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E. Kamler

Notes on the *Ephemeroptera* Fauna of Tatra streams

Department of Hydrobiology of the Warsaw University

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Since the time of Dziędzielewicz (1919) and Nowicki (1867) no work on the *Ephemeroptera* of the Tatra has appeared in Poland.

The following work is an attempt at a general faunal picture of the *Ephemeroptera* of the Polish Tatra.

Material and methods

The studies were carried out on the terrain of the Polish side of the High Tatra and Western Tatra in 1954—1957 in the months: May, July, August, September, October.

In all 34 streams (fig. 1, table I), 9 lakes (in the Valley of Five Polish Lakes: Lake Przedni, Lake Wielki, Lake Czarny, Wole Oko and Lake Zadni, one lake from the Valley of Five Spiskich Lakes, Lake Morskie Oko, Lake Toporowy, Lake Kurtkowiec in Gąsienicowa Valley) and 2 sources in the Kościeliska Valley: source on the Hala Pisana and the Lodowe source were examined.

Fig 1. gives a map of the Tatra waters. The lakes studied are denoted by straight line shading, streams studied by dots' along their courses. Numbers 1—14 denote small streams studied:

1. Pod Mostem
2. Zagonny
3. Prostopadły
4. Potrójny
5. Czarny
6. Stream flowing from Lake Czarny Gąsienicowy
7. Stream in the Spadowiec Valley
8. Sarni stream
9. Świński
10. Czerwony
11. Prawy
12. Skomplikowany
13. Mały
14. Za Prawym

Table 1

Occurrence of Ephemeroptera in examined Tatra streams

× — larves and imagines, □ — larves alone, △ — imagines alone

Species \ Name of stream	Świński (affluent of Olczyski)	Roztoka	Rybi	Olczyski	Prawy (affluent of Olczyski)	Mały (affluent of Olczyski)	Small stream on Bocani	Prostopadły (affluent of Roztoka)	Kościeliski	Skrzypkowy (affluent of Olczyski)	From Lake Czarny (Valley of 5 Lakes)	Waksmundzki	From Lake Czarny above Morskie Oko	Potrójny (affluent of Roztoka)	Pod Mostem (affluent of Roztoka)	Zamikający (affluent of Roztoka)	Biały	Stream in the Spadowiec Valley	Strążyski	Czerwony (affluent Olczyski)	Zagonny (affluent Roztoka)	From Lake Czarny Czesnicowy	Small stream from side of Mt. Miedziane	Sucha Woda	From Lake Zadni (Valley of 5 Lakes)	Stream from side of Mt. Kosista (affluent of Waksmundzki)	Jaworzynka	Stream in the Zimna Wode Valley	Za Prawym (affluent Olczyski)	Stream in the Ku Dziurze Valley	Bystra	Czarny (affluent of Olczyski)	Sarni	Small stream (affluent of Strążyski)	% inhabited streams
Baëtis carpathica (typical)	□	×	□	×	□	□	□	□	□	□	□	□	□	□	×	□	×	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	100
Rhitrogena semicolorata	×	×		×	×	□	□		×	□	□	□	□	□	□	×	×	□					□	□	□	□		□	□	×	□				76
Ecdyonurus venosus	×	×		△	□	□			□	□					□	□	□	□	□	□	□													41
Ameletus inopinatus	×	×		□	□					□	□	△	□	△																				27
Habroleptoides modesta	□		□			□	□		□																									15
Baëtis carpathica (of long middle cerci)			□		□	□	□	□																										15
Ecdyonurus subalpinus	△	□		△																														9
Epeorus assimilis		×	□																															6
Ecdyonurus forcipula		×																																3
Baëtis bioculatus	□																																	3
Cloëon dipterum																																		-

654 samples were taken which yielded 4620 specimens of *Ephemeroptera*. Methods for taking samples, the working over of the material and the character of the stream milieux were described in the paper by K a m l e r and R i e d e l (1960 and 1960a).

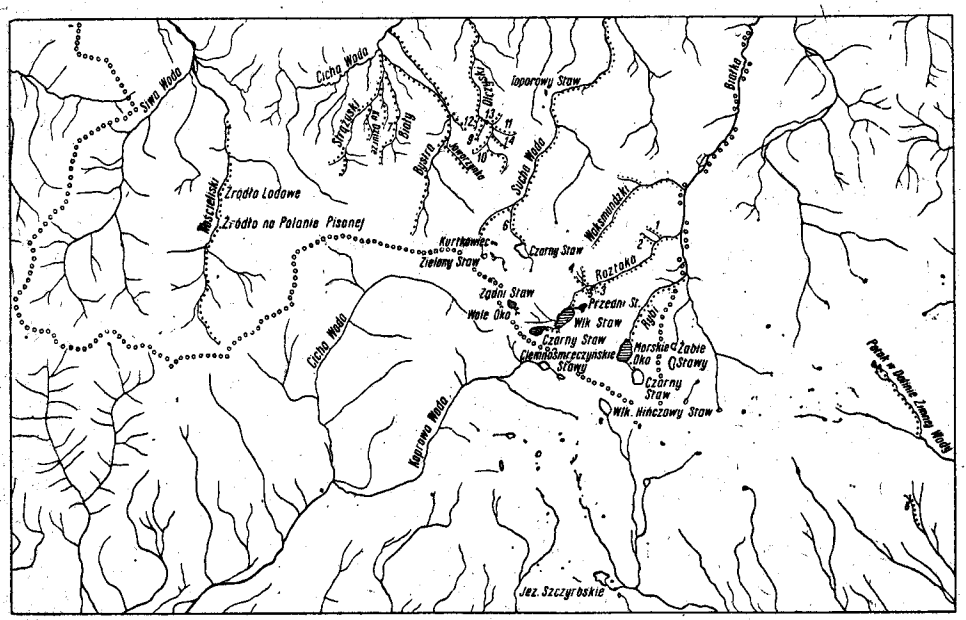

Fig. 1. Map of Tatra waters
ooooo state border, hatched areas — examined lakes; . . . . . — examined streams

