

REVISION OF THE STATUS OF *PROCLOEON NANA* (BOGOESCU, 1951) AND *PSEUDOCENTROPTILOIDES SHADINI* (KAZLAUSKAS, 1964) (EPHEMEROPTERA: BAETIDAE)

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Abstract.— The taxonomic status of some Ephemeroptera species is still not finally established. Such a situation is found in the case of a few species from the family Baetidae. *Procloeon nana* and *Pseudocentropiloides shadini* have been included in the past in one of the following genera: *Centroptilum*, *Cloeon*, *Procloeon* or *Pseudocentropiloides*. The changes in the taxonomic positions of these species are presented, starting from their first descriptions. After critical analysis of all these opinions, the following status: *Procloeon nana* (Bogoescu, 1951) and *Pseudocentropiloides shadini* (Kazlauskas, 1964) is considered valid. On the basis of the material from the river Bug (North-West Poland), the different stadia: nymph, male and female imagoes, egg are redescribed and the main diagnostic features are presented.



Key words.— Ephemeroptera, Baetidae, *Procloeon nana*, *Pseudocentropiloides shadini*, new status.

INTRODUCTION

The descriptions of new species which were made some years ago have often been imprecise and incomplete. Repetition of the earliest inaccuracies by later investigators tangled the taxonomic status of some species. Such was the case with two species from the family Baetidae, *Procloeon nana* (Bogoescu, 1951) and *Pseudocentropiloides shadini* (Kazlauskas, 1964). The original descriptions of both species have been corrected and supplemented many times.

History of studies on *Procloeon nana* and *Pseudocentropiloides shadini*. Bogoescu (1951) described a new species *Centroptilum nana* (= *Procloeon nana*) from male and female imagoes and their eggs found in Romania. Nymphs remained unknown. Unfortunately, his description was very simple, which

led to difficulties in the species identification. Only the structure of the egg provided sufficiently reliable diagnostic features.

Further data concerning *C. nana* came from North-East Europe. Kazlauskas and Sanvaitite (1962) published the list of mayfly species from the River Gauja (Latvia) with the *C. nana* (= *P. nana*) on it. They mentioned that the nymphs of this species were characterized by a long claw on the tarsi and by single gills which separated them from other *Centroptilum* (= *Procloeon*) species.

The *Centroptilum (Procloeon) nana* nymph was described in more detail by Kazlauskas in 1964. He mentioned the elements of mouthparts, leg, hind wing and forceps. In the same paper, he described also a new species *Pseudocentropilum? shadini* sp. nov. (= *Pseudocentropiloides shadini*) based on the

nymphs from the River Oka (south of Moscow). As in the case of *P. nana*, he presented the elements of mouthparts and pointed out a very long claw on the tarsus. Unfortunately, most of the nymphs described were without gills although some specimens possessed the first pair, which were single and asymmetric.

Following information concerning the distribution of *P. nana* originating from Poland, Keffermüller (1967) found nymphs of *Centroptilum* species in the River Warta. Single and asymmetric gills led her to describe these specimens as *Centroptilum nanum* (*Procloeon nana*). She enclosed, in her work, the drawings of the gills, unknown so far, as well as the copulative apparatus, hind wing and legs of a male, which was reared from the nymph. She also tried to fit the grammatical form of the species name (*nana*) to the name of the genus (*Centroptilum*). As a result of such "corrections", the new name *C. nanum* arose.

The first revision of the *Centroptilum* species was made by Keffermüller and Sowa (1984). Because the type specimens of the species under discussion were unobtainable, they used the material from the River Warta (Central Poland) for the study. The adult specimens were obtained by rearing the nymphs. They transferred *Pseudocentroptilum? shadini* to the genus *Centroptilum*. It appears that *Centroptilum* (*Procloeon*) *nana* gills have an additional, small dorsal lamella, while *Centroptilum* (*Pseudocentroptiloides*) *shadini* gills are single. On these grounds, the earlier descriptions of *Centroptilum* (*Procloeon*) *nana* (Kazlauskas and Sanvaitite 1962, Keffermüller 1967) refer to *Centroptilum* (*Pseudocentroptiloides*) *shadini*. They also described the egg of these species, which match the original Bogoescu description. The median band of greater papillae is narrower in the case of *Centroptilum* (*Procloeon*) *nana*.

The next revision was made by Jacob (Jacob and Głazaczow 1986). On the basis of the material from the River Bug (North-East Poland), he established a new genus *Pseudocentroptiloides* with the type species *P. shadini*. A few years later, after the revision of the family Baetidae, which was carried out by McCafferty and Waltz (1990), the second species, *C. nana* was also transferred to the other genus. All the European species of the genus *Centroptilum*, except *C. luteolum*, were included in the genus *Procloeon* (Bengtsson, 1915)

The last attempt to change the taxonomical status of the species was made by Kluge and Novikova (1992). They described a new species *Cloeon* (*Procloeon*) *macronyx* Kluge et Novikova and because, in their opinion, Bogoescu and Kazlauskas described the same species, they made a new combination *Cloeon* (*Pseudocentroptiloides*) *nana* (Bogoescu, 1951) comb. n. and changed the rank of the genus *Procloeon* to subgenus.

