

*Aus dem Kemijski Institut "Boris Kidric", Ljubljana und der
Bundesanstalt für Wassergüte, Wien*

THE DEVELOPMENT OF THE QUALITY OF THE WATER OF THE
MUR/MURA RIVER NEAR THE AUSTRIAN-JUGOSLAVIAN BORDER AT
SPIELFELD

J. GRBOVIČ, W. RODINGER

Abstract

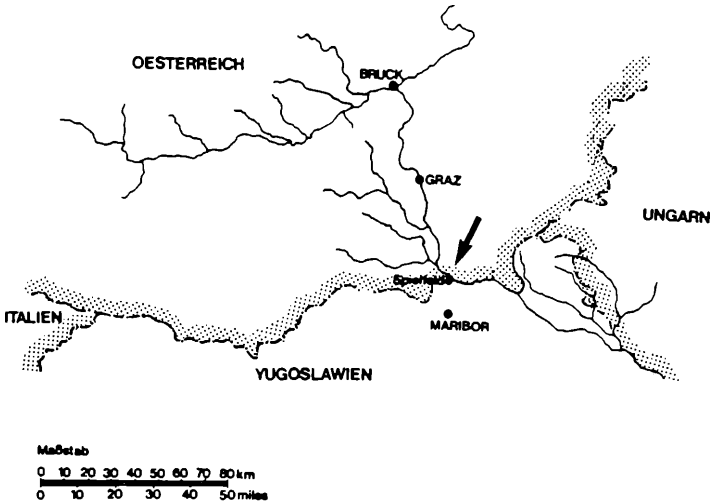
The Federal Institute for Water Quality in Vienna together with the "Boris Kidrič" Institute of Chemistry in Ljubljana carried out biological testing of the quality of the water of the Mur/Mura river near the Austrian-Jugoslavian border at Spielfeld from 1979 to 1987. This paper deals with the changes within the biocoenoses as well as the slow improvement of the quality of the water, categorised as "Güteklasse" according to LIEBMANN and saprobic indices according to PANTLE and BUCK, ZELINKA and MARVAN and PERRET. It also includes diagrams referring to the "Relative Güte/Relative Belastung" and "Gütelängsschnitt" according to KNÖPP. Each index of saprobity of the different taxa was taken from the lists by SLÁDEČEK and WEGL. The Mur/Mura-river's type of running water was classified according to the MOL system of division. The text is illustrated by five figures.

Introduction

The Mur/Mura river forms the border between Austria and Jugoslavia from Spielfeld/Šentilj to Radkersburg/Gornja Radgona. Representatives from both countries decided to assess the quality of the water by means of repeated testing and observation. This joint research started in 1965 and has been continued until now. Slovenian experts representing the Jugoslavian side, and Styrian specialists representing the Austrian side, have worked together with the Federal Institute for Water Quality in Vienna since 1979.

Chemical and biological examination of the quality of the water was carried out at several places along the river

between the towns mentioned above (Spielfeld/Šentilj Radkersburg/Gornja Radgona) As the result of this testing, it became clear that Spielfeld was the most important place for assessing the quality of the water of the Mur/Mura river over a longer period of time.



The Mur/Mura river could be categorised as type IV (Fast Flowing Large Rivers) according to MOL which is characterised by the following:

the geographical setting in the lower parts of mountainous areas in Central and Southern Europe
 origin waters coming from tributaries
 gradient from 1 to 5 ‰
 current velocity from 0,5 to 1 m/second
 annual amplitude of monthly mean temperatures of about 20° C
 width spread from 20 to 300 m
 dominant substrate formed by pebbles and gravel
 eutrophic nutrient status
 autotrophic energetic type
 eroding substrate activity
 oxygen content around 100 ‰ saturation.

