*Zootaxa* 1453: 41–54 (2007)
www.mapress.com/zootaxa/


ISSN 1175-5326 (print edition)
**ZOOTAXA**
ISSN 1175-5334 (online edition)

# Description of three new species of *Neoperla* (Plecoptera: Perlidae) and a historical review of tropical Southeast Asian Perlidae

THI KIM THU CAO, SOON AH HAM[1] & YEON JAE BAE[*]

*Department of Biology, Seoul Women's University, Seoul 139-774, Korea. E–mail: yjbae@swu.ac.kr*
*[1]Current address: Department of Biology, Chonnam National University, Gwangju 500–757, Korea*
*[*]Corresponding author*

## Abstract

The stonefly family Perlidae has successfully invaded tropical Southeast Asian streams. In this paper, three new species of *Neoperla* Needham, *N. sungi*, **sp. nov.**, *N. tamdao*, **sp. nov.**, and *N. yentu*, **sp. nov.**, are described from tropical Vietnam with line drawings of key characters. A brief historical review of investigations and trends in tropical Southeast Asian Perlidae diversity, including a species checklist, is provided.

**Key words:** *Neoperla sungi*, *Neoperla tamdao*, *Neoperla yentu*, Perlidae, Plecoptera, new species, description, historical review, Vietnam, tropical Southeast Asia

## Introduction

Plecoptera are known as a cold adapted group of aquatic insects, and the majority of the members of this group are found in streams of temperate regions. The Perlidae is the only family of stoneflies that has been highly successful invading tropical regions of peninsular and insular Southeast Asia, although a small number of species of other families, including Nemouridae, Leuctridae, and Peltoperlidae, are also present in tropical regions (Dudgeon1999, Hoang & Bae 2006).

The widespread genus *Neoperla* Needham is the most species–rich genus of the Perlidae in the streams of tropical Southeast Asia (Sivec *et al*. 1988). The *Neoperla* adult is characterized by a projected lobe or raised process located on the 7th abdominal tergum, by patches of conical spinules at the 7th to 9th abdominal terga in males, and by poor development of the subgenital plate in females (Sivec *et al*. 1988). The *Neoperla* nymph has a body of medium size and can be distinguished from other genera of the tribe Neoperlini by the incomplete lateral fringe in the pronotum and by the bare occipital ridge (Sivec *et al*. 1988, Stewart & Stark 2002). The species concept of *Neoperla* has been well–established since Zwick (1983) and Sivec *et al*. (1988) described the structure of the aedeagus, the chorionic sculpturing of the eggs, and the external setation of the nymphs.

In the present work, we describe three new species of *Neoperla* found in mountain areas in tropical Vietnam and also provide a historical review of Southeast Asian Perlidae.

## Material and methods

Adult materials were collected using a light trap or sweep net from stream sides of mountain areas throughout Vietnam. Nymphs were collected using a Surber net or a dipnet in the mountain streams. Last instar nymphs

*Accepted by Ed Dewalt: 12 Jan. 2007; published: 23 Apr. 2007*

were reared to adulthood when possible. All materials were preserved in 80% EtOH and are housed in the Aquatic Insect Collection of Seoul Women's University (SWU–AIC) in Seoul and Institute of Ecology and Biological Resources in Hanoi.

The preparation and dissection of specimens follow the methods of Zwick (1983) and Sivec *et al*. (1988). Frequently used abbreviations are as follows: alt. (altitude), NP (National Park), Prov. (Province), DHH (Duc Huy Hoang), and VVN (Van Vinh Nguyen).

***Neoperla sungi* Cao & Bae sp. nov.**
(Figs. 1–6)

**Description.** Male body length 8.0 mm; antennae 8.1 mm; forewings 9.4 mm; hindwings 8.2 mm. General body color pale yellow with brown to dark brown markings.

Head (Fig. 1) pale yellow, interocellar area dark brown. Ocelli two, relatively large, located close to each other, positioned at rear of head, and margined in black. Antennal scape and pedicle pale yellow; flagellum brown.

Pronotum with pale yellow background and symmetrical brown rugosities. Wings (Figs. 2, 3) hyaline; veins pale yellow; forewing Rs with 3 branches; forewing C–Sc with 15 crossveins. Hindwing 3A unforked. Tarsi, foretibiae, midtibiae, and proximal part of hindtibiae brown, otherwise pale yellow.

Abdominal tergum VII (Fig. 4) with median, triangular expansion on posterior surface; expansion in lateral view truncate, with spinules along margin; tergum VIII weakly sclerotized, medially with several anteriomedial spinules; tergum IX with median depression, with small spinules and minute hairs along anterior margin. Anterior processes of hemiterga (Fig. 4) straight, relatively long, nearly extending over tergum IX. Sterna unmodified. Aedeagus tube (Figs. 5, 6) length ca. 1.5 mm (ca. 5x width), mostly membranous proximally, but becoming more sclerotized midway and to distal surface, armed with 3 major groups of spinules. In lateral view (Fig. 5), bulb weakly sclerotized, with group of tiny dome–like spinules. In ventral view (Fig. 6), bulb slightly expanded, tube with group of tiny conical spinules in distal half. Inner sac (not everted) as long as aedeagus tube, sac covered with pushpin–like spinules on its basal 2/3. Cerci simple, pale yellow.

Female. Unknown.

Nymph. Unknown.

Egg. Unknown.

**Type Material.** Holotype: ♂ (SWU–PLE–28, aedeagus dissected), Vietnam, Vinh Phuc Prov., Tam Dao NP, alt. 900 m at waterfall below village, 10.x.1998, Yeon Jae Bae [SWU–AIC]. Paratypes: 2 ♂ (SWU–PLE–30, ♂ aedeagus dissected), Vietnam, Lam Dong Prov., Bao Loc Pass, Da Mre, alt. 290 m, 23.iii.2002, DHH & VVN [SWU–AIC]. **Other Material.** 2 ♂ (SWU–PLE–29), Da Nang Prov., Ba Na–Nui Chua, Tuy Loan, 31.iii.2002, DHH & VVN [SWU–AIC].

