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Autor: Zwick, Peter

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Contribution to the knowledge of *Phanoperla* BANKS, 1938 (Plecoptera: Perlidae)

PETER ZWICK

Limnologische Flussstation des Max-Planck-Instituts für Limnologie, Postfach 260, D-6407 Schlitz, Federal Republic of Germany

Phanoperla vietnamensis sp. n. and *P. imitatrix* sp. n. from Vietnam and *P. incompleta* from Borneo are described. A second male of *P. anomala* (BANKS, 1939) and aberrant specimens of *P. bakeri* (BANKS, 1924) (including probable hybrids with the former) as well as a doubtful specimen of *P. maculata* ZWICK, 1982, are reported from Borneo. Two unassociated females, *P. spec. H* and *P. spec. I*. from Thailand and Vietnam, respectively, are described. Diagnostic details of all taxa are illustrated.

In the authoritative Plecoptera catalogue of ILLIES (1966) the distinctness of genus *Phanoperla* from *Neoperla* NEEDHAM, 1905 was still doubtful because at that time none of its species had yet been adequately described. 28 valid named species were recognized in a revision of the genus (ZWICK, 1982). Three more have been added since (STARK 1983, ZWICK 1983) some additional information on known species is provided by ZWICK & SIVEC (1985), and a few more representatives of this strictly Oriental stonefly genus are here described. At the same time, it becomes clear that in some cases more material than presently available is needed to decide if slightly different specimens are members of a single variable, or of several closely related species.

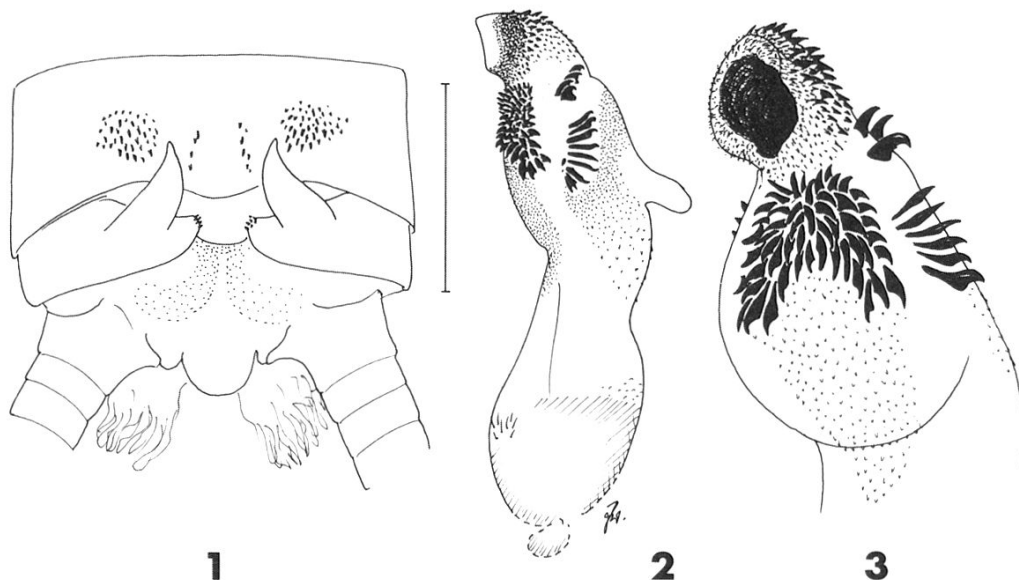
Illustrations of penes show that part of the base which is dorsal in resting position on the right hand side. The same orientation is accepted when the text refers to the dorsal or ventral face of penis or of its everted sac.

Specimens used in this study have been lent to me by P. BARNARD (British Museum of Natural History, Entomology, London; BMNH) and G. N. NISHIDA (Bernice P. Bishop Museum, Honolulu; BPBM). B. P. STARK (Clinton, Mass.) kindly provided illustration and description of a Bornean *P. bakeri* studied by him, and T. SOLDÀN (Ceske Budejovice) donated me with Plecoptera collected in Vietnam. These are presently kept in my collection, in the Limnologische Flussstation Schlitz, LFS. I would like to thank all mentioned for their help.

