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RYSZARD SOWA

Ekologia i biogeografia jętek *(Ephemeroptera)* wód płynących w polskiej części Karpat. 1. Rozprzestrzenienie i analiza ilościowa

Ecology and biogeography of mayflies *(Ephemeroptera)* of running waters in the Polish part of the Carpathians. 1. Distribution and quantitative analysis

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Abstract — Mayflies, mainly nymphs, of running waters in the Polish part of the Carpathians and the immediately neighbouring territory of the fork made by the Rivers Vistula and San, lying to the north, are elaborated. Investigations were carried out in the years 1958 to 1972 in 68 water units at 180 stations. The history of the hitherto carried out investigations, a list of species and their synonymy, discussion on dubious species or poorly known ones and their distribution are also given for the investigated territory. The maximum distribution of species and the degree of their attachment to the given type of running waters are discussed. For the main water systems 5 different communities of mayflies were discovered in their longitudinal distribution, the investigated water systems being divided into 6 longitudinal zones. In the water system Olszowy-Koninka-Porębianka-Raba the quantitative distribution of mayflies in five habitats on a stony-gravel bottom are elaborated, in zones 2., 3., and 4., seasonal variations in the abundance of communities in these habitats are given for the year 1969/70.

Introduction

Ephemeroptera are — apart from *Diptera* and *Trichoptera* — one of the most important groups of water insects in inland running waters, considering the number of species, their dispersion, abundance, and biomass. As phytophags they participate in the secondary production of these waters in an essential way, being a highly calloric and accessible feed for fish. Mayfly nymphs show a great differentiations as

to their environmental requirements and many of them show a distinct adaptation for living in the water current. Owing to this and to a distinct zonation which can be observed in the distribution of many species along the water courses, mayflies are specially useful in biological classification of running waters. There is a possibility of making use of mayfly nymphs as biological indicators in evaluating the purity of streams and rivers, as this group of animals is very sensitive to water pollution with sewage, and to other changes in the natural conditions of running waters, caused by man and also due to the fact that determination of a great majority of species is fairly easy even for the layman. Hence the interest in the order *Ephemeroptera*, for a long time lively also among hydrobiologists, has greatly increased in recent years, the number of papers on the biology of mayflies and especially their nymphs, amounting to some hundred items from Europe alone. In Hynes' monography (1971) devoted to the biology of running waters, the majority of ecological problems are discussed on the example of this insect group. Nevertheless, as concerns their systematics, *Ephemeroptera* remained till recent years surprisingly little known, even on the European continent; a great many species, especially within the *Heptageniidae*, *Beatidae* and *Caenidae*, are still awaiting a modern critical elaboration of their species composition based upon a large comparative material as, e. g., the especially valuable elaboration by Müller-Liebenau (1969) on European species of the genus *Baetis* Leach. Such a situation in the taxonomy of European mayflies and a great increase in the number of newly discovered species in recent years, making it necessary to treat the existing data carefully also in the line of ecology of many species, was not without influence on the character and arrangement of the present paper.

The present paper concerns the mayflies of running waters on the territory of the Polish part of the Carpathians and on the territories bound by the right side of the River Vistula. 68 streams representing various environmental conditions were investigated; from the spring section of the stream of high mountain character to a lowland river. The material was collected in the years 1958—1972. The paper presents the distribution in space and time of mayflies in the investigated area. It discusses their distribution along the streams and rivers, distinguishing separate longitudinal communities and analysing the abundance of species and their communities in spatially more important habitats on the example of the catchment area of the Raba. The history of the performed investigations on Carpathian mayflies, the synonymy of the discovered species for the investigated territory, and a taxonomic discussion of the material are also presented.

2. History of the hitherto investigated mayflies from the Carpathians

Studies on mayflies in the Polish part of the Carpathians can be divided into three periods. In the first of them are reports of faunistic character by E. Majewski, M. Nowicki, F. Schille, A. Wierzejewski and, above all, by Dziędzielewicz from the second half of the XIX and the first 15 years of the XX century; these were

based exclusively on adults of mayflies collected in various regions of the western and eastern Carpathians. A summing up of this pioneer period is given with a bibliography in the paper by Dziędzielewicz (1919), in which he mentioned 15 species from the territory where the present investigations were carried out and included a number of ecological and phenological remarks on them.

The second period, between the wars, comprises almost exclusively papers by Mikulski (1929, 1931, 1933, 1936, 1937, 1938). This author based his investigations also on nymphs, associating their occurrence with environmental factors. The problems dealt with refer to taxonomy and zoogeography of the order, considerable data also on the biology of particular species being given. In his key for the determination of mayflies of Poland Mikulski (1936) mentioned 42-species for the Polish part of the Carpathians, of which almost half were considered common species in this territory. Apart from Mikulski, Steinberg (1935) examined the development and morphology of larvae of *Baetis alpinus* (Pict.) in some streams in the Tatra Highlands.

The third period covers publications from the beginning of the fifties till the present time. The authors base their investigations mainly, or exclusively, on nymphal material and with regard to the discussed problems their works can be divided into some groups. The distribution of mayfly nymphs in the system of water bodies as well as data on the abundance of species and their phenology formed the subject of the investigations of Mikulski (1950), Sowa (1959), Kamler (1960, 1962), and Głowaciński (1968). Similar as to the problems but discussing mayflies together with other groups of water insects or with the whole macrofauna of the bottom of the streams, were the elaborations by Musiał et al. (1958, 1962), Sowa (1961, 1965, 1965 a), Ciszek, Sosińska (1965), Krzanowski et al. (1965), Kownacka, Kownacki (1965, 1968), Kownacki, Kownacka (1965), Zięba,Zaćwilichowska (1968), Zięba (1968), Kownacka (1971), Krzyżanek (1971) and Szczęsny (1974). The papers by Kamler (1965, 1966, 1967) concern the relation between chosen abiotic factors of the environment and the mayfly nymphs; the author analyses, among others, the effect of drying out of streams, the influence of water temperature and the current speed on the behaviour of species and discusses their altitudinal distribution. The taxonomy and autecology of some species less frequent, poorly known, or new for science are dealt with by Sowa (1961a, 1962, 1971, 1971a, 1971b, 1971c, 1972, 1973, 1973a, 1973b, 1974), Thomas, Sowa (1970), and Keffermüller, Sowa (in press).

The great majority of the mentioned papers concern mayflies of the running water system. Data referring to stagnant waters, especially the Tatra lakes, can be found in Mikulski (1936), Kamler (1960), Kownacki, Kownacka (1965). As concerns running waters, the greatest attention was paid to mayflies of the Tatra streams and some rivers in the Tatra Highlands region (Kamler 1960, 1962, 1965, 1966, 1967, Kamler, Riedel 1960, Ciszek, Sosińska 1965, Krzanowski et al. 1965, Kownacka, Kownacki 1965, 1968, Kownacka 1971). Some large, or medium sized streams in the Silesian Beskids (Mikulski 1950), in the Beskid Mały (Sowa 1965), in the Gorce Mountains and in the Beskid Wyspowy (Mikulski

1937), in the Beskid Sądecki (Zaćwilichowska 1968, Szczęsny 1974) were also investigated as well as fragments of some streams in the Bieszczady Mts (Kamler 1965, 1967) and of some highland and lowland streams and small rivers in the vicinity of Cracow (Sowa 1959, Głowaciński 1968) and in the Oświęcimska Valley (Sowa 1961). In spite of this relatively rich literature many important physiographical regions in the Polish part of the Carpathians have not yet been elaborated with regard to the composition and distribution of mayflies, especially little being known of the mayflies inhabiting the great Carpathian rivers from which only the Dunajec has been investigated in this respect over its whole length.

From the other parts of the Carpathians, the territory lying within the Czechoslovak borders has been relatively the best elaborated. Mayflies were here the subject of faunistic and taxonomic investigations of some older authors such as F. Klapálek, J. Šamál, J. Komárek, A. Mocsáry and S. Pongrácz, and of a number of hydrobiological investigations, especially on running waters in the Slovakian part of the Tatras and some larger tributaries of the Danube. Among more recent papers which concern this region of the Carpathians exclusively or partly, the following deserve mention: Zelinka (1950, 1953a, 1969, 1973), Winkler (1952), Obr (1955), Dudich (1958), Husárova-Dudikova (1960), Zelinka, Rothschein (1967) and Landa (1968, 1968a, 1969). Zelinka and Rothschein (1964) give a total of 61 species for the running and stagnant waters of Slovakia.

There are not many publications on mayflies of running waters from the Eastern Carpathians lying within the borders of the USSR. The results of older faunistic investigations can be found in the papers by Dziędzielewicz (1919) and Mikulski (1936). The streams in the Czarnohora massif were investigated by Mikulski (1935) and a number of streams and torrents in the catchment area of the Prut were investigated by Pawłowski (1959).

There are also relatively few data on the habitation by *Ephemeroptera* of various Carpathian massifs on the territory of Rumania, though this order was there the subject of many ecological and taxonomical elaborations, the key to the Rumanian mayflies of Bogoescu (1958) being partly a summing up of these investigations. Among papers concerning the distribution of mayfly nymphs in the system of running waters, there are some publications by Tabacaru (1956) for the region of Suceava, by Miron (1959, 1960) for the catchment area of the Bistrita in the Rumanian part of the Eastern Carpathians, and by Botosaneanu and Tabacaru (1963) for the Transylvanian Alps.

3. Investigation area

3.1. General remarks

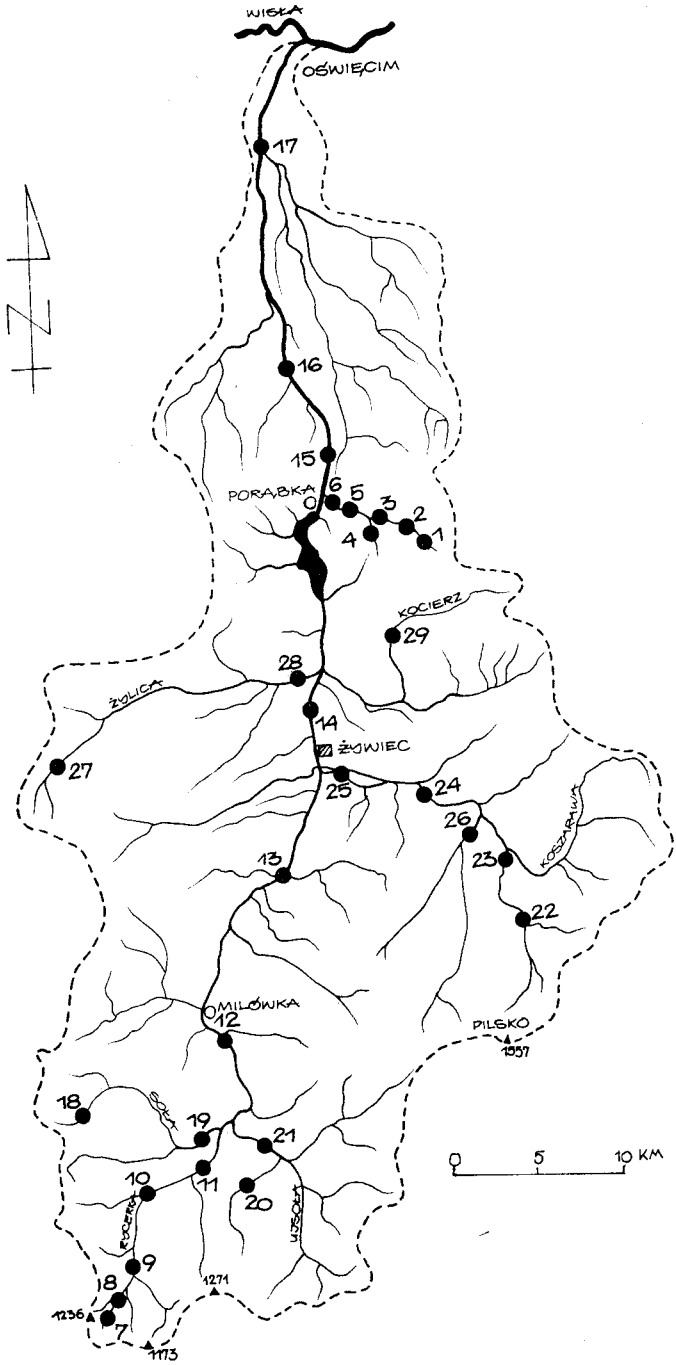
The area selected for the investigation resembles an irregular triangle whose north-western side is constituted by the bed of the Vistula down to the mouth of the San, the eastern one the river bed of the San, and the southern one the Polish

border with Czechoslovakia. This area was divided into 6 investigation regions which, with geographically take in the majority of mountain units lying in the Polish part of the Carpathians: the Tatras and the Tatra Highlands (Podhale), the Silesian Beskids, the Beskid Wysoki, the Gorce Mountains, the Beskid Wyspowy, the Pieniny Mountains, the Beskid Sądecki, and the Bieszczady Mountains. With regard to hydrography, the particular regions cover: region I — the catchment area of the Soła; region II — the tributaries of the Skawica and Orawa in the Babia Góra massif, region III — the catchment area of the Raba, region IV — the catchment area of the Dunajec, region V — the catchment area of the San, and region VI — some tributaries of the Vistula in the vicinity of Cracow. In this territory a total number of 180 stations were selected for investigation, these being distributed in 68 running water units. The difference in altitude between the highest and the lowest lying stations was more than 1400 m. The majority of stations lie in the mountainous territory where the investigations were carried out above all in the streams which sculpturing the main valleys with wooded slopes, subsequently form larger hydrographical units, the tributaries of the Soła, Skawa, Raba, Dunajec, and San. A great number of stations were sitauted on those rivers, with the exception of the Skawa. According to the assumption made in these investigations no stagnant waters were considered.

3.2. Description of streams in particular regions

3.2.1. Region I — the Soła and its tributaries

The Soła, which together with its tributaries drains the territory of the Silesian and Żywiec Beskids is 88 km long, 780 m total gradient, and 8.4 pro mille mean unitary gradient. The catchment area is 1388 km^2. After joining the Rycerka at Ujsoły, the Soła flows in its middle course across the Żywiecka Valley where the Żylica and Koszarawa — which drain, among others, the greatest elevation in the catchment area of the Soła, i. e the Pilsko massif (1557 m above sea level) — fall into it. Having passed the narrow valley of the range of the Beskid Mały the Soła flows along the large preglacial valley of the River Vistula, falling into this river at an altitude of 220 m above sea level. In the middle course of the Soła two dam reservoirs have been built from which only that at Porąbka existed at the time of the investigations. Along almost its whole course the Soła has the character of a mountain river. It is characterized by a straightened course making easier the run-off of flood waters in consequence of rapid freshets and quick falls in the water level caused also by the rather poor afforestation of the territory of the Żywiecka Valley (Pasternak 1960). In the river basin of the Soła 29 stations were established on 9 water units (fig. 1). A list of these stations with their short hydrological characteristics is given in Table I.



Ryc. 1. Rozmieszczenie stanowisk w dorzeczu Soły (region I)
Fig. 1. Distribution of sampling stations in the catchment area of the Soła (region I)

Tabela I. Podstawowe dane hydrograficzne i hydrologiczne dla stanowisk w dorzeczu Soły (region I); średni lub średnio niski stan wody. a - odcinki zwężone o szybkim prądzie; b - głęboczki lub lenityczne rozlewiska.

Table I. Basis hydrographic and hydrological data for the stations in the catchment area of the River Soła (region I); average or average low level. a - narrowed sections of fast current; b - deep parts or lenitic parts

Numer i usytuowanie stanowiska w potokach i rzekach Number and localization of the station in streams and rivers	Wysokość npm Altitude in m	Odległość od źródła Distance from spring w km	Spadek jednostkowy Gradient w ‰	Szerokość wody Breadth of water w m		Głębokość wody Depth of water w m		Maksymalna szybkość prądu Maximum current velocity w m/sec.
				a	b	a	b	
1 - Wielka Puszcza in forest	650	0,5	166	0,5	1,0	0,1	0,2	0,8
2 - Wielka Puszcza in forest	560	1,2	50	0,8	1,5	0,1	0,5	1,2
3 - Wielka Puszcza below a village	440	3,6	33	1,0	2,0	0,2	0,4	1,2
4 - Affluent of the Wielka Puszcza	450	2,6	36	0,8	3,0	0,2	0,6	0,9
5 - Wielka Puszcza in forest	410	5,0	22	2,4	5,0	0,3	0,6	1,3
6 - Wielka Puszcza at Porąbka	310	8,4	14	2,5	6,0	0,3	0,7	1,0
7 - Beginning of the Rycerka	1000	0,05	150	0,3	0,5	0,03	0,1	0,3
8 - Rycerka in forest	900	0,9	90	1,5	2,0	0,1	0,3	0,8
9 - Rycerka at the edge of forest	700	4,0	30	2,0	3,0	0,2	0,4	0,9
10 - Rycerka above Rycerka Górna	590	8,0	17	3,0	6,0	0,2	0,5	1,5
11 - Rycerka at Rycerka Dolna	520	14	10	8	15	0,3	0,8	1,5
12 - Soła at Milówka	445	26	6,6	12	16	0,3	0,8	1,2
13 - Soła at Wieprz	370	35	4,7	15	20	0,4	0,9	1,8
14 - Soła below Żywiec	335	43	3,5	15	30	0,4	0,6	1,5
15 - Soła below Porąbka	290	58	2,0	16	35	0,3	0,5	1,3
16 - Soła at Kęty	270	65	1,5	25	35	0,5	1,3	1,2
17 - Soła at Rajsko	245	79	1,1	20	30	0,5	1,2	1,5
18 - Roztoka below Zwardoń	590	2,5	26	1	3	0,2	0,4	1,0
19 - Soła at Rycerka Dolna	525	10,5	7,0	5	10	0,3	0,6	0,8
20 - Affluent of the Ujsoła at Glinka	640	4,0	25	1	2	0,1	0,2	0,8
21 - Ujsoła below Ujsoła	520	10,0	10,0	5	8	0,3	0,5	0,9
22 - Glinny at Korbielów	520	6,5	28	2	4	0,3	0,5	1,0
23 - Koszarawa below Krzyżowa	460	11,5	20	5	8	0,3	0,7	1,0
24 - Koszarawa at Jeleśnia	400	18	9,0	15	25	0,5	1,0	1,3
25 - Koszarawa above Żywiec	370	25	6,5	15	30	0,5	1,2	1,2
26 - Sopotnia above Jeleśnia	450	13	17	6	9	0,4	0,6	1,0
27 - Żylica above Szczyrk	580	3,5	50	4	5	0,2	0,4	1,5
28 - Żylica above mouth	340	19,5	8,0	6	10	0,3	0,5	1,0
29 - Kocierski above Łękawica	470	8,0	15	3	4	0,2	0,3	1,2

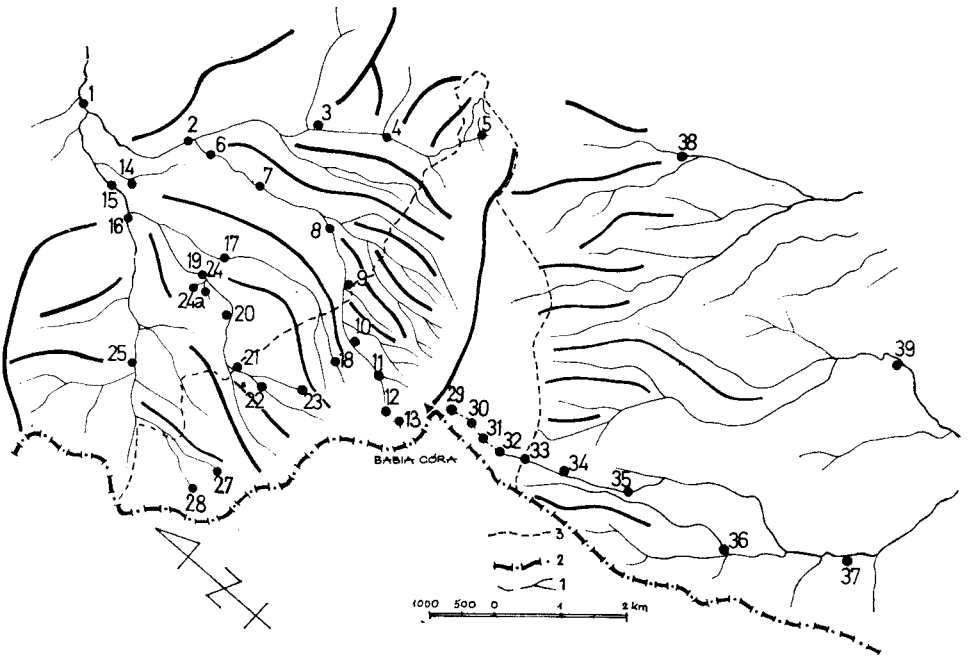
Stations 1—6 were situated on the stream Wielka Puszcza, which flows along a narrow wooded valey in the Beskid Mały. The stream has a lotic character along its whole length and a stony bottom with a prevalence of large and medium sized flat sandstones. The paper by Sowa (1965) contains a detailed description of the stream. Of a similar character is the Rycerka at stations 7 — 9, a tributary of the Ujsoła at station 20, and the streams Glinny at Korbielów and Żylica at Szczyrk as well as the Kocierski stream above Łękawica (stations 22, 27, and 29).

Stations 11—14, 19, 21, and 24—26, situated in the lower course of the Rycerka, Ujsoła, Sopotnia, the middle and lower course of the Koszarawa and the upper and middle course of the Soła, are characterized by the occurrence of great amounts of rounded rock débris forming distinct shelves in the riverbed. In the water course narrower lotic parts are formed alternately with larger lenitic parts with a slower current. Deep places or "sleeves" with sediments of sand and mud are formed at the sides. Also the stones in the lenitic parts are sometimes covered with a thin layer of mud. In the lotic parts, diagonal heaps of stones or coarse gravel are often formed, the water overflowing them making shallow rapids. On the bottom medium sized or large stones, flat and imbricated sandstones are often found. At stations 15—17 in the lower course of the Soła the bottom is formed by small stones mixed with medium sized ones, a large percentage of the area being occupied by banks formed of gravel.

Stations 1, 2, 7, and 29 were situated in a mixed wood and were completely protected from the sun. Fairly shaded were the stations: 5, 6, 8, 9, 22, and 27, situated at the edge of the forest or having banks overgrown with clumps of trees. Other stations were fully insolated. Stations 15—17 were subjected during the investigation period to the influence of a specific rhythm of changes in the level of the water let out from the dam reservoir at Porąbka. Station 14 had distinct traces of pollution with municipal and industrial wastes from Żywiec and station 28 with wastes from the tanning industry at Łodygowice. Within the other stations the investigated streams were practically clean. Traces of technical regulation of the banks of the bed were visible at stations 11, 15, 17, and 24.

3.2.2. Region II — the streams of the Babia Góra massif

Mt. Babia Góra, the highest elevation in the Beskid Wysoki, has clearly developed zones of land vegetation including the Alpine zone. From the top of this elevation (1726 m above sea level) till about 1200 m above sea level the gradient of the slopes is greater in the northern than on the southern side of the massif. In the interval of altitude 1200 m — 700 m the two slopes of the massif have a similar gradient and are cut by fairly shallow V-shaped valleys down which numerous streams, affluents of the Orawa and Skawica, flow. For the investigations 13 water units were chosen on which 38 stations (fig. 2) were established. A list of the stations with their hydrological characteristics is given in Table II. The streams on which the stations were established can be divided, with regard to their physiography into 6 groups:



Ryc. 2. Rozmieszczenie stanowisk w dorzeczu Skawicy i Orawy (region II). 1 — potoki i stanowiska; 2 — granica państwowa z Czechosłowacją; 3 — granica Babiogórskiego Parku Narodowego
Fig. 2. Distribution of sampling stations in the catchment area of the Skawica and Orawa (region II). 1 — streams and stations; 2 — state frontier with Czechoslovakia; 3 — boundary of the Babia Góra National Park

—springs and short sections of outflows situated on the Alpine or mountain pine zone. Their bottoms are stony and covered with gravel, in places having sediments of detritus with mud. Stations: 13, 29, and 30; — upper sections of the main streams situated in the upper montane zone and the upper part of the lower montane zone and also in the lower part of the mountain pine zone. On the bottom a majority of large stones and boulders; at the banks and deep places gravel and detritus sediments. The water flows between boulders forming cascades. The stones are richly overgrown with water moss. Stations: 9—12, 23, 27, 31—34; — streams in the montane zone, not sculpturing distinct valleys, affluents of main streams. The bottom is stony with a majority of medium sized and small stones or covered with gravel with sediments of mud and detritus. The water flows on the whole breadth of the narrow, shallow river bed. Stations: 5, 17, 18, 22, and 28; — well developed middle and lower sections of the main streams in the lower montane zone and arable fields flowing in larger valleys. Stone shelves and long lotic sections alternately with short lenitic ones are formed in the riverbeds. On the bottom there is a prevalence of large stones. Behind the stones or at the banks narrow sediment banks of gravel and sand are sometimes formed. Stations: 2—4, 6—8, 15, 16, 19—21—25, 35, 36, 38, and 39; — initial sections of small mountain rivers with wider stone shelves and

Tabela II. Podstawowe dane hydrograficzne i hydrologiczne dla stanowisk w dorzeczu Skawicy i Orawy (region II); średni lub średnio niski stan wody. a - odcinki zwężone o szybkim prądzie; b - głęboczki lub lenityczne rozlewiska

Table II. Basic hydrographic and hydrological data for the stations in the catchment area of the Rivers Skawica and Orawa (region II); average or average low water level. a - narrowed sections of fast current; b - deep parts or lenitic parts

Numer i usytuowanie stanowiska w potokach i rzekach Number and localization of the station in streams and rivers	Wysokość npm Altitude in m	Odległość od źródła Distance from spring w in km	Spadek jednostkowy Gradient w in ‰	Szerokość wody Breadth of water w in m		Głębokość wody Depth of water w in m		Maksymalna szybkość prądu Maximum current velocity w in m/sec.
				a	b	a	b	
1 - Skawina at Zawoja Widły	600	9,5	17	6,0	10,0	0,4	1,0	1,1
2 - Jaworzyna at Zawoja Widły	645	7,0	27	4,0	7,0	0,3	0,6	1,3
3 - Jaworzyna near forest	720	3,5	25	2,0	3,0	0,2	0,4	0,9
4 - Jaworzyna in forest	760	2,3	30	1,5	2,0	0,2	0,3	0,9
5 - Beginning of the Jaworzyna	900	0,05	170	0,3	0,9	0,05	0,2	0,3
6 - Stonów above mouth	690	6,5	38	4,0	5,0	0,3	0,6	1,0
7 - Stonów in forest	745	5,4	40	3,0	4,0	0,3	0,5	1,4
8 - Suchy in forest	770	3,8	28	2,5	3,0	0,3	0,4	1,3
9 - Suchy in forest	820	2,6	120	1,0	2,0	0,2	0,4	1,5
10 - Suchy on the slope conuexity	1000	1,5	225	0,7	1,0	0,1	0,3	1,0
11 - Suchy in a deep gorge	1200	0,6	275	0,5	1,0	0,1	0,2	0,8
12 - Spring of the Suchy with outflow	1400	0-0,05	275	0,3	0,7	0,05	0,2	0,3
13 - Spring of an affluent of the Suchy	1550	0,005	500	0,3	-	0,05	-	0,4
14 - Meadow stream in Zawoja Widły	625	1,4	5	0,5	1,5	0,2	0,4	0,5
15 - Jałowiec at Zawoja Widły	620	6,3	20	5,0	8,0	0,3	0,5	1,0
16 - Jałowiec above the mouth of the Markowy	635	5,2	21	3,0	5,0	0,2	0,4	1,2
17 - Dejaków in forest	730	4,0	40	1,0	2,0	0,2	0,3	0,9
18 - Dejaków on a glade	1100	0,6	260	0,6	1,0	0,2	-	1,4
19 - Marków above a village	720	4,0	52	3,0	4,0	0,3	0,5	1,3
20 - Marków near forest	750	3,1	55	2,5	3,0	0,3	0,4	1,1
21 - Affluent of Markowy in forest	820	2,0	110	1,5	2,0	0,2	0,3	1,2
22 - Affluent of Markowy in forest	960	1,3	200	0,5	1,0	0,1	0,3	0,8
23 - Affluent of Markowy in forest	1180	0,3	320	0,8	1,5	0,1	0,2	1,3
24 - A meadow stream	685	0,4	50	0,8	1,0	0,1	0,2	0,7
25 - Jałowiec in forest	730	2,9	29	2,0	3,0	0,3	0,4	1,2
27 - Jałowiec in a deep gorge	1100	0,4	450	0,5	1,0	0,1	0,2	1,0
28 - Stream on the Glade Czarna	1080	0,3	220	0,3	0,8	0,1	0,2	0,8
29 - Rheocren with outflow	1620	0-0,05	340	0,3	0,4	0,1	-	0,5
30 - Rheolimnocren with outflow	1500	0-0,03	300	0,6	0,9	0,1	0,3	0,5
31 - Przywarówka in the dwarf mountain pine	1450	0,6	200	0,5	0,8	0,1	0,3	0,7
32 - Przywarówka above forest	1400	1,1	450	1,5	-	0,2	-	kaskady-cascades
33 - Przywarówka in forest	1100	1,5	250	1,0	2,0	0,2	0,3	1,5
34 - Przywarówka in forest	960	2,3	150	1,5	2,5	0,2	0,4	1,3
35 - Przywarówka below forest	860	3,4	50	2,0	3,0	0,3	0,4	1,1
36 - Affluent of the Przywarówka	750	4,5	40	6,0	8,0	0,4	0,7	1,2
37 - Przywarówka at Roztoki	700	8,0	25	8,0	10,0	0,6	1,2	1,5
38 - Syhlec near forest	790	2,0	30	3,0	4,0	0,3	0,5	1,3
39 - Lipnica at Kiczory	700	7,5	18	5,0	7,0	0,3	0,6	0,9

longer lenitic overflow parts. In the bottom there is a greater participation of medium and small sized flat stones. Stations: 1 and 37; — meadow streams with shallow, narrow riverbeds filled with water on the whole breadth. Grass immersed in the water hangs from the banks. There is a gravel-sandy bottom with small stones on long section covered with sediments of sand with mud and detritus. Stations: 14 and 24.

Stations: 4, 7—9, 11, 17, 20—23, 25, 27, 33—35 were completely or almost completely shaded. Stations 3, 6, and 31 were also slightly shaded, the remainder being completely or almost completely exposed to the sun. All the investigated streams were practically unpolluted.

3.2.3. Region III — the Raba and its tributaries

The Raba and its tributaries drain the north-western part of the Gorce Mts and the major part of the Beskid Wyspowy. The river is 137 km long, the total gradient 5.3 pro mille and the catchment area 1528 km^2. Investigations were carried out in this region at 22 stations comprising 10 water units (fig. 3). A list and short hydrological characteristics are given in Table III. For more detailed quantitative investigations the lower and middle course of the Raba were chosen as well as the system of tributaries flowing down from Mt Turbacz (1311 m above sea level): the Olszowy-Koninka-Porębianka stream, falling into the Raba through a short section of the River Mszanka. Till the mouth of the Mszanka the Raba is longer than that river by about 15 km. The catchment areas of the two rivers, however, are similar, and the amount of water carried by the Mszanka is sometimes even greater (Punzet 1969). 11 stations were situated in this system.

Station 1a — rheocrene, covered with disintegrated rubble with admixture of gravel in a young spruce wood.

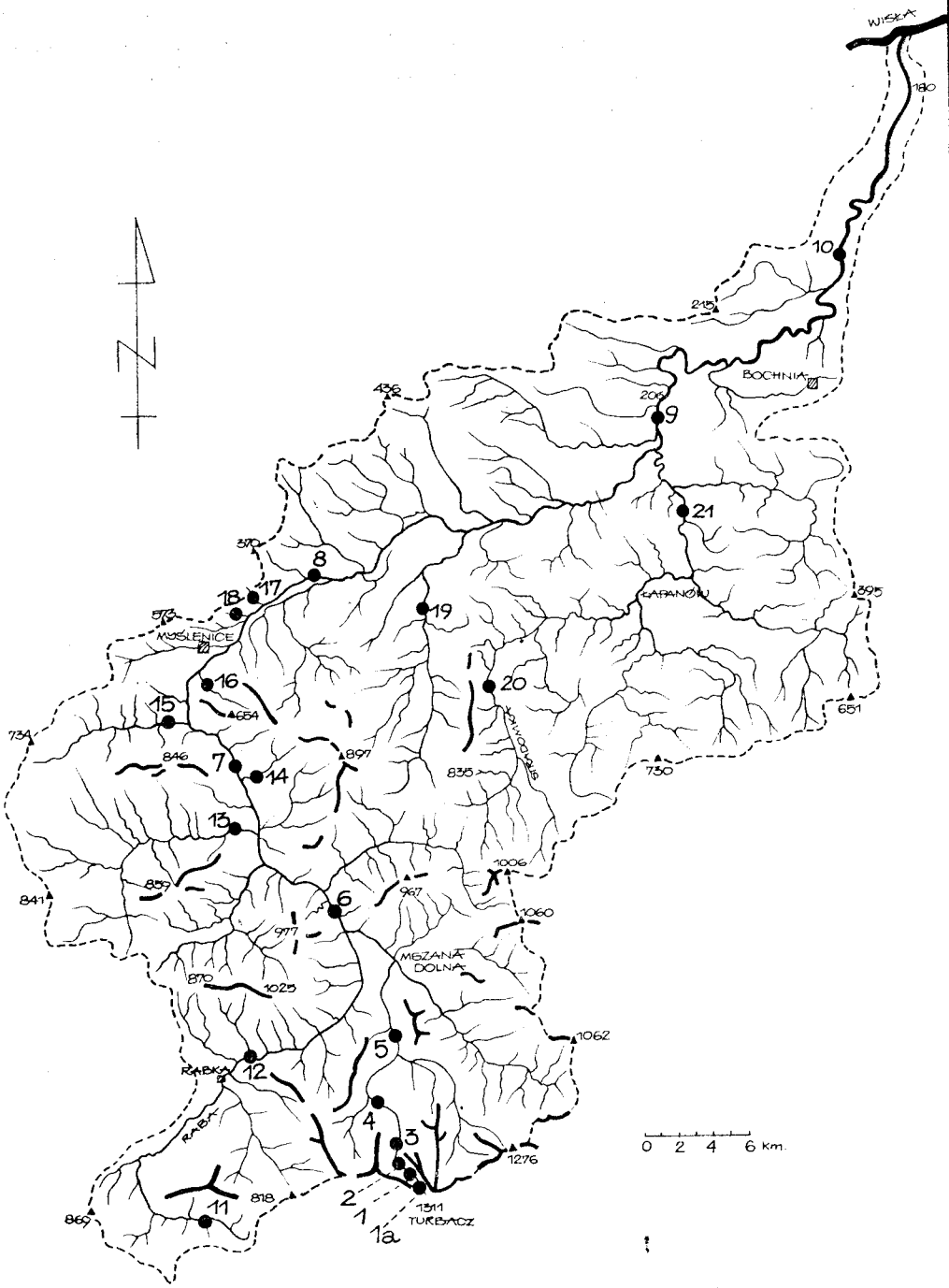
Station 1 — the spring outflow of the Olszowy stream in a narrow V-shaped valley densely overgrown with mixed forest. The bottom is covered with large flat stones, in shallow pools with slow current sediments of gravel and stones are formed.

