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THE NEMATODE-FAUNA (NEMATHELMINTHES, NEMATODA) OF A POLLUTED PART OF THE RIVER MUR (STYRIA, AUSTRIA)

by
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There is no single method that can be used to indicate the chemical and biological quality of fresh water systems. However, Zullini (1976) suggests that non-parasitic nematodes can provide a biological evaluation of running waters, as they are resistant to chemical and organic pollution and occur regularly in different environments. Moreover, the species-composition is sensitive to different levels of organic material and other chemical pollutants in the water. Oligochaetes and protozoa also occur regularly, but nematodes are easier to observe, and to extract and fix for identification.

This paper refers to an investigation of the effect of paper mill waste water discharged into the river Mur between Stübing and Graz on the nematode fauna. During the investigation the mill stopped discharging untreated waste water into the river and introduced a system of mechanical purification before the discharge. About the same time an improvement programme was started for the river Mürz, which is the main contributory of the Mur. The effects of these changes are reflected in the changes of the nematode species-composition.

Materials and methods

The river Mur is the main river of Styria and is part of the Danube river-system. Between the cities of Judenburg and Graz it runs through a highly industrialized region and therefore is heavily polluted with domestic and industrial wastes, the latter mainly from the iron and paper-making industries.

The field investigations (carried out by the second author) were made mainly in the section of the river between Stübing and Graz and included the outlet of waste water from a paper mill, located at Gratkorn. At three-monthly intervals, from August, 1977 to August, 1979 samples of water were taken from four locations:

I = Left river-bank of the Mur near Stübing, altitude 391 m.

II = Right river-bank near Gratkorn, about 500 m downstream of the paper mill waste-water outlet, altitude 370 m.

III = Right river-bank, about 2.5 km downstream of location II altitude 366 m.

IV = Right river-bank in Weinzödl, about 150 m downstream of the old weir, altitude 359 m.

At these locations the river water smelt badly and was of a dark brown colour; the river bed was covered by a thick layer of the « sewage fungus », *Sphaerotilus natans*. In September, 1978 and August, 1979 samples were taken from the unpolluted part of the river upstream of the city of Murau.

On each sampling date a standpipe and pump (Bou and Rouch, 1967, Kirchengast, 1979) were used at three places at each sampling location to extract 6 l of water from three different depths, 0 cm, 35 cm and 70 cm in the riverine sediments. The samples were filtered through a 80 μm nylon net and the filtrates of sediment, detritus and animals contained therein were fixed in 4% formaldehyde. The nematodes were extracted, using a x15 stereoscopic microscope, then mounted in glycerine and identified with a microscope using high magnification.

The dissolved oxygen concentrations and the water temperature were measured immediately after the samples had been taken at the bottom of the standpipe using a DO-probe YSI-57. Other abiotic parameters were determined in the laboratory, using unfixed water samples. These parameters included pH, total hardness of the water and chemical oxygen demand (COD). Further information on the methods used and on the further evaluation of the data is reported elsewhere (Kaiser and Kirchengast 1979, 1982; Kirchengast 1981; Kirchengast and Kaiser 1981).

Table I - *Chemical and physical parameters.*

Stations		I	II	III	IV
Imhoff-Cones	ml/l	—	3.3	3.0	5.6
COD (mg/l)	(A)	120	266	—	233
	(B)	44	65	—	61
pH	0	7.1	7.2	7.4	7.2
		6.8-7.7	6.6-7.9	6.9-8.6	6.9-8.1
	35	7.5	7.4	7.6	7.4
		6.9-8.0	7.0-7.8	6.9-8.6	6.9-8.1
	70	7.6	7.5	7.7	7.5
		6.9-8.0	7.2-7.8	6.8-8.5	6.9-8.5
o_d	0	8.3	9.1	8.5	8.9
		6.0-9.5	6.0-11.0	6.5-9.0	7.5-10.0
	35	10.0	10.6	10.9	10.5
		7.0-13.5	7.0-15.0	7.0-15.0	7.0-13.5
	70	10.0	10.3	11.0	10.6
		7.0-13.0	7.0-14.0	7.0-14.0	7.0-14.0
O_2 (% of saturation)	0	66	70	64	78
	35	8.5	8.0	7.5	9.0
	70	7.5	6.0	5.6	5.4

(A) measurement before and (B) after the beginning of the purification. 0, 35, 70=depths (cm) in the riverine sediments, measured from the river bottom. The sedimentation (Imhoff-cones) was measured only from Oct. 1978 until March 1979. The water temperature varied between 0.7 and 17.7°C according to the different seasons. The river-water had an O_2-content between 4.5 and 11.8 ppm, the interstitial water between 0.1 and 2.5 ppm.

