

NEW SPECIES OF APHELOCHEIRUS (*HETEROPTERA*: *APHELOCHEIRIDAE*) FROM THAILAND

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ABSTRACT

Three new species of *Aphelocheirus* from Thailand are described herein. *Aphelocheirus tessellatus* and *Aphelocheirus siriphumus* were collected from streams on Doi Inthanon in Chiang Mai Province and *Aphelocheirus kra* was collected from two localities in Nakhon Si Thammarat Province at the southern end of the Isthmus of Kra. In addition, *Aphelocheirus jendeki* Zettel is reported from Doi Inthanon and Doi Suthep, and previously was known only from China and Vietnam. This brings the number of described species of *Aphelocheirus* reported from Thailand to 15.

Key words: Insecta, Heteroptera, Aphelocheiridae, Naucoridae, *Aphelocheirus*, Thailand, new species

INTRODUCTION

Aphelocheirids are predacious aquatic insects (Heteroptera: Aphelocheiridae) and are common inhabitants of gravel riffles in streams of the Old World. These insects are considered to be generalist predators, although specialization on mollusks has been suggested (POLHEMUS & POLHEMUS, 1989). The family is represented by a single genus, *Aphelocheirus*, with 80 species currently described (see SITES & ZETTEL, 2005, and citations therein). *Aphelocheirus* reaches its greatest taxonomic richness in tropical Asia, and Indochina in particular. Currently, 11 species are known from Thailand. Described herein are three additional species from Thailand and a range extension of a species previously known only from southern China and Vietnam. Thus, this brings the number of described species known from Thailand to 15 and the world to 83.

MATERIALS AND METHODS

Collecting was conducted in cooperation with the Faculty of Agriculture, Kasetsart University, Bangkok; Faculty of Science, Chiang Mai University, Chiang Mai; Faculty of Natural Resources, Prince of Songkla University, Hat Yai; and the Royal Forestry Department, Bangkok, Thailand.

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SYSTEMATICS

Aphelocheirus kra sp. n.

(Figs. 1, 5a, 6a–e, 7)

Type Material

Holotype, macropterous male and **Allotype, macropterous female**.—THAILAND: Nakhon Si Thammarat Province, Tambon Krung Ching, Klong Nob, 08° 44' N 99° 39' E; 89 m, 16 June 2004, Sites, Vitheepradit, Prommi, L-772.

Paratypes.—9 macropterous males, 5 macropterous females, same data as primary types; 7 macropterous males, 5 macropterous females, same locality as primary types, 18 June 2004, L-778; 1 macropterous male, 4 macropterous females, same locality as primary types, 26 May 2003, Vitheepradit & Ferro, L-570; 4 macropterous males, 3 macropterous females, 1 nymph, Tambon Krung Ching, Klong Krai, 08° 47.387' N 99° 38.695' E, 80 m, 18 June 2004, Sites, Vitheepradit, Prommi, L-779.

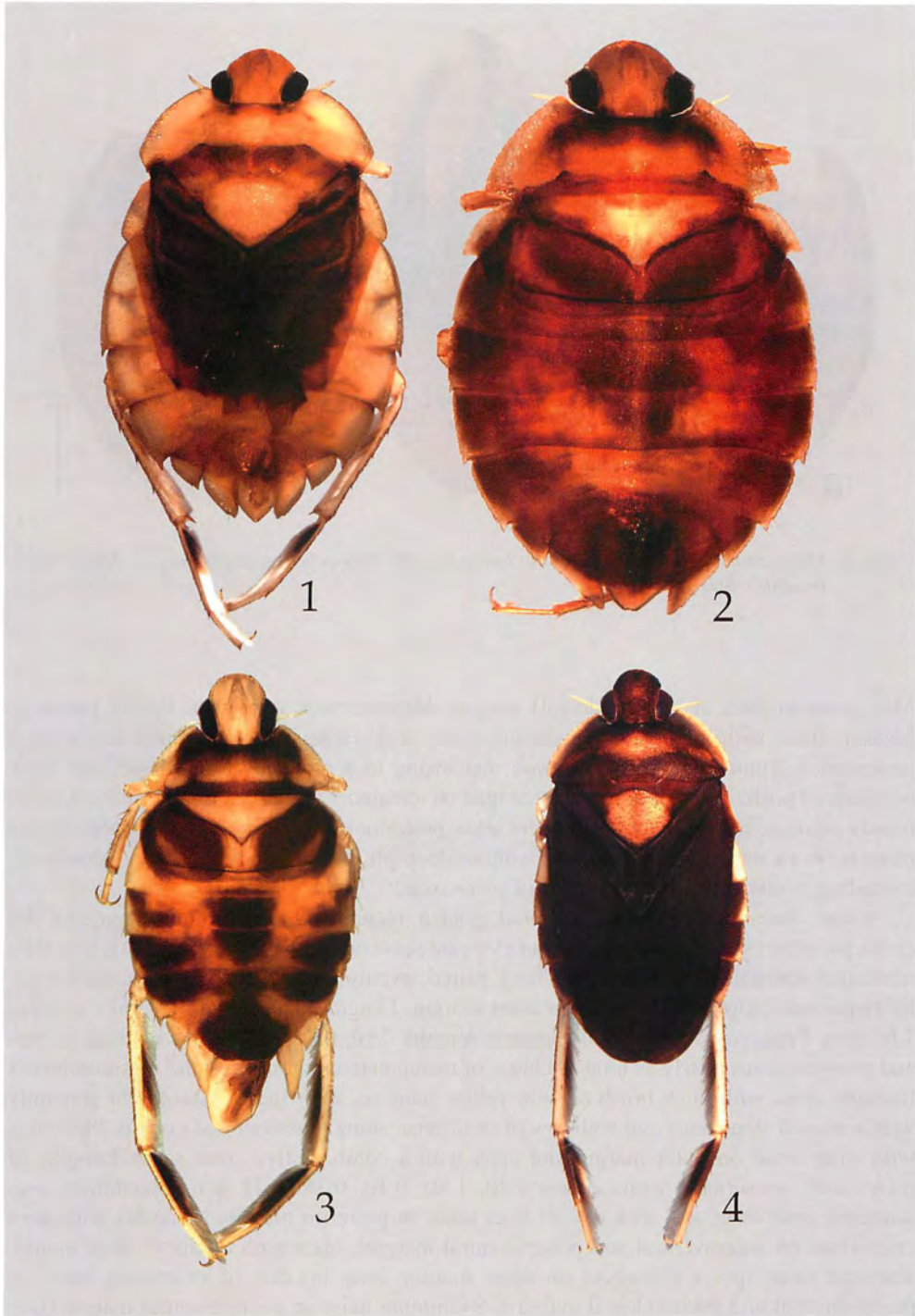
Description**Macropterous male**

Size (n=10): Length, \bar{y} = 9.19 mm; range = 8.96–9.54 mm. Width: \bar{y} = 6.03 mm; range = 5.98–6.14 mm. Maximum width across abdominal segment 3.

Overall appearance: Elongate ovate (Fig. 1), flattened. Dorsally, mostly yellow with dark brown wings. Ventrally, yellowish, dark longitudinal marking laterally on meso- and metathorax.

Head: Mostly yellowish-orange, with thin grayish-brown line with elongate punctures at posterior margin paralleling anterior margin of pronotum (can be retracted within pronotum). Head glabrous, coarsely punctate. Greatest width at anterolateral corners of eyes, 1.88 mm. Head length 1.92 mm. **Eyes** black, divergent anteriorly, lateral margins nearly straight. Interocular distance between anteromedial corners of eyes 1.36 mm, between posteromedial corners of eyes 0.86 mm. Eye length 1.12 mm. Head extends anteriorly in front of eyes 0.48 mm. Ventrally, yellowish and slightly darker anteriorly. Antennae pale, 4-segmented. Ratio of antennal segment lengths: 3-8-15-21. Beak yellowish orange, darker in distal half, shining, attaining middle of mesocoxae (not including protruding stylets). Ratio of 3 visible beak segment lengths: 3-61-16.