Station 2 — the Olszowy stream below the junction of two spring streams in an open V-shaped valley. The current fills the whole river bed, forming sections of cascades between boulders and large stones and distinct deep places with a bottom formed of small stones and gravel with sediments of detritus (fig. 4A).

Station 3 — the Olszowy stream in a deep valley overgrown with mixed forest with a prevalence of beech and hornbeam. Shallow marginal pools are formed at the sides of the riverbed, the bottom being formed of stones and gravel with sediments of mud and detritus. In the lotic parts there is a prevalence of large, flat stones.

Station 4 — the Koninka stream on the edge of the forest. In the lotic parts the water over solid rock boulders and large stones. In places where the current is slower stones of medium and small size prevail, narrow gravel sediments (fig 4B) occurring at the edges of larger-stone heaps.

Station 5 — the River Porębianka at Podobin. It flows in a channelled valley. In the riverbed a stone shelf of considerable size is formed. Lotic sections with



Ryc. 3. Rozmieszczenie stanowisk w dorzeczu Raby (region III)
Fig. 3. Distribution of sampling stations in the catchment area of the Raba (region III)

Tabela III. Podstawowe dane hydrograficzne i hydrologiczne dla stanowisk w dorzeczu Raby (region III); średni lub średnio niski stan wody. a - odcinki zwężone o szybkim prądzie; a - głęboczki lub lenityczne rozlewiska

Table III. Basic hydrographic and hydrological data for the stations in the catchment area of the River Raba (region III); average or average low water level; a - narrowed sections of fast current; b - deep parts or lenitic parts

Numer i usytuowanie stanowiska w potokach i rzekach Number and localization of the station in streams and rivers	Wysokość npm Altitude in m	Odległość od źródła Distance from spring w in km	Spadek jednostkowy Gradient w in ‰	Szerokość wody Breadth of water w in m		Głębokość wody Depth of water w in m		Maksymalna szybkość prądu Maximum current velocity w in m/sec.
				a	b	a	b	
1a- Spring of Olszowy with outflow	1200	0-0,01	266,0	0,3	0,4	0,05	0,1	0,4
1 - Olszowy in forest	1180	0,2	285,0	0,4	0,7	0,1	0,2	0,7
2 - Olszowy in forest	990	0,8	240,0	1,2	2,0	0,2	0,5	0,8
3 - Olszowy in forest	780	2,3	72,0	1,5	3,0	0,3	0,4	1,3
4 - Kominka near forest	580	7,1	22,0	4,0	8,0	0,4	0,9	1,0
5 - Porębianka at Podobin	460	13,6	16,0	8,0	15,0	0,6	1,0	1,5
6 - Raba at Kasinka	370	37	4,3	15,0	25,0	0,8	1,0	1,3
7 - Raba near Stróża	315	48	3,9	20,0	30,0	0,8	1,0	1,5
8 - Raba at Brzączowice	250	65	2,7	25,0	30,0	1,0	1,5	1,2
9 - Raba near Bochnia	210	95	0,6	30,0	40,0	1,2	1,2	1,0
10 - Raba at Bogucice	185	117	0,6	30,0	35,0	1,5	1,0	1,0
11 - Raba at Sieniawa	560	3,6	22,0	2,5	4,5	0,3	0,8	0,8
12 - Raba below Rabka	470	20,8	5,9	10,0	18,0	0,5	0,8	1,0
13 - Krzczonówka above mouth	360	15,0	6,0	6,0	10,0	0,3	0,5	1,2
14 - Affluent of Raba in forest	370	2,0	70,0	1,3	2,5	0,2	0,5	1,1
15 - Trzebunia above mouth	320	8,0	10,0	4,5	7,0	0,3	0,4	1,0
16 - Kobylak in forest	350	3,5	45	2,5	4,0	0,2	0,4	0,9
17 - Forest stream at Droginia	300	0,3	160,0	0,5	1,0	0,1	0,1	0,5
18 - Meadow stream at Droginia	280	0,3	10,0	0,4	1,2	0,2	0,2	0,3
19 - Krzyworzeka near Racięchowice	280	11,0	12	8,0	13,0	0,3	0,5	0,9
20 - Stradomka near Żegartowice	320	12,0	6,5	8,0	12,0	0,3	0,4	1,0
21 - Stradomka near Kobylec	220	36,0	2,5	12,0	15,0	0,4	0,9	0,9

a narrowed channel intersperse with longer lenitic sections. In both these sections there is a prevalence of medium sized stones with a great share of small ones.

Stations 6—8 — In the middle part of the Raba, are of a similar character. The river changes its channel from bank to bank between large stone shelves, forming distinct lotic sections interspersed, as in the Soła, with lenitic ones. Shallow rapids are often formed in the heaps of gravel and stones behind which "sleeves" or deep places with sediments of sand covered with mud are formed (fig. 5A and 5B).

Station 9 — the Raba near Bochnia. Lotic and lenitic sections are no longer distinctly marked. The bottom is usually of gravel and small stones on which single, flat stones lie. Behind the reinforced banks backwaters with sediments of sand and mud are formed.

Station 10 — the Raba at Bogucice. The river flows here almost in the whole breadth of the regulated riverbed. In the middle of the channel the bottom consists of gravel mixed with coarse sand, sparsely distributed single stones of various sizes. At the sides are sandbanks with sediments of mud.

Stations 11 and 12 are situated in the upper course of the River Raba. At the first station, at Sieniawa, the Raba is still a stony piedmont stream of medium size in which banks of gravel and sand appear in places. At the second one, below Rabka, the river is similar in appearance to the Porębianka at Podobin. Krzczonówka, Trzebunia, Krzyworzeka, and Stradomka are in the area of stations 13, 15, 19 and 20 small piedmont rivers developing distinct stone heaps (shelves) in their beds. The general appearance of these rivers is similar to that of the Porębianka at station 5. Stations 14 and 16 concern medium sized streams similar to the Olszowy at station 3. Stations 17 and 18 were situated at the mouth section of small streams, a forest and a meadow one, falling into the Raba above Droginia. The forest stream flows in a narrow gorge overgrown with mixed forest. On large sections of the stream bottom argillaceous slates are uncovered, while in other places shallow gravel beds or sediments of sand and mud are formed. The meadow stream has a clayey and stony bottom. The Stradomka, within the station 21, flows in a regulated bed in which long sections of slow current and a sandy-muddy bottom are interspersed with short sections with gravel deposits and swift current.

Stations: 1a, 1, 2, 3, 14, 16, 17 were completely or almost completely shaded. Stations 4 and 11 were half shaded the remainder fully exposed to the sun. Distinct traces of pollution with municipal sewage were observed at station 10, others being pracitically free from any pollution. In the course of the investigations, traces of regulation of sections of the river bed by means of a bulldozer or by removing stones and gravel were visible from station 5 to station 9. Detailed geological and pedological characteristics of the catchment area of the Raba and of the bottom sediments can be found in Pasternak's papers (1969, 1969a).

3.2.4. Region IV — the Dunajec and its tributaries

The Dunajec drains the highest part of the Polish Carpathians — the Tatras. From its springs situated in the Western Tatras at an altitude of about 1600 m above sea level, the river flows through a number of physiographically distinctly different

Tabela IV. Podstawowe dane hydrograficzne i hydrologiczne dla stanowisk w dorzeczu Dunajca (region IV); średni lub średnio niski stan wody. a - odcinki zwężone o szybkim prądzie; b - głęboozki lub lenityczne rozlewiska

Table IV. Basis hydrographic and hydrological data for the stations in the catchment area of the River Dunajec (region IV); average or average low water level. a - narrowed sections of fast current; b - deep parts or lenitic parts

Numer i usytuowanie stanowiska w potokach i rzekach Number and localization of the station in streams and rivers	Wysokość npm Altitude in m	Odległość od źródła Distance from spring w in km	Spadek jednostkowy Gradient w in ‰	Szerokość wody Breadth of water w in m		Głębokość wody Depth of water w in m		Maksymalna szybkość prądu Maximum current velocity w in m/sec.
				a	b	a	b	
1 - Chochołowski above a tourist sheller	1200	1,8	133,0	1,0	2,5	0,2	0,5	1,0
2 - Chochołowski below a tourist sheller	1100	3,5	34,0	2,5	4,0	0,3	0,4	1,2
3 - Chochołowski at the Chochołowskie Źródło	995	7,3	25,0	3,0	5,0	0,3	0,5	1,0
4 - Chochołowski at the end of the valley	900	11	16,0	5,0	7,0	0,4	0,6	1,3
5 - Czarny Dunajec at Kojsówka	850	15	15,0	6,0	15,0	0,5	0,8	1,2
6 - Dunajec at Łopuszna	550	55	4,5	30,0	45,0	0,8	1,0	1,4
7 - Dunajec above Czorsztyn	505	68	4.1	50,0	60,0	0,8	1,2	1,3
8 - Dunajec at Krościenko	420	96	3,3	30,0	60,0	0,4	1,0	1,8
9 - Dunajec above Nowy Sącz	290	140	2.9	35,0	45,0	0,5	1,3	1,2
10 - Dunajec at Zgłobice	195	210	1,58	40,0	50.0	0,7	1,5	0,9
11 - Kościeliski above Hala Ornak	1110	3,5	45,0	1,5	3,0	0,2	0,3	0,9
12 - Kościeliski near Lodowe Źródło	980	7,5	20,0	3,5	5,0	0,3	0,5	1,4
13 - Kościeliski at the end of the valley	940	10,0	13,0	6,0	8,0	0,4	0,6	1,3
14 - Rogoźnik above Nowy Targ	600	22,0	5,0	10,0	18,0	0,4	0,8	0,9
15 - Małołącki in the Mała Łąka valley	1020	0,6	118,0	0,5	1,2	0,1	0,3	1,0
16 - Cicha Woda above Zakopane	830	6,0	6,0	3,0	6,0	0,2	0,4	0,8
17 - Biały Dunajec at Szaflary	640	30	8,0	8,0	16,0	0,3	0,5	1,0
18 - Biały Dunajec above Nowy Targ	595	35	5,0	10,0	18,0	0,4	0,7	1,5
19 - Strążyski below Siklawa	1070	0,3	200,0	1,0	2,0	0,1	0,2	0,6
20 - Strążyski in forest	920	2,5	48,0	2,5	5,0	0,2	0,4	1,2
21 - Bystra at Kuźnice	1010	2,5	66,0	3,5	6,0	0,3	0,7	1,5
22 - Olczyski above Jaszczurówka	940	1,6	57,0	4,0	7,0	0,4	0,7	1,3
23 - Sucha Woda in forest	880	11	23,0	5,0	7,0	0,3	0,6	1,2
24 - Poroniec at Kośne Hamry	770	17	11,0	6,0	10,0	0,4	0,6	1,0
25 - Leśnica above mouth	560	15	5,0	5,0	8,0	0,3	0,5	0,9
26 - Białka Tatrzańska below Jurgów	750	22	9,5	8,0	15,0	0,5	0,6	1,7
27 - Białka Tatrzańska near Kramnica	620	31	9,0	10,0	18,0	0,5	1,0	1,5
28 - Białka Tatrzańska near Dębno	550	39	8,5	10,0	20,0	0,5	1,0	1,3
29 - Podgórzański at Białka	650	2,8	25,0	3,0	3,5	0,2	0,3	0,7
30 - Spring stream of the Czarny	820	0,2	230,0	0,7	1,5	0,1	0,3	0,8
31 - Czarny in forest	580	5,0	35,0	2,0	3,0	0,2	0,4	1,0
32 - Muszynka above Muszyna	490	15,0	9,0	8,0	12,0	0,5	0,8	1,1
33 - Mała Roztoka above Rytro	600	3,0	49,0	3,5	5,0	0,3	0,6	1,4
34 - Wielka Roztoka above Rytro	460	5,5	36,0	4,0	5,0	0,3	0,6	1,3
35 - Homole in the Homole gorge	640	2,5	69,0	2,0	3,0	0,2	0,3	1,0
36 - Lepietnica above Nowy Targ	630	16,0	7,0	4,0	6,0	0,3	0,5	0,9
37 - Pieniński in Pieniny	600	1,2	30,0	1,3	2,0	0,2	0,3	1,0
38 - Spring stream of Kamienica Gorczańska	1220	0,1	145,0	0,4	0,8	0,1	0,2	0,4
39 - Kamienica Gorczańska in forest	1180	0,3	145,0	0,5	1,0	0,1	0,3	0,8
40 - Kamienica Gorczańska in forest	1100	1,1	120,0	1,0	2,0	0,2	0,4	1,0
41 - Kamienica Gorczańska in forest	820	8,0	44,0	2,5	4,0	0,3	0,6	1,2
42 - Kamienica Gorczańska above a village	720	12,0	19,0	3,5	6,0	0,5	0,9	1,3
43 - Kamienica Gorczańska at Szczawa	510	21,0	18,0	5,0	12,0	0,5	1,0	1,2
44 - Affluent of Kamienica Gorczańska at Szczawa	520	3,0	35,0	1,5	3,0	0,2	0,5	1,0
45 - Forest stream, affluent of Zbłudza	650	1,0	50,0	0,8	2,0	0,1	0,2	0,7

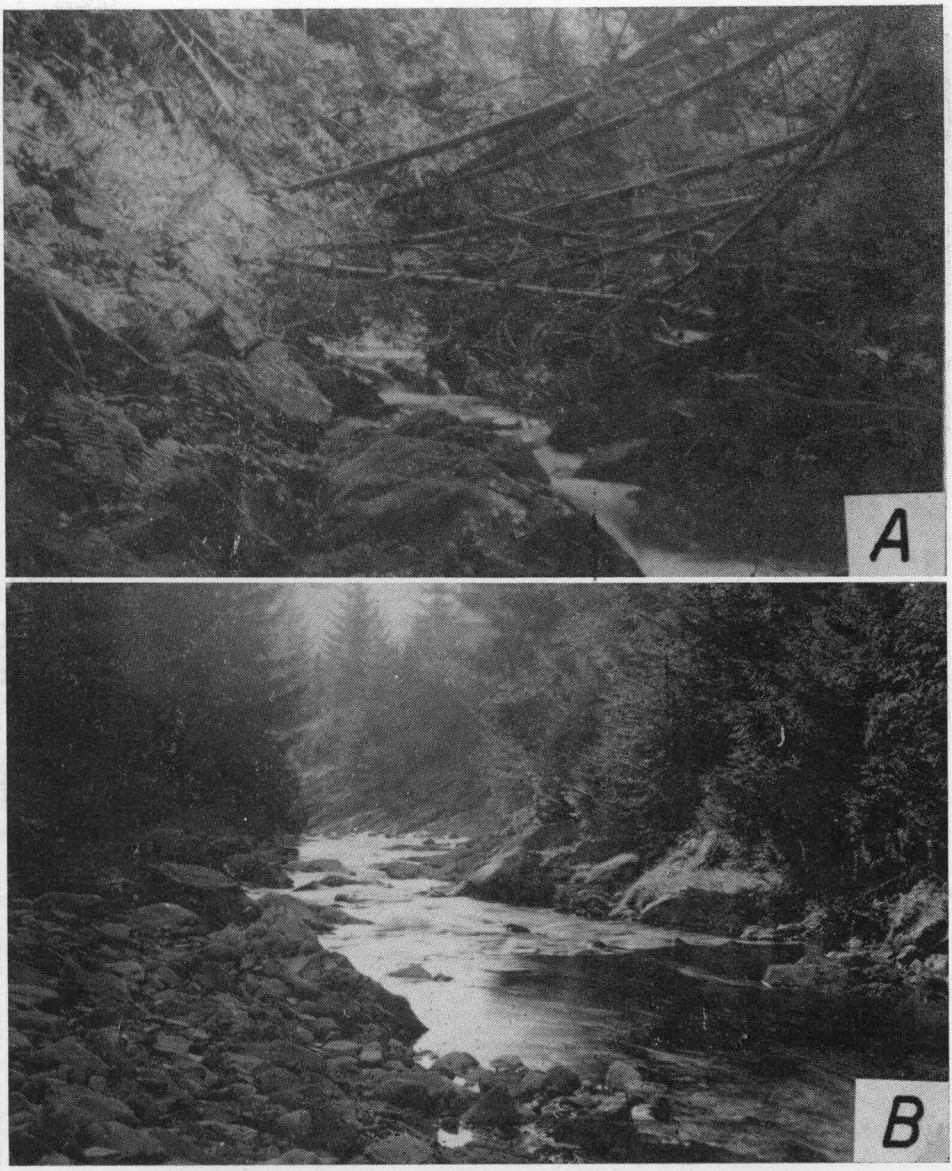
territories: the Podhale (Tatra Highlands), the Nowotarska Valley, the Pieniny Mts, the Beskid Sądecki and the Nowosądecka Valley. The Dunajec is 251 m long its catchment area 6 798 km^2, total gradient 1450 m, mean unitary gradient 5.8 pro mille. In this territory investigations were carried out in 21 water units on which 45 stations were established. Descriptions of the stations together with hydrological data are presented in Table IV.

The investigated sections of the Tatra streams (stations: 1—4, 11—13, 15, 19—23) differ, above all, in their bottom structure. Granite boulders, rocks, and stones of various sizes in the form of rounded boulders are deposited chaotically in the riverbeds. The share of pure gravel fractions, sand, and mud is minimal. On the other hand, thick detritus is often collected at the banks. Among the tributaries of the Dunajec, flowing in the Podhale and in the Nowotarska Valley (stations: 14, 16—18, 24—29, and 36), the Białka Tatrzańska is distinguished by its specially mountainous character with granite boulders of various sizes in its bed which preserves its character unchanged till its mouth. The Lepietnica, Rogoźnik, Leśnica, and Cicha Woda have the appearance of small piedmont rivers on their investigated sections, with a bottom built up of stones and gravel and slower current. The Potok Czarny, Muszynka, and the streams Wielka Roztoka, Mała Roztoka, and Kamienica Gorczańska (stations: 30—34, 38—43) are similar to sections corresponding in size of the water system Olszowy-Koninka-Porębianka in the cartchment area of the Raba. The tributary of the Zbłudza stream (station 43) flows on a shallow incised slope, overgrown with mixed forest. The whole width of the riverbed is filled with water. The bottom is formed mainly of sandbanks with gravel, small stones and partly of sand or sand and mud. The Dunajec down to Nowy Sącz (stations: 5—9) has the character of a mountain river. The station in the vicinity of Czorsztyn is different, the river flowing here along a narrowed valley, large boulders and rocks embedded in its bottom. In other places the Dunajec resembles the Raba or Soła in their middle course. Below the dam at Rożnow (station 10) the Dunajec becomes a piedmont river. The bottom is of gravel and stone or gravel, the banks of the river are partly regulated, and there is a distinct prevalence of lenitic sections over short lotic ones.

Stations: 16, 19, 23, 30, 33, 34, 37—40 were completely or at least half shaded. Stations 1, 3, 11—13, 15, 20, 31, 41, 42, and 45 were also slightly shaded, others being fully insolated. Stations: 6, 17, 18, and 32-showed during investigation a slight but noticeable pollution of the water with sewage.

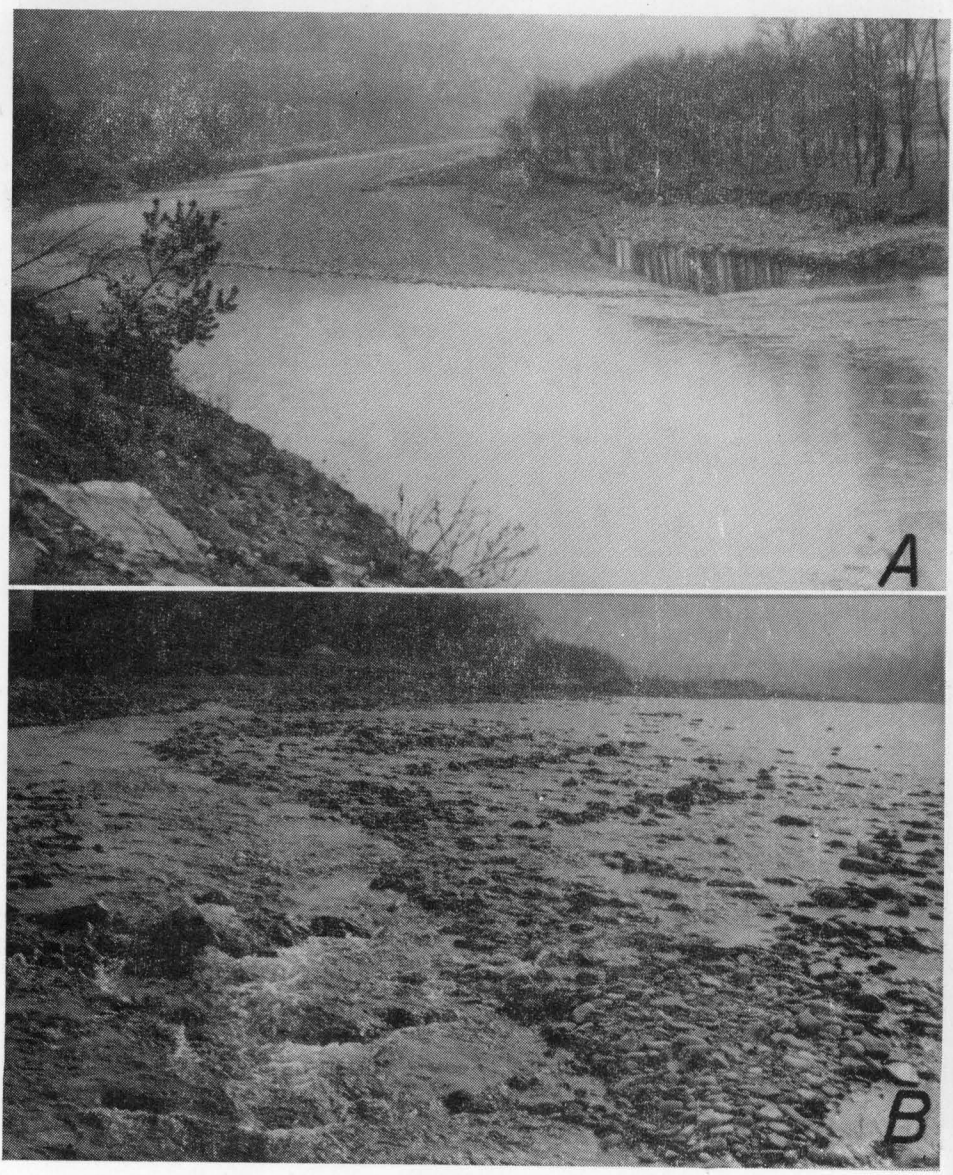
3.2.5. Region V — the San and its tributaries

The San is the longest Carpathian tributary of the River Vistula. It is 444 km long, the catchment area 16 732 km^2, total gradient 750 m, mean unitary gradient 1.7 pro mille. The course of the San can be divided into three sections: the mountain section in the Bieszczady Mts from the springs till the mouth of the River Hoczewka; the piedmont section from the mouth of the River Hoczewka till Przemyśl where



Ryc. 4. Potok Olszowy w obrębie stanowiska 2 (A) oraz potok Koninka w obrębie stanowiska 4 (B) (region III). Średni stan wody (fot. B. Szczęsny)

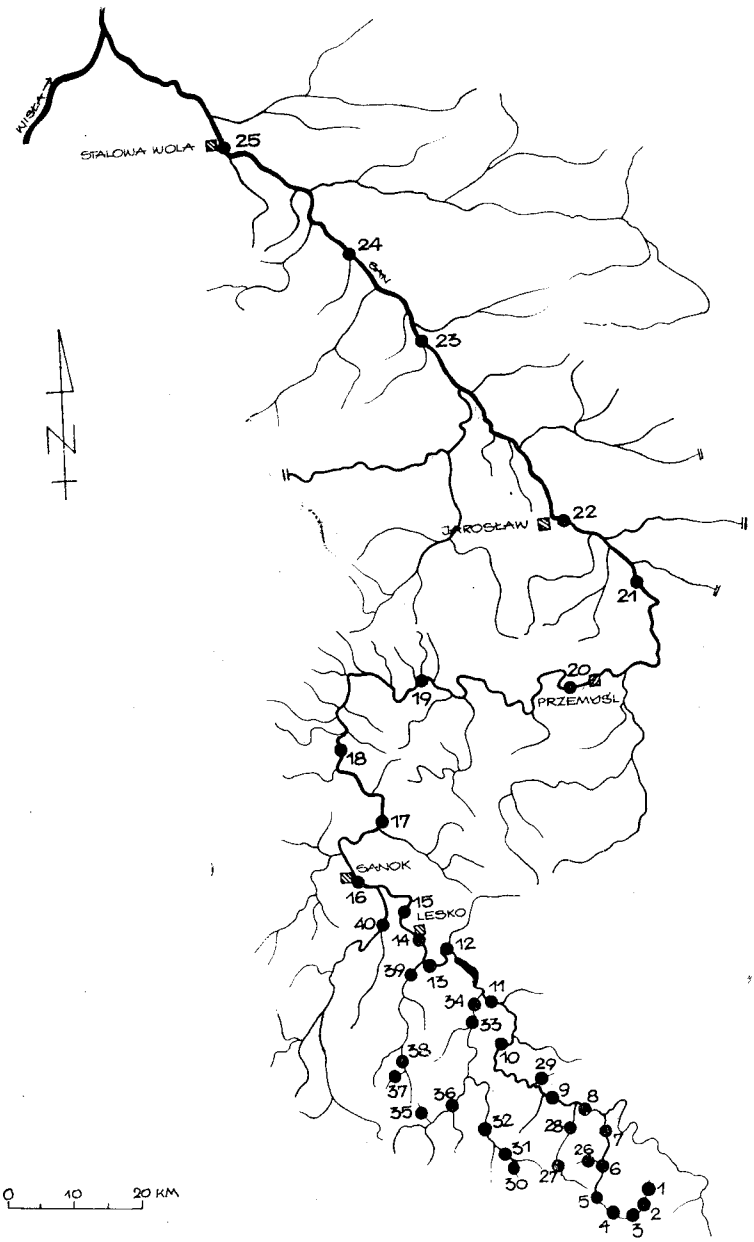
Fig. 4. The Olszowy stream within station 2 (A) and the Koninka stream within station 4 (B) (region III). Average water level (phot. B. Szczęsny)



Ryc. 5. Raba koło Stróży, w pobliżu stanowiska 7 (region III). A — lenityczne rozlewisko rzeki; B — fragment koryta na odcinku zbystrzenia wody. Po lewej stronie główny nurt, po prawej szypoty przelewowe. Niski stan wody (fot. R. Sowa)

Fig. 5. The Raba near Stróża in the vicinity of station 7 (region III). A — lenitic parts of the river; B — section of the riverbed in lotic part of the water. On the left side the main current, on the right shallow riffles. Low water level (phot. R. Sowa)

the river drains a part of the Beskid Niski the so-called „Doły Jasielsko-Sanockie" and Pogórze Dynowskie, taking in the River Osławka; the lowland section, in which the San flowing along the Sandomierska Valley takes in two large tributaries, the Wisłoka and the Tanew. In this region 11 water units were subjected to investigation. The part of the San above the mouth of the Wołosaty was omitted because of technical difficulties in reaching this section. In the further course of the San 17 stations were established and in the other water units 23 stations (fig. 6). A list of stations with hydrological data is given in Table V. Seven stations were situated in the Wołosatka-Wołosaty stream whose springs are situated at an altitude of about 1200 m above sea level on the southern slope of Mt Tarnica (1348 m above sea level), the highest elevation in the Polish part of the Bieszczady Mts. In its upper course in the forest (station 1—3) Wołosatka resembles the Olszowy stream in the Gorce Mts. In its further course down to Ustrzyki Górne (stations 4 and 5) the stream flows across a wide valley. In the riverbed there are fairly large shelves, the water flow forming lotic parts and lenitic shallows. The bottom is covered with flat sandstones of various sizes. Below Ustrzyki Górne (stations 6 and 7), in consequence of cutting the mountain range, the stream changes its character. In the riverbed solid rock is uncovered or slanting or oblong rocky sills stand out. The water flows in the whole riverbed, often between large boulders or rocks. Lack of visible assymetry in the cross-profile of the riverbed and water current,— observed in the case of the Soła Raba and Dunajec and some smaller rivers or even larger Carpathian streams — is a typical feature of the upper part of the San (stations 8—14). The river even at an average water level flows almost in the whole, flat, self-eroded riverbed. In the bottom rocky sills are often formed, narrow and transversal or slanting in relation to the axis of the riverbed. The water flows through the gaps in the sills, between which a network of rocky basins of moderate current is formed, the bottom being covered with stones of various sizes. The riverbeds of the lower sections of the Solinka, Hoczewka, and Osława (stations: 33, 34, 39, 40) are formed in a similar way. From the vicinity of Lesko (stations 15—20) the bottom of the San is filled with a more disintegrated and rounded stone bedding. The water channel changes its course within a large stone heap. Apart from lotic sections longer and longer lenitic ones are gradually formed with sandbanks of sand and mud existing in them. After entering the Sandomierska Valley the river changes again. At first there are still lotic sections with a gravel bottom (station 21) but from Jarosław the San takes on the character of a lowland river. The middle of the riverbed has a sandy bottom, whereas at the river banks, especially on the bends and behind the fascine spurs, thick deposits of mud and disintegrated detritus are formed. The current becomes slower, laminar. In some places the river uncovers a silty bottom (station 24), while over short distances a stony bottom may also occur (stations 22—25), originating from destroyed spurs and reinforcements of the river banks. Higher water vegetation appears in the San from station 13 (*Potamogeton* sp., *Myriophyllum* sp.), growing also in the sections of the river close to the mouth of the Rivers Hoczewka and Osława. Except for the station at Krzeszów, such vegetation occupies only small marginal parts of the riverbed.



Ryc. 6. Rozmieszczenie stanowisk w dorzeczu Sanu (region V). W dolnym biegu Sanu zaznaczono tylko większe dopływy, niektóre z nich tylko w dolnych odcinkach

Fig. 6. Distribution of sampling stations in the catchment area of the San (region V). In the lower course of the San only larger tributaries are marked and some of them only in their lower parts

Tabela V. Podstawowe dane hydrograficzne i hydrologiczne dla stanowisk w dorzeczu Sanu (region V); średni lub średnio niski stan wody. a - odcinki zwężone o szybkim prądzie; b - głęboczki lub lenityczne rozlewiska

Table V. Basic hydrographic and hydrological data for the stations in the catchment area of the River San (region V); average or average low water leve. a - narrowed sections of fast current; b - deep parts or lenitic parts

Numer i usytuowanie stanowiska w potokach i rzekach Number and localization of the stations in stream and rivers	Wysokość npm Altitude in m	Odległość od źródła Distance from spring w in km	Spadek jednostkowy Gradient w in ‰	Szerokość wody Breadth of water w in m		Głębokość wody Depth of water w in m		Maksymalna szybkość prądu Maximum current velocity w in m/sec.
				a	b	a	b	
1 - Spring stream of Wołosatka	1150	0,5	160,0	0,5	0,9	0,1	0,2	0,5
2 - Wołosatka in forest	1000	1,3	125,0	1,0	2,5	0,1	0,4	1,1
3 - Wołoska in forest	850	3,5	28,0	2,5	3,5	0,3	0,4	1,3
4 - Wołosatka below Wołosate	770	7,5	13,0	4,0	7,0	0,3	0,4	1,5
5 - Wołosatka above Ustrzyki Górne	680	12,8	11,0	5,0	8,0	0,3	0,5	1,5
6 - Wołosaty below Ustrzyki Górne	600	19,7	9,0	10	13	0,4	0,6	1,4
7 - Wołosaty above Stuposiany	560	27	6,0	12	16	0,4	0,6	1,2
8 - San at Dwerniczek	510	66	2,5	40	45	0,5	0,7	1,0
9 - San at Zatwarnica	490	74	4,3	40	50	0,4	0,6	1,2
10 - San at Rajsko	410	92	2,2	50	55	0,3	0,5	0,9
11 - San at Solina	375	109	2,1	45	55	0,5	0,8	1,0
12 - San near Myczkowce	350	121	2,1	40	60	0,5	1,0	1,1
13 - San at Zwierzyń	342	125	2,0	55	60	0,5	1,2	0,8
14 - San above Lesko	325	136	1,5	65	70	0,4	0,6	0,5
15 - San at Wola Postołowa	310	144	1,9	50	65	0,5	0,8	1,1
16 - San above Sanok	297	154	1,30	45	65	0,5	0,9	0,9
17 - San at Mrzygłód	270	171	1,58	50	65	0,5	0,9	1,0
18 - San at Niewistka	250	188	1,17	50	60	0,6	1,3	0,8
19 - San near Babice	220	221	0,99	50	70	0,5	1,5	1,0
20 - San above Przemyśl	195	266	0,55	55	60	0,5	1,2	0,9
21 - San at Radymno	183	300	0,39	50	65	0,8	1,5	1,0
22 - San at Jarosław	178	314	0,29	50	55	1,2	1,5	0,7
23 - San below Leżajsk	167	357	0,25	55	65	1,5	2,0	0,7
24 - San at Krzeszów	163	375	0,22	60	70	1,2	2,0	1,1
25 - San at Stalowa Wola	158	410	0,14	70	80	1,5	3,0	1,0
26 - Bystry an affluent of Wołosaty	610	3,0	20,0	1,5	3,5	0,2	0,3	1,2
27 - Prowcza above Berehy Górne	790	2,0	30,0	1,2	2,8	0,2	0,3	1,3
28 - Nasiczniański above Dwernik	570	12,0	23,0	4,5	7,0	0,4	0,6	1,4
29 - Affluent of San at Zatwarnica	500	0,6	157,0	0,6	1,0	0,1	0,3	0,9
30 - Wetlinka above Wetlina	680	5,3	21,0	2,0	3,5	0,2	0,4	1,2
31 - Wetlina at Wetlina	630	9,0	14,0	3,0	4,0	0,3	0,4	0,9
32 - Wetlina at Kalnica	580	17,5	5,7	5,0	8,0	0,3	0,6	1,4
33 - Solinka at Wołkowyja	415	43,0	4,6	30,0	35,0	0,4	0,6	0,9
34 - Solinka above Solina	375	52,0	2,7	35,0	38,0	0,4	0,5	0,8
35 - Affluent of Solinka above Cisna	620	2,5	45,0	1,0	2,0	0,1	0,2	1,0
36 - Solinka below Dożyca	510	23,0	4,1	8,0	10,0	0,3	0,4	1,2
37 - Kołonica at Łubne	560	4,5	18,0	3,0	5,0	0,2	0,4	0,8
38 - Hoczewka at Baligród	480	12,0	10,0	5,0	7,0	0,5	0,7	1,3
39 - Hoczewka at Hoczew	340	28,0	2,5	20,0	30,0	0,5	0,8	0,9
40 - Osława above Zagórze	300	75,0	2,0	35,0	40,0	0,5	0,9	0,7

Stations 26, 27, 29, and 35 were situated on small or medium size streams of the Bieszczady Mts with stony bottom. The Wetlinka within the stations 30 and 31, and the Kołonica stream at station 37 resemble in their appearance the Wołosatka above Ustrzyki Górne. The Wetlinka at station 32, the Nasiczniański stream at station 28, the Solinka at station 36, and the Hoczewka at station 38 look very much like the Wołosaty below Ustrzyki Górne.