Results and Discussion

The results of the chemical and physical analyses are given in Table I, and of the identification of nematode-species and their relative abundance in Table II.

Micoletzky (1914) has made the only previous investigation of nematodes in the river Mur. His results have been adapted to be comparable with the present findings. The density of the nematode fauna was generally less in the area of the waste water outlet than upstream. This can be related to the build-up of lignosulfonic acids and similar contaminants, which are not readily decomposed by bacteria. Fig. 1 illustrates the decrease in species such as *Tripyla glomerans, Tobrilus husmanni* and *T. pellucidus* compared with the more

Table II - *Relative abundances of the nematode-species* ([a]).

	% OCCURANCE AT EACH STATION					
	Murau	Pernegg	I	II	III	IV
Monhystera dispar Bastian, 1865	—	18.8	0.6	—	—	—
Monhystera filiformis Bastian, 1865	—	17.9	1.1	4.4	2.7	1.5
Monhystera paludicola De Man, 1880	—	—	1.5	1.8	3.0	0.6
Monhystera similis Bütschli, 1873	—	3.6	—	—	—	—
Monhystera vulgaris De Man, 1880	—	2.7	—	—	—	—
Theritus ruffoi Andrassy, 1959	2.7	—	—	—	—	—
Plectus cirratus Bastian, 1865	2.7	3.6	2.3	2.6	3.3	0.4
Plectus tenuis Bastian, 1865	—	0.9	—	—	—	—
Achromadora ruricola (De Man, 1880) [1]	—	0.9	—	—	—	—
Achromadora terricola (De Man, 1880) [2]	—	4.5	1.1	—	—	—
Ethmolaimus pratensis De Man, 1880 [3]	—	0.9	—	—	—	—
Chromadorita leukarti (De Man, 1876) [4]	—	1.8	—	—	—	—
Cephalobus persegnis Bastian, 1865	—	—	—	—	—	0.4
Rhabditis intermedia De Man, 1880	—	—	0.9	—	0.6	0.4
Diplogaster rivalis (Leydig, 1854)	—	—	—	—	0.6	0.2
Paroigolaimella bernensis (Steiner, 1914)	—	—	0.4	4.4	12.7	16.3
Acrosticus nudicapitatus (Steiner, 1914)	—	—	—	—	2.1	0.4
Filenchus filiformis (Bütschli, 1873) [5]	—	17.0	—	—	—	—
Paramphidelus dolichurus (De Man, 1876) [6]	—	0.9	—	—	—	—
Tripyla filicaudata De Man, 1880	—	—	0.2	—	—	—
Tripyla glomerans Bastian, 1865 [7]	37.8	2.7	13.7	0.9	1.2	0.9
Tobrilus gracilis (Bastian, 1865)	5.4	7.1	38.7	60.5	62.0	72.5
Tobrilus husmanni (Altherr, 1958)	—	—	11.0	7.0	3.0	0.1
Tobrilus pellucidus (Bastian, 1865)	32.4	—	23.3	3.5	4.1	2.9
Tobrilus sp.	—	—	—	0.9	—	—
Prismatolaimus dolichurus De Man, 1880	—	0.9	—	—	—	—
Ironus tenuicaudatus De Man, 1876	—	—	0.2	—	—	—
Mononchus truncatus Bastian, 1865 [8]	16.2	3.6	2.1	13.2	3.8	2.7
Dorylaimus filiformis Bastian, 1865 [9]	—	1.8	—	—	—	—
Dorylaimus stagnalis Dujardin, 1845	—	—	1.9	—	0.3	—
Eudorylaimus carteri (Bastian, 1865) [10]	2.7	10.7	1.1	0.9	0.9	0.2
Eudorylaimus obtusicaudatus (Bastian, 1865)	—	—	—	—	—	0.2
Penetrantia fam. gen. sp.	—	—	—	—	—	0.2
Total percentage	100	100	100	100	100	100
Total number of nematodes identified	37	112	473	114	339	527

([a]) Relative abundances of the nematode-species. The abundances are according to one sampling station (each station = 100%).

The figures under the station Pernegg are those given by Micoletzky (1914). In his paper the following different species-names are used: 1) *Cyatholaimus ruricola* De Man 1884; 2) *Chromadora lacustris* Micoletzky 1913; 3) *C. alpina* Micoletzky 1914; 4) *C. leuckarti* De Man 1884; 5) *Tylenchus filiformis* Bütschli 1873; 6) *Alaimus dolichurus* De Man 1884; 7) *Tripyla papillata* Bütschli 1873; 8) *Mononchus macrostoma* Bastian 1866; 9) *Dorylaimus bastiani* Bütschli 1873; 10) *D. carteri* Bastian 1866. The results of Micoletzky do not include the interstitial habitats.

