

Notes on the European Species of *Procloeon* Bengtsson with Particular Reference to *Procloeon bifidum* (Bengtsson) and *Procloeon ornatum* Tshernova (Ephemera: Baetidae)

by RYSZARD SOWA

Department of Hydrobiology, Institute of Zoology, Jagiellonian University, Oleandry 2, 30-063 Kraków 19, Poland

Ent. scand. 6. 1975. 107—114.

Abstract

A comparative description of imagines, subimagines, eggs, and nymphs of *Procloeon bifidum* (Bengtsson) and *P. ornatum* Tshernova is given on the basis of material from Poland. Some remarks about the type specimens of both species are pre-

sented with the designation of their lectotypes. From the other European species of *Procloeon* Bngtss. the *P. pseudorufulum* Kimmins and *P. lychnidense* Ikononov are regarded as the junior synonyms of *P. bifidum* (Bengtsson).

1. Introduction

Procloeon bifidum (Bngtss.) was for the first time described within the genus *Cloeon* Leach, on the basis of material from Sweden. Soon afterwards it was designated by Bengtsson (1915) as the nominal species for the genus *Procloeon* Bngtss. Tshernova (1928), Verrier (1949, 1949a), and more recently Kimmins (1957, 1960) and Ikononov (1962) increased the number of European species of this genus to seven. One of them, *P. pseudorufulum* Kimm., established by Kimmins (1957) as a new taxon identical with *Cloeon rufulum* sensu Eaton, 1885 pro parte, var. II (nec *Ephemerarufula* O. F. Müller, 1776) according to the material from England, was later found in many countries of Central Europe, including Poland (Keffermüller 1956, 1960). It seems that from the fact that Bengtsson's species is still little known (no detail of the structure of the original material has so far been presented in the literature, with the exception of an egg drawn by Bengtsson (1913)) many misunderstandings arise in the taxonomy of the genus. The species of Tshernova (1928), described for the first time from the River Moskva in the district of Zvenigorod, is also poorly known. Illies (1967) even classifies *P. bifidum* (Bngtss.) as a dubious species and regards *P. ornatum* Tsher. as a junior synonym of *P. pseudorufulum* Kimm., this being an obvious misunder-

standing: if we accepted this synonymy, the earlier described species of Tshernova should take priority.

2. *Procloeon bifidum* (Bengtsson), 1912 and *P. ornatum* Tshernova, 1928

2.1. *Remarks on the type material*

From the Department of Systematics of the Zoological Institute, University in Lund I have recently received a lectotype imago male of *P. bifidum* (Bngtss.), designated by Per Brinck and I. Müller-Liebenau in 1961 (unpublished). The lectotype has a label with the following inscription by Bengtsson: "Sk., Skräbeån och stranden af Ifösjön vid Bromölla o. Ifvetofta. 26—27/VI. 1906". The banks of Lake Ifösjön are one of the type localities quoted in Bengtsson's original description (1912). At the same time, from the Zoological Museum of the University in Hamburg, I received 4 adult specimens (3 ♂♂ and 1 ♀) of *P. ornatum* Tsher., from a type series, sent at one time by Tshernova to G. Ulmer's Collection. The specimens have labels with Tshernova's hand-written inscriptions: "Prov. Moskva, distr. Zvenigorod, fl. Moskva-Reka, 15.VIII.1923"; "*Procloeon ornatum* Tsher., cotypi, Tshernova 1927".

The *P. bifidum* (Bngtss.) lectotype is well preserved but in consequence of being kept for

a long time in alcohol wholly depigmented. The length of the body and fore-wing is 5.5 mm, that of tails 11 mm. The turbinate eyes, seen in profile, are medium high and distinctly dilated in the upper part, while seen from above they are elongate-oval, distinctly longer than their breadth, parted to the sides and divergent to the anterior. In the pterostigma seven cross-veins are present, the majority of them not connected with the subcosta. Proportions in the length of segments of legs, measured on their outer side are as follows:

	femur	tibia	tarsus (without claws)			
foreleg	13.0	17.4	8.1	6.3	3.7	2.0
median-leg	10.4	9.4	3.8	1.5	0.8	1.9
hind-leg	10.1	9.1	3.5	1.4	0.7	1.7

The end of the abdomen seen from the ventral side and the end of the forceps are shown in figs. 1 and 2.

