Breg and Brigach, source streams of the Danube: changes based on macrophyte surveys 1967, 1989, and 2004

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Introduction

The Breg and Brigach streams are the head waters of the Danube, which is formed by their confluence in the town of Donaueschingen. The macrophytes of the two rivers were first assessed by BACKHAUS (survey in 1960, published in 1967), and later surveys were made by JUNG (1989) during a diploma thesis and by JANAUER et al. (2004) as part of the MIDCC project (supported by the Austrian Federal Ministry of Education, Science and Culture). Despite some difficulties the original investigation sites could be traced back by our team and a comparison of macrophyte species composition and abundance could be made. Results refer to macrophyte diversity and habitat types, reflected by water quality data.

General features

Breg and Brigach bear much resemblance in length, bedrock type and flow velocity, but they differ by landuse and demography: Breg catchment is dominated by agricultural land use, but industries and a higher population density dominate the mid and lower reach of the Brigach (Umweltqualitätsziele Gemeindeverwaltungsband Donaueschingen, 1999).

Flow velocity

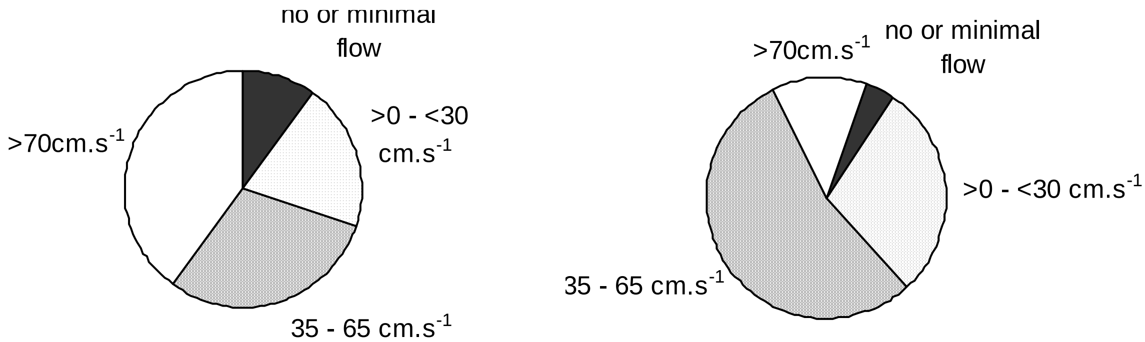

Figure 1: Flow class distribution in Breg (left) and Brigach (right)

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Sediment

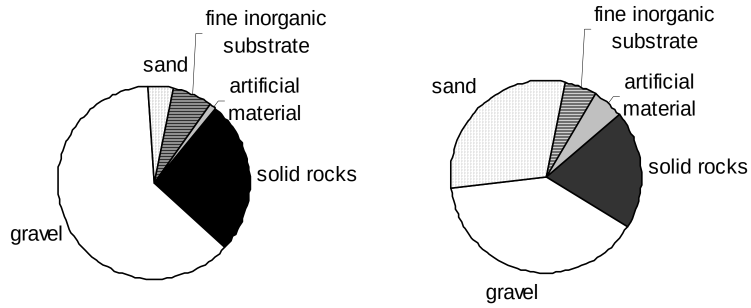

Figure 2: Sediment type distribution in Breg (left) and Brigach (right)

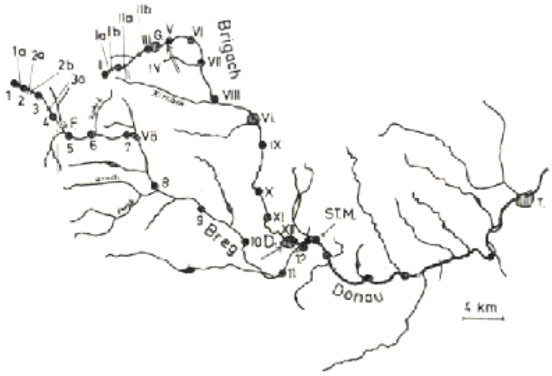

Figure 3: Map of the investigation area after BACKHAUS 1967

Water quality

The tables below show the saprobic water quality for 1957, 1991 and 2004.