Stations: 1—3, 6, 28, 30, 35, 37, and 38 were situated in wooded sections and were completely or almost completely protected from the sun. To a small extent stations 4, 5, 7, 29, and 36 were also shaded with low littoral vegetation. The remaining stations were fully exposed to the sun. During the investigation period a dam reservoir was built at Myczkowce in the vicinity of station 12, exerting some influence, though a very small one, on the lower situated stations on the San. At stations below Przemyśl a progressive increase in water pollution in the river with municipal and industrial wastes from this town and industrial wastes from Sarzyna and Stalowa Wola was observed during the investigation period.

3.2.6. Region IV — the tributaries of the Vistula near Cracow

The investigations concerned a small river, the Wilga, flowing down from the Pogórze Wielickie, a lowland river, the Drwinka, and two streams from arable fields. Altogether 6 stations were situated there.

Station 1 — the Wilga near its springs. A small stream flowing on a meadow in a syncline valley. The distance from the spring was 0.4 km, altitude 340 m above sea level, unitary gradient 25 pro mille. The bottom is of sand and mud and along a short section gravel and small stones. Depth 0.3 m. Current velocity 0.3 m/sec.

Station 2: — the Wilga at Koźmice. A larger stream 1.5 km from the springs. Altitude 300 m above sea level. The breadth of the riverbed is 4 m. The depth of the water reaches to 0.5 m, current velocity to 1 m/sec. The bottom is gravel and on section with slow current sand and mud.

Station 3 — The Wilga at Opatkowice. A small river. Distance from the springs 14 km. Altitude 225 m above sea level. Unitary gradient 8 pro mille. The riverbed is 6 — 8 m wide with a stony bottom in the channel and a narrow shelf. At the river banks there are gravel deposits or sand deposits with mud and detritus.

Station 4: — Melioration ditch at Kłaj in the catchment area of the Drwinka. Distance from the outflow 0.5 km. Altitude 200 m above sea level. Unitary gradient — 2.0 pro mille. The breadth of the river bed is up to 1 m. The bottom has a thick layer of black mud and detritus, overgrown at the banks with tufts of *Veronica beccabunga*. The depth reaches to 0.5 m, the current velocity being up to 0.5 m/sec.

Station 5 — The Drwinka near Ispina. Distance from the springs 15 km. Altitude 190 m above sea level, unitary gradient 0.5 pro mille. It flows among arable fields and meadows in a regulated riverbed 5—6 m wide. It was a sandy bottom with sediments of mud and detritus at the banks. In summer it is densely overgrown on the whole breadth with *Nuphar luteum* and *Potamogeton* sp. Depth 1—1.5 m, current velocity 0.3 m/sec.

Station 6 — a meadow stream at Podgórski. Distance from the springs 1.5 km. Altitude 220 m above sea level. Unitary gradient 4 pro mille. The breadth of the riverbed is 1.5—2.5 m, regulated. The bottom is mud and sand, and in some sections gravel. The banks are overgrown with *Elodea canadensis*. Depth to 0.3 m. Current velocity 0.5 m/sec.

Station 3 was partly shaded with alder but the other stations were exposed to the sun. All stations were practically unpolluted. The Drwinka is distinctly eutrophized, its waters being slightly brown in colour.

3.3. Characteristics of some physico-chemical factors of the environment

3.3.1. Variations in water level and flows

All the investigated Carpathian rivers and their larger tributaries are characterized by considerable variations during the course of the year in the water level in the riverbed and its flow capacity. The highest water levels usually occur in them early in the spring, i. e. in March or April during snow thaws and in summer, usually in July and June in consequence of intensive rainfall on the territory of the catchment area. Great freshets always seriously affect the riverbed and the habitats existing in it or even cause its complete developmental transformation. The lowest water levels and flows occur in the Carpathian streams and rivers in autumn. i.e. in September and October, also during the winter the water level being low. The greatest amplitude of water level variations is found in the Dunajec — 10 m — a smaller one in the San — 7 m — and a still smaller one in the Raba and Soła — 3 or 4 m. The Tatra streams and the upper sections of the Beskid streams situated on wooded territories have the most equalized water states and flows. The increase in water there is low and activates the ground little or not at all.

3.3.2. Velocity of the current

At average or low water level the maximum velocity of the current at particular stations, along the course of the investigated stream, rarely exceeded 1.5 m/sec, usually varying around 1 m/sec. (Table I—V). The San, similarly as its tributaries the Hoczewka and Osława in their lower sections, had at almost all stations a relatively slow current in consequence of the winding riverbed and specific shape of the bottom (Table V).

Within the range of particular stations the current velocity is distributed non-uniformly giving a mosaic of values, both in the cross — and longitudinal sections of the riverbed. In the cross-section the fastest current usually occurs in the middle of the riverbed or at one of its banks where the water is deeper. In the longitudinal section, especially in larger streams, lotic parts with a fast or cascade — like current

are interspersed with sections where, in consequence of enlargement of the water flow the current becomes slow and more equalized. At high water levels the current velocity increases considerably in larger streams, and, according to Mikulski (1963), in rivers reaches even 5 m/sec. Simultaneously, owing to the great water capacity, the current becomes more uniform in the longitudinal section of the riverbed.

3.3.3. Temperature

The amplitude of annual variations of water temperature in the main Carpathian rivers in their middle and lower sections is usually 26—29°C but can also, though rarely, reach 30°C. Maximum temperatures in these river sections are recorded in summer from June to August. Approaching the springs, the annual amplitude gradually decrease, in the upper forested parts of the streams reaching 10°C. Especially small variations in the water temperature in the annual cycle are demonstrated by the springs of the majority of the Tatra streams, their water reaching in summer 5 — 6°C and in the case of springs situated above 1400 m even 2—3°C (Wit, Ziemońska 1960). Also the high lying springs of the streams of Mt Babia Góra have during hot summer days a very low temperature: the water temperature of a spring situated at an altitude of 1620 m above sea level was 3.6°C and of one situated at an altitude of 1500 m above sea level only 1.3°C (stations 29 and 30, according to the data by Sowa, Szczęsny 1970). The annual amplitudes of the water temperature and its maximum summer values decrease in the streams of these two mountain regions towards the springs. In the lower flowing streams of the Beskid Mts, however the annual amplitude of the water temperature shows the lowest values in the sections situated in deeper parts of the valley, while in short spring outflows another small increase in temperature is observed. This occurs in consequence of the small productivity of the surface springs, which have a higher water temperature

Tabela VI. Temperatura wody (tw) i powietrza (ta) na stanowiskach w systemie wodnym Olszowy-Koninka-Porębianka-Raba (region III) w °C. Pomiarów dokonywano w ciągu dnia, kolejno od najwyżej do najniżej położonego stanowiska

Table VI. Water temperature (tw) and air temperature (ta) at the stations in the water system Olszowy-Koninka-Porębianka-Raba (region III) in °C. Measurements were performed during the day, from the highest situated station to the lowest one successively

Data / Stanowisko Date / Station		1	2	3	4	5	6	7	8	9	10
1969	ta				27,0	27,0	26,5	30,0	30,0	24,0	23,0
25-29.VII.	tw	11,0	9,2	10,5	17,0	20,0	24,0	25,5	27,0	24,0	22,5
1969	ta	9,5	10,0	12,5	17,0	19,0	23,0	20,0	19,0	12,0	11,0
4-6.IX.	tw	9,0	8,0	9,5	13,5	16,0	17,0	18,0	17,5	17,0	15,5
1969	ta	10,0	11,0	9,5	8,0	13,5	18,5	13,2	9,5	9,5	9,0
21-23.X.	tw	6,0	6,5	7,0	8,5	9,0	11,2	11,3	9,8	10,6	10,0

Tabela VII. Wyniki dobowych pomiarów temperatury wody (tw) i powietrza (ta) w wybranych stanowiskach systemu wodnego Rycerka-Soła (region I) w ciągu 16 i 17 sierpnia 1961 (w °C).
Uwagi: od godziny 24 do 6 zachmurzenie umiarkowane lub duże, potem od godziny 14 słonecznie, następnie zachmurzenie przejściowe, wieczorem przelotne deszcze. Stan wody średnio niski, przezroczystość do dna.

Table VII. Results of day and night measurements of water temperature (tw) and air temperature (ta) at selected stations of the water system Rycerka-Soła (region I) during 16th and 17th August 1961 (in °C).
Note: from midnight till 6 a.m. average or considerable cloud, then till 2 p.m. sunny, then transitory clouds, in the evening occasional showers. Average low water level, transparency - to the bottom.

Stanowisko Station	Rycerka at Rycerka Górna		Soła at Węgierska Górka		Soła at Tresna	
Godzina Hour	ta	tw	ta	tw	ta	tw
24^{00}	7,7	11,3	13,0	15,3	13,4	15,8
4^{00}	5,3	10,2	11,0	14,2	11,4	14,8
6^{00}	8,1	10,4	12.5	14.4	11,1	14,7
8^{00}	8,3	10,7	13.9	14,7	15,0	15,0
10^{00}	11,0	12,7	16,7	15,2	19,6	15,0
12^{00}	15,3	15,2	19,7	17,1	20,3	17,7
14^{00}	15,0	15,1	21,6	18,6	21,9	18,7
16^{00}	14,9	14,6	20.6	18.9	19,8	18,9
18^{00}	13,8	13,9	17,5	18,7	19,2	19,0
20^{00}	9,7	13,0	14,3	17,9	14,2	18,2
22^{00}	9,5	11,9	12,6	16,8	11,6	17,1
24^{00}	9,3	11,6	12,6	16,1	13,0	16,7
Amplituda Amplitude	10,0	5,0	10,6	4,7	10,8	4,3
Średnia Mean	10,3	12,7	16,3	16,5	16,5	16,8

in summer, and of the warmer microclimate of the valleys, initially rather shallow. The water of the sections of the streams situated lower is colder, sometimes by 2—3°C, among other factors owing to a richer flow of ground waters from deeper rock layers. This phenomenon was observed in the Wielka Puszcza stream (Sowa 1965) and is confirmed also in other streams of the catchment area of the Soła and the Raba. On May 10th 1971 in sunny weather and at an air temperature of 23—24°C the water temperature of the spring stream Rycerka (region I) measured between 10 a. m. and 2 p. m. was respectively at stations 7, 8, and 9 11.6°C, 8.3°C and 9.9°C. A similar, though less distinct system of water temperature was recorded in the upper course of the Olszowy stream (region III) in July and September 1969 (Table VI). On the contrary during the winter the stream sections in deeper valleys can have somewhat warmer as compared both with the lower and higher lying sections. The increase in water temperature is, however, very small and already after a few kilometres of the course of the stream the water temperature is near 0°C. Such a temperature is attained in all the rivers of the investigated territory in their middle course

Tabela VIII. Wyniki dobowych pomiarów temperatury i chemizmu wody w Sanie koło Babic (stanowisko 19) w ciągu 4 i 5 września 1966. ta - temperatura powietrza w cieniu; tw - temperatura wody w prądzie na głębokości 0,25 m od dna (w °C).

Uwagi: słonecznie, lub przelotne lekkie zachmurzenie. Stan wody podwyższony, przezroczystość 0,4 m. Około godziny 19 poziom wody obniżył się o 0,2 m, a przezroczystość wzrosła do 0,8 m

Table VIII. Results of day and night measurements of temperature and of water chemism in the San near Babice (station 19) during the 4th and 5th September, 1966. ta - air temperature in shade; tw - water temperature in the current at a depth of 0.25 m from the bottom (in °C).

Note: Sunny or occasionally slightly cloudy. Water level raised, transparency 0.4 m. About 7 p.m. water level decreased by 0.2 m and transparency increased to 0.8 m

Godzina Hour	ta	tw	pH	Twardość ogólna w °n Total hardness in G.d.
12^{00}	20,5	18,2	8,2	10,0
14^{00}	18,5	18,4	8,4	9,3
16^{00}	15,3	18,3	8,4	9,1
18^{00}	11,9	18,0	8,4	9,2
20^{00}	10,0	17,3	8,3	9,2
22^{00}	8,9	17,2	8,4	9,2
24^{00}	8,0	16,8	8,3	9,4
2^{00}	7,8	16,4	8,4	9,3
4^{00}	7,4	16,2	8,4	9,5
6^{00}	10,6	16,0	8,4	9,8
8^{00}	20,5	16,2	8,1	9,8
10^{00}	23,0	16,9	8,1	9,8
12^{00}	25,1	18,0	8,2	9,9
Amplituda Amplitude	17,7	2,4	0,3	0,9
Średnia Mean	16,2	17,2	8,2	9,5

as well as in larger Beskid streams and a considerable number of the Tatra streams (Gołek 1961, Oleksynowa, Komornicki 1965). In the rivers this may occur already in October and still in April. During the winter period the waters of the large Carpathian rivers may warm up temporarily to almost 10°C in December, to over 6°C in January, and to about 5°C in February, these, however, being maximum values taken from many years' observations. Usually during the winter, especially in January and February, the mean monthly temperature of the water is 1—3°C.

Daily variations in water temperature in larger Carpathian rivers are not great during the summer period. The results of measurements performed in the middle course of the Soła and the Rycerka in August 1961, during a fairly warm day, indicate a great thermal stability of these two rivers (Table VII). The daily amplitude of water temperature at the stations did not exceed 5°C, being about two times lower than that of the air temperature. A still greater stability in this respect characterizes water of the San in its middle course (Table VIII). The daily pattern of the water temperature along the course of the streams of the Beskids was observed during a hot summer period (Sowa 1965). At a few stations in the Wielka Puszcza stream (region I) the daily amplitude at particular stations was between 4.2 and 5.5°C but at station 2 it was only 1.6°C. During a hot summer day the water temperature

in the stream reached a fairly high value, equalling e. g. 20°C and 17.3°C at stations, 3 and 1 respectively. The Olszowy stream, flowing down from higher mountains attains on sections correspondingly long a lower water temperature, which only slightly exceeds 10°C in summer. A similar or still lower water temperature, between 8 and 10°C, characterizes in summer the upper sections of the streams of Mt Babia Góra, and in the higher situated sections of the Tatra streams the water temperature did not during that period exceed 8°C, though their lower courses carried waters warmed up to 13—15°C (Oleksynowa, Komornicki 1965). In summer the highest increase in water temperature is visible along the course of the Carpathian streams and rivers from the spring to the mouth, the difference in temperature between the extreme stations reaching or slightly exceeding 25°C. In late autumn, through the winter, and in early spring a relative homothermy became established along the course and the difference between the stations did not exceeed a few degrees centigrade.

3.3.4. Turbidity

At average and low flow levels the great majority of the Carpathian streams and rivers have clear water with a minimal amount of suspension, its transparency reaching the bottom in all places of the station. The lower course of the San, having a quite distinctly turbid water, during all seasons of the year, is an exception. A slight turbidity of the water occurs in the Soła, the Dunajec, and the San on the sections situated below the dam reservoirs. A considerable, though short lasting turbidity of the waters of the streams and rivers occurs, on the other hand, during freshets. Then the water carries many mineral particles of soil washed away from the territory of the catchment area and takes on the colour of white coffee, transparency being reduced even to a few centimetres. Such turbidity recedes after a few of several hours following a rainfall. A longer lasting, though usually less distinct turbidity of the waters of streams and rivers takes place early in spring during snow thaws. The smallest variations in the water turbidity in the course of the year are shown by stream sections in the wooded territories of the catchment area, especially of the Tatra and Babia Góra streams. For the Tatra streams Bombówna (1968, 1971) gives values from 0 to 13.5 mg/dcm^3 SiO_2. The granulometric composition of the suspension of the Carpathian rivers during freshets was recently presented by Pasternak, Cyberski (1973).

3.3.5. pH

The reaction of the waters in the investigated territory in the section determined by stations varied in the interval 6.3—8.9. The spring outflows and the upper fragments of the Beskid streams (e. g. the upper part of the Wielka Puszcza stream, the spring section of the Rycerka, the upper courses of the Babia Góra streams) and also the upper sections of the Tatra streams show a slightly acidic reaction. Further

sections of these streams and medium-sized and large Carpathian rivers have, during a low or average water level, a neutral or slightly alkaline reaction. Values above 8 were recorded in the lower sections of large rivers and in the lower course of the San the water reaction even reached 9, especially in the meanders. A fairly equalized, slightly acidic reaction of the water is shown by larger Carpathian streams and rivers during the spring freshets, when the intensity of washing out of acidic soils in their catchment areas increases. In the Olszowy stream, in the catchment area of the Raba, the water reaction during the summer-autumn period and at an average water level is almost neutral or slightly alkaline right from the springs. In 1969 at stations 1a—3 pH values 7.2 to 8.1 were recorded, the pH at other stations of this water system till the mouth of the Raba varying around 8.

3.3.6. Total hardness

The total hardness varies in the investigated streams mainly in dependence on the geological character of the subsoil of the catchment area. The waters of the Soła and its tributaries have, according to Bombówna (1960) a generally low hardness, decreasing in the range 1.9—9.0°G, the lowest values being given by the author for smaller mountain tributaries of this river. Along the Wielka Puszcza stream the water hardness varies through the year in the range 2.0 to 4.7°G. In the catchment area of the Raba the water hardness is comparatively slightly higher, according to Bombówna (1969) being on the average 4.7—12.1°G. Some tributaries of the Raba in its lower course carry waters of a hardness exceeding 14°G. Pasternak (1964) gives for the waters of the upper section of the San variations in total hardness within the range 6.1—8.3°G, and for the middle section of that river from 8.0—10.8°G For the mountain tributaries of the river on the territory of the Bieszczady the values are lower and are according to that author 2.2—6.5°G. Especially soft waters are found in the streams flowing down from the crystal massifs of the High Tatra, their total hardness varying according to Bombówna (1968, 1971) from 0.6—1.5°G. The streams of the Western Tatras, on the other hand, carry waters of total hardness approximating that of the waters of the catchment area of the Raba (Oleksynowa, Komornicki 1965, Pasternak 1968).

3.3.7 Oxygen content

The amount of dissolved oxygen in the water of the investigated streams and rivers varies between 8 and 12 mg/dcm^2 O_2, sometimes reaching 13 mg/dcm^2 O_2 according to the data from all the seasons of the year. Lower values, which can be considered approximate to the critical values for the water animals were recorded by Bombówna in the Wielka Puszcza stream (region I). They equalled 6.5 and 7.7 mg/dcm^3 O_2 at concomitant values of water saturation with oxygen amounting to 64 and 68 per cent respectively. This kind of decrease in water saturation is,

however, in the investigated water units rare and short lasting. The normal oxygen saturation of the water there exceeds 80 or 90 per cent, supersaturation often being recorded even to 130 per cent.

4. Methods and terminology

Mayfly nymphs were the basic subject of the investigations. Winged forms, imagines and subimagines, were caught when collecting the nymphal material during the day within the same stations. The catches had a qualitative character; they were performed in order to establish the period of emergence of particular species as well as to make possible the determination to species of certain nymphal forms. Some of the listed specimens derive also from nymphs from field and laboratory cultures. The nymphs were caught by means of quantitative, semiquantitative, and qualitative methods. For quantitative catches a bottom sampler was used made of a square metal frame with sides 22.5 cm or 15 cm in lenght onto which a long net of bolting cloth was fastened and protected on both sides against tearing (from outside with a linen collar, from inside with a coarse mesh string net). The diameter of the mesh of the bolting cloth was about 300μm. The bottom sampler was dug into the bottom at a depth of 5—10 cm with its open side directed against the current, and the area of bottom lying in front of it, about 5 dcm^2 or 2 dcm^2 for the larger and smaller bottom scraper respectively, was manually swept inside. From various fractions of a stony bottom samples were collected with a larger sampler and from a sandy and muddy bottom with a smaller one. The material collected with the substrate was poured into a spherical vessel with a calibrated volumetric scale in which the volume of the sample was measured and the composition and disintegration of the substratum recorded. Subsequently, after preliminary reduction of the substratum present in the sample, animals were washed out with a strong water current onto a straining net of mesh size identical with that of the sampler net. The thus densified material was placed together with the remainder of the substratum in glasses or large test tubes and fixed in situ with 3 per cent formaline solution or, less frequently, with 80 per cent ethyl alcohol. In smaller streams 5—6 samples were usually taken at every station and on every date, whereas in larger ones 10 to 12 quantitative samples were taken. All habitats occurring at the station were taken into consideration. Apart from the quantitative samples 1—2 semi-quantitative samples were collected at the station. These samples were collected with the same instrument, their volume or area of the substratum not being determined. They were collected "in time", penetrating various habitats on a larger area usually for 5 minutes. At some stations the material was collected only by this method but the number of samplings was increased. For a quantitative elaboration of the distribution of mayfly nymphs it was decided to adopt as reference unit the so-called projection area of the bottom, i.e. a square with a

surface area of 5 dcm^2. Care was taken that the volume of this section should be 2 dcm^3, possible differences being equalized by a suitable recounting of the specimens in the sample. The obtained results can thus be referred both to the area and to the volume of the substrate.

The frequency and way of collecting materials in particular regions of investigation were not uniform in the catchment area of the Soła (region I) samples were collected by means of quantitative and semiquantitative methods in the years 1958—1960. Stations 7—27 were visited at that time four times: in March, June, August, and September. Stations 1—6 were visited more frequently, more or less at monthly intervals except in the winter of 1959/60. In the catchment area of the Skawica and the Orawa (region II) materials were collected by means of a semiquantitative method in various month in the years 1962—1967 and in the year 1972. Each of these stations was visited at least three times at various seasons of the year. In the catchment area of the Raba (region III) stations 1—10 in the water system Olszowy-Koninka--Porębianka-Raba, at which material was collected for quantitative investigations, were visited 7 times and almost at the same time in the following months of the year 1969/1970: July, September, October, December, March, May, and June. Other stations were visited less frequently, though not less than 3 times in various seasons of the years 1964—1972. At stations 1—11 samples were collected by means of quantitative and semiquantitative methods, whereas at other stations only the semiquantitative one was used. For the majority of the stations in the Raba, the material from some years preceding the year 1969 was also available and for the lower section from the following years as well. In the catchment aera of the Dunajec and in the streams in the vicinity of Cracow (region IV and VI) material was collected in the years 1959—1972 exclusively by the semiquantitative method. All the stations in region VI were visited three or four times at various seasons of the year, similarly as the stations in theTatra streams. Other stations in the catchment area of the Dunajec were investigated less frequently, twice or even only once. In the catchment area of the San (region V) materials were collected in the years 1958—1967 simultaneously by the quantitative and semiquantitative methods of sampling or, as in the lower course of the San, only by the semiquantitative method. For technical reasons it was not possible to examine all the stations in the catchment area at once during one visit. Each of them was visited, however, in the course of those years at least three of four times at various seasons of the year with the exception of the winter months. The localization of the stations was adapted to the changes in environmental conditions occurring along the course of the streams. In their upper sections where these changes proceeded faster, the stations were distributed more densely, in the middle parts and lower parts the distances between neighbouring stations being greater. The lenght of the section of the water unit treated as a station also differed; in streams it did not exceed 10-20 m while in rivers, especially large ones, it reached 100 or even 200 m. This resulted from the distribution of habitats, the repeating set of which can be found in rivers on longer sections of the riverbeds as compared with streams. The velocity of the current was measured at the water surface by Thorup's method. The following scale of current

velocity was adopted: 0—0.10 m/sec — very slow current; 0.11—0.25 m/sec — slow current; 0.26—0.50 m/sec — average current; 0.51—1.0 m/sec — fast current; over 1.0 m/sec — very fast current. Stones of 3—7 cm in diameter were regarded as small, 8—15 cm as medium sized, and 16—25 cm as large. The total hardness of the water and pH were measured by means of Christ and Kaeding's complexometric method and the Yamada calorymetric method.

The following terms were used in the paper: sporadic, not numerous, numerous etc., denote the number of specimens of the species in one or many places. The terms: rare, frequent, common, etc., signify the existence of the species in some or many places. Abundance or inhabiting density means the number of specimens with respect to unit of substratum. Relative abundance or dominance means the participation of specimens of a species expressed as a percentage of the total number of specimens of all species. The following scale of dominance was adopted: dominant — a species with a participation of 5 or more per cent, subdominant — a species with 2—4.9 per cent participation, adominant — a species with under 2 per cent participation.

The term biotope determines a certain part of the environment with its constituent ecological factors which, by their value and range of variations, condition the existence of complexes of living organisms. This is a hierarchical approach and may mean a whole stream, a group of streams, or a section of a stream, e. g. a station. The habitat is a structural unit of the substratum within a station or stations, a place where determined species or their groups are always encountered. All the specimens of all species existing at a given habitat or biotope were defined by the term community in the neutral meaning which corresponds with the term taxocen or zoom used by some authors (Kownacki 1971, Brinck 1949, Ulfstrand 1968 a). In using the word population all the specimens of the given species were considered.

5. Material and its taxonomic situation

At 180 investigation stations a total number of 3346 specimens of winged mayflies and over 100000 nymphs belonging to 97 species were caught. A certain number of rarer species were found only in nymphal stage. The list of species given below contains their synonymy from existing literature in a range possible to establish and for some species the necessary general synonymy, the total number of specimens caught in 6 investigated regions and a list of the stations at which they were found.

5.1. List of species

Potamanthidae

Potamanthus luteus (Linnaeus), 1758. 9♂♀ si, 997 nymphs. I: 11—17, 19, 24; III: 6—10; IV: 9, 10; V: 8—25, 34, 39, 40

Ephemeridae

Ephemera danica O. F. Müller, 1764. 8♂, 2♀, 15♂♀ si, 290 nymphs. I: 3—6, 9—13, 18—21, 23, 26, 29; II: 1—3, 6—8, 14—17, 19, 20, 25, 35—39; III: 4—6, 11, 13—17, 19, 20; IV: 14, 16, 25, 31—33; 45; V: 4—11, 26, 28, 30—33, 35—39; VI: 1—3.

E. lineata Eaton, 1870 (= *glaucops*: Dzięgdzielewicz 1919; = *vulgata*: Zięba, Zaćwilichowska 1966). 292 nymphs. I: 13; III: 6—10; IV: 8—10; V: 7—23, 33, 34, 39, 40.

E. vulgata Linnaeus, 1758. 16♂, 9♀, 131 nymps. VI: 5, 6.

Polymitarcidae

Ephoron virgo (Olivier), 1791. 2♂, 1♀, 133 nymph. V: 15—25.

Heptageniidae

Arthroplea congener Bengtsson, 1909. 1 nymph. V: 25.

Rhithrogena germanica Eaton, 1885. 11♂, 2♀, 29♂♀ si, 461 nymphs. I: 11—17, 19, 24, 26; III: 5—9, 13, 15, 21; IV: 6—10, 14, 17, 18, 25, 28, 32; V· 6—21, 32—34, 36, 39, 40.

Rh. hercynia Landa, 1969 (= *tatrica*: Ciszek, Sosińska 1965 pro parte; = sp. (*hercynia*?): Kownacka 1971). 1♂, 6♀ si, 163 nymphs. IV: 5, 17, 18, 20, 26—28.

Rh. hybrida Eaton, 1885 (= *tatrica*: Ciszek, Sosińska 1965 p. p.; Kownacka, Kownacki 1965 p. p.). 37♂, 4♀, 3♂♀ si, 419 nymphs. I: 27; II: 7, 8; III: 2, 3; IV: 3—5, 12, 13, 20, 22, 23, 26, 40—42.

Rh. gorganica Klapálek, 1907. 2♂, 2♀, 1♀ si, 29 nymphs. V: 2, 3, 4.

Rh. loyolaea Navás, 1922 (= *tatrica*: Kownacka, Kownacki, 1965 p. p., 1968; Sowa, 1962). 76♂, 7♀, 12♂♀ si, 1357 nymphs. I: 27; II: 5, 8—11, 18, 27—33; III: 1—4; IV: 1—4, 11—13, 15, 19—22, 38—41.

Rh. semicolorata (Curtis), 1834 (= *grisoculata*: Kownacka, Kownacki, 1965; Sowa, 1965a). 145♂, 10♀, 5♂♀ si, 2131 nymphs. I: 11—17, 19, 21, 24—26; II: 1, 37; III: 4—11, 13, 15, 20, 21; IV: 6—10, 14, 17, 18, 26—28, 32, 36, 43; V: 5—19, 32—34, 36, 39, 40.

Rh. iridina iridina (Kolenati), 1860 (= *semicolarata*: Dzięgdzielewicz, 1919 p. p.; Głowaciński, 1968 p. p.; Kamler, 1960 p. p.?; Kownacka, Kownacki, 1965 p. p.; Sowa, 1965; Zaćwilichowska, 1968 p. p.; = sp. (*semicolorata*): Kownacka, Kownacki, 1968; = spp: Kownacka, 1971 p. p.; = *picteti carpathica* Sowa, 1971). 344♂, 49♀, 5♂♀ si, 5060 nymphs. I: 1—10, 18, 20, 22, 23, 27, 29; II: 1—10, 15—22, 25, 27, 28, 33—36, 38; III: 1—4, 14, 16, 17; IV: 2—4, 12, 13, 19, 20, 23, 30, 31, 33—35, 39—45; V: 2—5, 26, 27, 29—31, 35, 37, 38.

Rh. ferruginea Navás, 1905 (= *semicolorata*: Ciszek, Sosińska, 1965 p. p.; Dzięgdzielewicz, 1919 p. p.; Głowaciński, 1968 p. p.; Kownacka, Kownacki, 1965 p. p.; Mikulski, 1936 p. p.; Sowa, 1959 p. p.; = spp: Kownacka, 1971 p. p.). 119♂, 45♀, 5♂♀ si, 3098 nymphs. I: 10—13, 18—23, 26, 27, 29; II: 1—3, 6, 15, 16, 37, 39; III: 3—7, 11—13, 16, 19, 20; IV: 4, 5, 14, 16, 24, 26, 29, 42, 43; V: 4—11, 28, 30—34, 36, 38, 39.

Rh. diaphana Navás, 1916 (=*aurantiaca*: Eaton, 1885; Mikulski, 1929, 1936; ? = sp. II: Kownacka, Kownacki, 1965; nec *Baetis aurantiacus* Burmeister

1839). 28♂, 34♀, 743 nymphs. I: 12—17, 19, 24; III: 6—10; IV: 5—10, 27, 28, 32; V: 12—21, 39, 40.

Epeorus sylvicola (E. Pictet), 1865 (= *assimilis* Eaton, 1885; = *alpicola*: Dzięgdzielewicz, 1919). 32♂, 3♀, 1401 nymphs. I: 3—6, 9—15, 19, 21—24, 26, 27, 29; II: 1—3, 6—10, 15, 16, 19, 20, 35—37; III: 4—8, 11, 13—16, 20; IV: 4—6, 24, 26—28, 32, 35, 36, 42, 43; V: 5—12, 26, 28, 30—38.

Ecdyonurus subalpinus Klapálek, 1905 (= *helveticus*: Zaćwilichowska, 1968 p. p.). 24♂, 14♀, 1♂ si, 705 nymphs. I: 1—4, 7, 8, 27; II: 5, 8—10, 20—23, 27, 28, 33, 34; III: 1a—2; IV: 20, 30, 35, 38—40; V: 1—4, 29.

E. carpathicus Sowa, 1973 (= *helveticus*:Zaćwilichowska, 1968 p. p.). 10♂, 90 nymphs. I: 20; II: 16, 38, III: 4, 17; IV: 44, 45; V: 4, 30, 31; VI: 1.

E. macani Thomas et Sowa, 1970 (= *venosus*: Ciszek, Sosińska, 1965 p. p.; Sowa, 1959 p. p.). 29♂, 4♀, 7♂♀ si, 167 nymphs. III: 7—9, 21; IV: 10; V: 9—23, 39, 40; VI: 3.

E. torrentis Kimmins, 1942. 37♂, 23♀, 41♂♀ si, 1472 nymphs. I: 5, 6, 9—17, 19, 21—24, 26, 27, 29; II: 1, 2, 6, 7, 15, 16, 19, 36—39; III: 4—9, 11—13, 15, 19—21; IV: 5—9, 14, 17, 18, 24, 25, 27, 28, 32, 36, 42, 43; V: 5—17, 28, 30—34, 36—40.

E. venosus (Fabricius), 1775 (= *forcipula*: Kamler, 1960). 32♂, 23♀, 3♂♀ si, 623 nymphs. I: 8—12, 20, 23, 24, 26—29; II: 1—4, 6—9, 15—17, 19, 20, 24, 25, 35, 36, 38; III: 2—6, 14, 21; IV: 3—7, 13, 16, 20, 22—28, 31, 34, 36, 41—43; V: 3—6, 26, 28, 30, 31, 35—38; VI: 3.

E. starmachi Sowa, 1971 (= *torrentis*: Sowa, 1965 p. p.). 28♂, 3♀, 2♂♀ si, 438 nymphs. I: 3—5, 12, 13, 18; II: 14; III: 4, 5, 11, 12, 16, 17, 21; IV: 29, 35, 45; V: 5; VI: 2, 3.

E. submontanus Landa, 1969. 103♂, 11♀, 12♂♀ si, 341 nymphs. I: 10—13, 18—20, 22; II: 2, 3, 6, 14—16, 24, 25, 39; III: 4, 5, 11, 12; IV: 24, 31, 33, 34; V: 5, 6, 26, 33, 34, 36.

E. dispar (Curtis), 1834 (? = *fluminum*: Dzięgdzielewicz, 1919; = *fluminum*: Ciszek, Sosińska, 1965 p. p.; Mikulski, 1936; Musiał and others, 1958 p. p.; Sowa, 1965, 1965a). 63♂ 23♀, 29♂♀ si, 2236 nymphs. I: 5, 11—19, 21, 23—26, 28; II: 1, 2, 15, 37; III: 5—13, 15, 19—21; IV: 6—9, 17, 18, 32, 36; V: 6—25, 32—34, 36, 39, 40.

