

## THE MAYFLY GENERA (EPHEMEROPTERA) OF SOUTHERN THAILAND

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### ABSTRACT

In January 1995 and July 1997, the southernmost 10 provinces of Thailand were surveyed for their mayfly fauna. Fifty-two morphospecies representing 28 genera and 13 families were collected from waterfalls, streams, and ponds. Twelve genera are reported for the first time from Thailand. An annotated list and illustrated taxonomic key of the genera are presented.

Key words: aquatic, Ephemeroptera, fauna, Insecta, mayfly, Thailand

### INTRODUCTION

Tropical peninsular Thailand is topographically diverse with many mountain ranges and associated waterfalls and streams. These numerous aquatic systems as well as vegetated ponds harbor a diverse aquatic insect fauna. The composition of lotic insect communities in southern Thailand is shaped in part by natural biogeographic distributions as well as by disturbances from a variety of natural and anthropogenic origins. Scouring monsoons occur primarily from October through December (NUTTONSON, 1963); however, rainfall occurs throughout the year with an average of approximately 240 cm per year (ARBHABHIRAMA ET AL., 1988), and a recorded high of 660 cm (PENDLETON, 1962). Most streams of peninsular Thailand have their origins in the forested mountains. Although extensive deforestation occurred in the 1970s and 1980s, resulting in the removal of riparian vegetation, the government banned commercial logging in 1989, affording greater protection for these aquatic systems and associated organisms. In addition, use of streams for personal hygiene and for the disposal of acids during the commercial production of rubber contributes to the presence or absence of particular members of the aquatic insect community.

Water quality is an environmental issue receiving increasing consideration in Thailand. Because the aquatic insect fauna can be used as an inexpensive means of monitoring for aquatic perturbations, a great many indices have been developed to exploit the relative sensitivities or tolerances of higher taxa to contamination (see RESH & JACKSON, 1993). Larvae of Chironomidae (Diptera) are generally regarded as tolerant of aquatic perturbations and have been investigated for their potential use as indicators of water quality in Thailand (MUSTOW ET AL., 1997). Ephemeroptera constitutes an order of aquatic insects which is

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used widely as a taxon generally sensitive to most types of aquatic perturbations. Further, this order represents an important component of the trophic web of aquatic systems, particularly as providing a food source for fish.

Recently, Thai scientists have undertaken a series of studies investigating domestic biodiversity, which has been promulgated in part by funding initiatives by the Thai government. These projects include inventories as well as studies of ecological diversity, although a fundamental, preliminary documentation of the native fauna of aquatic and other insect taxa generally is lacking. In the only published study focusing on the regional fauna of a taxon of aquatic insects in southern Thailand, SITES *ET AL.* (1997) provided details regarding the taxonomy and distribution of Naucoridae (Heteroptera). Although most treatments of Asian Ephemeroptera are of taxonomic focus, several faunal lists are available for regions of South and Southeast Asia, including Bangla Desh, Bhutan, Burma, India, Nepal, Pakistan, Sikkim, Sri Lanka (HUBBARD & PETERS, 1978), Hong Kong (HUBBARD, 1986), and the Philippine Islands (HUBBARD & PESCADOR, 1978). UÉNO (1961) and GOSE (1969) published limited information about Thai mayflies. Keys to the genera of aquatic insects of tropical Asia were given by DUDGEON (1999), although this excellent reference is limited to the lotic fauna. In a series of papers addressing aquatic ecological questions in southern Thailand, as many as nine families of mayflies were reported (WATANASIT, 1995, 1996; WATANASIT & JAROONWATANA, 1997), although finer taxonomic resolution was not given. Further, in a taxonomic list of insect species of southern Thailand (CHINAJARIYAWONG *ET AL.*, 1986), no mayflies were included.

Biological and ecological research generally is more meaningful with increased taxonomic resolution. Presently, published information concerning the mayfly fauna of southern Thailand is scattered at best, and community level research requiring generic or specific levels of identification is not easily possible. Thus, to establish a baseline understanding of the mayfly fauna of this region, we present an annotated list of genera and illustrated taxonomic key of the mayflies presently known from southern Thailand. This paper is intended as a taxonomic primer from which additional research on mayfly taxonomy, biology, biogeography, and ecology, or use as biological indicators will benefit. We realize that this paper is only a starting point and fully anticipate that availability of this paper will stimulate research not previously possible and that additional mayfly taxa will be discovered in southern Thailand.

## FIELD COLLECTIONS

Forty-eight collections were made in the southernmost 10 provinces of Thailand (Nakhon Si Thammarat, Narathiwat, Pattani, Phang Nga, Phattalung, Phuket, Satun, Songkhla, Trang, Yala), including in national parks (NP), wildlife sanctuaries (WS), and wildlife management stations (WMS) with permission. Because of political instability, collecting was not conducted in extreme southeastern Narathiwat Province. This area is mountainous with waterfalls and streams, and holds promise as harboring taxa not included herein. Our sampling emphasized lotic (stream) habitats. Collecting was conducted with an aquatic D-net. In streams, the substrate was kick-sampled, allowing the current to carry organic debris, including insects, into the net. Waterfalls were sampled by scouring the rock surfaces by hand, allowing the current to carry insects into the net. Along stream margins and in

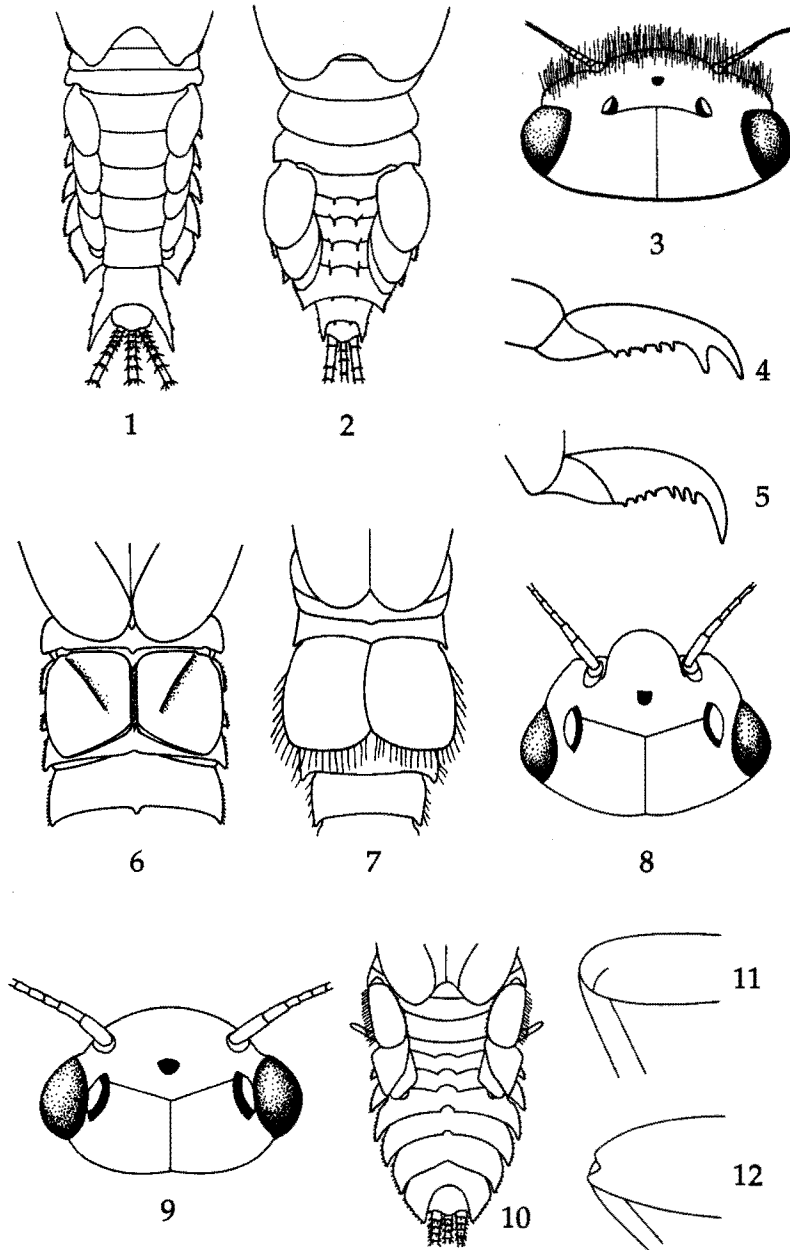
ponds, vegetation was swept with the D-net. All insects were placed into 80% ethyl alcohol. In addition, research and teaching collections maintained by colleagues at Prince of Songkla University, Hat Yai, Thailand, were examined.