Table 1: Water quality of the Breg from the source to the confluence
Data source: Landesanstalt für Umweltschutz BW (2004).

section number	1	2	2a	3	3a	4	5	6	7	8	9	10	11	12
water quality 1957	I	I	I	II	II	II	III	II	I - II	I - II	I - II	II	II - III	III
water quality 1991	I	I	I	II	II	II	II	II	II	II	II	I -II	II	II
water quality 2004	I	I	I	I	I	I	I - II	II	II	II	I - II	I - II	II	II

Table 2: Water quality of the Brigach from the source to the confluence
Data source: Landesanstalt für Umweltschutz BW (2004).

section number	I	II	IIa	IIb	III	IV	V	VI	VII	VIII	IX	X	XI	XII
water quality 1957	I	I	I	I	I - II	I - II	III - IV	III	III	II	II - III	IV	IV	IV
water quality 1991	I	I	I	I	I	II	II	II	II	II	II - III	II - III	II - III	II - III
water quality 2004	I	I	I	I	I	I	I - II	II	II	II	II - III	II - III	II - III	II - III

Trophic status of survey site "X" in the Brigach was calculated as TIM (SCHNEIDER 2000), I.B.M.R. (HAURY et al. 2000) and MTR (DAWSON 1999, HOLMES 1999). The results for this site indicate a eutrophic status (Table 3) in all the periods of macrophyte survey.

Table 3: Calculated Trophic Status of Section X (Brigach)

Brigach X	1960	1988	2004
TIM	2,49	2,88	2,86
IBMR	7,96	9,50	8,71
MTR	40	60	50

In the other sites species number and/or abundance was too low to calculate all indices in parallel.

Methods

BACKHAUS surveyed the aquatic flora in 12 representative locations, length 50 metres. He estimated the plant mass ("abundance") in a three-level scale (1=few, 2=moderate, 3=frequent). Chemical data were published by BACKHAUS (1967). JUNG, as well as JANAUER and collaborators applied a 5-level descriptor scale (KOHLER & JANAUER 1995). For better comparability, BACKHAUS' estimates were converted to this scale (1=1, 2=3 and 3=5). JUNG also quantified the chemical parameters. In her study section lengths were a minimum of 220 and a maximum of 5140 metres (see JUNG 1969). In the survey carried out by JANAUER and his team in 2003 / 2004 near to the entire length of both streams was investigated as part of the MIDCC project (see acknowledgements).