Phanoperla vietnamensis sp. n. (Figs. 1–3)

Material: ♂ holotype, pinned, genitalia on microslide, Republic of Vietnam, Kim Lien, 7.VII.1968, Bruce W. MILLER (BPBM). ♂ paratype, Vietnam, Lam Dong Prov., Da Nhim R., Duc Trong, 27.X.1984, T. SOLDÀN (in alcohol; coll. ZWICK in LFS).

Wings 8–9 mm long, Rs with fork. Pale yellowish, ocellar rings black, rugae on transverse pronotum (length:width = 1:3), enlarged tibiae und distal half of antennae lightly infusate. Rhomboid occipital mark projects between ocelli.



Figs. 1–3: *Phanoperla vietnamensis*, ♂: 1, abdominal tip; 2, everted penis, lateral; 3, lateroventral view of everted penis sac. Scale is 0.5 mm.

Male: Tergite 9 with two widely separate patches of short conical setae, two irregular rows of similar setae along median depression. Hemitergites 10 simple, their anterior processes wide, pointed, tips outwardly curved. Sternite 7 with sternal brush. Paraprocts and cerci simple.

Dorsal penis sclerite not well delimited, essentially T-shaped with narrow base. Ventral pair of sclerites and little setae in front of these as usual. Everted penis sac with bare dorsobasal finger. Apex curved ventrad. Major armature consists of several groups of variously arranged spines. Ventrally, there is a U-shaped large patch of hooks, the basal ones with wide base, some distal ones much more slender, pin-shaped with narrow base. Laterally, a longitudinal divided band of hooks, tips directed dorsad. Hooks in basal section with very wide bases, less wide in distal hooks, more strongly curved. On convex side of apex, numerous smaller hooks and many fine spinules form an apical band. Except on sides and on dorsal finger, most of surface of sac covered with very fine asperities.

Female: Unknown.

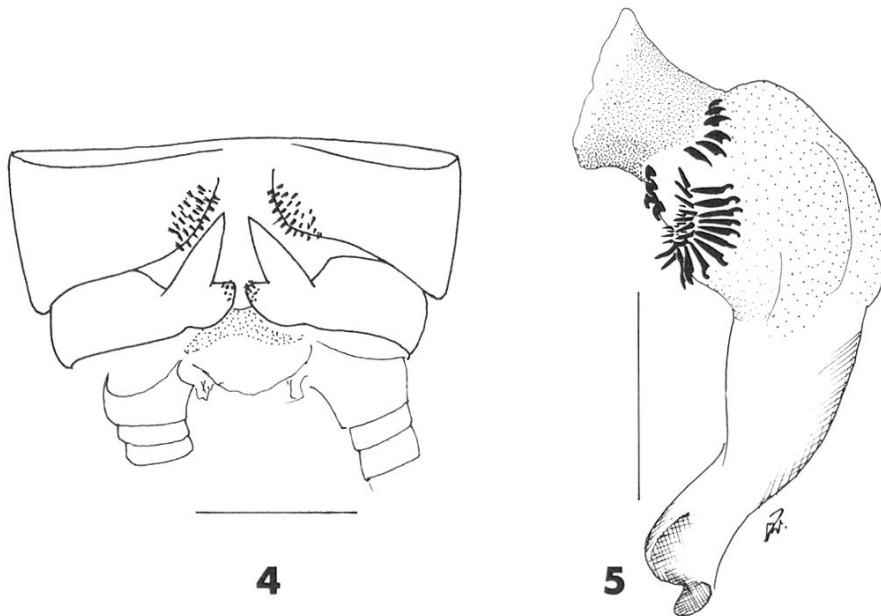
Larva: A larva collected together with the paratype might be of the same species. It resembles *Phanoperla* spec. 6 of ZWICK, 1982.

Notes: A member of the *flaveola*-subgroup (ZWICK, 1982). Genitalia most similar to *P. sumatrae* ZWICK, 1982, but clearly distinct. *P. sumatrae* also differs from the present species by its brown pronotal mark and the increased number of veins leaving cell between *M* and *Cu*.

