*Journal of Environmental Sciences (China)*, Vol. 1, No. 2, pp 10–14, 1989 ISSN 1001-0742

# Advances of studies on biomonitoring of water pollution in China

Wang Deming[1] and Yu Shuwen[2]

(Received December 26, 1988)

**Abstract**—The progress of biomonitoring on water pollution in recent years in China has been summarized in this paper.
**Keywords:** biomonitoring; water pollution; China

## COMPREHENSIVE ASSESSMENT OF WATER POLLUTION

Since 1974, we have adopted many water pollution indices in a series of comprehensive evaluations on water pollution. They are:

Comprehensive pollution index ($K$);
Water quality index ($P$);
Comprehensive index of water body quality ($I_w$);
Comprehensive pollution index ($I_p$);
Comprehensive assessment value of organic pollution ($A$);
Pollution index of surface water ($I^0$);
Water quality index ($WQI$).

There are still other formulae for evaluating the water environment. But generally speaking, they are not so satisfactory since they can not describe the quality of water environment perfectly. Evaluation levels for environment pollution in water area nearby the mouth of the Pearl River have been shown in Table 1.

**Table 1** Evaluation levels for environment pollution in water area nearby the mouth of the Pearl River

| The level | The range of index values of whole environment | The range of index values of environmental elements | | |
|---|---|---|---|---|
| | | Water | Sediment | Biota |
| Clean | < 0.4 | < 0.2 | < 0.4 | < 0.4 |
| Minute pollution | 0.4–0.6 | 0.2–0.4 | 0.4–0.6 | 0.4–0.6 |
| Slight pollution | 0.6–0.8 | 0.4–0.7 | 0.6–0.8 | 0.6–0.8 |
| Medium pollution | 0.8–1.0 | 0.7–1.0 | 0.8–1.0 | 0.8–1.0 |
| Serious pollution | > 1.0 | > 1.0 | > 1.0 | > 1.0 |

## BIOMONITORING OF WATER POLLUTION

Biomonitoring of water environment quality in China has been reviewed by Wang Deming (1984, 1985). Liang Zhirong *et al.* (1985) considered that fungi of saprolegniaceae have some regularity in its distribution and quantity in various polluted water bodies. We have to further study its feasibility whether it can be used as a comprehensive biomonitoring assessment index for water body. Fungi, heterotrophic bacteria, coliform group, salmonella group

[1]Institute of Hydrobiology, Academia Sinica, Wuhan.
[2]Shanghai Institute of Plant Physiology, Academia Sinica, Shanghai.