Species were found belonging to the following taxonomic divisions:

Suborder: *Heptagenioidea*
Family: *Ecdyonuridae*
1. *Epeorus assimilis* Eaton
2. *Ecdyonurus forcipula* Kollar-Pictet
3. *Ecdyonurus subalpinus* Klapalek
4. *Ecdyonurus venosus* Fabricius
5. *Rhitrogena semicolorata* Curtis
Family: *Siphlonouridae*
6. *Ameletus inopinatus* Eaton
Suborder: *Baëtoidea*
Family: *Baëtidae*
7. *Baëtis carpathica* Morton
8. *Baëtis bioculatus* Linné
9. *Cloëon dipterum* Linné
Family: *Leptophlebidae*
10. *Habroleptoides modesta* Hagen

In identifying the species use was made of the following keys and specialised work. Bengtsson (1912, 1917), Bogoescu and Tabacaru (1957), Gauthier (1933—1934, 1952), Handlirsch (1926—1930), Keffermüller (1956), Kimmins (1950), Klapalek (1909), Landa (1945), Lestage (1916, 1919), Macan (1950), Mikulski (1931, 1935, 1936), Morton (1910) Schoenemund (1929, 1930), Tabacaru (1956), Ulmer (1928, 1943).

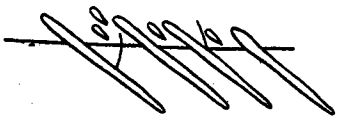

Fig. 3. Part of upper surface of *femur* of larvae *Baëtis carpathica* (typical) see Fig. 2

Fig. 2. Terminations of *tarsus* of I pair of legs of larvae *Baëtis carpathica* (typical) found 15.VIII.1954 in Roztoka stream

Up till now species of the genus *Baëtis* have been poorly described from the morphological taxonomic point of view. This presents considerable difficulties in the identification of species belonging to this genus as has been mentioned by many authors.

Results

Baëtis carpathica Morton (larva), I found this species in large numbers in all the Tatra streams examined. The imago is described by *Morton* (1910), larvae by Mikulski (1935) and Bogoescu and Tabacaru (1957). Mikulski (1936) writes ,,till now in Czarnohora, probably endemic''. This statement when compared with my findings as to the very large quantities of specimens which I found made me doubt the correctness of my findings and necessitated the accurate re-examination of my specimens. Of the 28 known species of the genus *Baëtis* coming from Eurasia, the species, which I dealt with from the morphological point of view, is related to 6 species: *Baëtis carpathica* Morton, *Baëtis rhodani* Pictet, *Baëtis vernus* Pict., *Baëtis tenax* Eaton, *Baëtis alpinus* Pictet and *Baëtis gemellus* Eaton.

Of the individuals of *Baëtis carpathica* which were found the one character which does not quite agree with Mikulski's description (1935) is the greater slenderness of the maxillae in the larvae (fig. 6). This difference, however, may be considered as relatively unimportant in view of the fact that the larvae described by Mikulski came from Czarnohora as well as the fact that larvae of the genus *Baëtis* are distinguished by their considerable variability (Steinberg 1935, Verrier 1943, Macan 1950). After becoming acquainted with the work of Bogoescu and Tabacaru (1957) I came to the conclusion that, the larvae which I found correspond to the exhaustive description of *Baëtis carpathica* given in that work (fig. 2). I discovered however certain differences in the structure of the *area canini*. The variability of the structure of the *mandibulae* in the larvae belonging to the same species of the genus *Baëtis* is known in the literature. Steinberg (1935) even states that she found a variation in the shape of the *mandibulae* during the individual lifetime of *Baëtis* sp.

Figures 2—12 refer to the specimens of *Baëtis carpathica* (typical) which were found.

Legs. (figs. 2,3). On the upper surface of the *femur* (fig. 3) there are long, sharply pointed spines. I p.—60, II p.—58, III p.—50. In addition

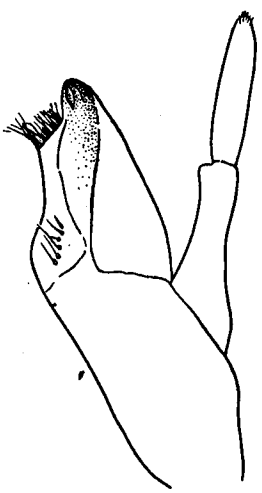

Fig. 5. Left mandible, larva *Baëtis carpathica* (typical) see Fig. 2

Fig. 4. Right *maxilla* of larva *Baëtis carpathica* (typical) see Fig. 2

there are short strong spines: I p. — 26, II p. — 26, III p. — 40, and also sparse, fine hairs. At the *apex* of *femur* — 10 short, thick spines and fine hairs. The *tibia* connects with the *tarsus* by a short apophysis equiped with 3 spines. On the upper surface there are strong spines and short, fine sparse hairs.