The specimens of *P. ornatum* Tsher. from Hamburg, also preserved in alcohol, are fairly shrivelled and in a great measure depigmented. The colour characteristic for this species, i.e. red spots and lines on the tergites of the abdomen, is not preserved. The males are devoid of forelegs and sometimes even of some others. Nevertheless the genitalia are well preserved and may be compared with the Swedish specimens. The forceps and penis of one of the homogeneous males are shown in figs. 4 and 5. I designate this male as a lectotype, and the only female in the collection I designate as a lectoallotype of this species. The proportions in the length of segments of hind-legs in the two specimens are as follows:

	femur	tibia	tarsus (without claws)			
Lectotype						
imago ♂	7.9	6.5	2.9	1.0	0.4	1.6
Lectoallotype						
imago ♀	7.7	6.0	2.5	0.9	0.4	1.2

The shape of the tubinate eyes of the lectotype and other details of the external structure of the body are consistent with Tshernova's description (1928).

The forceps of the two species are fairly

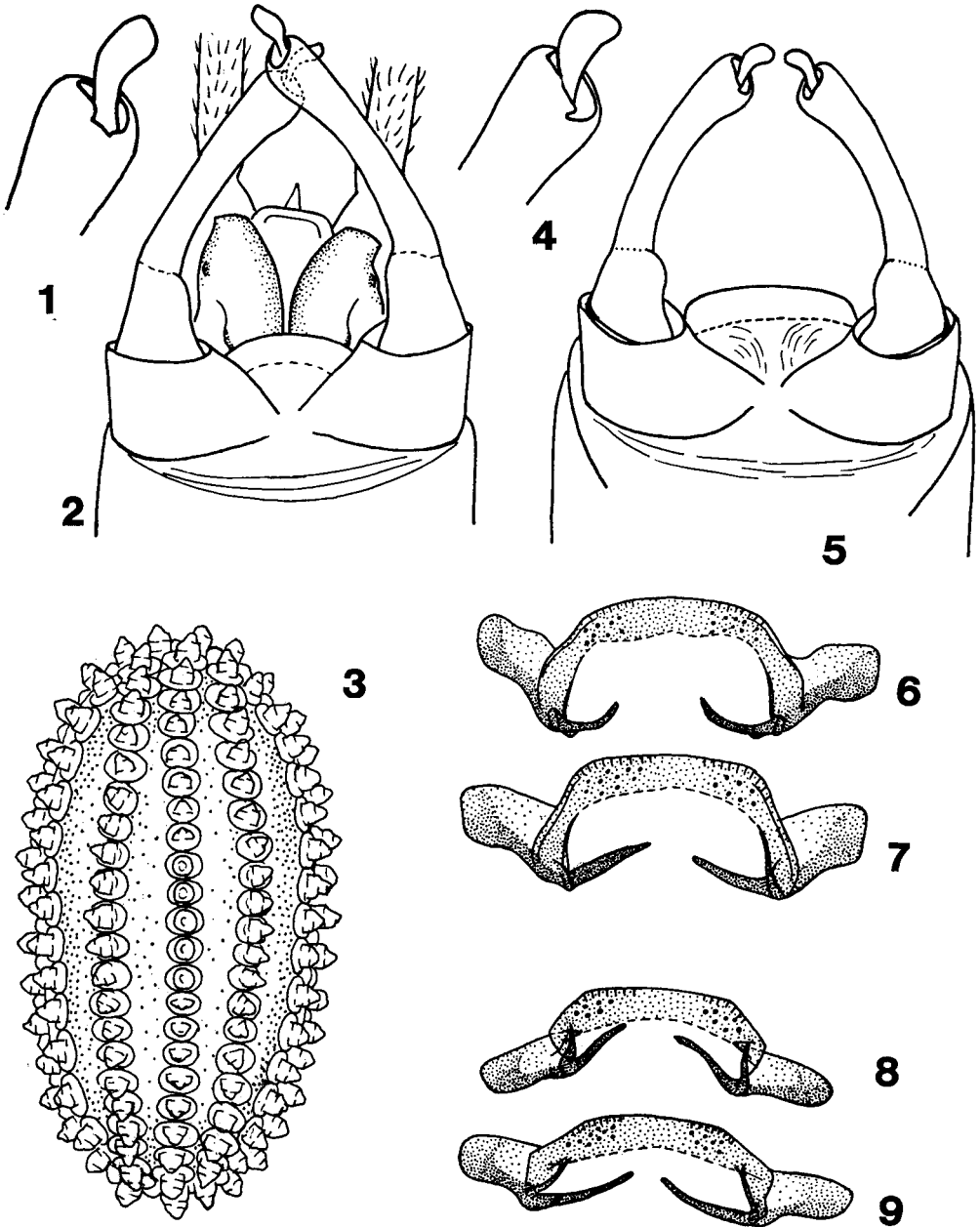
similar, certain difference being visible in the shape of the second segment of the forceps. In *P. bifidum* it is fairly slender and gradually narrows towards the base of the third segment, while in *P. ornatum* it is shorter, more stumpy and sinusoidal on the inner apical angle, where it forms a distinct swelling at the base of the third segment. In *P. bifidum* the penis is short and rounded while in *P. ornatum* it is fairly long and truncate or only slightly rounded (figs. 2 and 5).