and so on had been used as hygienic index to show the relationship between city water body and population partly (Zhao Yinwei 1985). Lin Wenna *et al.* (1984) reported that when some toxic substance appeared in the environment, obvious reduction of *Bacillus subtilis* spore may be taken as an index. Zhai Shumao *et al.* (1984) pointed out that reproduction inhibiting test of *Tetrahymena pyriformis* could inferred approximately the threshold concentration and allowable concentration of toxic substance in water. Shi Jingyuan (1984) found in the test of *Tetrahymena pyriformis* that trace selenium could produce an antagonism to nickel and thallium whereas no antagonistic effect to cobalt and chromium (VI) was found from selenium in the similar conditions. Considering metal toxicity sequence obtained in test was about the same with those results from $LD_{50}$ tests using mammals, Tang Renhuan *et al.* (1986) proposed that *Tetrahymena pyriformis* could be used as a fast-monitoring method. Han Hongying (1984) reported toxicity threshold by mercury to *Scenedesmes obliquus* in its growth was between 0.02–0.05 mg/L and the lowest concentration controlled wholly in its growth was between 1–2 mg/L and he also considered that inhibition by mercury to photosynthesis and autospore formation was the major factor for lag growth. Gong Xunju (1986) considered that eutrophication process is accelerated in the centre area of the East Lake based on the investigation of protozoa in the lake. Xie Fengyun (1986), according to the phytoplankton population distribution, described certain organic pollution in the Kunming, Jishuitan, Houhai, Beihai and Tongzihu Lakes in the city of Beijing and considered that it was significant to monitor and evaluate water body by using phytoplankton population distribution. Applying Hohn's semidetailed reading to study species, dominant species and density of cell of attached algae in Xiangjiang River, Luo Sunyan *et al.* (1985) deduced equations which show distance of discharge points and its biological parameters. Pollution of water body in Second Songhua River was evaluated by Wang Wei (1985), he found that many algological indices could be comprehensively applied by maximum element of matrix of fuzzy clustering. So that the Second Songhua River could be divided into 5 pollution classes and 6 pollution zones. Based on the investigation on pollution level and growth of phytoplankton during freezing season in Harbin–Tungho reaches of the Songhuajiang River, Lu Yangsheng (1985, a) considered that most areas in this section have a medium pollution zone mainly with many algae such as *melosira, fragilarie, asterionella, nitzschia, synedra, ankistrodesmus, phacus, synura, stauroneis* and so on. After studies on Menhinick diversity index and biotic index of zooplankton, phytoplankton and attached algae in Songhuajiang River, Lu Yangsheng (1985,b) evaluated the water quality and determined pollution levels in different sections of the river. Lin Qiangguo (1985) attempted to evaluate the water quality in Dongting Lake applying benthic fauna constructure. He thought that Trent biotic index, Chandler score system and Goodningt–Whitely index fit to the conditions of the Dongting Lake, however, if quantity of species resistant to pollution equals to sensitive species or in the cases that the former is less than the latter, Shannon index and Simpson index usually received index value against to reality owing to considering quantity and quality of the species only. Qi Sang *et al.* (1985) reused macroinvertebrate to evaluated pollution in Guangzhou section of the Pearl River and compared biological pollution index with Shannon–Weaver, Pieloe, Heip, Simpson, Brillouin, Fisher– a indices. He concluded that the former had a good effect and suggested to develop local bio-indices followed the conclusion by Lenat *et al.* (1980)(Qi Sang 1986). By monitoring, the mercury concentration in mussels in Xiamen Harbour is between 0.007–0.043 mg/L. With an average of 0.017 mg/L, the content of mercury is lower 18 times than that of in sea products with an allowable concentration (0.3 mg/L) according to the hygienic standard in China. The concentration of mercury in sea water ranged from 0.007 to 0.054 mg/L with an average of 0.11 mg/L which is 45 times lower than that of fishery water quality standard (0.5 mg/L). Thus Lai Derong *et al.* (1984) considered that there is no mercury pollution in Xiamen Harbour at present, and the results based on mussel as medium for biomonitoring and chemical analysis of sea water shown a consistent mercury concentration variance on the whole. This indicated that the method of monitoring mercury pollution by using mussel in

coastline water is feasible. It is also feasible to show the water pollution of Lijiang River by applying bio-index of benthic fauna construction such as Beck index, Goodnight index, Gleason index and Shannon diversity index (Shi Dakong, 1985). Guo Zhiming (1984) considered that Trent index and Chandler score system are suitable to evaluate water quality for 14 sections in Luanke River. Xie Lingge (1985) found that substances injured DNA could slow the growth of snail embryo. Mechlorethanine, Mitomycin C and 5 Fluorouracil could injure DNA and slow the growth of snail embryo 6 pharmaceuticals he tested, whereas snail embryos treated by chloramphenicol, ascorbic acid and analgen could grow paralelled with controls without injury to DNA. Zhang Yuqi *et al.* (1984) inferred out mercury pollution levels of the Bohai Gulf in each year by measuring the mercury residue in gull's feather of different years. Li Xingfu *et al.* (1984) considered that one could only get a more comprehensive understanding by using different species and growing stages in toxicity tests when evaluating toxicity of some toxicant. They tested the toxicity of 8 metals with *Rana nigromaculate* embryo and tadpoles. Toxicity to tadpoles is as follows : $Ag^{+} > Hg^{+} > Cu^{2+} > Cd^{2+} > Cr^{6+} > Pb^{2+} > Zn^{2+} > Ni^{2+}$; as for frog embryo, toxicity of Hg is larger than that of Ag; $Cr^{6+}$, $Zn^{2+}$ and $Ni^{2+}$ have an obvious teratogenic effect to frog embryo. Pesticide like aldicarb has a $LC_{50}$ 7.4 mg/L to gold fish (Chen Xingwu, 1986). Yin Yiwei *et al.* (1986) performed acute toxicity test for fingling, fry and eggs of *Hypophalmichthys molitrix* with 36 chemicals and suggested that the safe factor for sodium pentachloro-phenol, fenitrothion and methyl phenol should be chosen between 0.1–0.05. Test results by Jian Lifen *et al.* (1985) showed that maximum critical temperature rise for ventilation rate of *Ctenopharyngodon idelles, Hypophthalmichthys molitrix* and *Cerassius auratus* should not exceed over 35°C. Tests showed that H-chrysenel accumulated mainly in bone, stomach and liver of *Cyprinus carpio*, Wang Bingkun *et al.* (1986) found that accumulation curve showed a better correlation between concentration factor $CF$ and time $t$. The regression equations are as follows:

| | |
|---|---|
| Gill | $CF$=91.8 + 14.6 ln$t$ |
| | r=0.93($t$:0.1 - 144h) |
| Liver | $CF$=-241.2 + 777 ln$t$ |
| | r=0.82($t$:48 - 144h) |
| Bone | $CF$=-31.1 + 29.0 ln$t$ |
| | r=0.92($t$:24 - 144h) |
| Stomach | $CF$=-59.9 + 35.1 ln$t$ |
| | r=0.99($t$:24 - 144h) |
| Scale | $CF$=-77.2 + 27.1 ln$t$ |
| | r=0.83($t$:48 - 144h) |
| Skin | $CF$=52.0 + 20.8 ln$t$ |
| | r=0.92($t$:24 - 144h) |
| Meat | $CF$=-99.6 + 30.2 ln$t$ |
| | r=0.95($t$:48 - 144h) |

Dun Wanru *et al.* (1985) indicated that *Tradescantia palludosa* micronuclei method could monitor lead pollution in water and air. Considering not growing of *Tradescantia palludosa* under cold condition and growing only in ordinary greenhouse but with a high micronuclei rate, Hou Jialong *et al.* (1985) suggested that *Tradescantia palludosa* should be grown in the ordinary greenhouse first and then transplanted them which are enough for one bio-assay to a small greenhouse (at a temperature of 20–25°C). Since micronuclei rate can drop into a normal level, this can meet the demands of biomonitoring. Through determination the micrographic method, Wang Yinyan *et al.* (1986) found that the position of tetrad flower bud during cleavage stage of inflorescence is nearby the seventh pair, inflorescence size and maturity can influence the making of early tetrad micronuclei glass and background micronuclei rate can be controlled within 1.1–

3.6% under suitable condition for culture. Hou Jialong *et al.* (1985) carried out sensitivity tests for $^{137}Cs$ with *Tradescantia palludosa* and indicated that the pollen matricyte has a definite limits of sensitivity for absorbed $^{137}Cs$. It is with a largest sensitivity when dosage is 65–135 $\mu\mu C$. An ultra–dosage reaction will appear when it is over 130 $\mu\mu C$ whereas there is in sensitivity when it is lower than 65 $\mu\mu C$. With wider spectrum of the tested substances, Wang Yingyan *et al.* (1984,1986) suggested that monitoring system of *Vicia faba* root tip cell micronuclei can monitor water soluble and insoluble chemicals. With respect of induction of $^{60}Co$ irradiation and bleomycin $A_5$ to *Vicia faba* root tip cell micronuclei, a linear correlation was shown between the dosage and the inducing rate. Chen Guangrong *et al.* (1985, 1986), applying water pollution index in the technic of *Vicia faba* tip cell micronuclei, divided water bodies into 0–1.5 standing for almost no pollution; 1.5–2 standing for light pollution; 2–3.5 standing for medium pollution and serious pollution when the index is over 3.5. A succeeded pollution monitor was done in Qingshan Lake. The pollution levels in four areas of the lake are A>B>C>D. The mean of micronuclei rate is D<C<B<A. Lin Taixi *et al.* (1986) reported that *Vicia faba* root tip cell and larvae of *Hemicentrotus pulcherrimus* are good materials for monitoring fresh water and sea water. Guo Baojiang found that there is a good linear relationship between micronuclei cell rate by *Ranunculus sceleratus* root tip cells and concentration of pollutant.

