Some notes on hydrobiological investigations in the Turiec river basin

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Abstract


Hydrobiological investigations were carried out in the Turiec river basin, the lower part of which is a protected locality of the huchen. The amounts of CPOM and CTOM [coarse particulate (and transported, respectively) organic material] reached highest values in little watery upper streams. By contrast, the amounts of FTOM and particularly FPOM [fine transported (and particulate, respectively) organic material] reached a maximum in the more watery Turiec tributaries. Streams passing through deep deforested valleys showed increased displacement of FTOM [erosion]. The amount of periphyton was determined by the intensity of illumination, and phosphate and calcium contents of the water. With macrophytes, the stream water stand was also important. Based on stonefly taxocoenoses, epi-, meta- and hyporhithral with interspersed ecotone sections characterized by increased diversity and lowered abundance of Plecoptera were recorded in the basin. Three endangered stonefly species were found to occur in the hyporhithral: Brachyptera monilicornis, Taeniopteryx schevenemundi and Amphinemura borealis.

A team of hydrobiologists from several institutions in Slovakia decided to elaborate detailed and complex characteristics of the live environment of the huchen in the protected natural locality, the river Turiec and of some of its important tributaries. We concentrated our attention to various trophic levels (primary producers and primary and secondary consumers), their structure, production, seasonal and longitudinal dynamics, trophic structure, supply of allochthonous organic material, microuisdistribution of zoobenthos, and basic chemical, physical and physiographic characteristics of the streams. Some interesting results of the first stage of our investigations will be presented below.

In the Turiec river basin we selected 14 stationary sites of the 2nd-5th order, situated from 1000 to 400 m above the sea level. The source of the river Turiec is located in the Kremnické vrchy mountains under the Srčinnik at 1090 m above the sea level. The river basin has a surface area of 934 km² and the stream is 66 km long (it empties itself into the river Váh at Vrútky). In
the upper part, the river Turiec passes through the Kremnické vrchy (volcanic mountains with prevailing andesites and rhyolites), and in the central and lower parts through the Turčianska kotlina basin. Maximal flow rates are reached in the spring (March, April); average flow rate at Martin is about 10 m³ s⁻¹. The 21 km long section of the river Turiec from the village Moškovec up to the estuary of the Bystrický brook has been declared a protected locality of the huchen. In addition, we followed the Blatnický brook, a typical Veľká-Fatra-type right-hand tributary of the river Turiec, passing through Mesozoic sediments; and the Valčiansky brook, a Malá-Fatra-type left-hand tributary of the river Turiec, passing through a geologic break between Paleozoic rocks and Mesozoic sediments.

The localities on these streams were regularly visited four times a year (March, May, July, October). Physiographic characteristics were evaluated according to Platts et al. (1983). Chemical and physical factors were determined by routine methods. At each locality, 3—4 samples (1500—2000 cm²) were taken from the stream section with prevalent rocks and boulders, and 2—3 samples (1000—1500 cm²) from still sections with proportional representation of finer substrates. We simultaneuously used two types of net with mesh sizes of 1.0 and 0.1 mm. Transported organic material was collected into the smaller drift net. Periphyton and macrophytes were scraped off from the substrate, the surface of which was estimated with the help of an aluminium foil. The degree of similarity between the individual localities based on abiotic and biotic factors was evaluated by the method of GOODALL (1978).

Three basic types of biotope could be distinguished based on an analysis of abiotic factors:

1. Upper sections of Turiec tributaries (1000—600 m above the sea level), of which the slope reaches 170—57 %, the thickness of laminar water sublayer above the substrate (STATZNER, 1981) varies from 0.2 to 0.4 mm, and the average maximal temperatures are not higher than 10 °C. We call them mountain brooks (epihithral).

2. Central and lower tributaries of the river Turiec and its central part (725—470 m above the sea level), of which the slope reaches 35—8 %, the thickness of laminar water sublayer 0.35—0.8 mm, and the average maximal temperatures vary from 10 to 15 °C. We call them submountain brooks (metigraphal).

3. Lower part of the river Turiec at an altitude of 465—400 m above the sea level, of which the average slope is 2 %, the average thickness of laminar water sublayer 0.7 mm, and the average maximal temperature is higher than 15 °C. We call it submountain river (hyporhithral).

In the mountain brooks, submountain brooks and submountain river, the daily maximal temperatures were not higher than 12, 17 and 21 °C, respectively.

The oxygen balance at the localities under study was very good. The situation with BSKs was worse from the village Turček up to the last site on the river Turiec (Košťany), where gradual deterioration occurred (from 2 to 4 mg 1⁻¹). Calcium contents depended primarily on the geological substrate: in the Blatnický brook it reached up to 135 mg l⁻¹ as compared with 16—32 mg l⁻¹ in waters passing through volcanites and granodiorites.

