Bull. Environ. Contam. Toxicol. (1990) 44:844–850

Environmental Contamination and Toxicology

Relationship Between Serum GOT of *Cyprinus carpio* and Biotic Index of Diatom in the Diagnosis of Water Quality

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Many studies have been conducted in which fish were experimentally stressed and the ensuing changes in serum enzyme activities were recorded. Serum enzymes in rainbow trout were proposed as tools in the diagnosis of water quality (Wieser and Hinterleitner 1980). The examination of diatom flora was also proposed as an indicator of water quality (Lin 1979). Diatom flora bioassay is time-consuming and uneconomical, but serum enzyme determination is easy and time-saving. If there is some relationship between the two aspects in water quality determination, the idea that serum enzyme in fish is an indicator in the diagnosis of water quality will be further supported.

MATERIALS AND METHODS

Fifteen water sampling sites were selected within a section, between Fushun and Nanzamu (see Figure 1), of the Hunhe River and its tributaries. One 10-L-water sample was obtained, 30 cm below the water surface, from each of the fifteen sites, respectively. The collecting period was from April 28 to May 4, 1984. Twenty-two carps (Cyprinus carpio)weighing about 300 g each were bought from a local fishpond, about 50 km away from Fushun, in which the water was not polluted. Having been acclimatized to the laboratory conditions (water temperature 23±2° C, PH 6.9±0.2; water being aerated with fresh air; 1 g breeding powder comprising one part of fish bone meal and five parts of soybean cake/100 g/d) for 10 d, one fish was put into a container containing one of the fifteen 10-L-water samples. After the fish were exposed to the sampling water for 48 hr without food but with aeration, a 2-mL-blood sample was collected with a clean and dry all-glass syringe punctured carefully into the ventricle. Immediately after the syringe was withdrawn, the blood was transfered into a conical glass centrifuge tube and centrifuged at 4000 g for 20 min. In this way,