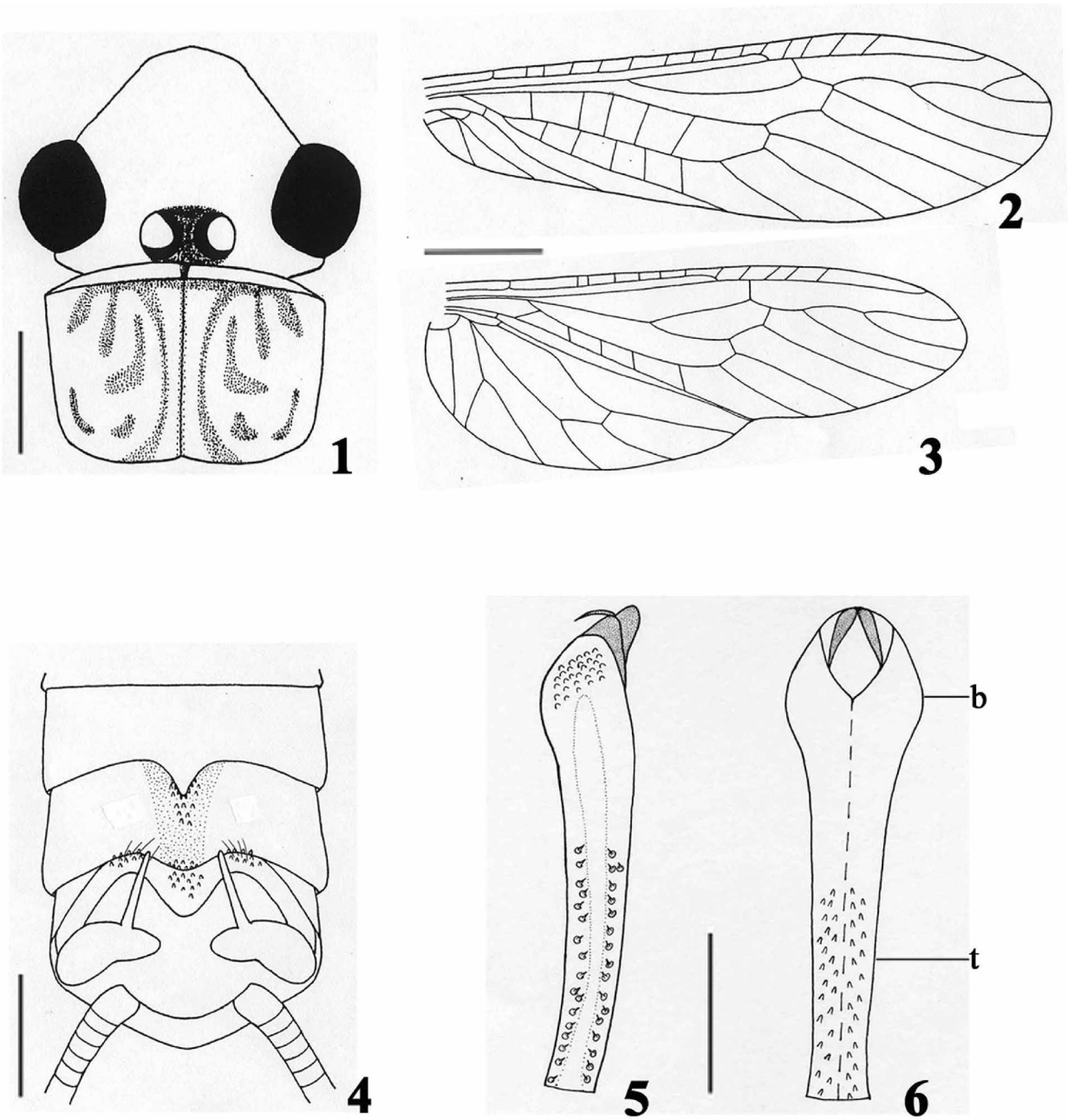
**Etymology**. This species is named after the late Prof. Dr. Cao Van Sung of the Institute of Ecology and Biological Resources in Hanoi who pioneered ecological and conservational studies in Vietnam.

**Diagnosis.** On account of general spinules on male abdominal tergum VIII, arranged in a single band, *Neoperla sungi* **sp. nov.** can be assigned to the *aeripennis*–subgroup of the *clymene*–group, which is endemic to the Oriental region. The male adult of *N. sungi* is similar to that of *N. saraburi* Zwick (in Zwick 1988) of Thailand in general body shape, but *N. sungi* lacks spinule patches on the lateral part of the abdominal tergum VIII (Fig. 4). The external setation of the aedeagus in *N. sungi* (Figs. 5, 6) is unique among known species of *Neoperla* and it distinguishes this species from its congeners.

**Habitat and biology.** Adults of *N. sungi* were found alongside small mountain streams (alt. 290–900 m) in northern and central Vietnam. The streams were approximately 4 m wide, 10–20 cm deep, and canopied with typical regional flora, including dipterocarp and bamboo; the substrate consisted of boulder (65%), cob-

ble (20%), and pebble and gravel (15%). The adults were collected in March and October, suggesting that emergence may occur at most any time of the year.

**Distribution.** Northern and central Vietnam.




**FIGURES 1–6.** *Neoperla sungi* **sp. nov.**, male adult. (1) Head and pronotum. Scale bar = 0.5 mm. (2 & 3) Right forewing and hindwing. Scale bar = 2 mm. (4) Dorsal terminalia. Scale bar = 0.5 mm. (5 & 6) Lateral and ventral aedeagus. Scale bar = 0.5 mm. b = bulb, t = tube.

***Neoperla tamdao* Cao & Bae sp. nov.**
(Figs. 7–15)

**Description.** Male body length 12.6 mm; antennae 10.2 mm; forewings 13.3 mm; hindwings 11.7 mm. General body color pale yellow with dark brown markings.

Head (Fig. 7) dark brown medially, pigment extending from anterior of frons to occiput. Ocelli set forward to middle of compound eyes; ocellar area dark brown. A pair of light spots present between ocelli and compound eyes. Anterior edge of frons and large areas posterior to compound eyes pale yellow. Antennae generally dark brown; scape pale yellow. Maxillary and labial palpi dark brown. Pronotum pale yellow, with symmetrical dark brown rugosities, posteriorly narrowed, flared to anterolateral angular corners. Wings (Figs. 8, 9) hyaline; veins brown; forewing Rs with 3 branches; C–Sc with 18 crossveins. Hindwing 3A unforked. Legs relatively long; tibiae, tarsi, and distal part of femora dark brown.

Abdomen pale yellow in membranous areas and brown in sclerotized areas; tergum VII (Fig. 10) strongly sclerotized in almost entire area and posteriorly with paired submedian lobes; submedian lobes each with 4–5 spinules terminally; terga VIII–IX (Fig. 10) sclerotized anterolaterally and membranous posteromedially; tergum VIII with submedian patches of ca. 10 spinules; tergum IX strongly swollen, with submedian patches of ca. 14 spinules and a few long hairs anteriorly. Hemiterga (Fig. 10) strongly sclerotized, medial lobe with scattered spinules, anteriorly directed processes slighly curved and extending over half of tergum IX. Aedeagus tube (Figs. 12, 13) ca. 1.0 mm long, plump (length ca. 3x width), and largely membranous. In lateral view (Fig. 12), everted sac with fingerlike lobes; each lobe with dark spinules. In dorsal view (Fig. 13), bulb weakly sclerotized, slightly swollen at middle. Sac with lateral groups of conical spinules, forming a V–shaped patch of dark spinules from dorsal view. Cerci simple, brown.

Female body length 17.0–19.8 mm; antennae 12.2–13.9 mm; forewings 18.3–20.5 mm; hindwings 16.5–18.6 mm. Female much larger than male. Sterna I–V pale yellow; sterna VI–X brown; sternum VIII (Fig. 11) weakly sclerotized in posteromedian area; subgenital plate (Fig. 11) without lobes. Vagina (Fig. 14) sac–shaped, large, and very expansible; upper folds and front of attachment of receptacle distinctly sclerotized; marginal parts soft, irregularly folded and wrinkled; spermathecal stalk ca. 0.5x length of vaginal sac.