Thorax: Pronotum yellowish anteriorly and orangish brown posteriorly where pronotum overlaps mesonotum, narrow darker band along anterior margin abutting head; coarsely punctate; sparse, recumbent setae throughout and 7–12 peglike setae along lateral margin; posterolateral corner angled and nearly straight; posterior margin shallowly concave medially. Pronotum width 4.59, length 1.27 mm. Mesoscutum medium brown. Scutellum swollen, yellow, heavily punctate. Scutellum length 1.39 mm, width 1.97 mm. Hemelytra medium brown, appearing darker where overlapping dark coloration of terga beneath; sparse recumbent setae especially evident laterally; corium dull, heavily punctate; membrane faintly shining; clavus and embolium clearly delineated; claval vein evident; distal angle of embolium rounded; hemelytra broken distally at level of 5th tergum. Hindwings fully developed and folded beneath hemelytra. Terga visible lateral to wings. Prosternum acutely carinate. Propleuron yellowish laterally, yellowish-brown medially. Inner margin of propleuron with notch ~60 degrees, posteromedial corner curved to blunt point (Fig. 6a).



Figures 1–4. Dorsal habitus of (1) *Aphelocheirus kra*, (2) *Aphelocheirus siriphumus*, (3) *Aphelocheirus tessellatus* brachypterous form, (4) *Aphelocheirus tessellatus* macropterous form.



Figure 5. Male genital capsules of (a) *Aphelocheirus kra*, (b) *Aphelocheirus siriphumus*, (c) *Aphelocheirus tessellatus*. Size bar = 0.5 mm.

Mesepimeron dark at lateral (dorsal) margin. Mesosternum yellowish, lightly pruinose. Mesosternum with scattered, recumbent setae; with large, well-developed mid-ventral tumescence. Tumescence broad at base, narrowing to a rounded carina, becoming more pronounced posteriorly; setae more dense than on remainder of mesosternum. Metepisternum mostly pruinose with scattered recumbent setae, posterior margin weakly sinuate. Metasternal plate between meso- and metacoxae without deep pit, posterior apex broadly acuminate, extending posteriorly to anterior 1/5 of metacoxae.

Legs: Pale yellow. Sparse, scattered, golden, recumbent setae on most segments. All coxae pruinose, with dense row of stout elongate setae on mesoapical margin. All legs with trochanter through tarsus shining. Claws paired, evenly curved, tips dark orange-brown. Profemur with row of long setae on outer margin. Length of profemur 1.98 mm, protibia 1.68 mm. Protarsus 3-segmented, segment lengths 0.10, 0.30, 0.32 mm. Arolium of pro- and mesopretarsus nearly as long as claws, of metapretarsus short. Pro- and mesotrochanter through tarsus with thick brush of light yellow hairs on inner faces. Mesofemur generally with scattered stout setae and with row of stout setae along posterodorsal margin. Mesotibia with stout setae on outer margin and apex with a comb of five stout setae. Lengths of mesofemur, mesotibia, 3 tarsomeres 2.20, 1.80, 0.10, 0.36, 0.42 mm. Metafemur with scattered stout setae, and with row of stout setae on posterior margin. Metatibia with stout erect setae on anteroventral and posteroventral margins, apex with circling of stout spines, scattered stout spines elsewhere on outer margin, long brushes of swimming hairs on posteroventral and posterodorsal margins. Swimming hairs on posteroventral margin pale, on posterodorsal margin dark in basal third, pale in distal 2/3. Tarsal segments with both series of swimming hairs continuing from metatibia. Swimming hairs of tarsal segment 2

on posteroventral margin pale, on posterodorsal margin dark in basal third, pale in distal 2/3; both series pale on tarsal segment 3. Tarsi with scattered stout setae on outer margin; segment 1 inconspicuous; 2 long, twice length of segment 3. Lengths of metafemur, metatibia, tarsomeres 2 and 3: 2.87, 3.08, 1.80, 0.80 mm.

Abdomen: Perimeter mesad to narrowly beneath margins of wings yellow, remainder of terga beneath wings dark brown. Anterolateral corners of terga with slight fumosity. Terga pruinose throughout; scattered recumbent setae on areas of tergum exposed beyond wings; trichobothria laterally on segments 3–7. Abdominal scent gland openings on posterior margin of tergum 3, 1/7-distance to lateral margin from midline. Posterolateral corner of segment 2 produced, 3–6 spinose, 7 elongate and bluntly pointed. Lateral margins of 3–7 with peglike setae. Posterior margin of tergum 5 asymmetrical with rounded notch on left side. Parameres visible through tergum 5. Ventrally, with sparsely scattered, pale, recumbent setae throughout. Sterna yellow, slightly darker medially on sterna 6–8, anterolateral corners, and posteromesal margin of connexivum 7. Sterna generally pruinose throughout. Hydrostatic sensory organ 3/4 distance from mesal end of sternum 2 to lateral margin. Spiracular rosettes on sterna 2–6 2/3 distance from midline to lateral margin. Midline of sternum 3 with weakly developed, posteroventrally directed knob (sometimes absent). Midline of sternum 3 with 0–1 dark peglike setae, 3–5 on sternum 4, 4 on 5, 3–4 on 6, and 2 on 7. Posterior margin of sternum 5 asymmetrical, deeply concave to left of midline. Posterior margin of sterna 6 and 7 convex, sternum 8 concave posteriorly. Genital capsule light yellow, slightly asymmetrical and drawn to left posteriorly, apex bluntly pointed.

Genitalia: Pygophore with apical processes between parameres asymmetrical and short, left process ca. 1/3 length of left paramere, right process ca. 1/4 length of right paramere; left process with mesal margin explanate over base of right process; right process with apex of mesal margin produced mesad to rounded point, lateral margin rounded; lateral margins of both processes with short, peglike setae (Fig. 6b). Left paramere with apical third broadly reflexed entad; lateral margin broadly concave; faintly rastate on underside extending to mesal surface in distal third; short setae beneath in distal 1/5 and scattered on lateral surface (Figs. 5a, 6c). Right paramere lanceolate; gently curving mesad and entad; brush of elongate setae on distal half of lateral surface; faintly rastate knob on mesal surface immediately below three distinct ridges that articulate with peglike setae of pygophore (Figs. 5a, 6d). Aedeagus with right side broadly, weakly concave; apex sharply deflexed ventrad and to left (Fig. 6b).

Macropterous female

Size (n=10): Length, \bar{y} = 9.35 mm; range = 9.05–9.71 mm. Width: \bar{y} = 6.10 mm; range = 5.89–6.31 mm. Maximum width across abdominal segment 3.

Coloration and setation: Similar as for male. Posterior margin of tergum 5 nearly straight in middle third. Posterior margin of tergum 6 produced to broadly rounded lobe at midline. Exposed portions of connexiva 7 as broad as long. Ventrally, coloration same as male except subgenital plate yellow in basal 1/4, orangish yellow in distal 3/4. Subgenital plate broadly triangular; sides nearly straight, gradually converging to broadly-rounded point (Fig. 6e); width 1.34, length 1.20, with lateral trichobothria 1/2 distance from base to apex, recumbent setae throughout, row of 2–3 peglike setae and group of long, stout setae just basad of apex. Sterna 7 yellow, lateral margin straight but serrate to accommodate 4–5 peglike setae, last peglike seta usually multiple and with trichobothria; anterolateral