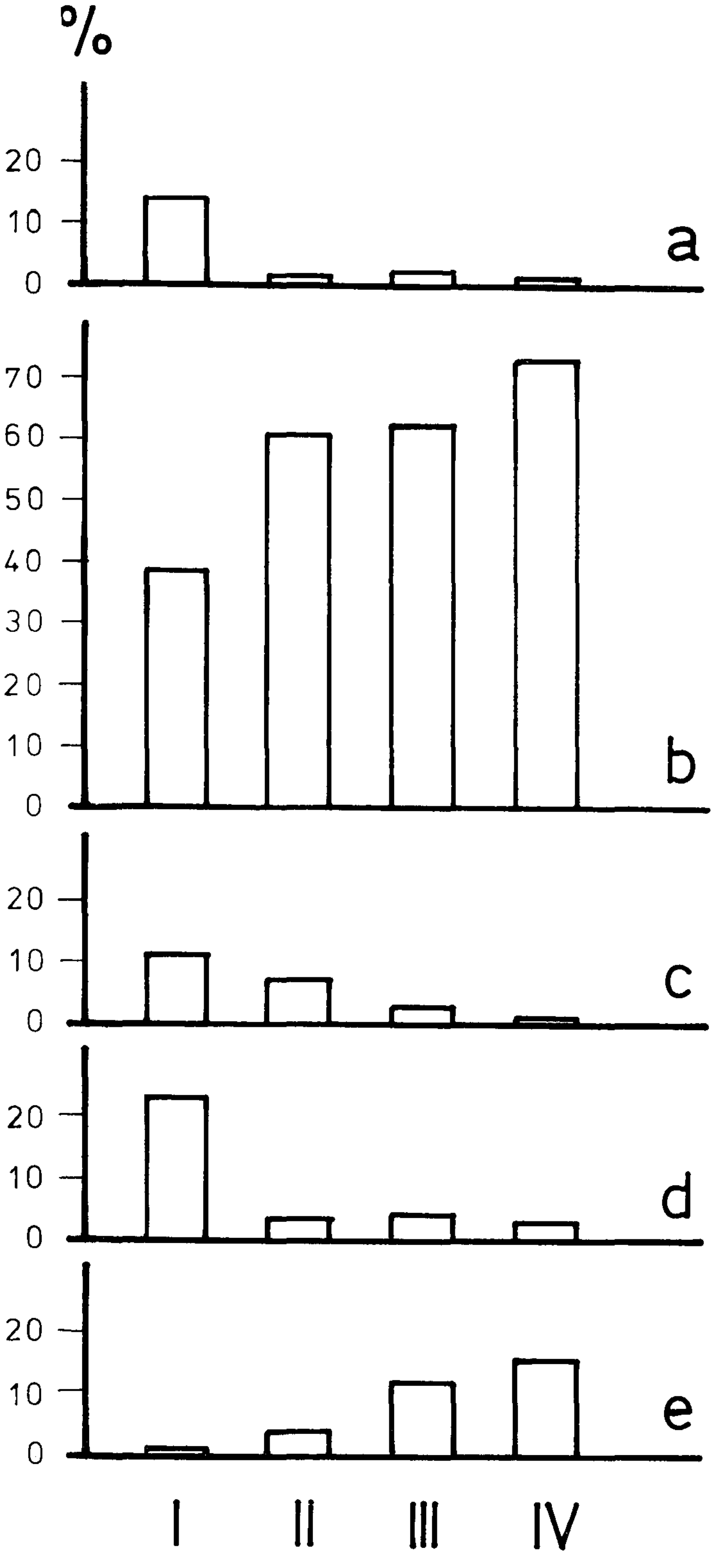

Fig. 1 - Abundance of selected nematode species according to each sampling station (100%): (a) *Tripyla glomerans*, (b) *Tobrilus gracilis*, (c) *T. husmanni*, (d) *T. pellucidus*, (e) *Paroigolaimella bernensis*.