Mayfly nymphs are particularly fragile because the gills and terminal filaments detach from the body or break very easily. Therefore, when possible, series of specimens should be collected maximize the likelihood of obtaining intact specimens and accurate determinations. To minimize damage to specimens, it is best to collect mayflies into containers separate from other aquatic insects. Voucher specimens have been deposited in the museums of the Department of Pest Management, Faculty of Natural Resources, Prince of Songkla University (PSU), Hat Yai, Thailand; Royal Thai Agriculture Department, Bangkok, Thailand; and the Enns Entomology Museum, University of Missouri, Columbia, Missouri. Although we collected many more taxa than expected from the region based on the literature, it is quite probable that additional genera exist in southern Thailand. Therefore, this key will require modification in the future if additional genera are discovered. The utility of this key is based on the availability of late-instars because early instars frequently do not exhibit the structural attributes characteristic for mayfly genera.

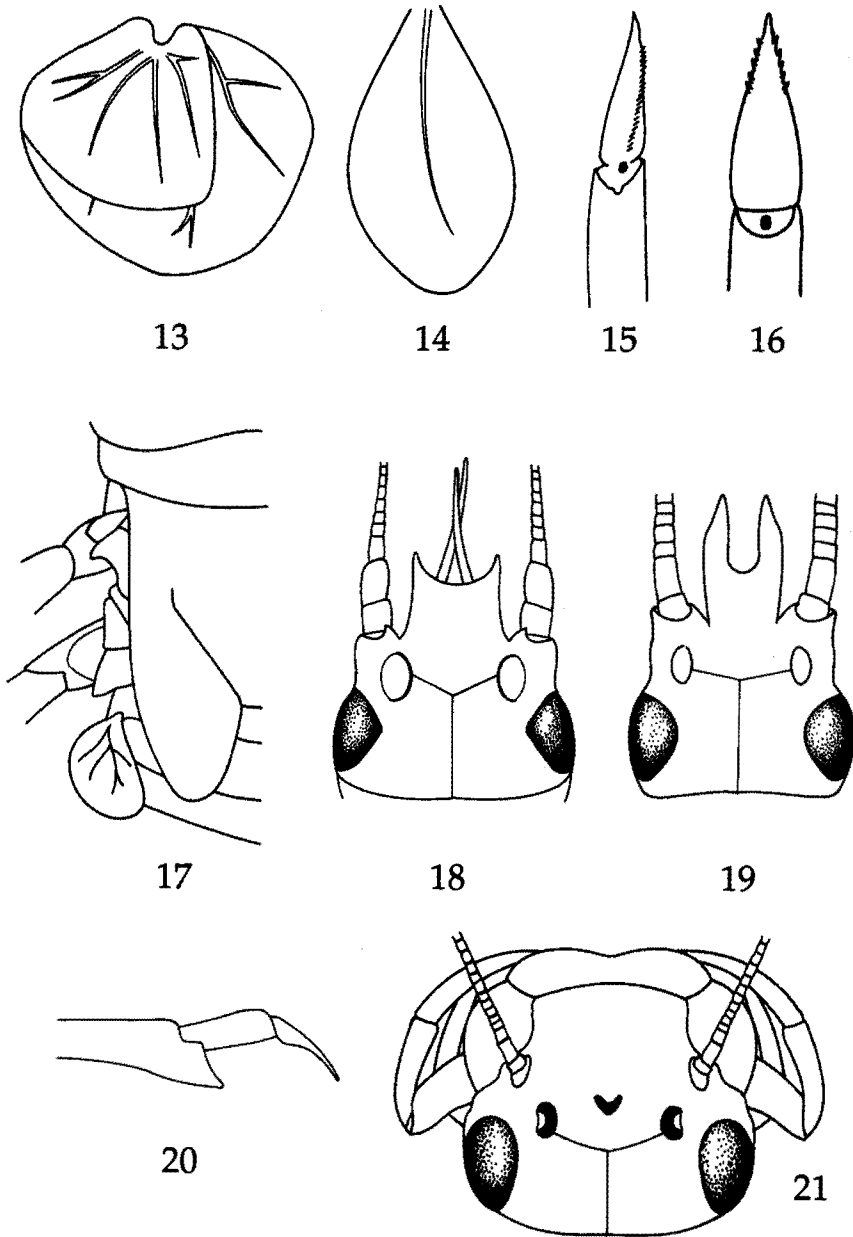
#### KEY TO THE NYMPHS OF FAMILIES AND GENERA OF EPHEMEROPTERA OF SOUTHERN THAILAND

1. Form beetle-like with enlarged, rounded, convex mesonotum that covers remainder of thorax and anterior abdominal segments; length of body excluding terminal filaments  $\leq 5$ mm (**Prosopistomatidae**).....*Prosopistoma*
- 1'. Form mayfly-like, without enlarged mesonotum; size variable .....2
2. Gills absent on abdominal segment 2 (Figs. 1, 2) (**Ephemerellidae**).....3
- 2'. Gills present on abdominal segment 2 .....6
3. Head capsule with profusion of long setae on dorsal surface, especially dense anteriorly (Fig. 3); posterolateral projections of abdominal segment 9 extending posteriorly well beyond hind margin of segment 10 (Fig. 1) .....*Crinitella*
- 3'. Head capsule with at most scattered long setae on dorsal surface; posterolateral projections on segment 9 not or scarcely extending posteriorly beyond hind margin of segment 10 (Fig. 2) .....4
4. Tarsal claw with long, subapical denticle, giving a bifid appearance (Fig.4) .....*Teloganopsis*
- 4'. Tarsal claw without long, subapical denticle, although series of shorter denticles present (Fig. 5) .....5
5. Head capsule with scattered elongate setae on vertex; abdominal terga 6-7 with paired posterodorsally directed tubercles on the midline (Fig. 2); setae of median caudal filament erect and subequal in length to the length of the filament segment .....*Serratella*
- 5'. Head capsule with row of distinct spatulate setae along anterior margin; abdominal