So many changes in the taxonomy of these two species caused many obscurities and incomprehensibilities. For example, in the last few years, the same species was described from Hungary by the same authors as *Pseudocentroptilum nanum* (Kovacs et al. 1998), *Procloeon nana* (Kovacs et al. 2001), *Centroptilum nanum* (Kovacs et al. 2002) or *Procloeon macronyx* (Kovacs 2005).

Evidence which could provide an explanation as to which assumptions were correct, could be found by checking the type specimens. All our attempts to obtain these specimens from Romania were unsuccessful. Also, because of river pollution, the distribution of these species has declined and they are extinct from the localities in the river Warta. We could only get specimens from the river Bug, and on the material from this river, the genus *Pseudocentroptiloides* was established.

The aim of the present paper is to redescribe *Procloeon nana* and *Pseudocentroptiloides shadini* on the basis of material from Poland at all developmental stages, to find critical distinguishing characters in eggs, larvae and adults, in order to compare with original descriptions and review opinions on taxonomic positions.

MATERIAL AND METHODS

Mayflies submitted to the analysis were collected both by Keffermüller in the river Warta and by Głazaczow in the rivers Bug and Narew. Some of the adults were obtained by rearing the nymphs and this material was used for describing the developing stages. The material was deposited in the Natural History Collections of the Faculty of Biology, Adam Mickiewicz University. The eggs for the SEM study were prepared with the help of the standard method (Karnowsky 1965).

Material analysed. *Procloeon nana*. River Bug (north-east Poland), Barcice: 16.07.1994 – 5 imago males; Drohiczyń: 27.06.1993 – 1 imago female, 17.07.1994 – 4 imago females, 19.07.1994 – 7 imago females, 23.07.1994 – 1 imago male, 27.06.1997 – 8 nymphs; Nur: 17.07.1994 – 4 imago males; River Narew (north-east Poland), Laskowiec: 25.08.1999 – 4 nymphs (Głazaczow).

Pseudocentroptiloides shadini. River Warta (central Poland), Ostrowsko: 11.06.1964 – 1 imago female, 20.06.1973 – 1 imago female; Krzeczów: 6.06.1973, 1 imago female (Keffermüller); River Bug, Drohiczyń: 17.07.1994 – 4 imago females, 27.06.1997 – 9 nymphs; Mierzvice: 24.07.1992 – 9 imago males; Nur: 17.07.1994 – 1 imago male; River Narew, Laskowiec: 25.08.1999 – 22 nymphs, 26.08.1999 – 1 imago female, 26.08.1999 – 1 imago male (Głazaczow).

TAXONOMY

Procloeon nana (Bogoescu, 1951)

Centroptilum nana Bogoescu, 1951.

Centroptilum nana: Bogoescu 1958, Kazlauskas 1964, Sowa 1975, Soldan 1981.

Centroptilum potamonensis: Jacob 1973 (pro parte: nymph).

Centroptilum nanum: Keffermüller 1978, Keffermüller and Sowa 1984, Kovacs *et al.* 2002.

Cloeon macronyx: Kluge and Novikova 1992; Kovacs *et al.* 2003, Kovacs and Bauernfeind 2003, Kovacs 2005.

Procleon nanum: Glazaczow 1997.

Pseudocentroptilum nanum: Kovacs *et al.* 1998.

Description. Nymph. Body length 6–7 mm, tails 2.0–2.5 mm. Tinge of body light brown with darker pattern on abdominal tergites. Main features of pattern are oval spots running through middle of abdomen and more rarely near its side edges; darkest is segment 6 (Fig. 28). Mouthparts: shape of labrum typical for most species from family Baetidae. Its anterior margin rounded with small notch in the middle (Fig. 24). Canines of mandibles divided by deep incision. Galea and lacinia narrow, sharper towards apex and finished by one sharp-ended apical tooth (Fig. 25). Similarly, glossae and paraglossae also sharp-pointed (Fig. 26). Gills asymmetric. First five pairs have upper, rudimentary lamella (Fig. 27). Claws on the ends of tarsi are very long, only slightly shorter than tarsi. Full description see Keffermüller and Sowa 1984.

Male imago. Body length 5.0–5.5 mm, tails 9.0–10.5 mm. Turbinate eyes somewhat divergent and broaden upwards. Their upper surface oval and light brown (colour of the mayfly body kept in alcohol becoming pale after a few months), lateral margins rounded with darker rim. Thorax brown, abdomen light brown with rust-coloured end, tails white. Basic segment of forceps short and wide, taper and spread outwards. First segment of similar length but narrower, with tubercle on inner side, which is variable in size. In some specimens tubercle much more prominent than in others. Second segment slightly bent in middle part and broader at apex. Third segment small and clavate (Figs 29–30).

Female imago. Body length 5–7 mm, tails 8–10 mm. Compound eyes dark, seen from side are broader in front. Back part of thorax brown and abdomen light brown; underside pale, legs light brown and tails white.