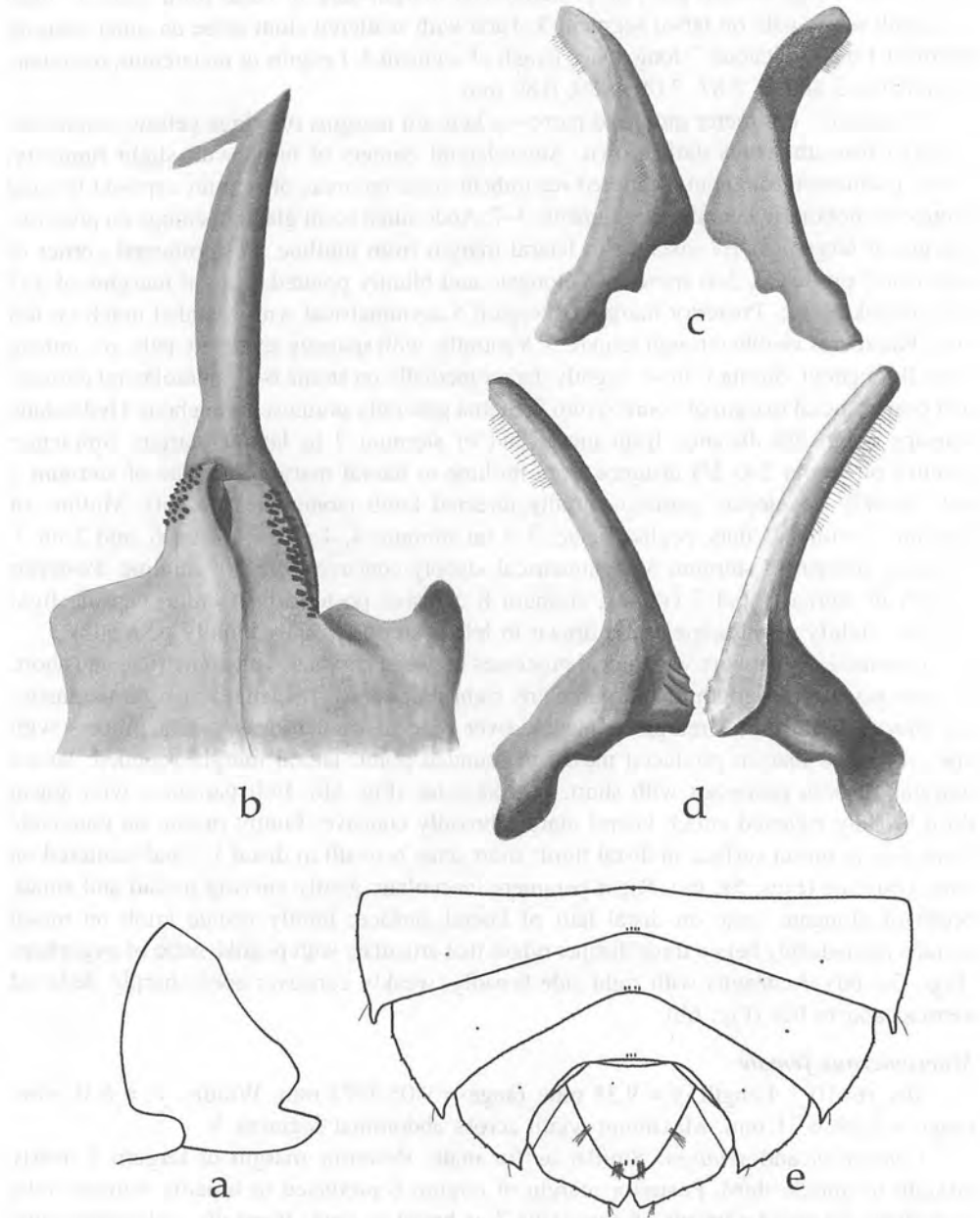


Figure 6. *Aphelocheirus kra*. (a) Posteromedial apex of propleuron (b) aedeagus and apex of pygophore, (c) lateral (left) and medial (right) aspects of left paramere, (d) medial (left) and lateral (right) aspects of right paramere, (e) female subgenital plate. Structure sizes are not relative to one another among lettered figures: See Fig. 5a for size relations among male genitalic components.

notch broadly rounded, not sharply angled; posteromedial angles bluntly-pointed, separated by v-shaped cleft. Midline of sterna 4–6 each with 3–4 peglike setae.

Brachypterous form

Unknown.

Disposition of specimens

The holotype, allotype, and some paratypes are deposited in the Enns Entomology Museum, University of Missouri-Columbia, U.S.A.; and additional paratypes in the National Science Museum, Pathum Thani, Thailand; Kasetsart University, Bangkok, Thailand; Prince of Songkla University, Hat Yai, Thailand; Naturhistorisches Museum - Vienna, Austria; Smithsonian Institution, Washington, D.C., U.S.A.; and the J. T. Polhemus collection, Englewood, Colorado, U.S.A.

Etymology

The specific epithet "*kra*" is a noun in apposition referring to the Isthmus of Kra, at the southern end of which this species is known to occur.

Habitat description

The type locality was a shallow, clear stream with a substratum of sand and small rocks. At three of the collections (L-570, -778, -779), current velocity ranged from 80.7 to 97.7 cm/sec and temperature ranged from 29 to 30° C. This species occurred in sand in very shallow riffles (ca. 3–10 cm depth). At site L-779, *A. kra* was collected with specimens of *A. grik* Polhemus and Polhemus and *A. femoratus* Polhemus and Polhemus. Photographs of the type locality, and other localities (identified as L-numbers) at which this species was collected, are available in a Locality Image Database via a link from the internet site of the Enns Entomology Museum, University of Missouri-Columbia.

Diagnosis and comparative notes

This species can be distinguished from other macropterous congeners in the region by the predominantly yellow coloration and distinctive male genitalic features. The male genitalia have parameres that are substantially more elongate than the apical processes of the pygophore, which is a similar feature to those of several species from Australia, Celebes, Borneo, and Papua New Guinea (e.g., *A. australicus* Usinger, *A. pallens* Horvath) and to *A. lao* Polhemus and Polhemus. *Aphelocheirus kra* is considered to be closely related to *A. carinatus* Royer from Vietnam, but differences in the parameres are diagnostic (H. Zettel, pers. comm.). Further, although the genitalic structure of *A. kra* is also similar to that of *A. lao*, it may be distinguished by somatic characters, including a much shorter length of head anterior to the eye, lighter coloration, smaller degree of angle of the propleural notch, and smaller body length/width ratio. Specimens of *A. kra* will key to *A. celebensis* in POLHEMUS & POLHEMUS (1989), which is known only from the southwestern peninsula of Celebes.

A distinctly different color pattern is observed in live specimens (Fig. 7) compared to that of specimens that have been in alcohol for as little as 15 seconds. Although the description above is based on preserved specimens, live specimens have white lateral margins of the pronotum, distinctly patterned hemelytra, and more distinctly patterned terga with pale lateral margins. Whether the maintenance of a plastron for respiration,

for which this genus is known (THORPE & CRISP 1947 a, b, c), is responsible for the pronounced color difference in live specimens is not known. Further, these insects were observed in the field to burrow into the sand, and when at rest, the hindlegs frequently were brought up to a position on the abdominal terga. Both of these behaviors, although principally the actions of the hind legs, likely account for the destruction of the apices of the hemelytra in all observed specimens.

Aphelocheirus siriphumus sp. n.

(Figs. 2, 5b, 8a–f)

Type material

Holotype, male.—THAILAND: Chiang Mai Province, Doi Inthanon National Park, gravel & rocks below Siriphum Waterfall at Ban Khun Khlung, 18°32' N 98°31' E, elev. 1380 m, 15 November 2001, R. W. Sites, L-248.

Allotype, female.—Same locality as holotype, 16 October 2002, CMU team; *Paratypes*: 1 male, same locality as primary types, 5 July 2002, CMU team; 1 female, same locality as primary types, 21 March 2002, R. W. Sites, L-314.

Description

Brachypterous male

Size (n=2): Length, 9.96–10.29 mm. Width, 6.31–6.39 mm. Maximum width across abdominal segment 3.

Overall appearance: Ovate (Fig. 2), moderately flattened. Dorsally, mostly yellow head and thorax, mottling of medium brown infuscation on wings and abdominal terga. Ventrally, yellowish brown, darker medially on sterna 6–8.

Head: Mostly yellowish with medium brown marking in posterolateral corners immediately posterior to eyes. Head glabrous, coarsely punctate; greatest width at anterolateral corners of eyes, 2.24 mm. Head length 2.30 mm. Eyes black, divergent anteriorly, lateral margins clearly sinuate with concavity in anterolateral 1/3. Interocular distance between anteromedial corners of eyes 1.64 mm, between posteromedial corners of eyes 1.15 mm. Eye length 1.26 mm. Head extends anteriorly in front of eyes 0.60 mm. Ventrally, yellowish. Antennae pale, 4-segmented. Ratio of antennal segment lengths: 5-13-17-26. Beak yellowish in basal quarter, orange-brown distad, shining, attaining middle of metacoxae (not including protruding stylets). Ratio of 3 visible beak segment lengths: 3-72-26.