- terga without tubercles, although groups of setae may be present; setae of median caudal filament recumbent and 2–3x the length of the filament segment .....*Torleya*
6. Gills on abdominal segment 2 operculate and covering gills of segments 3–5 .....7
- 6'. Gills on abdominal segment 2 not operculate and of same appearance as gills of segments 3–5 .....11
7. Operculate gills of segment 2 nearly meeting, meeting, or overlapping at midline (Figs. 6, 7); gills on abdominal segment 3–5 fringed .....8
- 7'. Operculate gills of segment 2 widely separated; gills on abdominal segment 3–5 not fringed .....10
8. Operculate gills of segment 2 without fringe of setae or spines on posterior margin (Fig. 6); gills on abdominal segment 2–5 double; (**Neophemeridae**) .....*Potamanthellus*
- 8'. Operculate gills of segment 2 with setae or spatulate spines on posterior margin (Fig. 7); gills on abdominal segment 2–5 single; (**Caenidae**) .....9
9. Clypeus with anterior margin produced (Fig. 8); foretibiae with long filtering setae .....*Clypeocaenis*
- 9'. Clypeus with anterior margin not produced (Fig. 9); foretibiae without long filtering setae .....*Caenis*
10. Median caudal filament and cerci present, giving a three-tailed appearance; abdomen wider than notum; posterior margins of abdominal terga 4–6 each with a pair of tubercles, thereby forming mid-dorsal notch (Fig. 10) (**Teloganellidae**) .....*Teloganella*
- 10'. Median caudal filament absent, but cerci present, giving a two-tailed appearance; notum wider than abdomen; posterior margins of abdominal terga 1–10 each with mid-dorsal tubercle (**Teloganodidae**) .....*Teloganodes*
11. Convergent mandibles projecting anteriorly and extending forward subequal to length of head and head without frontal process; lateral margin of mandible with tooth, giving forked appearance; abdominal segments 2–7 with elongate, bilobed, fringed gills (**Potamanthidae**) .....*Rhoenanthus*
- 11'. Mandibles usually much shorter than head, but if elongate and projecting anteriorly, then head with 2-pronged frontal process (Figs. 18, 19); gills variable .....12
12. Frontal sutures extending ventrad to the ocelli; apices of femora with dorsal lobes oriented ventrally and tending to wrap around the ventral lobes (Fig. 11); posterolateral projections (excluding stout bristle) on abdominal segments 7–9 poorly developed and blunt (**Baetidae**) .....13
- 12'. Frontal sutures extending to inner margin of ocelli or dorsad to the ocelli; apices of femora with dorsal lobes distinct from and not wrapping around ventral lobes (Fig. 12); posterolateral projections on abdominal segments 7–9 usually well developed and with pointed apices .....17



Figures 1–12. 1, dorsal aspect of abdomen of *Crinitella permkami*; 2, dorsal aspect of abdomen of *Serratella* sp.; 3, dorsal aspect of head of *Crinitella permkami*; 4, lateral aspect of tarsal claw of *Teloganopsis* sp.; 5, lateral aspect of tarsal claw of *Serratella* sp.; 6, operculate gills of *Potamanthellus* sp.; 7, operculate gills of *Caenis* sp.; 8, dorsal aspect of head of *Clypeocaenis* sp.; 9, dorsal aspect of head of *Caenis* sp.; 10, dorsal aspect of abdomen of *Teloganella* sp.; 11, distal end of femur of *Baetis* sp.; 12, distal end of femur of *Afronurus* sp.



Figures 13–21 13, double abdominal gills of *Cloeon* sp.; 14, single abdominal gill of *Baetis* sp.; 15, ventral aspect of pretarsus of *Baetis* sp.; 16, ventral aspect of pretarsus of *Centropetella* sp.; 17, left side of thorax of *Compsoeuriella* sp. showing supracoxal projections above meso- and metathoracic legs.; 18, dorsal aspect of head of *Ephemera* (*Ephemera*) sp.; 19, dorsal aspect of head of *Ephemera* (*Dicrephmera*) sp.; 20, distal end of mesothoracic leg of *Ephemera* (*Ephemera*) sp.; 21, dorsal aspect of head of *Choroterpides* sp.

13. Abdominal gills of one or more segments double (Fig. 13) .....*Cloeon*  
 13'. Abdominal gills single (Fig. 14) .....14
14. Tibia with dorsal setae nearly as long as or longer than width of tibia; tarsus with single bristle on inner margin 2/3 distance from base to apex (bristle may be broken or inconspicuous) .....15  
 14'. Tibia with dorsal setae (which may be inconspicuous) clearly shorter than width of tibia; tarsus with row of bristles on inner margin .....16
15. Body subcylindrical to slightly flattened; labrum 2/3 as long as wide; interantennal distance more than 3x that of antenna to lateral margin of head capsule .....*Pseudocloeon*  
 15'. Body distinctly dorsoventrally flattened; labrum 1/2 as long as wide; interantennal distance 2x that of antenna to lateral margin of head capsule .....*Platybaetis*
16. Tarsal claws with subapical bristles, but if bristles absent, then tarsal claws with only one row of denticles (Fig. 15) .....*Baetis*  
 16'. Tarsal claws without subapical bristles and usually with two rows of denticles (Fig. 16) .....*Centroptella*
17. Gills of abdominal segments 2-6 each with only one lamella and with underlying filaments .....18  
 17'. Gills of abdominal segments 2-6 each with two lamellae and without underlying filaments .....22
18. Prothoracic femur and tibia with long filtering setae (**Isonychiidae**) .....*Isonychia*  
 18'. Prothoracic femur and tibia without long filtering setae (**Heptageniidae**) .....19
19. Meso- and metaepimeron each with posteriorly-directed supracoxal projections (Fig. 17) .....20  
 19'. Meso- and metaepimera without supracoxal projections .....21
20. Overall color pale-brown with subtle pattern; pronotum concolorous pale brown; terminal filaments with dark bands near middle including parts of at least three segments .....*Thalerosphyrus*  
 20'. Overall color boldly contrasting shades of dark brown, medium brown, and creamy white; pronotum with paired white longitudinal submedian bands; terminal filaments with dark bands near middle including parts of only two segments .....*Compsoneriella*
21. Gills of abdominal segment 1 pointed apically .....*Afronurus*  
 21'. Gills of abdominal segment 1 rounded apically .....*Nixe*
22. Head with mandibular tusks, but if tusks atrophied, then middle segments of cerci short and with dense intersegmental setae, and head with 2-pronged frontal process (Figs. 18, 19) .....23

- 22'. Head without mandibular tusks (**Leptophlebiidae**) .....25
23. Metathoracic tibia produced distally beneath tarsus to form acute process (Fig. 20) (**Ephemeridae**) .....24
- 23'. Metathoracic tibia not produced distally (**Polymitarcyidae**) .....*Povilla*
24. Mandibular tusks well developed; 2-pronged frontal process of head at most as long as wide (Fig. 18) .....*Ephemera (Ephemera)*
- 24'. Mandibular tusks atrophied; 2-pronged frontal process of head approximately twice as long as wide (Fig. 19) .....*Ephemera (Dicrephmera)*
25. Terga of abdominal segments 3–7 extending around to venter to meet sterna ventrolaterally; gills 3–7 ventrolateral; lateral margin of abdominal segments rounded .....*Isca*
- 25'. Terga of abdominal segments 3–7 meeting sterna mid-laterally; gills lateral or dorsolateral; lateral margin of abdominal segments explanate or rounded .....26
26. Maxillary and labial palpi greatly elongated and extending beyond sides of head capsule (Fig. 21) .....*Choroterpides*
- 26'. Maxillary and labial palpi not greatly elongated and usually not extending beyond sides of head capsule .....27
27. Gills of abdominal segment 1 consisting of a single, slender filament and different in structure and size from the double, broad filaments of the middle abdominal segments .....*Choroterpes*
- 27'. Gills of abdominal segment 1 similar in structure and size to those of the middle abdominal segments ..... *Habrophlebiodes*

#### ANNOTATED LIST OF GENERA OF EPHEMEROPTERA OF SOUTHERN THAILAND

In the Material examined sections following the taxa, a locality number (L-#) is given for each collection, most of which have a corresponding photograph of the collecting site in a Locality Image Database available via a link from the internet site of the Enns Entomology Museum, University of Missouri–Columbia. In parentheses following each locality number is the number of specimens examined. All specimens examined were nymphs except specimens of *Povilla*, which were adults. Although we felt confident in some species determinations, the lack of a comprehensive understanding of the Southeast Asian fauna for most families and genera precludes the certainty required for species assignments. Further, it is likely that most species collected were undescribed. Thus, we report only genera and, in the Discussion sections, we mention described species that have been reported from the region in the literature.