2.2. Comparative description of the two species according to material from Poland

Nymphs of *P. bifidum*, only very generally described by Bengtsson (1912, 1936), are characterized by asymmetric single gills, a two-jointed maxillary palp, and a dilated last segment of the labial palp. Numerous nymphs which I caught in the lower course of rivers in the Polish part of the Carpathians are consistent both with Bengtsson's (l.c.) description of nymphs of *P. bifidum* and with Macan's (1949) description of nymphs of *P. pseudorufulum*. According to the outer pigmentation and the colouring of abdominal tergites, they can be divided into two groups:

A—nymphs without red spots on abdominal tergites (imaginal pigmentation) and at the most with one or two tergites with a pattern in the shape of spectacles, and *B*—nymphs with distinct red spots on abdominal tergites, the majority of these tergites having also a pair of central spots resembling spectacles.

In August and September 1973 I reared a large number of nymphs: group *A* from the lower course of the River Raba and group *B* from the lower course of the River Drwinka, and obtained several specimens of imagines (males and females) of both groups. I identified as *P. bifidum* the imagines emerging from the *A* group of nymphs, since their pigmentation was consistent with Bengtsson's description, and the shape of the turbinate eyes of males and their genitalia with the lectotype of this species. The imagines originating from the *B* group of nymphs did not differ from the description of *P. ornatum* and the genitalia of males were well comparable with those of males from the type series of this species. Since the two species have not been directly compared, I discuss the observed differences on the basis of fresh material from Raba and Drwinka.



Figs. 1—9. *Procloeon bifidum* (Bengtsson) (Figs. 1—3, 8, 9) and *P. ornatum* Tshernova (Figs. 4—7): 1 and 4 — terminal segment of forceps of imago male; 2 and 5 — genitalia of imago male from ventral side; 3 — egg; 6—9 — penis of imago male from ventral side, slightly flattened. 2, 4, and 5 after the lectotypes, and the remainder according to the material from Poland.

Material

Procloeon bifidum (Bngtss.): River Raba at Cikowice, alt. 190 m. 15.VIII—25.IX.1973. 11 ♂♂, 14 ♀♀ im., 17 ♂♂♀♀ subim., numerous nymphs and nymphal exuviae (reared); *Procloeon ornatum* Tsher.: River Drwinka below Ispina (Kraków district), alt. 185 m., 21.VIII—28.IX.1973. 13 ♂♂, 12 ♀♀ im., 21 ♂♂♀♀ subim., numerous nymphs and nymphal exuviae (reared). Leg. R. Sowa.