Thorax: Pronotum yellowish with anterior margin dark brown adjacent to head; broad, arcuate, fuscous band parallelling anterior margin to lateral 1/4 (absent in male paratype); apparent dark band along posterior margin where pronotum overlaps mesoscutellum; coarsely rugose; sparse peglike setae throughout and 10–12 peglike setae along lateral margins; angle of posterolateral concavity evenly rounded; posterior margin generally straight, with posteriorly rounded production 1/5 distance from lateral margin to midline; pronotum width 5.15 mm, length 1.34 mm. Scutellum yellowish; slight brown infuscation on anterior margin at midline, posterolateral margins at middle (absent in male paratype); coarsely rugose; anterior margin straight, posterior apex acuminate; scutellum length 1.72 mm, width 3.48 mm. Wings rugose, medium brown with yellowish embolium; lateral margin evenly convex; wings narrowly separated at midline; distance of separation, 0.18 mm;



Figure 7. Photograph of male *Aphelocheirus kra* on natural substrate showing coloration of live specimen and cryptic resemblance to substrate.

extending posteriorly to half width of tergum 2. Wing width 3.28 mm, length 1.97 mm (length measured from lateral corner of scutellum directly posteriorly). Prosternum acutely carinate. Propleuron yellow brown. Inner margin of propleuron with notch ~ 90 degrees, posteromedial corner sharply acuminate (Fig. 8a). Mesepimeron and mesosternum yellowish, sparsely covered with recumbent setae. Mesosternum with large, well-developed mid-ventral tumescence. Tumescence broad at base, narrowing to a rounded carina, becoming more pronounced posteriorly; profile view with small anterior knob, angling posteroventrally $\sim 45^\circ$ from longitudinal axis of body (Fig. 8b); posterior surface of tumescence with dorsoventral carina causing posteriormost tip to appear acuminate in ventral view; surface of tumescence finely setose; tumescence length 0.76 mm. Metepisternum mostly pruinose with scattered recumbent setae. Metasternal plate between meso- and metacoxae yellow; posterior apex acuminate, extending posteriorly to anterior 1/4 of metacoxae.

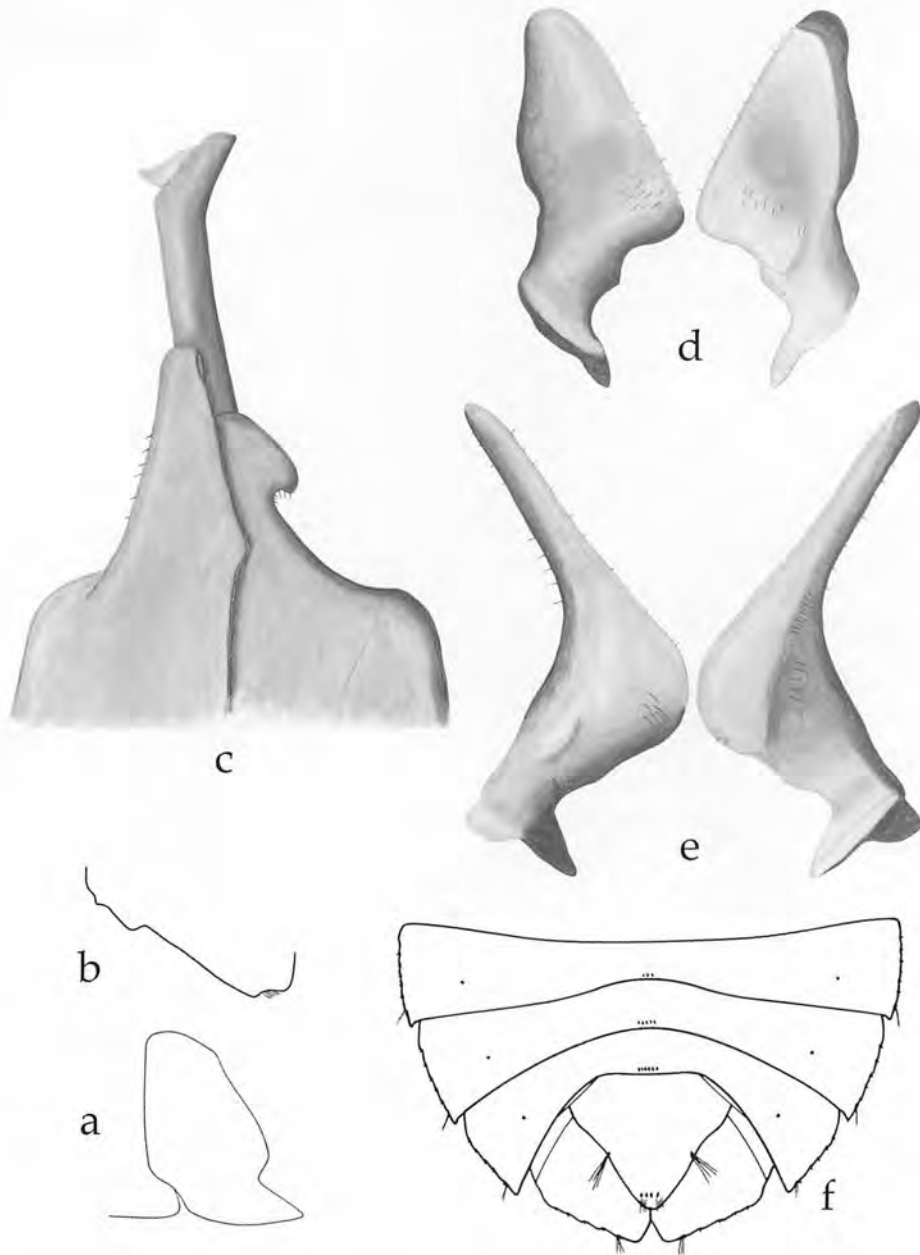


Figure 8. *Aphelocheirus siriphumus*. (a) Posteromedial apex of propleuron, (b) profile of mesosternal carina, (c) aedeagus and apex of pygophore, (d) lateral (left) and medial (right) aspects of left paramere, (e) medial (left) and lateral (right) aspects of right paramere, (f) female subgenital plate. Structure sizes are not relative to one another among lettered figures: See Fig. 5b for size relations among male genitalic components.

Legs: Yellowish; sparse, scattered, pale, recumbent setae on most segments. Mesal surface of all coxae pruinose; lateral surface shining, with dense row of stout elongate setae on mesoapical margin. All legs with trochanter through tarsus shining. Claws paired, dark yellow, gently curved, tips orange-brown. Profemur with row of long, pale setae on outer margin. Length of profemur 2.38 mm, protibia 2.09 mm. Protarsus 3-segmented, segment lengths 0.12, 0.33, 0.45 mm. Arolium of pro- and mesopretarsus nearly as long as claws, of metapretarsus short. Pro- and mesotrochanter through tarsus with thick brush of light yellow setae on inner faces. Mesotibia with stout setae on outer margin and apex with comb of 4-5 stout setae. Lengths of mesofemur, mesotibia, 3 tarsomeres 2.42, 1.97, 0.16, 0.45, 0.49 mm. Meso- and metafemora with scattered, stout setae throughout. Metatibia with stout erect setae on anteroventral and posteroventral margins, apex with circlet of stout spines, scattered stout spines elsewhere on outer margin, long brushes of pale swimming hairs on posteroventral and posterodorsal margins. Tarsal segments with both series of swimming hairs continuing from metatibia, hairs dark basally on segment 2, pale on segment 3, scattered stout setae on outer margin. Tarsal segment 1 inconspicuous; 2 long, nearly twice length of segment 3. Lengths of metafemur, metatibia, tarsomeres 2 and 3: 3.07, 3.48, 1.84, 1.02 mm.