Family **Baetidae** Leach, 1815Genus **Baetis** Leach, 1815

**Diagnosis.**—This genus is similar to *Centroptella* in that the abdominal gills have a single lamella and the tibia has dorsal setae that are either shorter than the width of the tibia or a bristle is absent on the inner margin of the tarsus. It differs from *Centroptella* by the tarsal claws which usually have subapical bristles, but if the subapical bristles are absent, then the claws have only one row of denticles. The bristles may be broken off or very difficult to see.

**Discussion.**—Seven morphospecies of *Baetis* were collected from streams throughout southern Thailand from near the Malaysian border north to Nakhon Si Thammarat Province. The genus is common throughout Southeast Asia. Twenty-three species were listed from the Indian Subregion alone by HUBBARD & PETERS (1978). As many as 13 species of *Baetis* have been recorded from western Malaysia (MÜLLER-LIEBENAU, 1984), nine from Hong Kong (HUBBARD, 1986), nine from India (GILLIES, 1949), seven from Sri Lanka (MÜLLER-LIEBENAU & HUBBARD, 1985), four from the Philippines (MÜLLER-LIEBENAU, 1982a), and three from Java and Sumatra (ÜLMER, 1940). This eclectic genus is in need of taxonomic revision and includes species representing a wide range of morphological variation. Thus, the genus is difficult to characterize succinctly.

**Material examined.**—NAKHON SI THAMMARAT Prov.: stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (4); Chawang Rd., ca. 8 km S. of Khao Luang NP, roadside stream, 12-VII-1997, Sites & Permkam, L-139 (3); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (4); PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (1); Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (13); ca. 3 km E Khao Chong WMS on Hwy 4, 12-I-1995, Sites & Nichols L-69 (3); SATUN Prov.: Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (1); SONGKHLA Prov.: Ton Nga Chang WS, 7-VII-1997, R. W. Sites, level 6 of waterfall, L-128 (1); same locality, waterfall levels 2 and 3, 6-I-1995, Sites & Nichols, L-66 (1); Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (6); same locality, 7-I-1995, Sites & Nichols, L-60 (1); Khao Nam Khang NP, ca. 21 km SW Nathawi, 13-I-1995, Sites & Nichols, L-72 (1); TRANG Prov.: Khao Chong WMS stream, 11-VII-1997, Sites & Permkam, L-137 (2).

Genus **Centroptella** Braasch and Soldán, 1980

**Diagnosis.**—This genus is similar to *Baetis* in that the abdominal gills have a single lamella and the tibia has dorsal setae that are shorter than the width of the tibia. It differs from *Baetis* in having tarsal claws without subapical bristles and usually with two rows of denticles.

**Discussion.**—Only one specimen of *Centroptella* was collected and appears to be an undescribed species. Distributions of described congeners from southeast Asia include

China (BRAASCH & SOLDÁN, 1980) and Sri Lanka (MÜLLER-LIEBENAU, 1983). This genus was considered a synonym of *Cloeodes* Traver by WALTZ & MCCAFFERTY (1987). A undescribed species representing a genus near *Centropetella* was recorded from West Malaysia (MÜLLER-LIEBENAU, 1984). The specimen we collected represents the first record of *Centropetella* from Thailand.

**Material examined.**—SONGKHLA Prov.: stream from Ton Plieuw, 8-I-1995, Sites & Nichols, L-64 (1).

#### Genus *Cloeon* Leach, 1815

**Diagnosis.**—This genus may be distinguished from the other genera of Baetidae of southern Thailand by the compound abdominal gills (2 lamellae) on one or more segments, whereas the other genera have gills with only a single lamella.

**Discussion.**—Thirteen species of *Cloeon* were listed from the Indian Subregion (HUBBARD & PETERS, 1978). The genus occurs throughout Southeast Asia including China and Formosa (HUBBARD & PESCADOR, 1978), Hong Kong (HUBBARD, 1986), India (KIMMINS, 1947; GILLIES, 1949; UÉNO, 1969), Java, Sumatra (ULMER, 1940), the Philippines (HUBBARD & PESCADOR, 1978), Sri Lanka (UÉNO, 1969), Taiwan (HUBBARD & PETERS, 1978), and Thailand (UÉNO, 1961, 1969). The known fauna of *Cloeon* of Thailand includes *C. bimaculatum* Eaton from Chiang Mai (UÉNO, 1961) and *C. marginale* Hagen from Bangkok, Chiang Mai (UÉNO, 1961), and Songkhla (UÉNO, 1969). We collected two morphospecies of *Cloeon* from southern Thailand.

**Material examined.**—NARATHIWAT Prov.: Narathiwat experiment station, 16-I-1995, Sites, Nichols, & Permkam, vegetated ponds, L-79 (2); PHANG NGA Prov.: lake at Samanora Park, 3 km E of Muang District, 13-VII-1997, Sites & Permkam, L-141 (2); PHATTALUNG Prov.: Praiwan Waterfall, 3 km W of Ban Phut, 11-VII-1997, Sites & Permkam, pond with vegetation, L-135 (1); SATUN Prov.: Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (1); Thale Ban, 9-VII-1997, Sites & Permkam, large shallow lake w/ emergent vegetation, L-133 (41); SONGKHLA Prov.: PSU campus, Hat Yai, 5-I-1995, Sites & Nichols, vegetated ponds, L-56 (5); same locality, 8-I-1995, L-67 (5); same locality, 8-VII-1997, R. W. Sites, L-129 (50); reservoir at end of stream from Ton Plieuw, 7-I-1995, R. W. Sites, L-61 (2); Ton Nga Chang WS, 7-VII-1997, R. W. Sites, level 6 of waterfall, L-128 (1); same locality, waterfall levels 2 and 3, 6-I-1995, Sites & Nichols, L-66 (1); pond near Sadao, 9-I-1995, Sites & Nichols, L-68 (1); Khu Khut bird sanctuary, 31-I-1995, B. J. Nichols, L-84 (1); TRANG Prov.: Khao Chong WMS stream, 11-VII-1997, Sites & Permkam, L-137 (1); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (1); Than To, experiment station, 14-I-1995, R. W. Sites, vegetated pond, L-74 (1).

#### Genus *Platybaetis* Müller-Liebenau, 1980a

**Diagnosis.**—This genus is similar to *Pseudocloeon* in that the abdominal gills have a single lamella and the tibia has dorsal setae that are longer than the width of the tibia. It

differs from *Pseudocloeon* in that the head capsule is flattened, resembling that of heptageniid mayflies, and the interantennal distance is twice that of the antenna to the lateral margin of the head capsule.

**Discussion.**—The genus *Platybaetis* is widespread throughout the Oriental Region and has been reported from the Nam Chai River in Chiang Mai Province, Thailand (POLHEMUS & POLHEMUS, 1988). Specifically, *Platybaetis edmundsi* MÜLLER-LIEBENAU is known from the Philippines and *P. uenoi* MÜLLER-LIEBENAU from Nepal (MÜLLER-LIEBENAU, 1980a; and see UÉNO, 1955). *Platybaetis bishopi* Müller-Liebenau was described from specimens collected in the River Gombak and tributaries north of Kuala Lumpur, Malaysia (1980b). The habitat of *P. bishopi* at the type locality was characterized as large boulders with smaller rocks, gravel, and sand (MÜLLER-LIEBENAU, 1980a). We (RWS) also have collected *Platybaetis* from the vertical rock faces of waterfalls.