Adult males

The ground colour of the male of *P. bifidum* is lighter. The turbinate eyes are uniformly light yellowish-green, only the lower part of the side wall of eyes being darker. *P. ornatum* male has turbinate eyes of similar but slightly darker colour, the upper margin of the eye often having a dark narrow rim. The thorax of both species is light brown, but in *P. bifidum* the ventral side of the mesothorax is often a little darker than the dorsal side, this not being observed in *P. ornatum*. The legs of *P. bifidum* are slightly more slender and white. Median- and hind-legs of *P. ornatum* are pale grey, the forelegs being dark grey. The venation of wings of *P. bifidum* is almost white, the first three longitudinal veins being yellowish. The venation of *P. ornatum* is distinctly visible and dark, while the cross-veins in the pterostigma are often bifurcated. A distinct difference occurs in the coloration of the abdomen of the two species. *P. bifidum* has the 2.—7. abdominal segment white and translucent, the pigmentation of corresponding tergites (pinkish-orange or orange spots with a greenish hue) being limited to the side and hind parts. Certain more pigmented specimens have an additional pale pink spot in the middle of the anterior part of the tergites. The remaining abdominal tergites are orange with a light brick-red hue. The abdomen of *P. ornatum*, seen from above, is either almost uniformly wine-red and non-translucent or on the slightly translucent 2.—6. tergite red or wine-red spots, five in the number on each tergite, are distinctly visible against the background. Sternites 2.—6. are semi-translucent in all specimens, the remainder being creamy white. The first and often also the second segment of the forceps is darkened. The setae of *P. bifidum* are white and those of *P. ornatum* whitish-grey, more pigmented specimens of the latter show-

ing several basal segments of pale pink colour, especially on the joints. Differences in the shape of segments of the forceps, discussed for lectotypes of the two species, are also supported by the reared material from Poland, with the reservation that with the specimens of *P. bifidum* from the Raba the second segment of the forceps is sometimes slightly sinusoidal on the inner side. The shape of the penis of the two species is similar but fairly variable in each of them. The penis of *P. bifidum* is proportionally distinctly broader and shorter (figs. 8 and 9) than that of *P. ornatum* (figs. 6 and 7), its greatest breadth being attained in the middle of its length and not at the very base as with the species of Tshernova.

Adult females and the subimagines

The difference in the colour of females of the two species are of the same type as in males, adult females usually showing weaker pigmentation. In the females of *P. ornatum* the proportions in the length of the leg segments do not differ from the lectoallotype from the River Moskva. In this species the second segment of the hind tarsus is almost three times shorter than the first one, while in *P. bifidum* it is only two and half times shorter. In practice, the male and female subimagines of both species are only discernible on the basis of differences in pigmentation of the abdominal tergites.

Eggs

The eggs of *P. bifidum*, obtained from freshly killed females and seen in water without staining, are of elongate-oval shape. The surface of the eggs shows numerous adhesive papillae of conical or pyramidal shape, lying in 15 rows (thus 7—8 in the field of vision) of meridian direction (fig. 3). In each row 19—21 papillae occur, touching each other with transversely-oval bases. The distance between the bases of papillae adjoining each other in two rows does not exceed the breadth of each of the bases even in the equatorial zone of the egg. Dimensions of eggs: length 170—180 μm , breadth 85—96 μm . The general shape, size, and structure of the eggs of *P. ornatum* are fairly similar, adhesive papillae being slightly shorter, narrower, and usually digital. The arrangement of papillae in rows is less regular, each row containing 23—25 elements. The distance sepa-

rating the bases of papillae, adjoining each other in two rows in the equatorial zone of the egg, is slightly longer than the breadth of each of them. The length of the eggs is 180—205 μm , the breadth 108—112 μm .