Phanoperla spec., cf. *maculata* ZWICK, 1982
(Figs. 4, 5)

Phanoperla maculata ZWICK, 1982, Systematic Entomology 7: 111, figs. 16e, f.

Material: Sarawak: 1 ♂, Mt. Dulit, R. Koyan, 2,500 ft, primary forest 14.X.1932, 1 ♂, foot of Mt. Dulit, junction of rivers Tinjar and Lelok, 15.IX.1932 (both Oxford Univ. Exped., B. M. HOBBY + A. W. MOORE (BMNH)).



Figs. 4, 5: *Phanoperla* spec., cf. *maculata*, ♂: 4, abdominal tip; 5, everted penis. Scales are 0.5 mm.

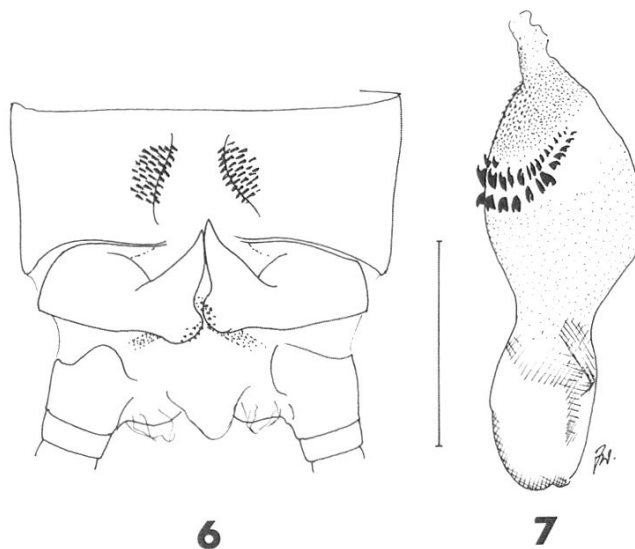
The present specimens are distinctly larger than the type, their wings being 10.0–10.5 mm long. They differ also from the type in that the discal wing spot is very vague and visible only to the naked eye, under certain angles of infalling light.

Genitalia resemble the type, except that the dorsobasal hump of the everted sac was not noticed, but the penis base of both present specimens is damaged. The more basal band of very low, wide hooks and elongate pin-like spines next to these appears to be a little shorter than in the type. More material is needed to decide definitely on the status of these specimens.

Phanoperla incompleta sp. n.

(Figs. 6,7)

Material: ♂ holotype, British N. Borneo, Tawau, Quoin Hill, Cocoa Res. Sta., 4.XI.1962, light trap, Y. HIRASHIMA (BPBM).



Figs. 6,7: *Phanoperla incompleta*, ♂: 6, abdominal tip; 7, everted penis; scale is 0.5 mm.

Small, wings only 7.5 mm long, *Rs* with simple fork. Ocelli small, about one diameter apart, the rhomboid occipital area protrudes between ocelli. Ochre, outer side of tips of femora and of tibiae as well as entire tarsi darker. Antennae missing.

Male: Sternite 6 with small, 7 with well developed setal brush. Tergite 8 unmodified. Tergite 9 with two widely separate patches of short conical setae. Hemitergites 10 with very blunt median tips, anterior processes very wide, triangular, pointed. Penis with plump oval everted sac, apex conical with fine armature, most of sac covered with slightly coarser but sparser fine armature. A dorsally incomplete oblique double ring of large hooks forms the main armature. It is a little irregular ventrally. The more basal hooks are basally, the distal ones distally directed.