**Material examined.**—SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (6); Ton Plieuw, 7-I-1995, Sites & Nichols, wet rock face of waterfall, L-63 (6); Ton Nga Chang WS, waterfall levels 2 and 3, 6-I-1995, L-66, Sites & Nichols (4); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (2).

#### Genus *Pseudocloeon* Klapálek, 1905

**Diagnosis.**—This genus is similar to *Platybaetis* in that the abdominal gills have a single lamella and the tibia has dorsal setae that are longer than the width of the tibia. It differs from *Platybaetis* in the absence of distinct flattening and the interantennal distance more than 3 times that of the antenna to the lateral margin of the head capsule.

**Discussion.**—In Southeast Asia, this genus has been recorded from the Bismarck Archipelago, (HUBBARD & PESCADOR, 1978), Formosa, Java, (ULMER, 1940), Hong Kong (HUBBARD, 1986), the Philippines, Sumatra (ULMER, 1940; HUBBARD & PESCADOR, 1978), Malaysia, and Sri Lanka (MÜLLER-LIEBENAU, 1982b). In peninsular Malaysia, *Pseudocloeon verum* Müller-Liebenau was described from the River Gombak and tributaries north of Kuala Lumpur (MÜLLER-LIEBENAU, 1984). Our collections represent the first record of the genus *Pseudocloeon* from Thailand.

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S of Khao Luang NP, 12-VII-1997, Sites & Permkam, roadside stream, L-139 (3); stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (21); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, Permkam, L-78 (3); PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (4); Royal Thai Dept. Agric. Propagation Ctr, ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (2); ca. 3 km E Khao Chong WMS on Hwy 4, 12-I-1995, Sites & Nichols, L-69 (2); SATUN Prov.: Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (2); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW Nathawi, 13-I-1995, Sites & Nichols, L-72 (3); Ton Nga Chang WS, waterfall levels 2 and 3, 6-I-1995, Sites & Nichols, L-66 (1); Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (7); TRANG Prov.: Khao

Chong WMS stream, 11-VII-1997, Sites & Permkam, L-137 (2); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (8).

#### Undescribed Genus

**Diagnosis.**—Although this specimen is damaged, it appears quite typical of the *Baetis* complex with a femoral villopore.

**Discussion.**—Only one specimen was collected and no others were found in existing collections.

**Material examined.**—SONGKHLA Prov.: Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (1).

Family **Caenidae** Newman, 1853

Genus **Caenis** Stephens, 1835

**Diagnosis.**—This genus can be distinguished easily from *Clypeocaenis* by the lack of a spatulate clypeal protrusion and the lack of long filtering setae on the foretibiae. Generally, color patterns and the condition of the anterolateral corner of the pronotum are diagnostic for species of *Caenis*.

**Discussion.**—This genus occurs throughout Southeast Asia including Bali, Java, Sumatra (ULMER, 1940), Hong Kong (HUBBARD, 1986), India (KIMMINS, 1947; HUBBARD & PETERS, 1978), the Philippines (ULMER, 1940; HUBBARD & PESCADOR, 1978), and Thailand (UENO, 1961). Specifically, *Caenis nigropunctata* Klapálek has been recorded in Thailand from Chiang Mai (UENO, 1961). We collected six morphospecies of *Caenis* in southern Thailand.

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S of Khao Luang NP, 12-VII-1997, Sites & Permkam, roadside stream, L-139 (3); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (1); Narathiwat experiment station, 16-I-1995, Sites, Nichols, & Permkam, vegetated ponds, L-79 (1); PHATTALUNG Prov.: Royal Thai Dept. Agric. Propagation Center; ca. 3 km E of Khao Chong WMS, 11 -VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (2); PHUKET Prov.: Ton Sai Waterfall, Prataw Wildlife Conservation Unit, 13-VII-1997, Sites & Permkam (1); SATUN Prov.: Wangpachan District, Ton Bliw, 9-VII-1997, Sites & Permkam, rocky & sandy stream, L-131 (1); Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (2); Thale Ban, 9-VII-1997, Sites & Permkam, large shallow lake with emergent vegetation, L-133 (7); SONGKHLA Prov.: PSU campus, Hat Yai, 4-I-1995, Sites & Nichols, vegetated ponds near reservoir, L-55 (3); same locality, 5-I-1995, Sites & Nichols, stream on campus, L-57 (13); same locality, 8-VII-1997, R. W. Sites, L-129 (18); Ton Nga Chang WS, waterfall levels 2 and 3, 6-I-1995, Sites & Nichols, L-66 (2); same locality, level 6 of waterfall, 7-VII-1997, R. W. Sites, L-128 (1); same locality, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (3); TRANG Prov.: Khao Chong WMS stream, 11-VII-1997, Sites & Permkam, L-137 (5); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (3);

Genus *Clypeocaenis* Soldán, 1978

**Diagnosis.**—This genus can be distinguished easily from *Caenis* by the spatulate clypeal protrusion and the long filtering setae on the foretibiae.

**Discussion.**—This genus was described from India and Iran. The species are diagnosed primarily by the number of elongate setae on the anterior margin of the clypeal protrusion. Specifically, *C. bisetosa* Soldán has two setae and *C. multisetosa* has four or more (SOLDÁN, 1978). We collected immatures with various numbers (including zero) of elongate setae on the clypeal protrusion, including three morphospecies syntopically at Ton Nga Chang WS. We suspect that intraspecific variation in the chaetome of the clypeal protrusion in *Clypeocaenis* exists, which would require revision of the genus. The genus has been recorded previously from India, Iran (SOLDÁN, 1978), Vietnam, and Upper Volta (SOLDÁN, 1983). Our collections represent the first record of the genus *Clypeocaenis* from Thailand.

**Material examined.**—SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW Nathawi, 13-I-1995, Sites & Nichols, L-72 (1); Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (6).

Family Ephemerellidae Klapálek, 1909  
Genus *Crinitella* Allen and Edmunds, 1963

**Diagnosis.**—This genus may be recognized from the others presented here by the profusion of elongate setae on the dorsal surface of the head capsule and the posterolateral spines of abdominal segment 9 that extend further posteriorly than the hind margin of segment 10.

**Discussion.**—This genus occurs in riffles of streams with moderate current velocity. Of the five described species, three are known from Pakistan, one from Nepal, and one from Thailand (WANG & SITES, 1999). Specifically, *Crinitella permkami* Wang and Sites was taken in five Thai provinces that extend from Yala Province near the Malaysian border to as far north as Nakhon Si Thammarat Province (WANG & SITES, 1999) and was described from the collections listed below.

**Material examined.**—NAKHON SI THAMMARAT Prov.: stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (3); Chawang Rd., ca. 8 km S. of Khao Luang NP, roadside stream, 12-VII-1997, Sites & Permkam, L-139 (2); PHATTALUNG Prov.: ca. 3 km E Khao Chong WMS on Hwy 4, 12-I-1995, Sites & Nichols, L-69 (1); SATUN Prov.: Wangpachan District, Ton Bliw, 9-VII-1997, Sites & Permkam, rocky & sandy stream, L-131 (1); SONGKHLA Prov.: Ton Nga Chang WS, 6-I-1995, Sites & Nichols, stream at Buddhist temple, L-59 (1); same locality, 7-I-1995, Sites & Nichols, L-60 (3); same locality, 8-I-1995, Sites & Nichols, L-65 (2); same locality, 6-VII-1997, Sites & Permkam, L-127 (45); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (6).

Genus *Serratella* Edmunds, 1959

**Diagnosis.**—This genus is similar to *Torleya* in that the posterolateral spines of abdominal segment 9 do not extend past the hind margin of segment 10 and the tarsal claw does not appear bifid. It differs from *Torleya* by the paired tubercles on the midline of abdominal segments 5-7, and the absence of spatulate setae on the anterior margin of the head capsule.