Abdomen: Medium brown mottled with yellowish. Yellowish area mostly medially on terga 4 and 5. Terga rugose throughout. Scattered recumbent setae and sparse, short, peglike setae throughout; trichobothria laterally on segments 3-7. Abdominal scent gland openings evident as concave inflections of posterior margin of tergum 3, 1/3-distance to lateral margin from midline. Posterolateral corner of segment 2 squared, 3 acuminate, 4-6 with progressively larger broadly triangular spines, 7 elongate and bluntly pointed. Ventrally, with scattered recumbent setae throughout. Yellowish to yellow-brown throughout with a dark brown area medially on sterna 5-8. Mesal margin of connexivum 7 dark brown. Sterna generally pruinose throughout. Hydrostatic sensory organ 4/5 distance from mesal end of sternum 2 to lateral margin. Spiracular rosettes on sterna 2-6 3/4 distance from midline to lateral margin. Sternum 2 with lateral margin evenly rounded. Midline of sternum 3 without distinct posteroventrally directed knob, but with 2 dark peglike setae. Midline of sternum 4 with series of 4 dark peglike setae, 6-7 on sternum 5, 7 on 6, and 6 on 7. Posterior margin of sternum 5 asymmetrical, deeply concave to left of midline. Posterior margin of sternum 6 with pronounced rounded lobe immediately to left of midline. Sternum 7 with posterior margin broadly produced at midline. Sternum 8 slightly concave posteriorly. Genital capsule light yellow; asymmetrical, produced to left; apex shallowly notched.

Genitalia: Pygophore with apical processes between parameres asymmetrical, with apex of left process bluntly rounded, mesal surface excavate beneath to accommodate right apical process of pygophore; right apical process shorter, strongly hooked on lateral margin, with stiff, short setae (Fig. 8c). Left paramere with mesal surface acetabular to accommodate left apical process of pygophore (Figs. 5b, 8d). Right paramere lanceolate, gently curved mesad, apex bluntly pointed, with brush of setae 1/3 distance from base to apex on lateral surface (Figs. 5b, 8e). Aedeagus straight, with distinct 30° angle to right distally (Fig. 8c), apex deflexed ventrad and slightly to left.

Brachypterous female

Size (n=2): Length, 10.29 mm. Width, 6.64-6.72 mm. Maximum width across abdominal segment 3.

Coloration and setation generally same as for male, except yellowish abdominal areas are paired on either side of the midline on terga 3–6. Coloration ventrally mostly yellowish throughout. Subgenital plate dark brown with yellowish band across anterior margin; broadly triangular; sides shallowly concave, gradually converging to broadly-rounded point (Fig. 8f); width 2.00 mm, length 1.58 mm; with lateral trichobothria 1/2 distance from base to apex; recumbent setae throughout; row of 6 peglike setae and group of long, stout setae just basad of apex. Sterna 7 with lateral margin straight but serrate to accommodate 6 peglike setae; posteromedial angles bluntly-pointed, separated by v-shaped cleft. Posterior margins of sternum 5 evenly concave and 6 convex in middle third. Midline of sternum 3 with weakly developed, posteroventrally directed knob; sternum 4 with 3 peglike setae; 5 and 6 each with 6 peglike setae.

Macropterous form

Unknown.

Disposition of specimens

The holotype, allotype, and female paratype are deposited in the Enns Entomology Museum, University of Missouri–Columbia, U.S.A. The male paratype is in the Smithsonian Institution, Washington, D.C., U.S.A.

Etymology

This species is named for Siriphum Waterfall, the gravelly stream below in which all specimens were collected. In Thai, Siriphum is a combination of the names of the queen (Queen Sirikit) and king (King Bhumibhon) of Thailand.

Habitat description

The type locality was a shallow (ca. 0.3 m maximum depth), clear, swiftly-flowing stream with a substratum of large rocks and gravel riffles. The riparian area was heavily wooded on one side, with a banana plantation on the other side. The canopy was closed above the stream. Two of the collections were taken as part of a larger project concerning water quality and the aquatic insect community. As a consequence, detailed physical and chemical conditions are available. The following are data for physicochemical features at the type locality for the 5 July and 16 October 2002 collections, respectively: Air temp 21.0, 19.5°C; water temp 19.0, 18.0°C; stream width 2.7, 4.2 m; max depth 0.27, 0.52 m; current velocity 0.98, 1.04 m/sec; discharge 0.137, 0.197 m³/sec; turbidity 8.0, 4.0 mg/l; pH 7.3, 8.6; conductivity 30.4, 17.8 μ S; total dissolved solids 14.8, 8.9 mg/l; alkalinity 15.0, 9.5 mg/l; dissolved oxygen 7.9, 8.9 mg/l; biological oxygen demand 0.60, 0.35 mg/l; ammonia 0.25, 0.22 mg/l; nitrate 0.1, 1.3 mg/l; orthophosphate 0.05, 0.09 mg/l. Photographs of the type locality in November 2001 and March 2002 (identified as L-248 and L-314, respectively) are available in a Locality Image Database via a link from the internet site of the Enns Entomology Museum, University of Missouri-Columbia.

Diagnosis and comparative notes

This species is relatively large for the genus, and is the largest of the many species of *Aphelocheirus* found at Doi Inthanon and elsewhere in northern Thailand. For the genus, *A. siriphumus* is relatively robust dorsoventrally, rather than strongly flattened as are many congeners, and can also be distinguished by its mostly yellow head and notum, and brown mottled with yellow abdomen and wings. The hook on the right apical process of the male

pygophore is diagnostic. The female paratype is inconsistent with the description because it has wings that are asymmetrical and apparently malformed. At the type locality, *A. siriphumus* co-occured with the congeners *A. monthathanus* Sites and Zettel, *A. lahu* Polhemus and Polhemus, *A. jendeki* Zettel, *A. femoratus*, and *A. tesselatus* Sites (described herein), as well as with naucorid taxa including *Gestroiella limnocoroides* Montandon, *Cheirochela* sp., and *Heleocoris* sp. Because of the weak development of the posteromedian knob on sternum 3, *A. siriphumus* will key to either *A. kinabalu* or *A. philippinensis* in POLHEMUS & POLHEMUS (1989), which are known only from northern Borneo and the Philippines, respectively. *Aphelocheirus siriphumus* is uncommon and has not been collected anywhere other than at the type locality despite widespread, monthly sampling at a series of sites on Doi Inthanon and Doi Suthep. Only a single specimen was collected on each of four occasions, thus, only four specimens are known.

***Aphelocheirus tesselatus* sp. n.**

(Figs. 3–4, 5c, 9a–f)

Type material

Holotype, male and **Allotype, female**: THAILAND : Chiang Mai Province, Doi Inthanon National Park, Mae Klang River at Ecologde, 18° 32' N, 98° 32' E, 1000 m, 2 May 2003, UMC and CMU teams, L-494; **Paratypes**: 11 male, 4 female brachypterous, same data as primary types; 17 male, 4 female brachypterous, 23 nymphs, same locality as primary types, 8 May 2002, L-399; 16 male, 12 female brachypterous, 4 male, 8 female macropterous, 31 nymphs, same locality data as primary types, 4 April 2002, L-324.

Additional material examined

THAILAND: Chiang Mai Province: 2 female brachypterous, same data as primary types, 9 June 2002; 3 male, 2 female brachypterous, same data, 7 July 2002; 1 female brachypterous, same data, 10 August 2002; 1 male, 1 female brachypterous, same data, 22 September 2002; 1 male brachypterous, same data, 6 October 2002; 1 female brachypterous, same data, 13 November 2002; 1 female brachypterous, same data, 7 December 2002; 1 male, 2 female brachypterous, same data, 13 January 2003; 1 male brachypterous, same data, 15 February 2003; 1 female brachypterous, same data, 13 March 2003; 1 male, 1 female brachypterous, same data, 2 April 2003, L-437; 1 female macropterous, Doi Inthanon National Park, Siriphum Waterfall, 18° 32' N, 98° 31' E, 1460 m, 5 July 2002, CMU team; 1 male macropterous, Doi Inthanon National Park, Huai Sai Luang, gravel stream below waterfall, 18° 31' N, 98° 27' E, 1060 m, 8 May 2002, UMC & CMU teams, L-396; 1 male brachypterous, same data, 11 August 2002; 1 male, 1 female brachypterous, same data, 14 November 2002; 1 male, 2 female brachypterous, same data, 7 December 2002; 1 male brachypterous, same data, 14 March 2003; 1 male brachypterous, Doi Inthanon National Park, Mae Pan Noi at Ban San Pathana, 18° 31' N, 98° 25' E, 750 m, gravel in bedrock stream, 7 May 2002, UMC and CMU teams, L-393; 3 male brachypterous, same data, 7 July 2002; 1 female brachypterous, same data, 7 December 2002; 4 male, 3 female brachypterous, Doi Suthep-Pui National Park, Monthathan Waterfall, 18° 49' N, 98° 55' E, 700 m, 5 May 2002, gravel, L-403; 1 male brachypterous, same data, 6 June 2002; 1 male brachypterous, same data, 24 September 2002; 1 male brachypterous, same data, 16 November 2002; 1 male brachypterous, same data, 14 January 2003; 1 male brachypterous,