Nymphs

The nymphs of the two species are similar in size. Pigmentation of the dorsal side of the abdomen varies to such a degree that it is impossible to find two specimens of the same species with an identical distribution of spots. A characteristic trait of the pigmentation of the abdomen of *P. ornatum* nymphs is the already-mentioned presence of two round dark spots resembling spectacles with a light dot inside, in the centre of the 2.—7. or 2.—8. abdominal tergite. An equally characteristic trait is the imaginal pigmentation of these tergites: red spots and lines appearing through the cuticle, visible even with young nymphs with a body length of 3—4 mm. In *P. bifidum* nymphs the spots in the shape of spectacles do not occur or are only discernible in the form of indistinct outlines on two or three anterior tergites. In place of these spots a light "umbrella" composed of two arched lines, or spots of another type, frequently occurs in *P. bifidum* nymphs (fig. 18). On the abdomen of nymphs of this species the imaginal colouring is also visible; this is orange with a greenish hue, similar to that of imagines, and is limited to the hind part of the 2.—7. tergite. Nymphs of the two species also differ in the structure of the gills. All seven pairs of gills are single in *P. bifidum* and *P. ornatum*; however, on the proximal margin of the lamella, near the base, a more or less distinct swelling occurs on the gills of the 2.—6. pair, being a rudiment of the second lamella. This rudiment, more distinctly visible in nymphs of *P. ornatum*, often develops into a kind of digital process protruding outside the margin of the lamella (fig. 15). In the nymphs of *P. bifidum* this swelling is most often barely visible under the microscope and its presence is indicated only by a small cut in the margin of the lamella (fig. 11). A certain difference can also be seen in the general appearance of the gills: they are slightly more slender and have less ramified tracheae of paler colour in the nymphs of *P. bifidum* (figs. 10—13), while in *P. ornatum* (figs. 14—17) they are broader and have more ramified, stronger and better pigmented tracheae. Nevertheless, the shape of

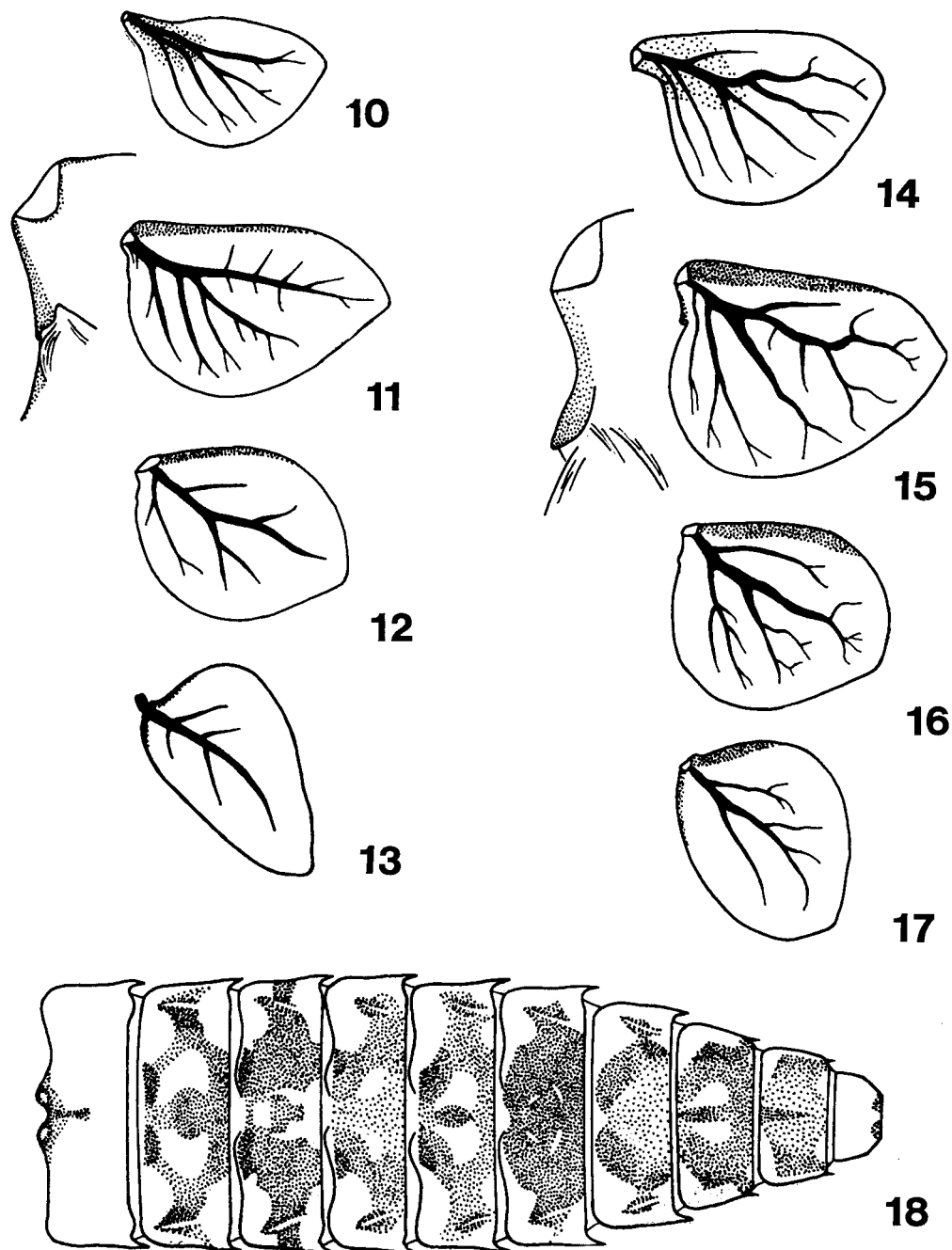
the gills is fairly variable in the nymphs of both species and this difference may often be hardly visible. Female nymphs of both species have more rounded and obtuse gills. In *P. bifidum* spines along the sides of abdominal segments appear from as late as the fifth (rarely fourth) segment, while in *P. ornatum* they are already visible on the fourth (rarely on the third or even second) segment.

