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Survey of Central European species of the genera *Centroptilum* EATON and *Pseudocentroptilum* BOGOESCU (*Ephemeroptera, Baetidae*)

Przegląd środkowoeuropejskich gatunków z rodzajów *Centroptilum* EATON i *Pseudocentroptilum* BOGOESCU (*Ephemeroptera, Baetidae*)

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ABSTRACT. Imagines and nymphs of Central European species of *Centroptilum* EATON and *Pseudocentroptilum* BOGOESCU are keyed and described. Two species from Southeastern Europe which can appear in Central Europe are included. The nymph of *C. romanicum* BOGOESCU and the presumptive nymph of *P. motasi* BOGOESCU are first described, the description of the female imago of *P. motasi* BOG. is complemented. *P. shadini* KAZLAUSKAS is transferred to the genus *Centroptilum* EAT. A possible splitting of *Centroptilum* EAT. into two separate genera is presented.

INTRODUCTION

The genus *Centroptilum* EAT. is still poorly known in Europe. Since the descriptions are scattered in numerous notes, often deal with only one stage and sometimes are difficult to obtain, it seems reasonable to present a comprehensive paper on the genus, even if only for Central Europe. Explanation is due also to the ambiguous taxonomic status of *Centroptilum* EAT. and its two nearest European relatives: *Pseudocentroptilum* BOGOESCU, 1947, and *Cloeoptilum* KAZLAUSKAS, 1972.

Within the European species of the genus *Centroptilum* EAT. two groups can be distinguished. One, not numerous, is represented in Central Europe only by *C. luteolum* (O.F. MÜLLER), the type species described from Denmark. Another, much more numerous, comprises the remaining species which differ from *C. luteolum* in many morphological features.

C. luteolum: Hind wings sharpened at ends. Penis on abdominal view conical in outline, with blunt tip; between the bases of forceps finger-like appendix. In nymph gills ending sharp and almost symmetric, except pair I which is very narrow. Canines of mandibles divided to the base. Segments II and III of palpus maxillaris of similar length. Lateral margins of posterior abdominal segments smooth. Surface of abdominal tergites without semicircular hollows. Tails not much shorter than the abdomen, natatory hairs amounting to 3/4 their length.

The second group (e.g., *C. pennulatum* EAT.): Hind wings blunt at ends or almost rounded. Penis in abdominal view semicircular, relatively broad. Between the bases of forceps no finger-like appendix. In nymph gills ending bluntly, distinctly asymmetric in pairs I–V; pair I relatively broad. Pairs I–V(VI) with a dorsal lamella. Canines of mandibles divided at most to about half length. Segment III of palpus maxillaris distinctly shorter than segment II often indistinctly separated. Lateral margins of posterior abdominal segments with numerous denticles directed backward. On surface of abdominal tergites semicircular hollows. Tails distinctly shorter than the abdomen, their natatory hairs reaching their ends. The group is rather diversified and can be divided into smaller species groups, e.g., *C. pennulatum* EAT. and *C. nemorale* EAT., *C. pulchrum* EAT. and *C. parapulchrum* KEFF. et SOWA, *C. nanum* BOG. and *C. romanicum* BOG.

The genus *Pseudocentroptilum* BOGOESCU was erected for *P. motasi* BOGOESCU, 1947 (pro parte: female imago, nec larva) found in Sačelu, Craiova region, Roumania. Its separation as a genus was based on the presence of a third short longitudinal vein in the hind wing and on rather numerous cross-veins. *P. shadini* KAZLAUSKAS, 1964, described in larval stage from the river Oka (USSR), became the second representative of this genus. This species was previously classified with *Pseudocentroptilum* merely on the basis of the presence of cross-veins in the hind wing pads. However, cross-veins in hind wings appear in many European *Centroptilum* species, e.g., *C. nanum* BOG., as well as in some Nearctic species, e.g., *C. bifurcatum* MCDUNNOUGH (NEEDHAM et al., 1935, p. 709). Sometimes they appear even in *C. luteolum* (MÜLL.). At the same time species of the genus *Baetis* LEACH (*Baetidae*) have two or three longitudinal

veins in the hind wing. Because of this we placed *P. shadini* KAZL. in the genus *Centroptilum* EAT. (KEFFERMÜLLER, 1967) — as *C. nanum* BOG. (?) (KEFFERMÜLLER, 1978; SOWA, 1975), notwithstanding the specificity of mouthparts and single gills of its nymph. The remaining structural features allow its inclusion in the *nanum* group.

When judging the taxonomic status of *Pseudocentroptilum* BOG. basing on diagnostic features chosen by BOGOESCU only, the genus could be regarded as junior synonym of *Centroptilum* EAT. Still, the distinctness of the two species groups within *Centroptilum* is as considerable as differences between genera. The female imago of the type species *Pseudocentroptilum* BOG., because of its bluntly ended wings, belongs to the second, larger species group of *Centroptilum*. Moreover, we know and describe below nymphs, most probably of *P. motasi* BOG. which also display structural characters of this group. Thus, it is very probable that *P. motasi* BOG. represents a distinct taxon of generic level, i.e., that *Pseudocentroptilum* BOG. is really a distinct genus which should comprise all species showing features of the second, more numerous group of *Centroptilum* EAT., with most European *Centroptilum* species. Further studies will be decisive: the knowledge of the male imago and an unequivocal determination of the nymph of *P. motasi* BOG.

KAZLAUSKAS (1972) already paid attention to the differences between *C. luteolum* (MÜLL.) and the remaining Palaearctic *Centroptilum* species. The differences listed by this author agree with the above mentioned features differentiating both species groups. In consequence KAZLAUSKAS erected a new genus *Cloeoptilum* to comprise the remaining *Centroptilum* species. However, KAZLAUSKAS' (l. c., p. 338) genus description does not fulfil the formal demands: first of all he did not determine the type species (HUBBARD, 1979). Judging by differences between the winged forms presented there and the species contents of the new genus (*C. pennulatum* EAT. listed as first) we presume that *Cloeoptilum* KAZLAUSKAS does not differ from our above described concept of the genus *Pseudocentroptilum* BOG. and thus becomes its junior synonym.

In this paper we include two species described from Southeastern Europe which we suspect to occur also in Central Europe. We describe the female nymph of *C. romanicum* BOG. found in the type locality in Roumania and identified on the basis of the egg chorion structure. We complement also the description of the female imago of *P. motasi* BOG., basing on the specimen from the Greek island Lesbos (collected by Dr. Hans Malicky from Lunz) and the nymph belonging probably to this species, basing on two full-grown specimens found in Bulgaria, near

the Greek frontier. Their hind wing pads have a dense net of cross-veins and the general view of veins indicates also *P. motasi* Boc. An almost formed male subimago found inside one of the nymphs has distinctly darkened tail bases and a broad, rounded penial plate.

We did not include, on the other hand, three Central European *Centroptilum* species, known almost exclusively from original descriptions, very rare and somewhat enigmatic:

C. stenopteryx Eaton, 1871, was described from Carinthia in Austria. Only the winged stage is known. A complementary description of the lectotype (male imago) was done by Kimmins (1960), and that of the lectoallotype (male subimago) by Kefferm üller and Sowa (1975). From these descriptions the species may belong to the *pulchrum* group or the *nanum* group.

C. lituratum (Pictet, 1843–1854) is known only from the foot of Mont Salève near Geneva and, like the former species, only in winged stage. According to the original description the species is distinguished by a particular pigmentation: a black stripe on the mesonotum, rows of spots on both sides of the abdomen and black circlets on cerci. It is not known whether the type material of this species is preserved. The collection of Pictet in the Museum of Natural History in Geneva contains only some dry specimens labelled as *Cloe litura*? Pict., from Burgdorf in Switzerland, not the type locality. We got this information thanks to Dr Volker Puthz from Schlitz.

C. hungaricum Pongrácz, 1913. We had at our disposal practically only the view of the hind wing (Pongrácz, 1913, p. 178, fig. 1). It is rather broad, sharpened, hind margin undulated, fore margin without processus costalis (!). Perhaps the description deals with a teratologic specimen. Type locality: Szaloncza (= Slavnica, Trenčín Czechoslovakia).

KEY FOR DETERMINATION OF SPECIES

Imagines

1. Hind wing ending sharp (fig. 2). Penis in ventral view triangular in outline, covered with spines, its tip blunt, (fig. 1a) . . . . . *C. luteolum* (O. F. Müll.)
—. Hind wing ending bluntly (figs 8, 12). Penis in form of a broad, trapezoid, smooth plate (fig. 7a) 2
2. Hind wing very narrow, its hind and fore margin parallel (figs 8, 12) . . . . . *C. pennulatum* Eat. and *C. nemorale* Eat.
—. Hind wing broadened at half its length or a little farther towards the hind margin (figs 13, 20) 3

3. Hind wing relatively broad, its posterior part distinctly enough triangular (fig. 20). Thorax dark, abdomen apically pigmented. Egg girdled equatorially with a band of papillae set in rows (fig. 36) . . . 4
—. Hind wing a little narrower, its posterior part usually more rounded (fig. 13). Thorax fair: yellow-brown or yellowish, abdomen whitish, at most hind margins of its tergites darkened, in female its tip sometimes yellowish. Egg without equatorial band of papillae, but with a "pyramid" of them on one or on both poles (figs 15, 19) . . . . . .*C. pulchrum* EAT. and *C. parapulchrum* KEFF. et SOWA
4. In male, segment II of forceps without a tubercle in the inner corner. Egg with a band of papillae set in 13–15 rows . . . . . *C. romanicum* BOG.
—. In male, segment II of forceps with a tubercle on the inner corner (figs 21, 26). Egg with a band of papillae set in at most 12 rows . . 5
5. In hind wing fore margin usually straight (fig. 20). Upper surface of turbinate eyes in male light brown with a dark border. Egg with a band of papillae set in 7–9 rows . . . . . *C. nanum* BOG.
—. In hind wing fore margin usually slightly bulged (fig. 25). Upper surface of turbinate eyes in male yellow-orange with a dark border. Egg with a band of papillae set in 11–12 rows . . . . . *C. shadini* (KAZL.)