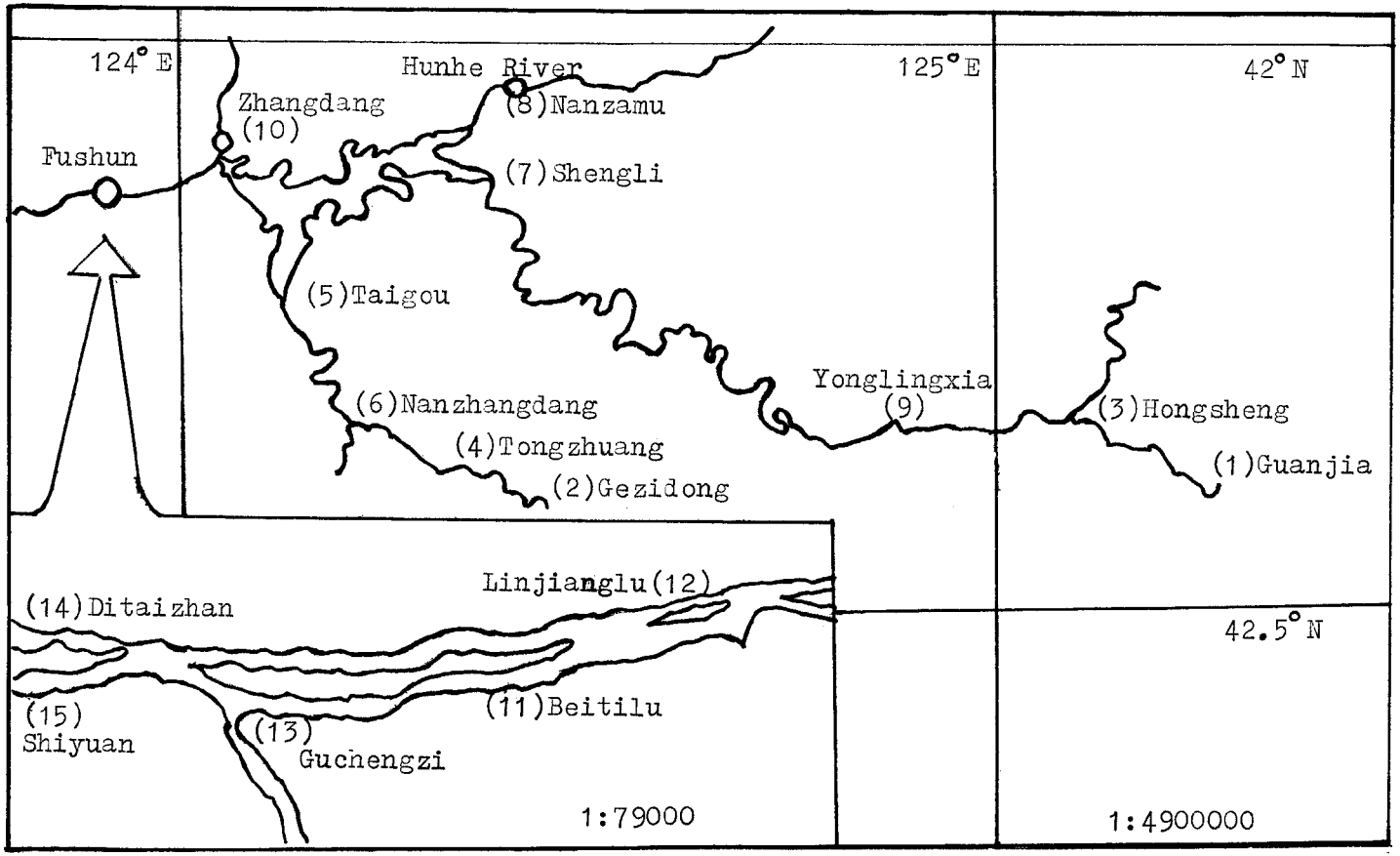

Figure 1. The map of sampling sites and their numbers.

haemolysis hardly occured. The activity of the serum glutamate-oxaloacetate transaminase (GOT,E.C.2.6.1.1.) was measured (Bergmeyer 1974). The enzyme GOT results in the formation of oxaloacetate which can be converted to malate by the enzyme malate dehydrogenase (MDH) with the simultaneous conversion of NADH to NAD, a reaction which can be followed spectrophotometrically at 340 nm. The composition of the analytical system was: NADH 0.18 mM, aspartate 100 mM, α-ketoglutarate 6 mM, phosphate buffer PH 7.5, temperature 25°C.

At each sampling site, an additional 1-L-water sample was collected in the way mentioned above; then 15 mL iodine solution (6 g iodine of potassium, 4 g iodine, 100 mL distilled water) was added. Most of the diatoms in the sampling water were classified and counted microscopically under these conditions. But a few could not; they were classified and counted only after being treated with concentrated hydrochloric acid (ten parts of HCl, one part of sampling water) and boilig for 20 min (Lin 1981). Finally, the biotic indices were calculated according to Shannor's formula (Wilhm 1967):

$$D = -\sum_{i=1}^{s} \left(\frac{Ni}{N}\right) \log_2 \left(\frac{Ni}{N}\right)$$

Where D stands for the biotic index of diatom; s, N, and Ni for the total number of the diatom species, the diatoms, and the ith species in a sample respectively.

RESULTS AND DISCUSSION

All the results are summarized in Table 1, Figure 2, and Figure 3. The different activities of serum GOT in different carps and the corresponding biotic indices of diatom summarized in Table 1 show some relationship between them. There has not been any literature giving the normal range of the carp serum GOT in nature population around Fushun and Nanzamu in China, but according to this experiment, the activities of the serum GOT of the fish exposed to water samples No.1 and No.2, collected from two spring ponds which were not polluted and flowed into two tributaries far away from cities and towns, and water samples No.3 and No.4, collected upstream of the same two tributaries, which were considered slightly polluted, may be the normal range which lies between 120 and 340 mU/mL. As the pollution degree of water goes up, the activity of serum GOT increases considerably. To the first four water samples, although the biotic index of diatom changes slightly,

Table 1. Activity of serum GOT, number of diatom species, biotic index of diatom, log-value of biotic index of diatom, water pollution degree.

sampling site	number of fish	weight of fish(g)	GOT (mU/mL)	number of diatom species	BID	$\log_{10}$BID	pollution degree
1	1	310	120	20	2.2341	0.3491	PN
2	1	306	122	21	2.2563	0.3529	PN
3	1	290	337	17	2.0614	0.3142	SP
4	1	289	314	17	2.1235	0.3211	SP
5	1	324	388	16	1.0517	0.0219	MP
6	1	311	430	14	1.2343	0.0914	MP
7	1	342	438	22	1.2227	0.0873	MP
8	1	316	543	18	0.6112	-0.2138	HP
9	1	303	782	14	0.6794	-0.1678	HP
10	1	288	998	13	0.5408	-0.2939	HP
11	1	317	1172	5	0.4666	-0.3311	HP
12	1	295	1123	4	0.2711	-0.5669	HP
13	1	280	1476	4	0.2093	-0.6792	EP
14	1	305	1601	3	0.2346	-0.6296	EP
15	1	310	1552	2	0.2007	-0.6975	EP

Note: PN = practically nonpolluted, SP = slightly polluted, MP = moderatelly polluted, HP = highly polluted, EP = extremely polluted, BID = biotic index of diatom. The pollution degree is based on the algae classification of polluted water in Shenyang (Lin 1979), which lies, 50 km away, to the west of Fushun.