The general view of biocoenosis is described for type IV as follows:

Euplancton cannot be found in fast flowing rivers
 Main primary production is created by mosses (i.e. *Fontinalis*), attached algae (i.e. *Hydrurus* -Chrysophyceae-, *Gomphonema* - Diatomeae-, *Cladophora* -Chlorophyceae-, *Batrachospermum*, *Chantransia* -Rhodophyceae-) and liverworts.
 The invertebrate fauna is dominated by cold stenothermous and current adapted insect larvae (for example: *Chloroperla*, *Dinocras*, *Leuctra* -Plecoptera-, *Oligoneurella*, *Heptagenia* - Ephemeroptera- *Rhyacophila*, *Hydropsyche*, *Agapetus*- *Trichoptera*-, *Calopteryx*, Gomphidae -Odonata-, Orthocladiinae, *Atherix* - Diptera-, *Limnaea*, *Ancylus*, *Physa*, *Unio* -Mollusca-).
 The fish fauna is a mixture of small swift "rhithron" elements, large stagnant water elements and anadromous forms (for example: Salmonidae, Cyprinidae, Esocidae, Percidae, Cyclostomata and Acipenseridae)

The natural appearance of the Mur/Mura river and especially its biocoenotic situation has changed since the beginning of the industrial period as a result of domestic and industrial (cellulosis) wastes. Hydroelectric power plants have also influenced the topography.

This paper deals only with the results of the biological testing at Spielfeld from 1979 to 1987 because this was the only place where data were available continuously from 1966 to 1987

Materials and Methods

In order to assess the quality of the water, biological experts from Yugoslavia and Austria sampled organisms of the periphyton semi-quantitatively. The individuals of the macrozoobenthos were also tested semi-quantitatively and quantitatively at low flow levels. Other characteristics at the sampling site were assessed such as signs of anaerobic phenomena (i.e. black undersides of stones, digested sludge) and the presence of filamentous bacteria, fungi and sessile ciliates. In addition, the depth of visibility, the current velocity and the amount of vegetation (attached algae) covering the banks of the river were observed. A SURBER-sampler (0,25 x 0,25 m) was used to sample the macrozoobenthos quantitatively. The sample was divided into two parts, conserved and transported to the laboratories in Ljubljana and Vienna, where the taxa were determined and the individuals counted. The data were multiplied by four and the results of both specialists were added together. Aside from the above-mentioned procedure, a first species analysis of the taxa of the macrozoobenthos was made at the additional semiquantitative sampling at the sampling site. The periphyton was taken off the stones of the river banks and analysed in vivo by the Austrian and Yugoslavian experts together on the same day as soon as possible.

With reference to the results of the examinations of the complete biocoenosis, a common report was prepared in which

the organisms were listed as well as their taxonomical index of saprobity and their abundance at each separate sampling time.

The taxa of the biocoenoses, periphyton and macrozoobenthos, formed the basis for the classification of the quality of the water (i.e. "Güteklasse") according to LIEBMANN. Saprobic indices were calculated which helped to classify the water quality. In order to judge the water quality of the Mur/Mura river individual indices for saprobity according to WEGL (his indices were better than SLÁDEČEK's) were multiplied with semiquantitative estimations of the population. This method followed the procedure according to PANTLE and BUCK (summing up the products described above and dividing that sum by the sum of the semiquantitative frequencies)

Another way of evaluating the analysed biocoenoses was the division of the portions of the taxa's valencies by the "Gütelängsschnitt". This is usually done to demonstrate the development of the quality of the water along a certain stretch of running water, but in this case the "Gewässergütelängsschnitt" was used to show the development of the quality during a certain time period. At each sampling time the products of species' saprobic valencies, according to WEGL and the individuals' semiquantitative measured abundances were added and depicted according to the method of KNÖPP and DEV M 7

Because quantitative samples of macrozoobenthos organisms were taken at each biological testing of the Mur/Mura river it was possible to compare the results of the semiquantitative samplings to the counted individual amounts. The quantitative samples enabled us to calculate saprobic

indices according to ZELINKA and MARVAN. The counts of individual numbers of the macrozoobenthos were recalculated according to DANECKER in order to get semiquantitative results for estimating saprobic indices according to PANTLE and BUCK.