Results

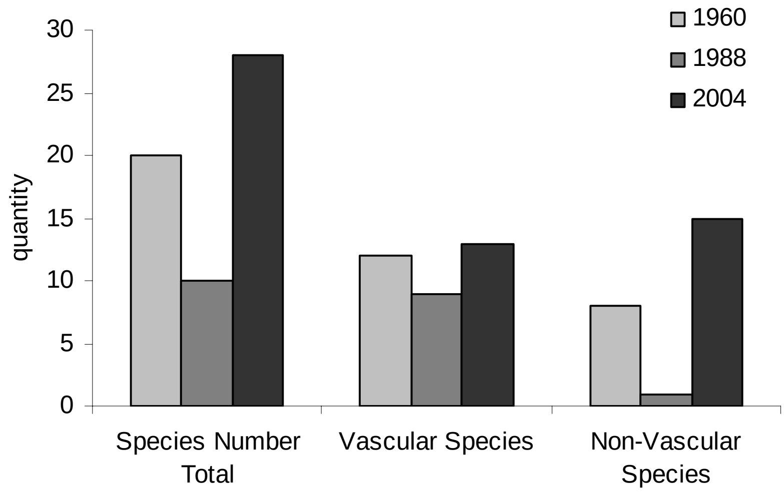

Figure 4: Breg: comparison of the species numbers found in 1960, 1988 and 2004

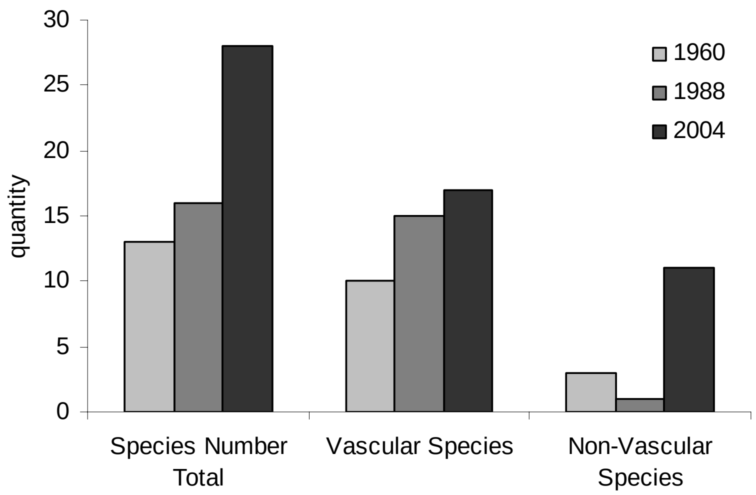

Figure 5: Brigach: comparison of the species numbers found in 1960, 1988 and 2004

Fig.4 and Fig.5 show that the species numbers and types are different in the three surveys. In the 2004 survey the highest number of species was detected in both streams, and the non-vascular species contributed most to this result. In 1988 only one non-vascular species (*Fontinalis antipyretica*) was reported for both streams. In 2004 17 (Breg) and 14 (Brigach) species were found which had not been mentioned in the studies 16, and 44, years earlier.

Species common to all survey are *Fontinalis antipyretica* (L.) Hedw. (Fon ant), *Callitriche hamulata* Kütz ex W.D.J. Koch (Cal ham), *Cardamine amara* L. (Cad ama), *Ranunculus fluitans* Lamarck (Ran flu), *Glyceria fluitans* (L.) R. Br. (Gly flu) *and Phalaris arundinacea* L. (Pha aru) in the Breg and *Fontinalis antipyretica, Callitriche hamulata, Lemna minor* L. (Lem min), *Potamogeton natans* L. (Pot nat), *Ranunculus fluitans, Veronica anagallis – aquatica* L. (Ver ana) *and Veronica beccabunga* L. (Ver bec) in the Brigach.