E. insignis (Eaton), 1870 (= sp. Głowaciński, 1968; Sowa, 1962). 5♂, 7♀, 10♂♀ si, 447 nymphs. I: 15—17; II: 1; III: 6—10; IV: 8—10; V: 7—25, 33, 34, 39.

E. aurantiacus (Burmeister), 1839 (= *fluminum*: Ciszek, Sosińska, 1965 p. p.; Musiał et al., 1958 p. p.; = *pazsiczkyi* (Pongracz), 1913; = *paziczkyi*: Mikulski, 1936). 4♂, 4♀, 17♂♀ si, 688 nymphs. I: 15—17; III: 7—10; IV: 10; V: 11—25, 40.

E. affinis (Eaton), 1887. 1♂ si, 40 nymphs. V: 17—25.

E. fascioculatus Sowa, 1974. 2♂, 1♀, 5 nymphs. III: 9.

E. lateralis (Curtis), 1834 (= *Heptagenia lateralis* (Curtis); = *H. fallax*: Zaćwilichowska, 1968 p. p.). 36♂, 5♀, 10♂♀ si, 2859 nymphs. I: 1—6, 8—29; II: 1—4, 6—8, 14—17, 19, 25, 35, 36, 38; III: 2—11, 13, 15, 17, 18—21; IV: 3—8, 13, 28, 35, 42, 45; V: 3—16, 26—28, 30—33, 35—40; VI: 1—3.

E. quadrilineatus (Landa), 1969 (= *Heptagenia quadrilineata* Landa; ? = *H. fallax*: Zaćwilichowska, 1968 p. p.). 2♂, 2♂♀ si, 54 nymphs. III: 11, 12, 17, 18; V: 4; VI: 2.

Heptagenia coerulans Rostock, 1877. 139 nymphs. III: 8, 9; IV: 10; V: 14—25.

H. fuscogrisea (Retzius), 1783. 6 nymphs. V: 25; VI: 5.

H. flava Rostock, 1877. 3♂, 2♀, 11♂♀ si, 551 nymphs. III: 9, 10; V: 21—25; VI: 3.

H. longicauda (Stephens), 1836 (= *flavipennis* (Dufour), 1841). 1♂, 2♀, 7♂♀ si, 67 nymphs. III: 8—10, V: 23—25.

H. sulphurea (O. F. Müller), 1776 (= *sulfurea*: Mikulski, 1936). 18♂, 1♀, 407 nymphs. I: 15—17; III: 7—10; IV: 9, 10; V: 8—25, 32, 40.

Ametropodidae

Ametropus fragilis Albarda, 1878 (? = *eatoni* Brodskij, 1930; = *eatoni*: Sowa, 1961a). 1 nymph. V: 25.

Leptophlebiidae

Habroleptoides modesta (Hagen), 1864 (= *Habrophlebia modesta*: Ciszek, Sosińska, 1965; Sowa, 1961; = *Paraleptophlebia cincta*: Zaćwilichowska, 1968). 65♂, 21♀, 24♂♀ si, 4222 nymphs. I: 1—6, 8—24, 26—29; II: 1—8, 14—17, 19—22, 24, 25, 28, 34—38; III: 2—11, 13—17, 19—21; IV: 4, 5, 8, 14, 16—18, 20, 25, 27, 28, 36, 41—43, 45; V: 3—23, 26—40.

Habrophlebia lauta Eaton, 1884 (= *Habroleptophlebia* (sic!) *lauta*: Zaćwilichowska, 1968). 107♂, 9♀, 6♂♀ si, 613 nymphs. I: 3—6, 10—20, 22—24, 26—29; II: 1, 2, 6, 14—16, 37, 39; III: 4—10, 12, 13, 15, 17, 19—21; IV: 6—10, 29, 45; V: 5—13, 30—39; VI: 2, 3.

H. fusca (Curtis), 1834. 101 nymphs. III: 17, 18; VI: 1, 2, 5.

Paraleptophlebia cincta (Retzius), 1783. 11♂, 3♀, 1♂ si, 31 nymphs. I: 15—17; III: 10; IV: 10; V: 18—25, 40.

P. submarginata (Stephens), 1836. 10♂, 1♀, 4♀ si, 86 nymphs. I: 12, 13; II: 1—3, 6, 7, 14—16, 24; III: 7—10, 17, 19, 20; IV: 8; V: 8—25, 34, 40; VI: 2, 3.

Leptophlebia marginata (Linnaeus), 1767. 2♂, 1 nymph. V: 25.

L. vespertina (Linnaeus), 1758. 6♂, 2♀, 84 nymphs. VI: 4—6.

Choroterpes picteti (Eaton), 1871. 11♂, 1♀ si, 86 nymphs. I: 17; III: 8; IV: 10; V: 12—25, 40.

Isonychiidae

Isonychia ignota (Walker), 1853. 60 nymphs. I: 17; III: 10; V: 21—25.

Siphlonuridae

Ameletus inopinatus Eaton, 1887. 9♂, 4♀, 6♂♀ si, 1042 nymphs. I: 27; II: 4, 5, 7—10, 18, 21—23, 27, 28, 32—34; III: 2—5; IV: 1—5, 11—13, 15, 19—23, 26, 40—42.

Siphlonurus armatus (Eaton), 1870. 2 nymphs. VI: 4.

S. aestivalis (Eaton), 1903. 9 nymphs. V: 22—25.

S. lacustris (Eaton), 1870. 4♂, 1♀, 5♂♀ si, 1638 nymphs. I: 29; III: 7; IV: 8, 27, 42; V: 5—8.

Baetidae

Baetis alpinus (Pictet), 1843 (= *carpatica*: Kownacka, Kownacki, 1965,

1968; Musiał et al., 1958; = *carpathica*: Dzięgzielewicz, 1919; Kamler, 1960 p. p.; Kamler, Riedel, 1960; Mikulski, 1936; Sowa, 1959; = *carpaticus*: Ciszek, Sosińska, 1965; Głowaciński, 1968; Sowa, 1965; Zaćwilichowska, 1968). 30♂, 20♀, 6♂♀ si, 13687 nymphs. I: 1—13, 18, 20—23, 26, 27, 29; II: 1—11, 15—23, 25, 27—38; III: 1—6, 11, 13—16; IV: 1—5, 11—13, 15, 16, 19—24, 26—28, 31, 33—35, 37, 39—43; V: 2—10, 26—32, 35—38.

B. melanonyx (Pictet), 1843 (= *carpathica*: Kamler, 1960 p. p.; = *kulindrophtalmus*: Kownacka, 1971). 23♂, 36♀, 1♂ si, 1174 nymphs. I: 8, 9; II: 2—4, 6—10, 15, 16, 22, 24, 34, 35, 38; III: 2—6, 11, 12, 14; IV: 2—5, 12, 19—21, 23, 34, 40—42; V: 2—8, 27, 28.

B. lutheri Müller-Liebenau, 1967 (= *venustulus*: Ciszek, Sosińska, 1965 p. p.; Głowaciński, 1968; Kownacka, Kownacki, 1965; Krzanowski et al. 1965; Sowa, 1959 p. p., 1961, 1961b, 1965). 5♂, 8♀, 4591 nymphs. I: 3—6, 10—13, 15—17, 19—24, 26, 29; II: 1, 2, 6, 15, 37, 39; III: 4—13, 15, 16; IV: 5—8, 25—29, 31, 36, 42, 43; V: 5—15, 26, 30—34, 36—39; VI: 3.

B. vardarensis Ikonomov, 1962 (= *venustulus*: Sowa, 1959 p. p.). 3♂, 29♀, 1♂ si, 6488 nymphs. I: 11—17, 24—26; III: 5—10, 13, 15, 21; IV: 7—10; V: 7—23, 32—34, 36, 40.

B. sinaicus (Bogoescu), 1931 (= *Acentrella sinaica*: Mikulski, 1936; Sowa, 1962). 1♂, 4♀, 338 nymphs. III: 6, 7, 11, 13; IV: 7, 14, 17, 26—28; V: 6—13, 32—34.

B. rhodani (Pictet), 1843. 29♂, 6♀, 18♂♀, si 17353 nymphs. I: 1—29; II: 1—4, 6—8, 14—17, 19—21, 25, 35—39; III: 1a, 2—17, 19—21; IV: 4—10, 14, 16—18, 23—28, 31, 32, 34—37, 42, 43, 45; V: 3—24, 26—40; VI: 3.

B. vernus Curtis, 1834 (= *tenax* Eaton, 1870; = *vernus*+*tenax*: Ciszek, Sosińska, 1965; Kownacka, Kownacki, 1965; Mikulski, 1936; Sowa, 1965; = *tenax*: Dzięgzielewicz, 1919; Sowa, 1959). 6♂, 628 nymphs. I: 3, 4; II: 4, 9, 10, 24, 28; III: 6, 11, 12, 17, 18; IV: 29, 31; V: 5, 24; VI: 2—6.

B. beskidensis Sowa, 1972. 309 nymphs. I: 10—14, 19; III: 3—10; IV: 9, 31; V: 6—19, 33, 34, 36, 39, 40.

B. fuscatus (Linnaeus), 1761 (= *bioculatus*: Mikulski, 1936). 129♂, 2♀, 19♂♀ si, 7841 nymphs. I: 11—26, 28, 29; II: 1, 37; III: 5—13, 15, 19—21; IV: 6—10, 14, 32, 36, 43; V: 5—25, 28, 31—34, 36, 39, 40; VI: 3.

B. scambus Eaton, 1870 (= *bioculatus*: Kamler, 1860; Kamler, Riedel, 1960; Kownacka, 1971). 10♂, 5♀, 2292 nymphs. I: 3—5, 8—15, 18—24, 26—29; II: 1—3, 6, 15, 16, 19, 25, 36, 37, 39; III: 2—7, 11, 13, 15, 16; IV: 5—7, 14, 16—18, 24—29, 31, 32, 36, 42, 43; V: 4—17, 26, 28, 30—33, 35—38; VI: 2, 3.

B. buceratus Eaton, 1870. 4♂, 1♀ si, 414 nymphs. III: 9, 10; V: 9—25, 39, 40; VI: 5.

B. calcaratus Keffermüller, 1972. 2♂, 4♀, 85 nymphs. III: 9, 10; V: 19—25.

B. tricolor Tshernova, 1928. 2♀, 137 nymphs. V: 20—25; VI: 5.

B. digitatus Bengtsson, 1912. 1♂, 2♀ si, 2 nymphs. VI: 5.

B. niger (Linnaeus) 1761. 3♂, 1♀, 9♂♀ si, 443 nymphs. II: 14; III: 9; IV: 36; V: 8, 18, 22, 23, 32.

B. gracilis Bogoescu et Tabacaru, 1957. 97♂, 3♂♀ si, 145 nymphs III: 9, 10; IV: 10; V: 14—25.

B. muticus (Linnaeus), 1758 (= *pumilus* (Burmeister), 1839). 45♂, 13♀, 3820 nymphs. I: 2—6, 8—29; II: 1—3, 6—10, 14—17, 19—22, 25, 28, 35—39; III: 2—11, 13—17, 19—21; IV: 4—8, 13, 14, 16—18, 24—29, 31—35, 37, 41—43, 45; V: 3—22, 26—40; VI: 2, 3.

Pseudocloeon inexpectatum Tshernova, 1928 (= *hyalopterum*: Sowa, 1962). 1♂, 4♀, 35 nymphs. III: 8—10; V: 13—25, 40.

Baetopus tenellus (Albarda), 1878. 7 nymphs. V: 21—25.

Centroptilum luteolum (O. F. Müller), 1776. 6♂, 12♀, 5♂ si, 965 nymphs. I: 3—6, 9—13, 15—24, 29; II: 1—3, 6, 7, 14—16, 19, 20, 25, 36, 37; III: 5—21; IV: 5—10, 16—18, 20, 24—29, 31—34, 36, 42, 43; V: 4—26, 28, 30—32, 36, 38, 40; VI: 1—6.

C. nemorale Eaton, 1885 (?) 1♂, 17 nymphs. II: 14.

C. pennulatum Eaton, 1870. 10♂, 4♀, 5♂♀ si, 226 nymphs. I: 3—5, 12, 13, 15—17, 19, 21, 24; II: 1, 15, 37; III: 6—10, 19—21; IV: 6—10; 14, 18, 27; V: 9—19, 24, 28, 32—34, 36, 39, 40.

C. pulchrum Eaton, 1885. 18♂, 6♀ 5♂♀ si, 143 nymphs. III: 8—10; V: 11—25.

C. parapulchrum Keffermüller et Sowa, 1975. 1♀. III: 7.

C. nana Bogoescu, 1949. 17♂, 1 nymph. V: 25.

Procloeon bifidum (Bengtsson), 1912. 6♂♀ si, 267 nymphs. I: 16, 17, 24; III: 8—10; IV: 10; V: 7—19, 23—25, 34, 40; VI: 5.

P. ornatum Tshernova, 1928 (= *pseudorufulum*: Głowaciński, 1968; = *Cloeon rufulum*: Mikulski, 1936). 270 nymphs. III: 9; V: 17—25; VI: 5.

Cloeon cognatum Stephens, 1835. 78 nymphs. VI: 5.

C. dipterum (Linnaeus), 1761. 250 nymphs. V: 23—25; VI: 4—6.

C. inscriptum Bengtsson, 1914. 133 nymphs. VI: 4—6.

C. simile Eaton, 1870. 8 nymphs. VI: 4.

Oligoneuriidae

Oligoneuriella mikulskii Sowa, 1961. 139 nymphs. V: 23—25.

O. pallida (Hagen), 1855 (= *Oligoneuria rhenana* v. *pallida* Hagen). 8 nymphs. V: 24.

O. rhenana (Imhoff), 1852. 25♂, 8♀, 2342 nymphs. I: 11—17, 19, 21, 24, 25 III: 5—11, 15, 21; IV: 6—10, 25, 27, 28, 32; V: 7—25, 33, 34, 38, 40.

Ephemerellidae

Ephemerella ignita (Poda), 1761. 20♂, 11♀, 9♂♀ si, 2762 nymphs. I: 3—6, 10—24, 26, 28, 29; II: 1, 2, 14—16, 37; III: 4—13, 15, 16, 19—21; IV: 5—10, 14, 17, 18, 24, 25, 27—29, 32, 36, 43, 45; V: 6—25, 28, 30—34, 36, 38—40; VI: 2, 3.

Eph. mesoleuca (Brauer), 1857. 5♂, 5♂♀ si, 79 nymphs. V: 23—25.

Eph. notata Eaton, 1887. 6 nymphs. III: 8, 9; IV: 9, 10; VI: 3.

Eph. krieghoffi (Ulmer), 1919 (= *Chitinophora krieghoffi* Ulmer; ? = *Ephemerella* sp: Kownacka, Kownacki, 1968). 3♂, 1♂ si, 297 nymphs. I: 3—6, 8, 9, 23, 27, 29; II: 1—3, 6—8, 15, 16, 19, 25, 35, 38; III: 3—7, 11, 14, 16; IV: 6, 7, 14, 17, 18, 22, 36, 39—42; V: 4—13, 27, 28, 30—32, 35—39.

Eph. major (Klapálek), 1905 (= *Torleya major* Klapálek). 3♂, 34♀, 1553 nymphs. I: 3—6, 9—13, 15, 16, 18—24, 26, 29; II: 1—3, 6, 15, 16, 38; III: 4—11, 13, 14, 16, 20; IV: 6—9, 25, 32, 35, 36, 42, 43; V: 5—22, 27, 28, 30—40.

Caenidae

Caenis rivulorum Eaton, 1884. 10♂, 16♀, 488 nymphs. I: 10—13, 18, 19, 21—24, 26, 28; II: 1, 2, 15, 16, 37; III: 4—8, 11, 12, 16; IV: 43; V: 5—7, 28, 30—33, 36—38.

C. beskidensis Sowa, 1973. 21♂, 26♀, 133 nymphs. I: 3—6, 18, 22, 23, 29; II: 14; III: 4, 11; IV: 29, 31, 45.

C. pseudorivulorum Keffermüller, 1960 (= *horaria*: Zięba, Zaćwilichowska, 1966), 357♂, 47♀, 1♂ si, 3122 nymphs. I: 11—17, 19, 21, 24, 26, 28; II: 1; III: 5—10, 12, 15, 21; IV: 6—10; V: 7—25, 32—34, 39, 40.

C. macrura Stephens, 1836 (= *moesta*: Krzyżanek, 1971). 752 nymphs. I: 12, 13, 15—17, 24, 28; III: 5—10, 12, 18, 21; IV: 6—10; V: 6—25, 33, 34, 36, 39, 40; VI: 3, 5, 6.

C. moesta Bengtsson, 1917. 3 nymphs. V: 25; VI: 5.

C. robusta Eaton, 1884, 21 nymphs. VI: 4.

Brachycercus harrisella Curtis, 1834. 19 nymphs. V: 24, 25.

B. minutus Tshernova, 1952. 12 nymphs, V: 24, 25.

B. pallidus Tshernova, 1928. 7 nymphs. V: 24, 25.

5.2. Remarks on some common species

In analysing the existing data on species the author had only little opportunity to check personally the original materials of the previous authors. The synonyms cited in the previous chapter (5.1) refer mainly to those cases when determination of the species seemed with certainty to be wrong in the light of the present knowledge of its distribution in space and time. A great number of the synonyms were also given as the result of recent changes in the nomenclature of European mayflies and the general progress in taxonomy of the order. For some species it was not possible to establish full synonymy. This refers mainly to three taxons which had been treated until recently as "common species" and are now recognized as groups consisting of 2 or 3 species:

Baetis bioculatus (L.). A species name no longer valid (Müller-Liebenau (1969)). In older papers this name was used to determine the species known now under the name *B. fuscatus* (L.). In those papers, especially the ones concerning nymphs, the species could, in fact, be identified with two other allied ones often accompanying it: *B. scambus* Etn. and *B. beskidensis* Sowa.

Rhithrogena semicolorata (Curt.). Previous reports on this species from the Carpathians seem to concern in many cases also *Rh. ferruginea* Nav., *Rh. iridina* (Kol), and even *Rh. loyolaea* Nav.

Ecdyonurus venosus (Fabr.). In this case a false determination could concern, especially in larval form, at least three species: *E. torrentis* Kimm., *E. macani* Thomas and Sowa and *E. starmachi* Sowa.

5.3. Discussion on species poorly known or new for the Polish fauna

Rhithrogena hybrida Etn. and *Rh. hercynia* Landa. These two species show a close alliance in all developmental stages. The nymphs of *Rh. hercynia* from the rivers of the Polish part of the Carpathians usually agree with the original description by Landa (1969, 1970) who designated a nymph as the holotype of this species. They do not differ from the nymphs originating from the type-locality of the species (Otava, Sušice, ČSSR) which, thanks to the kindness of Dr. Landa, was available for examination. Nymphs of this species differ from those of *Rh. hybrida* mainly in colour: the presence of dark, fairly diffused spots on the femur and pigmentation of tergites of the abdomen, of which the few first ones, the eighth and ninth, are bright and the tenth is dark.

Rh. diaphana Nav. Nymphs of this species, usually mentioned in the literature under the name *Rh. aurantiaca* (Burm.) (Thomas 1968, Puthz 1973), demonstrate a similar pigmentation of the body as *Rh. semicolorata* (Curt.) nymphs, except that the tenth tergite of the abdomen is dark. The margins of the gills are smooth and the first gill lacks a fold on its upper surface.

Ecdyonurus quadrilineatus (Landa). This species is very similar to *E. lateralis* (Curt.) but is somewhat larger and fairly variable. The nymphs differ from those of the other three species of the *lateralis* (Curt.) group living in Poland in rings of long spines on tails; these spines reach in the basic half of the tail, more than midway along the segment neighbouring with that out of which they grow. Spines on the surface of the femurs are densely placed, the claws of the legs usually have two teeth and the last gill is greatly elongated. A new species in the Polish fauna captured by the author also in the streams flowing down the southern slope of Mt Święty Krzyż in the Świętokrzyskie Mountains.

E. fascioculatus Sowa. In all developmental stages very similar to *E. affinis* Etn. Nymphs differ mainly in the lateral spine outgrowths of the abdomen segments (Sowa 1974) being less distinctly curved downwards.

Baetis digitatus Bgtss. Allied with *B. niger*, described originally according to Swedish material. According to Müller-Liebenau (1969), the nymphs differ from those of *B. niger* in three features: hairs on the labium (only 3—4 hairs at the tip of the glossa in the lower face), a pointed assymetric seventh gill, and a single dark band on the tail. Judging from the available material of the two species only the first of these three features is of differentiating taxonomical value. The other two undergo in *B. niger* great individual variability and often become similar to those of *B. digitatus*. New in the Polish fauna.

Baetis vardarensis Ikon. This is known in the literature only in larval stage (Ikonomov 1962, Müller-Liebenau 1969, 1974), though most probably the male imago (not larva) *B. meridionalis* Ikon. (Ikonomov 1962) belongs to the same species. The nymphs of *B. vardarensis* resemble those of *B. lutheri* from which they differ externally mainly in a much longer intermediate tail reaching in fully grown nymphs half or even more than half of the length of lateral tails, and in the absence of paired dark spots on most of the abdomen tergites.

Baetis calcaratus Kefferm. In nymph stage practically indistinguishable from those of *B. tricolor* Tsher. Mature nymphs can be determined by the imaginal features: by the hind wings and by the structure of the egg chorion (female nymphs).

Baetopus tenellus (Alb.). This species, mentioned here for the first time in the Polish fauna, was originally described in the genus *Centroptilum* Etn. on the basis of an imago male (Albarda 1887). Nymphs identical with those possessed by the author were described by Lestage (1919) under the name *Baetis? niger* (L.). According to the features given by Keffermüller (1960, 1967) there is no doubt that this species belongs to the genus *Baetopus* Kefferm. The fact that the nymphs caught belonged to the species of Albarda was established on the grounds of the structure of the hind wing germ, the general size, the colour of the body, and germs of sexual organs in a male nymph just before emergence. Most probably *B. balticus* Kazlauskas 1962 is a junior synonym of the species of Albarda.

Centroptilum nemorale Etn.? is known so far on the basis of a holotype (imago male) caught in Italy (Appenino, Pistojese). An imago male raised by the author from a nymph caught in the stream at Zawoja (station II; 14) is similar to the holotype (Kimmins 1960), but the penis plate is sclerotized, in the author's specimen on a slightly larger surface and the second segment of the gonopods is somewhat more slender. As the present knowledge of the Eaton species is rather poor it is impossible to say whether the differences noticed in the specimen from Poland are the result of individual or geographical variability or if they are of species level. Determination thus remains provisional. The nymph is very similar to that of *C. pennulatum*. New in the Polish fauna.

Centroptilum nana Bog. males from the San do not differ in their external features from Bogoescu's (1958) and Kazlauskas' (1964) descriptions, or the nymph from the latter author's description (op. cit.). This nymph, a female, has already developed eggs whose structure is in agreement with the data by Bogoescu and Tabacaru (1966) given for this species. It seems to be identical with that described by Jacob (1973) from Poland under the name *C. potamonensis* Jac.

Centroptilum pulchrum Etn. This species, together with *C. parapulchrum*, is the subject of a separate elaboration (Keffermüller, Sowa, 1975). Nymphs of these two species are almost identical and very similar to the *C. forlivense* Grandi (1964) nymphs.

Procloen bifidum Bgtss. and *P. ornatum* Tsher. These two very much allied species are the subject of a separate elaboration, (Sowa, 1975) based upon typical material. Nymphs differ from one another in the colour of the abdomen (red spots on tergites in *P. ornatum*) and the shape of gills (in *P. ornatum* a fairly distinct outgrowth forming second plate on the 2—5 gill is noticeable, this not being observed in nymphs of *P. bifidum*).

Cloeon cognatum Steph. An allied species of *C. dipterum* (L.) and so far identified with it. It is the subject of a separate elaboration (Sowa, 1976). New for the Polish fauna.

Brachycercus pallidus Tsher. Adult forms of this species were described on the basis of material from the River Oka (Tshernova 1928). A complementary

description of the nymphs from the River Neris in the Lithuanian SSR was given by Kazlauskas (1965). A new species for the Polish fauna. Nymphs very similar to *B. harrisella* (Curt.) but slightly smaller.

5.4. Dubious species in the territory of the investigations

From the Polish part of the Carpathians or from the neighbouring territories a number of species not found during the present investigations have been mentioned in the literature. These are either as yet poorly known species, often even of an uncertain systematic position, or good species which, however, in the author's opinion do not occur in the Polish part of the Carpathians and probably not even in the Carpathians at all.

Rhithrogena alpestris Eaton, 1885. Mikulski (1936) mentions it, among other places from the higher parts of the Tatras. More recent investigations did not, however, confirm the presence of this species in Poland. *Rh. alpestris* sensu Landa (1969) cannot belong to the Eaton species either, as the nymphs described by Landa from the High Tatras on the Sloviakian side have smooth gills, whereas *Rh. alpestris* Etn. nymphs have gills with incised margins. If the source of error does not lie in the mountain populations of *Rh. diaphana* Nav., the form described by Landa belongs to a species not yet named.

Rhithrogena henschii Klapálek 1906. Known, as yet, only in the form of a male imago cited by Klapálek (1906) and subsequently by Mikulski (1936) from Kieżmark in Slovakia. Thanks to the kindness of Dr Puthz from Schlitz the author was able to examine the sexual organs of the holotype kept in Zagreb. The general shape of the penis and of the titillators indicates an alliance with *Rh. loyolaea* Nav.; the position of the inner tooth of the penis lobes and their shape seen from behind are, however, not identical in the two species. A certain doubt is also aroused by the place of catching. Considering the title of Klapálek's paper (op. cit.) it cannot be excluded that in labelling the material a mistake could have been made and the specimen was in fact caught in Yugoslavia.

Epeorus alpicola (Eaton), 1871. The presence in the Carpathians of this high mountain Alpine species is dubious. The specimens given by Dzięndzielewicz (1919) belong, according to Mikulski (1936), to *E. assimilis* Etn (at present a synonym of *E. sylvicola* E. Pict.).

Ecdyonurus fluminum (Pictet), 1843—1845. The type of this species has perished. According to Thomas (1968a), Pictet most probably had to do with *E. dispar* (Curt.), formerly described from England, whereas Eaton (1883—1888) joined under the name "*fluminum*" two other species: *E. forcipula* (Pict.) and *E. aurantiacus* (Burm.). In Poland and in the whole territory of the Carpathians the specimens determined as "*E. fluminum*" should, however, belong in fact to *E. aurantiacus* (Burm.), *E. dispar* (Curt.) or to *E. submontanus* Landa.

Ecdyonurus forcipula (Pictet), 1843—1845. According to Thomas's data (1968a) the certain localities of occurrence of this species have up till now been localized

on the territory of Western Europe (the Alps, the Pirenees). Mentions from the territory of the Carpathians refer, it would seem, to other allied species, most frequently, surely, to *E. venosus* (Fabr.). The source of many errors lies in Schoenemund's key (1930) in which a set of white spots on the dorsal part of the body, contrasting greatly with the dark background was adopted as a feature characteristic of *E. forcipula* (Pict.) nymphs. In fact such a set of spots occurs in some nymphs of *E. venosus* (Fabr.) and some other *Ecdyonurus* species not belonging to Pictet's species.

Ecdyonurus helveticus (Eaton), 1887 is a species living in South-Western Europe and its presence in the Carpathians is of small probability. Specimens determined with this name should in fact belong to *E. carpathicus* Sowa or to *E. subalpinus* (Klap.).

Heptagenia montana (Pictet), 1843—1845. This is a species known only from an original description of adult forms from the Sabaudian Alps. It has not yet a well-determined systematic position but from the description data it may be assumed that it belongs to the genus *Ecdyonurus* Etn. Specimens mentioned by Dzięddzielewicz (1919) from Zakopane may belong to *E. venosus* (Fabr.).

H. fallax (Hagen), 1864. This is a Mediterranean species known from Corsica and Sardinia (Grandi 1960). Its presence in the Carpathians is doubtful. The nymphs reported by Zaćwilichowska (1968) under this name from the Kamienica Nawojowska and its tributaries belong, without doubt, in the majority to *Ecdyonurus lateralis* (Curt.), a species in nymphal stage similar to *Heptagenia fallax*, which the author does not mention in her paper; they may also belong partly to *Ecdyonurus quadrilineatus* (Landa).

5.5. Species expected in the investigated territory

It seems that the list of 97 species found in running waters of the investigated territory is almost complete, especially in the case of mountain streams and rivers. Some species can possibly be found in the streams and smaller rivers of the Carpathian plateau and in the part of the Sandomierska Valley situated on the right side of the River Vistula, which however, were not investigated so exactly. There is a possible occurrence, at least, of *Baetis pentaphlebodes* Ujhelyi and *Paraleptophlebia tumida* Bengtsson species known from the lowland of Poland (Keffermüller 1972, Jażdżewska 1971) and also from Hungary and Czechoslovakia.

The possibility of occurrence of *Habroleptoides carpatica* Bogoescu et Crăsnaru, 1930, known from the Rumanian part of the Carpathians (Bogoescu 1958), and *Ephemerella mucronata* Bengtssson, 1909 a North European species mentioned by Mikulski (1935) from the streams of the massif of the Czarnohora, is not clear. The first of these species is similar to *Habroleptoides modesta* Hag., from which it differs in the nymphal stage mainly in a two-segmented maxillary palp. All the nymphs of the *Habroleptoides* Hag. genus caught in the Polish part of the Carpathians

had a three- segmented maxillary palp. The species of Bengtsson, on the other hand, both in the winged form and in the nymphal stage, is very similar to *Ephemerella krieghoffi* Ulmer. These two species, which have not so far been directly compared, are at present the subject of separate investigations by Dr. M. Keffermüller from Poznań, who takes the material from the Carpathians, among others, as a basis. If they prove identical the name proposed by Bengtsson, as an older one, should have priority.

6. Zoogeographic characteristics

6.1. Maximum ranges

An exact establishment of the whole distribution of the mayfly species found in the investigated territory is difficult and in many cases not yet possible. This results both from incomplete recognition of the composition and distribution of mayfies in particular provinces of the Palearctic and even in Europe as well as from the necessity of checking, in consequence of the recent progress in systematics of the group, some older data as to the distribution of species from many regions of Europe and Asia. The species composition and distribution of mayflies on the territory of the Caucasus, Turkey, and the Iberian Peninsula are very poorly known. It may also be feared that determination of the range of a certain number of species, which used to live in large European rivers, will be the subject of hypothesis only because of the reconstruction and pollution of these rivers. A zoogeographical analysis of European mayflies was recently presented by Illies (1967) and as to the Czechoslovak fauna also by Landa (1969). The below-given geographical characteristics of distribution of the Carpathian mayflies differs in many respect from the data given in the papers of these two mentioned authors, especially with regard to *Heptageniidae* and *Baetidae*.

Among the identified 97 species the local endemites are lacking. To the Carpathian endemites at least three species can be included: *Rhithrogena gorganica*, *Ecdyonurus carpathicus*, *E. subalpinus*.

From these species only *Rhithrogena gorganica* is limited in occurrence to the Eastern Carpathians (USSR, Poland). *Ecdyonurus carpathicus*, known so far from Poland and Rumania (Sowa 1973), occurs, most probably, in the whole Carpathians. *E. subalpinus* belongs to the extensive Carpathian endemites. Apart from the Carpathians, where the centre of its habitation is found, it was encountered in the upland territories of Southern Czechoslovakia, and Landa (1969) believes that it also inhabits the Sudeten Mountains.

Also five other species were found in the Carpathians, either in the Carpathians themselves or near these mountains:

Rhithrogena iridina iridina, Ecdyonurus fascioculatus, E. quadrilineatus, Baetis beskidensis, B. gracilis, Caenis beskidensis.

Apart from *Rhithrogena iridina iridina*, which may prove to be only an extensive Carpathian endemite, others of this provisionally combined group should have, however, a larger geographical distribution in Central Europe.

According to the so far obtained data the following species belong to the Central European ones:

Rhithrogena germanica, Rh. hercynia, Rh. hybrida, Rh. loyolaea, Ecdyonurus affinis, E. macani, E. torrentis, E. starmachi, E. submontanus, Baetis alpinus, B. melanonyx, B. lutheri, Baetopus tenellus, Oligoneuriella pallida, Ephemerella krieghoffi, E. mesoleuca.

The centre of habitation of some of the species belonging to this group are the Alps and a belt of mountains and uplands especially on the northern side of the Alps and the Carpathians and for the remainder the Central European Lowland and the Pannonian Lowland. The first of the species — the Alpine Carpathian ones — consist of the mentioned representatives of *Rhithrogena* (with the exception of *Rh. germanica*), representatives of the genus *Baetis* and *Ephemerella krieghoffi*. *Rhithrogena loyolaea* is distinguished by its disjunctive Carpathian-Alpine-Pirenean distribution. Within the second group *Rh. germanica* and *Ecdyonurus torrentis* are known also from Great Britain and the former and *E. macani* also from the South of France. *E. affinis* and *Baetopus tenellus* are spread over the Central European Lowlands, from Belgium to the north-western border of the USSR. *Oligoneuriella pallida* and *Ephemerella mesoleuca* are, apart from Poland, known also from Hungary and Lower Austria.

The following species constitute the South-Central European group:

Rhithrogena diaphana, Rh. ferruginea, Rh. semicolorata, Epeorus sylvicola, Ecdyonurus aurantiacus, E. dispar, E. insignis, E. lateralis, E. venosus, Heptagenia coerulans, H. longicauda, Habroleptoides modesta, Choroterpes picteti, Isonychia ignota, Baetis buceratus, B. sinaicus, B. vardarensis, Centroptilum pennulatum, Oligoneuriella mikulskii, O. rhenana, Ephemerella major, E. notata.

The northern range of the species of this group is similar to that of the Central European ones; they do not occur in the North European parts of the USSR and Scandinavia, though some of them are known from England and Denmark. In the south the area of their occurrence reaches over the Balkan Peninsula, Central and even Southern Italy and Spain. For *Rhithrogena semicolorata, Rh. diaphana, Ecdyonurus insignis, Baetis sinaicus, B. vardarensis, Habroleptoides modesta* and *Ephemerella major* the Carpathians form the north-eastern limit of habitation.

The group of North-Central European species included:

Arthroplea congener, Heptagenia fuscogrisea, Ametropus fragilis, Habrophlebia lauta, Leptophlebia vespertina, Siphlonurus armatus, Ameletus inopinatus, Baetis digitatus, B. scambus, Procloeon bifidum, Caenis rivulorum, C. robusta, Brachycercus harrisella.

