Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences
Tome 51, No 11–12, 1998

BIOLOGIE
Ecologie

BULGARIAN BIOTIC INDEX (BGBI) - AN EXPRESS METHOD FOR BIOASSESSMENT OF THE QUALITY OF RUNNING WATERS

Y. Uzunov, L. Penev, S. Kovachev*, P. Baev**

(*Submitted by Corresponding Member V. Golemanski on August 29, 1997*)

Introduction. Today biological monitoring has hence become established as an integral part of the water quality monitoring as defined as surveillance carried out to determine trends in relation to predetermined standards. Bioassessment in the present context is the assessment of the river water quality based on the community of organisms, or a component thereof, present at the monitored site. It was found that more than 20 different biological methods were routinely being used to assess river water quality in Europe. In the national standards for assessment of the quality of running waters [1], there are 5 biological standardized criteria (and methods, respectively) based upon the species saprobic value and diversity of the riverine macrozoobenthic communities. These criteria reflect two of three main approaches to assess the response of macroinvertebrate communities to pollution: saprobic and diversity approach. Earlier, the third approach (of biotic indices) has been studied in comparisson to the last two [2,3]. Today the biotic approach is represented by Irish Q-rating Index [4] as accepted informally in the practice of biomonitoring of rivers as carried out by the environmental authorities in that country.

The purpose of the present paper is to describe the principles of a new method for bioassessment of the water quality as developed especially for the Bulgarian inland rivers. There are at least two reasons for carring out such an investigation. First of all, the method is based on specific biodiversity of the macrozoobenthos from Bulgarian rivers. And secondly, this is the need of an express method for water quality assessement while the other, already standardized ones, require higher qualification by the operators.

Materials and methods. The present study was based on data about species content and abundance/density of the macroinvertebrate comunities as provided by data bases of the information system BIOMONITOR as well as of some additional data sources. Totally, more than 1600 observations (collections since 1980 and earlier) at 452 sites along 39 Bulgarian inland rivers have been processed by the TWINSPAN in order to ordinate the natural groups of species and/or other taxa represented in the macrozoobenthos. A list of representative key systematical groups (Table 1) has been developed, and then ordinated by means of substitution and/or elimination of the ecological analogues along a continuum of consequent taxonomic sequence within the range of natural limnosaprobity (Table 2).

Table 1

Key groups of invertebrates from the riverine macrozoobenthos, representative for calculation of the BGBI

Systematical groups	Representative taxonomic level
Bryozoa	Class
Porifera	Class
Turbellaria	Genus
Oligochaeta	Family
Hirudinea	Genus
Mollusca	Genus
Malacostraca	Genus
Ephemeroptera	Genus
Plecoptera	Genus
Odonata	Family
Teichoptera	Family
Heteroptera	Genus
Coleoptera	Family
Diptera	Family

Results and discussion. The data processing determined 14 key systematical groups which representatives were the most common and frequent in the macrozoobenthos of the Bulgarian inland rivers. The respective level of representativeness of each group is shown on Table 1. Further, 36 indicator groups were determined for each class

Table 2

Indicator groups and BGBI scores for various number of key groups represented in the riverine macrozoobenthos

Class *	Indicator groups	Remarks	1–5	6–10	11–15	16–20	21+
A	Crenobia alpina, Bythinella, Syphlonurus, Prosimulium, Blephariceridae		–	–	8	9	10
B	Dugesia gonocephala, Ancylus fluviatilis, Epeorus, Ephemerella, Rhytrogena, Brachiptera, Leuctra, Perla, Nemoura, Rhyacophila, Silo		–	6	7	8	9
C	Dugesia lugubris, Nais, Sylaria lacustris, Glossiphonia, Theodoxus fluviatilis, Gammarus, Ecdyonurus, Potamanthus, Heptagenia, Odonata	All groups above absent	4	5	6	7	8
D	Branchiura sowerbyi, Pristina, Erpobdella octoculata, Helobdella stagnalis, Asellus aquaticus, Physa acuta	All groups above absent	2	3	4	5	6
E	Tubifex tubifex, Limnodrilus, Chironomus gr. riparius, Chironomus gr. thummi	All groups above absent	1	2	–	–	–

* Water quality classes corresponding to the limnosaprobic degrees: xenosaprobity (A), oligosaprobity (B), β-mesosaprobity (C), α-mesosaprobity (D), and polysaprobity (E).

of the water quality corresponding to the saprobic degrees within the range of limnosaprobity (Table 2). It should be mentioned here that the term "indicator group" does not cover the purely taxonomic definitions for group, and may include species, genera and higher taxa. The indicator groups consist of specially selected species amongst good bioindicators for each saprobic degree/water quality class in order to make their systematic determination easier.