Nymph. Unknown.

Egg. Egg (Fig. 15) stout and oval, 0.40 mm long and 0.29 mm wide. Chorion smooth. Collar narrow, with flanged margin. Anchor attached inside collar. Micropyles in upper third; orifices sessile.

**Type material.** Holotype: ♂ (SWU–PLE–19, aedeagus dissected), Vietnam, Vinh Phuc Prov., Tam Dao NP, Thac Bac, alt. 700 m, 16.iv.2002, DHH & VVN [SWU–AIC]. Paratypes*:* 2 ♂ (SWU–PLE–20, ♂ aedeagus dissected) & 3 ♀ (SWU–PLE–21, ♀ vagina dissected), same data as holotype [SWU–AIC]. **Other Material.** ♂ (SWU–PLE–22), Vietnam, Ha Tinh Prov., Huong Son, Son Kim, 9.v.2004, Thi Kim Thu Cao; ♂, Quang Nam Prov., Phuoc Son, LoXo Pass, alt. 1000m, 1.v.2005, Hoang Vu Tru.

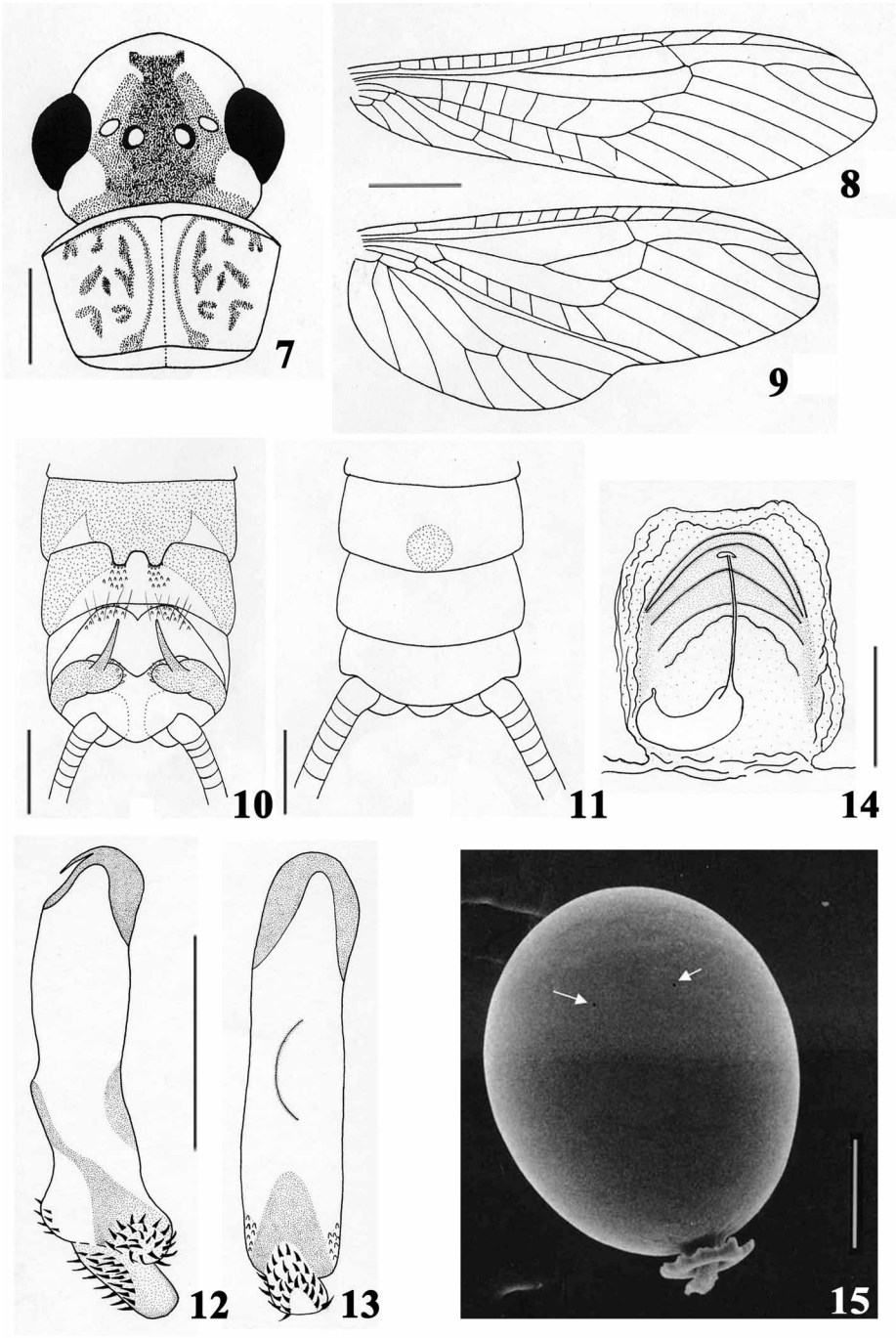
**Etymology.** The specific name, *tamdao* (noun), refers to the holotype locality of this species.

**Diagnosis.** The male adults of *Neoperla tamdao* **sp. nov.** have paired submedian lobes on the 7th abdominal tergum and the female adults have relatively large and expansible vagina, which may suggest a close affinity with the *borneensis*–subgroup of the *montivaga*–group. The male adult of *N. tamdao* is similar to that of *N. harina* Navás (in Zwick 1986a) in general body shape, but can be distinguished by distinct head markings (Fig. 7) and the everted sac lacking protrusions. The female adult can be distinguished by the shape of the vagina that is sclerotized and wrinkled marginally (Fig. 14).

**Habitat and biology.** Adults of *N. tamdao* were collected from stream sides of small to medium–sized (4–30 m wide) mountain streams (alt. 290–1000 m) in northern and central Vietnam. The streams were 50 to 100% canopied by evergreen trees such as bamboo and ficus and the substrate consisted of boulder (40%), cobble (30%), gravel (15%), coarse sand (15%), and abundant fallen leaves. The adults were collected from late March to May.