The southern limit of the range of these species is constituted by the northern slopes of the Alps and the northern Carpathians, some spreading over the territory

of the Balkans. It is not known how far they reach in the south of the European part of USSR. In the north these species live in the greater part of the territory of Scandinavia, a great number of them also being recorded from Lapland.

The group of European species consists of:

Ephemera danica, Heptagenia sulphurea, Habrophlebia fusca, Paraleptophlebia submarginata, Siphlonurus aestivalis, Baetis muticus, B. niger, B. vernus, Cloeon simile, Caenis macrura, C. moesta.

Species of this group are recorded in the whole or almost the whole of Europe except for its south-eastern region where their possible presence should be the subject of further investigations.

To the group of Eurasian species belong:

Heptagenia flava, Siphlonurus lacustris, Baetis tricolor, Pseudocloeon inexpectatum, Procloeon ornatum, Ephemerella ignita, Caenis pseudorivulorum, Brachycercus pallidus.

From this group only *Siphlonurus lacustris* and *Ephemerella ignita* are known from almost the whole of Europe. The distribution of the other species is limited, according to the present data, to its central-western parts of Poland, the USSR and, apart from *Procloeon ornatum* and *Brachycercus pallidus*, also Czechoslovakia. *Heptagenia flava* and *Baetis tricolor* are known also from Bulgaria and Yugoslavia.

The group of palearctic species is formed by:

Potamanthus luteus, Ephemera lineata, E. vulgata, Ephoron virgo, Paraleptophlebia cincta, Baetis fuscatus, B. rhodani, Brachycercus minutus.

They are widely spread in the European Western Siberia Province but *Ephemera lineata* and *Ephoron virgo* do not occur in their northern part and *Brachycercus minutus* is known in Europe so far only from the USSR, Poland, and Bulgaria. In the south species of this group penetrate the Mediterranean Province and the Central Asian Province, and in the east, on the other hand, at least to the western parts of the East Asian and East Siberian Provinces.

To the holarctic species belong:

Leptophlebia marginata, Centroptilum luteolum.

Illies (1967) includes also into this group *Cloeon dipterum*, whose distribution. however, as well as that of *C. cognatum* and *C. inscriptum* should be verified by further investigations. The last three species, similarly as *Centroptilum luteolum*, are certainly widespread in Europe. For *Leptophlebia marginata*, on the other hand, the Alps and the southern Carpathians form the southern limit of its European distribution.

The distribution of some representatives of the *Baetidae*, *Baetis calcaratus* and *Centroptilum* species, not included into any group, require some further investigations.

As can be seen from the above given review, the South-Central European, Central European, and North- Central European elements are most numerously represented in the running waters in the investigated territory. Taken together, they constitute over 52 per cent of all species caught. During further investigations on European mayfly distribution the participation of these elements will perhaps prove still higher. The number of species with a small area of distribution, among them the Carpathian endemites, is very small. It seems that the great number of the species caught, a much greater one than so far reported from similar areas from Central or Southern Europe,

is connected, on the one hand, with the geographical situation of the investigated running waters and the climate of the territory — which create living conditions both for the species from the north and from the south of Europe — and, on the other hand, with the great differentiation of the biotopes existing there.

6.2. Distribution in the investigation area

In the catchment area of the Soła (region I) 51 species were found to occur a list of which, with their distribution at stations (except for the less exactly investigated station 25), is given in Tables IX and X. Table IX gives a list of species slightly changed in relation to the previously given one (Sowa 1965) as a result of more recent taxonomical investigations. In the catchment area of the river Skawica on the northern part of the Mt Babia Góra massif (region II) 38 species were caught, of which 29 were also found in the catchment area of the Orawa on the southern side of Mt Babia Góra. A list of species is given in Table XI, illustrating their altitudinal distribution in the whole region. The distribution of species in the water system of the streams Suchy-Stonów-Jaworzyna-Skawica is given in Table XII and in a meadow stream at Zawoja in Table XIII. In the Raba and its tributaries (region III) 68 species were found, a list of which (except for *Centroptilum parapulchrum*, caught only as an imago ♀) is given in Tables XIV and XV together with their distribution along the water system of the streams Olszowy-Koninka-Porębianka-Raba and at stations 11 and 17. Data for other stations are not presented in tabular form because of the smaller amount of material. In the whole investigated section of the catchment area of the Dunajec (region IV) 57 species were found. Some of them, given in Table XVI, which concerns the altitudinal distribution of the mayfly nymphs in the streams of the Polish part of the Tatras, combined according to the author's own materials and critically treated data from the so far published papers by Kamler (1960, 1962, 1965, 1967), Kamler, Riedel (1960), Kownacki, Kownacka (1965), Kownacka, Kownacki (1965, 1968), Kownacka (1971), and Sowa (1971). Data concerning the distribution of species in other studies sections of the catchment area can be found in paragraph 5.1. In the San and its tributaries from the Bieszczady Mts (region V) a total number of 79 species were found, a full list of them with distribution in the river system Wołosatka-Wołosaty-San, being presented in Table XVII. In other tributaries of the San 42 species on this list were found (paragraph 5.1.). Finally, in the tributaries of the Vistula in the vicinity of Cracow (region VI) 36 species from the complete list in Tables XVIII and XIX, which concern the Wilga, Drwinka, and the stream at Kłaj, were found.

Of the species occurring in the investigated territories only two, *Rhithrogena loyolaea* and *Ameletus inopinatus* can be considered as high mountain forms, these being numerous and common in the Tatra streams. In the Beskids their occurrence is localized and restricted to individual higher mountain massifs. The two species are cohabitant but *A. inopinatus* is also numerous in the oligotrophic Tatra lakes. They do not descend below an altitude of 500 m above sea level.

To the mountainous elements of the fauna of brooks and smaller montane rivers belong:
Rhithrogena gorganica, Rh. hybrida, Rh. iridina, Ecdyonurus subalpinus, Baetis alpinus. B. melanonyx.

Of especially great range in the altitudinal occurrence of these species is *Baetis alpinus*, which is numerous and widespread in the Tatras and, together with *Rhithrogena iridina*, also in the Beskids. For these two species the lower limit is an altitude of about 300 m above sea level. Together with these species there occurs *Baetis melanonyx*, which has, however, a smaller altitudinal range. The occurrence of *Rhithrogena gorganica* is limited to the Western Bieszczady Mts where it replaces *Rh. hybrida*. Widespread in the spring sections of the mountain streams is *Ecdyonurus subalpinus*.

The group of both mountainous and piedmont species, occurring in the becks, streams, and smaller rivers is constituted by:
Ephemera danica, Rhithrogena ferruginea, Rh. hercynia, Epeorus sylvicola, Ecdyonurus carpathicus, E. quadrilineatus, E. starmachi, E. submontanus, E. torrentis, E. venosus, Baetis lutheri, Caenis beskidensis, C. rivulorum.

Ecdyonurus carpathicus and *E. quadrilineatus* are mainly connected with smaller streams situated at lower altitudes. More numerous and at a larger number of stations in these streams are *E. starmachi, E. submontanus, Caenis rivulorum, C. beskidensis* which penetrate to small piedmont rivers. The altitudinal range of all six species is about 250—800 m above sea level. Much higher, almost to 1000 m above sea level, reaches *Ecdyonurus venosus* which, like *Ephemera danica*, is a common species in the Carpathians. Equally common in the altitude range 200—900 m above sea level and, moreover, numerous or very numerous, are *Rhithrogena ferruginea, Epeorus sylvicola, Ecdyonurus torrentis*, and *Baetis lutheri* distributed in larger streams and small rivers, penetrating far into the middle sections of larger Carpathian rivers. Localized in altitudinal occurrence is *Rhithrogena hercynia*, found between 950 and 500 m above sea level, at the foot of the Tatras and in large rivers of the Tatra Highlands (Podhale). Except for *Epeorus sylvicola* and *Rhithrogena hercynia* the species of this group occur also in smaller upland streams.

To the group of species inhabiting medium sized and large Carpathian rivers and including up to the uplands belong:
Rhithrogena diaphana, Rh. germanica, Rh. semicolorata, Ecdyonurus dispar, E. insignis, E. macani, Paraleptophlebia cincta, Choroterpes picteti, Baetis beskidensis, B. gracilis, B. sinaicus, B. vardarensis, Centroptilum pennulatum, Oligoneuriella rhenana, Ephemerella major, E. notata.

All three species from the *Rhithrogena, Ecdyonurus dispar, Baetis sinaicus, B. beskidensis, B. vardarensis, Oligoneuriella rhenana*, and *Ephemerella major*, also penetrate the lower sections of larger streams in these territories up to an altitude of 600—700 m above sea level and *Rhithrogena diaphana* even to 850 m above sea level. Except *Baetis sinaicus* and *B. beskidensis*, they are numerous and widespread species. More restricted in altitudinal range are *Ecdyonurus macani, Baetis gracilis, Paraleptophlebia cincta, Choroterpes picteti*, and *Ephemerella notata* of which only

Ecdyonurus macani reaches a height of 500 m above sea level, the others not exceeding 350 m above sea level. For almost all species of this group the lower limit of range is between 150 and 250 m above sea level, only for *Baetis sinaicus* being 350 m above sea level.

The group of species characteristic of large rivers from the piedmont territories to the lowland ones inclusive, is constituted by:

Potamanthus, luteus, Ephemera lineata, Ephoron virgo, Ecdyonurus aurantiacus, Heptagenia coerulans, Baetis buceratus, B. calcaratus, B. fuscatus, Pseudocloeon inexpectatum, Centroptilum pulchrum, Caenis macrura, C. pseudorivulorum.

This group of species is linked as to its distribution with the former group and some of the species, such as *Baetis fuscatus, Caenis macrura* and *C. pseudorivulorum*, is spread also over small piedmont rivers to an altitude of 600 m above sea level or even (*Baetis fuscatus*) 700 m above sea level. For *Potamanthus luteus, Heptagenia sulphurea, Baetis buceratus*, and *Ephemera lineata* the upper limit of range is 500 m above sea level and for other species 400 m above sea level. Species included in this group, however, also live in large or medium sized lowland rivers. Only *Baetis fuscatus* and *Caenis pseudorivulorum* form numerous populations in the territory of investigations, the majority being species of average numbers.

To the group of species occurring in large or medium sized lowland rivers belong:

Ecdyonurus affinis, Heptagenia flava, H. fuscogrisea, H. longicauda, Ametropus fragilis, Ephemerella mesoleuca, Isonychia ignota, Baetis tricolor, Baetopus tenellus, Centroptilum nana, Procloeon ornatum, Oligoneuriella mikulskii, O. pallida, Brachycercus harrisella, B. minutus, B. pallidus.

The majority of these species were found only in the lower course of the San. Only *Ecdyonurus affinis* reaches 270 m above sea level, for other species 200 m above sea level is the upper range of distribution.

Species occurring in various types of running waters, often within a great altitudinal range:

Ecdyonurus lateralis, Paraleptophlebia submarginata, Habroleptoides modesta, Habrophlebia lauta, Ephemerella ignita, E. krieghoffi, Baetis scambus, B. muticus, B. rhodani, B. vernus, Centroptilum luteolum.

Except for *Baetis vernus* and *Ephemerella krieghoffi*, these species are common in the investigated system of running waters and, apart from the two mentioned species and *Paraleptophlebia submarginata* and *Habrophlebia lauta*, also the most abundant forms in this territory. The two last species do not exceed the upper limit of 750 m above sea level, inhabiting smaller or medium size mountain and piedmont rivers but also smaller piedmont and upland streams. Other species occur from the upper or spring sections of mountain streams or also from the lower courses of streams of high mountain character to the upland sections of larger Carpathian rivers. The upper limit of their altitudinal range varies from 850 m above sea level for *Ephemerella ignita* to 1200 m above sea level for *Baetis rhodani* and *Ephemerella krieghoffi*. For the remainder it is between 900 and 1000 m above sea level.

The group of species connected equally with running and stagnant waters or those occurring mainly in stagnant waters is composed of:

Ephemera vulgata, Siphlonurus aestivalis, S. armatus, S. lacustris, Arthroplea congener, Leptophlebia marginata, L. vespertina, Procloeon bifidum, Cloeon cognatum, C. inscriptum, C. simile, C. dipterum, Caenis moesta, C. robusta.

Of these *Siphlonurus lacustris* is distinguished by great abundance; it is found mainly in marginal pools cut off in the channel from larger streams to larger Carpathian rivers inclusive, within the altitudinal interval from 720 to 315 m above sea level. Other species belonging to this group were found in running waters in the investigation territory to an altitude of slightly over 200 m above sea level, though some of them, i. e. *Leptophlebla vespertana* or species from the group of *Cloeon dipterum*, were found in stagnant waters, also close to the rivers, in the Carpathians at much greater altitudes, *Leptophlebia vespertina* being considered by Landa (1969) a typical form for mountain lakes.

It is difficult to determine the type of distribution of the other five species: *Habrophlebia fusca, Baetis digitatus, B. niger, Centroptilum nemorale*, and *C. parapulchrum*. With the exception of the last named, these species were caught in streams or small rivers with well developed aquatic vegetation. Only *Habrophlebia fusca* and *Baetis niger* attain in them any great abundance. The latter, found also in larger Carpathian rivers, was caught in the altitudinal interval from 630 to 167 m above sea level.

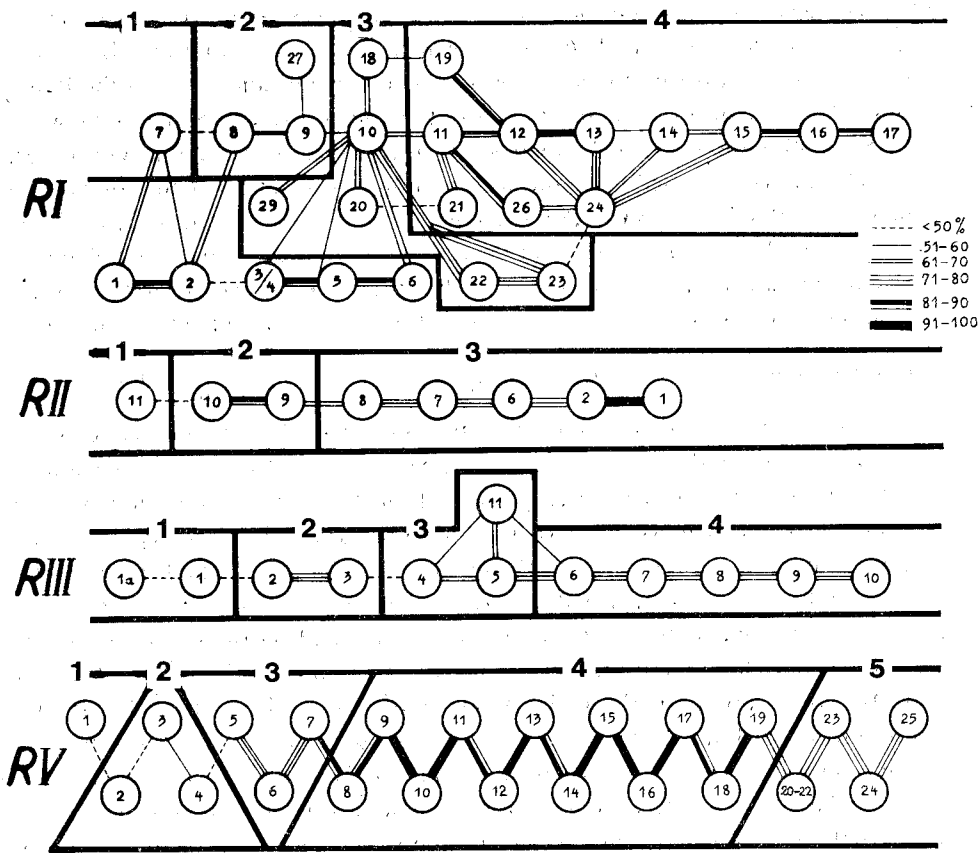
7. Distribution along the water courses

Data on the distribution of mayfly species and their communities along the water systems, mainly along the streams or smaller mountain and piedmont rivers are scattered over a fairly rich hydrobiological literature concerning either this order only or the whole benthos macrofauna. Zelinka (1953) distinguished in the catchment area of Moravica, generalizing also the data from other water systems in Czechoslovakia, several habitation zones of mayfly nymphs successively from the springs: the zone of *Ameletus, Rhithrogena, Ecdyonurus, Oligoneuriella* and *Ephemera*. The adopted criteria for this division was the dominance of characteristic species in the sense of general abundance and number of species in particular zones. For determination of individual ecological zones in smaller streams of the Lipper Bergland and Sauerland in the GFR, Illies (1952) and Dittmar (1955) took into consideration also the distribution of mayflies. Illies (1953) gives detail of habitation of mayfly nymphs along the more than 200 km long course of the Fulda, distinguishing communities and characteristic species for three zoocenoses discriminated in the region of *Salmonidae*. Kawecka, Kownacka and Kownacki (1971) mentioned among the forms determining longitudinal biocenotic zones in the High Tatra streams also *Rhithrogena loyolaea* and *Baetis alpinus*. In spite of the existing literature from which only a part was discussed above, the longitudinal distribution of mayflies in the running waters and the possibly occurring zonation of this distribution are not yet properly known in Central Europe. This refers mainly to larger rivers on their whole length for which only fragmentary materials exist. On the other hand, the existing information on habitation of smaller mountain streams

is often charged with taxonomical inaccuracy especially with regard to species of the families *Heptagenidae* and *Baetidae*, which are most important here. For evaluation of mayfly distribution along the course of streams and rivers in the Polish part of the Carpathians the catchment areas of the Soła, Raba, and San and the water system Suchy-Stonów-Jaworzynka-Skawica in the massif of Mt Babia Góra were chosen. The analysis is based upon the species composition and structure of nymphs dominance (Tables IX, X, XII, XVII) calculated for particular stations as a mean value from all the samples, both quantitative and semiquantitative, and from all habitats distinguished within the station. The degree of similarity in the species composition between communities of two stations was determined by means of a percentage coefficient according to Jaccard's formula: $P = \frac{c}{a+b-c} 100$, in which a denotes the sum of species at one, b — the sum of species at the second of the compared stations, and c — the sum of species common for these two stations. The calculation results are presented graphically in fig. 7. The connection between stations in particular regions (RI, RII, RIII, RV) is expressed by the degree of their qualitative similarity in agreement with the value of the coefficient P given in the list of symbols (legend). In particular water systems the similarity was determined only for neighbouring stations. However, stations situated on the tributaries of the system Rycerka-Soła and one station in the catchment area of the Raba were compared also with stations of the main system and graphically connected with that (or those) with which they demonstrated the closest similarity. Such a way of presenting the results of analysis resulted from finding in the course of analysis that the closest similarity, as to species composition was as a rule shown by neighbouring stations in the given water system; and for stations situated further away this similarity constantly decreases as the result of the progressing exchange of some species for others, which can be observed along the course of a water course both in its lotic and lenitic habitats. In view of the existing gradual exchange of species in the mayfly nymph communities in running waters, it seems that the longitudinal zonation of these communities cannot be made on the exlusive basis of the differences in their species composition. To distinguish different communities the quantitative factor of the degree of changes in the composition of dominants was also considered. Those from the neighbouring stations in which a prevalence of the number of taxonomically different dominants over common dominants occurred were considered to belong to two different zones, in spite of the fact that in some cases they still demonstrated a fairly great species similarity. Stations regarded as belonging in the given water system to the same zone were marked in fig. 7 with a thick line and each of the successive zones was denoted with a large numeral.

7.1. Analysis of mayfly distribution in particular water systems

Along the course of the Rycerka-Soła, including the majority of larger tributaries (fig. 7 RI), at least four zones can be distinguished within which the mayfly communities have a similar character.



Ryc. 7. Schematy podobieństwa w składzie gatunkowym jętek, między sąsiadującymi stanowiskami wybranych systemów wodnych w dorzeczu Soły (RI), Skawicy (RII), Raby (RIII) i Sanu (RV) Stanowiska usytuowane na dopływach systemu Rycerka-Soła (RI) połączono także z tym stanowiskiem lub stanowiskami systemu głównego (7—17), z którymi wiąże je największe podobieństwo. Linie pogrubione, oddzielające grupy stanowisk, wyznaczają strefy wzdłużnego rozsiedlenia jętek wyróżnione na podstawie różnic w składzie dominantów

Fig. 7. Schemes of similarity in the mayfly species composition between neighbouring stations of selected water systems in the catchment area of the Soła (RI), the Skawica (RII), the Raba (RIII), and the San (RV). Stations situated on the tributaries of the system Rycerka-Soła (RI) were also connected with this station or stations of the main system (7—17) with which they are connected by the greatest similarity. Thick lines, separating groups of stations, outline the zones of longitudinal mayfly distribution distinguished on the basis of differences in the composition of dominants

Zone 1. is restricted to station 7, the spring stream Rycerka, in which the community consists of several species of a not fully developed structure of dominance (Table X) with the characteristics *Ecdyonurus subalpinus*.

Zone 2. covers stations 8 and 9. The dominating species are here *Baetis alpinus* and *Rhithrogena iridina*, with a fairly great participation of *Ecdyonurus subalpinus*. In this zone a section of the Żylica within station 27 was included. The number of species in the lower part of the zone increases to over 10.

Tabela IX. Rozmieszczenie i struktura dominacji jętek na stanowiskach w potoku Wielka Puszcza (region I). Wartości z wszystkich terminów badań i z wszystkich siedlisk. Próby ilościowe. Podkreślono gatunki dominujące. a - wysokość npm w m; b - odległość od źródła w km; c - spadek jednostkowy w ‰

Table IX. Distribution and structure of the mayflies dominance at stations in the stream Wielka Puszcza (region I). Values from all investigation data and from all habitats. Quantitative samples. Dominants underlined. a - altitude in m; d - distance from the spring in km; c - gradient in ‰

Stanowisko / Station		1	2	3/4	5	6
Gatunek / Species	a	650	560	440 -450	410	310
	b	0,5	1,2	2,6- 3,6	5,0	8,4
	c	166	50	33 - 36	22	14
Ecdyonurus subalpinus		43,3	12,7	0,1		
Rhithrogena iridina		26,8	53,6	11,8	5,8	2,8
Baetis alpinus		16,8	25,4	9,9	10,3	2,8
Baetis rhodani		8,3	7,0	26,8	28,0	40,2
Habroleptoides modesta		3,6	0,9	17,0	10,5	6,7
Ecdyonurus lateralis		1,2	0,1	0,7	1,0	2,7
Baetis muticus			0,3	2,3	5,7	6,9
Ecdyonurus starmachi				8,9	5,7	
Epeorus sylvicola				5,7	11,4	8,2
Baetis scambus				4,4	4,0	14,8
Centroptilum luteolum				2,9	2,8	2,2
Baetis lutheri				2,7	3,0	2,8
Caenis beskidensis				3,4	2,7	0,3
Ephemerella krieghoffi				1,0	0,3	0,8
Centroptilum pennulatum				0,7	0,2	
Habrophlebia lauta				0,6	2,9	0,3
Ephemerella ignita				0,4	0,3	3,3
Ephemera danica				0,4	0,2	1,6
Ephemerella major				0,2	0,1	0,2
Baetis vernus				0,1		
Ecdyonurus torrentis					5,0	3,4
Ecdyonurus dispar					0,1	
Suma gatunków / Sum of species		6	7	20	20	17

Station 10, in the middle course of the Rycerka, was excluded and treated as a separate zone 3. as the result of the further changes in the composition of dominating species occurring here: *Baetis rhodani*, *Rhithrogena ferruginea* and *Habroleptoides modesta*. With station 10 the value of the similarity coefficient of the following stations is related about 60—80 per cent: 18, 20, 22, 23, and 29, situated in the upper Soła, in the Ujsoła, the Glinny stream, in the Koszarawa, and in the Kocierz stream.

Station 11, in the lower course of the Rycerka, shows a closer similarity in the composition of species and structure of their dominance to stations 12 and 13, situated lower down the Soła, than with station 10, hence it was included with them as a fragment of zone 4. In this zone *Baetis alpinus* is reduced to the level of nondominant, *B. rhodani*, *B. lutheri*, *B. scambus*, *Ecdyonurus dispar*, and *Oligoneuriella rhenana* being dominants and at station 13 also *B. fuscatus*. Into this zone the following stations are also included: 19, 21, 26 and 24 in the upper Soła, in the lower Ujsoła, the Sopotnia, and in the Koszarawa. Classification of further stations in the middle and lower Soła is difficult because of changes in its natural character resulting from human activity. The structure of dominance is changed most distinctly at station 14, probably by pollution of the water with sewage from Żywiec, the total number of species being also distinctly reduced in comparison with the

Tabela XI. Pionowy zasięg jętek w wodach płynących masywu Babiej Góry, zestawione według materiałów z wszystkich stanowisk badań

Table XI. Altitudinal range of mayflies in running waters of the Babia Góra massif listed according to the materials from all investigation stations

Gatunek / Species — Wysokość / Altitude w / in m	1500	1300	1100	900	700
Rhithrogena loyolaea					
Baetis alpinus					
Ameletus inopinatus					
Ecdyonurus subalpinus					
Rhithrogena iridina					
Epeorus sylvicola					
Baetis vernus					
Baetis muticus					
Habroleptoides modesta					
Baetis melanonyx					
Ephemerella krieghoffi					
Ecdyonurus venosus					
Ephemera danica					
Baetis rhodani					
Ecdyonurus lateralis					
Rhithrogena hybrida					
Ecdyonurus carpathicus					
Ephemerella major					
Centroptilum luteolum					
Baetis scambus					
Paraleptophlebia submarginata					
Ecdyonurus torrentis					
Ecdyonurus submontanus					
Rhithrogena ferruginea					
Baetis lutheri					
Rhithrogena semicolorata					
Habrophlebia lauta					
Ecdyonurus dispar					
Baetis fuscatus					
Caenis rivulorum					
Ephemerella ignita					
Ecdyonurus starmachi					
Centroptilum nemorale ?					
Baetis niger					
Caenis beskidensis					
Centroptilum pennulatum					
Caenis pseudorivulorum					
Ecdyonurus insignis					
Suma gatunków / Sum of species	2	2	3	3	4	9	10	15	21	31

neighbouring stations. A negative influence of the water dam at Porąbka on the mayfly communities at stations 15—17 is also noticeable; it is expressed — if one compares this section of the Soła with a similar section in the middle course of the Raba (Table XV) — by a decrease in participation in the relative abundance of *Caenis pseudorivulorum*, *Centroptilum luteolum*, *Rhithrogena semicolorata*, and some other species, and even the elimination of others, e. g. *Ephemera lineata*. With regard to species composition, however, these stations demonstrate great similarity to one another and also to station 24 in the lower course of the Koszarawa and stations 12 and 13 in the Soła. It is probable that before the dam was built they formed within them the same zone. Within 6 stations in the Wielka Puszcza stream two zones can be easily distinguished in the longitudinal distribution of mayflies; one comprises stations 1 and 2 and the other stations 3, 4, 5, and 6. None of the communities in these zones corresponds, however, as to the number of species and their relative abundance with communities of the zones distinguished for the water system Rycerka-Soła and other tributaries of the Soła. The individuality is expressed, above

Tabela X. Rozmieszczenie i struktura dominacji jętek na stanowiskach w systemie wodnym Rycerka-Soła i w niektórych dopływach Soły (region I). Dane z prób ilościowych. Znak + oznacza udział w liczebności wzajemnej mniejszy niż 0,05 %. Pozostałe objaśnienia jak w tabeli IX

Table X. Distribution and structure of mayflies dominance at stations in the water system Rycerka-Soła and in some tributaries of the Soła (region I). Data from quantitative samples. Sign + denotes participation in relative abundance lower than 0.05 per cent. Other explanations as in Table IX

Cieki - Runs	Rycerka - Soła											Górna Soła		Ujsoła		Glinny-Koszarawa			Sopot-nia	Żylica		Ko-cierz
Stanowisko / Station	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	26	27	28	29
Gatunek / Species a	1000	900	700	590	520	445	370	335	290	270	245	590	525	640	520	520	460	400	450	580	340	470
b	0,05	0,9	4,0	8,0	14	26	35	43	58	65	79	2,5	10,5	4,0	10	6,5	11,5	18	13	3,5	19,5	8,0
c	150	90	30	17	10	6,6	4,7	3,5	2,0	1,5	1,1	26	7,0	25	10	28	20	9,0	17	50	8,0	15
Ecdyonurus subalpinus	46,6	3,4																		0,1		
Baetis alpinus	20,0	48,1	79,1	39,1	0,5	0,1	0,5					2,4		22,3	0,9	41,7	0,9		0,3	83,9		9,4
Rhithrogena iridina	16,7	27,5	8,4	0,3										6,7		31,6	0,2			5,7		0,2
Baetis rhodani	16,7	1,0	1,1	26,7	18,0	30,7	9,8	29,9	7,9	3,8	2,2	31,1	19,1	45,6	37,3	14,2	68,9	45,8	3,7	3,8	61,6	51,6
Baetis melanonyx		16,3	6,7											0,8			0,6	0,1	0,2	1,2	1,2	1,0
Ecdyonurus venosus		0,7	0,9	1,1	0,3	0,1								0,8	2,0	0,8	2,4	3,5	5,7	0,3	2,5	2,2
Habroleptoides modesta		0,7	2,2	6,9	11,5	5,6	1,7	2,6	0,2	0,4	0,3	19,9	24,6	3,6	1,0	0,8	4,2	1,7	30,7	0,3	4,9	1,6
Ecdyonurus lateralis		1,4	0,5	0,2	0,3	4,5	2,7	4,5	23,8	1,4	0,8	4,4	10,6	1,0	9,3	4,3	2,9	0,8	1,1	0,5	0,4	4,4
Baetis muticus		0,3	0,2	2,4	9,1	2,2	2,1	0,9	0,1	0,1	0,1	2,9	1,2	9,0	7,4	1,1	1,7	4,3	12,1	+	3,3	0,8
Baetis scambus		0,3	+	0,4	10,8	3,4	6,0	1,0	0,1			7,0	11,2				0,1			1,0		0,1
Ephemerella krieghoffi		0,3	+												0,3	1,3	0,7	1,4	1,2	1,9		2,5
Epeorus sylvicola			0,6	2,2	2,7	1,6	1,2	0,3	0,1				0,2	0,2	0,3	1,2	1,2	0,2				0,1
Centroptilum luteolum			0,2	0,5	0,4	0,1	0,1		0,1	0,1	0,2	0,3	0,2	0,6	1,2	0,3	0,5	0,6	0,3			0,1
Ephemerella major			+	0,2	0,4	0,7	0,2		0,2	0,1		0,5	1,0		4,0	0,5	3,2	2,4	5,2	0,1		2,2
Ecdyonurus torrentis			+	0,7	4,5	5,7	2,6	3,1	1,3	0,6	0,9		2,5	0,4	0,2		0,2		0,1			0,1
Ephemera danica			+	0,3	0,1	0,1	0,1					0,1	0,1	7,6	0,9	0,1	2,5		17,4	0,3		12,1
Rhithrogena ferruginea				15,7	8,7	0,2	0,6					6,8	0,5	3,4	4,6	0,3	6,2	4,4	1,3			0,9
Baetis lutheri				2,2	11,3	10,1	6,2		1,1	0,1	0,1		2,6									
Baetis beskidensis				0,1	0,2	0,6	0,5	0,1					1,2									
Ephemerella ignita				0,1	2,2	2,0	4,4	6,5	17,0	8,4	3,6	5,3	2,6	0,8	7,7	0,5	0,7	5,1	0,6		10,2	1,7
Habrophlebia lauta				0,1	0,2	0,1	0,1	0,1	0,7	0,1	0,1	14,6	0,1	0,2		0,2	0,2	0,5	0,1	+	1,2	0,5
Ecdyonurus submontanus				0,2	0,5	0,8	0,2					1,2	1,0	1,8		0,2						
Caenis rivulorum				0,6	1,9	3,5	0,2					0,4	0,5		4,5	0,1	0,2	0,5	0,2		0,4	
Baetis vardarensis					0,7	1,7	3,4	9,9	6,5	16,7	3,2							5,7	0,2			
Baetis fuscatus					2,6	4,7	34,5	29,4	24,0	47,4	67,2	0,6	7,8	1,1	2,9	0,7	1,2	5,0	7,2		5,7	1,9
Rhithrogena semicolorata					0,9	3,0	3,5	3,0	1,1	0,6	0,5		1,4					6,9	1,7			
Rhithrogena germanica					0,2	0,5	0,2	0,4	0,2	0,1	0,1		0,4					1,4	0,8			
Ecdyonurus dispar					9,1	8,7	6,6	6,5	5,9	4,9	1,6	1,5	5,5		8,6		1,2	3,1	9,8		3,7	
Oligoneuriella rhenana					2,7	1,9	7,1	0,3	1,5	2,0	1,5		1,6		0,2			0,3				
Potamanthus luteus					0,1	0,1	0,1	0,2	0,5	6,2	4,1		+					0,1				
Caenis pseudorivulorum					0,1	4,0	3,3	0,9	0,7	0,2	1,2		1,6		4,3			4,6	0,1		4,1	
Centroptilum pennulatum						0,1	0,2		0,3	0,1	0,2		2,1		0,2			0,3				
Rhithrogena diaphana						1,0	1,3	0,4	0,1	0,4	1,0		0,2					1,1				
Ecdyonurus starmachi						0,1	0,1					0,3										
Paraleptophlebia submarginata						0,1	0,1											0,1			0,8	
Caenis macrura						2,0	0,2		2,6	3,5	1,2											
Ephemera lineata							0,2															
Ecdyonurus insignis									0,5	0,4	1,3											
Ecdyonurus aurantiacus									2,5	2,1	7,5											
Heptagenia sulphurea									0,7	0,1	0,6											
Paraleptophlebia cincta									0,3	0,1	0,2							0,1				
Procloeon bifidum										0,1	0,1											
Isonychia ignota											0,1											
Choroterpes picteti											0,1					0,1	0,1					0,1
Caenis beskidensis												0,4		0,1								
Ecdyonurus carpathicus																				0,1		
Rhithrogena loyolaea																				0,4		
Rhithrogena hybrida																				0,3		
Ameletus inopinatus																						6,5
Siphlonurus lacustris																						
Suma gatunków: / Sum of species:	4	11	15	20	27	32	32	19	27	26	27	19	26	18	21	19	22	26	22	17	13	21

Tabela XII. Rozmieszczenie i struktura dominacji jętek w systemie wodnym Suchy-Stonów-Jaworzyna-Skawica (region II). Dane z prób półilościowych. Pozostałe objaśnienia jak przy tabeli IX.

