，10，20，50ppm。按上述方法测得不同浓度锂对衣藻生长分裂影响的曲线，如图 1。

在图 1 上取时间 T 等于 90 小时，以不同

表 1　衣藻培养液配方

物质名称	取量(ml/l)	浓度(mol/l)
微量元素储液	1	
10%NaCitrate · $2H_2O$	5	1.7×10^{-3}
1%$FeCl_3\cdot6H_2O$	1	3.7×10^{-5}
4% $CaCl_2$	1	3.6×10^{-4}
10% $MgSO_4\cdot7H_2O$	3	1.2×10^{-3}
10% NH_4NO_3	3	3.7×10^{-3}
10% KH_2PO_4	1	7.3×10^{-4}
10% K_2HPO_4	1	5.7×10^{-4}
去离子 H_2O	984	
固体 $CH_3COONa\cdot3H_2O$	2(g/l)	1.5×10^{-2}

微量元素储液（mg/l）：$H_3BO_3$100，$ZnSO_4\cdot7H_2O$ 100，$MnSO_4\cdot4H_2O$40，$CoCl_2\cdot6H_2O$20，$Na_2MoO_4\cdot2H_2O$20，$CuSO_4$4。

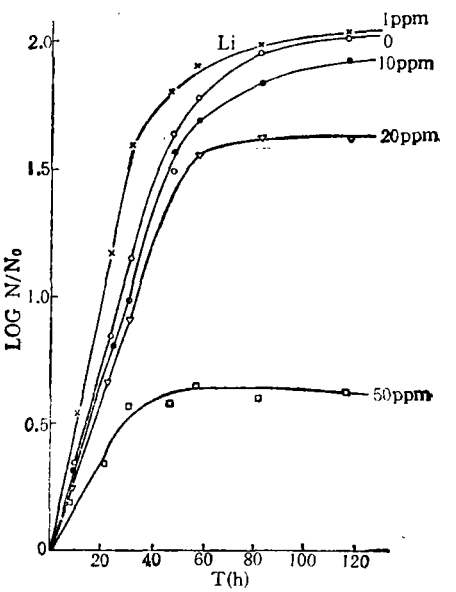

图 1　不同浓度锂存在时衣藻细胞的生长曲线

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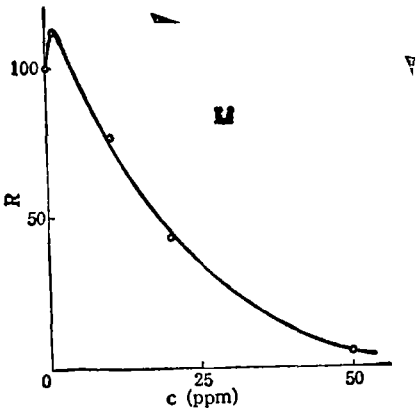

图 2 锂浓度 C 与衣藻生长相对增殖率 R 的关系

浓度锂对衣藻生长相对增殖率

$$R = \frac{(N/N_0)_{Li}}{(N/N_0)_{Li=0}} \times 100\%$$

作图，得图 2。 Li = 0 指未加锂元素离子时的对照组。

用测定锂的同样方法，将 NaCl 水溶液定量移入培养液中，使钠离子的浓度分别为 0, 500, 3500, 6000ppm.

将 KCl 水溶液定量移入培养液中，使钾离子的浓度分别为 0, 20, 70, 1000, 3000 ppm.

将 RbCl 水溶液定量移入培养液中，使铷离子的浓度分别为 0,5,10,50,100,200, 500 ppm.

将 CsCl 水溶液定量移入培养液中，使铯离子的浓度分别为 0, 5, 10, 50, 100, 200 ppm.

将碱土金属中的 $MgCl_2$, $CaCl_2$, $Sr(NO_3)_2$, $BaCl_2$ 水溶液分别移入培养液中，使镁离子的浓度为 0,30,50, 100, 200ppm. 钙离子的浓度为 0,14, 20, 100ppm. 锶离子的浓度为 0, 5, 10, 50ppm. 钡离子的浓度为 0,1,5,10,20ppm.

分别测出不同浓度的钠、钾、铷、铯和镁、钙、锶、钡对衣藻生长的影响曲线。取培养时间 T 等于 90 小时，分别画出它们与衣藻生长相对增殖率 R 的关系图，并按该元素在周期表中的位置综合绘在图 3 中。

图 3 中每个元素的曲线图纵坐标 R 代表衣藻细胞生长的相对增殖率，横坐标代表以元素含量计的浓度 C(ppm).