**Distribution**. Northern and central Vietnam.

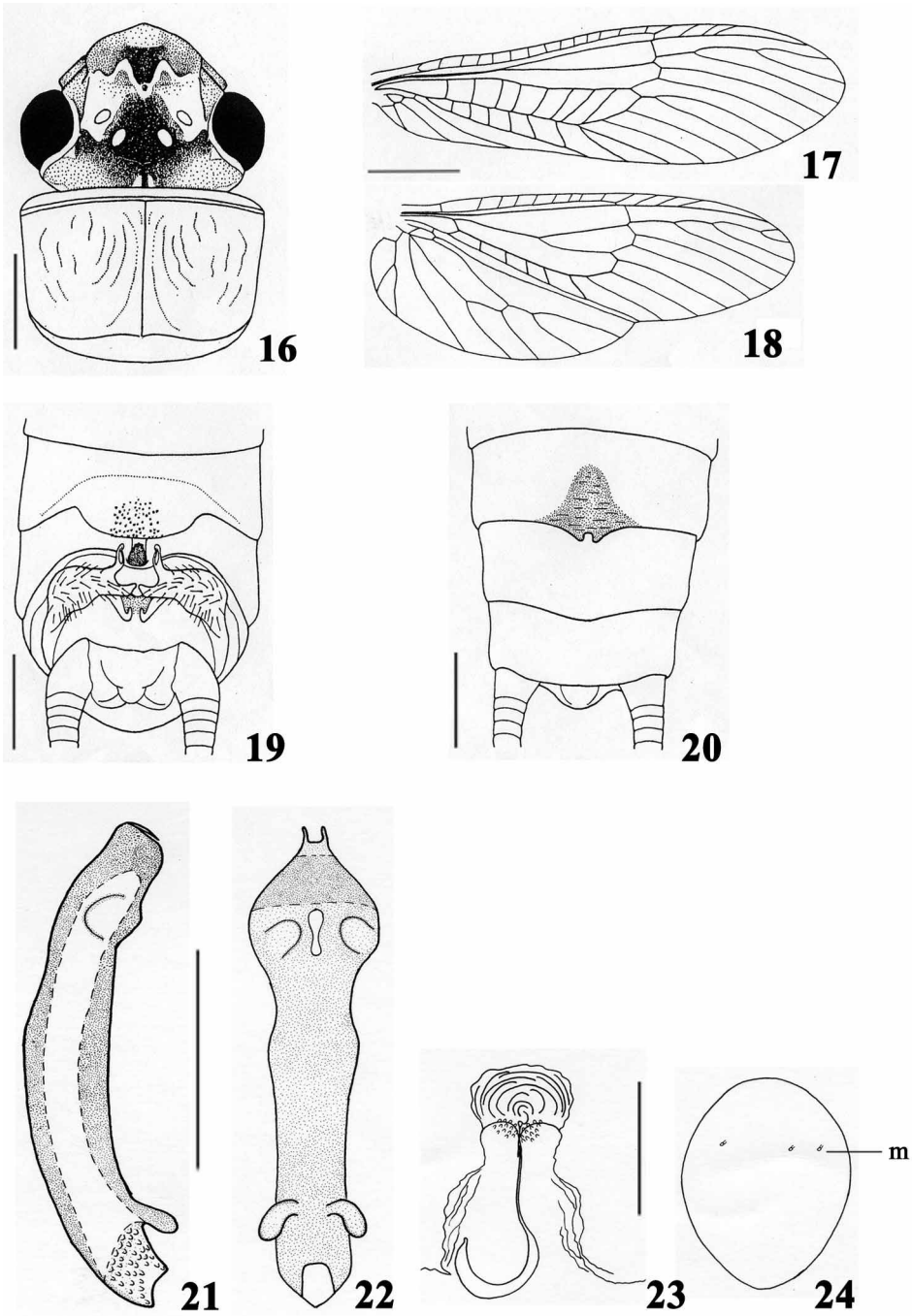
**Remarks.** The male and female adults of *N. tamdao* were collected simultaneously from the habitat site and no other neoperlids were found at that time. In addition, the complete agreement in head markings between the male and female adults substantiate this conspecificity.




**FIGURES 7–15.** *Neoperla tamdao* **sp. nov.** (7) Male head and pronotum. Scale bar = 0.5 mm. (8 & 9) Male right forewing and hindwing. Scale bar = 2 mm. (10) Male dorsal terminalia. Scale bar = 0.5 mm. (11) Female ventral terminalia. Scale bar = 0.5 mm. (12 & 13) Everted lateral and dorsal aedeagus. Scale bar = 0.5 mm. (14) Female vagina. Scale bar = 0.2 mm.(15) Lateral egg. Scale bar = 0.1 mm. Micropyles arrowed.

***Neoperla yentu* Cao & Bae sp. nov.**
(Figs. 16–31)

**Description.** Male body length 14.6 mm; antennae 10.1 mm; forewings 15.3 mm; hindwings 13.5 mm. General body color light brown with darker brown markings.




**FIGURES 16–24.** *Neoperla yentu* **sp. nov.** (16) Male head and pronotum. Scale bar = 0.5 mm. (17 & 18) Male right forewing and hindwing. Scale bar = 3 mm. (19) Male dorsal terminalia. Scale bar = 0.5 mm. (20) Female ventral terminalia. Scale bar = 0.5 mm. (21 & 22) Everted lateral and ventral aedeagus. Scale bar = 1 mm. (23 & 24) Female vagina and egg. Scale bar = 0.2 mm. M = micropyle.

Head (Fig. 16) light brown, with dark triangle on frons anterior to M–line, with large dark brown area from M–line to occiput and extending to compound eyes. Ocelli two, relatively small, located between compound eyes. Antennae dark brown. Maxillary and labial palpi dark brown.

Pronotum pale brown, slightly rugose, anteriorly slightly wider; anterolateral margin round. Mesonotum and metanotum pale brown. Wings (Figs. 17, 18) hyaline; veins brown. Forewing Rs with 5 branches; C–Sc with 18 crossveins. Hindwing 3A forked. Legs relatively long; coxae and proximal femora yellow; tibiae, tarsi, and distal half of femora dark brown.

Abdominal tergum VII (Fig. 19) weakly sclerotized, posteriorly with broad and round expansion covered with spinules; tergum VIII (Fig. 19) with triangular sclerotized process possessing spinules at its apex; tergum IX covered with hairs. Hemiterga (Fig. 19) hairy, weakly sclerotized, divided into three lobes; anterior, finger-like lobe short and curved at tip; median lobes truncate and nearly meeting; posterior lobes as long as anterior lobes, acutely hooked distally. Sterna unmodified. Aedeagus tube (Figs. 21, 22) ca. 2.3 mm long (length 5–6x width), entirely sclerotized. In lateral view (Fig. 21), inner sac (not everted) relatively long and narrow; tube distally with tiny conical spinules. In ventral view (Fig. 22), bulb swollen and darker, with paired lobes (Fig. 22), with a pair of lobes ventrodistally. Cerci brown (cerci terminally broken).

Female body length 16.6–17.4 mm; antennae 10.7–11.2 mm; forewings 17.6–18.4 mm; hindwings 14.5–15.8 mm. General morphology similar to male. Subgenital plate (Fig. 20) strongly sclerotized posteromedially, emarginate, with lobes projecting posteriorly. Vagina sac–shaped (Fig. 23) and membranous, anterolaterally with numerous concentric folds, raised medially with two wide, sclerotized, folded lobes separated by a median line; lobes covered with conical spinules. Spermathecal stalk and receptacle membranous.