Table XII. Distribution and structure of mayflies dominance in the water system Suchy-Stonów-Jaworzyna-Skawica (region II). Data from semiquantitative samples. Other explanations as in Table IX

Stanowisko / Station	12	11	10	9	8	7	6	2	1
Gatunek / Species a	1400	1200	1000	820	770	745	690	645	600
b	0,05	0,6	1,5	2,6	3,8	5,4	6,4	7,7	9,5
c	275	275	225	120	28	40	38	27	17
Rhithrogena loyolaea		65,3	42,4	23,5	1,3				
Baetis alpinus		34,7	33,2	27,6	28,9	17,5	14,8	5,6	2,0
Ameletus inopinatus			5,2	16,2	3,9	0,5			
Baetis melanonyx			12,2	11,8	8,6	6,1	4,7	3,4	1,0
Baetis vernus			1,7	0,7					
Ecdyonurus subalpinus			3,5	0,7	0,7				
Rhithrogena iridina			0,6	12,9	19,7	20,3	12,4	6,1	0,5
Baetis muticus			0,6	3,3	15,8	3,3	6,5	3,9	4,3
Epeorus assimilis				0,7	3,3	4,2	8,9	9,5	4,8
Ecdyonurus venosus				2,2	5,9	17,0	4,1	3,3	2,0
Rhithrogena hybrida				0,4	2,0	1,4	0,6		
Baetis rhodani					1,9	9,4	16,0	19,6	19,5
Ecdyonurus lateralis					0,7	3,8	5,2	7,2	7,2
Habroleptoides modesta					5,9	12,7	15,4	16,8	12,1
Ephemerella krieghoffi					0,7	0,9	0,6	0,6	0,5
Ephemera danica					0,7	0,9	2,9	3,8	2,4
Centroptilum luteolum						0,5	1,2	1,7	1,4
Baetis scambus						0,5	0,6	2,8	5,3
Paraleptophlebia submarginata						0,5	0,6	1,1	0,5
Ecdyonurus torrentis						0,5	1,8	3,4	4,8
Ephemerella major							1,2	0,5	0,9
Baetis lutheri							1,2	2,7	8,7
Rhithrogena ferruginea							0,6	2,8	5,3
Ecdyonurus submontanus							0,6	1,1	0,5
Ecdyonurus dispar								0,6	7,7
Habrophlebia lauta								1,7	2,4
Ephemerella ignita								0,6	4,3
Caenis rivulorum								1,1	1,4
Caenis pseudorivulorum									0,5
Suma gatunków / Sum of species		2	9	11	15	17	20	23	24

Tabela XIII. Skład gatunkowy i struktura dominacji jętek w strumieniu łąkowym w Zawoi Widłach (region II). Dane z prób półilościowych. Pozostałe objaśnienia jak przy tabeli IX

Table XIII. Composition of species ans structure of mayflies dominance in the meadow stream at Zawoja Widły (region II). Data from semiquantitative samples. Other explanations as in Table IX

Stanowisko / Station	14
Gatunek / Species a	625
b	1,4
c	5,0
Baetis niger	31,9
Centroptilum luteolum	31,6
Habrophlebia lauta	12,4
Ephemera danica	5,9
Ecdyonurus submontanus	5,1
Ecdyonurus starmachi	4,9
Ephemerella ignita	2,2
Paraleptophlebia submarginata	1,6
Baetis muticus	1,6
Baetis rhodani	1,4
Caenis beskidensis	0,6
Ecdyonurus lateralis	0,5
Centroptilum nemorale ?	0,3
Suma gatunków / Sum of species	13

Tabela XIV. Skład gatunkowy i struktura dominacji jętek w strumieniu leśnym, dopływie Raby (region III). Dane z prób półilościowych. Pozostałe objaśnienia jak przy tabeli IX

Table XIV. Composition of species and structure of mayflies dominance in a forest stream, a tributary of the Raba (region III). Data from semiquantitative samples. Other explanations as in Table IX

Stanowisko / Station	17
Gatunek / Species — a	300
b	0,3
c	160
Rhithrogena iridina	30,8
Baetis muticus	26,7
Baetis rhodani	14,7
Baetis vernus	9,1
Ecdyonurus quadrilineatus	6,8
Ecdyonurus starmachi	4,1
Habroleptoides modesta	2,7
Ephemera danica	1,6
Habrophlebia lauta	1,0
Ecdyonurus carpathicus	0,7
Habrophlebia fusca	0,6
Ecdyonurus lateralis	0,5
Paraleptophlebia submarginata	0,5
Centroptilum luteolum	0,2
Suma gatunków / Sum of species	14

all, in the decreased dominance of *Baetis alpinus* on the whole length of the stream, an extended range of the dominance of *Rhithrogena iridina*, and in penetration within the dominating species for the second zone of *Ecdyonurus starmachi* and *Epeorus sylvicola* (Table IX).

At station 12 in the system Suchy-Stonów-Jaworzynka-Skawica no mayfly

Tabela XVI. Pionowy zasięg jętek w wodach płynących w polskiej części Tatr. +++++ – występowanie okresowe; ----- – występowanie trwałe

Table XVI. Altitudinal range of mayflies in running waters of the Polish part of the Tatras +++++ – periodical occurrence; ----- – constant occurrence

Wysokość / Altitude w m / Gatunek / Species	1800 1600 1400 1200 1000
Baetis alpinus	++++++++++++
Rhithrogena loyolaea	++++++++++++
Ameletus inopinatus	+++
Rhithrogena iridina	
Epeorus sylvicola	
Baetis vernus	
Rhithrogena hybrida	
Habroleptoides modesta	
Ecdyonurus venosus	
Ecdyonurus subalpinus	
Baetis melanonyx	
Baetis muticus	
Baetis rhodani	
Baetis scambus	
Ecdyonurus lateralis	
Rhithrogena ferruginea	
Rhithrogena hercynia	
Ephemerella krieghoffi	
Centroptilum luteolum	
Suma gatunków / Sum of species	2 2 3 3 4 8 9 14 15 19

Tabela XVII. Rozmieszczenie i struktura dominacji jętek na stanowiskach w systemie wodnym Wołosatka-Wołosaty-San (region V). Dane z prób ilościowych i półilościowych. Pozostałe objaśnienia jak przy tabeli IX

Table XVII. Distribution and structure of mayflies dominance at stations in the water system Wołosatka-Wołosaty-San (region V). Data from quantitative and semiquantitative samples. Other explanations as in Table IX

Cieki - Runs	Wołosatka - Wołosaty							San															
Stanowisko / Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20 - 22	23	24	25
Gatunek / Species a	1150	1000	850	770	680	600	560	510	490	410	375	350	342	325	310	297	270	250	220	195 - 178	167	163	158
b	0,5	1,3	3,5	7,5	12,8	19,7	27	66	74	92	109	121	125	136	144	154	171	188	221	266 - 314	357	375	410
c	160	128	28	13	11	9,0	6,0	2,5	4,3	2,2	2,1	2,1	2,0	1,5	1,9	1,3	1,58	1,17	0,99	0,55-0,29	0,25	0,22	0,14
Ecdyonurus subalpinus	100,0	31,4	5,9	0,2																			
Baetis alpinus		42,9	45,2	36,8	16,2	6,7	2,8	0,4	0,6	0,2													
Rhithrogena iridina		24,3	36,1	32,6	3,0																		
Baetis melanonyx		0,7	9,9	2,7	5,6	4,4	0,5	0,1															
Rhithrogena gorganica		0,7	0,4	5,2																			
Baetis rhodani			1,7	7,0	18,1	14,8	14,5	15,1	18,5	9,7	8,1	6,5	3,4	4,1	5,2	3,9	3,3	6,3	1,1	4,4	3,2	0,1	
Baetis muticus			0,2	4,1	5,8	4,4	2,9	2,4	6,6	1,0	2,0	2,3	1,0	1,0	0,8	0,5	0,6	0,5	1,1	0,2			
Habroleptoides modesta			0,2	2,9	9,3	11,1	9,5	1,2	1,5	1,8	2,4	1,9	1,5	2,3	1,9	1,6	1,9	2,2	1,8	0,2	0,4		
Ecdyonurus venosus			0,2	2,9	2,4	0,2																	
Ecdyonurus lateralis			0,2	0,8	2,9	3,7	3,6	0,1	0,1	0,2	0,2	0,2	0,1	0,2	0,2	0,2							
Rhithrogena ferruginea				2,0	13,1	13,4	12,3	1,5	1,9	0,5	0,2												
Baetis scambus				0,4	4,0	6,7	6,1	0,4	1,0	1,6	2,6	1,5	1,0	1,2	0,5	0,5	0,4						
Ephemerella krieghoffi				0,4	0,6	0,5	0,6	0,2	0,1	0,2	0,2	0,2	0,2										
Ephemera danica				0,2	2,1	0,3	0,5	0,2	0,2	0,1	0,2												
Centroptilum luteolum				0,2	0,8	0,3	0,3	0,1	0,8	0,8	1,0	1,0	0,7	1,0	0,8	0,5	0,6	0,8	0,1	0,2	0,2	0,1	0,2
Ecdyonurus carpathicus				0,4																			
Ecdyonurus quadrilineatus				0,2																			
Siphlonurus lacustris					5,3	1,1	0,2	0,5															
Ecdyonurus torrentis					4,3	5,6	3,4	1,1	1,9	2,4	2,4	2,7	1,8	2,1	0,2	0,2	0,2						
Baetis lutheri					1,3	8,1	16,6	2,4	1,5	1,3	1,0	0,4	0,1	0,4	0,2								
Caenis rivulorum					1,3	4,0	0,2																
Ephemerella major					1,1	1,2	3,0	7,7	7,4	6,8	9,9	17,3	24,0	9,8	6,6	6,5	4,6	2,0	0,4	0,7			
Ecdyonurus submontanus					0,9	0,3																	
Epeorus sylvicola					0,5	1,4	1,3	3,4	1,0	1,3	1,2	0,2											
Habrophlebia lauta					0,5	1,1	1,0	0,2	0,2	0,2	0,4	0,2	0,1										
Ecdyonurus starmachi					0,3																		
Rhithrogena semicolorata					0,2	0,9	2,8	11,3	13,3	5,6	6,7	4,2	5,1	5,9	3,4	4,7	6,2	4,1	0,6				
Baetis fuscatus					0,2	1,4	2,8	2,5	6,0	19,7	12,7	12,3	9,8	13,9	12,6	8,4	10,8	10,5	8,6	12,3	13,4	4,3	8,2
Baetis vernus					0,2																	0,4	
Baetis sinaicus						4,4	2,5	0,6	0,5	0,6	0,6	0,4	0,1										
Ecdyonurus dispar						1,8	2,5	4,8	3,0	4,7	4,2	3,1	1,6	1,7	3,7	2,2	2,9	1,8	0,8	1,5	1,2	1,7	1,1
Ephemerella ignita						1,4	3,0	0,8	1,6	1,4	1,4	0,4	0,3	0,4	1,4	1,0	1,7	3,3	0,8	1,1	3,0	4,0	1,6
Rhithrogena germanica						0,4	0,3	0,2	0,7	0,3	0,8	0,9	0,9	1,2	2,3	2,2	2,1	1,5	0,5	0,4			
Baetis beskidensis						0,2	0,3	2,2	2,5	3,5	2,0	2,5	0,7	0,6	0,8	0,6	0,6	0,6	0,1				
Caenis macrura						0,2	0,3	2,6	0,9	0,8	3,0	2,7	4,2	1,9	1,8	2,4	1,2	2,5	0,9	0,4	1,0	1,5	1,8
Oligoneuriella rhenana							0,5	2,6	2,9	3,2	3,5	3,4	2,7	3,9	8,1	4,7	5,8	1,7	1,7	4,4	5,1	0,9	0,1
Procloeon bifidum							2,0	0,4	0,4	0,3	0,2	0,2	0,3	0,4	0,5	0,6	1,0	0,7	6,0		0,8	0,9	0,7
Baetis vardarensis							2,0	33,0	19,9	23,2	19,2	10,0	7,3	10,8	8,2	7,6	8,1	8,0	8,2	3,1	0,6		
Ephemera lineata							1,2	1,0	1,2	1,6	2,8	4,0	3,7	3,7	3,9	7,1	2,5	2,3	0,5	1,1	0,4		
Caenis pseudorivulorum							0,3	0,1	0,1	0,2	1,2	8,8	17,6	19,4	16,6	27,1	23,0	16,3	18,8	15,4	17,4	20,7	22,7
Ecdyonurus insignis							0,3	0,1	0,2	0,3	0,2	0,2	0,7	0,2	0,3	0,3	0,6	0,3	0,2	0,9	0,4	0,1	0,1
Potamanthus luteus							0,2	2,1	2,0	2,3	0,2	2,7	2,7	2,9	2,4	1,4	3,7	3,5	10,0	5,9	0,8	0,4	1,9
Paraleptophlebia submarginata								0,4	0,7	0,2	4,5	0,2	0,1	0,2	0,2	0,2	0,2	0,2	0,1	0,6	0,2	0,2	0,1
Heptagenia sulphurea								0,2	0,1	0,2	0,2	0,6	0,8	0,7	1,0	2,0	1,9	13,3	14,8	6,8	8,5	0,1	0,5
Baetis niger								0,1	0,1		0,6				3,5			0,2		0,6	0,4		
Ecdyonurus macani								0,1			0,1							1,3		1,3	0,2		
Baetis buceratus									0,6	0,8	1,0	0,9	0,7	1,2	1,5	1,7	2,3	1,3	0,7	1,3	0,2		
Centroptilum pennulatum									0,1	1,9	1,0	1,0	0,7	1,6	1,6	2,5	1,9	2,3	0,7	9,2	9,5	13,4	3,6
Centroptilum pulchrum									0,1	1,1	1,2	0,4	0,7	0,6	0,5	0,3	0,2	1,0	0,5			0,1	
Ecdyonurus aurantiacus											1,0	2,7	1,2	1,4	1,1	0,6	0,6	1,2	0,7	0,2	0,6	1,4	0,9
Rhithrogena diaphana											0,2	2,3	2,9	1,9	3,4	2,4	3,1	5,5	1,1	7,4	3,8	0,6	5,8
Choroterpes picteti												1,1	1,2	2,1	3,2	3,9	4,8	1,7	0,6	0,7		0,1	0,1
Pseudocloeon inexpectatum												0,4	0,1	0,4	0,5	0,6	0,4	1,0	4,9	0,6	0,2	0,4	0,9
Heptagenia coerulans													0,1	0,2	0,2	0,2	0,2	0,2	0,4	0,4	0,4	0,7	1,3
Baetis gracilis														0,2	0,2	0,3	0,4	0,8	4,0	7,5	6,5	0,4	0,2
Ephoron virgo														0,2	0,5	0,3	0,9	1,1	3,2	3,3	0,4	3,5	0,1
Ecdyonurus affinis														0,2	0,1	0,8	0,2	0,6	1,4	2,0	7,5	0,8	0,2
Procloeon ornatum														0,2			0,2	0,2	0,3	0,4	3,5	1,6	0,9
Paraleptophlebia cincta														0,2			0,9	0,2	0,5	0,7	0,2	0,2	0,4
Baetis calcaratus														0,2			0,2	0,3	0,1	2,6	1,2	0,4	0,2
Heptagenia flava																				1,7	6,3	6,9	29,8
Isonychia ignota																				0,5	0,2	2,0	2,7
Baetopus tenellus																				0,4	0,2	0,1	0,3
Baetis tricolor																				0,2	3,8	7,3	4,2
Siphlonurus aestivalis																					1,2	0,1	0,1
Oligoneuriella mikulskii																					1,0	7,4	5,1
Ephemerella mesoleuca																					0,6	6,0	1,7
Heptagenia longicauda																					0,4	0,5	0,6
Cloeon dipterum																					0,4	0,1	3,1
Brachycercus harrisella																						1,1	0,6
Oligoneuriella pallida																						0,9	
Brachycercus minutus																						0,8	0,4
Brachycercus pallidus																						0,6	0,2
Centroptilum nana																							0,1
Caenis moesta																							0,1
Leptophlebia marginata																							0,1
Heptagenia fuscogrisea																							0,1
Ametropus fragilis																							0,1
Arthroplea congener																							0,1
Suma gatunków: / Sum of species:	1	5	10	17	25	28	32	35	35	35	36	36	36	35	36	35	36	36	36	38	39	40	42

Tabela XV. Rozmieszczenie i struktura dominacji jętek w systemie wodnym Olszowy-Koninka-Porębianka-Raba (region
Dane z prób ilościowych i półilościowych. Znak + oznacza udział w liczebności wzajemnej mniejszy niż
Pozostałe objaśnienia jak przy tabeli IX

Table XV. Distribution and structure of mayflies dominance in the water system Olszowy-Koninka-Porębianka-Raba
Data from quantitative and semiquantitative samples. Sign + denotes participation of relative abundan
than 0.05 per cent. Other explanations as in Table IX

Cieki - Runs	Olszowy				Koninka	Porębianka	Raba				
Stanowisko / Station	1a	1	2	3	4	5	6	7	8	9	10
Gatunek / Species a	1200	1180	950	780	580	460	370	315	250	210	185
b	0,01	0,2	0,8	2,3	7,1	13,6	36	48	63	89	113
c	260	285	240	72	22	16	4,3	3,9	2,7	0,6	0,6
Baetis rhodani	80,0		1,2	2,2	34,3	37,1	19,5	5,1	2,0	0,7	0,6
Ecdyonurus subalpinus	20,0	28,3	0,9								
Baetis alpinus		51,6	41,0	30,7	26,7	1,9	0,2				
Rhithrogena iridina		15,1	11,0	34,4	1,8						
Rhithrogena loyolaea		5,0	17,4	0,2	+						
Ameletus inopinatus			21,6	11,4	0,1	+					
Baetis melanonyx			5,6	6,9	3,0	0,2	0,1				
Baetis muticus			0,9	7,7	6,2	9,6	7,5	4,5	1,9	0,5	0,5
Ecdyonurus venosus			0,2	1,7	0,2	+	0,2				
Ecdyonurus lateralis			0,1	2,1	0,1	5,8	1,8	0,6	0,6	1,6	0,5
Habroleptoides modesta			0,1	0,5	2,0	7,0	7,0	1,7	1,3	0,7	
Rhithrogena hybrida			+	2,0							
Baetis scambus			+	+	0,7	3,3	2,6	0,1			
Ephemerella krieghoffi				0,1	0,2	+	+	+			
Rhithrogena ferruginea				+	13,0	9,3	0,6	0,4			
Baetis beskidensis				+	+	0,1	0,1	0,4	0,1	0,4	0,5
Baetis lutheri					4,6	15,5	6,7	11,4	2,7	0,3	0,1
Ephemerella major					1,6	0,2	+	+	0,1	+	0,1
Epeorus sylvicola					1,6	0,7	0,1	0,2	0,1		
Ephemerella ignita					1,5	1,0	4,2	3,8	6,1	5,9	11,4
Caenis beskidensis					0,8						
Caenis rivulorum					0,7	1,6	1,2	0,1	0,1		
Rhithrogena semicolorata					0,3	0,3	4,2	3,9	1,9	2,0	1,0
Ecdyonurus submontanus					0,1	0,6					
Ecdyonurus starmachi					0,1	0,1					
Ecdyonurus torrentis					0,1	0,5	0,8	1,1	1,1	1,3	
Ecdyonurus carpathicus					0,1						
Habrophlebia lauta					0,1	0,3	0,2	0,1	+	0,3	0,1
Ephemera danica					+	+	0,1				
Baetis fuscatus						2,3	11,8	14,5	15,1	22,1	31,7
Baetis vardarensis						1,2	23,1	25,8	32,7	11,7	5,4
Ecdyonurus dispar						0,5	2,6	3,4	7,0	4,5	1,2
Caenis pseudorivulorum						0,3	0,4	0,6	13,9	10,7	18,2
Rhithrogena germanica						0,2	0,7	1,1	0,2	0,4	
Oligoneuriella rhenana						0,1	2,2	19,1	2,9	10,2	0,7
Centroptilum luteolum						+	0,4	0,1	0,2	1,3	0,4
Caenis macrura						+	0,8	0,4	1,8	+	1,2
Rhithrogena diaphana							0,4	0,7	0,3	6,7	4,0
Ecdyonurus insignis							0,1	0,1	0,8	3,8	0,9
Baetis vernus							0,1				
Potamanthus luteus							+	0,2	4,8	3,2	4,7
Ephemera lineata							+	0,1	0,2	0,1	0,1
Baetis sinaicus							+	0,1			
Centroptilum pennulatum							+	0,1	0,2	0,3	0,3
Centroptilum pulchrum									0,5	0,5	1,9
Ecdyonurus macani								0,1	0,3	0,5	
Heptagenia sulphurea								0,1	0,2	0,7	0,3
Paraleptophlebia submarginata								+	+	0,7	0,4
Ecdyonurus aurantiacus								+	0,5	3,0	3,2
Siphlonurus lacustris								+			
Heptagenia coerulans									+	0,1	
Choroterpes picteti									+		
Ephemerella notata									+	+	
Heptagenia longicauda									+	0,2	2,7
Procloeon bifidum									+	3,0	0,1
Pseudocloeon inexpectatum									+	0,1	0,1
Procloeon ornatum										0,3	
Baetis calcaratus										0,8	1,8
Baetis gracilis										0,6	3,2
Heptagenia flava										0,3	0,7
Baetis niger										0,2	
Baetis buceratus										0,1	1,8
Ecdyonurus fascioculatus										+	
Paraleptophlebia cincta											0,1
Isonychia ignota											+
Ecdyonurus quadrilineatus											
Suma gatunków: / Sum of species:	2	4	13	15	27	31	35	35	37	41	34

nymphs were found. The other eight stations represent three zones having different communities (fig. 7 RII). The first of them, downstream, is formed by station 11 where the mayfly community includes only two species (Table XII). The second zone covers two stations, 10 and 9, where, among others, *Rhithrogena loyolaea* and *Baetis alpinus* dominate. It is only here that, as a subdominant, *Ecdyonurus subalpinus* appears. The third zone, comprising station 8 to 1, shows a certain differentiation in the arrangement of dominants at particular stations, and the community of station 8 has a transitional character between this and the former zone. In the third zone *Rhithrogena iridina* and *Baetis rhodani* dominate along with *B. alpinus* and in its lower part also *B. lutheri* and *Rhithrogena ferruginea*. *Rh. loyolaea* and the *Ameletus inopinatum* being non-dominants.

In the water system Olszowy-Koninka-Porębianka-Raba (fig. 7 RIII) four longitudinal zones were distinguished showing similarity with the corresponding zones in the water system Rycerka-Soła and partly also with some zones in the catchment area of the Skawica. At station 1a, at the springs of the Olszowy, the presence of only two species (Table XV) was established. Also within station 1 the number of species is small and the dominance structure of the community not fully developed, *Ecdyonurus subalpinus* being a species common for the two stations included in zone 1. Stations 2 and 3, constituting zone 2., show a high degree of qualitative similarity and a similar composition of species dominating in communities. *Baetis alpinus* and *Rhithrogena iridina* dominate here and *R. loyolaea* and *Ameletus inopinatus* are also characteristic dominants. At stations 4 and 5 included in zone 3. the number of species increases considerably. The first dominant is here *Baetis rhodani* and the characteristic dominant *Rhithrogena ferruginea*. Zone 4. is represented by the middle and lower course of the Raba within stations 6 to 10. Communities of this zone are characterized at particular stations by a further increase in the number of species and a change in the structure of dominants. The first dominants are here *Baetis vardarensis* along with *B. fuscatus*. Among other species, *Oligoneuriella rhenana*, *Ephemerella ignita*, and *Caenis pseudorivulorum* dominate. Characteristic species as subdominants, are here *Rhithrogena semicolorata* and *Ecdyonurus dispar*. Station 10 has a somewhat smaller number of species, probably as a result of the pollution of this section of the Raba with sewage from Bochnia.

Along the system Wołosatka-Wołosaty-San (fig. 7 RV) five zones of distribution of mayfly nymphs are distinguished. Zone 1. covers station 1 with only *Ecdyonurus subalpinus* living there. Zone 2. covers stations 2, 3, and 4 in the upper course of the Wołosatka. Communities at these stations, in spite of a relatively small qualitative similarity, are related by the common dominants: *Baetis alpinus* and *Rhithrogena iridina*, *Rh. gorganica* being here the characteristic dominant. In the lower part of this zone the number of species increases to 27. Zone 3. is represented by stations 5, 6, and 7 in the middle course of the Wołosatka and Wołosaty. The first dominant in this zone is *Baetis rhodani* (at station 7 — *B. lutheri*), and characteristic dominants are *Rhithrogena ferruginea*, *Baetis lutheri*, and *Habroleptoides modesta* (Table XVII). The number of species increases to 32. The whole course of the San from station 8 to station 19 is included in the next zone 4. At successive stations

changes in the species composition in communities are very small. *Baetis vardarensis*, *Rhithrogena semicolorata*, and *Ephemerella major* dominate and the number of species at particular stations is almost constant. To zone 5. belong stations 20—25, which are characterized by a fairly distinct similarity in species composition in the communities, though not so great as in the previous zones. Apart from the increased distance between stations, this may result also from the pollution of the lower course of the San with sewage from Przemyśl and Sarzyna. Considering the number of caught species, 38—42 — at particular stations, the pollution of the lower course of the San during the investigations was not yet very great. The community of this zone is characterized by a distinct reduction of participation in the relative abundance and by the subsequent complete disappearance of three species dominating in the previous zone: *Baetis vardarensis*, *Rhithrogena semicolorata*, and *Ephemerella major*. The first dominant here was *Caenis pseudorivulorum*; the dominants include in their composition among others *Heptagenia flava*, *H. coerulans* and *Baetis buceratus*, and locally also *Oligoneuriella mikulskii*. Representatives of *Rhithrogena* recede completely, the number of *Ecdyonurus* species decreases, and the number of species known from large lowland rivers, on the other hand, increases.

The discussed zones of longitudinal distribution of mayflies, compared respectively according to the order of localization in the water system, show great similarity in the four catchment areas. This results from a sufficiently large dispersion of the majority of species on the investigated territory and from similar or approximate longitudinal ranges and mutual exchange of species, especially systematically allied ones, in particular in larger water systems. The types of longitudinal range of particular species at successive stations can be followed on the basis of data presented in Tables X, XII, XV, and XVII. The best examples are supplied by genera richer in species — *Rhithrogena*, *Ecdyonurus*, and *Baetis* — but this refers also to genera poorer in species — *Caenis*, *Ephemerella*, or *Centroptilum*. Except in zone 5., spreading probably till the middle course of the Vistula and thus not investigated over its whole length, it is difficult to find species limited in longitudinal occurrence to one zone only; most frequently they penetrate more or less deeply into the neighbouring zones and some of them, e. g. *Baetis rhodani* or *Centroptilum luteolum*, can be encountered on the whole length of the examined water systems. Replacement of systematically related species proceeds gradually and on a certain length of the stream these species occur concomitantly even if they occupy the same habitat. Differences refer then to the proportions in their abundance. The distribution of *Rhithrogena iridina*, *Rh. ferruginea*, *Rh. semicolorata* or that of *Baetis lutheri*, and *B. vardarensis* can serve as examples. Proceeding from the springs a gradual increase in the number of species at successive stations in noticeable along particular water systems. In the case of streams and smaller rivers the increase rate is quite considerable, while in larger rivers it is slower and the community becomes established at the level of 32—36 species, reaching in the lower course of the San 40 species.

The above-presented longitudinal distribution of mayflies does not exhaust all the possibilities of coexistence of species in the investigated territory. In some smaller streams situated at lower altitudes the species composition of the communities

Tabela XVIII. Rozmieszczenie i struktura dominacji jętek na stanowiskach w Wildze (region VI). Dane z prób półilościowych. Pozostałe objaśnienia jak przy tabeli IX

Table XVIII. Distribution and structure of mayflies dominance at stations in the Wilga (region VI). Data from semiquantitative samples. Other explanations as in Table IX

Stanowisko / Station		1	2	3
Gatunek / Species	a	340	300	225
	b	0,4	1,5	14
	c	25	42	8
Ecdyonurus lateralis		34,8	13,5	3,2
Ephemera danica		26,0	4,2	2,3
Habrophlebia fusca		23,9	6,3	
Centroptilum luteolum		8,7	3,5	2,7
Ecdyonurus carpathicus		6,5		
Habrophlebia lauta			29,6	7,7
Ephemerella ignita			13,4	12,7
Baetis scambus			12,7	7,2
Ecdyonurus quadrilineatus			12,0	
Baetis vernus			8,5	10,4
Ecdyonurus starmachi			4,9	5,4
Baetis muticus			0,7	7,2
Paraleptophlebia submarginata			0,7	0,9
Baetis rhodani				16,3
Heptagenia flava				9,5
Caenis macrura				4,1
Ecdyonurus macani				3,6
Baetis lutheri				3,2
Baetis fuscatus				1,8
Ecdyonurus venosus				1,4
Ephemerella notata				0,4
Suma gatunków / Sum of species		5	12	18

Tabela XIX. Skład gatunkowy i struktura dominacji jętek w strumieniu melioracyjnym i w Drwince (region VI). Dane z prób półilościowych. Pozostałe objaśnienia jak przy tabeli IX.

Table XIX. Species composition and structure of mayflies dominance in the melioration stream and in the Drwinka (region VI). Data from semiquantitative samples. Other explanations as in Table IX.

Stanowisko / Station		4	5
Gatunek / Species	a	200	190
	b	0,5	15,0
	c	2,0	0,5
Baetis vernus		47,6	3,7
Cloeon dipterum		22,1	11,4
Cloeon inscriptum		9,9	8,5
Leptophlebia vespertina		7,6	0,4
Caenis robusta		6,4	
Centroptilum luteolum		3,5	31,1
Cloeon simile		2,3	
Siphlonurus armatus		0,6	
Procloeon ornatum			23,7
Cloeon cognatum			9,0
Ephemera vulgata			5,3
Baetis buceratus			2,1
Baetis tricolor			1,9
Procloeon bifidum			0,9
Caenis macrura			0,7
Habrophlebia fusca			0,6
Heptagenia fuscogrisea			0,4
Baetis digitatus			0,2
Caenis moesta			0,1
Suma gatunków / Sum of species		8	16

and the structure of dominance of species are quite different. An individual community is shown by the meadow stream at Zawoja Widły in the catchment area of the Skawica (Table XIII). The absence of species of the genus *Rhithrogena* and generally poor presence of *Heptageniidae* is striking as well as the decisive dominance of *Baetis niger* and *Centroptilum luteolum*, which in communities of the main water systems have a much smaller participation. An individual community is also found in a forest stream, a tributary of the Raba near Droginia (Table XIV), in spite of the fact that the general character is similar to the upper sections of the highland streams. Though *Rhithrogena iridina* is the first dominant, it is striking that *Baetis alpinus* is completely absent, probably because it fails to find here proper thermal or current conditions. Other examples of different longitudinal communities are found in the Wilga (Table XVIII), the stream near Kłaj, and the Drwinka (Table XIX). It may be supposed that the communities of smaller streams of the piedmont and upland territories will show greater differentiation in the regional sense in comparison with those of the main Carpathian streams.

7.2. General characteristic of the communities of mayflies and of the zones occupied by them along the Carpathian running waters

Taking as basis the communities of mayfly nymphs in the previously discussed water systems in the catchment area of the Soła, Skawica, Raba, and San as well as the analysis of species distribution and their abundance in the Dunajec and its tributaries from the Tatras and the Gorce and also the data from literature (Kamler 1960, 1962, Kownacka, Kownacki 1965, Kownacka 1971, Ciszek, Sosińska 1965) a certain number of longitudinal zones were distinguished, these being inhabited by different mayfly communities as to species composition and dominance structure. The distinguished zones and their arrangement have in the examined territory a recurrent character in particular water systems with, however, the following limitation: with regard to larger and small streams they refer to those of them whose springs are situated at an altitude of about 700 m above sea level at least and which flow down across wooded territories, eroding distinctly formed gorges or valleys, and join gradually into larger hydrographical units. Hence, the communities of other small streams, especially those situated at a lower altitude, as well as of some smaller rivers of the plateau are not included in the subsequent division.

Zone O. covers the springs and more or less short initial sections of streams, including also those which periodically drying up. Mayflies do not occur there at all or, if they do then, habitation of this zone by young nymphs of some species from the next zone — usually *Baetis alpinus* — is brief and limited to certain periods of the year. The length of this zone is in the streams of the Beskids from a few to many metres. In the Tatra streams it can be much longer (Kownacka 1971).

Zone 1. extends orer the stream section lying near the spring in shallow-cut forest gorges or on the slopes of valleys and at higher altitudes also in the mountain pines zone. Mayfly communities have there a permanent character but still consist

of a small number of species (1—5). The structure of dominance is not fully developed and the community abundance low. In the regional sense one of the two following varietes of mayfly communities occur in this zone, in dependence on the environmental and especially climatic conditions, this being connected with the altitude above sea level. In the majority of the Beskid streams the community of this zone consists of 1—5 species of which *Ecdyonurus subalpinus* is a characteristic one, often accompanied by *Baetis rhodani* and *B. alpinus*, sometimes even more abundant. In some streams of Mt Babia Góra and in the streams of the Tatras a community composed of 1—3 species occurs, with *Rhithrogena loyolaea* as characteristic and occurring together with *Ameletus inopinatus* and *Baetis alpinus*. Zone 1. extends in the Beskids at an altitude of 700 to about 1600 m above sea level, and in dependence on it, its length being from 0.5 to 1 km. The sections of streams lying in this zone are characterized by a high unitary gradient (300—100 pro mille) and a relatively high stability of water flow. The water temperature is low in summer and shows a small amplitude of variations during the year. In the Tatras this zone is longer and covers stream sections up to 1600 m above sea level (Kownacka 1971).

Zone 2. covers the middle and lower courses of larger Tatra and Babia Góra streams and the middle and partly also the lower sections of the Beskid ones. In the majority of the Beskid streams this zone is inhabited by a community composed of 6 to 20 species having a fully developed structure of dominance and a characteristic dominant *Rhithrogena iridina* which, alternately with *Baetis alpinus* is there also the first or second dominant. Among other species, the participation in relative abundance of *Ecdyonurus venosus*, *Epeorus sylvicola*, and *Rhithrogena hybrida* is also high. In the Olszowy stream and in the streams of Mt Babia Góra (probably also in the streams flowing down from Mts Pilsko and Skrzyczne in region I) and in the Tatra streams the discussed community occupies a lower part of zone 2. In its upper part, however, a different community is formed consisting of 6 to 13 species in which the first three dominants are *Rithrogena loyolaea*, *Baetis alpinus*, and *Ameletus inopinatus*, *Rhithrogena iridina* having a much smaller participation in the relative abundance or even being a nondominant. In these streams zone 2. is thus divided into two sub-zones: sub-zone 2a — situated higher, where in the community of mayflies high mountain species occur among the dominants, and sub-zone 2b — situated lower where in the community of mayflies the mentioned species are absent, either not occuring there at all or at least as dominants. In the Beskid streams zone 2., extends at an altitude of about 500 to 1100 m above sea level (sub-zones 2a and 2b in the interval 800 to 1100 m and 500 to 800 m above sea level respectively). It begins at a distance of 0.7 to 1.5 km from the spring, depending on the situation of the stream, and ends at a distance of 2.5 to 9 km, the length of sub-zone 2a being shorter in the Beskids and not exceeding 2 km. The unitary gradient of the streams within zone 2. varies from 250 to 15 pro mille the width of the stream bed being 1.5 to 15 m. The respective sections of the streams are most frequently shaded to a great extent by forest, annual water temperature variations being from 6—15°C.