Egg. Oval, length 130–150 μm (Fig. 8). Chorionic surface (except equatorial area) covered by reticulated structure with more or less regular meshes, rounded in outline (2.3–4.6 μm in diameter); net joints 1.2–3.0 μm in breadth (Fig. 10). Fibrous attachment structures fill almost whole surface of each mesh (Fig. 14). They are thin threads of non-coiled type. In equatorial area wide band (30 μm) of large papillae composed of 9 rows

(Fig. 9). They are stout and cylindrical processes, rounded in apical part (diameter 3.5–4.0 μm), and lie aslant longer axis of egg (Fig. 11). Papillae placed in meshes of net shaped like irregular polygons (Fig. 12); joints in this part of reticulation thin (width 0.4–0.6 μm). Near band of large papillae are 1–2 micropyles (Fig. 15). The sperm guide roundish and lies in one of meshes. Its surface granulated and micropylar rim thin.

Distribution. The range of *Procloeon nana* is not exactly known. It includes east Europe and the west part of Asia. It has also been found in Romania (Bogoescu 1951), Bulgaria (Russev *et al.* 1991), Czech Republic (Soldan 1981), Poland (Keffermüller and Sowa 1984, Glazaczow 1997), Lithuania (Kazlauskas 1964) and lately also in Hungary (Kovacs *et al.* 1998, 2001, 2002). Some of its localities are in the Asiatic part of Russia and in Kazakhstan (Kazlauskas 1964; Kluge and Novikova 1992).

Pseudocentroptiloides shadini (Kazlauskas, 1964)

Pseudocentroptilum shadini Kazlauskas, 1964.

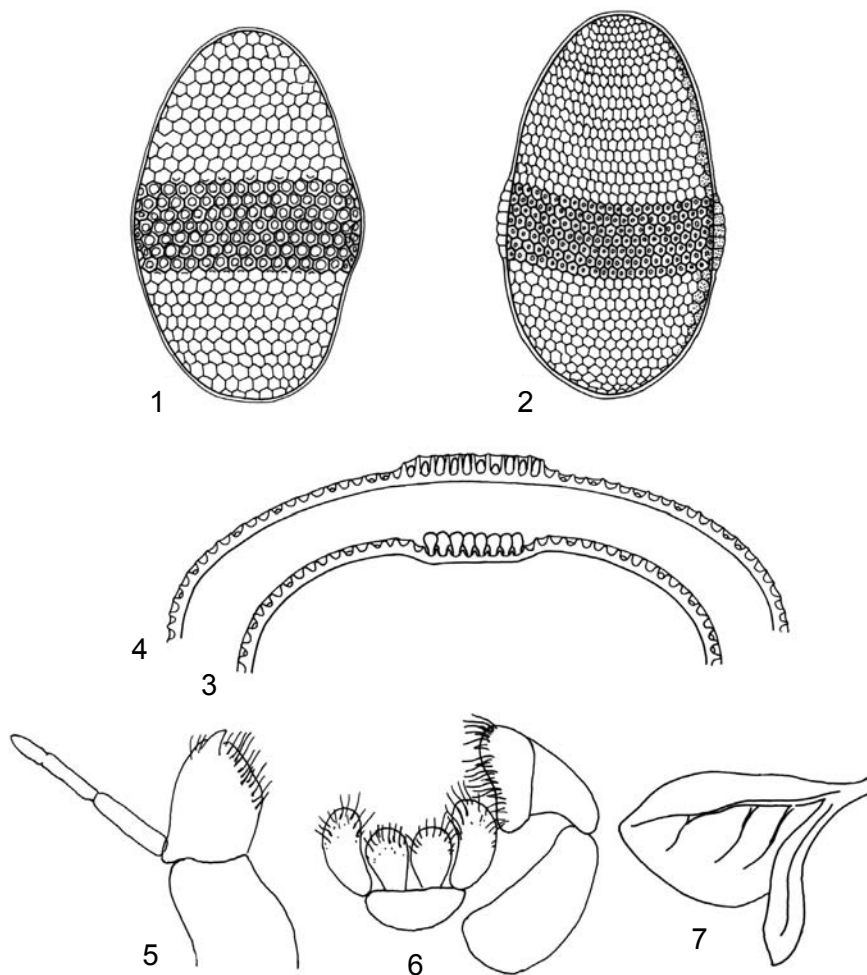
Centroptilum nanum: Kazlauskas and Sanvaityte 1962, Keffermüller 1967, Kovacs and Bauernfeind 2003.

Centroptilum shadini: Keffermüller and Sowa 1984.

Cloeon nana: Kluge and Novikova 1992.

Description. Nymph. Body length 6–8 mm, tails 2–3 mm; in size similar to previous species but somewhat slender. Pigmentation pale, sandy, only on some abdominal tergites characteristic pattern with two lighter spots between darker sides and central part of tergite appear (Fig. 35). Mouthparts: labrum with broad, triangular notch which gives characteristic shape with two side lobes (Fig. 31). Canines of mandibles divided for almost whole of their length by deep incision. Galea and lacinia broad, galea with 2–3 slender apical teeth, lacinia with 4 teeth, 3 of which are much shorter and broad at the base (Fig. 32) and do not taper so much as in case of *P. nana*. Glossa shorter than paraglossa and both elements broad ended and rounded on the top (Fig. 33). Gills single and asymmetric (Fig. 34). Legs have very long claws, somewhat longer than tarsi. Full description see Keffermüller and Sowa 1984.