**Discussion.**—*Serratella* is Holarctic in distribution and uncommonly collected in Asia. The taxonomic status of this genus in Asia needs further research.

**Material examined.**—NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (3); SONGKHLA Prov.: Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (1).

Genus *Teloganopsis* Ulmer, 1939

**Diagnosis.**—This genus is distinctive among the Ephemerellidae of southern Thailand by the elongate subapical denticle of the tarsal claw, which gives the appearance of a bifid tarsal claw. *Serratella*, with which *Teloganopsis* bears a superficial resemblance, has only smaller denticles.

**Discussion.**—*Teloganopsis* frequently has been misidentified as *Serratella* because these genera are very similar morphologically. *Teloganopsis media* Ulmer is the only described species in the genus and was described from specimens from Java and Sumatra (ULMER, 1940). We collected two morphospecies in southern Thailand that differ based on attributes of the dorsal color pattern. Our collections represent the first record of the genus *Teloganopsis* from Thailand.

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S. of Khao Luang NP, roadside stream, 12-VII-1997, Sites & Permkam, L-139 (1); stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (2); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (4); PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (3); Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (1); SONGKHLA Prov.: Ton Nga Chang WS, 6-I-1995, Sites & Nichols, stream at Buddhist temple, L-59 (1); same locality, 6-VII-1997, Sites & Permkam, L-127 (4); stream from Ton Plieuw, 7-I-1995, Sites & Nichols, L-62 (1); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (2).

Genus *Torleya* Lestage, 1917

**Diagnosis.**—This genus is distinctive in that the head capsule has a row of spatulate setae along the anterior margin mesad and laterad of the antennae. This genus may be further distinguished from *Serratella* and *Teloganopsis* by the length of the setae on the median caudal filament and the inner margins of the cerci. In *Torleya*, the setae are

recumbent and approximately 2–3 times the length of the segment with which they are associated, whereas for the other genera, they are erect and approximately the same length as the filament segment.

**Discussion.**—This genus is closely related to *Serratella* and *Hyrtanella* Allen and Edmunds. *Torleya* has been recorded from Europe and Asia (LESTAGE, 1917), including Nepal (HUBBARD & PETERS, 1978). Our collections represent the first record of the genus *Torleya* from Thailand.

**Material examined.**—NAKHON SI THAMMARAT Prov.: stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (8); NARATHIWAT Prov.: stream 14 km W Srisakhon, 15-I-1995, Sites & Nichols, L-77 (1); SATUN Prov.: Wangpachan District, Ton Bliew, 9-VII-1997, Sites & Permkam, rocky & sandy stream, L-131 (1); SONGKHLA Prov.: Ton Nga Chang WS, 8-I-1995, Sites & Nichols, stream at Buddhist temple, L-65 (3); same locality, 6-VII-1997, Sites & Permkam, L-127 (10).

Family **Ephemeridae** Latreille, 1810

Genus ***Ephemera*** Linnaeus, 1758

**Diagnosis.**—This genus has a bifurcate frontal process, distally rounded tibia, and mandibular tusks which may be atrophied in some species. Members of this family are elongate and flexible to allow excavation of, and existence in, U-shaped tunnels in soft sediment in which they undulate to create current to facilitate respiration.

**Discussion.**—This genus occurs throughout southern and Southeast Asia, including Java, Sumatra (ULMER, 1940), Burma, China, Hong Kong, India, Nepal, Pakistan, Sri Lanka, and Taiwan (HUBBARD & PETERS, 1978). In Thailand, the genus has been recorded from the Nam Chai River in Chiang Mai Province (POLHEMUS & POLHEMUS, 1988). More specifically, *Ephemera* (*Dicrephemera*) *siamensis* Uéno was described from Chiang Mai (UÉNO, 1969) and *Ephemera* (*Ephemera*) *javana* Navás was collected at lights at Mae Sae Waterfall in northern Thailand. *Ephemera javana* also has been recorded from Java and Sumatra (UÉNO, 1969). These two species differ based on the development of the mandibular tusks (atrophied in *E. siamensis*) and the width of the two-pronged frontal process of the head (see key). We collected two species in southern Thailand, which may represent the two species mentioned above, syntopically in a silty stream bottom among emergent vegetation near the stream margin at Khao Chong WMS in Trang Province. Current velocity was negligible in this mesohabitat.

**Material examined.**—PATTANI Prov.: Sai Khao, 16-I-1995, Sites & Nichols, L-80 (2); PHATTALUNG Prov.: Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (1); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (2); TRANG Prov.: Khao Chong WMS stream, 11-VII-1997, Sites & Permkam, L-137 (18); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (2).

Family **Heptageniidae** Needham, 1901Genus **Afronurus** Lestage, 1924

**Diagnosis.**—This genus may be distinguished from *Compsoeuriella* and *Thalerosphyrus* by the absence of meso- and metathoracic supracoxal spines. It differs from *Nixe* by the apically pointed gills of abdominal segment 1.

**Discussion.**—This genus has been recorded from Doi Inthanon in northern Thailand, as well as Java (ULMER, 1940; UÉNO, 1961) and the Philippines to the south (UÉNO, 1961) and India to the west (HUBBARD & PETERS, 1978). We collected four morphospecies of *Afronurus* in southern Thailand.

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S of Khao Luang NP, 12-VII-1997, Sites & Permkam, roadside stream, L-139 (1); stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (22); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (2); PHATTALUNG Prov.: Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream w/ algae covered rocks, L-136 (1); SATUN Prov.: Wangpachan District, Ton Bliew, 9-VII-1997, Sites & Permkam, rocky & sandy stream, L-131 (1); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (10); Ton Nga Chang WS, 6-I-1995, Sites & Nichols, stream at Buddhist temple, L-59 (4); same data, 7-I-1995, L-60 (3); same data, 8-I-1995, L-65 (11); same locality, 6-VII-1997, Sites & Permkam, L-127 (205); stream from Ton Plieuw, 8-I-1995, Sites & Nichols, L-64 (2); reservoir at end of stream from Ton Plieuw, 7-I-1995, R. W. Sites, L-61 (1); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (1).

Genus **Compsoeuriella** Ulmer, 1939

**Diagnosis.**—This genus differs from *Afronurus* and *Nixe* in the presence of meso- and metathoracic supracoxal spines. It may be distinguished from *Thalerosphyrus* by the boldly contrasting shades of dark brown, medium brown, and creamy white. More specifically, the pronotum has paired white longitudinal submedian bands and the terminal abdominal filaments have dark bands near the middle that include parts of only two segments.

**Discussion.**—The genus has been recorded from Borneo, Java, and Sumatra (ULMER, 1940). Two morphospecies were collected from a total of three localities in southern Thailand. Each appears to be an undescribed species. Our collections represent the first record of the genus *Compsoeuriella* from Thailand.

**Material examined.**—NARATHIWAT Prov.: stream 14 km W Srisakhon, 15-I-1995, Sites & Nichols, L-77 (1); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (1); Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (8).

Genus **Nixe** Flowers, 1980

**Diagnosis.**—This genus may be distinguished from *Compsoeuriella* and *Thalerosphyrus* by the absence of meso- and metathoracic supracoxal spines. It differs



from *Afronurus* by the apically rounded gills of abdominal segment 1.

**Discussion.**—This genus is Holarctic in distribution. Our collections represent the first record of the genus *Nixe* from Thailand.

**Material examined.**—SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (7).

Genus *Thalerosphyrus* Eaton, 1881a

**Diagnosis.**—This genus differs from *Afronurus* and *Nixe* in the presence of meso- and metathoracic supracoxal spines. It may be distinguished from *Compsoeuriella* by the pale-brown color with only a subtle pattern. More specifically, the pronotum is concolorous pale brown and the terminal abdominal filaments have dark bands near the middle that include parts of at least three segments.