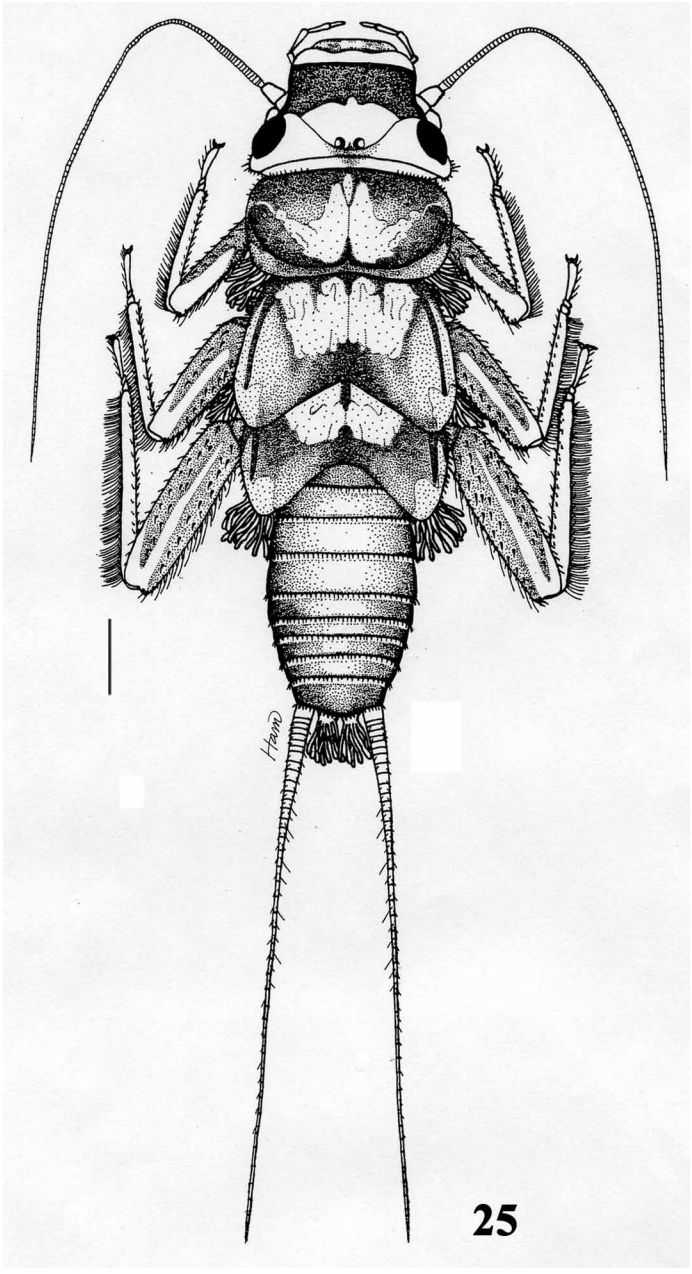
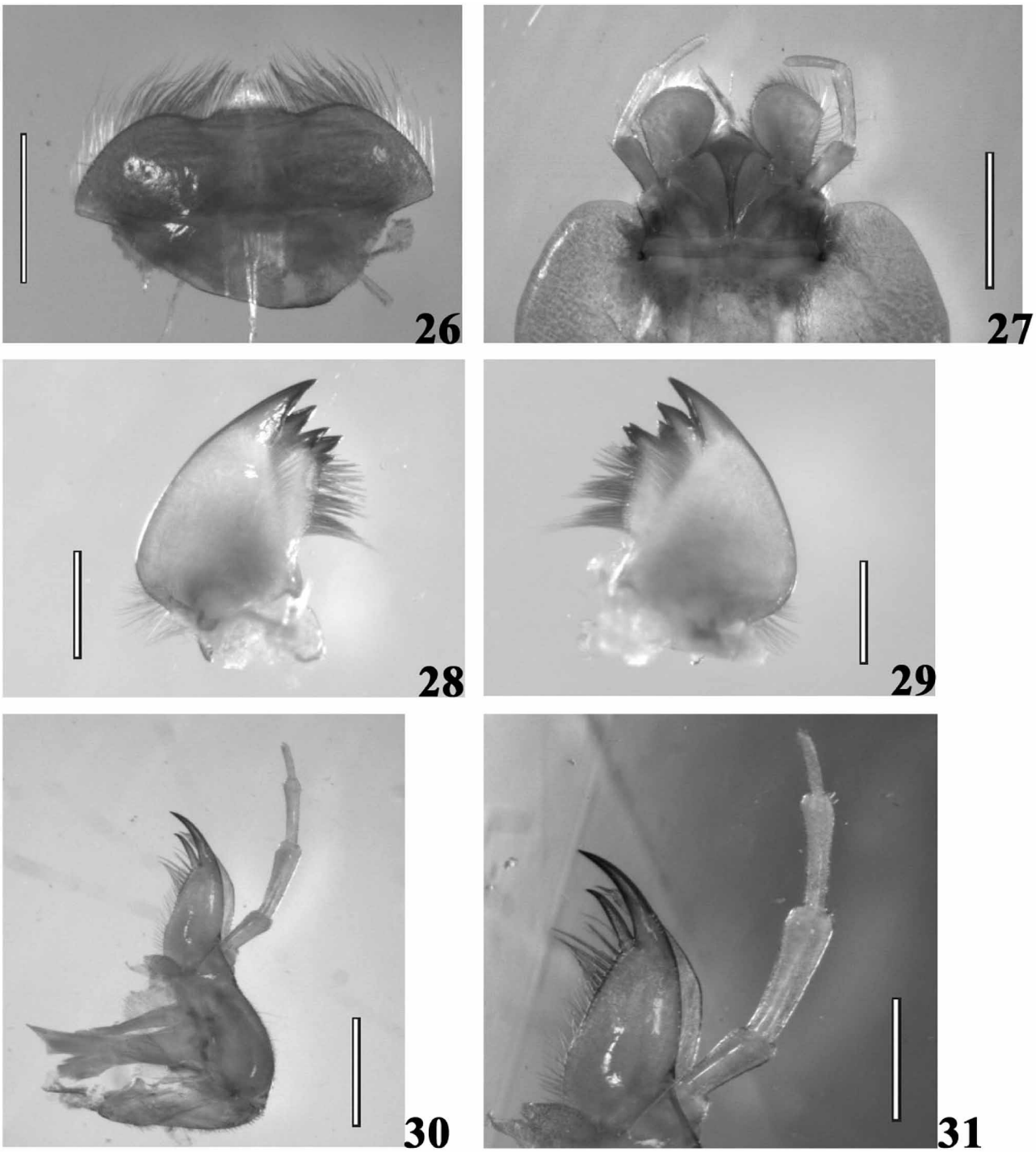



**FIGURE 25.** *Neoperla yentu* **sp. nov.**, nymph. Scale bar = 1 mm.




**FIGURES 26–31.** *Neoperla yentu* **sp. nov.** nymphal mouthparts. (26) Labrum. Scale bar = 0.5 mm. (27) Labium. Scale bar = 1 mm. (28 & 29) Left and right mandibles. Scale bar = 0.5 mm. (30) Right maxilla. Scale bar = 1 mm. (31) Tip of right maxilla. Scale bar = 0.5 mm.