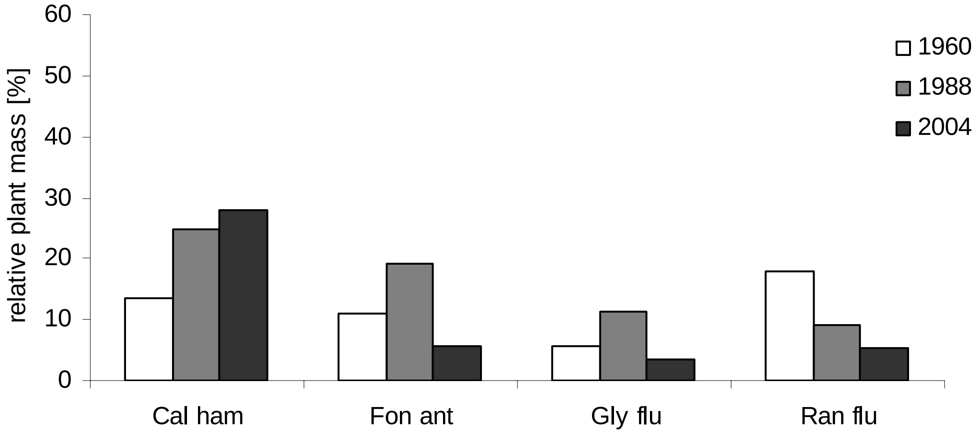

Figure 6: Breg: comparison of relative plant mass

The dominance of species, expressed as Relative Plant Mass (RPM, PALL & JANAUER 1995), differed in the three surveys (Fig.4). Regarding other species in 1960 the alga *Nitella flexilis* (L.) Ag. (Nit flex) was dominant in the Breg, followed by *Ranunculus fluitans* and *Callitriche hamulata*. In 1988 *Callitriche hamulata*, *Montia fontana* L. (Mon fon) and *Fontinalis antipyretica* showed the highest RPM. In the 2004 survey, *Callitriche hamulata*, *Veronica beccabunga* and *Veronica anagallis-aquatica* were dominant. These results implicate that only *Callitriche hamulata* showed constant occurrence over this period of 44 years.

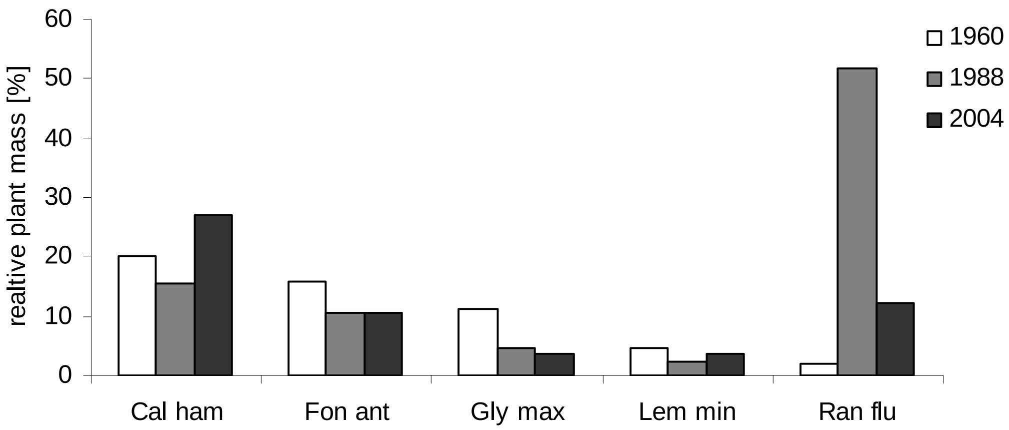

Figure 7: Brigach: Comparison of relative plant mass

The variability in species dominance in the Brigach is shown in Fig.5. In 1960 the relative plant mass in the Brigach was highest for *Glyceria fluitans, Callitriche hamulata* and *Fontinalis antipyretica*. In 1988 *Ranunculus fluitans* dominated with a relative plant mass of over 50%. *Callitriche hamulata* and *Fontinalis antipyretica* scored under 16%. In 2004 *Callitriche hamulata*, *Ranunculus fluitans* and *Fontinalis antipyretica* were the dominant species. In the Brigach *Callitriche hamulata, Ranunculus fluitans* and *Fontinalis antipyretica* were the prevailing species.

Conclusion

Regarding the three surveys there is a notable difference in species composition and in the dominance, expressed as Relative Plant Mass. Despite the fact that water quality based on saprobic index (see above) improved considerably in the two rivers, the application of different trophic indices based on macrophyte occurrence did not show a comparable improvement. As the two streams belong at least in some parts of their length to river types (*sensu* WFD) from which the original trophic assessments were derived, applying such indices in different geographical regions and in different river types without adaptation may cause difficulties and intercalibration should be performed.

Another problem arises with the assessment of ecological status with regard to the EU-Water Framework Directive. Variability of species composition and/or abundance between years has certainly not found enough attention on the classification process based on aquatic macrophytes. Therefore basic long-term studies must statistically ascertain that future monitoring work carried out only every third year results in reliable classification of the ecological status of rivers.

Acknowledgements

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