Male imago. Body length 5–7 mm, tails 9–10 mm. Turbinate eyes somewhat divergent and broader on top. Their upper surface yellow with darker rim along side margin. Thorax light brown, tergites on abdomen yellowish pale with darker, rust-coloured posterior margin. Ventral part of the body, legs and tails are whitish. Basal segment of forceps short and broad, taper somewhat and bend outwards. First segment also tapers, has tubercle on inner side, variable in size as in former species. Second segment, fused with first,



Figures 1–7. (1–2) *Procloeon nana* (= *Centroptilum nana*), egg: (1) from Bogoescu 1951; (2) from Bogoescu 1958; (3) *Cloeon* (*Procloeon*) *macronyx* sp. nov., egg from Kluge and Novikova (1992); (4) *Cloeon* (*Pseudocentroptiloides*) *nana* (Bogoescu, 1951) egg from Kluge and Novikova (1992); (5–7): Baetidae sp. from Niezviestnava-Shadina (1931): (5) maxilla; (6) labium; (7) second gill.

slightly bent in middle part and broadened at end. Third segment very small and clavate (Figs 36, 37).

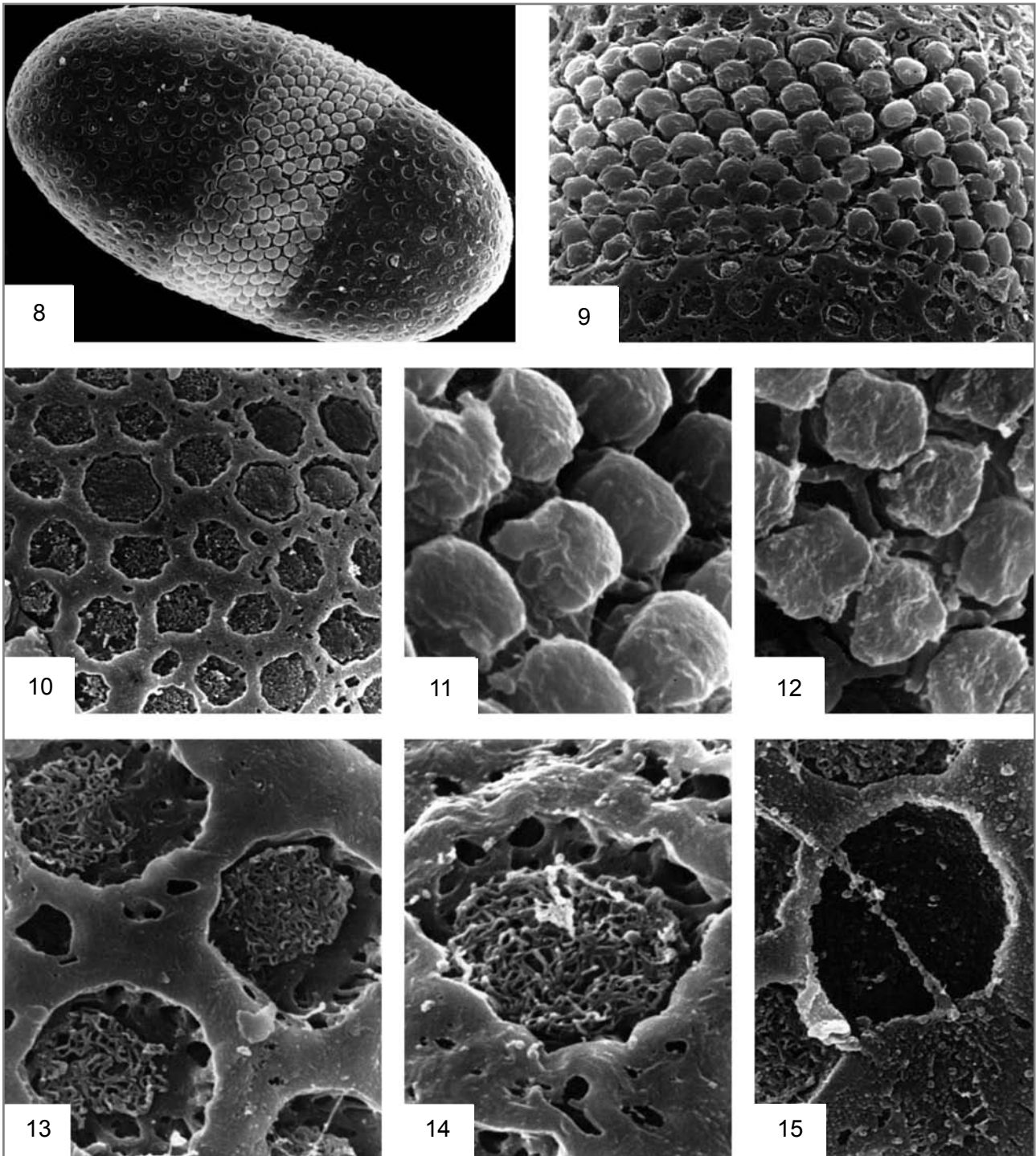
Female imago. Body length 5–6 mm, tails 8 mm. Compound eyes oval, broader in front part, dark. Thorax and abdomen light brown, posterior margins of abdominal tergites dark red, underside of body and legs pale.