Nymph. Body length 10.0–11.0 mm; antennae 9.4–10.6 mm; cerci 9.5–10.5 mm. Body (Fig. 25) ground color pale yellow with darker brown markings. Head relatively flat, with wide dark brown band on anterior dorsal head; ocellar area and occiput not pigmented. Compound eyes relatively large, black, and with dense fringe of small bristles posteriorly. Antennae nearly as long as body, slender, light brown; basal two segments lighter in color.

Mouthparts pale brown. Labrum (Fig. 26) width ca. 3x length; anterior margin fringed with fine hairs. Labial (Fig. 27) paraglossae large and round, with fringe of fine marginal hairs; glossae reduced to proximal paraglossae; labial palpi slender, 3-segmented; palpal segments nearly equal in length; submentum very large, wider than long, anterior corners round; mentum reduced to narrow band. Hypopharynx triangular, with round hairly frontal margin. Mandibles (Figs. 28–29) with two rows of bristles, with 5-6 teeth. Maxillae (Figs. 30–31) with strongly developed lacinial tooth, with a large moveable tooth followed by fringe of long bristles; maxillary palpi 5-segmented; segments 3 and 4 longer than other segments.

Pronotum (Fig. 25) subquadrate, dark brown, with large pale areas medially; lateral margins incompletely fringed. Mesonotum and metanotum nearly similar in size, yellow-brown, with various darker markings. Thoracic gill tufts consisting of nine pairs: two on posterior supracoxal prosternum ($PSC_{1,}$ sensu Stewart & Stark 2002), two on posterior supracoxal mesosternum ($PSC_2$), two on posterior thoracic abdomen (MTA), one on posterior supracoxal metasternum ($PSC_3$), one on anterior thoracic mesosternum ($AT_2$), and one on anterior thoracic metasternum ($AT_3$). Legs relatively long, somewhat flattened; femora fringed with stout brown setae on both anterior and posterior regions (medially bare), with row of long white hairs along posterior margin; tibiae relatively long, slender, fringed with dense white hairs along outer margin.

Abdomen cylindrical, fringed with row of brown stout setae along posterior margin. Subanal lobe cylindrical, with pair of gill tufts terminally. Cerci nearly as long as body, dark brown.

Egg. Egg (Fig. 24) oval, ca. 0.30 mm long and 0.21 mm wide; both poles similar. Collar and anchor absent. Chorion completely thin and seemingly smooth. Micropyles in upper third; orifices sessile.

**Type material.** Holotype: ♂ (SWU–PLE–23, reared, aedeagus dissected), Vietnam, Quang Ninh Prov., Yen Tu, 2.iii.2002, Thi Kim Thu Cao [SWU–AIC]. Paratypes: 2 ♂ (SWU–PLE–24, reared, 1 aedeagus dissected), 3 ♀ (SWU–PLE–26, reared, 1 vagina dissected) & 30 nymphs (SWU–PLE–25), same data as holotype [SWU–AIC]; 2 ♂, Vinh Phuc Prov., Tam Dao NP, 16.v.1995, by light trap, Van Quang Nguyen.

**Etymology.** The specific name, *yentu* (noun), refers to the holotype locality of this species.

**Diagnosis.** *Neoperla yentu* **sp. nov.** belongs to the *lushana*–subgroup of the *montivaga*–group, which is widespread in Asia. The male adult of *N. yentu* is similar to *N. diehli* Sivec (in Zwick & Sivec 1985) in terms of the shape of the abdominal tergum VII and the shape of aedeagus, but can be distinguished by the absence of a darkened area in front of the subquadrate area in the abdominal tergum VII (Fig.19) and by the absence of the spinules in two processes of the lobes of the aedeagus tube (Fig. 21). The female adult can be distinguished by the central vaginal sac that has two widely sclerotized and folded lobes covered by several spinules (Fig. 23). The nymph (Fig. 25) can be distinguished from other described SE Asian *Neoperla* by the combination of the following characters: head markings, marginal dark brown groove in the pronotum, and anterolateral dark brown margins of both the mesonotum and metanotum.

**Habitat and biology.** *Neoperla yentu* is widely distributed throughout Vietnam. The adults and nymphs were found in mountain areas (alt. 450–970 m) where the streams were 5–20 m wide, canopied by trees. The coarse mineral substrate consisted of boulder (40%), cobble (30%), gravel and coarse sand (30%), and abundant fallen leaves. The adults were collected by light trap.

**Distribution.** Vietnam.

## Discussion

The Perlidae is a relatively well–known family of stoneflies and is found in all biogeographical realms, except Australasia and the oceanic islands (Sivec *et al*. 1988). Since the 1980s, the perlid diversity of tropical Southeast Asia has been studied by P. Zwick (Indonesian fauna), B. P. Stark (mainland Southeast Asian fauna), and I. Sivec (Philippine fauna). As a result of these investigations, including this study, a total of 113 species of Perlidae belonging to 7 genera are known from the region (see Table 1 for species and citations). The genus

*Neoperla* is the most species–rich group of tropical Southeast Asian Perlidae, comprising more than 75% (94 species) of the total number of species, followed by *Phanoperla* Banks (10 species), *Chinoperla* Zwick (3 species), *Agnetina* Klapálek (2 species), *Tyloperla* Sivec & Stark (2 species), *Etrocorema* Klapálek (1 species), and *Togoperla* Klapálek (1 species). Despite these recent studies, the diversity of the tropical Southeast Asian Perlidae is still only partially known.

**TABLE 1.** Checklist of the tropical Southeast Asian Perlidae.

| No | Taxa | Distributions | Sources |
|---|---|---|---|
| 1 | *Agnetina jarai* Stark & Sivec | Vietnam | Stark & Sivec 1991 |
| 2 | *A. den* Cao & Bae | Vietnam | Cao & Bae 2006 |
| 3 | *Chinoperla fascipennis* (Banks) | Thailand, Malaysia | Zwick 1982c |
| 4 | *C. reducta* (Geijskes) | Indonesia (West Sumatra) | Zwick 1982c |
| 5 | *C. unidentata* Sivec & Zwick | Thailand | Sivec & Zwick 1989 |
| 6 | *Etrocorema nigrogeniculatum* (Enderlein) | Thailand, Malaysia, Indonesia (Sumatra) | Kawai 1968, Zwick 1982b |
| 7 | *Neoperla aeripennis* (Enderlein) | Indonesia (Sumatra & Java) | Zwick 1983 |
| 8 | *N. affinis* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 9 | *N. agusani* Sivec | Philippines | Sivec 1984 |
| 10 | *N. alboguttata* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 11 | *N. aliqua* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 12 | *N. angustilobata* Navás | Vietnam, China | Zwick 1988, Du *et al.* 1999 |
| 13 | *N. asperata* Zwick | Thailand, Malaysia | Zwick 1988 |
| 14 | *N. atripennis* Banks | Philippines | Sivec 1984 |
| 15 | *N. banksi* (Illies) | Malaysia, Thailand, China | Zwick 1988 |
| 16 | *N. bilobata* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 17 | *N. bicoronata* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 18 | *N. borneensis* (Enderlein) | Indonesia (Borneo) | Zwick 1986a |
| 19 | *N. caligata* (Burmeister) | Indonesia (Sumatra & Java) | Zwick 1983 |
| 20 | *N. cameronis* Zwick | Malaysia | Zwick 1988 |
| 21 | *N. connectens* Zwick | Indonesia (Borneo), Philippines | Zwick 1986a |
| 22 | *N. coronata* Zwick | Vietnam | Zwick 1988 |
| 23 | *N. dayak* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 24 | *N. dentata* Sivec | Indonesia (Borneo), Philippines | Sivec 1984, Zwick 1986a |
| 25 | *N. diehli* Sivec | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 26 | *N. distincta* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 27 | *N. divergens* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 28 | *N. edmundsi* Stark | Thailand, Indonesia (Borneo) | Stark 1983, Zwick 1986a |
| 29 | *N. fallax* Klapálek | Indonesia (Sumatra & Java) | Zwick 1983 |
| 30 | *N. flavicincta* Zwick | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 31 | *N. flinti* Sivec | Philippines | Sivec 1984 |
| 32 | *N. furcata* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 33 | *N. furcifera* Klapálek | Indonesia (Borneo) | Zwick 1986a |