Nymphs

1. Gills ending sharp, almost symmetric (fig. 6). Canines of mandibles divided to their base (fig.3) . . . . . *C. luteolum* (MÜLL.)
—. Gills ending bluntly, asymmetric (only pair VI can be almost symmetric (fig. 10). Canines of mandibles not so deeply divided 2
2. Canines of mandibles divided only at the top (figs 11, 16) 3
—. Canines of mandibles divided to about half their length (fig. 23) 4
3. In gill VI a rudimentary dorsal lamella (fig. 17). Claws of fore legs equal at least half tarsus length, in remaining legs they can attain 2/3 tarsus length (fig. 18). Body length in mature nymph 6–8 mm . . . . . *C. pulchrum* EAT. and *C. parapulchrum* KEFF. et SOWA
—. In gill VI the dorsal lamella about half as long as the ventral lamella (fig. 10). Claws of fore legs shorter than half tarsus length, in remaining legs equal about half its length (fig. 9). Body length in mature nymph 7–9 mm . . . . *C. pennulatum* EAT and *C. nemorale* EAT.
4. All gills single (fig. 27). Labrum at the top divided by a broad triangular notch into two lobes bent outward (fig. 29); glossae and paraglossae very broad, apices bluntly cut (fig. 33) . . . . . *C. shadini* (KAZL.)
—. Gills I–(V)VI with a dorsal lamella (figs 43, 44). Labrum with a relatively small median notch on apex (figs 37, 45); glossae and paraglossae narrower and narrowing towards the apex (figs 41, 48) . . . 5

5. Claws not much longer than half tarsus length (fig. 50). Gills strongly developed; dorsal lamella relatively very large, in pair VI more than half as long as the ventral lamella and not much narrower than long (fig. 44) . . . . . *C.* sp. (*P. motasi* Boc.?)
—. Claws distinctly longer than half tarsus length (figs 24, 42). Gills weaker developed: in pair VI a dorsal lamella, if present, less than half as long as the ventral one 6
6. Claws in fore legs only slightly surpass 2/3 tarsus length, in remaining legs they are a little longer (fig. 42). Dorsal lamella of the gills large enough; in pair VI small, but distinct (fig. 43) . . . . . *C. romanicum* Boc.
—. Claws in fore legs equal at least 3/4 tarsus length, in remaining legs almost as long as tarsus (fig. 24). Dorsal lamella of the gill relatively small, in pair VI absent (fig. 22) . . . . . *C. nanum* Boc.

DESCRIPTIONS OF SPECIES

Centroptilum luteolum (O. F. Müller, 1776)

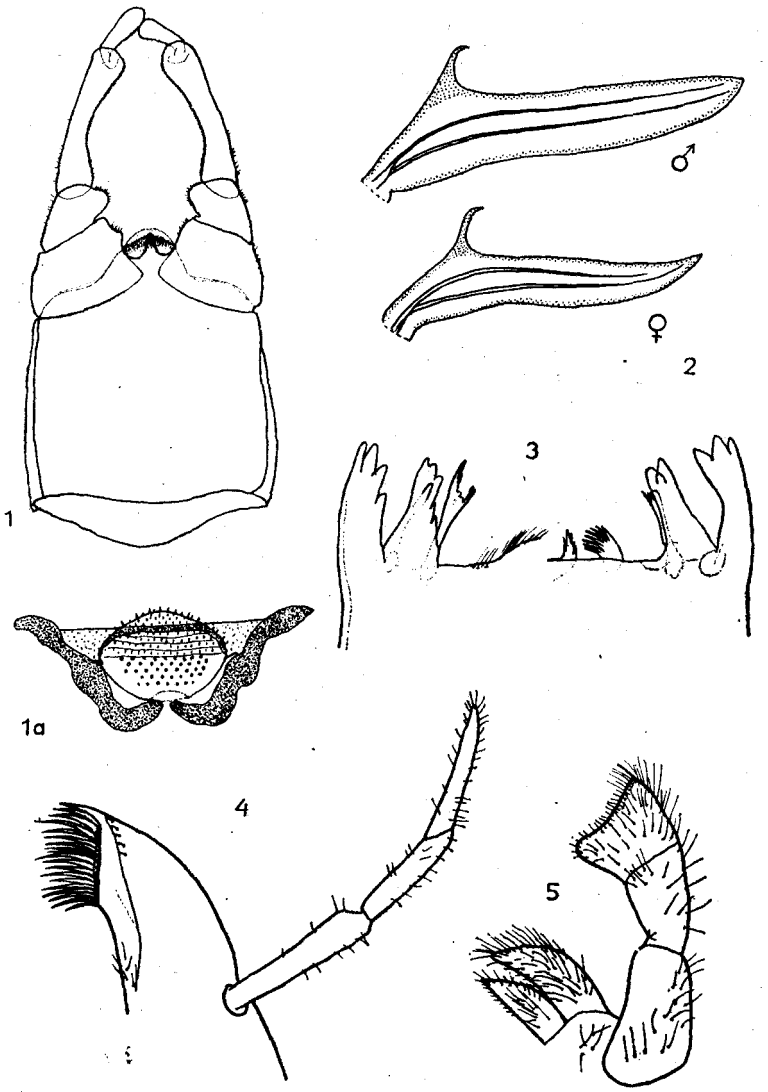
(Figs 1–6)

Ephemera luteola Müller, 1776.
Ephemera caudata Ström, 1783.
Cloeon ochraceum Stephens, 1835.
Cloeon hyalinatum Stephens, 1835.
Cloeon albipenne Stephens, 1835.
Cloeon translucide Walker, 1853.
Cloeon halterata Walker, 1853.
Cloeon bioculatum Hagen, 1863.
Cloë halterata Burmeister, 1839.
Cloë translucida Pictet, 1843–1845.
Cloë ochracea, hyalinata, albipennis Pictet, 1843–1845.
Baetis luteolus Eaton, 1868.

Male imago. Length: body 5–7 mm, tails 10–14 mm. Turbinate eyes high; anteriorly divergent, towards the top slightly broadened; upper surface almost 1.5 times longer than broad. Hind wings with a big processus costalis, ending sharp; fore margin straight, in the middle usually slightly convex. Basic segment of forceps shorter than broad, on the tip diagonally cut; segment I incurved, externally approximately as long as the basic one, internally shorter, narrowed at the base, farther strongly bulged; segment II about 3 times longer than the first one, at 1/3 its length narrowest and slightly incurved, at the end thickened; segment III about 3 times shorter than II, at the base thin, towards the

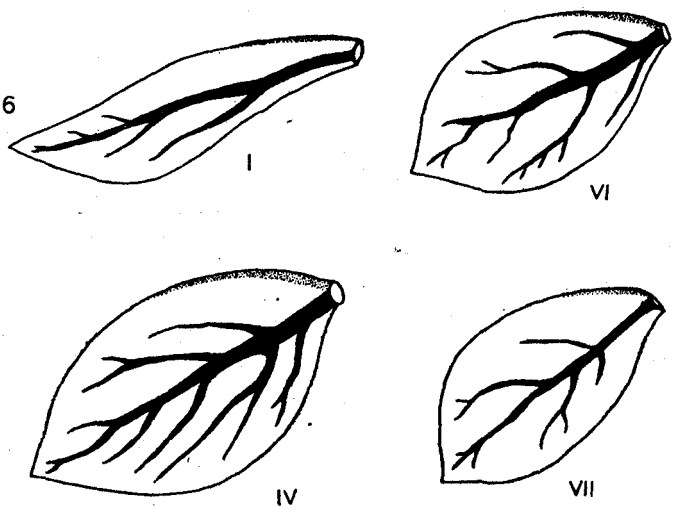
end gradually thickening. Penis in form of a broad triangle with rounded tip and bent lateral margins, at the ventral side strongly bulged, its apical part with sharp spines.

Pigmentation. Turbinate eyes yellow or ochrous to rusty brown, upper part of stem lighter. Head, thorax and abdominal tergite I ochreous



1–5. *Centroptilum luteolum* (O.F. MÜLL.). 1, 2 — imago: 1 — male genitalia, 1a — penis (preparation), 2 — hind wing (male, female); 3–5 — nymph: 3 — canines of mandibles, 4 — maxilla, 5 — labium

to light brown, thoracic segments VIII–X ochreous or rusty, sometimes with a winy red tint, and segments II–VII white, translucent, sometimes their tergites sprinkled with winy red. Wings colourless, veins sometimes yellowish. Forceps whitish, their basic segments yellowish. Legs and tails whitish.



6. *Centroptilum luteolum* (O.F. MÜLL.), nymph: gills I, IV, VI, VII

Female imago. Length: body 6–7.5 mm, tails 8–9 mm. Compound eyes relatively small, posteriorly elongated, oval.

Pigmentation as in male, only the abdomen yellow or light brown, underneath lighter; legs yellowish greenish, sometimes sprinkled with grey.

Subimago. Head and thorax light brownish grey, ventrally a little lighter; thoracic sclerites bordered with dark brown. Abdomen yellowish, its tergites with a grey or brownish coating. Wing membrane light grey brownish, veins yellowish, at base brownish. Legs and tails yellowish, joints of tarsi and claws dark.

Egg. Dimensions: 183–191 μm × 125 μm (according to DEGRANGE 1960). Exochorion covered with sculpture resembling a dense, irregular net. In its meshes single small, spherical papillae.