Egg. Spindle shaped, narrowing to egg poles, length 137–149 μm , width 82–87 μm (Figs 16, 17). Chorionic surface (except equatorial area) covered by thick net of reticulated structure, with irregular, polygonal meshes (Fig. 21). Joints of net broad and quite high (width 1.1–1.4 μm). Under membrane covering the meshes, attachment structures visible (Fig. 22). These are long, thin, non-coiled threads. The equatorial band, width 37–50 μm , composed of 11 rows of large, oval papillae (1.9–2.2 \times 2.2–4.1 μm) enlarged at top and depressed in middle (funnel-shaped) (Figs 18, 19). Net joints in this part of egg thin (width 0.6–0.7 μm) and diameter of polygonal meshes greater (2.4–3.0 μm) (Fig. 20).

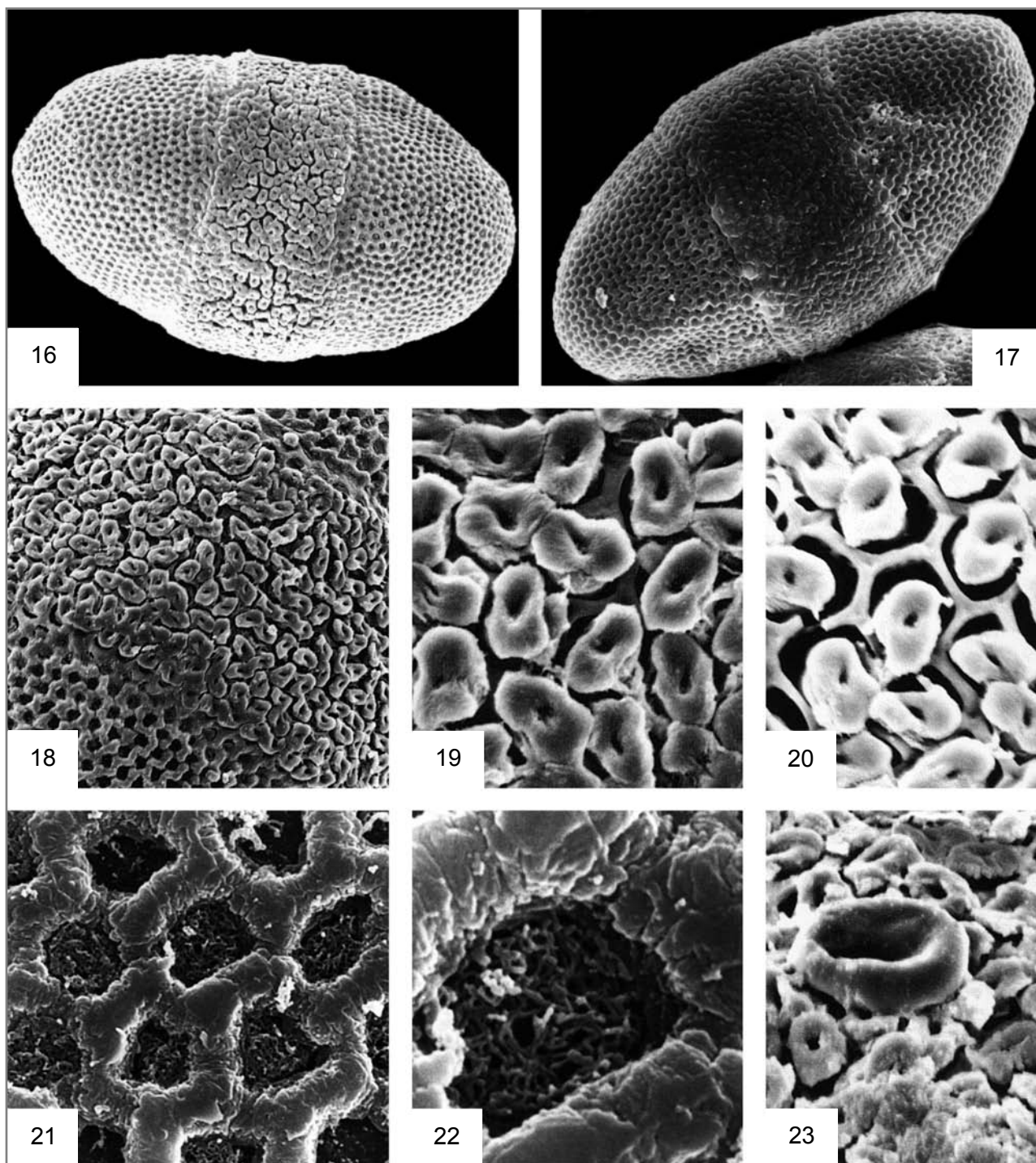
Distribution. *Pseudocentroptiloides shadini* is one of the mayfly species of rare occurrence. So far, its localities are known only in Poland (Keffermüller 1978, Głazaczow 1998), Lithuania and Latvia (Kazlauskas and Sanvaityte 1962), Russia (Kluge and Novikova 1992). Lately it was also found in Hungary (Kovacs *et al.* 2002).