*..... continued on the next page*

**TABLE 1** (continued)

| No | Taxa | Distributions | Sources |
|---|---|---|---|
| 34 | *N. gordonae* Stark | Laos, Thailand | Stark 1983 |
| 35 | *N. harina* Navás | Indonesia (Borneo) | Zwick 1986a |
| 36 | *N. hermosa* Banks | Philippines | Sivec 1984 |
| 37 | *N. hoabihnica* Navás | Vietnam | Zwick 1988 |
| 38 | *N. illiesi* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 39 | *N. inutilis* Zwick | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 40 | *N. jacobsoni* Klapálek | Indonesia (Sumatra & Java) | Zwick 1983 |
| 41 | *N. jewetti* Sivec | Philippines | Sivec 1984 |
| 42 | *N. kachin* Stark & Szczytko | Myanmar (Burma) | Stark & Szczytko 1979 |
| 43 | *N. laotica* Zwick | Laos | Zwick 1988 |
| 44 | *N. lieftincki* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 45 | *N. lahu* Stark | Thailand | Stark 1983 |
| 46 | *N. leptophallus* Zwick | Thailand, Malaysia | Zwick 1988 |
| 47 | *N. lushana* Wu | Himalayas, China | Wu 1934, Zwick & Sivec 1980 |
| 48 | *N. luteola* (Burmeister) | Indonesia (Sumatra & Java) | Zwick 1983 |
| 49 | *N. malleus* Zwick | Malaysia | Zwick 1988 |
| 50 | *N. melanocephala* Navás | Myanmar (Burma) | Zwick 1988 |
| 51 | *N. microtumida* Wu & Claassen | Thailand, China | Stark 1987 |
| 52 | *N. mnong* Stark | Vietnam, China | Stark 1987, Du *et al*. 1999 |
| 53 | *N. multilobata* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 54 | *N. naviculata naviculata* Klapálek | Indonesia (Borneo), Malaysia | Zwick 1986a |
| 55 | *N. naviculata crux* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 56 | *N. nigra* Sivec | Philippines | Sivec 1984 |
| 57 | *N. nishidai* Sivec | Philippines | Sivec 1984 |
| 58 | *N. nova* Zwick | Vietnam, Malaysia. | Zwick 1988 |
| 59 | *N. oculata* Banks | Philippines | Sivec 1984 |
| 60 | *N. oliqua* Banks | Philippines | Sivec 1984 |
| 61 | *N. pallescens* Banks | Philippines | Sivec 1984 |
| 62 | *N. pallicornis* Banks | Philippines | Sivec 1984 |
| 63 | *N. parva* Banks | Indonesia (Borneo) | Zwick 1986a |
| 64 | *N. paucispinosa* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 65 | *N. philippina* Sivec | Philippines | Sivec 1984 |
| 66 | *N. pilosella* Klapálek | Indonesia (Sumatra & Java) | Zwick 1983 |
| 67 | *N. pseudorecta* Sivec | Philippines | Sivec 1984 |
| 68 | *N. primitiva* Geijskes | Indonesia (Sumatra & Java) | Zwick 1983 |
| 69 | *N. propinqua* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 70 | *N. punan* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 71 | *N. recta* Banks | Philippines | Sivec 1984 |
| 72 | *N. regidipenis* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 73 | *N. reticulata* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 74 | *N. rougemonti* Zwick | Indonesia (Borneo) | Zwick 1986a |

*..... continued on the next page*

**TABLE 1** (continued)

| No | Taxa | Distributions | Sources |
|---|---|---|---|
| 75 | *N. sabah* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 76 | *N. saraburi* Zwick | Thailand | Zwick 1988 |
| 77 | *N. sarawak* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 78 | *N. securifera* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 79 | *N. serrata* Zwick | Thailand | Zwick 1988 |
| 80 | *N. seriespinosa* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 81 | *N. silvaeae* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 82 | *N. simplicior* Navás | Indonesia (Sumatra & Java) | Zwick 1983 |
| 83 | *N. sitahoanensis* Sivec | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 84 | *N. spinosa* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 85 | *N. starki* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 86 | *N. stueberae* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 87 | *N. sumatrana* (Enderlein) | Indonesia (Sumatra & Java) | Zwick 1983 |
| 88 | *N. sungi* Cao & Bae | Vietnam | This study |
| 89 | *N. tamdao* Cao & Bae | Vietnam | This study |
| 90 | *N. tenuispina* Klapálek | Indonesia (Sumatra & Java) | Zwick 1983 |
| 91 | *N. tetrapoda* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 92 | *N. thai* Stark | Thailand | Stark 1987, Zwick 1988 |
| 93 | *N. theobromae* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 94 | *N. wagneri* Sivec | Philippines | Sivec 1984 |
| 95 | *N. unicolor* Zwick | Indonesia (Borneo) | Zwick 1986a |
| 96 | *N. variegata* Klapálek | Indonesia (Borneo) | Zwick 1986a |
| 97 | *N. vesperi* Zwick | Indonesia (Sumatra & Java) | Zwick 1983 |
| 98 | *N. yao* Stark | Vietnam, China | Stark 1987, Du *et al*. 1999 |
| 99 | *N. yentu* Cao & Bae | Vietnam | This study |
| 100 | *N. zwicki* Sivec | Philippines | Sivec 1984 |
| 101 | *Phanoperla guttata* Zwick | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 102 | *P. imitatrix* Zwick | Vietnam | Zwick 1986b |
| 103 | *P. lao* Stark | Thailand | Stark 1983 |
| 104 | *P. lisu* Stark | Thailand | Stark 1983 |
| 105 | *P. malayana* Zwick | Vietnam, Thailand, Malaysia | Zwick 1982a, Stark 1987 |
| 106 | *P. minutissima* (Enderlein) | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 107 | *P. sertispina* Jewett | Thailand | Stark 1983 |
| 108 | *P. simplex* Zwick | Vietnam, Thailand, Malaysia, Indonesia (Sumatra) | Zwick 1982a, Stark 1987, Zwick & Sivec 1985 |
| 109 | *P. sumatrae* Zwick | Indonesia (Sumatra) | Zwick & Sivec 1985 |
| 110 | *P. vietnamensis* Zwick | Vietnam | Zwick 1986b |
| 111 | *Togoperla shan* Stark & Sivec | Thailand | Stark & Sivec 1991 |
| 112 | *Tyloperla illiesi* Stark & Sivec | Vietnam | Stark & Sivec 2005 |
| 113 | *T. khang* Stark & Sivec | Vietnam | Stark & Sivec 2005 |