The occurrence of macrozoobenthos organisms was evaluated by the method according to PERRET. When the water quality of running water in Switzerland was checked in the seventies, important criteria for judging the quality of the water were the taxa of the macrozoobenthos. Following methods devised by WOODIWISS, VERNEAUX and TUFFERY a matrix was formed by which biotic indices (Makroindex) could be observed. This matrix is divided into four steps in the abscissa (quotient of taxa insect larvae and taxa non-insect larvae; smaller than 1, 1-2, more than 2-6, and more than 6); the ordinate includes eight steps which depend on the occurrence of the number of Plecoptera's taxa (more than 4 and 3-4), taxa of Plecoptera and Trichoptera with larval cases (more than 4 and equal or less than 4), taxa of Ephemeroptera without *Baetis* (more than 2 and less than 2), *Gammarus* spp. and/or *Hydropsyche* spp. determined or not and last step *Asellus* sp. and/or Hirudinea and/or Tubificidae determined. All these criteria lead to the "Makroindex" from number 1 (indicating the best water quality) to number 8 (indicating the worst water quality)

Results:

Prior to 1978 the submersed flora and fauna of the Mur/Mura-river at Spielfeld was greatly harmed by large loads of wastes. The water quality was described as having an α -meso- to polysaprobic status. Since then new modifications in factories as well as industrial and domestic sewage

purifications in the upper parts of the river have led to the improvement of the quality of the water of the Mur/Mura-river. In 1979 a β - to α -mesosaprobic status (Güteklasse II-III) was ascertained; later on tendencies towards becoming β -mesosaprobic were detected. Since 1985 the Mur/Mura river can be classified as β -mesosaprobic, but a tendency towards the β - to α -mesosaprobic status (Güteklasse II/II-III) has been noted. Due to a decrease in the amount of waste dumped into the river (improvements in the paper mill and in the chemical pulp industries), the interrelations within the biocoenoses and some abiotic factors have also changed.

SLANINA determined the following when he carried out his testing from 1979 to 1984, and the tendencies he described have continued up to the present:

Sphaerotilus covering the stones and banks of the river at each sampling time slowly disappeared from 1979 through 1984.

This filamentous bacteria was never found again after October 1985 when testing in the autumn; *Sphaerotilus* has been only rarely observed in the winter testing. The drifting and the density of this filamentous bacteria lessened from year to year and eventually stopped. During the period of investigation the *Sphaerotilus natans* bacteria and its dichotomous ramified form changed in appearance and importance, which indicated a better water quality

Worthy of note was, that Rhodophyta became more and more abundant in the periphyton biocoenosis (*Chantransia* sp.) during the period from 1979 to 1987

During autumn investigations we discovered that the number of taxa and abundance of insect larvae had

increased, which indicated an improved water quality (i.e. Plecoptera, Ephemeroptera)

Some indicators of worse water quality decreased at the same time (i.e. *Asellus* sp. Crustacea-, sessile Ciliates)

From 1979 to 1987 the black-coloured undersides of the stones in the banks of the river disappeared for the most part; they could be found only during autumn investigations in 1982, 1983 and 1984.

As described in the "Materials and Methods" the data derived from the determined organisms were calculated in the following manner and the results depicted in diagrams.

In Fig. 1 the "Relative Güte/Relative Belastung" of the Mur/Mura river is seen from 1979 to 1987. The thin line represents the trend line of the data and depicts the improvement of the water quality at Spielfeld.

Fig. 1:
Diagram of the "Relative Güte/Relative Belastung" of the Mur/Mura river at Spielfeld from 1979 to 1987 (KNÖPP)