Maxillae (fig. 4) — slender. At 1/3 of their length near the external border a vertical row of bristles. *Palpus maxillaris* extends beyond *galea-lacinia* and is bijointed. It second joint terminates in several short hairs.

Mandibulae (figs. 5,6). Left mandible (fig. 5) has external tooth truncated. It stands up above the other canines. The left *prosthaeca* is equiped with 3—4 short and 2—3 long teeth. The *prosthaeca* is absent from the right mandible (fig. 6) and the canines are poorly differentiated. The mandible of the species found confirms the thesis put forward by Steinberg (1935) that the left-hand canines are dichotomous and the right-hand are monochotomous.

Labium is presented on fig. 9. *Paraglossa* (fig. 7) has 3 rows of bristles on the apex. *Glossa* (fig. 10) on internal border — 16 bristles, on external border — 7. *Palpus labialis* (fig. 8) has 3 joints. Length of first joint equals

Fig. 6. Right mandible, larva *Baëtis carpathica* (typical) see Fig. 2

Fig. 7. *Paraglossa*, larva *Baëtis carpathica* (typical) see Fig. 2

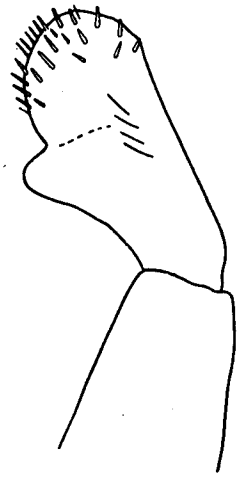

Fig. 8. *Palpus labialis*, larva *Baëtis carpathica* (typical) see Fig. 2

the combined lengths of the second and third. The third joint is dome shaped. Where the second and third joints join there is a vertical row of four bristles lying closer to the external surface. Numerous hairs on the apex of the third joint.

Gills (fig. 11) length in mm.: 0.54, 0.68, 0.72, 0.72, 0.60, 0.56, 0.40, ratio of lengths to first gill: 1, 1.26, 1.33, 1.33, 1.11, 1.04, 0.74. End of gills covered with short, very delicate hairs. Venation (*trachea*) not visible. Dark borders absent.

Labrum (fig. 12). 16 long bristles on each side of front border. They are arranged in a row beginning at one third of the length from the axis.

Fig. 9. *Labium*, larva *Baëtis carpathica* (typical) found 14.VIII.1954 in Olczyski stream

Fig. 10. *Glossa*, larva *Baëtis carpathica* (typical) see Fig. 2

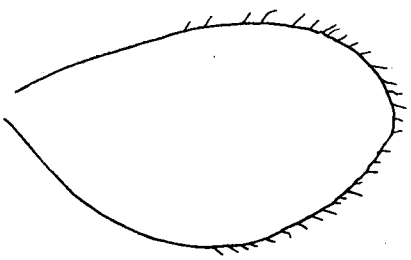

Fig. 11. Gills IV pair, larva *Baëtis carpathica* (typical) see Fig. 2

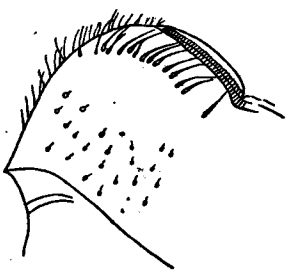

Fig. 12. *Labrum*, larva *Baëtis carpathica* (typical) see Fig. 2

Fig. 13. *Area canini*, right mandible, larva *Baëtis carpathica* (with long middle cerci) found 22.VIII.1956 in Rybi stream

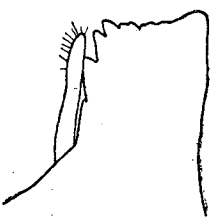

Fig. 14. *Area canini*, left mandible, larva *Baëtis carpathica* (with long middle *cerci*) see Fig. 13

In addition one bristle is visible on each side of the axis as if a continuation of the above mentioned row. 8 bristle on each side of the *labrum*. The anterior edge of the bristles lies behind the anterior edge of the *labrum*.

Cerci. Lateral *cerci* covered with long, dense hairs on the internal side. Central shorter than lateral by more than three times.

On revieving the material it was seen that some specimens deviated in their structure from the description given above. These differences occur in the ratio of the lengths of the central *cerci* to the lateral, their chaetotaxy, the details of the structure of the mandibles (figs. 13, 14) and the shape of the body. These differences were insignificant however. Comparing the structure of the larvae named above with data from work on larvae of the genus *Baëtis*, particularly the papers by Macan (1950) and by Bogoescu and Tabacaru (1957) it is seen that these specimens most clearly resemble *Baëtis carpathica*. Thus in this paper specimens with these structural characteristics will be called *Baëtis carpathica* Morton (with long central *cerci*) to distinguish them from larvae *Baëtis carpathica* (typical). It would appear that differences in the structure of the mandibles are not sufficient for qualifying specimens to separate species. Steinberg (1935) describes the occurrence of three types of mandibles in one species of the genus *Baëtis* from the streams of the Lower Tatra. She states that all three types may occur in one individual at various stages of the development of the larvae and thus the *mandibulae* are not a constant, valuable taxonomic character. The difference in the ratio of the lengths of the central and lateral cerci is large in individuals of *Baëtis carpathica* (typical) and those having long central cerci. In individuals of *Baëtis carpathica* (with long central *cerci*) the central *cerci* exceeds 1/3 of the length of the lateral *cerci*. There is also noted a considerable variation in the occurence of this characteristic in larvae of the genus *Baëtis* (Steinberg 1935, Verrier 1942). In the opinion of the above authors the ratio of the lengths of the central *cerci* to the lateral plays a part in the resistance to swift current.