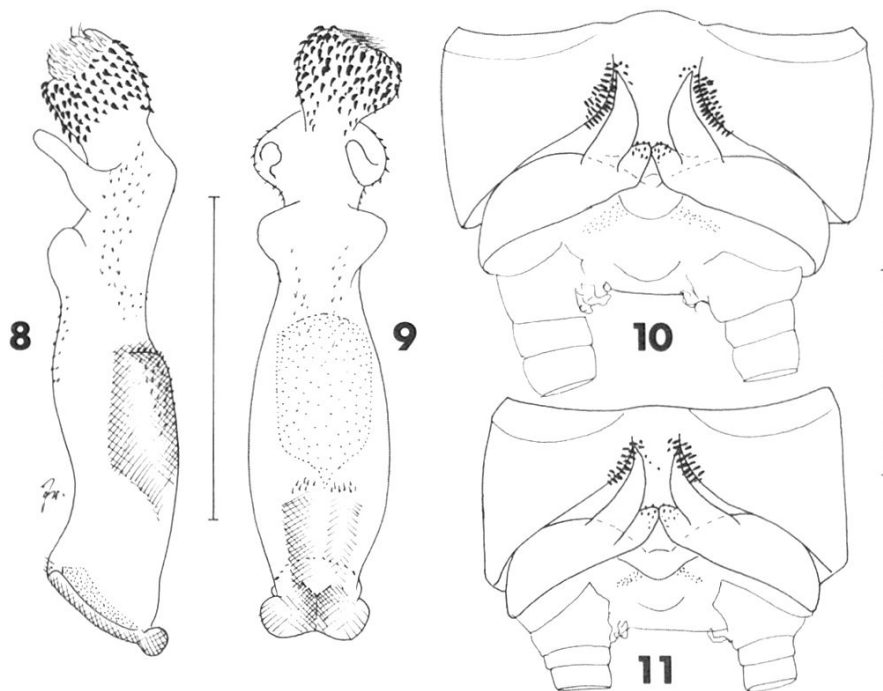
Female: Unknown.

Notes: The present species is a relative of *P. nervosa* BANKS, 1939. It differs by its small size, the short basal piece of the penis, the lack of a bare lobe of the everted sac, and the incomplete rings of spines.

Phanoperla imitatrix sp. n.
(Figs. 8–10)

Material: ♂ holotype, 4 ♂ paratypes, Viet Nam, Fyan, 900–1000 m, 11.VII.–9.VIII.1961, N. R. SPENCER (BPBM; 1 paratype in coll. ZWICK, LFS). Additional paratypes (STARK det. *simplex*): 1 ♂, taken with holotype; 1 ♂, Fyan, 30.VII.1961, N.R. SPENCER; 1 ♂, Viet Nam, Ban Me Thuot, 500 m, 16.–18.V.1960, L. W. QUATE; 1 ♂, Viet Nam, E. of Ban Me Thuot, 400–600 m, 8.–19.XII.1960, C. M. YOSHIMOTO (all BPBM).

Wings 7.5–8.0 mm long. Indistinguishable from mainland *P. simplex* ZWICK, 1982, unless genitalia are carefully examined.



Figs. 8–10: *Phanoperla imitatrix*, ♂: 8, everted penis, lateral; 9, the same, dorsal; 10, abdominal tip. Scale is 0.5 mm.

Fig. 11: *Phanoperla simplex*, ♂ from Khaophapha, abdominal tip. Scale is 0.5 mm.

Male: Anterior processes of hemitergites 10 a little stouter and more strongly sinuous than in *P. simplex* (Fig. 11). Posterior edge a little more sclerotized than rest of tergite 8, distally indistinctly notched. Sternite 7 with distinct, 6 with rudimentary brush. Penis like in *P. simplex*, but spines at apex relatively smaller. In dorsoventral view, two rhomboid membraneous expansions appear below the spiny apex, above the broad dorsal sclerite. The distal expansion with two curved hyaline appendages.

Female: Unknown.

Notes: The related *P. simplex* has a simple narrow tubular neck-like section between the broad base and the spiny apex of the penis.

Phanoperla anomala (BANKS, 1939)
(Fig. 12)

Dyaperla anomala BANKS, 1939, Bull. Mus. Comp. Zool. 85: 451, figs. 24, 26.

Phanoperla anomala – ZWICK, 1982, Systematic Entomology 7: 95, fig. 3.

Material: 1 ♂, Sarawak, Mt. Dulit, 4000 ft, moss forest, 22.X.1973, native collector, Oxford University Expedition, HOBBY & MOORE (BMNH).