**Discussion.**—This genus has been recorded from only Southeast Asia, including Hong Kong (HUBBARD, 1986), Java (ULMER, 1940), the Philippines, and Sumatra (ULMER, 1940; HUBBARD & PESCADOR, 1978). In Thailand, the genus *Thalerosphyrus* was reported from the Nam Chai River in Chiang Mai Province (POLHEMUS & POLHEMUS, 1988).

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S. of Khao Luang NP, roadside stream, 12-VII-1997, Sites & Permkam, L-139 (1); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (1); PATTANI Prov.: Sai Khao, 16-I-1995, Sites & Nichols, L-80 (17); PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (1); Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream w/ algae covered rocks, L-136 (10); ca. 3 km E Khao Chong WMS on Hwy 4, 12-I-1995, Sites & Nichols, L-69 (3); SATUN Prov.: Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (1); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (1); Ton Nga Chang WS, 6-I-1995, Sites & Nichols, stream at Buddhist temple, L-59 (2); same locality, 6-VII-1997, Sites & Permkam, L-127 (2); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (5).

Family *Isonychiidae* Burks, 1953

Genus *Isonychia* Eaton, 1871

**Diagnosis.**—This genus is easily recognized by its minnow-like shape and the profemora and -tibiae with long filtering setae. The abdominal gills are not operculate.

**Discussion.**—In southern Asia, this genus has been recorded from China (HSU, 1936-37), Borneo, Java, Sumatra (ULMER, 1940), and Pakistan (HUBBARD & PETERS, 1978). Our collections represent the first record of the genus *Isonychia* from Thailand.

**Material examined.**—PATTANI Prov.: Sai Khao, 16-I-1995, Sites & Nichols, L-80 (6); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW of Nathawi, 13-I-1995, Sites & Nichols, L-72 (6); Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream

at Buddhist temple, L-127 (1); stream from Ton Plieuw, 8-I-1995, Sites & Nichols, L-64 (1).

Family **Leptophlebiidae** Banks, 1900

Genus ***Choroterpes*** Eaton, 1881b

**Diagnosis.**—This genus may be distinguished from *Choroterpides* by the unelongated maxillary and labial palpi, and from *Isca* by the mid-lateral union of the abdominal terga and sterna. *Choroterpes* may be distinguished from *Habrophlebiodes* by the gills of abdominal segment 1, which are different in structure from those of segments 2–6; whereas *Habrophlebiodes* has the gills of segments 1–7 alike.

**Discussion.**—Worldwide, this genus is Ethiopian, Oriental, Palearctic, Nearctic and Neotropical (PETERS & EDMUNDS, 1970). In the Eastern Hemisphere, PETERS & EDMUNDS (1970) reported 18 species. In the Oriental Region, this genus has been reported from Burma, India, Pakistan, Sri Lanka (HUBBARD & PETERS, 1978), Formosa, Java, Sumatra (ULMER, 1940), Hong Kong (HUBBARD, 1986), Nepal, Korea, and Malaysia (PETERS & EDMUNDS, 1970). In Thailand, *Choroterpes* has been reported from Chanthaburi (GOSE, 1969). In southern Thailand, we collected three morphospecies.

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S of Khao Luang NP, 12-VII-1997, Sites & Permkam, roadside stream, L-139 (1); stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (4); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (1); PHATTALUNG Prov.: Royal Thai Dept. Agric. Propagation Center; ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (1); SONGKHLA Prov.: Ton Nga Chang WS., 7-VII-1997, R. W. Sites, level 6 of waterfall, L-128 (1); same locality, waterfall levels 2 and 3, 6-I-1995, Sites & Nichols, L-66 (1); ; same locality, stream at Buddhist temple, 6-VII-1997, Sites & Permkam, L-127 (1); TRANG Prov.: Khao Chong WMS stream, 11-VII-1997, Sites & Permkam, L-137 (2); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (1).

Genus ***Choroterpides*** Ulmer, 1939

**Diagnosis.**—This genus is distinctive in that the maxillary and labial palpi are greatly elongated, extending beyond the lateral margins of the head, and visible from above.

**Discussion.**—This genus occurs in Java, Nepal, Sumatra, and Thailand; and the nymphal habitat in northern Thailand is torrential rivers with rock bottoms (PETERS & EDMUNDS, 1970). Subimagos emerge at dusk and adult mating occurs at dusk during the following day (PETERS & EDMUNDS, 1970).

**Material examined.**—PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (39); Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream w/ algae covered rocks, L-136 (7); SATUN Prov.: Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (1); Wangpachan

District, Ton Bliew, 9-VII-1997, Sites & Permkam, rocky & sandy stream, L-131 (3); SONGKHLA Prov.: Ton Nga Chang WS, 6-I-1995, Sites & Nichols, stream at Buddhist temple, L-59 (8); same locality, 6-VII-1997, Sites & Permkam, L-127 (22).

Genus *Habrophlebiodes* Ulmer, 1920

**Diagnosis.**—This genus may be distinguished from *Choroterpides* by the unelongated maxillary and labial palpi, and from *Isca* by the mid-lateral union of the abdominal terga and sterna. This genus may be distinguished from *Choroterpes* by the simple, long, slender, deeply-forked gills of abdominal segments 1–7, all of which are similar in structure; whereas *Choroterpes* has the gills of segment 1 different in structure from those of segments 2–6.

**Discussion.**—Only three species are known from the Eastern Hemisphere (PETERS & EDMUNDS, 1970). *Habrophlebiodes prominens* Ulmer has been recorded from Java and Sumatra (ULMER, 1940); *H. gilliesi* Peters from China, including Hong Kong (PETERS & EDMUNDS, 1970; TSUI & PETERS, 1970; HUBBARD, 1986); and *H. semicastanea* Gillies from India (GILLIES, 1951). Additional notes on biology were given by PETERS (1963) and ULMER (1940). Our collections represent the first record of the genus *Habrophlebiodes* from Thailand.

**Material examined.**—PATTANI Prov.: Sai Khao, 16-I-1995, Sites & Nichols, L-80 (1); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW Nathawi, 13-I-1995, Sites & Nichols, L-72 (2).

Genus *Isca* Gillies, 1951

**Diagnosis.**—This genus may be distinguished from the other known genera of Leptophlebiidae of southern Thailand by the terga of abdominal segments 3–7 extending around to the venter to meet the sterna ventrolaterally, the ventrolateral origin of the gills of abdominal segments 3–7, the ventral portion of gills 2–6 slender with unbranched tracheae, the claws apically hooked and with a row of denticles, and abdominal segments 7–9 with small posterolateral spines.

**Discussion.**—This genus has been recorded from Hong Kong (GILLIES, 1951; PETERS & EDMUNDS, 1970; HUBBARD, 1986), India (GILLIES, 1951; PETERS & EDMUNDS, 1970), Sri Lanka, and Chiang Mai in northern Thailand (PETERS & EDMUNDS, 1970). The habitat of nymphs of *I. janiceae* Peters & Edmunds was beneath rocks in quiet waters of both mountain and lowland streams near Chiang Mai in northern Thailand (PETERS & EDMUNDS, 1970).

**Material examined.**—NAKHON SI THAMMARAT Prov.: Chawang Rd., ca. 8 km S of Khao Luang NP, 12-VII-1997, Sites & Permkam, roadside stream, L-139 (4); stream from Khao Luang NP, 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (4); PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (2); Royal Thai Dept. Agric. Propagation Center; ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (28); SATUN Prov.: Wangpachan District, Ton Bliew, 9-VII-1997, Sites &

Permkam, rocky & sandy stream, L-131 (2); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW Nathawi, 13-I-1995, Sites & Nichols, L-72 (2); stream from Ton Plieuw, 8-I-1995, Sites & Nichols, L-64 (2); Ton Nga Chang WS, 6-I-1995, Sites & Nichols, stream at Buddhist temple, L-59 (1); same locality, 6-VII-1997, Sites & Permkam, L-127 (1). YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (5).