Zone 3. is constituted by the lower sections of medium sized or large Beskid streams

and smaller mountain rivers or even the initial sections of the main Carpathian rivers. The community of mayflies of this zone is composed of 20 to 27 species, the first dominant being *Baetis rhodani* and characteristic dominants *Rhithrogena ferruginea* and *Baetis lutheri*. A high relative abundance is also often attained in this zone by *Habroleptoides modesta, Baetis muticus*, and *B. scambus* entering the composition of dominants or subdominants. In the upper part of the zone also *B. alpinus* is sometimes a dominant, together with the already receding *Rhithrogena iridina*. In the lower part of the zone also *B. vardarensis, Oligoneuriella rhenana, Rhithrogena semicolorata*, and even *R. diaphana* are subdominants or nondominants. The community of this zone shows a fairly great regional differentiation in the structure of dominance of species and in their composition, this being the result of the greater variety of biotopes constituting this zone and also of the greater possibility of immigration of species from the neighbouring zones and also from water bodies not taken into consideration in this division. The zone begins at an altitude of 450 to 750 m above sea level and at a distance of 4—9 km from the springs, sometimes even — in an open territory and with a smaller gradient of the riverbed — at a distance of 2.5 km (upper Soła). It extends over a distance of a few or more kilometres, depending on the altitude and character of the catchment basin. The unitary gradient of sections belonging to this zone is 30 to 4.0 pro mille, and the breadth of the stream bed 2—16 m. In the riverbeds short lenitic sections occur alternately with long lotic sections. The amplitude of water temperature variations is in the annual scale 18°C, sometimes slightly exceeding 20°C.

Zone 4. covers the middle and the lower course of the Soła, the Raba, the middle course of the San from Dwernik to Przemyśl, and probably also the whole middle and lower course of the Dunajec at least from Nowy Targ down. The characteristic dominant in its community is *Baetis vardarensis* which, along with *B. fuscatus* and in the lower part of the zone also with *Caenis pseudorivulorum*, is one of the first dominants. Characteristic species of this zone, as dominants or subdominants are also *Rhithrogena semicolorata, Rh. germanica*, and *Rh. diaphana*. Apart from these, a great relative abundance is attained by *Baetis rhodani, B. lutheri, Ecdyonurus torrentis*, and *E. dispar*, and in the lower part of the zone by *Ephemerella ignita* and *Potamanthus luteus*. Taking into consideration the unpolluted sections, 32—36 species occur on the average at the station and sometimes even 41 species. The zone begins at an altitude of 300—550 m above sea level. In the San it ends at an altitude of about 200 m above sea level and in other rivers at their issue into the Vistula. It begins at a distance of about 10 to 30 km from the springs and its length is at least some tens of kilometres, reaching in the San a length of about 200 km. The average width of the river within the zone is 8—40 m and in the San even up to 70 m, the unitary gradient reaching the value 17—0.6 pro mille. In the riverbed lenitic sections are formed alternately with comparatively shorter and shorter lotic parts. Except for the section of the San in the Bieszczady Mts there lies in the riverbed a large stone shelf in which the water can change its course. Variations of water temperature in the course of the year reach 27°C.

Zone 5. is formed in the investigation area only by the lower section of the San below Przemyśl. As discussed in the previous chapter of the present paper (7.1.), species of the genus *Rhithrogena* become nondominant. *Caenis pseudorivulorum* becomes the first dominant and, apart from it, *Baetis buceratus*, *Heptagenia flava*, *Ephemerella mesoleuca*, and *Oligoneuriella mikulskii* are the characteristic dominants. The community consists of 38—42 species at the station. The zone begins at an altitude of about 200 m above sea level and at a distance of about 230 km from the spring. The gradient of the riverbed varies from 0.55 to 0,14 pro mille, the width being 50—80 m. The lotic sections gradually disappear and the river flows with a laminary current. Unlike the previous zones, the bottom is mostly sandy with mud sediments. Annual variations of water temperature reach 28—30°C.

8. Quantitative analysis of mayflies in the catchment area of the River Raba

8.1. Abundance of mayflies in various habitats along the water system Olszowy-Koninka-Porębianka--Raba

For analysis of the distribution of mayflies and their abundance in habitats on a stony bottom stations 1—8 were chosen in the catchment area of the Raba (region III). At stations 1—4 only two habitats were distinguished: stony bottom with fast or very fast current (A) and a stony-gravel bottom with addition of mud and detritus in a slow or very slow current (B). At a further four stations three other habitats were distinguished apart from them: a stony-gravel bottom of shallow riffles in a fast or moderate current (As), stony bottom with a thin layer of mud and detritus in lenitic parts of the riverbed with a slow current (Ba), and a stony bottom in deeper places with a moderate current (Ab). In Table XX the mean habitation densities of species and higher taxons are presented, calculated for habitats at successive stations from all quantitative samples collected on seven dates in the year 1969/1970. Numerical values of habitation density of all taxons were referred to 5 dcm^2 of bottom area.

8.1.1. Stony bottom in a fast or very fast current (A)

This habitat has at stations 1—4 a fairly similar character. It consists in the great majority of large poorly rounded stones or boulders. At an average water level it is fairly shallow immersed, the water current being multi-directional. At further stations a corresponding habitat is usually found under a deeper water layer in the middle of the riverbed or at one of the banks. The community abundance of the habitat is very small at station 1, increasing considerably at the two next stations and attaining 70 specimens/5 dcm^2 bottom area at station 3, mainly owing

Tabela XX. Liczebność jętek w siedliskach systemu wodnego Olszowy-Koninka-Porębianka-Raba. Wartości średnie z prób ilościowych, z wszystkich terminów badań roku 1969/1970. Liczby okazów podane w przeliczeniu na 5 dcm^2 powierzchni dna.
++ - liczebność poniżej 0,05; + - liczebność poniżej 0,02

Table XX. Number of mayfles in habitats of the water system Olszowy-Koninka-Porębianka-Raba. Mean values from quantitative samples from all investigation data from the year 1969/1979. Numbers of specimens are calculated per 5 dcm^2 of the bottom area.
++ - numbers below 0.05; + - numbers below 0.02

Cieki / Rums	Olszowy					Koninka		Porębianka				Raba														
Stanowisko / Station	1	2		3		4		5				6					7					8				
Siedlisko / Habitat	A	A	B	A	B	A	B	A	Ab	Ba	B	A	Ab	As	Ba	B	A	Ab	As	Ba	B	A	Ab	As	Ba	B
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Potamanthus luteus																										
Ephemera danica							0,1				0,5		0,1			0,5	0,3			0,2	0,4	3,7	4,3	1,8	1,3	5,7
Ephemera lineata																0,1										0,1
Ogółem / Total Ephemeridae							0,1				0,5					0,6										0,1
Rhithrogena germanica								0,6	0,3	0,2	0,1	0,6		2,0	0,3		1,6	0,6	4,3	0,8	0,1			0,8		
- hybrida		++		1,3																						
- loyolaea	0,4	10,1	10,8	0,1	0,3	++																				
- iridina	0,6	6,3	4,4	25,0	12,3	2,1																				
- ferruginea				0,1		18,0	9,8	16,1	16,8	5,9	2,7	0,3	++	0,5				2,7	2,8	0,2						
- semicolorata						0,6	0,3	0,3	0,2	1,5		4,0	1,2	8,0	0,2	1,3	4,1	0,4	15,9	1,4	0,3	4,0	0,8	1,9	0,3	
- diaphana												0,4		1,5			0,4	0,2	0,9	0,2	0,3	0,4				
- spp., juv.						0,9	0,4																			
Epeorus sylvicola						3,0		2,4	1,2		0,1	0,1					0,1			0,1		0,2		0,3		
Ecdyonurus subalpinus	0,9		1,0																							
- carpathicus							0,1																			
- macani																	0,2	0,1								
- torrentis						++	0,1	0,3	0,5	1,6	1,8	0,4	1,2	1,0	0,6	0,4	0,4	0,6	6,9	0,8	0,8				1,0	0,3
- venosus				0,9	1,8		0,2						0,3			0,1										
- starmachi						++	0,4	0,1	0,7	0,4	1,0															
- submontanus							0,7	0,4	0,2	0,6	1,3															
- dispar								0,1	0,7	2,5	0,7	0,2	1,1	1,8	6,3	2,2	0,9	0,3	2,6	3,0	10,0	0,7	0,5	5,0	5,3	10,9
- insignis													0,1			0,3				0,1	0,1	0,1		0,5	0,3	0,4
- aurantiacus																				0,1						0,5
- lateralis			0,6	0,6	4,4	++	1,0	0,4		2,4	1,8	0,2	0,5	2,2	1,6	0,5	0,2	0,6	2,6	0,3						0,1
- spp., juv.																						0,6	1,2	1,3	2,8	2,2
Heptagenia sulphurea																	0,1			0,1						0,1
- longicauda																										+
- flava																										
Heptageniidae div. gen., juv.	0,9		3,0	1,7				0,3	0,2				0,8	3,5			0,2	1,0								
Ogółem / Total Heptageniidae	2,8	16,4	16,8	31,0	20,5	24,7	13,0	24,0	20,8	15,1	9,5	6,2	5,2	20,5	9,0	4,8	8,2	6,5	36,0	7,1	11,6	6,0	2,5	10,1	9,7	14,5
Habroleptoides modesta			0,1	0,3	0,7	1,1	7,8	6,3	4,5	11,6	11,1	2,7	3,0	1,2	5,3	11,3	0,2	0,6	6,5	0,8	1,1	0,7	0,2		0,7	0,5
Habrophlebia lauta							0,1			2,5	0,6	0,2			0,2	0,4	0,1		0,1		0,1					
Paraleptophlebia submarginata																										0,3
Ogółem / Total Leptophlebiidae			0,1	0,3	0,7	1,1	7,9	6,3	4,5	14,1	11,7	2,9	3,0	1,2	5,5	11,7	0,3	0,6	6,6	0,8	1,2	0,7	0,2		0,7	0,8
Ameletus inopinatus		0,3	20,3	0,1	36,2	0,1	0,1				0,1															
Baetis alpinus	2,2	33,6	2,3	27,7	0,3	48,2	1,1	1,9	1,0				0,5													
- melanonyx		6,5		2,5		0,6		0,6			0,2	0,1	0,1		0,1											
- lutheri						4,2	0,6	43,0	20,2	2,0	3,5	11,6	1,7	27,7	0,1	0,9	16,3	5,0	35,1	5,6	0,2	4,6	9,3		1,8	0,1
- vardarensis								2,2	3,7			20,9	1,7	60,5	0,1	1,4	31,1	6,7	70,8	5,9	0,1	30,5	1,2	115,8	2,0	0,6
- rhodani		++	1,4	2,5	1,6	36,3	8,6	58,2	59,7	5,6	7,7	18,6	12,0	38,9	3,4	0,6	2,6	11,0	9,4	0,5	0,7	0,8		7,9	0,5	
- vernus													0,1	0,3												
- beskidensis				+			0,1					0,1				0,4		0,3	1,0	1,2	1,1					0,1
- fuscatus								1,9	10,5	1,2	0,5	8,1	4,5	26,0	11,3	3,8	6,5	4,0	30,6	24,0	15,1	15,3	1,5	24,4	2,8	7,1
- scambus			0,1	0,1		++		1,0	4,3	2,7	7,1	0,4	1,0	1,8	1,9	2,0			0,3	0,2						
- mutious		0,5	0,6	7,5	5,6	5,9	7,1	14,3	9,7	3,9	3,6	8,5	4,8	18,3	0,9	0,2	3,6	1,7	14,8	5,1	1,4	1,3	0,8	1,9	1,3	0,3
- spp., juv.						19,0	5,0	34,8		9,6	3,8	0,6	3,3		0,3	1,1	1,4			1,7		0,3	2,7	9,0	0,8	0,9
Centroptilum luteolum											0,1		0,1		0,2	1,6				++						0,2
- pennulatum																0,1					0,1		0,3		1,0	1,1
Ogółem / Total Baetidae	2,2	40,6	4,4	40,3	7,5	114,2	22,5	157,9	109,1	25,0	26,5	78,1	29,8	173,5	18,3	10,3	61,5	28,7	126,0	44,2	18,7	52,8	15,8	159,0	10,2	10,4
Oligoneuriella rhenana								0,4	0,2			3,8	0,8	3,9	0,3	0,1	8,1	4,5	112,5	2,1	0,2	3,5	5,8	0,5	3,8	
Ephemerella ignita						0,9	1,7	0,5	5,9	1,3	2,0	3,9	2,8	0,7	4,5	2,2	1,1	3,0	0,9	3,8	10,3	2,5	0,7	6,9	2,7	4,5
- notata																						0,1				
- krieghoffi					0,2	0,4	0,3				++															
- major						1,0	4,5	0,2		0,5	++		0,1												0,2	0,1
Ogółem / Total Ephemerellidae					0,2	2,3	6,5	0,7	5,9	1,8	2,1	3,9	2,9	0,7	4,5	2,2	1,1	3,0	0,9	3,8	10,3	2,6	0,7	6,9	2,9	4,6
Caenis rivulorum						0,7	0,4	0,8	0,2	4,9	4,2	0,9	0,4	0,2	0,4	1,7				1,0		0,1				
- beskidensis							1,8																			
- pseudorivulorum								++		1,1	1,1	0,4	0,6	0,3	0,1	0,4	0,2		0,3	2,5	2,1	6,0	3,8	9,8	1,8	6,6
- macrura										0,3		0,1	0,5		0,4	2,2	0,2	0,7	1,0	0,2		0,2	1,7		0,3	1,9
- spp., juv.																			0,5							
Ogółem / Total Caenidae						0,7	2,2	0,8	0,2	6,3	5,3	1,4	1,5	0,5	0,9	5,3	0,4	0,7	1,8	3,7	2,1	6,3	5,5	9,8	2,1	8,5
Ogółem / Total Ephemeroptera	5,0	57,4	41,6	71,7	65,1	143,2	52,3	187,1	140,7	62,3	55,7	96,3	43,3	200,3	38,5	35,3	78,9	44,0	319,8	61,9	44,5	75,6	34,8	188,1	30,7	44,6

to participation of *Baetis alpinus*, *Rhithrogena loyolaea* (station 2), and *Rh. iridina* (station 3). In the Koninka stream at station 4, the community almost doubles in abundance in comparison with station 3, this probably being the effect of insolation of the stream after it leaves the wooded territory and of a richer development of the algae, i.e. feed stock. *Baetis alpinus* reaches here the greatest abundance (48 specimens) and along with it the participation of *B. rhodani* decides the abundance of this community. The greatest abundance is reached by the community at station 5 in the Porębianka — nearly 190 specimens — consisting mainly of the representatives of the genus *Baetis*, *B. rhodani* and *B. lutheri*, and, to a smaller extent, also *B. muticus* (Table XX). At station 6 in the Raba near Kasinka the abundance of the community of this habitat decreases almost by half and a further decrease is also noticeable at the net two stations, though it is so pronounced. The greatest abundance is still recorded for the genus *Baetis*, especially for *B. vardarensis*, and at station 7 *Oligoneuriella rhenana* is also very abundant.

8.1.2. Stony bottom in shallow riffles (As)

This habitat appears distinctly at stations 6—8 in the River Raba. The bottom is built mostly of small stones and coarse gravel, the water layer being shallow. At all three stations the nymphs community is the most abundant as compared with other habitats. Especially abundant here is *Baetis vardarensis*, which at station 8 reaches a mean density of habitation of 116 specimens, hence 4 times more than in habitat at this station. In comparison with habitat A, almost twice as abundant in the shallow riffles are: *B. lutheri*, *B. scambus*, *B. muticus*, and *Rhithrogena semicolorata*.

8.1.3. Stony bottom in a moderate current (Ab)

This habitat covers fairly great areas of riverbed beginning from station 5, occupying across, the lotic zone, the places situated between the lotic and marginal fragments of the riverbed with a slow current, as well as some parts of the lenitic zone. The substratum, does not distinctly differ, from the substrate of habitat A. The community of this habitat at stations 5—8 is distinctly less abundant than the previously discussed ones, the relative abundance not exceeding 50 specimens and only at the station 5 reaching 140 specimens/5 dcm^2 bottom area. As to the species composition, the habitat does not differ distinctly from habitat A, some rheobiontic species having here, however, much lower numerical values of mean habitation density (Table XX).

8.1.4. Stony bottom in lenitic parts (Ba)

This occupies large sections of the riverbed at stations 5—8. The water current in the places where the material was collected did not exceed 0.25 m/sec. The stones are usually covered with a thin layer of mud sediment. In this habitat too, the commu-

nity abundance is noticeably lower than in habitats A and As. Habitation density of species of the genus *Baetis*, from which only *B. fuscatus* reaches here a fairly great abundance — up to 24 specimens at station 7 — is decreased above all.

8.1.5. Stony or stony-gravel bottom in the marginal part of the riverbed (B)

In comparison with the previous ones this habitat presents greater differentiation in the composition of the substratum which forms it, also in dependence on the degree of development of the investigated water system. Marginal parts in the slow or very slow current in which the stony substratum has a fairly great admixture of sand and mud with detritus are included in it. In fragments closest to the banks the stones are usually partly emergent. The general abundance of the community of this habitat at stations 2 and 3 is only slightly smaller than in habitat A, this being influenced by the habitation density of *Rhithrogena loyolaea* and *Rh. iridina* (station 2) which develops on a similar way at the two habitats. The species composition of the communities of the two habitats at these stations is also similar. At station 4 the habitation density of the community of the habitat B is maintained on a similar level, as, with small variations, it is at successive stations. The majority of species do not exceed at station 4 or in further ones 1—2 specimens of mean habitation density and only participation of *Habroleptoides modesta*, *Ephemerella major*, *Rhithrogena ferruginea*, *Baetis muticus*, and *B. rhodani* can be greater, not exceeding, however, 10 specimens. At station 8 *Ecdyonurus dispar* (Table XX) is abundant. In this habitat the abundance of species of the genus *Baetis* decreases, *B. fuscus* being here of a certain importance as to quantity — up to 17 specimens at station 7.

It follows from the presented analysis that the species composition of the community and their abundance gradually change in each of the distinguished habitats with the water course (Table XX) and that the communities of habitats within a station are fairly similar as to species composition. The qualitative similarity becomes comprehensible when we consider the active migration of larvae of particular species within the riverbed at a station and their being passively carried along with the water current and subsequently settled in habitats or biotopes atypical for them where they can stay for a period of time. For the analysis of similarity or difference between mayfly communities of habitats two conclusions can be drawn. A comparison should be made within a station and be based upon the abundance of species. Such comparisons were made at stations 6 and 7 using Jaccard's formula and taking as basis the mean values of the habitation density of species. The results of calculation for five habitats are presented in Table XXI. At these two stations the greatest relative similarity is shown by habitats A and As, on the one hand, and habitats B and Ba on the other. These pairs of habitats could thus be regarded as structural parts of two larger zones within the station: the lotic and lenitic zones. The two groups of habitats are fairly distant from each other. Habitat Ab shows, with reference to mayfly communities, features transitional between two groups of habitats, being

Tabela XXI. Procentowe wartości współczynnika podobieństwa ugrupowań jętek dla pięciu siedlisk (A, Ab, As, B, Ba) na stanowisku 6 (po lewej stronie u dołu) i 7 (po prawej stronie u góry) w rzece Rabie (region III)

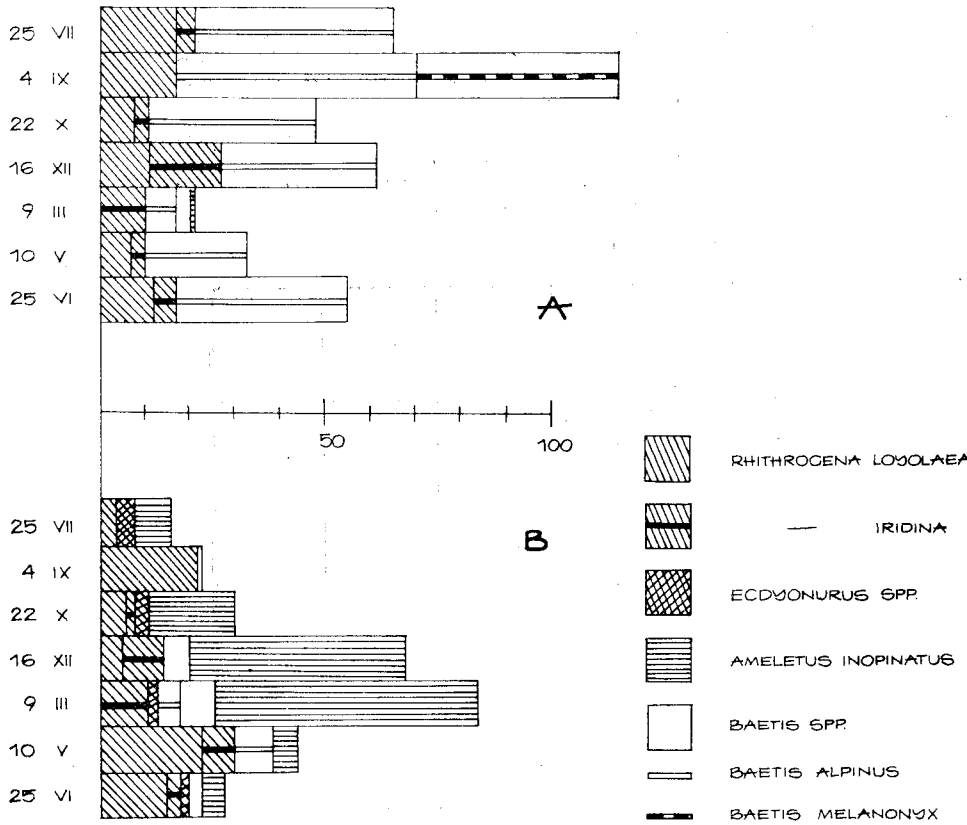
Table XXI. Percentage values of the similarity coefficient of mayfly communities for five habitats (A, Ab, As, B, Ba) at station 6 (on the left side at the bottom) and 7 (right side at the top) in the Raba (region III)

	B	Ba	Ab	A	As
B		39,3	15,7	11,7	7,4
As			32,0	28,6	16,1
A	43,1			26,2	12,1
Ab	12,8	33,7			24,0
Ba	11,7	19,7	32,1		
B	6,9	14,7	25,2	34,7	
	As	A	Ab	Ba	B

closest to habitat A, and thus to the lotic zone. In spite of this similarity, even habitats A and As and habitats B and Ba show a certain individuality in the abundance of the community of mayflies and should be distinguished in further investigations.

8.2. Seasonal changes in abundance of mayflies in habitats of several stations in the catchment area of the Raba

For investigations on changes in mayfly abundance in particular types of habitats during the season, stations 2.4, and 8 were chosen. They represent different zones in the longitudinal distribution of mayfles in the catchment area (chapter 7.1.). The results of calculations of mean habitation density for particular dates of the year 1969/70 are graphically presented in figs. 8—10. Quantitative samples from

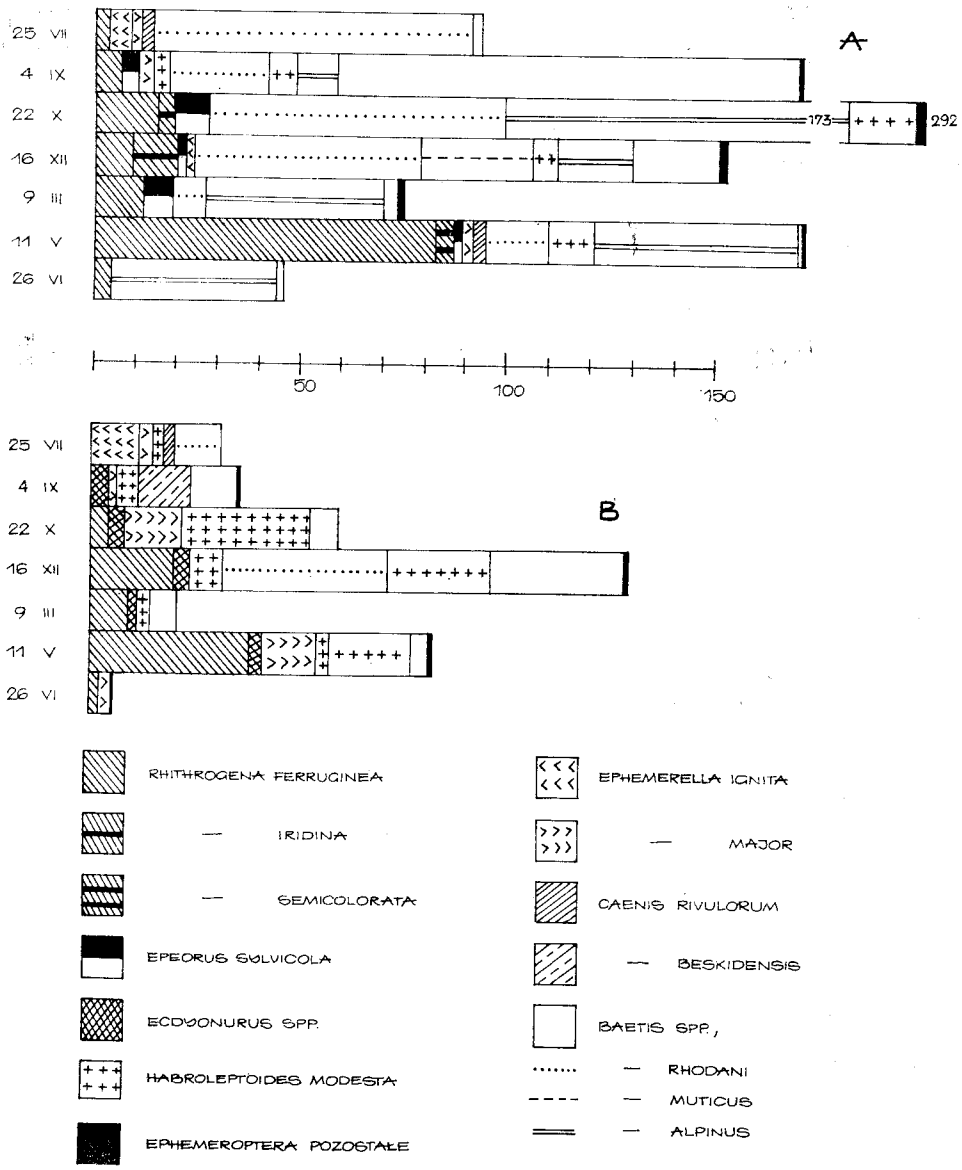


Ryc. 8. Liczebność jętek w kolejnych terminach badań, w roku 1969/1970 na stanowisku 2 w potoku Olszowym (region III). A — dno kamieniste w nurcie; B—dno kamienisto-żwirowe na obrzeżach i w głęboczkach. Wysokość słupka przedstawia liczbę okazów na 5 dcm² powierzchni dna. Uwzględniono te gatunki, które co najmniej w jednym terminie miały liczebność nie mniejszą niż 2 okazy, a w przypadku gatunków z rodzaju *Baetis* nie mniejszą niż 5 okazów

Fig. 8. Mayfly abundance on successive dates of investigations in 1969/1970 at station 2 in the Olszowy stream (region III). A — stony bottom in the current; B — stony-gravel bottom at the edges and in deep places. Height of the column presents the number of specimens on 5 dcm² bottom area. Species were considered whose abundance was at least on one date not less than 5 specimens

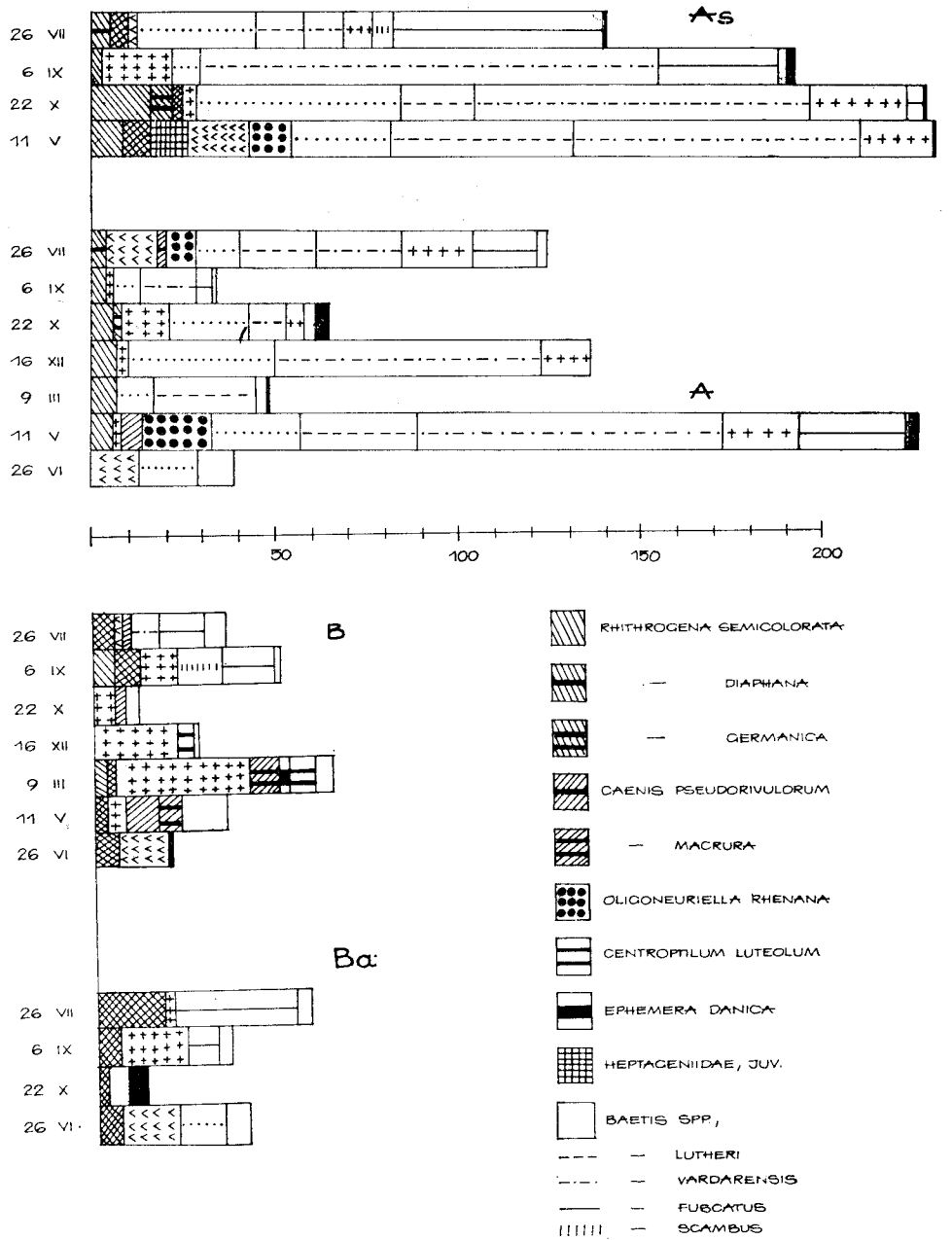
particular stations constituted the basis for calculation. Only those species were taken into consideration which were represented in the given habitat on at least one date by 2 or more specimens/5 dcm² bottom area, or in the case of the species of the genus *Baetis* by at least 5 or more speecimens/5 dcm² bottom area.

In the Olszowy stream at station 2, representing zone 2., in habitat A, the community of mayflies, consisting for the most part of *Baetis alpinus* and *B. melanonyx* mostly at young stages (fig. 8), reached a maximum abundance of 115 specimens in September. The total community abundance of habitat B in comparison with the previous one is considerably lower on successive dates, except for two winter dates when *Ameletus inopinatus* occurred in great numbers. In March 80 specimens of which 57 specimens belong to *A. inopinatus*, were observed.



Ryc. 9. Liczebność jętek w kolejnych terminach badań w roku 1969/1970 na stanowisku 4 w potoku Koninka (region III). A — dno kamieniste w nurcie; B — dno kamienisto-żwirowe na obrzeżach i w miejscach o wolnym prądzie. Wysokość słupka przedstawia liczbę okazów na 5 dcm² powierzchni dna. Uwzględniono te gatunki, które co najmniej w jednym terminie miały liczebność nie mniejszą niż 2 okazy, a w przypadku gatunków z rodzaju *Baetis* nie mniejszą niż 5 okazów

Fig. 9. Mayfly abundance on successive dates of investigations in 1969/1970 at station 4 in the Koninka stream (region III). A — stony bottom in the current; B — stony-gravel bottom on the borders and in places of slow current. Height of the column presents the number of specimens on 5 dcm² bottom area. Species were considered whose abundance was at least on one date not less than 5 specimens



Ryc. 10. Liczebność jętek w kolejnych terminach w roku 1969/1970 na stanowisku 6 w Rabie (region III). A — dno kamieniste w głównym nurcie; As — szypoty przelewowe; B — dno kamieniste przy brzegach koryta; Ba — dno kamieniste w lenitycznych rozlewiskach. Wysokość słupka przedstawia liczbę okazów na 5 dcm² powierzchni dna. Uwzględniono te gatunki, które co najmniej w jednym terminie miały liczebność nie mniejszą niż 2 okazy, a w przypadku gatunków z rodzaju *Baetis* nie mniejszą niż 5 okazów

Fig. 10. Mayfly abundance on successive dates of investigations in 1969/1970 at station 6 in the Raba (region III). A — stony bottom in the main current; As — shallow riffles; B — stony bottom at the banks of the riverbed; Ba — stony bottom in lenitic parts. Height of the column presents the number of specimens on 5 dcm² bottom area. Species were considered whose abundance was at least on one data not less than 5 specimens

In the Koninka stream at station 4, representing zone 3., in habitat A, the maximum habitation density of about 300 specimens was recorded in October, the great majority being the large numbers of *Baetis alpinus* and *B. rhodani* (fig. 9). The smallest abundance of the community, less than 50 specimens was observed in June and consisted almost entirely of *B. alpinus*. Apart from the genus *Baetis*, the community abundance of habitat A is to a great extent due to the habitation density of species of the genus *Rhithrogena*. The abundance of these two genera constitutes on particular dates at least 80 per cent and, often more, of the total abundance of the community.