P. anomala, *P. sertispina* JEWETT, 1975, *P. bakeri* (BANKS, 1924) and *P. fuscipennis* (NAVAS, 1932) form a group of closely related species. All have eggs with a narrow and long, bottle-neck-like collar; external genitalia of males (unknown for *fuscipennis*) are similar; the penis exhibits a common basic pattern: the finely spinulose everted sac has a pedunculate dorsal extension and a (sometimes incomplete) subterminal ring of big spines close to the conical apex. The pedunculate extension is finely spinulose in *anomala* and *bakeri*, but bare in *sertispina*. The two latter species are exceptional in the tribe Neoperlini in possessing a third anterior ocellus, while *P. bakeri* has only two ocelli, as typical of the tribe.

Surprisingly, the present material strongly suggests that *P. anomala* and *P. bakeri*, which appeared so distinct, may reproductively be incompletely isolated.

Of *P. anomala*, only a single male had previously been available. It came from Mt. Dulit, like the present one. Both agree in having an almost rectangularly bent plump penis sac. The big spines form a dorsal half ring. Several scattered ventro-distal spines look like being dislodged from the dorsal side of the ring. Immediately below the apex, the penis sac has a black protrusion covered with apparently coalescing black spinules. The present male differs a little from the type in the poor development of some ventral membraneous lobes at the bend of the everted sac; in the type, these are larger but not completely symmetrical.

In the present incomplete knowledge, presence of the anterior ocellus is – arbitrarily! – chosen as separating *P. anomala* from other, sometimes very similar morphs which are presently classified as *P. bakeri*, or as probable hybrids of *bakeri* with *anomala*, respectively.

Phanoperla bakeri (BANKS, 1924)

(Fig. 16) and probable *bakeri* × *anomala* hybrids (Figs. 13–15, 17)

Neoperla bakeri BANKS, 1924, Bull. Mus. Comp. Zool. 65: 426, fig. 19.

Phanoperla bakeri – ZWICK, 1982, Systematic Zoology 7: 95, fig. 4.

Material: *P. bakeri*: 1 ♂, East Malaysia, Sabah, Sungai Moyog, 3 mi. E. Penampang, 27.IX.1978, G. F. & C. H. EDMUNDS (USNM) (Fig. 16). *P. bakeri* × *anomala*: 1 ♂, British N. Borneo, W. Coast Residency, Ranau, 8 mi N. Paring Hot Springs, 500 m, 8.–11.X.1958, T. C. MAA (BPBM) (Fig. 13); 3 ♂♂ (one shown in Fig. 14), Borneo, Kunching, Matang, 450–894 m, 15.IX.1958, J. L. GRESSITT & T. C. MAA (BPBM); 1 ♂, North Borneo (SE), Forest Camp 19 km N. of Kalabakan, light trap, 14.X.1962, (Y.

HIRASHIMA) (BPBM); 1 ♂, British N. Borneo, Quoin Hill, 3.-7. VII.1962, H. HOLTSMANN (BPBM); 1 ♂ (Fig. 15); 1 ♂ (Fig. 17), Sarawak, foot of Mt. Dulit, junction of rivers Tinjar and Lelok, 11.IX.1932, Oxford University Expedition, HOBBY & MOORE (BMNH).

The specimen shown in fig. 16 has been referred to as a Bornean *P. bakeri*, from the illustration (ZWICK, 1982). In fact, it differs from typical Philippine males of *bakeri* by little more than the irregularity of the ring of spines.