9 specimens of *Baëtis carpatica* (with long central *cerci*) were found, all specimens in sites where there was either no current or a feeble one.

Baëtis carpathica Morton (imago). There were also difficulties in identifying the imagines. The specimens found differ from the description given by Morton (1910) in the venation of the second pair of wings. Other structural details are the same. The second pair of wings of the collected specimens lack the transverse veins going from the spur of the wing to the first longitudinal vein. The transverse veins between the first and second longitudinal veins are also absent and also those between the second longitudinal vein and the edge of the wing. This is a ,,venation of the second order'' (if we take as ,,venation of the first order'' three longitudinal veins which are in accordance with the description). Intraspe-

cial differences in ,,venation of the second order'' of the second pair of wings in the genus *Baëtis* are described by Verrier (1944). She says that twelve types of ,,venation of the second order'' of the second pair of wings occurred in *Baëtis vernus* reared from larvae collected from a 40-metre stretch of a stream.

Larvae and imagines of *Baëtis carpathica* Morton were found in all the Tatra streams under study (tab. I). Larvae of this species were not found in lakes but were found in two sources in the Kościeliska Valley: in the source on the Polana Pisana and in the Lodowe source. Specimens of this species accounted for 55,2% of the specimens collected. In streams it was found in all environments but most of all in stony milieu. This is a mountain species showing positive rheotaxis. Together with *Rhitrogena semicolorata* it is the main species inhabiting Tatra streams. I have not met with this species elsewhere than in the Tatra. It is described from Czarnohora in the Eastern Carpathians (from the Rumanian side of the Eastern Carpathians, the region of Suceava) from Vistula in Beskidy Śląskie and from the Cracow district. Thus it is a new species for the Tatra. According to Mikulski (1935) this species is the only representative of the *Ephemeroptera* in the places examined above. My observation confirm this.

Zoogeographical references: Bogoescu and Tabacaru (1957), Dzięgdzielewicz (1917—18, 1919—20), Lestage (1916), Mikulski (1935, 1936, 1950) and Sowa (1958).

Rhitrogena semicolorata Curtis. Larvae and imagines of this species were found in 26 Tatra streams (tab. I) and in one lake (Wole Oko in the Valley of Five Polish Lakes). Specimens of this species comprise 38.8% of all the specimens of Mayfly collected. In the streams it was found in stony, gravel and stagnant milieux. (Kamler, Riedel 1960a). This species shows positive rheotaxis and is also found at great heigths (see below). Together with *Baëtis carpathica* it is the main species inhabiting the Tatra streams. Apart from the Tatras I found it on the Orawa district (river Czarna Orawa) and in the streams below Mount Babia (Western Beskidy, Carpathians). The literature emphasises that it is distributed over the waters of the whole of Europe. It is described from Norway mountains, from the Tatra and all other parts of the Carpathians and also from the Alps, Pyrenees, Black Forest, Central Massif and the Vosges. It is a widely distributed species occuring in high and low mountains and on lowland, in Nothern, Central and Southern Europe.

Zoogeographical references. Despax (1927), Dorier and Vaillant (1954), Dzięgdzielewicz (1867, 1891, 1911, 1917—18, 1919—20), Gauthier (1952), Kimmins (1950), Klapalek (1909), Lestage (1916), Mikulski (1935, 1936, 1937, 1950), Nowicki (1867), Schoenemund (1930), Ulmer (1928), Verrier (1943, 1953).

Ecdyonurus venosus Fabricius. I found this species in 14 Tatra streams (tab. I) and in the lake Morskie Oko. Specimens of this species account for 1,9% of the collected specimens of *Ephemeroptera*. It occurred in the streams, in an environment of grooved depressions in the bottom of small streams and in stagnant and stony environments. It is a species with a poorly developed rheotaxis (see below) and mountain characteristics more weakly developed than in the previous species (see below). Apart from the Tatra I met this species in the Orawa district (in the river Czarna Orawa) in streams on the side of Mount Babia, in the Bieszczady (Carpathian range on the south-east of Poland, maximum height 1335 metres). According to Tiensuu (1939) this is a Central European species of which the northern border of its range reaches to Southern Finland. The species is described from the Tatra, from the Carpathians other than the Tatra (the Beskidy, Eastern Carpathians) and from the Alps, Black Forest and Central Massif. It occurs most frequently at the foot of mountains and on mountains of medium height rather than on high mountains. Thus it is a mountain species, typical for the lower heights of Central Europe and also occurring in Southern Scandinavia. Zoogeographical references: Avel (1932), Dorier and Vaillant (1954), Dzięd zielewicz (1917—18, 1920), Gauthier (1952), Klapalek (1909), Kimmins (1950), Lestage (1916, 1919), Mikulski (1931, 1935, 1936, 1937, 1950), Schoenemund (1930), Tiensuu (1939), Ulmer (1928) Verrier (1948, 1953).