对每个元素浓度均重复 4—5 次以上，观察计数 100 小时左右。对照组每次实验均平行三份。

二、结 论

从每个元素浓度与相对增殖率关系图上看，如果以相对增殖率高于 100% 作为促进衣藻生长的浓度范围，而低于 100% 作为开始抑制其生长分裂或开始显示毒性的浓度界限，则可将这两族元素的促进、抑制作用浓度范围列于表 2 中。 (Rb, Ca 从图上外推得值).

表 2 碱族、碱土族对衣藻生长的影响浓度 (ppm)

a 0—3 Li b >3	Be
a 0—5000 Na b >5000	0—50 Mg >50
a 0—1700 K b >1700	0—200 Ca >200
a 0—1000 Rb b >1000	0—18 Sr >18
a 0—200 Cs b >200	0—8 Ba >8

a: 促进衣藻生长的浓度区间(以元素含量 ppm计).
b: 开始抑制衣藻生长的浓度(元素含量 ppm).

从表 2 的结果可以看出，IA 和 IIA 主族元素中，除锂、镁外，随着原子序数的增加，促进衣藻生长的元素浓度范围缩小，或者说需要它的营养作用区间变窄。而开始抑制衣藻细胞分裂的元素浓度越小，即它对衣藻细胞的毒性愈强。两族元素的生物效应与它们