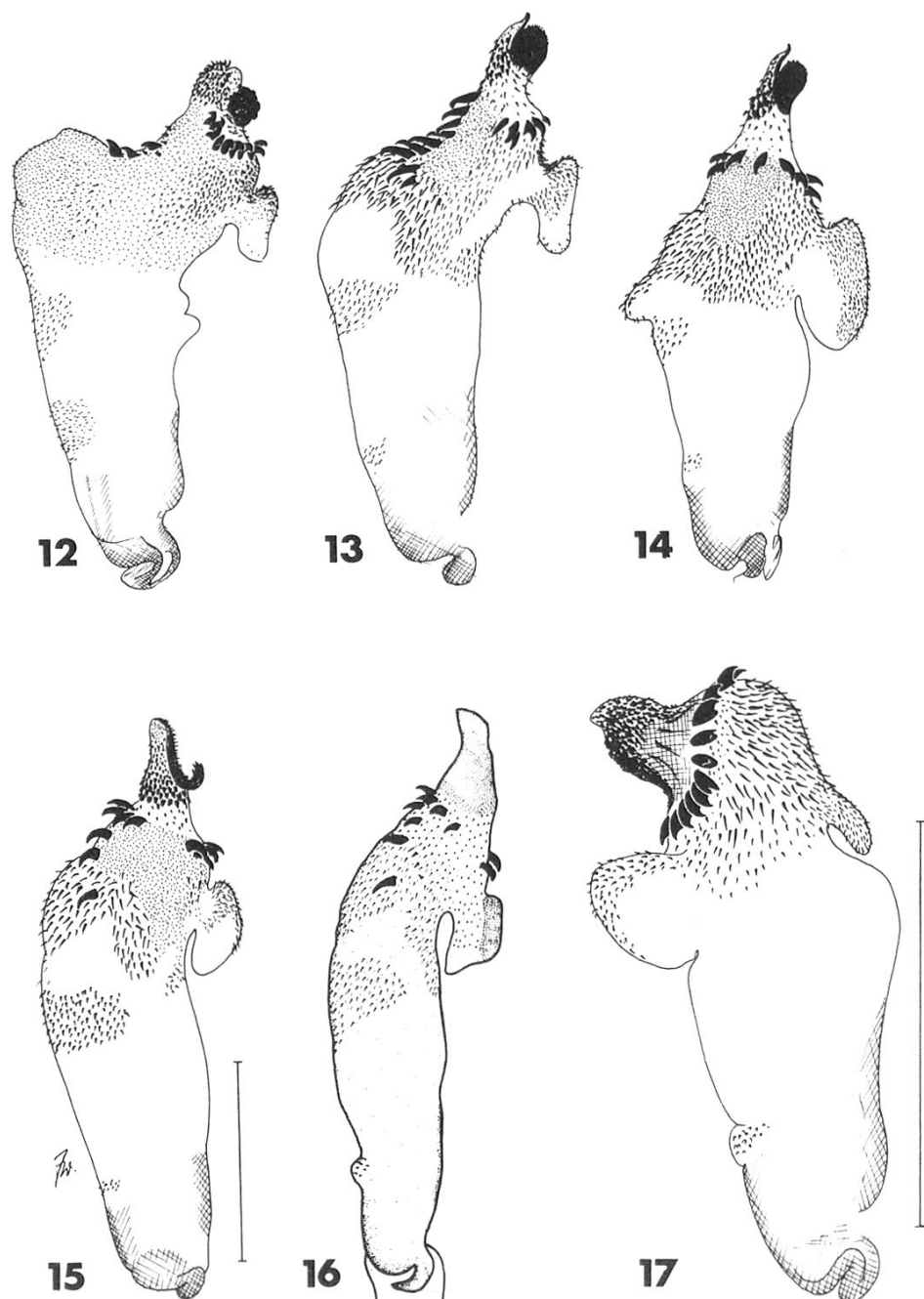


Fig. 12: *Phanoperla anomala*, ♂, everted penis, lateral.

Figs. 13-15: *Phanoperla bakeri* × *anomala*, ♂♂, everted penes, lateral; see list of material for details.

Fig. 16: *Phanoperla bakeri*, Bornean ♂, everted penis, lateral (drawing by B. P. STARK).

Fig. 17: Doubtful *Phanoperla bakeri* × *anomala* hybrid, ♂, everted penis. Scales are 0.5 mm, Figs. 12-15 are to same scale. Scale not known for Fig. 16.

Specimens in figs. 13–15 show various degrees of resemblance to *P. anomala* in the more or less bent sac or the presence of ventral lobes to the sac and, in particular, the blackish terminal protrusion with coalesced spines. Fig. 15 shows one of three very similar males where this protrusion takes the form of a narrow outwardly curved band. Otherwise, these specimens are very similar to *P. bakeri*. I believe that these various combinations of characters are presently best explained by assuming hybridisation between *bakeri* and *anomala*. However, some other cause of genetic heterogeneity producing different local morphs (of which *P. anomala* may in fact be just one) may also be considered.

A very small specimen (wing length 8 mm; fig. 17) has the most regular ring of hooks among the Bornean specimens, but an otherwise very peculiar penis. Its apex is displaced to the ventral side which has an extra basal bulb. This specimen is tentatively also considered a member of the presumed hybrid complex.