DISCUSSION

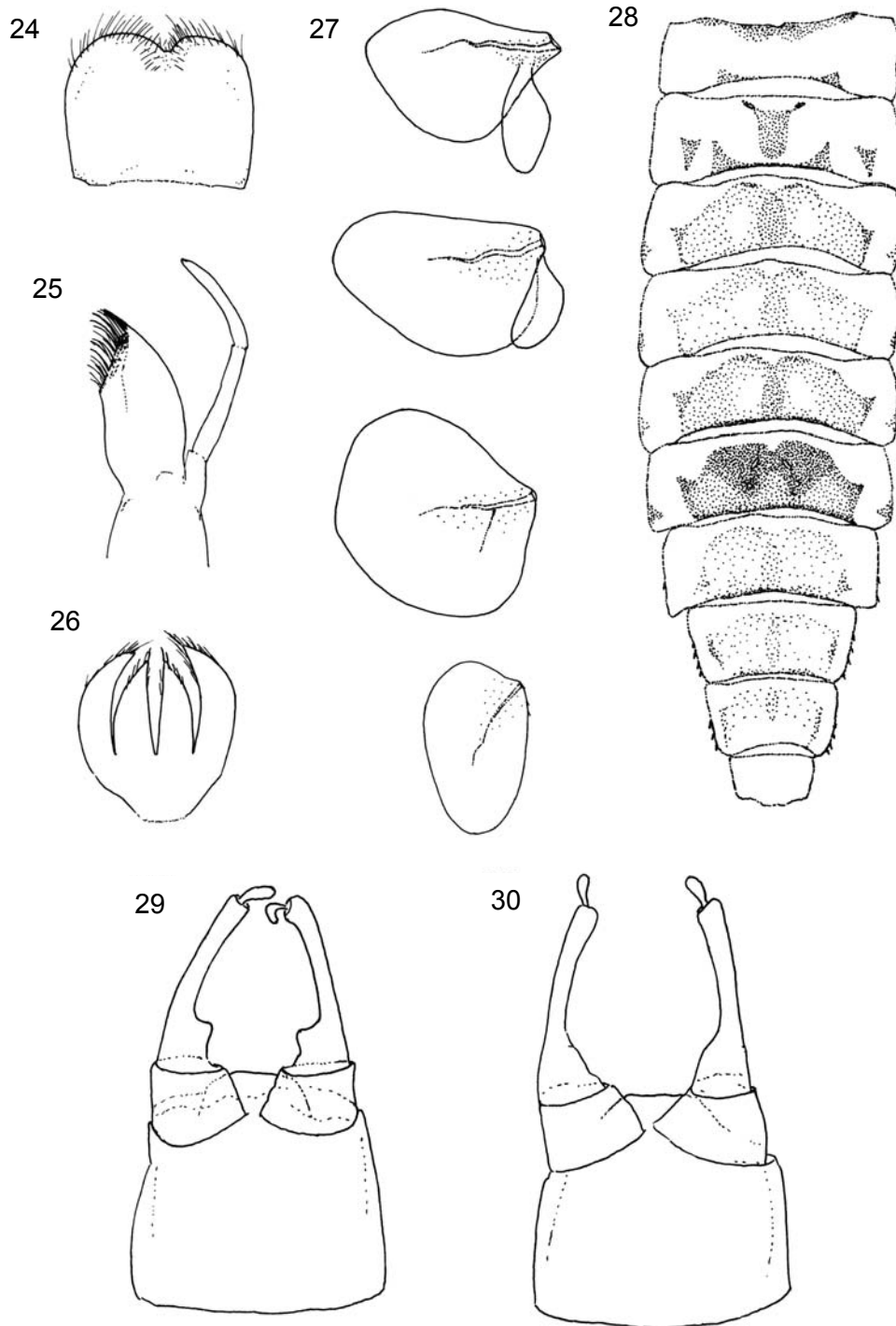
The genus *Centroptilum*, to which both the species discussed in this paper were originally placed, proved to be heterogeneous. Most of the European species were moved to the genus *Procloeon* (together with *C. nana* Bogoescu, 1951). *C. shadini* (Kazlauskas, 1964) was the type species of a new genus *Pseudocentroptiloides* and only one species (*C. luteolum*) stayed in the genus *Centroptilum*.



Figures 8–15. *Procloeon nana*, egg. (8) General outline of the egg; (9) band of large papillae in the equatorial area; (10) reticulation structure from the chorionic surface; (11) large papillae from the band in the equatorial area; (12) large papillae and joints of net in the equatorial area; (13–14) fibrous attachment structure present in the meshes; (15) micropyle.



Figures 16–23. *Pseudocentroptiloides shadini*, egg. (16–17) General outline of the egg; (18) band of large papillae in the equatorial area; (19) large papillae from the band in the equatorial area; (20) large papillae and joints of net in the equatorial area; (21) reticulation structure from the chorionic surface; (22) fibrous attachment structure in the mesh from the chorionic surface; (23) one of the large swollen papillae from the equatorial area.