Ameletus inopinatus Eaton. I found this species in 9 of the 34 streams studied (tab. I). I confirmed the occurrence of this species in the Valley of Five Polish Lakes: Lake Przedni, Lake Wielki, Lake Czarny and Lake Zadni, in the Valley of the Gąsienicowy Lakes in Lake Kurtkowiec and in one lake in the Valley of Five Spiski Lakes. Specimens of this species accounted for 2.4% of the specimens of *Ephemeroptera* found. This species mainly inhabits lakes and penetrates to streams rarely. (*Ameletus* comprises 0.35% of the stream *Ephemeroptera*). In streams it is restricted to stretches with a weak current, the maximum current velocity at which this species was found was 0.24 m./sec. It mainly favours stagnant pools of dimensions from 30×30 cm. to 70×80 cm. with a slimy-detritus bottom and relatively large depth. It is a northern mountain species of a typical discontinuous distribution. Apart from the Tatra I found this species in slowly flowing stretches of streams in the Bieszczady. The literature describes this species also from Northern Europe: Northern Norway and Northern Finland. Mikulski (1933) considers it as an arctic species. Up till now it has been described from the Tatra and other parts of the Carpathians (Czarnohora) and also from the Alps, Black Forest and the Vosges. Kimmins (1950) quotes it from lower mountain streams.

Zoogeographical references: Dzięd z i e l e w i c z (1917—18, 1919—20), K i m m i n s (1950), K l a p a l e k (1909), L e s t a g e (1916), M i k u l s k i (1935, 1936), T i e n s u u (1939), U l m e r (1928).

Habroleptoides modesta Hagen. I found this species in 5 Tatra streams (tab. I). I did not meet *Habroleptoides modesta* in lakes. Specimens of this species account for 0.62% of the specimens of *Ephemeroptera* found. In streams I found this species only in stony milieux. The mountain character of this species is poorly defined. Apart from the Tatra I found this species in the Bieszczady and in the Czarna Orawa River in the Orawa district. It is not described from the Tatra. It is known from the Gorce (Beskidy Western Carpathians) Vistula river in Beskid Śląski, known also from the Harz mountains, the Dauphiné Alps, the Martime Alps and Central Massif. Thus it is a mountain species, typical for the lower heights of Central and Southern Europe (Genoa and Corsica regions). The stations from the Tatra given here, particularly considering the climatic conditions have the most mountainous character of the stations described up till now.

Zoogeographical references: G a u t h i e r (1952), M i k u l s k i (1936, 1937, 1950), S c h o e n e m u n d (1930), U l m e r (1928), V e r r i e r (1953).

Epeorus assimilis Eaton. This species was found in two Tatra streams (tab. I). Its larvae do not occur in lakes. Specimens of this species comprise 0.109% of the number of specimens of *Ephemeroptera* caught. Apart from the Tatra I found this species in streams in the district of Mount Babia and in Czarna Orawa river. Not given from the Tatra before. It has been noted however from the Eastern Carpathians, the Beskid Wyspowy, the Beskid Śląski, the Dauphiné Alps, the Bavarian Alps, Black Forest, the Balkans, Harz Mountains, Erzgebirge Mountains, Central Massif. It has been noted from medium and low mountains. It is a species characteristic for the lower heights of Central and Southern Europe. The stations from the Tatra have a more mountainous character that the previous findings (see later).

Zoogeographical references: A v e l (1932), D o r i e r and V a i l l a n t (1954), D z i ę d z i e l e w i c z (1917—18, 1919—20), G a u t h i e r (1952), K l a p a l e k (1909), L e s t a g e (1916), M i k u l s k i (1935, 1936, 1937, 1950), S c h o e n e m u n d (1930), U l m e r (1928).

Ecdyonurus subalpinus Klapalek. This species was found in 3 streams (tab. I). Its larvae do not occur in lakes but were found, however in sources on the Polana Pisana in the Kościeliska Valley. Specimens of this species account for 0.43% of the specimens of Ephemeroptera collected. The mountainous character is poorly defined (see later). Known from the Tatra, Eastern Carpathians, Gorce, Beskid Śląski. It is endemic for the Carpathians. Not noted from lowland.

Zoogeographical references: Dzięd z i e l e w i c z (1917—18, 1919—20), L e s t a g e (1916), M i k u l s k i (1931, 1935, 1936, 1937, 1950).

Ecdyonurus forcipula Kollar-Pictet. Larvae of this species were found only in the Roztoka stream. Specimens of this species comprise 0.065% of the Ephemeroptera specimens collected. It was found at heights about 1150 metres above sea level. Known up till now from Tatra, Western Carpathians, Dauphiné Alps, Riesengebirge, Harz mountains and Erz Gebirge Mountains. Thus it is a characteristic species for the lower heights of Central Europe. Not noted from lowland.

Zoogeographical references: Dzięd z i e l e w i c z (1917—18, 1919—20), G a u t h i e r (1952), K l a p a l e k (1909), L e s t a g e (1916), M i k u l s k i (1936, 1937, 1950), S c h o e n e m u n d (1930), U l m e r (1928).