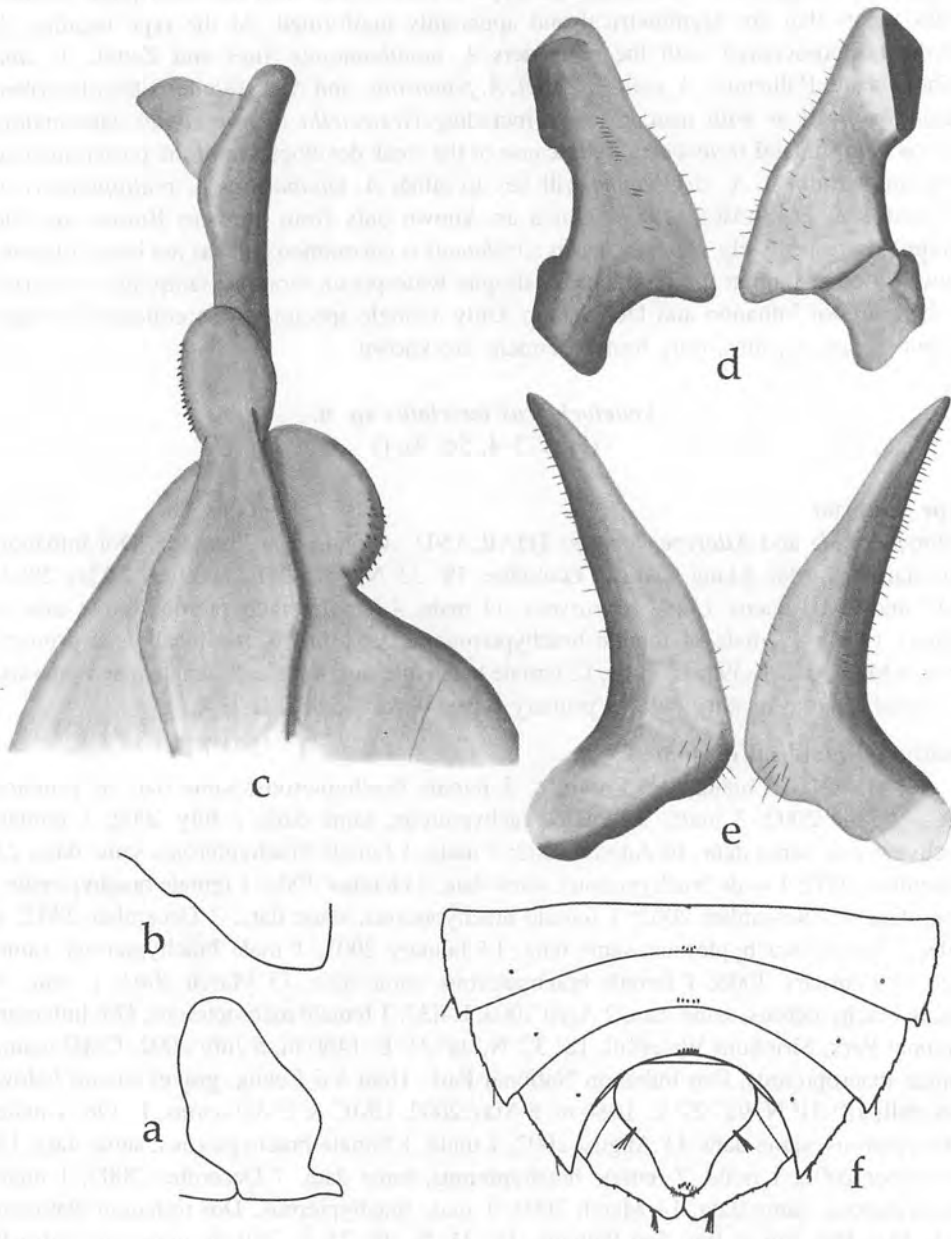


Figure 9. *Aphelocheirus tesselatus*. (a) Posteromedial apex of propleuron, (b) profile of mesosternal carina, (c) aedeagus and apex of pygophore, (d) lateral (left) and medial (right) aspects of left paramere, (e) medial (left) and lateral (right) aspects of right paramere, (f) female subgenital plate. Structure sizes are not relative to one another among lettered figures: See Fig. 5c for size relations among male genitalic components.

same data, 14 February 2003; 1 male brachypterous, same data, 12 March 2003; 1 female brachypterous, same data, 23 April 2003; 1 male macropterous, Doi Suthep–Pui National Park, Pa Ngerb, 18° 48' N, 98° 56' E, gravel in stream, 530 m, 29 March 2003, CMU team.

Description

Brachypterous male

Size (n=10): Length, \bar{y} = 8.45 mm; range = 7.64–8.80 mm. Width: \bar{y} = 4.62 mm; range = 4.48–4.90 mm. Maximum width across abdominal segment 3.

Overall appearance: Elongate ovate (Fig. 3), flattened. Dorsally, mostly yellowish brown with large, dark brown maculations creating checkered appearance. Ventrally, yellowish brown, slightly darker laterally on sterna 4, 5.

Head: Mostly yellowish with light brown triangular marking in posterolateral corners extending to slightly anterior to posteromedian corners of eyes. Usually with faint light brown longitudinal marking on midline between posterolateral markings. Head glabrous, coarsely punctate. Greatest width at anterolateral corners of eyes, 1.70 mm. Head length 1.56 mm. Eyes black, divergent anteriorly, lateral margins clearly sinuate with concavity in anterolateral 1/3. Interocular distance between anteromedial corners of eyes 1.15 mm, between posteromedial corners of eyes 0.82 mm. Eye length 0.92 mm. Head extends anteriorly in front of eyes 0.50 mm. Ventrally, yellowish with dark infuscation in posterolateral concavity where pronotum abuts head. Antennae yellowish, 4-segmented. Ratio of antennal segment lengths: 4-11-16-20. Beak yellowish orange, shining, attaining middle of mesocoxae (not including protruding stylets). Ratio of 3 visible beak segment lengths: 3-50-15.

Thorax: Pronotum yellowish in middle with dark brown marking along anterior margin extending almost to anterolateral point, especially broad posterolateral to eye. Posterior margin with dark band extending to lateral margin. Weak confluence of anterior and posterior dark markings halfway from midline to lateral margin. Coarsely rugose. Sparse, recumbent setae throughout and 11–13 peglike setae along lateral margins. Angle of posterolateral concavity evenly rounded. Pronotum width 3.81 mm, length 1.07 mm. Scutellum entirely yellowish, coarsely rugose. Anterior margin broadly, shallowly concave and nearly straight, posterior apex acuminate. Scutellum length 1.19 mm, width 2.75 mm. Wings dark brown with yellowish tips at midline, and oblique yellowish coloration extending anterolaterally from posterior margin. Embolium yellow on lateral margin, with lateral margin evenly convex. Wings narrowly separated at midline, distance of separation variable, 0.29–0.45 mm. Wings rugose, extending posteriorly to anterior one-third of tergum 2. Wing width 2.12 mm, length 1.64 mm (length measured from lateral corner of scutellum directly posteriorly). Prosternum acutely carinate. Propleuron yellow brown, medium brown along anterior margin; inner margin with notch ~90 degrees; posteromedial corner variable from acuminate to slightly curved, digitate (Fig. 9a). Mesepimeron and mesosternum yellowish, pruinose. Mesosternum with large, well-developed mid-ventral tumescence. Tumescence broad at base, narrowing to a rounded carina, becoming more pronounced posteriorly; profile view with anterior margin straight, angling posteroventrally 30–45° from longitudinal axis of body, ventral margin of tumescence only finely irregular (Fig. 9b), posteroventral corner broadly rounded, pruinose throughout, devoid of hairs. Tumescence length 0.22–0.26 mm. Metepisternum mostly pruinose with scattered recumbent setae, posterior margin convex and weakly sinuate. Metasternal plate between meso- and metacoxae

without deep pit, posterior apex extending posteriorly to anterior 1/7 of metacoxae.