Nymph. Length: body to 8 mm, tails not much shorter than the abdomen. Antennae bent backwards reach a little behind the thorax. Canines of mandibles divided to their base. Palpus maxillaris 3-segmented, segment III acute, longer than II; segment III of palpus labialis

projecting at the inner corner, forming almost a right angle, with a blunt tip, hind margin of this segment usually slightly concave, inner margin straight. Claws equal approximately half tarsus length, in basic part with small denticles. Gills single with sharp ends and almost symmetric, except the first pair, which is narrowest. Inner margins of subanal plates with more than 20 sharp, densely set denticles (in median section partly in 2 rows); among them some smaller denticles. Natatory hairs attain 3/4 tail length.

Pigmentation motley. Body yellow brown, usually light enough, with variable pattern of yellowish spots. Of abdominal tergites usually the VI is the darkest. Middle and sides of abdominal tergites light, and in the middle usually a pair of small, dark brown dots, on tergites II and VI often jointly embraced by a spot darker than the background; a similar spot at the base of each gill. Ventral side lighter than the dorsal one; abdominal sternites backwards gradually darker, on these sternites light spots in place of muscle insertion. Legs yellowish with a dark spot before the apex of femur and in the basic half of tibia. Gills white with dark brown tracheae. Tails light, in joints narrowly dark annulated.

Bionomics. Nymphs live among aquatic vegetation and under stones, in running waters of various size and on different altitudes as well as in lakes. Two generations per year. Holarctic species, common in Central Europe and locally numerous.

Closely related to *C. luteolum* (MÜLL.) are: the Balkan species *C.* sp. nympha *pirinense* IKONOMOV, 1962, and the Southwestern European *C.* sp. A, MÜLLER-LIEBENAU, 1974.

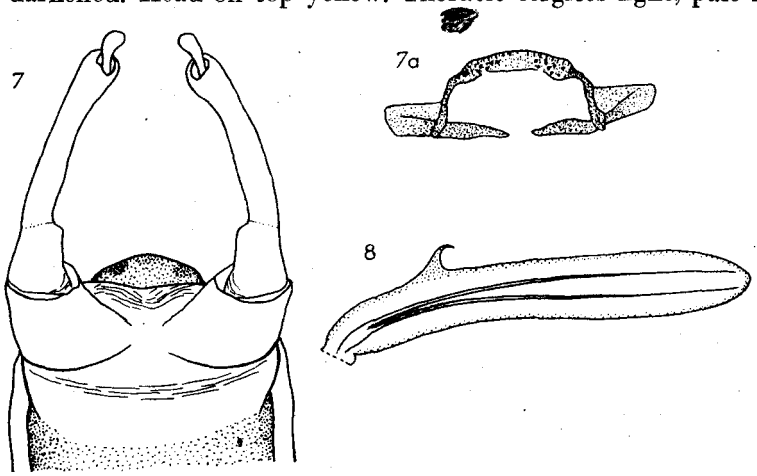
Centroptilum pennulatum Eaton, 1870

(Figs 7–11)

Male imago. Length: body 6–8 mm, tails 12–15 mm. Compound eyes slightly divergent anteriorly, moderately high, strongly broadened at the top; in the middle of the stem a shallow notch, upper surface almost 2 times longer than broad. In pterostigma 6–8 fully developed and 1–3 rudimentary cross-veins. Hind wing very narrow, processus costalis a little behind 1/3 wing length from the base, fore margin between processus costalis and tip almost straight, hind margin parallel to it; tip rounded. Basic segment of forceps shorter than broad at base, at the inner side narrowing towards apex; segment I of similar length but narrower, at the inner corner thickened, though not forming a distinct tubercle; segment II about 2.5 times longer than I, at base narrowest because of

a slight notch at the inner side, at apex distinctly thickened; segment III slender, pear-shaped. Penial plate broad, with a rounded hind margin.

Pigmentation. Turbinate eyes on the upper surface bricky red with a yellow margin, stem yellow, at the base dark brown, at the median notch darkened. Head on top yellow. Thoracic tergites light, pale fleshy



7, 8. *Centroptilum pennulatum* EAT., imago: 7 — male genitalia, 7a — penis (preparation) 8 — hind wing

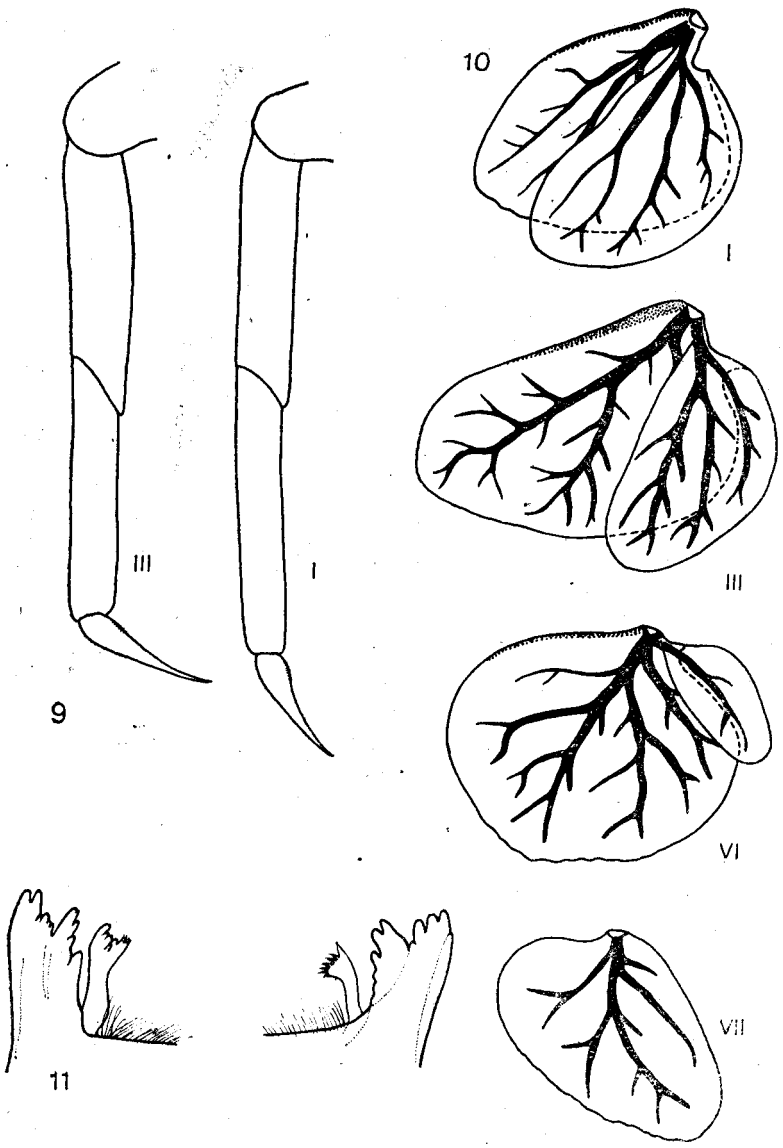
grey, scutum of mesonotum a little darker, posterior part of metanotum black brown, bordered with a transverse winy red stripe from the anterior, lighter part. Thoracic sternites darker than tergites, brown, sometimes dark brown. Legs whitish, femoral apices yellowish, tarsal apices darkened. Wings colourless, only fore veins yellowish, especially at the base, pterostigma slightly milky. Abdominal segments II–VI whitish, translucent, hind tergal margins rusty brown, at the sides, near the hind angle, an indistinct orange spot; tergites VII–X rusty reddish, sternites VII–IX and forceps white ochreous. Tails whitish.

Female imago. Length: body 6–8 mm, tails 7–13 mm. Compound eyes elongated weakly postero-dorsally, seen from above — divergent backward. In pterostigma about 10 cross-veins. Hind wing as in male.

Pigmentation. Head on top yellowish with two longitudinal rusty orange stripes. Thorax light, coloured as in male. Abdomen on top darker due to a rusty winy red pigmentation. On tergites a broad triangular or trapezoidal spot, on its background light spots in places of muscle insertion; hind margin of tergites strongly pigmented. Femora yellowish, tibiae whitish, tarsi, especially fore tarsi, greyish, claws brownish. Tails whitish.

Subimago. Wings dark grey, legs greyish with darker tarsi.

Egg. Dimensions: 171–177 μm × 95–98 μm (female collected in August); 183–191 μm × 113–121 μm (according to DEGRANGE, 1960). Exochorion



9–11. *Centroptilum pennulatum* EAT., nymph: 9 — legs I, III, 10 — gills I, III, VI, VII, 11 — canines of mandibles

covered with sculpture resembling a rather dense net with multiangular, irregular meshes. In most of them there are single narrow, rather high papillae uniform in size.

Nymph. Length: body 7–9 mm, tails a little shorter than half body length. Antennae bent backward reach the middle coxae. Canines of mandibles divided only on the top. Palpus maxillaris 3-segmented, segment III half as long as II. Segment III of palpus labialis externally not much shorter than broad at the base; its apical margin straight. Claws with a distinct enough basic swell and very small denticles; in fore legs claws shorter than half tarsus length, in the remaining equal half tarsus length. Abdomen relatively broad. Gills apically rounded, asymmetric; inner margin more convex than outer margin, which in pairs II–IV is approximately straight or even a little concave; in pair VII the relations are reverse, and pair VI is approximately round; moreover in pairs I–VI a dorsal lamella is present, gradually smaller towards the back, but in pair VI still reaching half of the ventral lamella length. Inner margins of subanal plates with about 10 long and sharp denticles, some of them smaller than the others. Natatory hairs reach the ends of the tails.

Pigmentation contrasting. The background sandy coloured with a dark brown pattern on vertex a pair of longitudinal stripes. On abdominal tergites small spots brown as well as whitish. Dorsal side of abdomen with a variable pattern of brown spots, on segments III, V and VI occupying usually most of the tergal surface; on their background whitish dots and lines in places of muscle insertion hind margins of tergites intensely coloured; usually also a very dark dot near the base of each gill. Legs yellowish, claws darker, especially in basic part. Gills whitish with dark brown tracheae. Tails brown annulated, a rather long section of their distal half darkened.