Phanoperla spec. H
(Fig. 18)

Material: 2 ♀, Thailand, Trang Prov., Khaophapha, Kaochang, 200 m, 9.–11.I.1964, Malaise Trap, G. A. SAMUELSON (BPBM).

Wings 10 mm long, Rs with simple fork. Ocelli moderately large, little more than one diameter apart, ringed with black. The modified occipital area is elongate-rhomboid and projects between ocelli. Ochre, antennal flagellum, palpi, outer faces of tibiae and tips of tarsi a little brownish.

Sternite 8 simple, a little more heavily sclerotized mediodistally. Egg oval, opercle fairly pointed, collar wide, funnel-shaped. Anchor short, mushroom-shaped, with very wide stalk. Adhesive bodies on margin not observed. Chorion smooth, except sparse punctation on opercle.

Phanoperla spec. I
(Figs. 19, 20)

Material: 1 ♀, Viet Nam, Dalat, 6 km S., 1400–1500 m, 9.VI.–7.VII.1961, N. R. SPENCER (BPBM).

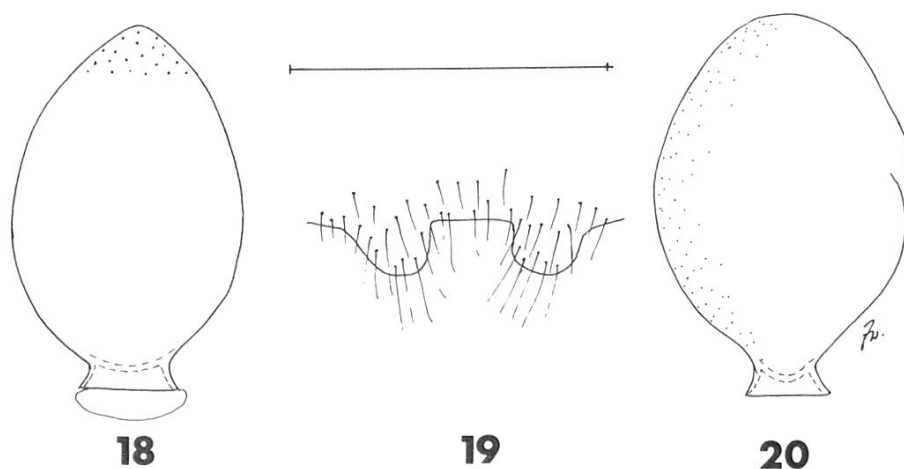


Fig. 18: *Phanoperla spec. H*, egg.

Figs. 19, 20: *Phanoperla spec. I*, ♀: 19, central portion of rear margin of sternite 7; 20, egg. Scale is 0.3 mm for Figs. 18, 20, but 0.6 mm for Fig. 19.

Wings 11.5 mm long, Rs with simple fork. Ocelli small, ca. 1.5 diameters apart, dark rings indistinct. Modified occipital area rather pointed, projecting between ocelli. Ochre, palpi and tips of tarsi brownish, C, Sc, and c-sc yellow and clearly brighter than other veins.

Sternite 8 with two widely separate, hardly convergent rounded lobes. Egg oval, opercle blunt. Collar funnel shaped, wide. Anchor not observed. Chorion covered with fine sparse punctation everywhere, except on collar.

ZUSAMMENFASSUNG

Phanoperla vietnamensis sp. n. und *P. imitatrix* sp. n. aus Vietnam sowie *P. incompleta* sp. n. aus Borneo werden beschrieben. Aus Borneo werden ein zweites Männchen von *P. anomala* (BANKS, 1939) und aberrante Exemplare von *P. bakeri* (BANKS, 1924) (einschließlich mutmaßlicher Hybriden mit ersterer) sowie ein zweifelhaftes Exemplar von *P. maculata* ZWICK, 1982 gemeldet. Zwei nicht zugeordnete Weibchen, *P. spec. H* und *P. spec. I* aus Thailand bzw. Vietnam, werden beschrieben. Die kennzeichnenden Merkmale aller Taxa werden abgebildet.

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