We found the weight of coarse benthic detritus (CPOM) markedly decreasing with increasing flow rate all the year round (Table 1); the mean values varied
from 80 to 15 g m\(^{-2}\). The values were highest in autumn and lowest in late spring. The course of the quantitative values of fine detritus (FPOM) was irregular. Highest values were recorded in lower sections of the tributaries and in the central section of the river Turiec (the range of mean values was 30–8 gm l\(^{-1}\)). The CPOM/FPOM ratio decreased significantly (Table 1) with increasing flow rate. The weight of coarse transported organic material in winter and summer had a course similar to that of CPOM (Table 1). The mean values ranged from 50 to 20 mg m\(^{-3}\). By contrast, the amount of fine transported organic material (FTOM) in the winter and summer markedly increased with in-

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Regression equation</th>
<th>(t)</th>
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<tbody>
<tr>
<td>Macrophytes (g m(^{-2}))</td>
<td>(Y = -14.95 + 0.1330s + 0.333L)</td>
<td>54 ++</td>
</tr>
<tr>
<td>Periphyton (g m(^{-2}))</td>
<td>(Y = -1.520 + 0.160s + 47.38PO_4 + 0.039Ca)</td>
<td>22 ++</td>
</tr>
<tr>
<td>March</td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>(Y = 1.087 + 0.1410s)</td>
<td>10 +</td>
</tr>
<tr>
<td>July</td>
<td>(Y = 1.13 + 0.070s + 0.01Ca)</td>
<td>14 ++</td>
</tr>
<tr>
<td>October</td>
<td>(Y = -19.261 + 0.1770s + 170PO_4 + 0.237Ca)</td>
<td>7 +</td>
</tr>
<tr>
<td>CPOM (g m(^{-2}))</td>
<td>(Y = 29.30 + 0.212/Q)</td>
<td>5 +</td>
</tr>
<tr>
<td>March</td>
<td>(Y = 1.018 + 0.001L)</td>
<td>44 ++</td>
</tr>
<tr>
<td>May</td>
<td>(Y = 27.66 + 0.304/Q)</td>
<td>6 +</td>
</tr>
<tr>
<td>July</td>
<td>(Y = 25.141 + 364/Q)</td>
<td>11 ++</td>
</tr>
<tr>
<td>October</td>
<td>(Y = 5.19L^{-0.196})</td>
<td>13 ++</td>
</tr>
<tr>
<td>CTOM (mg m(^{-3}))</td>
<td>(Y = 1/0.051 + 0.032)</td>
<td>93 ++</td>
</tr>
<tr>
<td>March</td>
<td>(Y = 19.000 - 0.56)</td>
<td>6 +</td>
</tr>
<tr>
<td>CTOM (mg m(^{-3}))</td>
<td>(Y = 85.76 + 47.75Q)</td>
<td>69 ++</td>
</tr>
<tr>
<td>FTOM (mg m(^{-3}))</td>
<td>(Y = 99.76 - 0.38/Q)</td>
<td>5 +</td>
</tr>
<tr>
<td>Ecological situation of the localities</td>
<td>(Y = 0.478 + 0.052LnQ)</td>
<td>10 ++</td>
</tr>
<tr>
<td>March</td>
<td>(Y = 0.281 + 0.400)</td>
<td>6 +</td>
</tr>
<tr>
<td>May</td>
<td>(Y = 0.39 + 0.048LnQ)</td>
<td>10 ++</td>
</tr>
<tr>
<td>July</td>
<td>(Y = 0.344 - 0.002Q)</td>
<td>11 ++</td>
</tr>
<tr>
<td>October</td>
<td>(Y = 0.183 + 0.0075)</td>
<td>10 +</td>
</tr>
<tr>
<td>Brachyptera (individuals m(^{-2}))</td>
<td>(Y = 4.984 + 1.731/Q - 0.009/Q^2)</td>
<td>16 ++</td>
</tr>
</tbody>
</table>

Weights given in dry weight values.

1) On the basis of periphyton, macrophytes, CPOM, FPOM, CTOM and FTOM.

2) On the basis of stonefly (Plecoptera) taxocoenoses.