2.3. Distribution and biology

P. bifidum seems to be widely distributed in Europe: from the Scandinavian peninsula and the British Isles, through the Central European Lowland to Yugoslavia. *P. ornatum* is so far known from the European lowland part of the USSR and from Poland. As nymphs, the two species inhabit the sandy and muddy bottom sediments of running waters, in places of slow or very slow current. They are particularly abundant on higher aquatic plants (*Potamogeton* spp., *Nuphar luteum*). *P. ornatum* mainly occurs in lowland water courses of various size, showing a certain preference for eutrophicated waters. *P. bifidum* occurs more commonly in running waters of piedmont areas up to an altitude of about 500 m (in Poland), and has also been found in oligotrophic lakes. Both species seem to have two generations a year, with the emergence period from May to October. Their nymphs have not been recorded in characteristic habitats during the late autumn and in winter, this suggesting the occurrence of a long period of embryonal development.

3. Remaining European species and general synonymy

Recognizing as a new species *Procloeon pseudorufulum* in *Cloeon rufulum* sensu Eaton, Kimmins (1957) compared it only with *P. bifidum* (Bngtss.) according to the original description of Bengtsson (1912). He came to the conclusion that the only trait differentiating the two species in the stage of male imago is the degree of spacing of basal segments of the forceps and, in the nymphal stage, the degree of roundness of the third gill. He also stressed that the difference in spacing of basal segments of the forceps may perhaps result from differences in the preservation of the specimens described and that these two species may in



Figs. 10—18. *Procloeon bifidum* (Bengtsson) (Figs. 10—13, 18) and *P. ornatum* Tshernova (Figs. 14—17), nymph: 10 and 14 — first gill; 11 and 15 — third gill with rudiment of second lamella (enlarged); 12 and 16 — sixth gill; 13 and 17 — seventh gill; 18 — one of the patterns of the dorsal side of the abdomen. Material from Poland.

future be recognized as synonyms. The Kimmin's assumption seems to be right. The lectotype of *P. bifidum* (Bngtss.) and also the specimens from the Raba have genitalia very similar to those of the holotype of *P. pseudorufulum* Kimm. from Kington, Hereford (Kimmins 1957: 31, fig. A). The general pigmentation is also identical with that of specimens from the Raba, the nymphs found here having the third gill similar to Macan's (1949) drawing. Two imago females, the paratypes of *P. pseudorufulum* Kimm., which I have lately received for examination from the British Museum (Natural History) in London and which were collected in Berkshire, Reading, and from the River Arrow at Kington, Hereford, have eggs identical with those of *P. bifidum* (Bngtss.). Therefore, I regard *P. pseudorufulum* Kimm. as the junior synonym of *P. bifidum* (Bngtss.).