Bionomics. Nymphs live in running waters, especially in larger, submontane and highland ones. Probably two generations a year. Southern Central European species, in the North it is found in Great Britain; it is described also from the basin of Pečora and from arctic Ural.

Very similar to *C. pennulatum* EAT. are, described from Italy: *C. nemorale* EATON, 1885, and *C. lacustre* EATON, 1885.

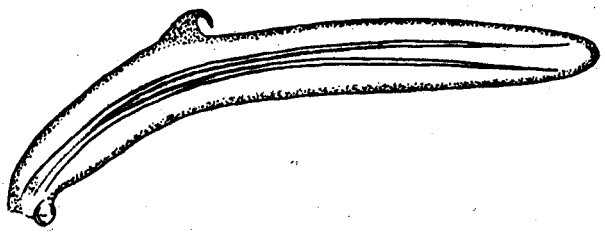
Centroptilum nemorale Eaton, 1885 (?)

(Fig. 12)

Male imago. Specimen resembling the holotype (KIMMINS, 1960) was reared of a nymph collected at Zawoja (Poland). Length: body 6.5 mm, tails 14 mm. Hind wing relatively narrower, more strongly bent and at

end more constricted than in *C. pennulatum* EAT., processus costalis displaced more towards tip.

Pigmentation: At the moment of determination the above mentioned specimen was already strongly discoloured. According to the original description: turbinate eyes on the upper surface intensely bright yellow,



12. *Centroptilum nemorale* EAT. (?), imago: hind wing

at sides paler. The upper surface of the body very slightly dark brown ochreous, abdominal segment I darker brown, segments II–VI translucent, white; hind margins of tergites II–IX brown ochreous; segment X more yellow than the preceding one; sternites VII–X whitish ochreous. Legs, forceps and tails translucent white, only femoral apices slightly yellowish.

Female imago and subimago not described.

Nymph. The exuvium of the nymph of which the male imago, resembling the holotype, was reared, in size and structure is almost identical with the nymph of *C. pennulatum* EAT. The only stated differences: number of hairs on the ventral surface of glossae and paraglossae approximately twice lower, and broadening of the base of claw stronger.

Bionomics unknown. Species described from Italy on the basis of one male imago. A dozen or so nymphs described above were collected in a meadow stream at Zawoja (leg. R. Sowa, July, 1963). Insufficient knowledge of the species does not allow a sure determination of this material.

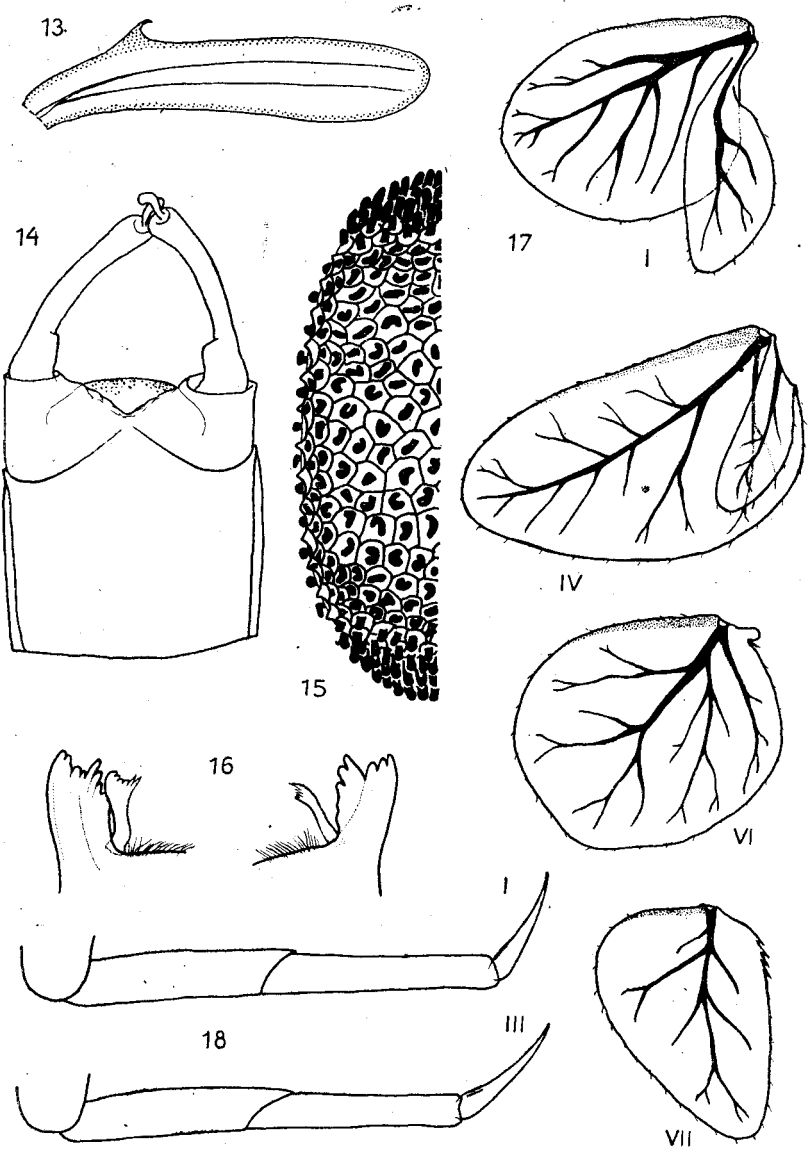
Centroptilum pulchrum Eaton, 1885

(Figs 13–18)

C. dacicum BOGOESCU et TABACARU, 1966.
C. potamonensis JACOB, 1973 (pro parte: imago).

Male imago. Length: body about 6 mm, tails 10–12 mm. Turbinate eyes divergent anteriorly, broadening towards the top; upper surface

about 1.5 times longer than broad and about 2 times longer than the height of the eye. In pterostigma 5–8 diagonal cross-veins, not branched as a rule. Hind wing very narrow, its tip rounded, fore margin



13–18. *Centroptilum pulchrum* EAT. 13, 14 — imago: 13 — hind wing, 14 — male genitalia: 15 — egg: sculpture of chorion on half surface; 16–18 — nymph: 16 — canines of mandibles, 17 — gills I, IV, VI, VII, 18 — legs I, III

a little convex, hind margin concave in basic half, convex in distal half of the wing. Basic segment of forceps shorter than broad at the base, on the inner side strongly narrowing towards the tip. Segment I narrower and a little shorter than the basic one, with a thickened inner corner; segment II narrower and more than 2.5 times longer than I, thickened at apex; segment III very small and relatively narrow. Penial plate truncate at apex.

Pigmentation. Turbinate eyes lemon yellow, stem with a median brown ring. Thorax light, yellow brown. Abdominal segments II–VII whitish, translucent, hind margins of their tergites darkened. The rest of the abdomen and forceps cream-coloured. Wings colourless, legs and tails whitish.

Female imago. Length: body 5–6 mm, tails 9–11 mm. Compound eyes not very elongated distally, on the circumference sharp-edged, seen from above distally divergent. Pterostigma and hind wings as in male.

Pigmentation. Dorsal side of thorax yellowish, sometimes with a reddish tint, ventral side white yellowish; abdomen whitish, sometimes the tergites yellowish. Wings colourless. Legs and tails white, only the proximal and distal parts of fore tibia darkened, especially on the outside.

Female subimago. Compound eyes as in imago.

Pigmentation: dorsal side of head and thorax yellowish grey, ventral side lighter. Thoracic sclerites with narrow dark brown margins. Abdomen yellow. Wings light, yellowish grey. Legs and tails yellowish.

Egg. Dimensions: 195–205 μm×100–104 μm (summer generation). The chorion surface covered with a net of multiangular fields resembling scales. In the middle of each field a papilla; in the median part of the egg the papillae are small, but on both ends they lengthen towards the poles, where they form a cone with a rounded top.

Nymph. Length: body to 8 mm, tails equal approximately half body length. Antennae bent backwards reach the end of the thorax. Canines of mandibles divided only at apex. Palpus maxillaris 3-segmented, much longer than galea/lacinia, segment III half as long as II. Segment III of palpus labialis with hind margin straightly cut, with inner margin slightly convex. Claws of fore legs equal at least half tarsus length, claws of the remaining legs longer, may reach 2/3 tarsus length; at the base they are a little bulged and furnished with very small denticles. Gills at tips rounded, asymmetric: in pairs I–VI outer margin straight, inner margin convex, in pair VII the reverse; pairs I–VI with 2 lamellae: dorsal lamella relatively small, tongue-shaped, distally gradually smaller, and rudimentary in pair VI. Inner margins of subanal plates with about

10 denticles, at base and apex small, large in the middle. Natatory hairs reach the end of the tails.

Pigmentation (alcohol). Background yellowish. Fore margin of pronotum and hind margins of abdominal tergites with narrow dark edges. On thoracic tergites and pleurites a variable pattern of brown dots. Abdominal tergites, except their anterior angles, pigmented brown: tergites II, III and VI darkest; on the dark background light dots appear in places of muscle insertion. Legs yellowish with a brown subapical coating at femur and blackish joint between tarsus and claw. Gills whitish. Tails yellowish, brown annulated, their distal half darkened; their natatory hairs grey, darkening at distal part of tail.

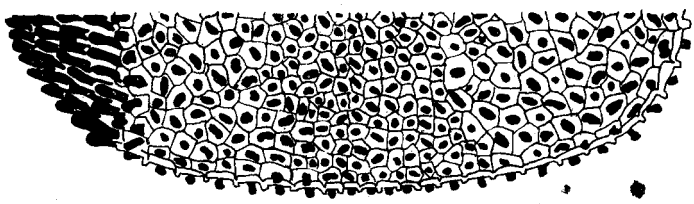
Bionomics. Nymphs live in slow current, on the bottom or among coastal vegetation of bigger lowland and submontane rivers. Probably two generations per year. Species found as yet in France, Roumania (as *C. dacicum* Boc. et Tab.) and in Poland. Closely related is the species described from Italy— *C. forlivense* Grandi, 1964, which is perhaps a junior synonym of *C. pulchrum* Eat.

