

凤眼莲根系微型动物群落的季节动态与净化效能的关系初探

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摘要 初步研究了在北京动物园利用凤眼莲处理污染水体时其根系微型动物相的季节变异特征, 以探讨其对系统净化效能的影响。于1992年在根系水域共发现微型动物70种, 其中8月份检出种类数最多, 为49属60种。7、8月份凤眼莲根系微型动物生物量(相对数量和平均湿重)较高; 原生动物类群的数量百分比在这2个月分别为76.9%和64.1%。报道了试验中各月(6—10月)检出的优势种(种群)。主要出水理化指标TN、TP、BOD呈季节性波动变化。7月份TSS去除率达82.9%, 8月份BOD、TP的去除率分别为66%和91.6%。说明凤眼莲系统净化效能与其根系微型动物群落结构的季节状态相关。

关键词 凤眼莲, 根系, 微型动物群落, 污水净化。

以凤眼莲为主体净化植物的生态工程——氧化塘技术已广泛被用于处理多种生活污水和工业废水。凤眼莲净化系统的净化功能与其根系微生态系统的活性状态关系极为密切。凤眼莲根系微型动物是表征凤眼莲净化功能状态的重要生物相, 它们通过自身的新陈代谢作用吸收、降解、转移、转化水体污染物, 并协同凤眼莲植物本身的生理机能共同达到净化水质的目的。在北方引种凤眼莲处理污染水体时, 由于气候的季节性和凤眼莲生长条件的变化, 必将影响凤眼莲根系微型动物群落的构成状态及演替过程, 从而导致凤眼莲系统净化效能的变化。尹宇等人^[1,2]研究了凤眼莲根系微型动物在污水净化中的作用, 但从动态水平追踪研究凤眼莲根系微型动物相的演变及其与水质关系的内容, 国内未见报道。

笔者于1990—1993年参加了“利用生态工程控制北京动物园水禽湖水质富营养化的生产性试验”课题的研究工作, 于1992年对凤眼莲根系微型动物群落结构的季节变化特征及其与凤眼莲净化系统净化效能的关系作了初步探讨。

1 试验部分

1.1 供试场地

以北京动物园水禽湖和牡丹亭湖为试验基

地, 开展污水资源化生态工程建设。采用自行设计的工艺, 除特殊情况外, 每年维持运行5—6个月。

1.2 试验方法

凤眼莲净化生态工程运转后, 于每月中旬随机取生物样品和水样。生物样品的采集方法见文献[1]。

凤眼莲根系微型动物定性分析采用活体镜检法; 用于定量分析的微型动物先用4%的福尔马林溶液处理、固定, 镜检计数后, 根据有关资料^[3]计算或按体积推算凤眼莲根系微型动物的平均湿重, 较大型者可拣出称重, 最终换算成每 m^3 水体所含生物量。

同时进行水质理化指标的测定和分析。

2 结果和讨论

2.1 微型动物各月的种类组成及优势种

在凤眼莲根系水域共发现微型动物57属70种, 各类群的季节分布见表1。其中8月份检出的微型动物种类数最多, 为49属60种, 包括原生动物26属33种, 轮虫13属17种, 腹毛类和线虫动物各1属1种, 水栖寡毛类2属2种, 蛭类1属1种, 枝角类2属2种, 介壳虫和桡足

类各 1 属 1 种,水生昆虫(幼虫)1 属 1 种。

纤毛类原生动物 6—10 月份种类数分别为 5、7、21、9、8 种;各月原生动物和轮虫类优势种或丰度较高的种类分别为:花臂臂尾轮虫、钟形钟虫和红眼旋轮虫、累枝虫和红眼旋轮虫、矛状鳞壳虫和钩状狭甲轮虫、矛状鳞壳虫和红眼旋轮虫。此外,腹毛虫和水线虫在 7、8、9 三个月的出现频率也较高。

表 1 凤眼莲根系微型动物各类群的季节分布(种数)					
月 份	5—6	7	8	9	10
原生动物	10	14	33	23	20
轮 虫	6	16	17	11	6
环节动物	1	2	3	4	1
甲壳动物	1	1	4	2	1
摇蚊幼虫	0	1	1	1	0
其 他	0	4	2	2	2
合 计	18	38	60	43	30

上述结果表明,6 月份凤眼莲根系微型动物群落结构简单,种类数不多。至 7—8 月份其根系微型动物群落结构趋于稳定和复杂化,种类数较多,种群构成优化,一些具有极强净化功能的类群相继成为优势,如缘毛目的钟虫属和累枝虫属,以及旋轮属的红眼旋轮虫等。9、10 月份根系微型动物种类数有所减少,但仍形成了优势和亚优势种类,随着水温的降低,微型动物的繁殖能力和代谢活性将会受到影响。