Figures 24–30. *Procloeon nana*, nymph. (24) Labrum; (25) maxilla; (26) labium; (27) gills I, IV, VI, VII; (28) pattern on the abdominal tergites; (29–30) imago – male genitalia.

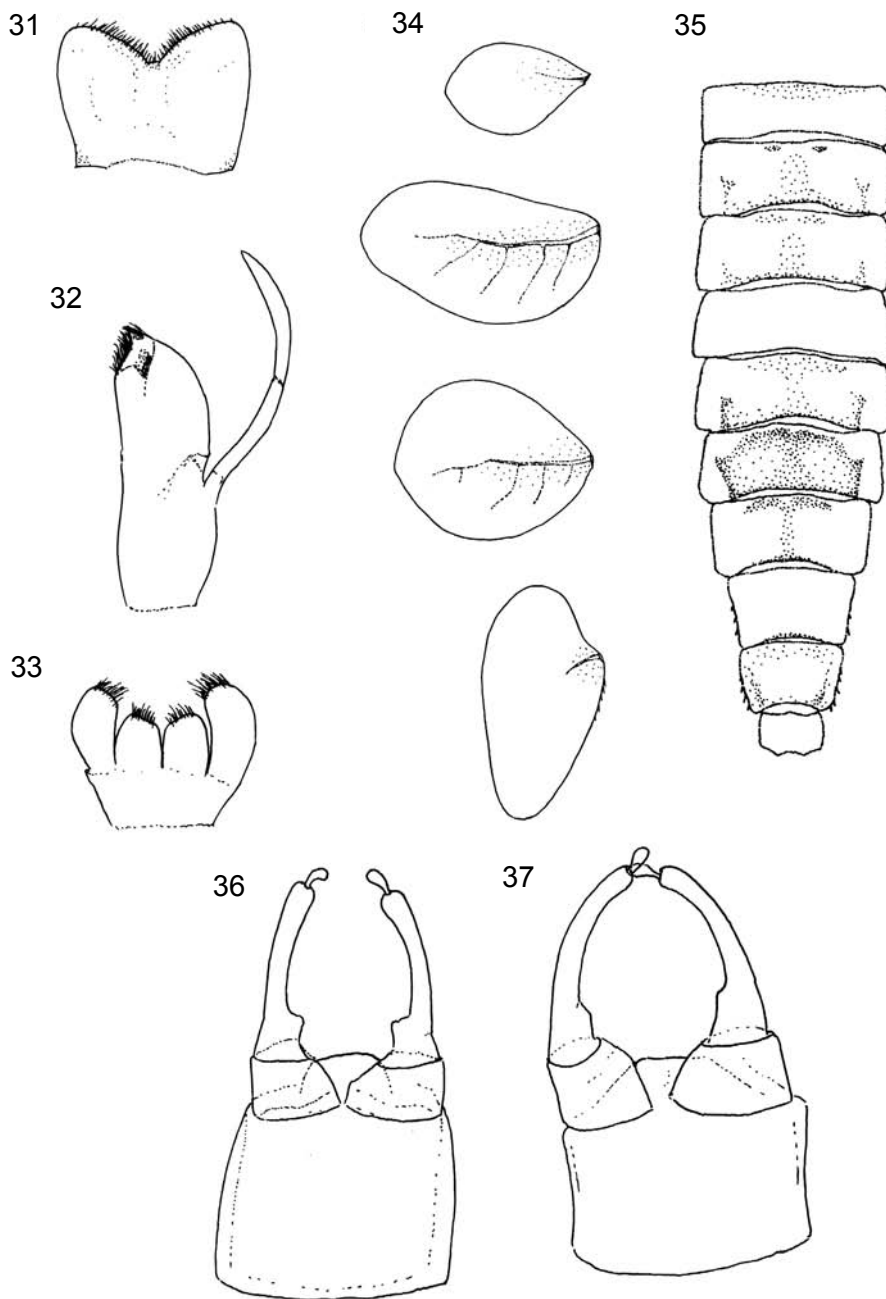
P. nana, described in the adult stage (male and female imago) and egg, is found in Romania (Bogoescu 1951). From this author a description of the egg structure (Figs 1, 2) enabled their nymphs to be recognized by connecting nymph and adult with the egg.

Contrary to the former species, *P. shadini* was described by Kazlauskas (1964) based on nymphs collected by Shadin in the River Oka (Russia, south of Moscow). In this case, recognizing the adults by rearing the nymphs was much easier.

The first information about the existence of a new genus in the family Baetidae can be found in the paper written by Niezviestnova-Shadina (1931). The authoress presented the mouthparts and gill as elements of an unknown species (Figs 5, 6, 7). It was shown later that the mouthparts belonged to the nymph of *P. shadini*, whereas the gill belonged to the nymph of *P. nana*. Giving these features as elements of the same species initially misled Kazlauskas, but after

describing the nymph of *P. shadini* (Kazlauskas 1964), he correctly characterised the nymph of *P. nana* also.