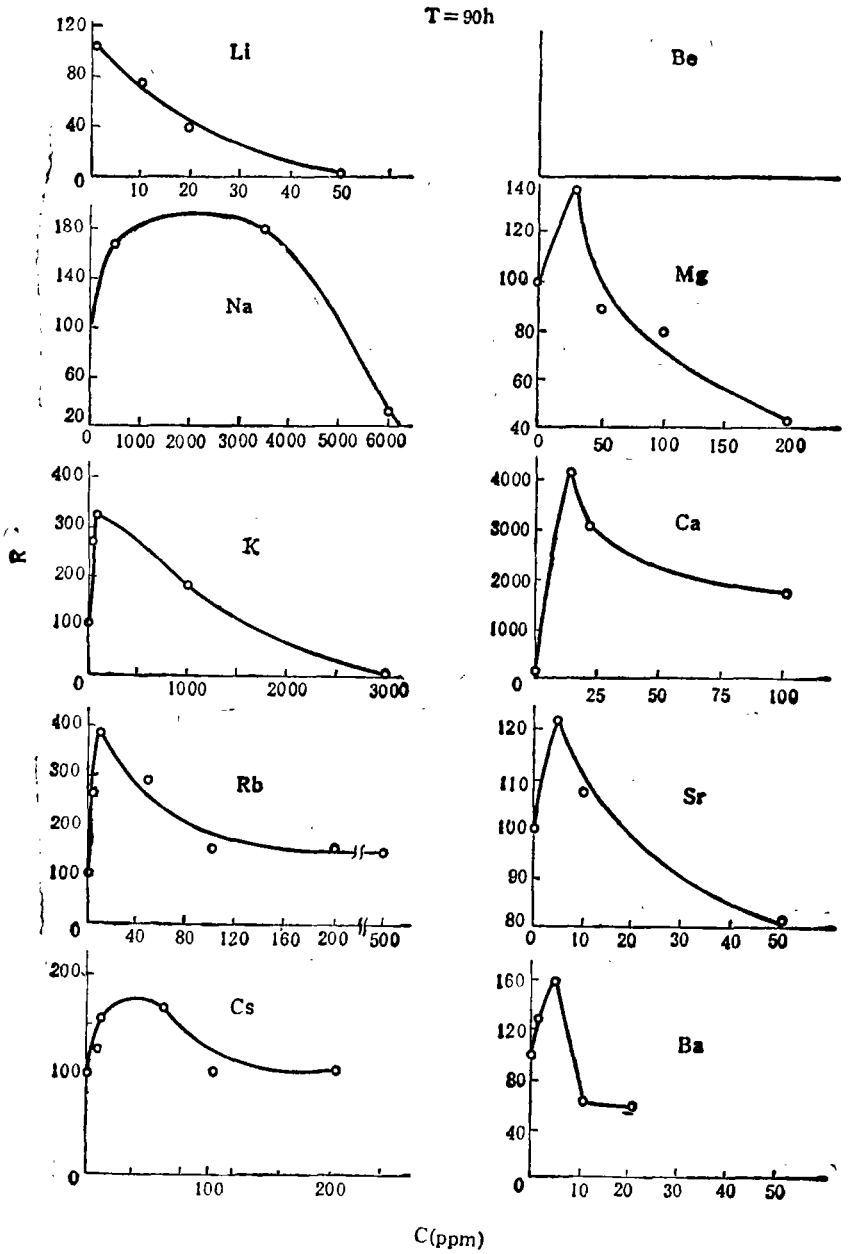

图 3　碱族、碱土族元素浓度 C 与衣藻细胞相对增殖率 R 的关系
$T = 90$ 小时

的性质、离子半径和所带电荷有关. 它们形成离子时虽然半径小于相应的原子半径，但同其他元素的离子半径相比仍然大得多. 它们形成化合物时还具有强离子键的特征. 锂和镁元素在各相应的族中有特别小的原子半径和离子半径，锂和镁在一定程度上容易形成共价键化合物. 我们的实验表明，锂、镁的毒性比相应族中其他元素高. IA 和 IIA 主族元素对衣藻的培养作用和毒性的规律，与周期表中它们的化学性质的规律很一致. 据此可以认为，碱族和碱土族元素对衣藻细胞的生化作用与它们形成　　(下转第70页)

表 3 对"宇宙-1402 号"监测中 K 值、β/α 比值

日期(月. 日)	K 值	β/α 比值
1.24	0.0629	2.8607
25	0.1135	2.0670
26	0.0418	2.6769
27	0.0650	1.8859
28	0.0469	2.0818
29	0.0576	1.9469
30	0.0997	1.9291
2.1	0.0708	2.2368
2	0.1005	3.2681
3	0.0815	2.0477
4	0.0538	1.8055
5	0.0918	1.9973
6	0.0766	2.0329
7	0.0539	1.5200
8	0.0875	1.6878
$\bar{X}\pm$	0.0736±0.0208	2.1362±0.4461

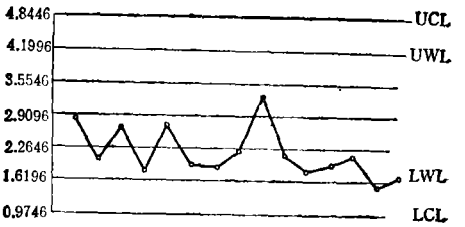

图 2 β/α 比值正常均值控制图曲线为对"1402 号"监测值

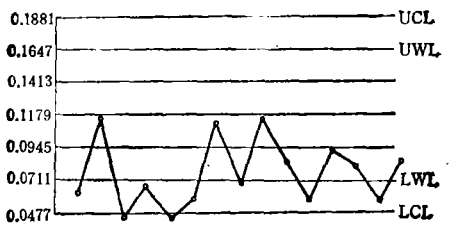

图 3 K 值正常值均数控制图(曲线为对"1402"监测值)

三、实 际 应 用

苏联于 1982 年 8 月 30 日发射了核动力卫星"宇宙—1402 号", 1982 年 12 月 28日解体后发生故障,核动力部分未进入高轨道,为观察其对我国造成核污染情况,我们于 1983 年 1 月 24 日到 2 月 8 日进行了核污染监测,并计算了空气气溶胶的 K 值, β/α 比值,结果列于表 3 .

为即时发现有无核污染, 分别以长春地区的 K 值和 β/α 比值的正常值绘制成均数控制图(图 2、图 3), 将监测到的结果填入图中,即可判断是否有新的污染.

从图 2、图 3 可以看出, 每天的监测结果, 都分布在上警戒线之内, 都属正常范围, 说明没有新的核污染. 事实又证明"宇宙-1402 号"解体后, 其动力部分,在绕地球进行轨道高度不断下降的情况下, 已于北京时间 1983 年 1 月 24日 6 时 21 分在印度洋迪戈加西亚岛东南约 1814 公里处坠落,对我长春地区不会有污染. 说明我们的监测和判断与事实是一致的.

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化合物的特性密切相关.