在各月的样品中均被检出的微型动物种类有蛞蝓筒变虫,针棘匣壳虫、钟形钟虫、红眼旋轮虫、红斑瓢体虫和锯缘真剑水蚤。这一方面

表明它们对水域生态环境的广适性,另一方面也显示出它们对水体污染的持久净化作用。

2.2 凤眼莲根系微型动物量的动态与水质

2.2.1 微型动物生物量百分比的动态变化

6—10 月份原生动物类群相对数量的百分比分别为 35.1、76.7、64.1、41.8 和 46.9,其中以 7、8 月份较高。轮虫数量百分比从 7 月份起呈升高趋势。其它种类微型动物数量百分比呈不规则变化。

表 2 表明原生动物生物量(平均湿重)百分比各月相差程度不明显,而轮虫的生物量百分比从 7 月份开始呈下降趋势,其他种类微型动物的生物量总和百分比逐渐升高。

表 2 凤眼莲根系微型动物各类群平均湿重组成(%)					
月 份	6	7	8	9	10
原生动物	0.6	1.9	2.7	8.6	1.6
轮 虫	19.6	44.2	32.1	24.4	25.4
其他类群 (甲壳动物、水生昆虫等)	79.8	54.9	65.2	67.0	73.0

2.2.2 微型动物生物量与净化率

表 3 给出不同月份微型动物数量和湿重及系统水质净化率,其中 7 月份对 TSS 去除率为 82.9%,8 月份对 BOD、TP 的去除率最高,分别为 66.6%和 91.6%,而 7 月和 8 月份采集到的凤眼莲根系微型动物的生物量(数量和湿重)较高。

2.2.3 出水 TN、TP 及 BOD₅ 的波动

表 3 凤眼莲根系微型动物生物量与水质						
时间(月)		6	7	8	9	10
微型动物湿重/水体(mg/m³)		1.24×10³	8.12×10⁴	7.42×10⁴	1.83×10³	3.36×10³
微型动物数量/水体(个/m³)		7.09×10⁵	3.18×10⁷	1.62×10⁷	1.25×10⁶	4.18×10⁶
去 除 率 (%)	BOD₅	64.1	19.2	66.6	47.7	
	COD	9.6	35.1	31.4	20.0	18.6
	TN	46.2	34.0	20.0	0.9	38.0
	TP	21.0	26.6	91.6	44.4	44.0
	TSS	22.7	82.9	60.1	16.6	

将主要出水理化指标绘制如图 1。由图 1 中结果得出,7 月和 8 月凤眼莲净化系统出水的

TN、TP 和 BOD₅ 指标最优,9 月和 10 月份净化效能减弱。

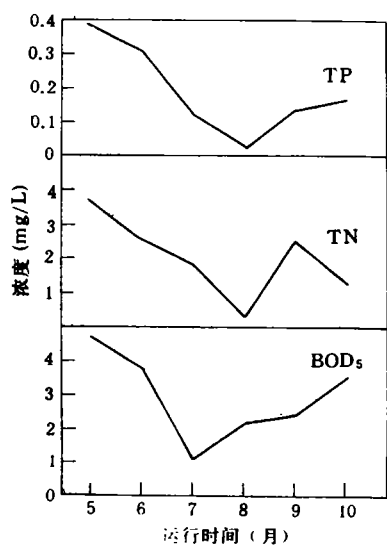


图1 凤眼莲净化系统出水 TN、TP、BOD₅ 浓度的变化

结合 2.2 所得结果看, 7、8 月份检出的凤眼莲根系微型动物相对数量最多(表 3), 而原生动物在这 2 个月的数量百分比较高。因而使 TN、TP、BOD 出水指标和 TSS 的去除效果较好(图 1、表 3)。到 9 月和 10 月份, 原生动物总

体数量有所降低, 出水指标较 7、8 月份为差。此外, 原生动物湿重百分比小且各月相差不大(表 2), 这与原生动物个体微小有关。

除原生动物和轮虫外, 其他种类的微型动物也是重要的净化功能类群, 笔者认为这类微型动物对维持水质的净化效果有一定作用。

3 结论

(1) 在北方引种凤眼莲净化水质时其根系微型动物群落在种类组成, 优势种及生物量等方面呈现季节性变异特征, 其中以 7—8 月份微型动物群落结构最为复杂和优化。

(2) 凤眼莲生态工程净化系统的净化效能与其根系微型动物相的季节状态密切相关。

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3 结束语

(1) 用日本理学高分辨双晶 XRF 多次重复测定样品中硫的化学价态时, 总硫含量有缓慢下降的趋势, 而干燥器内保存、在一定时间间隔内所测定单种化学价态的硫样, 其硫的化学价态基本没有变化。