From the remaining European species of *Procloeon* Bngtss., *P. concinnum* (Eaton), 1885 is only known from its type locality in Portugal (Porcalhota near Cintra) and only in adult stages. It differs in the stage of male imago from the species discussed above in the penis being narrower and sharper at the end. Judging from Verrier's original descriptions (1949, 1949a), *P. rabaudi* Verr. and *P. hovassei* Verr. belong to the genus *Cloeon* Leach and more precisely to the group of *C. simile* Etn. *P. lychnidense* Ikon., however, described by Ikononov (1962) on the basis of material from Lake Ochrida in Macedonia, does not differ from *P. bifidum* (Bngtss.), in any of the stages discussed by the Yugoslavian author and in my opinion is a junior synonym of Bengtsson's species. The differences observed by Ikononov (l.c.) in the structure of the two species result from the fact that the Yugoslavian author depended on the authority of Schoenemund (1930) who—in consequence of Bengtsson's (1936) mistake in the identification of material sent to Schoenemund for investigation—described the nymphs of *Cloeon schoenemundi* Bngtss. as those of *P. bifidum* (Bngtss.).

Synonymy of European Species of *Procloeon* Bngtss.:

Procloeon bifidum (Bengtsson), 1912
 = *pseudorufulum* Kimmins, 1957 syn. nov.
 = *lychnidense* Ikononov, 1962 syn. nov.
 = *bifidum*: Ulmer 1929 pro parte (imago, subimago); Schoenemund 1930 p.p. (imago, nec larvae = *Cloeon schoenemundi*

Bengtsson, 1936); Mikulski 1936 p.p. (imago); Bengtsson 1936; Grandi 1960.
 = *rufulum*: Macan 1949; Kimmins 1954.
 = *pseudorufulum*: Landa 1969 (p.p.?).
 = *Cloeon rufulum*: Eaton 1885 p.p. (var. 2); Esben-Petersen 1910.

Procloeon concinnum (Eaton), 1885

= *Cloeon concinnum* Eaton, 1885.

= *concinnum*: Kimmins 1960.

Procloeon ornatum Tshernova, 1928

? = *Cloeon rufulum*: Ulmer 1929; Schoenemund 1930 p.p. (imago); Mikulski 1936 p.p. (imago); Bogoescu 1958.

= *rufulum*: Keffermüller 1956.

= *pseudorufulum*: Keffermüller 1960.

= *ornatum*: Tshernova 1964.

Acknowledgements

I wish to express my appreciation and sincere thanks to many persons, for the loan or gift for comparison of the type and other material of European *Procloeon* species, and especially to Dr. Per Brinck and Dr. B. O. Landin from the Zoological Institute of the University in Lund, Dr. M. Keffermüller from the Institute of Biology, Adam Mickiewicz University in Poznań, Dr. T. T. Macan from the Freshwater Biological Association in Ambleside, Dr. P. H. Ward and Miss S. L. Bedford from the British Museum (Natural History) in London, and Dr. H. Weidner from the Zoological Institute and Zoological Museum, University in Hamburg.