The community of habitat B (fig. 9) is characterized on successive dates by a much smaller total abundance in comparison with the former community. The greatest habitation density of 130 specimens was recorded in December, with the chief participation of *Baetis rhodani* and *B. muticus*. On other dates the participation of these two and of other representatives of *Baetis* in the community abundance is here, however, much smaller. In their place *Ephemerella ignita, Caenis beskidensis, E. major*, and *Habroleptoides modesta* decide successively the general density of habitation of the community in habitat B. It is interesting that a great participation in the abundance of the community in this habitat is from December till May that of *Rhithrogena ferruginea*, whose nymphs present an externally distinct adaptation to life in the current. In this habitat, too, the smallest abundance of the community of only 5 specimens was recorded in June.

In the middle course of the Raba, at station 6, representing zone 4., the community in the main current (A) reached its greatest abundance of 227 specimens in May (fig. 10). On successive dates considerable variations in the community abundance were observed, these being caused mainly by changes in the abundance of species from the genus *Baetis*, which on all dates had a decisive participation in the general habitation density of the community. In this density, from autumn till spring, also *Rhithrogena semicolorata* had a fairly great participation and in summer and autumn *Ephemerella ignita* and *Oligoneuriella rhenana*. In shallow riffles (As) the abundance of the mayfly community was in relation to habitat A still higher on four given dates. In July a much greater abundance was attained in habitat As by *Baetis fuscatus* and *B. rhodani* (fig. 10) and in September and October also by *B. vardarensis*. Compared with habitat A, representatives of *Ecdyonurus* had a greater participation in the general abundance of this community: in July *E. dispar*, in May *E. lateralis*. In habitats B and Ba the abundance of the community of mayflies was on almost all dates much lower. In habitat B, only on one date did it slightly exceed 60 specimens (fig. 10). In habitat Ba *Baetis fuscatus* showed in July a fairly great habitation density of 33 specimens. In these two habitats the quantitative participation of *Ecdyonurus* species increased. On comparable dates habitat B differed from habitat Ba in a greater number of species having at least 2 specimens/5 dcm^2 bottom area habitation.

When comparing habitats A and B along successive stations, it can be seen that seasonal changes in the abundance of communities and in the abundance of particular species proceed in them differently for each station. This results partly from the occurrence at particular stations, both in habitats A and B, of a different compo-

sition of species whose nymphal stages have different periods of emergence and a different growth rate, and partly, in the case of common species, by the fact that species attain different abundance at particular stations and carry out their life cycle differently. At all stations, representatives of the genus *Baetis* decide on almost all dates the prevalence in the general abundance of the community in the habitat A in relation to the community in habitat B. On some dates participation of *Rhithrogena* species contribute to it as well. In habitat B the participation of species and genera in the general abundance of the community is more equalized.

In spite of similarity in the changes of general abundance and the participation in these changes of particular species which exist between the communities of habitats A and As on the hand, and the communities of habitats B and Ba, on the other, neither habitat As nor Ba are in this respect identical with habitats A and B. Habitat As is, moreover, a sort of breeding place for nymphs of some species of the genus *Baetis*, being more accessible for imago females of these species, which come there to lay their eggs on the stones.

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STRESZCZENIE

Przedmiotem badań były jętki, głównie ich stadia larwalne, wód płynących w polskiej części Karpat i na obszarze bezpośrednio przylegającym, ograniczonym biegiem Wisły i Sanu. Badania prowadzono na 68 jednostkach wodnych w sześciu wybranych regionach: dorzeczu Soły, Skawicy i Orawy, Raby, Dunajca, Sanu oraz w kilku dopływach Wisły w okolicy Krakowa, w latach 1958—1972. Z wyjątkiem dolnego biegu Sanu i zbiorników w okolicy Krakowa, badane systemy wodne

mają podłoże kamieniste złożone przeważnie z piaskowców, rzadziej z granitowych otoczaków, o różnym stopniu rozdrobnienia. W obrębie kamienistego dna wyróżniono głębsze odcinki zbystrzeń, płytkie szypoty przelewowe, miejsca przybrzeżne, lenityczne rozlewiska i miejsca o umiarkowanym prądzie.

Wśród zebranych ponad 3000 okazów uskrzydlonych i ponad 100 000 larw wykryto 97 gatunków należących do 27 rodzajów i 12 rodzin. Najobfitsze w gatunki są na obszarze badań *Baetidae* (31 gatunków) i *Heptageniidae* (30 gatunków). Udział przedstawicieli *Baetidae* w całkowitej liczbie larw wynosi 56,6%, a przedstawicieli *Heptageniidae* — 23,8%. Po raz pierwszy przytoczono dla badanego obszaru 16 gatunków, z czego 9 to gatunki nowe także dla fauny Polski. Przeprowadzono dyskusję taksoniczną tych, a także szeregu innych, słabiej poznanych gatunków, głównie z *Baetidae*.

Zdecydowana większość stwierdzonych na obszarze badań gatunków ma szerokie rozmieszczenie w Europie. Najliczniej reprezentowane są gatunki południowo-środkowoeuropejskie (22), środkowoeuropejskie (16) i północno-środkowoeuropejskie (13). Do endemitów karpackich zaliczono 3 gatunki, przy czym 2 z nich są endemitami ekstensywnymi. Najmniejsze zasięgi maksymalne w sensie geograficznym mają gatunki z rodzaju *Ecdyonurus* i *Rhithrogena* żyjące w potokach górskich i podgórskich.

Przeważająca liczba odszukanych gatunków jest w określonych biotopach na obszarze badań pospolita. Gatunków zasiedlających tylko cieki obszarów górzysto-wyżynnych odszukano 37. Dwa z nich, *Rhithrogena loyolaea* i *Ameletus inopinatus*, należą do elementów wysokogórskich, a 6 innych — do mieszkańców gór średnich. Gatunki te, łącznie z grupą elementów średniogórsko-podgórskich liczącą 13 gatunków, zasiedlają strumienie, potoki i mniejsze rzeki; pozostałych 16 gatunków żyje w średnich lub dużych rzekach na terenach podgórskich i wyżynnych. Gatunków związanych wyłącznie z dużymi rzekami podgórsko-nizinnymi odszukano 13, a gatunków znanych tylko z rzek nizinnych 16. 25 gatunków nie wykazuje przywiązania do określonego typu zbiorników wodnych; 11 z nich cechuje się dużą rozpiętością pionowego zasięgu.

Idąc od źródeł systemów wodnych obserwuje się wzdłuż ich biegu stopniowy wzrost liczby gatunków. W potokach przyrost ich jest znaczny, obniża się na odcinkach mniejszych rzek, a w środkowych biegach dużych rzek karpackich liczba gatunków na jednym stanowisku ustala się w granicach 32—36. Największą liczbę gatunków na jednym stanowisku wykryto w dolnym biegu Sanu (42); maksymalną liczbę gatunków dla jednego systemu wodnego złowiono wzdłuż biegu Wołosatka-Wołosaty — San (79).

Biorąc pod uwagę skład gatunkowy i strukturę dominacji larw jętek na stanowiskach w dorzeczu Soły, Skawicy i Orawy, Raby, Dunajca i Sanu, wyróżniono dla głównych systemów wodnych w obrębie polskiej części Karpat pięć kolejnych ugrupowań wzdłużnych, mających podobny charakter na całym badanym obszarze, a prawdopodobnie także w całych Karpatach. Systemy wodne podzielono w związku z tym na sześć stref. W strefie 0., obejmującej źródła i ich odpływy, jętki nie występują lub pojawiają się tylko okresowo. W strefie 1. ugrupowanie jętek ma charakter inicjalny i złożone jest z kilku gatunków o niskiej liczebności; w zależności od położenia cieku występuje ono w jednym z dwóch wariantów: średniogórskie lub wysokogórskie. Ugrupowanie strefy 2. w potokach o charakterze wysokogórskim dzieli się na dwie części, z których dolna odpowiada całości ugrupowania strefy 2. potoków średniogórskich. Strefę 5. tworzy tylko dolny bieg Sanu. Omówiono gatunki dominujące i charakterystyczne dla poszczególnych stref i niektóre wyróżniające strefy cechy środowiskowe.

Analizę ilościową rozmieszczenia jętek w różnych siedliskach dna kamienistego przeprowadzono w systemie wodnym Olszowy-Koninka-Porębianka-Raba, na stanowiskach 1—8 (strefy 1.—4.). W górnej części systemu (stanowiska 1—4) badano dwa siedliska: dno kamieniste w szybkim prądzie (A) i dno kamienisto-żwirowe w wolnym lub bardzo wolnym prądzie (B). Na dalszych stanowiskach badano ponadto szypoty przelewowe (As), lenityczne rozlewiska (Ba) oraz dno kamieniste w średnim prądzie (Ab). Biorąc za podstawę dane średnie z okresu badań, gęstość zasiedlenia ugrupowania siedliska A jest najmniejsza w strefie 1. zwiększa się stopniowo w strefie 2. i osiąga najwyższą wartość — 187 okazów/5 dcm^2 dna — w dolnej części strefy 3. Średnia gęstość ugrupowania siedliska B jest na całym przebiegu systemu wodnego dość wyrównana liczbowo, a na tych

samych stanowiskach niższa od liczebności siedliska A. Największą gęstość zasiedlenia, do 319 okazów/5dcm² dna, notowano dla ugrupowania siedliska As w strefie 4. O średniej rocznej liczebności ugrupowań siedlisk lotycznych (A, As, Ab) decydują gatunki z rodzaju *Baetis*, *Rhithrogena* i *Oligoneuriella*, zaś ugrupowań siedlisk lenitycznych (B, Ba) gatunki z rodzaju *Baetis*, *Ephemerella*, *Habroleptoides*, *Caenis* i *Ecdyonurus*.

Zmiany sezonowe w liczebności ugrupowań siedlisk prześledzono w tym samym systemie wodnym w strefie 2., 3. i 4. Przebiegają one w odmienny dla każdego z siedlisk sposób, a odmienność ta widoczna jest zarówno na danym stanowisku, jak i wzdłuż systemu wodnego. Przez większość terminów badań roku 1969/1970 ugrupowania siedliska A mają w porównaniu z ugrupowaniami siedliska B większą gęstość zasiedlenia. W obu siedliskach widoczne są znaczne wahania liczebności w ciągu roku, a najniższe i najwyższe wartości liczbowe przypadają w kolejnych stanowiskach na różne miesiące. O liczebności ugrupowań siedlisk lotycznych decydują stale gatunki z rodzaju *Baetis* i *Rhithrogena*, o liczebności zaś ugrupowań siedlisk lenitycznych w sposób zamienny gatunki z rodzaju *Baetis*, *Ecdyonurus*, *Ephemerella*, *Caenis* i *Habroleptoides*.

REFERENCES

Albarda H., 1878. Descriptions of three New European *Ephemeridae*. Ent. Month. Mag., 15, 128—130.

Bogoescu C., 1958. *Ephemeroptera*. Fauna R. P. Romine, *Insecta*, 7, 3, Bucuresti, 1—187.

Bogoescu C., I. Tabacaru, 1966. Beiträge zur Kenntnis der Morphologischen Artmerkmale der Ephemeropteren-Weibchen aus der Familie *Baetidae*. I. Gattung *Centroptilum* Eaton. Ent. Tidskr., 87, 171—178.

Bombówna M., 1960. Hydrochemiczna charakterystyka rzeki Soły i jej dopływów — Hydrochemische Characteristik des Flüsses Soła und seiner Nebenflüsse. Acta Hydrobiol., 2, 175—200.

Bombówna M., 1968. Hydrochemiczna charakterystyka potoku Białka Tatrzańska — Hydrochemical characteristics of the Białka Tatrzańska stream. Acta Hydrobiol., 10, 27—37.

Bombówna M., 1969. Hydrochemiczna charakterystyka rzeki Raby i jej dopływów — Hydrochemical characteristics of the river Raba and its tributaries. Acta Hydrobiol., 11, 479—504.

Bombówna M., 1971. Skład chemiczny wody potoków Polskich Tatr Wysokich ze szczególnym uwzględnieniem Suchej Wody — The chemical composition of the water of streams of the Polish High Tatra Mts. particularly with the regard to the Stream Sucha Woda. Acta Hydrobiol., 13, 270—391.

Botosaneanu L., I. Tabacaru, 1963. Ephéméroptères, Plécoptères et Trichoptères des Monts de Fagarasch (Alpes de Transsylvanie). Bull. Inst. roy. Sc. nat. de Belgique, 39, 38, 1—58.

Brinck P., 1949. Studies on Swedish Stoneflies (*Plecoptera*). Opus. Ent., Suppl. 11, 1—250.

Ciszek H., E. Sosińska, 1965. Mayflies (*Ephemeroptera*) and Beetles (*Coleoptera*) of the Dunajec River. Dratnal E., Szczęsny B.: Benthic fauna of the Dunajec River. Kom. Zag. Ziem Górskich PAN, 11, 182—186.

Dittmar H., 1955. Ein Sauerlandbach. Untersuchungen an einem Wiesen-Mittelgebirgsbach. Arch. f. Hydrobiol. 50, 305—552.

Dudich E., 1958. Die Grundlagen der Fauna eines Karpaten-Flusses. Acta Zool. Hung., 3, 179—200.

Dzięddzielewicz J., 1919. Owady siatkoskrzydłowate ziem Polski. Rozpr. i Wiad. Muz. Dziedusz., 3 (1917), 105—168.

Eaton A. E., 1883—1888. A revisional monograph of recent *Ephemeridae* or Mayflies. Trans. Linn. Soc., (2), 3, Zool.

Głowaciński Z., 1968. Badania nad fauną jętek (*Ephemeroptera*) okolic Krakowa — Studies of the fauna of mayflies (*Ephemeroptera*) of the environs of Cracow. Acta Hydrobiol., 10, 103—130.

Gołek J., 1961. Termika rzek polskich. Prace PIHM, 62, 1—79.

Grandi M., 1960. Ephemeroidea. Fauna d'Italia. Bologna, Calderini. 1—474.

Grandi M., 1964. Contributi allo studio degli Efemerotteri italiani. 26, Reperti sulle ninfe del genere *Centroptilum* Etn. Boll. Ist. Ent. Univ. Bologna, 27, 119—125.

Husárová-Dudiková A., 1960. Prispevek k poznaniu benthálnej fauny potoka Bystrica v Malych Karpatoch. Acta Fac. R. N. Univ. Com., 4, 415—436.

Hynes H. B. N., 1971. The Ecology of Running Waters. Liverpool, Univ. Press.

Ikonomov P., 1962. *Baetidae* (*Ephemeroptera*) na Makedonija. God. Zbor. Prir.-Mat. Fak.Univ. Skopje, 13, Biol., 1, 83—140.

Illies J., 1952. Die Mölle. Faunistisch-ökologische Untersuchungen an einem Forellenbach im Lipper Bergland. Arch. Hydrobiol., 46, 424—612.

Illies J., 1953. Die Besiedlung der Fulda (insbes. das Benthos der Salmonidenregion) nach dem jetzigen Stand der Untersuchung. Ber. Limnol. Flussstat. Freudenthal., 5, 1—28.

Illies J., 1967. *Ephemeroptera.* Limnofauna Europaea. Stuttgart, G. Fischer Verl., 212—219.

Jacob U., 1973. Ein *Centroptilum* des *stenopteryx*-Komplexes aus dem mitteleuropäischen Flachland (*Baetidae, Ephemeroptera*). Reichenbachia, 14, 21, 163—170.

Jażdżewska T., 1971. Jętki (*Ephemeroptera*) rzeki Grabi. Pol. Pismo Ent., 41, 2, 243—304.

Kamler E., 1960. Notes on the *Ephemeroptera* Fauna of Tatra streams. Pol. Arch. Hydrobiol., 8, 107—127.

Kamler E., 1962. La faune des Ephémères de deux torrents des Tatras. Pol. Arch. Hydrobiol., 10, 15—38.

Kamler E., 1965. Thermal conditions in mountain waters and their influence on the distribution of *Plecoptera* and *Ephemeroptera* larvae. Ekol. Pol., A, 13, 377—414.

Kamler E., 1966. L'influence du degré d'astatisme de certains facteurs du milieu sur la répartition des larves d'Ephémères et des Plécoptères dans les eaux des montagnes. Verh. Int. Ver. Limnol., 16, 663—668.

Kamler E., 1967. Distribution of *Plecoptera* and *Ephemeroptera* in relation to altitude above sea level and current speed in mountain waters. Pol. Arch. Hydrobiol., 14, 29—42.

Kamler E., Riedel, 1960. The effect of Drought on the Fauna of *Ephemeroptera, Plecoptera* and *Trichoptera* of a Mountain Stream. Pol. Arch. Hydrobiol., 8, 87—94.

Kawecka B., M. Kownacka, A. Kownacki, 1971. Ogólna charakterystyka biocenoz w potokach Polskich Tatr Wysokich — General characteristics of the biocoenosis in the streams of the Polish High Tatras. Acta Hydrobiol., 13, 465—476.

Kazlauskas R. S., 1964. Materialy k poznaniju podenok reki Oki. Trudy Zool. Inst. AN SSSR, 32, 164—176.

Kazlauskas R. S., 1965. *Brachycercus pallidus* Tshern. i *Baetopus wartensis* Keff. (*Ephemeroptera*) v rekach Litovskoj SSR. Nauč. Trudy vyš. učěb. zav. Lit. SSR,. Biol., 5, 201—203.

Keffermüller M., 1960. Badania nad fauną jętek (*Ephemeroptera*) Wielkopolski. Prace Kom. Biol. P. T. P. N., 19, 411—467.

Keffermüller M., 1967. Badania nad fauną jętek (*Ephemeroptera*) Wielkopolski. III. Bad. Fizjogr. Pol. Zach., 20, 15—28.

Keffermüller M., 1972. Badania nad fauną jętek (*Ephemeroptera*) Wielkopolski. Pol. Pismo Ent., 42, 527—533.

Keffermüller M., R. Sowa, Les espéces du groupe *Centroptilum pulchrum* Eaton (*Ephemeroptera, Baetidae*) en Pologne Pol. Pismo Ent., (in press — w druku).

Klapálek F., 1906. Přispěvek ke znalosti fauny Neuropteroid Chorvatska, Slavonska i zemi sousednich. Rozpr. česke Akad., 15, 16.

Kimmins D. E., 1960. The *Ephemeroptera* Types of Species described by A. E, Eaton, R. Mc Lachlan, and F. Walker. Bull. Brit. Mus. (Nat. Hist.), Ent. 9, 269—318.

Kownacka M., 1971. Fauna denna potoku Sucha Woda (Tatry Wysokie) w cyklu rocznym — The bottom fauna of the stream Sucha Woda (High Tatra Mts) in the annual cycle. Acta Hydrobiol., 13, 415—438.

Kownacka M., A. Kownacki, 1965. The bottom fauna of the river Białka and of its Tatra trib-

utaries the Rybi Potok and Potok Roztoka. Limnol. Invest. in the Tatra Mts and Dunajec River Basin. Kom. Zagosp. Ziem Górskich PAN, 11, 129—151.

Kownacka M., A. Kownacki, 1968. Wpływ pokrywy lodowej na faunę denną potoków tatrzańskich — The influence of ice cover on bottom fauna in the Tatra streams. Acta Hydrobiol., 10, 95—102.

Kownacki A., 1971. Taksoceny *Chironomidae* potoków Polskich Tatr Wysokich — Taxocens of *Chironomidae* in streams of the Polish Tatra Mts. Acta Hydrobiol., 13, 439—464.

Kownacki A., M. Kownacka, 1965. The bottom fauna of the lakes Morskie Oko and Wielki Staw in the Polish Tatra Mountains. Limnol. Invest. in the Tatra Mts and Dunajec River Basin. Kom. Zagosp. Ziem Górskich PAN, 11, 33—38.

Krzanowski W., E. Fiedor, T. Kuflikowski, 1965. Fauna denna kamienisto-prądowych siedlisk dolnych odcinków Białego Dunajca, Rogoźnika i Lepietnicy. Zesz. Nauk. U. J., Prace Zool., 9, 43—60.

Krzyżanek E., 1971. Fauna denna zbiornika zaporowego w Tresnej na rzece Sole w 1966 roku — Bottom fauna in the Tresna dam reservoir in 1966. Acta Hydrobiol., 13, 335—342.

Landa V., 1968. Die faunistische Erforschung der Wasserinsekten in der ČSSR und die Verwertung ihrer Ergebnisse. Abh. Ber. Naturk. Görlitz, 44, 2, 21—29.

Landa V., 1968a. Development cycles of Central European *Ephemeroptera* and their interrelationship. Acta ent. bohemoslov., 65, 276—284.

Landą V., 1969. Jepice — *Ephemeroptera*. Fauna ČSSR, 18, Praha, Academia.

Landa V., 1970. *Ecdyonurus submontanus*, *Heptagenia quadrilineata*, *Rhithrogena hercynia* — new species of mayflies (*Ephemeroptera*) of the family *Heptageniidae* from Czechoslovakia. Acta ent. bohemoslov., 67, 13—20.

Lestage J. A., 1919. Contribution à l'étude des larves des Ephémères paléarctiques. Sér. 2. Ann. Biol. Lac., 9, 89—192.

Mikulski J. S., 1929. Przyczynek do znajomości fauny doliny Popradu w okolicy Muszyny: *Ephemeroptera*, *Trichoptera* i *Neuroptera*. Spraw. Kom. Fizjogr. PAU, 65, 81—92.

Mikulski J. S., 1931. O kilku nowych dla Polski gatunkach jętek (*Ephemeroptera*). Fragm. Faun. Mus. Zool. Pol., 1, 323—325.

Mikulski J. S., 1933. Próba charakterystyki zoogeograficznej jętek (*Ephemeroptera*) fauny Polski. Pam. 14 Zjazdu Lek. i Przyr., Poznań, 476—478.

Mikulski J. S., 1935. Przyczynek do znajomości fauny Czarnohory: 7, *Ephemeroptera*. Rozpr. Spraw. Inst. Bad. Lasów Państw., A, 8, 43—51.

Mikulski J. S., 1936. Jętki (*Ephemeroptera*). Fauna Słodkowodna Polski, 15, Warszawa, Kasa im. Mianowskiego.

Mikulski J. S., 1937. Materiały do poznania fauny jętek (*Ephemeroptera*) Beskidu Wyspowego i Gorców. Fragm. Faun. Mus. Zool. Pol., 3, 47—56.

Mikulski J. S., 1938. Notiz über die Nymphen der Eintagsfliegen der Gattung Torleya Lestage. Ann. Mus. Zool. Pol., 13, 33—39.

Mikulski J. S., 1950. Fauna jętek (*Ephemeroptera*) źródłowych potoków Wisły. Prace Biol. Śląskie, 2, 143—162.

Mikulski Z., 1963. Zarys hydrografii Polski. Warszawa, PWN.

Miron I., 1959. Contribuţii la cunoaşterea Ephemeropterelor din bazinul mijlociu al Bistriţei. Anal. Ştiint. Univ. Iaşi, Sect. 2, 6, 307—314.

Miron I., 1960. Contribuţii la studiul nevertebratelor acvatice din Bistriţa şi afluenţii săi in zona lacului de baraj Bicaz. Anal. Ştiint. Univ. Iaşi, Sect. 2, 6, 719—728.

Müller-Liebenau I., 1969. Revision der europäischen Arten der Gattung *Baetis* Leach, 1815 (*Insecta*, *Ephemeroptera*). Gewässer u. Abwässer, 48/49, 1—214.

Müller-Liebenau I., 1974. *Baetidae* aus Südfrankreich, Spanien und Portugal (*Ephemeroptera*, *Insecta*). Gewässer u. Abwässer, 53/54, 7—42.

Musiał L., L. Turoboyski, M. Chobot, W. Łabuz, 1958. Badania nad zanieczyszczeniem rzeki Soły i jej zdolnością samooczyszczania. Pol. Arch. Hydrobiol., 4, 221—250.

Musiał L., M. Chobot, J. Pudo, 1962. Stan zanieczyszczenia rzeki Raby. Prace IGW, 1, 2, 49—87.

Obr S., 1955. Přispěvek ke studiu fauny pramenu, jezer a bystřin v Liptovských holich (Tatry). Acta Soc. Zool. bohemoslov., 19, 9—26.

Oleksynova K., T. Komornicki, 1965. The chemical composition of water in the polish Tatra Mountains and the problem of its variation in time. Limnol. invest. in the Tatra Mountains and Dunajec river basin. Kom. Zag. Ziem Górskich PAN, 11, 91—111.

Pasternak K., 1960. Gleboznawcza i geologiczna charakterystyka dorzecza rzeki Soły — Geological and pedological characteristics of the basin of River Soła. Acta Hydrobiol., 2, 159—174.

Pasternak K., 1964. Geologiczna i gleboznawcza charakterystyka dorzecza rzeki Sanu — Geological and pedological characteristics of the basin of the River San. Acta Hydrobiol., 6, 289—307.

Pasternak K., 1968. Charakterystyka podłoża zlewni rzeki Dunajec — Characteristics of the substratum of the River Dunajec catchment basin. Acta Hydrobiol., 10, 299—317.

Pasternak K., 1969. Szkic geologiczno-gleboznawczy zlewni rzeki Raby — A geological and pedological sketch of the Raba river catchment. Acta Hydrobiol., 11, 407—422.

Pasternak K., 1969 a. Wstępne badania nad właściwościami drobnych powierzchniowych osadów dennych rzeki Raby — Preliminary investigations on the properties of the fine surface bottom sediments of the River Raba. Acta Hydrobiol., 11, 505—515.

Pasternak K., J. Cyberski, 1973. Skład granulometryczny unosin wód rzek karpackich na tle jakości podłoża ich zlewni. Prob. Zagosp. Ziem Górskich PAN, 12, 131—152.

Pawłowski L. K., 1959 Remarques sur la répartition de la faune torrenticole des Carpathes. Prace Wydz. Nauk Mat. Przyr. Ł. T. N., 3, 57, 1—87.

Punzet J., 1969. Charakterystyka hydrologiczna rzeki Raby — Hydrological characteristics of the river Raba. Acta Hydrobiol., 11, 423—477.

Puthz V., 1973. Was ist *Baetis aurantiaca* Burmeister 1839 (*Insecta, Ephemeroptera*)? Eine bibliographische und Typenstudie. Philippia (Kassel), 1, 262—270.

Puthz V., 1973a. Zwei neue Synonyme in der Gattung *Epeorus* Eaton (*Insecta, Ephemeroptera*: *Heptageniidae*). Rev. suisse Zool., 80, 577—580.

Schoenemund E., 1930. Eintagsfliegen oder *Ephemeroptera*. Die Tierwelt Deutschlands, 19, Jena, 6. Fischer Verl.

Sowa R., 1959. Przyczynek do poznania fauny jętek (*Ephemeroptera*) okolic Krakowa. Acta Zool. Cracov., 4, 655—698.

Sowa R., 1961. Fauna denna rzeki Bajerki — The bottom fauna of the river Bajerka. Acta Hydrobiol. 3, 1—32.

Sowa R., 1961a. *Oligoneuriella mikulskii* n. sp. (*Ephemeroptera*). Acta Hydrobiol., 3, 287—294.

Sowa R., 1961b. Nowe i rzadkie w faunie Polski gatunki widelnic (*Plecoptera*) — New and rare species of stoneflies (*Plecoptera*) in the fauna of Poland. Acta Hydrobiol., 3, 295—302.

Sowa R., 1962. Materiały do poznania *Ephemeroptera* i *Plecoptera* w Polsce — Material for the study of *Ephemeroptera* and *Plecoptera* in Poland. Acta Hydrobiol., 4, 205—224.

Sowa R., 1965. Ecological characteristics of the bottom fauna of the Wielka Puszcza stream. Acta Hydrobiol., 7, suppl. 1, 61—92.

Sowa R., 1965a. Invertebrate Water Animals of the Dunajec River. Along the Dunajec River. 16 Limnol. Conv. in Polonia, Kraków, 11—14.

Sowa R., 1971. Sur la taxonomie de *Rhithrogena semicolorata* (Curtis) et de quelques espèces voisines d'Europe continentale (*Ephemeroptera*: *Heptageniidae*). Rev. suisse Zool., 77, 4, 56, 895—920.

Sowa R., 1971a. *Ecdyonurus starmachi* sp. n. et *E. submontanus* Landa des Carpates polonaises (*Ephemeroptera, Heptageniidae*). Bull. Acad. Pol. Scie., Cl. 2, 19, 407—412.

Sowa R., 1971b. Notatka o dwóch gatunkach rodziny *Heptageniidae* z Karpat polskich (*Ephemeroptera*) — Note sur les deux espèces de la famille *Heptageniidae* des Carpathes polonaises (*Ephemeroptera*). Acta Hydrobiol., 13, 29—41.

Sowa R., 1971c. Note sur quelques *Rhithrogena* Eaton de la collection Esben-Petersen et la rede

scription de *Rhithrogena germanica* Eaton (*Ephemeroptera, Heptageniidae*). Bull. Acad. Pol. Scie., Cl. 2, 285—289.

Sowa R., 1972. *Baetis beskidensis* n. sp. des Carpates polonaises (*Ephemeroptera: Baetidae*). Bull. Acad. Pol. Scie., Cl. 2, 20, 711—714.

Sowa R., 1973. Taxonomie et écologie d'*Ecdyonurus carpathicus* sp. n., des Carpates polonaises (*Ephemeroptera, Heptageniidae*). Bull. Acad. Pol. Scie., Cl. 2, 21, 285—289.

Sowa R., 1973a. Taxonomie et écologie de *Caenis beskidensis* sp. n., des Carpates polonaises (*Ephemeroptera, Caenidae*). Bull. Acad. Pol. Scie., Cl. 2, 21, 351—355.

Sowa R., 1973b. Contribution à l'étude des *Oligoneuriella* Ulm. européennes (*Ephemeroptera, Oligoneuriidae*). Bull. Acad. Pol. Scie., Cl. 2, 21, 657—665.

Sowa R., 1974. *Ecdyonurus fascioculatus* sp. n., espèce voisine d'*E. affinis* Eaton du midi de la Pologne (*Ephemeroptera, Heptageniidae*). Bull. Acad. Pol. Scie., Cl. 2, 22, 315-329.

Sowa R., 1975. Notes on the European species of *Procloeon* Bengtsson with particular reference to *Procloeon bifidum* (Bengtsson) and *Procloeon ornatum* Tshernova *(Ephemeroptera: Baatidae)*. Ent. scand., 6, 1—8.

Sowa R., 1976. What is *Cloeon dipterum* (Linnaeus). 1761? The nomenclatural and morphological analysis of a group of the European species of *Cloeon* Leach *(Ephemeroptera: Baetidae)*. Ent. scand., (w druku — in press).

Sowa R., B. Szczęsny, 1970. Widelnice (*Plecoptera*) i chruściki (*Trichoptera*) Babiej Góry. Ochrona Przyr., 35, 221—268.

Starmach K., 1956. Rybacka i biologiczna charakterystyka rzek — Characteristic of rivers from biological and fishery point of view. Pol. Arch. Hydrobiol. i Ryb., 3 (16), 307-332.

Steinberg A., 1935. Zur Biologie und larvalen Entwickung einer unbekannten *Baetis* larve. Verh. Int. Verein. Limnol., 7, 466—474.

Szczęsny B., 1974. Wpływ ścieków z miasta Krynicy na zbiorowiska bezkręgowych dna potoku Kryniczanka — The effect of sewage from the town of Krynica on the benthic invertebrates communities of the Kryniczanka stream. Acta Hydrobiol., 16, 1—29.

Tabacaru I., 1956. Contribuţii la studiul faunei de Ephemeroptere din regiunea Suceava. An. Univ. C. I. Parhon, 12.

Thomas A., 1968. Quelques *Ecdyonurus* et *Rhithrogena* européens de la collection Navás (*Ephemeroptera*). Ann. Limnol., 4, 209—218.

Thomas A., 1968a. Sur la taxonomie de quelques espèces d'*Ecdyonurus* du Sud-Ouest de la France (*Ephemeroptera*). Ann. Limnol., 4, 51—71.

Thomas A., R. Sowa, 1970. *Ecdyonurus macani* n. sp., espèce européenne voisine d *'E. torrentis* Kimmins (*Ephemeroptera, Heptageniidae*). Annl. Limnol., 6, 75—85.

Tshernova O. A., 1928. Materialy k poznaniju podenok bassejna reki Oki. Rob. Okskoj. biol. stancii, 5, 2—3.

Ulfstrand S., 1968. Benthic animal communities in Lapland streams. Oikos, suppl. 10, 1—120.

Winkler O., 1952. Die benthische Fauna. (Bilý-Hanuška-Winkler: Hydrobiologia Hnilca a Hornádu). Bratislava, SAVU.

Wit K., Z. Ziemońska, 1960. Hydrografia Tatr Zachodnich. Inst. Geogr. PAN, Kraków, PWN.

Zaćwilichowska K., 1968. Fauna denna dorzecza Kamienicy Nawojowskiej — Bottom fauna in the basin of the River Kamienica Nawojowska. Acta Hydrobiol., 10, 319—341.

Zelinka M., 1950. K poznáni zvířeny horskych potoků Slezských Beskyd. Přir. Sb. Ostrav. Kraje, 11, 3—28.

Zelinka M., 1953. Larvy jepic (*Ephemeroptera*) z povodi Moravice a jejich vztahy k čistotě vody. Práce Moravskoslov. akad. přir. věd., 25, 181—200.

Zelinka M., 1953a. K poznáni jepic (*Ephemeroptera*) Vysokých Tater. Spisy Přir. fak. Mas. univ. Brno, 348, 157—167.

Zelinka M., 1969. Die Eintagsfliegen (*Ephemeroptera*) in Forellenbächen der Beskiden. I.—Abundanz und Biomasse. Folia Fac. Sc. Nat. Univ. Purkyn. Brunensis, Biol., 10, 157—168.

Zelinka M., 1973. Die Eintegsfliegen (*Ephemeroptera*) in Forellenbächen der Beskiden. 2. Produktion. Hydrobiologia, 42, 13—19.

Zelinka M., J. Rothschein, 1967. Die Ephemeropteren der Slowakai. Ac. Rer. Nat. Mus. Nat. Slov., 13, 61—71.

Zięba J., 1968. Charakterystyka występowania fauny dennej w Wisłoku w rejonie Krosna — A characteristic of the appearance of bottom fauna in the river Wisłok near Krosno. Acta Hydrobiol., 10, 453—469.

Zięba J., K. Zaćwilichowska, 1966. Fauna denna Wisły pomiędzy Oświęcimiem a Krakowem — Bottom fauna in the Vistula between Oświęcim and Cracow. Acta Hydrobiol., 8, Suppl. 1, 389—410

Adres autora — Author's address

dr Ryszard Sowa

Zakład Hydrobiologii, Instytut Zoologii Uniwersytetu Jagiellońskiego, ul. Oleandry 2a, 30-063 Kraków