The lack of accessibility to the type material from Romania, caused a problem concerning the proper identification of both species. With today's advances in DNA analysis, it would be possible to compare the DNA from Bogoescu's specimens with contemporary specimens. This would be a more precise method than using the drawings of the egg. However, we do not have the



Figures 31–37. *Pseudocentropiloides shadini*, nymph. (31) Labrum; (32) maxilla; (33) labium; (34) gills I, IV, VI, VII; (35) pattern on the abdominal tergites; (36–37) imago – male genitalia.

type material. When it seemed that the problem with identification was resolved by Keffermüller and Sowa (1984), Kluge and Novikova (1992) proposed a new combination, introducing two changes to the systematics. On the one hand they included *Procloeon* and *Pseudocentroptiloides* in the genus *Cloeon* at the rank of subgenus. This assumption could be acceptable, but such a systematic construction was not acknowledged by the entomologists and according to this situation, we retain the generic rank of *Procloeon* and *Pseudocentroptiloides*. The other change is more complicated. They assumed that both species were incorrectly described which enabled them to introduce their own name. They considered that the new name (*Pseudocentroptilum? shadini*) that Kazlauskas gave to the unknown nymph, belongs to *Centroptilum nana*. In such a case, because the generic features are shown by the nymphs, this species should be classified as *Pseudocentroptiloides nana*. Simultaneously, a species described as *Centroptilum nana*, remained without a name. It was named by Kluge and Novikova as *Cloeon (Procloeon) macronyx*.

The structure of the egg chorion, shown in the first description by Bogoescu, is a decisive feature. It is difficult to state exactly what was seen by Bogoescu through the microscopes from the middle of the last century. His drawings are very schematic and show that there are two different parts to the egg. It can be noticed that in the middle part of the egg are 7 rows of larger papillae. However, these rows are less than in the egg of the species which has the narrower band (*P. nana* – 9 rows) and we do not know if the papillae composing it are rounded or depressed on the top. These papillae are larger than the others and have a regular shape. The author probably wanted to lay emphasis on their separate character.

Kluge and Novikova did not analyse the width of the equatorial band from Bogoescu's figure, they suspected depressions on the top of the large papillae. It is considered that from such schematic Bogoescu figures, the shape of papillae can not be inferred. More important is the width of this band, which corresponds with the

form described by the authors of this work as *Procloeon nana*.

Assuming that these papillae are depressed, attention is paid to the discrepancy which appears between the structure of the papillae and width of the equatorial band. The form with depressed papillae has this band much wider and composed of 11 rows.

As we mentioned above, type material comes from Romania and despite many efforts was inaccessible both to authors of this paper and earlier investigators (R. Sowa). We are of the opinion that our material comes from north-east Poland and this area is quite close to Lithuania where Kazlauskas lived and worked, as well as the River Warta. The mayflies from the River Warta were used in Keffermüller and Sowa's revision (1984). Therefore, mayflies studied by us are entirely suitable for this study.

CONCLUSIONS

The authors are of the opinion that, as a basis for comparing the egg, the width of the equatorial band only can be used. Thus, the egg with the narrower band composed of 9 rows of regular, oval papillae (though they do not protrude so distinctly above the other part of the egg chorion) is the egg which was presented on Bogoescu's figure. Just such eggs were obtained from the females which were reared from the nymphs qualified by Kazlauskas as *Procloeon (Centroptilum) nana*. The egg of the other species has a markedly broader band (11 rows) and papillae composing it are more erect, have irregular shape and are much more difficult to separate during observation.

On these grounds, it is considered that Kazlauskas described correctly both nymphs and there is no reason to synonymize *Procloeon nana* and *Pseudocentroptiloides shadini* and to set up the new species *Procloeon macronyx* and the new combination *Pseudocentroptiloides shadini*. In such a situation, if we are not sure which species was described first and we change the names, we might make the problem worse than it was.

Table 1. Main diagnostic features of *Procloeon nana* and *Pseudocentroptiloides shadini*.

	<i>Procloeon nana</i>	<i>Pseudocentroptiloides shadini</i>
nymph	anterior margin of the labrum with small notch; galealacina narrow, taper; glossae and paraglossae narrow, sharp-pointed; gills (1 to 5) with small, accessory lamella	anterior margin of the labrum with broad, triangular notch, galea and lacinia broad; glossa and paraglossa broad and rounded on the top; gills single
male imago	upper surface of the turbinate eyes light brown	upper surface of the turbinate eyes yellow
egg	oval shaped, in the equatorial part band of large, rounded papillae composed of 9 rows	spindle-shape, equatorial band composed of 11 rows of high, oval, funnel-shaped papillae

In some papers the species name of *P. nana* was changed. Bogoescu described his species under the name *Centroptilum nana* – “dwarf”, something tiny. The species name is in this case substantive and should not be declined. The “*nanum*” form, used by Kazlauskas and Sanvaitite (1962), Keffermüller (1967), Keffermüller and Sowa (1984) and Głazaczow (1997) is incorrect. We have no grounds for changing it and the species name “*nana*” originally proposed by Bogoescu should be restored. According to McCafferty and Waltz’s (1990) revision, the genus name was changed from *Centroptilum* to *Procloeon* and *Pseudocentroptiloides* and the correct species names are *Procloeon nana* (Bogoescu, 1951) and *Pseudocentroptiloides shadini* (Kazlauskas, 1964).

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