References

- BENGTSSON, S., 1912. Neue Ephemeriden aus Schweden. — Ent. Tidskr. 33. Uppsala. 107—117.
 — 1913. Undersökningar öfver äggen hos Ephemeriderna. — Ent. Tidskr. 34. Uppsala. 271—318.
 — 1915. Eine Namensänderung. *Procloeon* nom. n. für *Pseudocloeon*. — Ent. Tidskr. 36. Uppsala. 34.
 — 1936. Eine neue *Cloeon*-Art aus Dänemark, *Cl. Schoenemundi* n.sp. — Opusc. ent. 1. Lund. 3—5.
 BOGOESCU, C., 1958. Ephemeroptera. Fauna R. P. Romine. Insecta. 7.3. (A.R.P.R.) Bucharest. 1—187.
 EATON, A. E., 1883—1888. A revisional monograph of recent Ephemeridae or Mayflies. — Trans. Linn. Soc. (2). 3. Zool. London. 1—352 + 65 pl.
 ESBEN-PETERSEN, P., 1910. Ephemerida (Døgn-

- fluer). Danmarks Fauna. 8. (G. E. C. Gad) København. 64—105.
- GRANDI, M., 1960. Ephemeroidea. Fauna d'Italia. III. (Calderini) Bologna. 1—474.
- IKONOMOV, P., 1962. Baetidae (Ephemeroptera) na Makedonija. — God. Zbor. Prir.-Mat. Fak. Univ. Skopje. 13. Biol. 1. Skopje. 83—140.
- ILLIES, J., 1967. Ephemeroptera. Limnofauna Europaea (G. Fischer Verlag) Stuttgart. 212—219.
- KEFFERMÜLLER, M., 1956. Materiały do fauny jętek Wielkopolski. — Prace Kom. Biol. Pozn. Tow. Przyj. Nauk. 18. Poznań. 173—202.
- 1960. Badania nad fauna jętek (Ephemeroptera) Wielkopolski. — Prace Kom. Biol. Pozn. Tow. Przyj. Nauk. 19. Poznań. 411—467.
- KIMMINS, D. E., 1954. A Revised Key to the Adults of the British Species of Ephemeroptera. — Freshw. Biol. Ass. Sc. Publ. 7. Ambleside. 1—71.
- 1957. Notes on *Procloeon pseudorufulum* sp.n. (= *Procloeon rufulum* (Eaton)) and on *Cloeon simile* Eaton (Ephemeroptera). — Ent. Gaz. 8. London. 29—35.
- 1960. The Ephemeroptera Types of Species described by A. E. Eaton, R. McLachlan, and F. Walker. — Bull. Brit. Mus. (Nat. Hist.) Ent. 9. London. 269—318.
- LANDA, V., 1969. Jepice — Ephemeroptera. Fauna ČSSR. 18 (Academia) Praha. 1—350.
- MACAN, T. T., 1949. Descriptions of the nymphs of the British species of *Cloeon*, *Procloeon* and *Centropilum* (Ephem., Baetidae). — Ent. mon. Mag. 85. London. 222—228.
- MIKULSKI, J. St., 1936. Jętki (Ephemeroptera). Fauna Słodkowodna Polski. 15 (Kasa im. Miadowskiego) Warszawa. 1—168.
- MÜLLER, O. F., 1776. Zoologiae Danicae Prodrum. Havniae. 142—143.
- SCHOENEMUND, E., 1930. Eintagsfliegen oder Ephemeroptera. Die Tierwelt Deutschlands. 19 (G. Fischer Verlag) Jena. 1—106.
- TSHERNOVA, O. A., Neue Ephemeropteren aus Russland. — Zool. Anz. 75 (11, 12). Leipzig. 319—323.
- 1964. Otriad Ephemeroptera — podenki. Opre-delitel nasekomych evropejskoj časti SSSR. 1 (Nauka) Moskva—Leningrad. 110—136.
- ÜLMER, G., 1929. Eintagsfliegen, Ephemeroptera (*Agnatha*). Die Tierwelt Mitteleuropas. 4. 1b. 3 (Quelle and Meyer) Leipzig. 1—43.
- VERRIER, M. L., 1949. Description d'un nouveau *Procloeon* (Ephéméroptères). — Bull. Soc. zool. Fr. 74. Paris. 184—190.
- 1949a. *Procloeon hovassei* nov. sp., Ephéméroptère des lacs des Monts Dorés. — Rev. Sc. nat. Auvergne. 16. 58—64.

Manuscript received January 30, 1975.