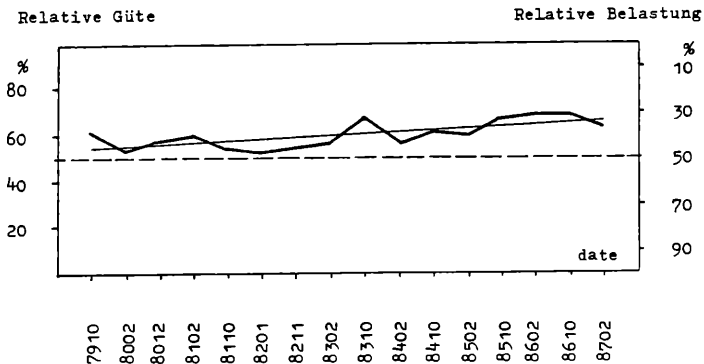
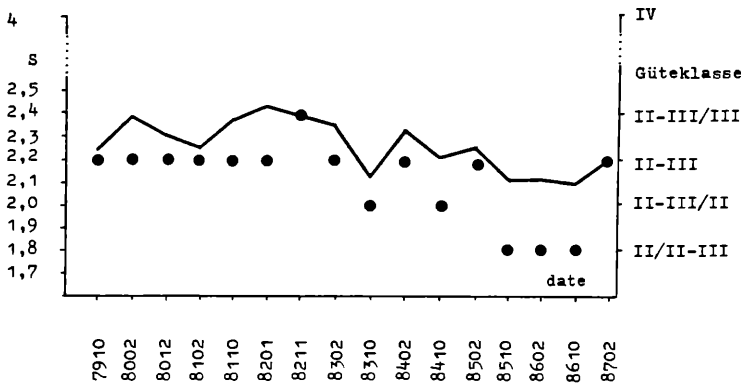


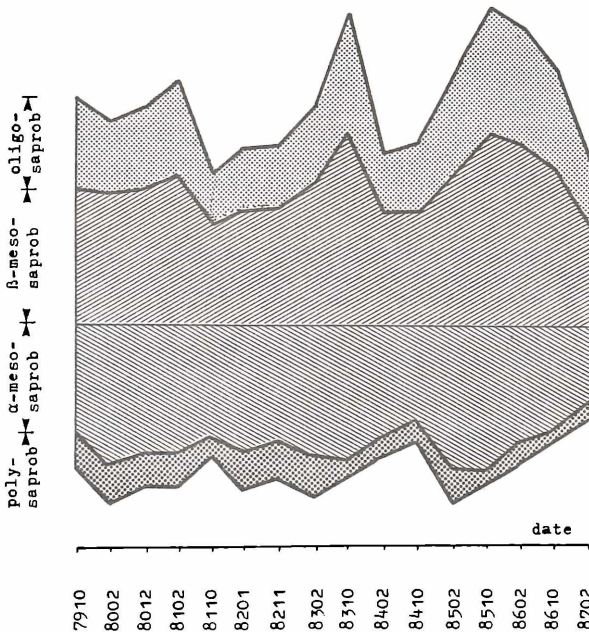
Fig. 2 shows the results of the saprobic indices according to PANTLE and BUCK. Data derived from periphyton and macrozoobenthos were used. Together with these data (drawn as a line) the estimated water quality (Güteklasse) according to LIEBMANN is shown in the diagram (dots) as well. The improvement of the biocoenotic situation can also be seen clearly in spite of the fluctuations of the data.

Fig. 2:
Saprobic indices of the Mur/Mura river at Spielfeld, periphyton- and macrozoobenthos organisms (PANTLE and BUCK; line) and levels of the described water quality (Güteklasse according to LIEBMANN; points) from 1979 to 1987



In the third diagram (Fig. 3) the oligosaprobic and β -mesosaprobic parts of the biological "Gütelängsschnitt" are increasing along the time axis and the α -mesosaprobic and polysaprobic portions are decreasing. These results also illustrate the improvement of the Mur/Mura river's water quality.

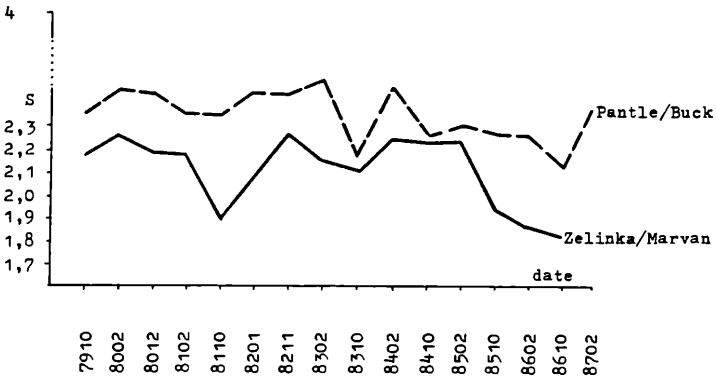
Fig. 3 :
"Gütelängsschnitt" of biological water quality of the Mur/Mura river at Spielfeld from 1979 to 1987 (KNÖPP)