Centroptilum parapulchrum Keffermüller et Sowa, 1975

(Fig. 19)

Male imago and subimago not described.

Female imago, subimago, nymph, In all these stadia no essential differences could be found in relation to *C. pulchrum* Eat.



19. *Centroptilum parapulchrum* Keff. et Sowa, egg: sculpture of chorion on half surface

Egg. The structure of the chorion resembles the structure of the eggs of *C. pulchrum* Eat., but the cone formed by the elongated papillae is developed only on one pole.

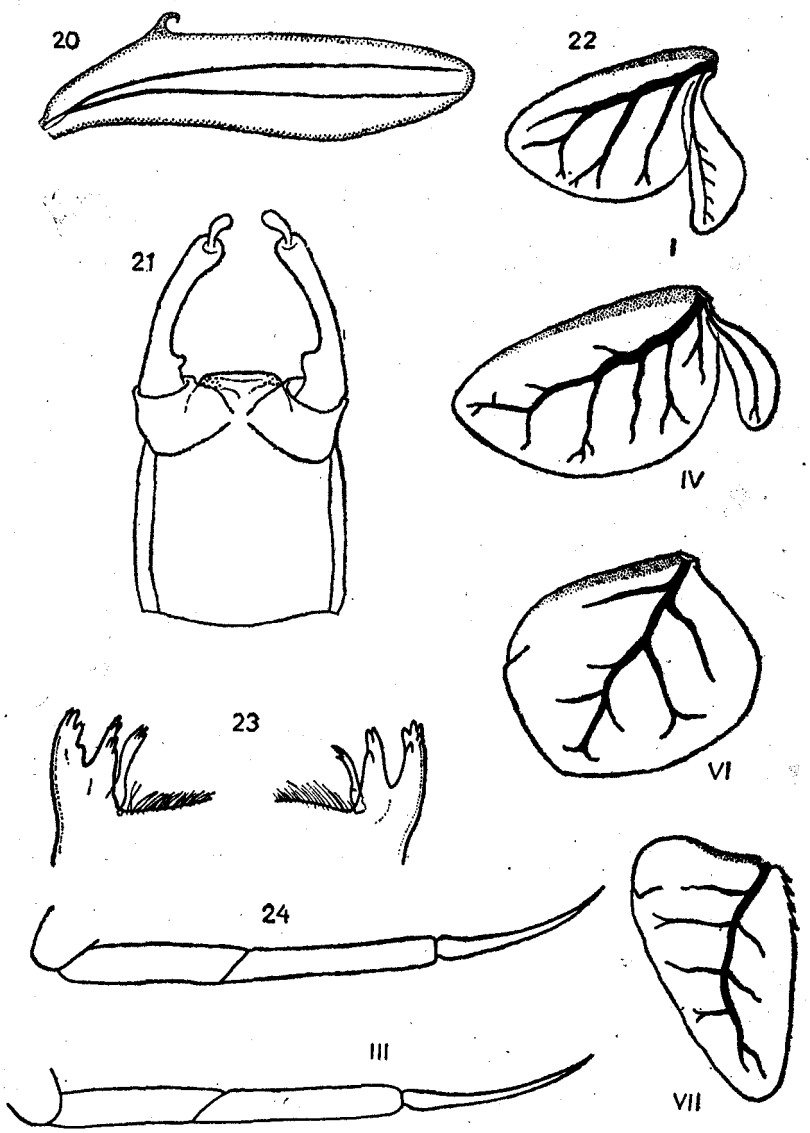
Centroptilum nanum Bogoescu, 1951

(Figs 20–24)

C. potamonensis Jacob, 1973 (pro parte: nymph).

Male imago. Length: body 5–6 mm, tails 8–11 mm. Turbinate eyes anteriorly divergent, upper surface of the eye about 1.5 times longer than broad, height of eye a little smaller than the breadth of the upper

surface. Pterostigma with 5–6 diagonal, slightly anastomosing cross-veins. Hind wings with fore margin straight, hind margin convex at half wing length or in distal half of the wing and diagonally reaching the rounded tip; in the basic half of the fore field usually about three delicate, diagonal cross-veins. Basic segments of forceps bent outward; each



20–24. *Centroptilum nanum* Bog. 20, 21 — imago: 20 — hind wing, 21 — male genitalia; 22–24 — nymph: 22 — gills I, IV, VI, VII, 23 — canines of mandibles, 24 — legs I, III

shorter than broad at the base, on the inside strongly narrowing towards apex. Segment I of similar length, but narrower, and the inner corner stretched into an almost rectangular tubercle; segment II slightly bowed towards the middle, grown together with the preceding one, about 3.5 times longer and almost half its breadth at the base, farther gradually thickening and apically distinctly broadened; segment III pear-shaped. Penis in form of a very short, broad plate with slightly rounded angles.

Pigmentation. Upper surface of turbinate eyes yellow light brownish with a narrow, dark edge; lateral margin at top yellow, at bottom brown. Thorax brown, dorsally dark with some longitudinal light fissures, ventrally lighter. Wing membrane colourless, three fore veins light brownish, especially at base; pterostigma milky. Legs yellowish: in fore legs femur, distal part of tibia, proximal part of tarsus and claws darkened. Upper part of abdomen brown pigmented: tergites I (II), VII and VIII intensely, and III–VI slightly pigmented and usually half-translucent; tergites IX and X yellowish brown; sternites I–VI yellow, VII–X yellowish light brown. Of the same colour are the basic segments of forceps, the remaining ones, as well as the tails — whitish.

Female imago. Length: body 5–7 mm, tails 9–11 mm. Compound eyes, in side view, very slightly elongated, from above their inner margins nearly parallel. Wings as in male.

Pigmentation. Head yellow light brown, dorsal side of thorax sepia brown, ventral lighter, yellow brown. Fore legs light brown with a sepia tint, the remaining legs have yellowish femora, tibia and tarsus whitish; apex of tarsus and claw grey. Wings with distinctly light brown veins. Abdomen dorsally light brown, ventrally pale yellowish. Tails light grey.

Female subimago. Body yellow greyish, mesonotum with dark brown sutures. Wings of similar colour, but lighter than body. Legs yellowish, apex of tarsus and claws grey brownish.

Egg. Dimensions: 153×95 µm (spring generation). Exochorion covered with sculpture resembling a dense net, in whose meshes are single small papillae. Equatorially a band of large papillae, arranged in 7–8(9) rows.

Nymph. Length: body to 8 mm, length of tails slightly exceeds half abdomen length. Antennae bent backwards reach the end of the thorax. Canines of mandibles divided to a little more than half their length. Palpus maxillaris indistinctly 3-segmented, its segment III more than half as long as II. Segment III of palpus labialis at top approximately straight, on the inside a little convex. Claws without denticles, in fore leg equal at least 2/3 tarsus length, in middle and hind legs almost as long

as tarsus. Abdomen relatively broad. Gills at ends rounded, asymmetric; in pairs I–VI outer margin straight, inner margin convex, in pair VII the relations are reverse; moreover, the pair I–V(?) with a small, tongue-shaped dorsal lamella, becoming gradually smaller towards the back. Subanal plates with about 9 large, sharp denticles on inner margin, separated by single, also sharp, but small denticle.

Pigmentation. The background of the body light. Thoracic tergites with an indistinct brown pattern: darkest spot above the base of the hind coxa. Abdominal tergites, except I and X, with a longitudinally oval, brown median spot. Moreover, most of the tergal surface sprinkled with a brown coating, in various degree, darkest on tergite VI; on this tergite light dots in places of muscle insertion are visible. Hind margins of tergites blackish and on tergites: I, II(–III) and IV a pair of such dots at the fore margin. Ventral side of body light, only the last abdominal sternites have dark lateral dots. Legs light with a dark dot at apices of femur and tarsus. Gills whitish, tracheae brownish. Tails light, but the outer spines on borders of their segments and natatory hairs brown.

Bionomics. Nymphs live in bigger lowland rivers. Species rare and not numerous, therefore biology almost unknown. Till now *C. nanum* Bog. was found in Roumania, Poland (lower San, Warta and Bug) and in USSR (rivers of the Lithaunian SSR and the river Oka).

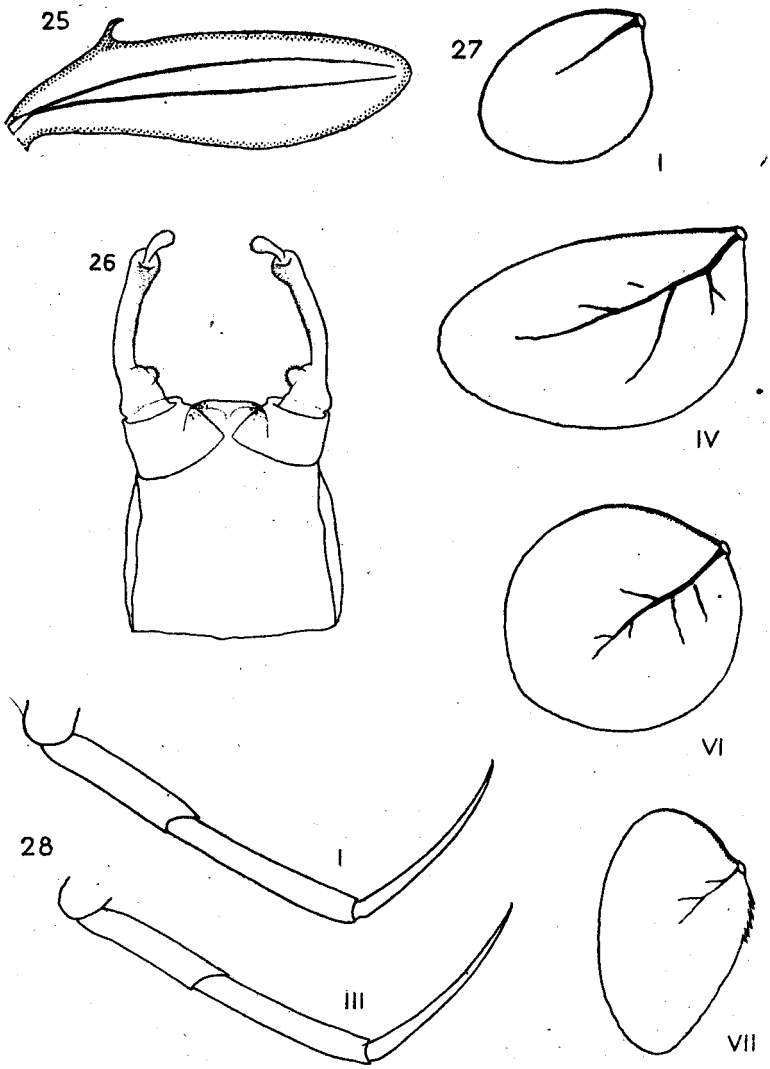
Centroptilum shadini (Kazlauskas, 1964) comb. n.