Os — angle at which profile of the stream (°)

L — sum of 1st order tributaries

PO_4 — phosphate contents in mg l\(^{-1}\)

Ca — calcium contents in mg l\(^{-1}\)

Q — flow rate in m\(^3\) s\(^{-1}\)

S — slope of the stream in %

\(+\) — \(P > 0.05\); \(+ +\) — \(P > 0.01\)

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creasing flow rate. High values, in particular in the spring and autumn, were recorded in the upper sections of the Turiec river and the Gaderský brook, which may be explained by deforestation of the adjacent slopes and a subsequently increased erosion. The values were highest during high water stands, the means varying from 200 to 50 kg m$^{-3}$. The amount of periphyton during the year was determined by the intensity of illumination of the given locality (this participates in total variability of the parameter in 25–61 %), and the amounts of phosphate and calcium dissolved in the water (0–10 % and 0–9 %, respectively). The highest values were recorded from March to May and the lowest in summer (heavy shading the streams). The mean values ranged from 45 to 1.5 g m$^{-2}$. The amount of macrophytes was also determined by illumination and flow rate. In the upper and central parts of the Gaderský brook (a tributary of the Blatnický brook) there occurs Cratoneuron commutatum, on the other localities Fontinalis antipyretica; Batrachium sp. grows in the lower section of the river Turiec. In general, it is possible to conclude that the participation of the autochthonous component increases with the stream order. The courses of the (biotic) parameters mentioned above (Table 1) throughout the year is in accordance with the river continuum theory (Vannote et al., 1980). Deforestation of some upper streams and geomorphological specificities of the Gaderská valley (gorge, inversion) has led to some discontinuity. In streams with an average flow rate of up to 0.05 m$^3$ s$^{-1}$, detritophages (shredders — 58 %) were prevalent among stoneflies; predators represented 40 % and algal periphyton scrapers 2 %. In streams with an average flow rate from 0.05 to 1.00 m$^3$ s$^{-1}$, detritophagous species were highly prevalent (up to 85 % of all plecoptera); predators and algal periphyton scrapers represented only 13 and 2 %, respectively. In the lower part of the river Turiec detritophages and predators each represented 50 %.

In the Turiec river basin we found 62 stonefly species, which represents 2/3 of the fauna of the CSFR. Surprisingly rich was the family Taeniopterygidae — 7 species (all are stenoecous species very sensitive to human activities). Longitudinal distribution of stoneflies in the Turiec river basin (Table 1) was determined by the altitude above the sea level, which is of decisive importance for the seasonal dynamics of stream temperature. The participation in total variability of the seasonal temperature dynamics, slope, and stream order was 89 %, 18 % and 7 %, respectively. The curve of stonefly species diversity had a two-peak course with maxima in the sections in the ecotone between the epi- and metarhithral (H = 1.9) and in the ecotone between the meta- and hyporhithral (H = 1.5); the average H values in the typical epi-, meta- and hyporhithral reached 1.7, 1.3 and 1.2, respectively. In the summer, the diversity in lower sections of the streams decreased markedly. By contrast, the abundance of stoneflies and a three-peak course with maxima where divertisy showed a depression and minima in ecotones. In a typical ephihithral, the average abundance reached about 900 individuals per m$^2$, as compared with 500 and 200 individuals per m$^2$ in the meta- and hyporhithral, respectively. Species characteristic of mountain brooks were Nemoura monticola, N. carpatica (new species for the fauna of the CSFR), Protonemura nimborum, P. montana, Leuctra armata, L. rauserti, Perlodes intricatus, Isoperla sudetica and Siphonoperla neglecta. Of submountain brooks characteristic were Taeniopteryx auberti, Amphinemura sulcicollis, Nemoura babiegorensis, N. uncinata, Leuctra albida, L.
aurita, L. hipposus, L. inermis, Isoperla oxylepis, Perlodes microcephalus, Perla marginata and Siphonoperla torrentium. The following rare species were typical of submountain-river: Brachyptera monilicornis, Taeniopteryx schoenemundi, Amphinemura borealis, Leuctra fusca, Isoperla difformis, I. grammatica, Perlodes dispar, Perla burmeisteriana and Chloroperla tripunctata. The highest number of polikilostenothermic species occurred in the Blatnický brook basin and the lowest number in the Valčiansky brook basin. This was the result of different hydrological and climatic characteristic of the streams under study. Very interesting and surprising was the occurrence of species (Brachyptera monilicornis, Taeniopteryx nebulosa, T. schoenemundi and Capnia bifrons) that are absent from other river basins of the upper and central Váh (up to Žilina) and so far have been known only from areas draining mountainis in immediate contact with the Danubian lowland. This fact is connected with climatic conditions, although we cannot exclude the possibility that their occurrence in the Turiec basin has been due to a contact of this basin with the Hron river valley and the Danubian lowland in recent geological history.

The results obtained indicate that the greatest danger for the Turiec river basin is the decreasing flow rate as a result of huge volumes of water used for irrigation and industrial purposes. In the last decade the flow rate in the lower part of the Turiec river decreased by about one fifth, which endangers the self-cleaning capacity of the river. In comparison with the period from 1973 to 1981, the abundance of fishes decreased significantly. This applies also to the huchen, the population structure of which shows negative changes (J. HOLČIK, unpublished research report 1989).

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