When comparing two different saprobic indices (Fig. 4) it becomes clear that the results of the saprobic indices according to PANTLE and BUCK (dotted line) seem to be more important for estimating the water quality according to LIEBMANN than the saprobic indices according to the calculations of ZELINKA and MARVAN (full line). The latter data seem to make the situation appear better than it is in reality. In spite of this, both indices show the very definite improvement of the quality of the water.

Fig. 4:

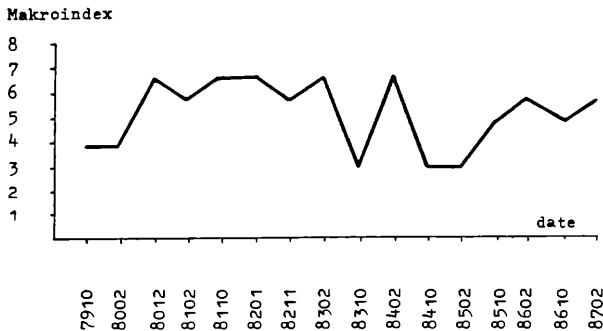
Comparison between two saprobic indices of the macrozoobenthos of the Mur/Mura river at Spielfeld from 1979 to 1987



During the research at the Mur/Mura river from 1979 to 1987 the "Makroindex" according to PERRET fluctuated from 3 to 7 as shown in Fig. 5. From December 1980 to February 1983 a stable biocoenosis was observed in the Mur/Mura river at Spielfeld indicating worse quality when evaluated

by PERRET's method because only very few Plecoptera and Ephemeroptera could be found. Since October 1983 greater fluctuations could be observed because biological indicators of better water quality began to settle in the biotop again. On the other hand, the appearance of higher numbers of the "Makroindex" indicated that this special biotop has not yet become completely stable and that the different wastes have affected the organisms of the Mur/Mura's biocoenoses at Spielfeld again and again.

Fig. 5:
Diagram of the macrozoobenthos "Makroindex" of the Mur/Mura river at Spielfeld from 1979 to 1987 (PERRET)



Conclusion

According to the results obtained by following the methods devised by KNÖPP, ZELINKA and MARVAN, PANTLE and BUCK, LIEBMANN and PERRET it can be seen that the quality of the water of the Mur/Mura-river at Spielfeld has slowly improved from 1979 to 1987. If the endeavours of purifying

industrial (mostly paper mill and chemical pulp) and domestic waste waters (as it was decided at the "Murgipfel" in 1986) are continued, one may assume that the Mur/Mura river will attain a stable β -mesosaprobic status without any disturbances in a few years, in accordance with its natural eutrophic nutrient status.

Ordered by the "Permanent Austrian-Jugoslavian Commission for the Mur/Mura river" the biological water quality of the river will be observed in the future as in the past by the joint team of biological experts. The investigators hope that the above prognosis for the quality of the water will come true.

SUMMARY

In this paper the improvement of the biological quality of the water of the Mur/Mura river near the Austrian-Jugoslavian border at Spielfeld is described for the period from 1979 to 1987 by using different methods. The results of the calculations according to KNÖPP, PANTLE and BUCK, ZELINKA and MARVAN, LIEBMANN and PERRET are illustrated in 5 diagrams.

Zusammenfassung

In der vorliegenden Arbeit wurde die Verbesserung der Gewässergüte der Mur nahe der österreichisch-jugoslawischen Staatsgrenze bei Spielfeld im Laufe der von 1979 bis 1987 reichenden Untersuchungsperiode und mit verschiedenen Auswertungsmethoden beschrieben. Die Ergebnisse der Berechnungen nach KNÖPP, PANTLE und BUCK, ZELINKA und MARVAN, LIEBMANN sowie PERRET wurden in 5 Abbildungen dargestellt.