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Academia Sinica, Beijing)

Zinc is an important element for life. Studying its background values in aquatic environment is significant for evaluation of water quality. This work describes that zinc contents in water samples taken from Xiangjiang River in Hunan Province and from from the rivers in Beijing-Tianjin area have been analysed by flame AAS. The distribution types of background values of zinc were handled by mathematical statistic method. The results show that the background values of zinc in the waters above mentioned are in normal ranges compared with world levels. The chemical speciation of zinc in water and sediments of Xiangjing River were studied as well. ASV-labile zinc in dissolved zinc were found as predominant forms in water. The bound to Fe-Mn oxides are major speciations of Zn in the sediments except residual. The background values of zinc and its different species in water are mainly affected by its geochemical charater and environmental factors. (See pp. 30—33)

Effects of Alkali and Alkaline Earth Groups of Population Growth of *Chlamydomonas Reinhardtii*

Shi Jinyuan et al. (Department of Tech. Physics, Peking University); Li Yunzhen (Department of Biology, Peking University)

The influence of alkali and alkaline earth group elementes of different concentrations on the population growth of green algae that is employed as a biological model. A certain regularity between biological effects of the elements and their position in the periodic table has been discussed. *Chlamydomonas reinhardtii* were cultured in the solution containing some inorganic salts. Based on relation rate of proliferation (R) on each element of IA and IIA Groups, the stimulating concentrations (when $R > 100\%$) and inhibitory concentrations (when $R < 100\%$) have been obtained. The results show that the toxicity of the elements on the algae will increase with the increase of their atomic number (Z) in the same group except Li and Mg. (See pp. 33—35)

Determination of the Quantity of Nonbiodegradable/Nonremoval Substances in Industrial Wastewater

Zhou Xiaojian (Environmental Protection Institute of the Ministry of Light Industry, Beijing)

According to the kinetics of biological process, this paper has proposed the determination of the quantity of nonbiodegradable substances in wastewater, which is then applied to the process of an anaerobic treatment and an aerobic treatment respectively. The results are as follows:

(1) In the anaerobic treatment of cotton pulp black liquor with an UASB reactor, when the COD concentration of the influent is 10—13g/L, the concentration of nonbiodegradable subsctances, through measuring and calculating, is 4.147g COD/L. Thus, the average value of the maximum COD removal is 63.3%. Meanwhile, in the batch experiment of the anaerobic treatment of cotton pulp black liquor, the result obtained in the same way is the maximum COD removal can be 63.9%, which further supports this result.

(2) As for the wine lees with the activated sludge process, the average value of the maximum COD removal can be expected to be 86.8%. (See pp. 36—39)

A Study on the Conditions for Treating Wastewater Containing Copper Complex by Reduction-Coagulation Method

Zhang Zhongyan, Yu Shouhui and Zhu Rongfen (Shanghai University of Industrial Technology, Shanghai)

The conditions for treating copper-containing complex wastewater by Fe^{2+} reduction coagulation have been studied. In the mean time, coprecipitation with other inorganic coagulants [$CaCl_2$, PAC, $Fe_2(SO_4)_3$] has been discussed. The results in lab and productive experiments show that when EDTA citric acid or tartaric acid exists in wastewater, the effect of single chemical precipitation on removing copper is very poor. As the unstability of complex copper in acidic solution, Cu^{2+} can be reduced to be Cu^{+} with Fe_2^{+} at $pH = 4.5—5$, and then by increasing pH to 8—9, coprecipitation will take place, In this way the residual copper in outflow is always less than Img/L. Thus, an economical and efficient technology will be presented for treating of cooper-containing complex wastewater. (See pp. 44—48)

Simutaneous Determination of Cobalt, Nickel, Copper, Zinc and Cadmium Using Kalman Filtering Spectrophotometry

Li Zhiliang (Hunan University, Changsha) and *Shi Leming* (China University of Sciences and Technology, Hefei)

A method for simultaneous determination of cobalt, nickel, copper, zinc and cadmium by Kalman Filtering Spectrophotometry has been proposed based on their chelate-forming reactions with 5-Br-PADN in the presence of Tween—80, Satisfactory results were obtained for the analysis of synthetic and river water samples by the method. (See pp. 56—57)

Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans in the Environment

Kang Junxing and Bao Zhicheng (Research Center for Eco-Environmental Sciences, Academia Sinica, Beijing)

Because of the extreme toxicity of some of the polychlorinated dibenzo-*p*-dioxins (PCDD) and dibenzofurans (PCDF), the concerns for the health hazards of exposure to PCDD and PCDF led to growing Studies of PCDD and PCDF. The purpose of this review is to provide the information of toxicity, construction, major sources, pollution and human professional exposure of PCDD and PCDF. The current status of PCDD and PCDF in China was also discussed primarily in this article. (See pp. 59—67)