The number of the key groups represented in the benthic communities is of great importance for the BGBI-scores calculation. The reduction of this number means a reduction of biodiversity as a reflection of the non-specific community response to pollution discharge and/or other affecting impacts upon the macrozoobenthos.

Thus, the method of BGBI incorporates desirable features of the saprobity approach as based on the pollution tolerance of the indicator species presented, and of the diversity approach which uses the components of the community structure (richness, eveness, abundance). The BGBI method combines a quantitative measure of species diversity with qualitative information on the ecological sensitivity of individual taxa into a single numerical expression. To this end, the proposed BGBI method may be described as a modified implementation of the basic principles of biotic approach which has been developed in the original Trent River Biotic Index by [5] and correspoding to the recent developments of numerous similar indices in Europe (Table 3). A comparisson with the indices being in practice of some European countries shows some advantages of BGBI method mainly in the quantitative way of sampling and analysing of materials and data obtained from the communities which makes the results for different sites and rivers comparable.

The BGBI scores vary between 0 and 10. They appear in a good correspondence to the water quality classes (originally "categories", according to the Regulation No 7/1986 [1]) as follows:

8-10 – I class (pure water, drinking water quality)

6-7 – II class (conditionally pure water)

Table 3

Comparison of BGBI with major methods of biotic indices for assessment of running waters in EC countries based on macroinveretbrates (after [6])

Country	Index Method	Sampling (1)	Analysis (1)	Identification level (2)	Standard (3)	Range
Bulgaria	BGBI	QN	QN	OFGS	N?	0-10
Belgium	BBI	QL	QL	OFGS	N	0-10
Denmark	DFI	QL	QL	FGS	N	1-4
France	IBG	QN/QL	QL	F	N	0-20
Germany	BEOL/S	QL	QN	S	N	0-100/1-4
Greece	–	–	–	–	–	–
Ireland	Q-rating	QL	QL	FGS	N	0-5
Italy	EBI	QL	QL	OFG	R	0-14
Luxemburg	IB	QL	QL	OF	N	0-10
Netherlands	K 135	QL	QL	FGS	R	100-500
Portugal	BMWP	QL	QL	OFG	–	0-10
Spain	BMWP	QL	QL	F	–	0-150+
UK	BMPW/ SPT	QL	QL	F	N	0-150+/ 0-10

Notes: (1) QL – qualitatively, QN – quantitaively; (2) O=order, F=family, G=genus, S=species; (3) N - national, R - regional

3-5 – III class (polluted water)
1-2 – beyond classes (very strongly polluted water)
0 – beyond classes (abiotic situation as result of strong toxic or inert impacts)

Some preliminary assessments (based on 286 cases) of the BGBI correspondence with other biological parameters, some of them standardized, showed good correlation with Margalef's species diversity (correlation index R =0.883), Shannon's diversity (R =0.833), Pantle & Buck's ($R = -0.729$) and Rothschein's saprobic index (R =0.711), etc. The results above are very encouraging for further steps in stardardizing the BGBI for practical implementation in the biological monitoring of the Bulgarian inland rivers.

A special software for data processing and calculation of BGBI has been developed by PENSOFT on the base of the product BioDiv [7] which may create species-by-site matrix and data bases for the aims of biomonitoring, including of inland rivers.

The development of BGBI has been supported by the National Environmental Protection Fund under project No 28-1432/1994. The results have been adopted by the Superior Environmental Expert Council of the Ministry of the Environment after Decision No V-4/1997.

REFERENCES

[1] Държ. вестн.,96, 1986. [2] Ковачев С. В: Съвр. постиж. бълг. зоол., БАН, 1987, 252–256. [3] Янева И., Б. Русев. В: I Нац. конф. пробл. биол. монит., 1987, 97–102. [4] Fanagan, Toner (1972) after Knoben R. E. A. et al. Biological assesement methods for watercourses. UN/ECE Task Force on Monitoring & Assesment, **3** (Lelystad, NL), 1995, 86. [5] Woodiwiss F.S. Chem. & Ind., **11**, 1964, 443–447. [6] De Pauw N., D. Van Damme, A. Bij de Vaate. Manual for macroinvertebrate identification and water quality assessment. 1996. CEC PHARE/TACIS, Ghent/Lelystad, 238. [7] Baev P., L. Penev. BIODIV. A Program for Calculating Biological Diversity Parameters, Similarity, Niche Overlap, and Cluster Analysis, Sofia/Moscow, 1995, 57.

Central Laboratory for General Ecology
Bulgarian Academy of Sciences
2, Gagarin Str.
1113 Sofia, Bulgaria

**Biological Faculty*
University of Sofia
8, Dr. Tsankov Blvd
1421 Sofia, Bulgaria

***Space Research Institute*
Bulgarian Academy of Sciences
6, Moskovska Str.
1000 Sofia, Bulgaria