Cloëon dipterum Linné. In the Tatra I found larvae of this species only in Lake Toporowy in the coniferous forest zone. Specimens of this species comprise 0.32% of the number of *Ephemeroptera* specimens collected. I only found this species in the lowest lying Tatra lakes. This is connected with the lowland and non rheophyllous character of this species. T i e n s u u (1939) states that this species reaches the northern borders of its range in Southern Finland. Not noted from Tatra to date. From hilly districts it has only been given from the environs of Grenoble, from ,,Baumberge'' in the Munich district and from the Romanian Carpathians (Suceawa). Apart from the Tatra I found this species, as the only representative of *Ephemeroptera* fauna, in pools of water in the vicinity of Mikołajki (Mazurian Lake District in Northern Poland). It is a lowland species frequently occurring in the European lowlands and sporadically in lower mountainous heights.

Zoogeographical references: B e y e r (1932), B o g o e s c u and T a b a c a r u (1957), G a u t h i e r (1952), K i m m i n s (1950), K l a p a l e k (1909), L e s t a g e (1916), M i k u l s k i (1936), S c h o e n e m u n d (1930), T i e n s u u (1939), U l m e r (1928).

Baëtis bioculatus Linné. I found only one specimen of this species (larva) in the Tatra, in the Świński stream (an affluent of the Olczyski). It represents 0.02% of the collected specimens of *Ephemeroptera*. It was found at a height of about 1000 metres above sea level. The literature underlines its lowland character. Apart from the Tatra I found this species in the Czarna Orawa river in the Orawa district. In the north known from Finland and Norway. T i e n s u u (1939) describes this species as being widely distributed in Central and Northern Europe. It has been given from the Vosges, the ,,Baumberge'' and from the Rumanian Carpathians (Suceawa). However it is mainly given from hilly country and lowlands. It is therefore a characteristic species for the European lowlands, sporadically appearing in low mountains.

Zoogeographical references: Beyer (1932), Bogoescu and Tabacaru (1957), Dzięd zielewicz (1917—18), Kimmins (1950), Klapalek (1909), Landa (1945), Lestage (1916), Macan (1950), Mikulski (1931, 1936, 1937), Schoenemund (1930), Tiensuu (1939), Ulmer (1928), Verrier (1953).

Among those found new species for the Tatras are *Baëtis carpathica. Habroleptoides modesta, Epeorus assimilis, Cloëon dipterum* and *Baëtis bioculatus.*

New species fot the Carpathians.: *Habroleptoides modesta, Cloëon dipterum* and *Baëtis bioculatus.*

Influence of altitude on the distribution of *Ephemeroptera*

The Tatra are divided up into 3 regions: Bielskie Tatra, High Tatra and Western Tatra. The Bielskie Tatra stretch in the east from the ,,pod Kopą'' pass. They are made up of sedimentary rock. They lie entirely on the Czechoslovakian side and were not studied. High Tatra stretch from the ,,pod Kopą'' pass in the east (1756 metres above sea level) to the Liliowe pass in the west (1952 metres above sea level). It is the one group of the Carpathians of a truly high mountainous character. It is composed of granite. The highest peak-Gerlach (2663). Western Tatra range in the west to the Liliowe pass. They are mainly composed of sedimentary rock. Highest peak-Bystra (2250 metres).

Comparing the streams of the High and Western Tatra from the point of view of the qualitative differentiation of *Ephemeroptera* it was found that the streams of the Western Tatra are richer in species of *Ephemeroptera.* It was found that in the Western Tatra there is an average of 3.4 species per stream whereas in the High Tatra 2.5. In the Western Tatra flow all streams in which 5 species were found, 75% in which 4 species were found 43% streams with 2 species and 33% of all the streams in which 1 species was found. The streams of the Western Tatra which were examined are on a lower level than the streams of the High Tatra. The causes of the relatively greater abundance of fauna of the Western Tatra streams may be looked for in the eliminating influence of height on some species. At heights of 1000—1100 metres above sea level 8 species were found, 1100—1200 metres — 6 species and over 1200 metres only 3 species. In fig. 15 are given the heights at which I found particular species and a comparison with data from the literature. Various authors give various borders of heights for a given species. On the fig. 15 the maximum and minimum value quoted is taken into account independently from which mountain the data comes.

Similarly D o d d s and H i s a w (1925) present the height range of larvae of aquatic insects. A given species does not appear within the same altitudinal border in all ranges. This is due to the climatic differences of mountains of different geographical situation. Thus, for example, *Rhitrogena semico-*

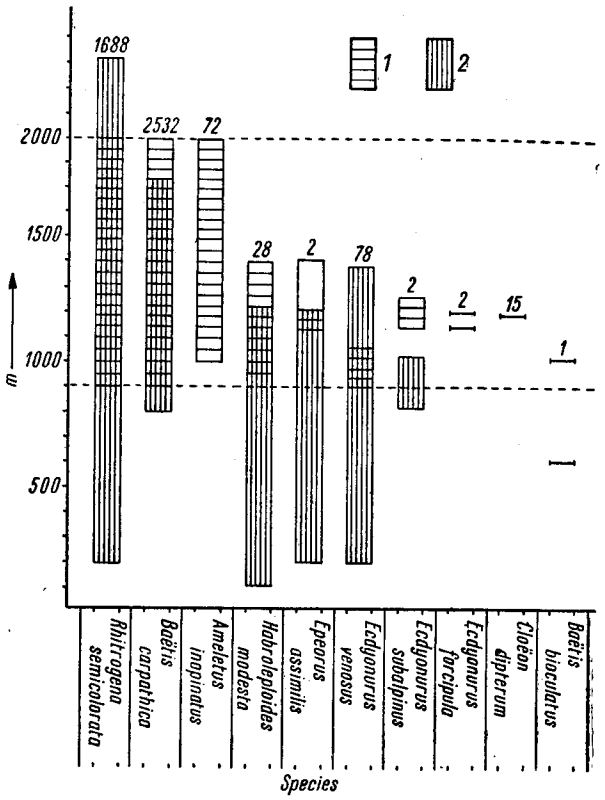

Fig. 15. Altitudinal range for particular species of *Ephemeroptera*

1 — height at which I found a given species; 2 — range of occurrence of particular species given in the literature (numerical data show numbers of specimens of a given species caught)