Izvešček

Izboljšanje kvalitete reke Mure blizu avstrijsko jugoslovanske meje v Spielfeldu od 1979 do 1987 je prikazano z različnimi metodami. Rezultati so podani po Knöppu, Pantle in Bucku, Zelinka in Marvanu, Liebmannu in Perretu in prikazani na petih doigramih.

Acknowledgements

The joint testing of the quality of the water of the Mur/Mura river was commissioned by the "Permanent Austrian-Jugoslavian Commission for the Mur/Mura river" The authors want to thank the leaders of the commission's group of experts Dipl.Ing. H.Senekovič-Marchisetti and Dipl.-Ing.H.Ertl for their help. We also want to express our gratitude to Dipl.Ing. H.Ertl for making the Styrian government's laboratory available to us for our joint investigations.

Der für die gemeinsame Untersuchung und Gutachtenerstellung notwendige Gedankenaustausch der biologischen Experten der "Ständigen Österreichisch-Jugoslawischen Kommission für die Mur" findet in englischer Sprache statt, die auch die Form und den Inhalt der gemeinsam verfaßten vorliegenden Arbeit bestimmt. Die Autoren bedanken sich herzlich für die freundliche Genehmigung der Schriftleitung von "Wasser und Abwasser", ausnahmsweise in dieser Sprache veröffentlichten zu dürfen.

References

- DANECKER,E. (1986) Makrozoobenthosproben in der biologischen Gewässeranalyse.- Wasser und Abwasser 30,325-405.
- DEUTSCHE EINHEITSVERFAHREN ZUR WASSERUNTERSUCHUNG (1971) M 7, 6. Lieferung.- Vlg. Chemie,Weinheim.
- MOL,A. (1979) Flora and Fauna of European Running Waters.- European Committee for the Conservation of Nature and Natural Resources; Council of Europe.
- KNÖPP,H. (1955) Grundsätzliches zur Frage biologischer Vorfluteruntersuchungen, erläutert an einem Güte-längsschnitt des Mains.- Arch Hydrobiol Suppl. XXII, 3/4.
- LIEBMANN,H. (1962): Handbuch der Frischwasser- und Abwasserbiologie, Bd. 1.- Vlg. G. Fischer, Jena.
- PANTLE,R., BUCK,H. (1955) Die biologische Überwachung der Gewässer und die Darstellung der Ergebnisse.- GWF 96, 604.

- PERRET, P. (1977): Zustand der Schweizerischen Fließgewässer in den Jahren 1974/75 (Projekt Mapos).- Hsg. Eidgenössisches Amt für Umweltschutz-EAWAG.
- SCHWOERBEL, J. (1980): Methoden der Hydrobiologie Süßwasserbiologie.- UTB G.Fischer Vlg.
- SLÁDEČEK, V. (1981): Biologický rozbor povrchové vody.- Komentář K ČSN 83 0532 - části 6 : Stanovení saprobního indexu.
- SLANINA, K.: Die Gewässergüte der Mur von 1979 bis 1984.- Unpublished.
- WEGL, R. (1983): Index für die Limnosaprobität.- Wasser und Abwasser 26.
- ZELINKA, M., MARVAN, P. Zur Präzisierung der biologischen Klassifikation der Reinheit fließender Gewässer.- Arch Hydrobiol 57, 389-407.

Anschrift der Verfasser: Mag. Jasna GRBOVIČ, Kemijski Institut "Boris Kidric", Hajdrihova 19, YU-61000 Ljubljana, Jugoslavia.
Rat Dr. Wolfgang RODINGER, Bundesanstalt für Wassergüte, Schiffmühlenstraße 120, A-1223 Wien.

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Wasser und Abwasser](#)

Jahr/Year: 1987

Band/Volume: [1987](#)

Autor(en)/Author(s): Grbovic J., Rodinger W.

Artikel/Article: [The development of the quality of the water of the Mur/Mura river near the austrian-jugoslavian border at Spielfeld 365-379](#)