(Figs 25–33)

Pseudocentroptilum shadini Kazlauskas, 1964.

Male imago. Length: body 5–5.5 mm, tails about 9 mm. Turbinate eyes, anteriorly slightly divergent, towards top broadened, upper surface oval, about 1.5 times longer than broad and a little broader than the height of the eye. In pterostigma about 6 cross-veins. Hind wing with fore margin very slightly convex, hind margin concave behind the base and at half its length or behind it convex and diagonally running to the rounded tip; in the fore and hind fields usually delicate diagonal cross-veins. Basic segments of forceps bent outward, each shorter than broad at base, and on the inside strongly narrowing towards apex. Segment I of similar length as the basic one, at the inside also narrowing towards apex, but subapically provided with a big tubercle, a little more distinct than in the preceding species; segment II grown together with segment I, half its breadth, slightly bent towards the middle, apically club-like broadened; segment III pear-shaped. Penial plate short and rather broad, with rounded angles.

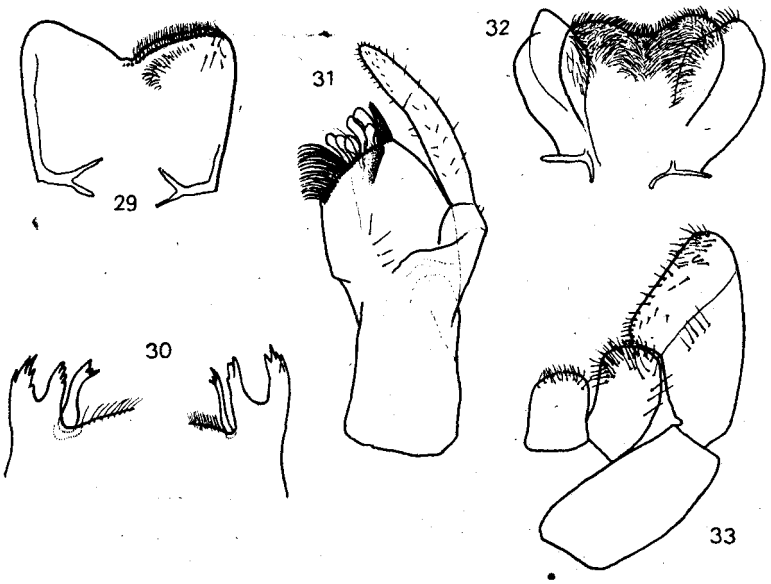
Pigmentation. Turbinate eyes yellow orange, upper margin edge bordered with a very narrow blackish line, lower half of stem nut-brown. Thoracic tergites nut-brown with lighter lines, bordered with a darker line; sternites lighter. Abdominal segments II–VI half-translucent, the next ones milky; their tergites yellow greyish and laterally, along the



25–28. *Centroptilum shadini* KAZL. 25, 26 — imago: 25 — hind wing, 26 — male genitalia; 27, 28 — nymph: 27 — gills I, IV, VI, VII, 28 — legs I, III

hind margin and in the middle, sprinkled with a rusty coating; abdominal sternites, legs, genitalia and tails whitish.

Female imago. Length: body about 5 mm, tails about 6 mm. Compound eyes in side view distinctly elongated, and seen from above have inner margins almost till apex slightly convergent towards the back. Wings formed as in male.



29–33. *Centroptilum shadini* KAZL., nymph: 29 — labrum, 30 — canines of mandibles, 31 — maxilla, 32 — hypopharynx, 33 — labium

Pigmentation. Body yellowish sepia, thoracic tergites darkest, bordered dark brown. Ventral side lighter than the dorsal one. Along the lateral margins and on the surface of abdominal tergites blackish outlined tracheae. Legs have grey yellowish femora, tibiae lighter, tarsi whitish with grey claws. Wing membrane with a very slight sepia tint, veins a little darker, especially at base. Tails whitish.

Male subimago. Thoracic tergites coloured similarly as in imago, only with a smaller number of light longitudinal lines; abdominal tergites I–VI grey brown, VII–X yellowish rusty, milky; on all tergites rusty dots, as in imago, but weaker. Ventral side of abdomen, forceps and tails greyish yellowish. Fore legs yellow grey, the remaining lighter, greyish yellowish. Wings light grey.

Egg. Dimensions: 149–164 μm × 92–113 μm. Exochorion covered

with sculpture resembling a dense net, with single small papillae in meshes. In the equator a band of big papillae, arranged in 11–12 rows.

Nymph. Length: body 5–6 mm, tails not much longer than half abdomen length. Head in side view has the front rounded (most convex is the frons above ocelli, vertex flat, genae and the lower part of the frons shorter in comparison with other species). Compound eyes distinctly elongated postero-dorsally. Antennae bent backwards reach at most the middle coxae. Labrum and the median lobe of hypopharynx broadened towards the front, and in the middle with a broad, triangular notch. Canines of mandibles divided to more than half their length. Laciniae broad, palpus maxillaris considerably longer than laciniae, 3-segmented, segment III slightly individuated, less than half as long as II. Glossae shorter than paraglossae, both the former and the latter at apices diagonally cut, broadly rounded and provided with a scopula of hairs. Segment III of palpus labialis distinctly broader than long, tip slightly concave, external margin strongly convex. Claws without denticles, with a slightly individuated basic swell; in fore legs tarsi approximately equally long, in the remaining ones a little longer. Abdomen relatively narrow and slender. Gills rounded apically, single, asymmetric: inner margin more convex than the outer, outer margin on pair III even straight, only in pair VII the relations are reverse, pair VI almost round. Inner margins of subanal plates with about 6 big, sharp denticles, separated from one another with a single, also sharp, but small denticle.

Pigmention similar to the nymph of *C. nanum* Boc., only dotting slighter, though more contrasting. Pronotum without dots, mesonotum strongly darkened at the fore margin. Abdominal tergites I, IV and VIII–X without the median oval spot; tergite IX almost as dark as tergite VI (according to the original description, on the sides of tergites II, III, V, VI, VIII and IX there are pink dots, which were not observed in the Polish material). Legs whitish or yellowish with dark distal parts of femur and tarsus. Gills white. Tails whitish or yellowish with a slightly marked annulation every fourth segment, at half their length a little darkened.

Bionomics. Nymphs live on sandy-gravelly bottom of big lowland rivers, in places with a rather strong current. Species rare, till now found only in USSR (river Oka) and in Poland (Warta and Bug).

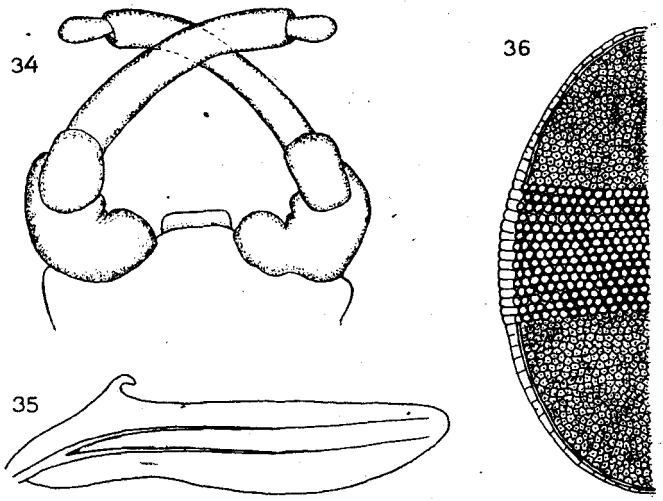
Centroptilum romanicum Bogoescu, 1949

(Figs 34–43)

Male imago (according to Bogoescu, 1958). Length: body 5–6 mm, tails 13–15 mm. In pterostigma 7 or 8 cross-veins. Hind wing with a blunt tip, fore margin almost straight, hind margin convex behind half its

length. In forceps segment I without a tubercle in the inner corner; distinctly separated from segment II, last segment incurved.

Pigmentation. Head light brownish. Turbinate eyes on upper surface rusty brown, narrowly bordered with a grey white stripe; upper part of stem yellow brown, light, basic part dark brown. Thorax on top dark



34–36. *Centroptilum romanicum* Bog. 34, 35 (according to Bogoescu) — imago: 34 — male genitalia, 35 — hind wing; 36 — egg: sculpture of chorion on half surface

brown, at sides light brown. Wings hyaline with light brown veins. Dorsal side of abdomen light brown, ventral pale yellow. Forceps yellow brown.

Female imago. Length: body 5–6 mm, tails 13–15 mm. Pterostigma as in male.