(2) 高分辨双晶 XRF 测定硫的化学价态, 其光路中第 2 块 Ge[Ⅲ]晶体装卸微小位置变化, 使各种不同价态硫的谱峰能量值改变, 但各种价相对本次测定 S⁰ 价的谱峰能量差变化不

大, 基本在一个能量差范围内。

(3) 本法适用于部分单种化学态硫样品的分析, 同时可判定非单种化学价态硫样品及这类样品中硫的化学状态。

致谢 实验工作由孟玲同志承担完成, 在此谨致谢意。

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autumn. In addition, the concentration of nitrate and sulfate were often of high values in one or two days before raining and in 3 or 4 days after raining. This indicates that rainfall had a significant effect of scavenging particulates. The level of nitrate in particulates was found to have a much better correlation with ozone concentration than the level of sulfate in particulates.

Key words: particulate, nitrate, sulfate, ozone, ion chromatography.

Study on the Photocatalytic Degradation of Organo-Phosphorus Pesticides. Chen shifu et al. (Dept. of Chemical Eng., Zhengzhou Institute of Technology, Zhengzhou 450002); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 61–63

The feasibility of photocatalytic degradation of three different structures' organophosphorus pesticides using TiO_2 powders as a photocatalyst was studied. The results show that different structures of organophosphorus pesticides had different photodegradation efficiencies, and four organophosphorus pesticides of 1.0×10^{-4} mol/L were completely photocatalytically degraded into inorganic phosphate after 40 min illumination with a medium pressure mercury lamp of 375 W. Some intermediate products of photocatalytic degradation of monocrotophos were detected and the effects of the parameter, such as amount of TiO_2 , flow rate of air and Fe^{3+} concentration, on the photocatalytic degradation were also investigated. The mechanism were discussed preliminarily.

Key words: organophosphorus pesticides, photocatalytic degradation, TiO_2 powders.

Preliminary study on the relationship between seasonal dynamics of microfauna in the root system of water hyacinth and their effects on the purification of waterbody. Li Baolin (Beijing Municipal Research Academy of Environmental Protection, Beijing 100037); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 64–66

Seasonal variation characteristics of microfauna in the root system of water hyacinth has been primarily studied when it was used to treat sewage water from the Beijing Zoo. 70 species of microfauna was found in the water-root system in 1992, with the largest number of 60 species in 49 genera in August. Biomass (by relative quantity and average wet weight) of microfauna was heavier in July and August, and the weight percentage of protozoa in the same two months were 76.9% and 64.1%. The dominant species (po-

pulation) examined in each month (June to October) was reported. The main physical and chemical indexes such as TN, TP and BOD varied seasonally. The removal of TSS was up to 82.9% and those of BOD and TP were 66.6% and 91.6%. This study demonstrates that the purifying efficiency of water-hyacinth system was in a relationship with the seasonal characteristics of the microfauna built up in its rootsystem.

Key words: water hyacinth, root system, microfauna, purification.

Study on the Decolourization Activity of Activated Sludge with Immobilized Decolourization Bacteria. Zhang Lin et al. (Dept. of Environ. Eng., Taiyuan Univ. of Technology, Taiyuan 030024), Ma Minghuan (Shanxi Textile Industry Designing Institute, Taiyuan 030002); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 67–69

The highly efficient decolourization bacteria were selected and immobilized on an activated sludge by using an aggregated/cross-linked immobilization method to form a microstructure of cross-linked floccule-granule. The activity of decolourization enzyme increased by about 70% as compared with a non immobilized activated sludge. The results of textile dyeing wastewater treatment under anaerobic condition show that there was an average colour removal 77.3% with an average COD_{Cr} removal of 65.1%.

Key words: aggregated/cross-linked immobilization, the activated sludge with immobilized decolourization bacteria, activity of decolourization enzyme, dyeing wastewater.

Study on Environmental Etiology Among a Population at a High Risk of Gastric Cancer in Xianghuangqi County of Inner Mongolia: An Appraisalment on the Endogenous Synthesis of Nitrosamines in Human Body. Song Xiuxian et al. (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085), Liu Kezhong (Inner Mongolia Autonomous Region's Hospital, Huhhot 010017); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 70–71

The contents of nitrites in water from 15 rural areas in Xianghuangqi, Xilinguole Meng, Inner Mongolia Autonomous Region, were measured. The results show that the contents of nitrites in water widely varied and could be classified broadly into three groups with an average nitrite level of 0.186, 0.640 and 3.840 $\mu\text{g}/\text{ml}$ respectively. The contents of amines in mildewed cheese were