## REFERENCES


Chen Guangrong *et al* ., Environ. Sci. in China, 1985, 5:2

Chen Guangrong *et al* ., China Environ. Sci., 1986, 6:60

Chen Xingwu and Sun Anqiang, Chinese J. of Environ. Sci., 1986, 7:26

Dun Wanru *et al.*, Environ. in China, 1985, 5 : 45

Gong Xunju, Acta Hydrobiologica Sinica, 1986, 10 : 340

Guo Baojiang, Acta Scientia Circumstantiae, 1985, 5 : 322

Guo Zhiming, Chinese J. of Environ. Sci., 1984, 5 : 39

Han Hongying, Acta Scientiae Circumstantiae, 1984, 4 : 157

Hou Jianglong *et al.*, J. of Ecology, 1985, 25

Hou Jianglong *et al.*, Environ. Sci. in China, 1985, 5 : 8

Jiang Lifan and Cao Guihe, Chinese J. of Environ. Sci, 1985, 6 : 15

Lenat, D.R. *et al.*, Use of benthic macroinvertebrates as indicators of environmental quality. In : Worf, D. L. ed, Biological monitoring for environmental effects, 1980, 97

Li Xingfu and Zhang Fuyin, Environ. Sci. in China, 1984, 1 : 59

Liang Zhirong and Yu Yongnian, Acta Scientiae Circumstantiae, 1985, 5 : 366

Lin Taixi *et al.*, Acta Scientiae Circumstantiae 1986, 6 : 107

Lin Wenna *et al.*, Chinese J. of Environ. Sci., 1984, 5 : 23

Lin Qingguo, Chinese J. of Environ. Sci., 1985, 6 : 59

Lu Yangsheng(a), Chinese J. of Environ. Sci., 1985, 6 : 58

Lu Yangsheng (b), Chinese J. Environ. Sci., 1985, 6 : 33

Luo Sunyan and Leng Shan, Environ. Sci. in China, 1985, 5 : 11

Qi Sang and Lin Meixin, Acta Scientiae Circumstantiae, 1985, 5 : 354

Qi Sang, China Environ. Sci., 1986, 6 : 64

Shi Dakong, Chinese J. of Environ. Sci., 1985, 6 : 54

Shi Jinyuan *et al.*, Chinese J. of Environ. Sci., 1984, 5 : 41

Tang Renhuan *et al.*, China Environ. Sci., 1986, 6 : 9

Wang Bingkun *et al.*, Chinese J. of Environ. Sci., 1986, 7 : 25

Wang Deming, General situation and prospects of studies on biomonitoring in China, International symposium on biological monitoring of the state of the environment (bioindicator), Indian National Science Academy, New Delhi, 1984, 74

Wang Deming, Ecological Sci., 1985, 90

Wang Wei, Environ. Sci. in China, 1985, 5 : 31

Wang Yingyan *et al.*, Chinese J. of Environ. Sci., 1984, 5 : 20
Wang Yingyan *et al.*, China Environmental Sciences, 1986, 6 :19
Wang Yingyan *et al.*, Chinese J. of Environ. Sci., 1986, 7 : 77
Worf, D.L., Biological Monitoring for Environmental effects, D.C. Health and Company, Lexington, 1980
Xie Fengjun, Chinese J. of Environ. Sci., 1986, 7 : 70
Xie Linge, Acta Scientiae Circumstantiae, 1985, 5 : 228
Yin Yiwei *et al.*, China Environ. Sci., 1986, 6 : 3
Zhao Shumiao *et al.*, Chinese J. of Environ. Sci., 1984, 5 : 39
Zhang Yuqi and Chen Xulong, Chinese J. of Environ. Sci., 1984, 5 : 27
Zhao Yinwei *et al.*, Chinese J. of Environ. Sci., 1985, 6 : 39