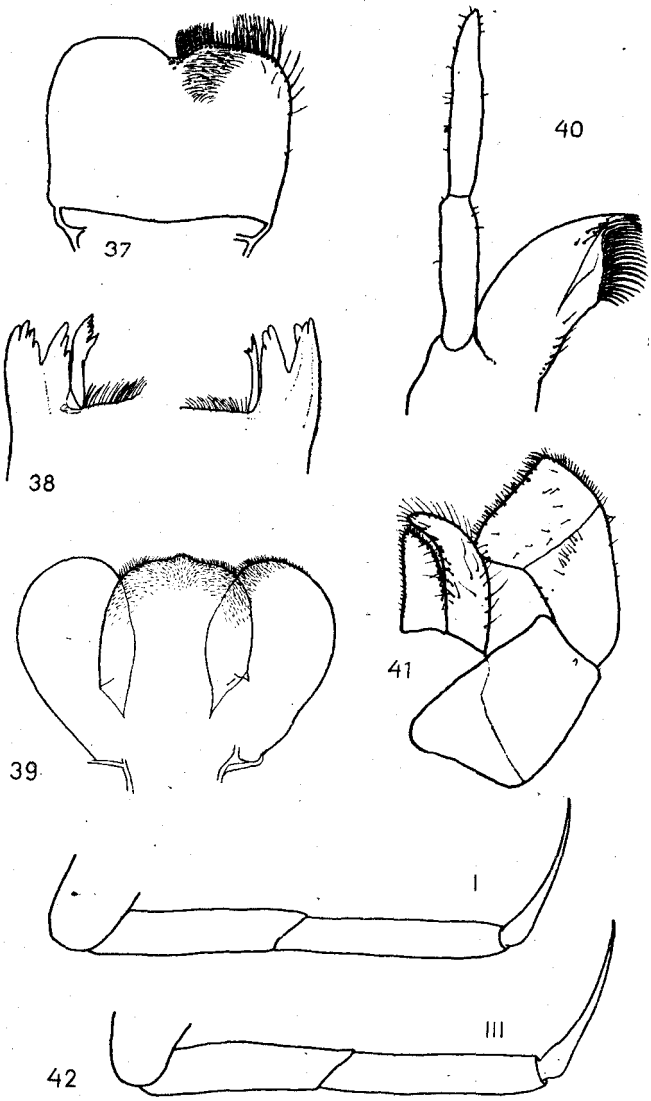
Pigmentation. Head yellow brown. Pronotum brown rusty, mesonotum and metanotum dark brown, ventral part yellow brown. Legs light, yellow brownish. Fore wings colourless, veins dark brown. Abdomen dorsally light brown, ventrally pale yellow. Tails light grey.

Subimago. General colour yellow brown, light. On mesonotum 6 longitudinal, dark brown, very narrow stripes. Wings grey, legs pale yellow.

Egg. Dimensions: about 0.175–0.100 mm (according to Bogoescu, 1966). Exochorion covered with sculpture resembling a dense net, in the meshes there are single small papillae. Equatorially a stripe of big papillae in 13–15 rows.

Nymph. Length: body 6 mm, antennae 2 mm, tails 3 mm. Labrum almost rectangular, anterior part slightly widened. Mandibles stocky, canines divided to half their length. In mandibles no subapical denticle.

Palpus maxillaris longer than galea/lacinia. Median lobe of hypopharynx as high as the lateral ones, with a small tubercle at apex. Labial palpi very stocky, their segment III slightly concave at apex. Paraglossae strongly narrowed towards apex and so bent that they almost touch one

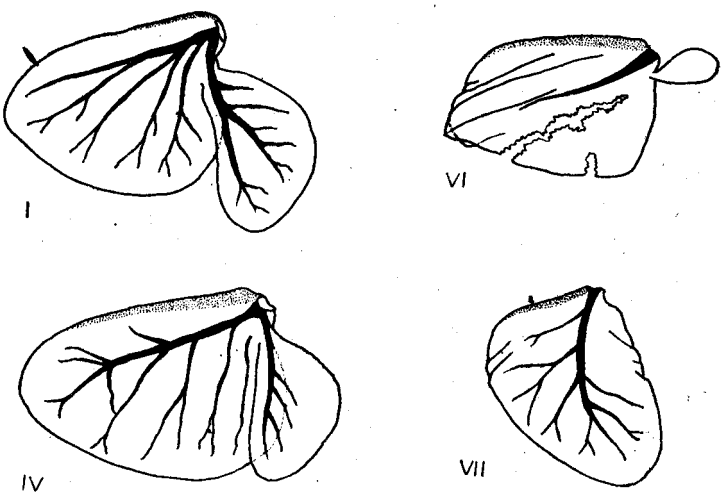


37–42. *Centroptilum romanicum* Boc., nymph: 37 — labrum, 38 — canines of mandibles, 39 — hypopharynx, 40 — maxilla, 41 — labium, 42 — legs, I, III

another over glossae. Claws lacking denticles, in fore legs equal almost 2/3 tarsus length, in the remaining legs exceeding 3/4 tarsus length. Length ratio of leg segments:

	femur	tibia	tarsus	claw
fore leg	7.9	4.6	4.6	3.2
middle leg	8.1	4.6	4.6	3.5
hind leg	8.0	4.5	4.5	3.5

Gills in number of 7 pair, rounded at ends, asymmetric; outer margin almost straight, inner margin convex, only in pair VII the reverse though outer margin slightly convex; pairs I–VI double: dorsal lamella relatively small, but in pair VI still quite distinct. Subanal plate with 10 acute denticles on inner margin, among them small irregularly set denticles.



43. *Centroptilum romanicum* Boc., nymph: gills I, IV, VI, VII

Pigmentation described on the basis of a preparation, in which besides antennae, mouth parts, legs and gills there remained only abdominal segment X with tails, and also eggs which served as basis for the determination of the species (in the preparation the eggs were split and swollen, so that they could not be measured). Legs light, yellowish, femur subapically slightly darkened, outer side of the distal half of tarsus and the base of claw more strongly darkened. Gills whitish, only the basic part of the membrane yellowish grey; in tracheae at most the basic part of principal shaft light brownish pigmented. Abdominal segment X light, only its tergite bordered frontally with a very narrow dark line, and the

median (provided with denticles) part of the hind margin darkened. Tails with weak traces of dark annulation, darkened also behind half their length and at ends.

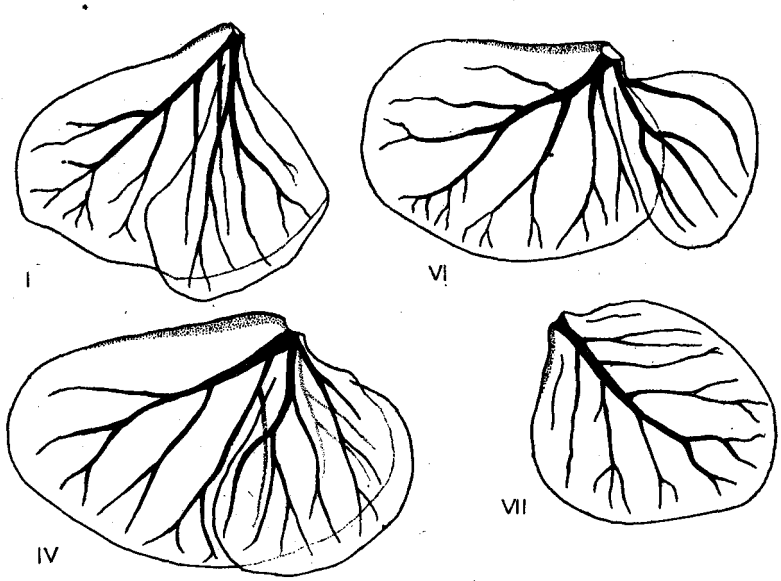
Bionomics unknown. Imago and subimago described from Sačelu in Roumania. The only nymph (female, mature) was collected (leg. R. Sowa, August 1975) on the same locality, in the stream Blahnitza. In the river Warta, near Uniejów, one male imago was collected (leg. M. Keffermüller, June 1973), approximately corresponding to the description of *C. romanicum* Boc., but because of the scantiness of material, this locality requires confirmation. The species collected in the river Fier (France), determined by Degrange (1960) as *C.? lituratum* (Pict.) has eggs of the same chorion structure and with dimensions: 164–101 μm. Forwarded to R. Sowa one female imago of this collection (leg. Ch. Degrange, 11 VIII 1962) has also hind wings typical for *C. romanicum* Boc., what affirms its appartenance to this species.

Centroptilum sp. (? = *P. motasi* Bogoescu, 1947)

(Figs 44–52)

Male imago not described.