In terms of geographic distribution, 41 species of Perlidae are known in mainland Southeast Asia, including Vietnam, Laos, Cambodia, Thailand, western Malaysia, and Myanmar (Burma) (Kawai 1968, Stark & Szczytko 1979, Zwick 1982a, 1982b, 1982c, 1986b, 1988, Stark 1983, 1987, Sivec & Zwick 1989, Stark & Sivec 1991, Stark & Sivec 2005, Cao & Bae 2006). Sixty species are known from Indonesian islands of Sumatra, Java, and Borneo (Zwick 1982a, 1982b, 1983, 1986a, Zwick & Sivec 1985), while 18 species are known in the Philippines (Sivec 1984, Zwick 1986b). Seventeen species of Perlidae are formally known in Vietnam (Zwick 1986b, 1988, Stark 1987, Stark & Sivec 1991, 2005, Stark & Sivec 2005, Cao & Bae 2006), although Cao (2002) informally recorded 23 species, including 9 species of undetermined nymphs. According to a recent investigation based on quantitative sampling in streams, the number of Plecoptera taxa, particularly that of genera and families, declines as the latitude decreases in East Asia (Hoang and Bae 2006). Despite this tendency, the Perlidae is regarded as an exceptionally species–rich group of stoneflies in the streams of tropical Southeast Asia.

**Acknowledgements**

We thank Hoang Duc Huy (Ho Chi Minh University of Science, Ho Chi Minh) and Nguyen Van Vinh (Hanoi University of Science, Hanoi) for their assistance in the field, and Nguyen Van Quang (Hanoi University of Science, Hanoi) and Hoang Vu Tru (Institute of Ecology and Biological Resources, Hanoi) for their donation of materials. This work was supported by the research project from the Ministry of Environment of Korea in 2007.

**References**

Cao, T.K.T. (2002) Systematics of the Plecoptera of Vietnam. Master's Thesis, Department of Biology, Seoul Women's University, Seoul.

Cao, T.K.T. & Bae, Y.J. (2006) *Agnetina den*, a new species of perlid stonefly (Plecoptera: Perlidae) from Vietnam. *Entomological Research*, 36, 45–47.

Du,Y., Sivec, I. & He, J. (1999) A checklist of the Chinese species of the family Perlidae (Plecoptera: Perloidea). *Acta Entomologia Slovenica*, 7, 59–67.

Dudgeon, D. (1999) *Tropical Asian Streams. Zoobenthos, Ecology and Conservation.* Hong Kong University Press, Hong Kong, 830 pp.

Hoang, D.H. & Bae, Y.J. (2006) Aquatic insect diversity in a tropical Vietnamese stream in comparison with that in a temperate Korean stream. *Limnology*, 7, 45–55.

Kawai, T. (1968) Stoneflies (Plecoptera) from Thailand and India with descriptions of one new genus and two new species. *Oriental Insects*, 2, 107–139.

Sivec, I. (1984) Study of genus *Neoperla* (Plecoptera: Perlidae) from the Philippines. *Scopolia*, 7, 1–44.

Sivec, I., Stark, B.P. & Uchida, S. (1988) Synopsis of the world genera of Perlinae (Plecoptera: Perlidae). *Scopolia*, 16, 1–66.

Sivec, I. & Zwick, P. (1989) Addition to the knowledge of genus *Chinoperla* (Plecoptera, Perlidae). *Aquatic Insects*, 11, 11–16.

Stark, B.P. (1983) Description of Neoperlini from Thailand and Malaysia (Plecoptera: Perlidae). *Aquatic Insects*, 5, 99–114.

Stark, B.P. (1987) Records and descriptions of Oriental Neoperlini (Plecoptera: Perlidae). *Aquatic Insects*, 9, 45–50.

Stark, B.P. & Sivec, I. (1991) Description of Oriental Perlini (Plecoptera: Perlidae). *Aquatic Insects*, 13, 151–160.

Stark, B.P. & Sivec, I. (2005) New species of *Tyloperla* (Plecoptera: Perlidae) from Vietnam and Thailand. *Illiesia*, 1, 1–7.

Stark, B.P. & Szczytko, S.W. (1979) A new species of *Neoperla* (Plecoptera: Perlidae) from Burma. *Aquatic Insects*, 1, 221–224.

Stewart, K.W. & Stark, B.P. (2002) *Nymphs of North American stonefly genera (Plecoptera)*. Second edition. The Caddis Press, Columbus, Ohio. 510 pp.

Wu, C.F. (1934) Aquatic insects of China. Article XXI. New species of stoneflies from East and South China (Order Plecoptera). *Peking Natural History Bulletin*, 9, 227–243.

Zwick, P. (1982a) A revision of the Oriental stonefly genus *Phanoperla* (Plecoptera: Perlidae). *Systematic Entomology*, 7, 87–126.
Zwick, P. (1982b) Note on Plecoptera (6), *Etrocorema nigrogeniculatum* (Enderlein). *Aquatic Insects*, 4, 104.
Zwick, P. (1982c) Contribution to the knowledge of *Chinoperla* (Plecoptera: Perlidae: Neoperlini). *Aquatic Insects*, 4, 167–170.
Zwick, P. (1983) The *Neoperla* of Sumatra and Java (Indonesia) (Plecoptera: Perlidae). *Spixiana*, 6, 167–204.
Zwick, P. (1986a) The Bornean species of the stonefly genus *Neoperla* (Plecoptera: Perlidae). *Aquatic Insects*, 8, 1–53.
Zwick, P. (1986b) Contribution to the knowledge of *Phanoperla* Banks, 1938 (Plecoptera: Perlidae). *Bulletin de la Societe Entomologique Suisse*, 59, 151–154.
Zwick, P. (1988) Species of *Neoperla* from the Southeast Asian mainland (Plecoptera: Perlidae). *Entomologica Scandinavica*., 18, 393–407.
Zwick, P. & Sivec, I. (1980) Beitrage zur Kenntnis der Plecoptera des Himalaja. *Entomologica Basiliensia*, 5, 118–120.
Zwick, P. & Sivec, I. (1985) Supplements to the Perlidae (Plecoptera) of Sumatra. *Spixiana*, 8, 123–133.