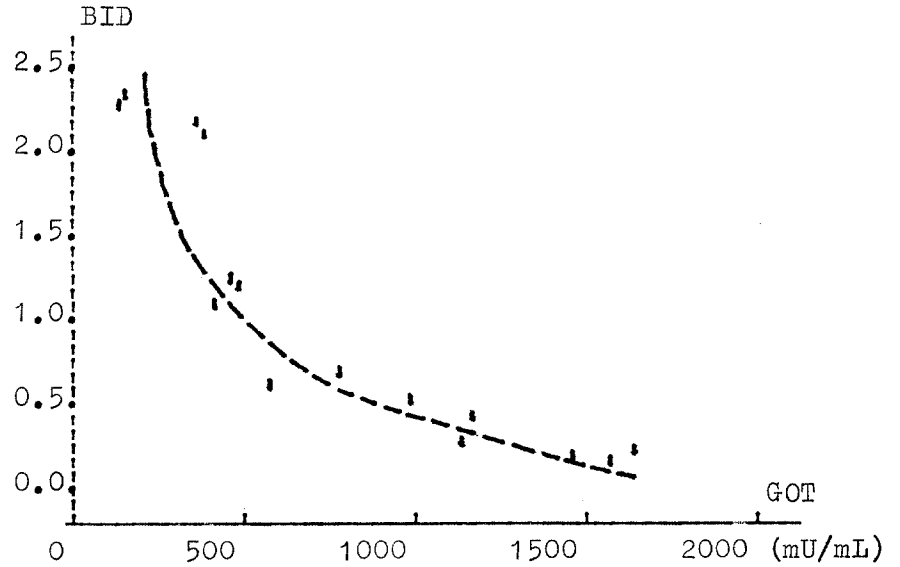

Figure 2. The activity of GOT and the biotic index of diatom.

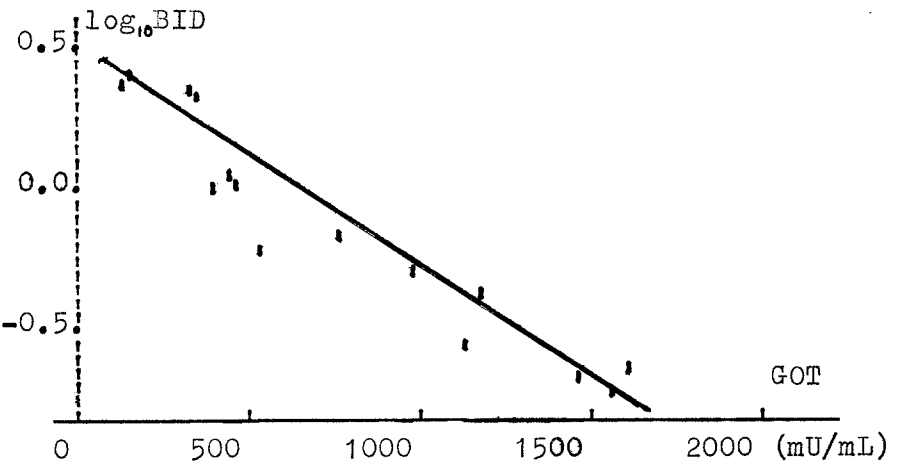

Figure 3. The activity of GOT and the logrithmic value of the biotic index of diatom.

the corresponding serum GOT changes much. It means that the serum GOT is more sensitive to water pollution than the biotic index of diatom. The last two water samples were collected from two extremely polluted watercourses which just flowed out from Fushun which is a heavy industrial city with a population of more than one million. The experimental fish could live for 48 hr in these extremely polluted water samples and had a high value of serum GOT.

In Table 1, the data on fish GOT only apply to short-term (48 hr) exposure of fish, whereas the diatom data apply to long-term adjustments of diatom in the river. This is just the advantage. The purpose of this experiment is to find a short-term test which may have the same function as one of some long-term test. Although the long-term effects of polluted water on fish may be the bases of other indicators of water quality, sometimes it is difficult or impossible to find Cyprinus carpio in the highly or extremely polluted water . For example, Cyprinus carpio could not live for 72 hr in the extremely polluted water sample. Even if the fish can be caught in the polluted water, the GOT can not be used as a sensitive indicator of water quality because of biochemical adaptation. All these facts tell us that the serum GOT of Cyprinus carpio may be used as an indicator of water pollution in short-term test.

Figure 2 shows the relationship between the activity of serum GOT and the corresponding biotic index. There is probably an exponential relationship between them. The activity of serum GOT and the logrithmic value of the biotic index of diatom are shown in Figure 3. There may be a linear relationship between them. After calculating, the corresponding regression function is:

$$\log_{10}BID = 0.4118 - 0.00072\ GOT \qquad (p < 0.05)$$

where BID is the biotic index of diatom, GOT is the value of the glutamate-oxaloacetate transaminase activity (unit: mU/mL). This result can further support the idea stated above.

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Received August 17, 1989; accepted December 27, 1989.