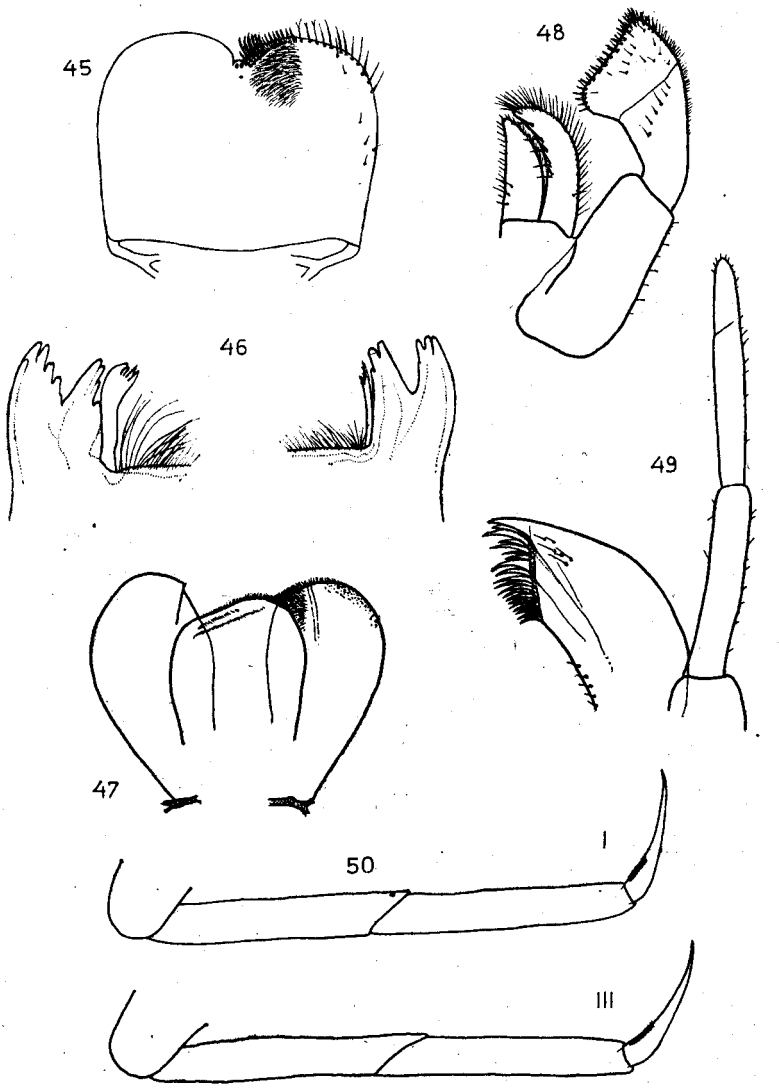
Female imago. Probably female imago is known as *Pseudocentroptilum motasi* Boc.



44. *Centroptilum* sp. (? = *P. motasi* Boc.), nymph: gills I, IV, VI, VII

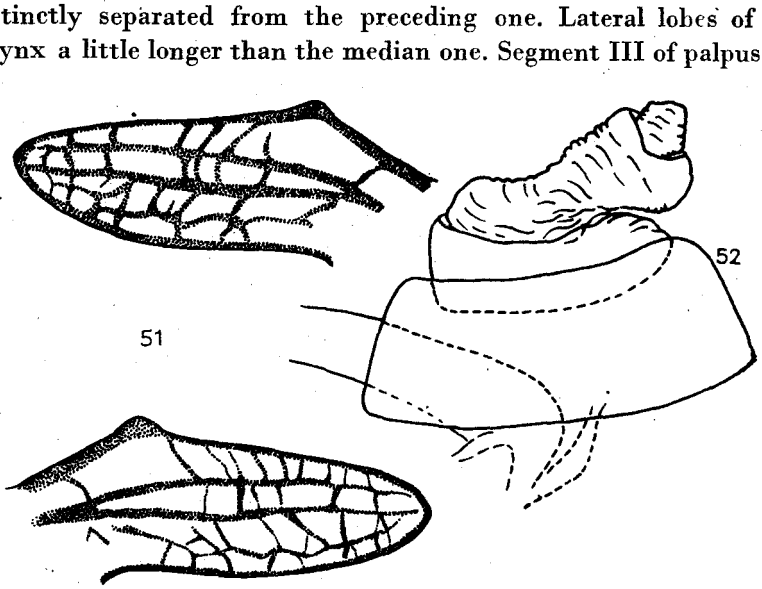
Male subimago (inside the nymph). Penial plate very broad and short, with hind margin only very slightly convex and broadly rounded corners. Base of tails darkened.

Nymph. Length: Body 9 mm, antennae 2.5 mm, cerci 3.5 mm, filum terminale 3 mm. Labrum almost rectangular in form, only the frontal



45–50. *Centroptilum* sp. (? = *P. motasi* Bog.), nymph: 45 — labrum, 46 — canines of mandibles, 47 — hypopharynx, 48 — labium, 49 — maxilla, 50 — legs I, III

half a little broader. Both mandibles broad, canines divided almost to half their length. Palpus maxillaris 3-segmented, segment III short and indistinctly separated from the preceding one. Lateral lobes of hypopharynx a little longer than the median one. Segment III of palpus labia-



51, 52. *Centroptilum* sp. (? = *P. motasi* Bog.), nymph: 51 — hind wing pads (female nymph) ,52 — male genitalia (half) taken out of exuviae

lis straightly cut at apex. Paraglossae a little longer than glossae, both the former and the latter sharp at apex and incurved. Length ratio of leg segments:

	femur		tibia		tarsus		claw	
	♀	♂	♀	♂	♀	♂	♀	♂
fore leg	8.4	9.1	5.6	6.1	5.3	5.8	2.6	2.9
middle leg	8.5	8.8	5.6	5.9	5.0	5.2	2.7	3.1
hind leg	8.8	8.8	5.9	6.1	5.2	5.4	2.8	3.1

Claws with small denticles. Hind wing pads with 2 longitudinal veins and distinct cross-veins placed as in female of *Pseudocentroptilum motasi* Bogoescu. Gills in number of 7 pairs, on tips rounded, asymmetric; pairs I–VI double, their outer margins straight, inner margins convex, and dorsal lamella relatively large; pair VII single, their outer margin straight more convex than the inner, but asymmetry rather slight. Subanal plate (well visible only in one nymph) with 9 big, sharp denticles, among which, not regularly, small denticles are placed.

Pigmentation of abdominal tergites rather softened; tergites III and VI darkest; so are hind tergal margins in part with denticles and

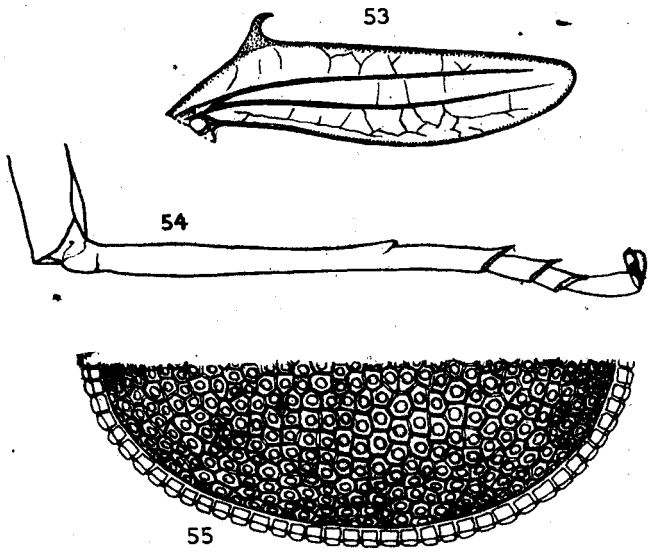
sometimes fore margins, narrowly dark bordered; moreover, on hind margin of tergites (IV)V–IX 2 dark dots, each outside the section with denticles; on segment X the pair of dark dots is set partly on the base of filum terminale. Gills darkened at the base, lighter towards apex; outer margin and shafts of tracheae light brownish. Legs light, only the outer margin of the femoral distal part, the proximal tibial part, and especially dorsal side of tarsus and the basic swell and apex of claw darkened. Tails light.

Bionomics unknown. Two mature nymphs (male, female) were collected (leg. R. Sowa, 2 VIII 1974) in a stream near Melnik (southern Bulgaria). Species not found in Poland. Size of nymphs, distribution of veins in hind wing pads and darkened bases of tails in subimago, present in larval exuviae, allow supposition that these nymphs belong to the species described from female imago as *Pseudocentroptilum motasi* BOGOESCU.

Pseudocentroptilum motasi Bogoescu, 1947

(Figs 53–55)

Female imago (according to BOGOESCU's description and on the basis of a specimen from Lesbos). Length: Body 8–9 mm, tails about 12 mm. Head small. Prothorax narrow. In pterostigma 7 or 8 cross-veins. Hind



53–55. *Pseudocentroptilum motasi* BOG. 53, 54 — female imago: 53 — hind wing (less magnified then pads), 54 — leg III; 55 — egg: sculpture of chorion on half surface (specimen from Lesbos)

wing in specimen from Lesbos has a straight fore margin, hind margin at first parallel to it, in distal 1/3 length bowed to a blunt tip. From the base of longitudinal veins goes a very short vein III (visible only under strong magnification) close to the wing joint; besides there are numerous cross-veins whose plexus between longitudinal vein II and hind margin of wing forms an apparent longitudinal vein, not connected with the base of the wing. In this specimen the length ratio of tarsal segments is the following: leg I: 17: 10.5: 6: 14; leg III: 17: 7.5: 4.5: 13.

Pigmentation. Head yellow brownish, light. Compound eyes dark grey. Pronotum reddish, prosternum yellow brownish, light. Remaining parts of thorax sepia brownish with darker dots near base of wings and legs. On mesonotum numerous narrow, dark brown stripes running as in genus *Baetis* LEACH. Metanotum brown reddish, darker than pronotum; on metasternum, at the base of legs, 2 dark brown dots. Outer parts of femora light sepia brown, inner parts white greyish; other segments of legs light grey, joints brown reddish. Fore wings translucent, except costal and subcostal fields, which are opaque; first 3 veins brown reddish, the remaining pale. Abdomen on dorsal side dark sepia, on ventral side yellow brown; along the side of each tergite an elliptic spot, similarly, a dark brown spot in each frontal angle of all sternites; moreover, on sternites I–VII a dark brown pattern of 2 elliptic oblique spots and 2 dots behind them. Tails at base brown reddish, farther gradually paler sepia, finally white.

Egg (taken from the female imago from the island Lesbos). Dimensions: 203–209 μm × 136–142 μm. Adhesive layer very thick in form of a net with relatively large meshes, with single large papillae in meshes, all of the same size. On one side of the egg about 48 papillae on the longitudinal axis and about 22 on the lateral one.

Subimago and nymph. Probably both stages that have been described in this paper as *Centroptilum* sp. belong to this species.

Bionomics unknown. Type specimens (female imagines) collected in Sačelu in Roumania, one female imago collected at the stream Chidira, Greek island Lesbos (leg. Dr. Hans Malicky, 28 V 1975).

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