lorata is given from the Pyrenees from heights of 2200 metres above sea level, from the Alps from 200—2000 metres. *Ecdyonurus venosus* is given from the Alps from heights of 200—1000 metres, from the Eastern Carpathians at 1200—1400 metres. Of the 10 species studied in this work the one which most favours a mountain habitat was *Rhitrogena semicolorata* and the one which least favours it was *Baëtis bioculatus*. It would appear significant that in the waters of the Tatra the most specimens were collected

from 2 species which most strongly favour a high mountain habitat whereas species favouring medium mountains and lowland account for only a very small % of the material collected (comp. numerical data giving the number of specimens caught of each species)(fig. 15).

Rheotaxis phenomena

In order to determine the degree of positive rheotaxis of the larvae of some species of Ephemeroptera the data concerning the current velocities, collected during the ecological studies in July and August 1957, were considered (Kamler and Riedel 1960a and Kamler 1960a). I was able to obtain data on 4 species, the rest were found either in too small numbers or in places where the terrain conditions hampered the measurement of current velocities. The results obtained are given in table II. Of the four species studied the most positive rheotaxis is shown by *Baëtis carpathica* and the least by Ameletus inopinatus. This way of arranging species according to decreasing rheotaxis is confirmed by the other data. It is characteristic that markedly rheophyllous species dominate in a stony milieu and species which are less rheophyllous transfer to lenitic milieu: to stagnant pools, grave milieu and bath shaped bottom depressions im small stream. Observations were made on the inhabitation of single stones by particular species of May-fly depending on the strength of the current and the side of the stone. (It follows from the studies by Dorier and Vaillant (1954) that the current is weaker under the stone than over it. In these observations no measurements were made of the current velocities). Where the surface current is weak *Ecdyonurus venosus* occurs on the surface of stones and where there is a medium current it occurs under the stones and where there is a strong current it does not occur at all. *Rhitrogena semicolorata* appeared on the surface of a stone if the surface current was medium *Baëtis carpathica* does not occur under the conditions of weak currents but only in medium and strong currents and then mainly on the upper surface of the stone. It was also confirmed that in a stony environment as the current velocity increases a drop in the % of *Rhitrogena semicolorata* is observed and an increase in the % of *Baëtis carphatica* (in environments populated mainly by these two species). This shows that of these two species *Baëtis carpathica* exhibits a more positive rheotaxis. I have not seen data on the positive rheotaxis of *Baëtis carpathica* in the literature. The authors however emphasise the extremely positive rheotaxis of some species of this genus, presumably closely related to *B. carpathica* (*B. gemellus*, *B. alpinus*, *B. niger*) Lestage — 1916, Ulmer — 1928, Schoenemund — 1930, Verrier — 1948, 1953, Mikulski — 1936, Dorier and Vaillant — 1954, Verrier, 1948, 1953). Do-

rier and Vaillant (1954) state that *Ecdyonurus venosus* is a species which is weakly rheophyllous. I did not find data in the litterature on the current velocities prevailing where *Ameletus inopinatus* occurs in streams. The weak rheotaxis shown by this species is demonstrated by the fact that it occurs mainly in lakes and by its streamlined type of structure, long middle cerci, abundant cilia on cerci. As mentioned above, Verrier (1942) and Steinberg (1935) established the presence of these characteristics in species of lowland and mountain May-fly occurring in lenitic water and their absence in species from lotic waters. However Dorier and Vaillant (1948, 1954), Avel (1932), Popovici-Baznosanu (1928) discuss this point of view claiming that habitus does not influence adaptation to swift current.

The question of sensitivity to current velocity is connected with the question of the differentiation of fauna into stream and lake fauna. In the greater number of lakes studied (6 out of 9) *Ameletus inopinatus* was found which shows a weak rheotaxis. Larvae of *Baëtis carpathica* which has the strongest rheotaxis were not found in the lakes. In Lake Wole Oko in the Valley of Five Polish Lakes *Rhitrogena semicolorata* was found and *Baëtis carpathica* (with long middle cerci). The latter is less rheophyllous than *Baëtis carpathica* (typical). The occurrence of *Rhitrogena semicolorata* and *Baëtis carpathica* (of long middle cerci) in Lake Wole Oko can be explained by the fact that through this small, shallow body of water (surface area 0.1 ha and depth 2.5 metres), flows a large stream which may give the lake fauna a more rheophyllous character. *Ecdyonurus venosus* was found in Lake Morskie Oko. The lowland and non rheophyllous species *Cloëon dipterum* was found, as I mentioned earlier, in the lowest lying lakes in the Tatra.