Legs: Light yellow. Sparse, scattered, pale, recumbent setae on most segments. All coxae pruinose, with dense row of stout elongate setae on mesoapical margin. All legs with trochanter through tarsus shining. Claws paired, evenly curved, distal 1/3 dark orange-brown. Profemur with row of long setae on outer margin. Length of profemur 1.74 mm, protibia 1.62 mm. Protarsus 3-segmented, segment lengths 0.12, 0.32, 0.38 mm. Arolium of pro- and mesopretarsus nearly as long as claws, of metapretarsus short. Pro- and mesotrochanter through tarsus with thick brush of light yellow setae on inner faces. Mesotibia with stout setae on outer margin and apex with a comb of 4-5 stout setae. Lengths of mesofemur, mesotibia, 3 tarsomeres 1.86, 1.56, 0.18, 0.30, 0.40 mm. Meso- and metafemora with scattered, stout setae and pale recumbent setae throughout. Metatibia with stout erect setae on anteroventral and posteroventral margins, apex with cirlet of stout spines, scattered stout spines elsewhere on outer margin, long brushes of swimming hairs on posteroventral and posterodorsal margins. Swimming hairs on posteroventral margin pale, on posterodorsal margin dark in middle third, pale otherwise. Tarsal segments with both series of swimming hairs continuing from metatibia, both series dark on segment 2, pale on segment 3, scattered stout setae on outer margin. Tarsal segment 1 inconspicuous; 2 long, twice length of segment 3. Lengths of metafemur, metatibia, tarsomeres 2 and 3: 2.38, 2.95, 1.72, 0.86 mm.

Abdomen: Yellow with four, large, dark-brown patches creating checkered appearance; patches laterally on terga 4-5, on midline of terga 2-4 and 5. Weak dark-brown maculation laterally on tergum 3 corresponding with those of 4-5. Terga rugose throughout. Scattered recumbent setae throughout, and trichobothria laterally on segments 3-7. Abdominal scent gland openings evident as concave inflections of posterior margin, of tergum 3, 1/4-distance to lateral margin from midline. Posterior margin of tergum 3 curving anteriorly immediately laterad of scent gland opening. Posterolateral corner of segment 2 squared, 3-5 acuminate, 6 broadly triangular, 7 elongate and bluntly pointed. Ventrally, with scattered recumbent setae throughout. Yellowish to yellow-brown throughout with broad dark brown area laterally and anterolaterally on sterna 4-5 and weaker corresponding dark brown areas on sternum 3. Mesal margin of connexivum 7 dark brown. Sterna generally pruinose throughout. Hydrostatic sensory organ 3/4 distance from mesal end of sternum 2 to lateral margin. Spiracular rosettes on sterna 2-6 3/4 distance from midline to lateral margin. Sternum 2 with lateral margin evenly rounded. Midline of sternum 3 with distinct posteroventrally directed knob. Midline of sternum 4 with series of 2-4 dark peglike setae, 5 on sternum 5, 5-6 on 6, and 4 on 7. Posterior margin of sternum 5 deeply concave to left of midline (asymmetrically) so that series of stout setae on posterior margin of 5 oriented in semicircle or penellipse. Posterior margin of sternum 6 sometimes with rounded lobe immediately to left of midline. Sternum 7 distinctly convex or acuminate posteriorly. Connexiva of 7 asymmetrical, with right more slender and elongate than left. Sternum 8 straight or slightly concave posteriorly. Genital capsule pale yellow, asymmetrical, produced to left side, apex rounded.

Genitalia: Pygophore with apical processes between parameres asymmetrical; left process extending forward of right process as rounded lobe, lateral margin with stiff, short setae; right apical process shorter, a semicircular lobe, straight medially and rounded laterally, posterior half of lateral margin with stiff, short setae (Fig. 9c). Left paramere with lateral margin broadly concave, surface rounded with scattered setae; mesal surface subtly

acetabular to accommodate left apical process of pygophore; apex sharply margined on mesal and lateral corners, flattened beneath (Figs. 5c, 9d). Right paramere lanceolate, with row of scattered setae beneath (Figs. 5c, 9e). Aedeagus with right side broadly concave in apical half, apex deflexed ventrad and to left (Fig. 9c).

Brachypterous female

Size (n=10): Length, \bar{y} = 8.42 mm; range = 7.80–8.71 mm. Width: \bar{y} = 4.83 mm; range = 4.65–4.98 mm. Maximum width across abdominal segment 3.

Coloration similar as for male, but with expansion of dark brown patches dorsally so that patches attain various degrees of confluence. Setation generally same as for male. Tergum 6 entirely dark brown except for yellow posterolateral corners, posterior margin convex medially. Connexiva 7 dorsally with anterior dark brown coloration. Ventrally dark brown coloration variable, but extends further anteriorly and posteriorly than in male. Subgenital plate generally yellowish brown, sometimes with brown infuscation in posterior 3/4; broadly triangular; sides shallowly concave, gradually converging to broadly-rounded point (Fig. 9f); width 1.43 mm, length 1.23 mm; with lateral trichobothria 1/2 distance from base to apex; recumbent setae throughout; row of 4–5 peglike setae and group of long, stout setae just basad of apex. Sterna 7 light brown with dark brown along mesal margin; lateral margin straight but serrate to accommodate 4–5 peglike setae, last peglike seta usually triplet; anterolateral notch broadly rounded; posteromedial angles bluntly pointed, separated by v-shaped cleft. Posterior margins of sternum 5 evenly concave and 6 concave to slightly convex at midline. Midline of sternum 4 with 3–4 peglike setae, sternum 5 with 4–6, and 6 with 5–6.

Macropterous male

Size (n=4): Length, \bar{y} = 8.69 mm; range = 8.63–8.80 mm. Width, \bar{y} = 4.46 mm; range = 4.32–4.65 mm. Maximum width across abdominal segment 3.

Similar to brachypterous form with following differences: Overall body shape slightly more elongate (Fig. 4). Head more elongate, dark brown with yellow brown area at midline between eyes. Pronotum more massive, posterior third dark brown, posterolateral corners less incised; scutellum swollen, yellow with lateral corners medium brown, heavily punctate; mesoscutum medium brown, distinguished from scutellum by posteriorly convex suture, nearly completely subtending pronotum. Hemelytra dark brown; corium and embolium dull, heavily punctate; membrane faintly shining; clavus shining, clearly delineated, claval vein evident; embolium clearly defined; terga visible lateral to wings, yellow laterally, medium brown medially, width of yellow variable and sometimes restricted to posterolateral corners; wings fully developed, reaching approximately to tip of abdomen; embolar margin produced to a narrowly-rounded point, shallowly concave anterior to point. Ventral surface generally medium brown, lighter mesad.

Macropterous female

Size (n=8): Length, \bar{y} = 8.62 mm; range = 8.47–8.96 mm. Width: \bar{y} = 4.60 mm; range = 4.48–4.81 mm. Maximum width across abdominal segment 3.

Differences from brachypterous female similar to those of macropterous male from brachypterous male. Additionally, ventral surface of subgenital plate usually medium brown throughout distal 3/4, but if not, then with medium brown concentrated at lateral margins and midline.

Disposition of specimens

The holotype, allotype, and some paratypes are deposited in the Enns Entomology Museum, University of Missouri-Columbia, U.S.A, and additional brachypterous and macropterous paratypes in the National Science Museum, Pathum Thani, Thailand; Kasetsart University, Bangkok, Thailand; Naturhistorisches Museum-Vienna, Austria; Smithsonian Institution, Washington, D.C., U.S.A.; and the J. T. Polhemus collection, Englewood, Colorado, U.S.A.