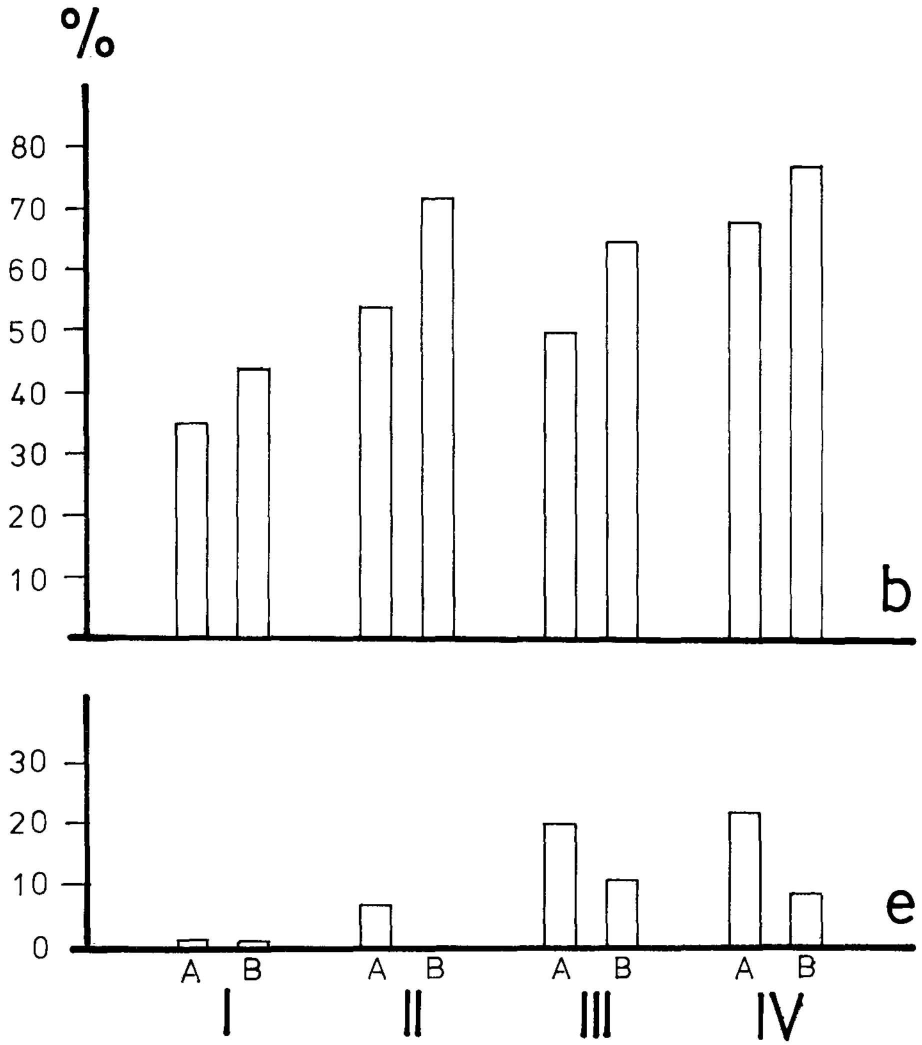

Fig. 2 - Effects of purification measures on (b) *Tobrilus gracilis* and (e) *Paroigolaimella bernensis*. A = before and B = after the beginning of the purification. Abundances determined as in Fig. 1.

saprobic species like *Tobrilus gracilis* and *Paroigolaimella bernensis*. The continuous increase observed in these latter species is associated with the very slow decomposition of lignosulfonic acids and other paper mill wastes in the river. However, in the riverine sediments there was a partial decomposition of the waste materials. There the very low speed of the hyporheic interstitial water (which is in constant exchange with the river water) ensures a relatively longer time in the system, compared to the movement of the river water down-stream; this allows the build-up of large numbers of bacteria which are a food source for saprobic nematodes.

The results of actions taken to purify the river Mürz and to prevent untreated paper mill wastes from entering the river are illustrated in Fig. 2. The numbers of *Paroigolaimella bernensis* decreased and the ones of *Tobrilus gracilis* increased, indicating a lower bacterial level and thus lower saprobity. In Zullini's (1976) investigation of the river Seveso, Italy, only the total number of *Tobrilus* species were presented. This is considered to give a false picture of the events as *T. husmanni* and *T. pellucidus* decrease in situations where contamination and associated bacteria are high, whereas *T. gracilis* numbers increase in this case (Table II).

The COD and O_2-levels prevailing after the beginning of the purification of the river accord with the species-diversity of the nematodes. Before purification the COD-rates were much higher than expected in relation to the composition of the nematode fauna (Zullini, 1976). This is explained by the fact that the substances causing high COD-rates are decomposable by bacteria and thus enter the biological processes, whereas those substances that are not reduced biologically have no obvious effects upon the fauna (provided the waste materials are not poisonous). This explanation is confirmed by the level of dissolved oxygen in the river water, which corresponds well to the nematode species-composition.

The species-composition of the nematode-fauna thus provides a good indicator of the level of saprobity influencing the biological processes in running waters.

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SUMMARY

The effects of paper mill waste waters upon the species composition of non-parasitic nematodes in a part of the river Mur (Styria, Austria) were studied. The correlation between the species-composition and the biologically decomposable saprobity, found by Zullini (1976) for the river Seveso (Italy), is confirmed. The spectra of nematode-species are a good means for judging the degree of saprobity of running waters.

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