The species compounds of fauna in streams is different. The most common species here is *Baëtis carpathica* (found in 100% of streams examined). The least common species are *Ecdyonurus forcipula* and *Baëtis bioculatus*, both species found in 3% of the streams (table I). The most commonly found groups are

Baëtis carpathica, Rhitrogena semicolorata — in 10 streams

Baëtis carpathica, Rhitrogena semicolorata, Ecdyonurus venosus — in 4 streams

Baëtis carpathica, Rhitrogena semicolorata, Ameletus inopinatus — in 4 streams

Baëtis carpathica, Ecdyonurus venosus — in 3 streams

and finally in three streams only *Baëtis carpathica* was found. The groups given above are found altogether in 71% of the streams examined. Other

groupings occur in single streams. According to V e r r i e r (1953), G a u t h i e r (1952) and others larvae of the genera *Baëtis* and *Rhitrogena* have the largest frequency of occurrence in mountain streams.

The emergence of imagines

Imagines of 7 species of May-fly were caught. I was unable to catch the adult forms of *Cloëon dipterum*, *Habroleptoides modesta* and *Baëtis bioculatus*, presumably because on the terrain under study larvae of these species occurred only sporadically and in small numbers. The imagines of those species whose larvae were collected in the water (table I) were not caught over all the streams. There may be several reasons: 1) at the time of collecting samples there was not an emergence of imagines (M a c a n 1958); 2) the difficulty of finding rarely occurring individuals. The imagines of those species whose larvae were not found in streams were sometimes found over streams.

T a b l e II

Current velocities of streams water inhabited by Ephemeróptera species

Species	Minimum and maximum values of current velocity at which a given species was found m./sek.	Mean current velocity m./sek.	Experimental data by Dorier and Vaillant (1954) on the maximum current velocity overcome in the experiment m./sek.
Ameletus inopinatus	0 —0.24	0.068	—
Ecdyonurus venosus	0 —0.36	0.16	0.99
Rhitrogena semicolorata	0 —1.41	0.43	1.25
Baëtis carpathica	0.11—1.41	0.51	—

The emergence of imagines was observed during the following periods:

over streams	
Rhitrogena semicolorata	5.VII — 14.X
Baëtis carpathica	5.VII — 14.X
Ameletus inopinatus	24.VII — 16.VIII
Ecdyonurus venosus	9.VII — 22.IX
Ecdyonurus subalpinus	22.VII and 22.IX
Ecdyonurus forcipula	15.VII
Epeorus assimilis	24 and 26.VII
over lakes	
Ameletus inopinatus	15.VII — 20.VII
Baëtis carpathica	18.VII
Ecdyonurus subalpinus	10.X

The imagines of *Ameletus inopinatus* caught over lakes come from larvae living in lakes which comprise the greater part of the May-fly fauna.

Larvae of *Baëtis carpathica* were not found in Lakes. However, I caught two specimens of imagines over the Przedni Lake 18.VII. I assume that they flew here from one of the numerous streams in this valley.

Table III

Dates of emergence of *Ephemeroptera imagines*

× — my findings, — periods of emergence after other authors

Species \ Months	May	June	July	August	September	October
Rhitrogena semicolorata			× ××××× ×	××× ××× ××× ×	××××	×× ×
Baëtis carpathica			× ××××	× × ××	×	× ×
Ameletus inopinatus			× ××× × ×	×		
Ecdyonurus venosus			×××	×		×
Ecdyonurus subalpinus			×		×	
Ecdyonurus forcipula				×		
Epeorus assimilis			××			

Table III compares the data of my findings with the findings of other authors for imagines. Data from other authors have been taken into account taking into consideration the most early and most recent findings for a given species. Since the data quoted not only relate to the Tatra but also to lower mountains (Eastern Carpathians, Gorce, Central Massif) it is understandable that they show ranges of occurrence which are wider in time than for the Tatra themselves. It is significant that during our searches in May imagines were not found in spite of the fact that the literature records appearances in this month of some species However imagines of *Rhitrogena semicolorata* and *Ecdyonurus venosus* were found in the latter days of October. The appearances of imagines *Ephemeroptera* in this month till now was not observed.

My observations confirm the known fact that the metamorphosis of larvae into subimagines and then into imagines occurs in a period of considerable atmospheric humidity. In July 1957 on the Olczyski stream I more than once came across numerous subimagines emerging from the water. This was a period of exceptionally high rainfall (monthly sum of rainfall — 189.7 mm.). It was also shown that the flight of imagines occurred on a damp day. *Ephemeroptera* observed over streams flew in the direction of the source

by a zigzag route advancing feebly then returning and again making a zigzag flight towards the source of the streams. Swarming was observed for only three species: *Baëtis carpathica*, *Rhitrogena semicolorata* and *Ecdyonurus venosus*. As has already been mentioned these three species represent the greater part of the fauna on this terrain. This may account for the fact that we did not see swarming of other species. In the case of simultaneous swarming individual swarms do not mix with each other. Swarming of *Baëtis carpathica* was only observed twice: 17.VII.1956 and 18.VII.1957 over the stream Pod Mostem at the same place in both cases. This was a widening of the gully through which the stream flowed shaded by *Pinus montana*. In both cases the atmosphere was very humid. Dzięd z i e l e w i c z (1917—18) writes that this species ,,chooses quiet places as stations for such activities, among mountain ridges . . . among trees or *Pinus montana*''.

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