Etymology

This species is named "*tesselatus*" for the checkered appearance of strongly contrasting yellow with dark brown markings on the dorsum of the brachypterous form.

Habitat description

On 2 May 2003 (L-494), the type specimens were collected from small gravel in a clear, swiftly-flowing stream with a substratum of large rocks and exposed bedrock with extensive gravel riffles. The water was 20°C, current velocity in unobstructed flow was 119 cm/sec, and the deepest pools were ca. 0.75 m deep. The margins were heavily vegetated and provided a nearly closed canopy above the stream. Sixteen other collections from four localities were taken as part of a larger project concerning water quality and the aquatic insect community [Huai Sai Luang (6), Mae Pan Noi (2), Monthathan (7), and Siriphum (1)]. Detailed physical and chemical conditions are presented for those collections (Table 1). Photographs of the type locality, and other localities (identified as L-numbers) in which this species was collected, are available in a Locality Image Database via a link from the internet site of the Enns Entomology Museum, University of Missouri-Columbia.

Diagnosis and comparative notes

This species can be recognized immediately in the brachypterous form by its distinctly checkered appearance of boldly contrasting yellow with dark brown. A slightly smaller species, *A. monthathanus*, with which *A. tessellatus* co-occured at Huai Sai Luang, Mae Pan Noi, Monthathan, Pa Ngerb, and Siriphum also has wings that do not meet at the midline and a similar color pattern. They differ in that the contrast in color pattern is much less pronounced and the overall color saturation more subdued in *A. monthathanus*, resulting in a more subtle pattern. Macropterous individuals of *A. tessellatus* can be distinguished from those of *A. monthathanus* by an entirely dark embolium and narrow pale marginal stripe on each tergum which gradually widens posteriorly on each segment (the dark brown coloration can encroach upon and obliterate the pale markings on the terga). Whereas, in *A. monthathanus*, the embolium is largely pale anteriorly, and the pale marginal area laterally on each tergum is restricted to a patch in the posterolateral third. The male genitalia are quite different in that *A. tessellatus* has rounded apical lobes of the pygophore, whereas *A. monthathanus* has angulate apical lobes. Although this species is somewhat small for the genus, it clearly belongs to the subgenus *Aphelocheirus*, rather than to the diminutive *Micraphelocheirus*. Because of the erect, peglike setae of sternum 5 and posteromedian knob on sternum 3, *A. tessellatus* will key to *A. kinabalu* in POLHEMUS & POLHEMUS (1989), which is known only from northern Borneo.

Table 1. Physicochemical variables associated with collections of *A. tessellatus*. Ranges are given for three collecting sites, and only a single value for Siriphum because *A. tessellatus* was collected there on only one date. See Material Examined for specific dates for each locality.

Variable	Huai Sai Luang	Mae Pan Noi	Monthathan	Siriphum
air temp (°C)	19.5–25.0	23.0–24.0	18.0–26.0	21.0
water temp (°C)	17.0–20.0	20.0–22.0	17.6–22.8	19.0
stream width (m)	3.3–8.6	6.7–7.1	2.8–5.3	2.7
max depth (m)	0.36–0.66	0.55–0.77	0.14–0.31	0.27
current velocity (cm/sec)	51–115	76–104	54–132	98
discharge (m ³ /sec)	0.09–0.54	0.27–0.35	0.05–0.28	0.14
turbidity (mg/l)	10–31	11–40	7–39	8
pH	6.5–8.6	7.2–7.4	6.8–8.4	7.3
conductivity (µS)	11.2–23.0	40.4–46.7	30.8–37.8	30.4
total dissolved solids (mg/l)	5.6–11.6	20.2–23.2	15.2–18.8	14.8
alkalinity (mg/l)	6.5–10.5	19.2–24.5	14.0–17.5	15.0
dissolved oxygen (mg/l)	7.1–9.2	8.0–9.1	6.9–8.8	7.9
biological oxygen demand (mg/l)	0.2–3.4	0.2–1.1	0.4–5.2	0.6
ammonia (mg/l)	0.17–0.36	0.19–0.34	0.08–0.43	0.25
nitrate (mg/l)	0.8–1.3	0.2–1.2	0.5–1.3	0.1
orthophosphate (mg/l)	0.05–0.46	0.05–0.07	0.04–0.28	0.05

Aphelocheirus jendeki Zettel

Aphelocheirus jendeki Zettel, 1998: 83–84.

Aphelocheirus jendeki Zettel: 2001, 2–4 (description of macropterous forms).

Material examined (all brachypterous)

THAILAND: Chiang Mai Province: 1 male, 1 female, Doi Inthanon National Park, gravel & rocks below Siriphum Waterfall at Ban Khun Khlang, 18° 32' N, 98° 31' E, elev. 1380 m, 15 November 2001, R. W. Sites, L-248; 3 males, 5 females, same locality, 16 February 2003, P. Thamsenanupap; 10 males, 14 females, Doi Inthanon National Park, Siriphum Waterfall, level 2, gravel, elev. 1460 m, 21 March 2002, R. W. Sites, L-314; 2 females, Doi Inthanon National Park, Mae Klang River at Ecolodge, gravel, 18° 32' N, 98° 32' E, 1000 m, 16 February 2003, CMU team; 1 male, same locality, 8 December 2002; 2 males, 5 females, Doi Inthanon National Park, Mae Pan Noi at Ban San Pathana, 18° 31' N, 98° 25' E, 750 m, gravel in bedrock stream, 8 July 2002, CMU team; 2 males, 2 females, Doi Inthanon National Park, Mae Pan River at Ban Mae Chaem, 18° 31' N, 98° 23' E, 540 m, gravel, March 2003, CMU team; 2 females, Doi Suthep-Pui National Park, Pa Ngerb, 18° 48' N, 98° 56' E, gravel in stream, 530 m, 1 March 2003, CMU team; 3 females, same data, 30 March 2003.

Distributional notes

The brachypterous form of *A. jendeki* was described from specimens from Yunnan Province in China (ZETTEL, 1998). Subsequently, it was collected in Vietnam and the

macropterous form was described (ZETTEL, 2001). This species was collected in both Doi Inthanon and Doi Suthep–Pui National Parks in three watersheds (Mae Pan, Mae Klang, Huai Kaew). These collections represent the first records of *A. jendeki* in Thailand and extend the known range of this species substantially to the south and west.

DISCUSSION

The insect fauna, including that of *Aphelocheirus*, of the mountains in Chiang Mai Province, particularly of Doi Inthanon and Doi Suthep, is taxonomically rich, and the discovery of additional undescribed species of *Aphelocheirus* can be expected in this region. Descriptions of species presented here and in SITES & ZETTEL (2005) necessitate modification of existing taxonomic keys and a review or revision of the genus from the region. Further, recent collections have produced many records of a large form of *A. femoratus* from throughout the northern region of Thailand. The male genitalia deviate only very slightly in the left paramere and left apical process of the pygophore from the much smaller individuals found in southern Thailand (Songkhla to Phang Nga and Nakhon Si Thammarat provinces). However, intermediate expression of the male genitalia in individuals from Prachuap Kiri Khan and Kanchanaburi provinces suggests that the differences might be clinal. Further investigation of the taxonomic status of the northern populations is warranted.

The fauna of *Aphelocheirus* at Doi Inthanon is especially rich in part because it represents the nexus of overlapping distribution patterns and provides high elevation continuity with similar habitats further to the north, west, and south. For example, *A. jendeki* extends northward and eastward to Yunnan Province of China and to Vietnam. The ranges of other species, such as *A. brevirostris* Polhemus & Polhemus, *A. fang* Polhemus & Polhemus, and *A. lahu* extend westward and northward, and *A. femoratus* extends southward along the mountain spine to Malaysia. Further adding to the uniqueness of the fauna, *A. monthathanus*, *A. tesselatus*, and *A. siriphumus* are apparently endemic to Doi Inthanon and Doi Suthep. Thus, this area supports the most diverse assemblage of species of *Aphelocheirus* known in Southeast Asia.

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