Family **Neophemeridae** Traver, 1935

Genus **Potamanthellus** Lestage, 1931

**Diagnosis.**—Species of this genus are similar to those of Caenidae but may be distinguished by the non-overlapping, subquadrate operculate gills of segment 2 without a fringe of setae or spines on the posterior margin, and the gills of abdominal segments 2-5 have underlying gill branches.

**Discussion.**—This genus is eastern Palearctic, Oriental, and western Nearctic (Oligocene) in distribution (BAE & MCCAFFERTY, 1998). Three of the five described extant species have been recorded from Thailand (BAE & MCCAFFERTY, 1998). Specifically, *P. amabilis* (Eaton) occurs from the northern limit of the Isthmus of Kra northeastward to China and Vietnam, *P. edmundsi* Bae & McCafferty occurs throughout most of Thailand and peninsular Malaysia, and *P. caenoides* (Uhler) has been recorded from Indonesia, the Philippines, and West Malaysia to northwestern Thailand (BAE & MCCAFFERTY, 1998).

**Material examined.**—NARATHIWAT Prov.: stream 14 km W Srisakhon, 15-I-1995, Sites & Nichols, L-77 (1); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (7).

Family **Polymitarcyidae** Banks, 1900

Genus **Povilla** Navás, 1912

**Diagnosis.**—This genus is very similar to *Ephemera* (Ephemeridae), but differs in that the metathoracic tibia is not produced distally into an acute process. It differs from other genera of Polymitarcyidae in that the frontal process is present but not prominent, and that the mandibular tusks are broad with the apex strongly toothed (HUBBARD 1984).

**Discussion.**—This genus was revised by HUBBARD (1984) and eight species have been recorded, one of which is African. The seven Asian species are recorded from Cambodia, India, Java, Simalur, Sri Lanka, Sumatra, and Thailand (HUBBARD, 1984). In Thailand, *P. heardi* Hubbard is known from Khon Kaen Province, *P. ulmeri* Hubbard from Bangkok, and *P. junki* Hubbard from floating vegetation in Bung Borapet. The biology of *P. junki* in Bung Borapet was described by VEJABHONGSE (1937). GILLIES (1951) reported *P. cambodjensis* Ulmer to swarm in late December and early January in Bangkok, however, the species he observed probably is actually *P. ulmeri* (see HUBBARD, 1984). Two specimens of adults were identified in the teaching collection of the Pest Management Department, PSU. Certain species of *Povilla* are well-known for their habits of burrowing into submerged wooden structures, occasionally causing significant damage to the structure (see VEJABHONGSE, 1937; HUBBARD, 1984).

**Material examined.**—SONGKHLA Prov.: Hat Yai, PSU campus dormitories, 13-VI-1996, Chutima (2 adults).

Family **Potamanthidae** Albarda, 1888

Genus **Rhoenanthus** Eaton, 1881b

**Diagnosis.**—Species of Potamanthidae are characterized by dorsoventrally flattened bodies; convergent, elongate mandibles; outstretched legs; and posteriorly directed, fringed, bilobed abdominal gills on abdominal segments 2–7. These mayflies are most easily confused with those of other families of Ephemeroidea, but can be distinguished easily by the lack of a frontal process of the head. The genus *Rhoenanthus* may be distinguished from *Potamanthus*, the only other Oriental genus of Potamanthidae, by the length of the mandibles subequal to or longer than the length of the head. In *Potamanthus*, the mandibles are  $< 1/2$  the length of the head.

**Discussion.**—*Rhoenanthus speciosus* Eaton, recognizable from its congeners by forked mandibular tusks, was recorded from the sandy substrate of a stream in Khao Nam Khang NP in Songkhla Province (Parnrong, in lit.). Southern Thailand is the northernmost known limit of the range of *R. speciosus*. Southward, it extends into Malaysia and Indonesia (BAE & MCCAFFERTY, 1991). Two congeners, *R. distafarcus* Bae and McCafferty and *R. obscurus* Navás, are known from Thailand north of the Isthmus of Kra (BAE & MCCAFFERTY, 1991).

**Material examined.**—SONGKHLA Prov.: Khao Nam Khang NP, 15-I-2000, 23-IV-2000, Parnrong and Buathong (4 male, 6 female imagoes; 3 subimagoes; 9 nymphs).

Family **Prosopistomatidae** Lameere, 1917

Genus **Prosopistoma** Latreille, 1833

**Diagnosis.**—Species of *Prosopistoma* are immediately recognizable by their beetle-like form and small size. The mesonotum is convex and enlarged, forming a carapace which covers the remainder of the thorax, legs, and anterior abdominal segments.

**Discussion.**—This genus is widely distributed throughout the Old World, and is represented by 17 described species, of which nine occur in the Oriental Region (PETERS, 1967; SOLDÁN & BRAASCH, 1984; TONG & DUDGEON, 2000). Several specimens of *P. wouterae* Lieftink have been collected from a stream emanating from Boripat Waterfall in Satun Province (Parnrong, in lit.).

**Material examined.**—SATUN Prov.: 100–500 m downstream from Boripat Waterfall, 28-IV-2000, 25-X-2000, Buathong and Parnrong.

Family **Teloganodidae** Allen, 1965

Genus **Teloganodes** Eaton, 1882

**Diagnosis.**—This genus may be distinguished from members of Neoephemeridae and Caenidae by the widely separated operculate gills of segment 2. It may be distinguished from *Teloganella* (Teloganellidae) by the absence of a median caudal filament and the

posterior margins of abdominal segments 1–10, each of which has a mid-dorsal tubercle.

**Discussion.**—This genus has been recorded from throughout southern and Southeast Asia. A widespread species that might represent the specimens that we collected in southern Thailand is *Teloganodes tristis* (Hagen), which is known from Java, the Philippines, Sri Lanka, and Sumatra (ULMER, 1940; HUBBARD & PESCADOR, 1978; HUBBARD & PETERS, 1978). Our collections represent the first record of the genus *Teloganodes* from Thailand.

**Material examined.**—NAKHON SI THAMMARAT Prov.: stream from Khao Luang Nat. Pk., 12-VII-1997, Sites & Permkam, stream under bridge, L-140 (4); NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (3); PHATTALUNG Prov.: Mom Jui Waterfall, 4 km W of Tamote Village, 11-VII-1997, Sites & Permkam, rocky stream, L-134 (5); Royal Thai Dept. Agric. Propagation Ctr., ca. 3 km E of Khao Chong WMS, 11-VII-1997, Sites & Permkam, stream with algae covered rocks, L-136 (3); SATUN Prov.: Kwandon District, Yaroy Waterfall, 9-VII-1997, Sites & Permkam, stream with large rocks & sand, L-132 (1); Wangpachan District, Ton Bliew, 9-VII-1997, Sites & Permkam, rocky & sandy stream, L-131 (5); SONGKHLA Prov.: Khao Nam Khang NP, ca. 21 km SW Nathawi, 13-I-1995, Sites & Nichols, L-72 (5); Ton Nga Chang WS, stream at Buddhist temple, 7-I-1995, Sites & Nichols, L-60 (1); same locality, 6-VII-1997, Sites & Permkam, L-127 (5); Ton Nga Chang WS, waterfall levels 2 and 3, 6-I-1995, Sites & Nichols, L-66 (4); Ton Plieuw, 7-I-1995, Sites & Nichols, wet rock face of waterfall, L-63 (1); stream from Ton Plieuw, 7-I-1995, Sites & Nichols, L-62 (1); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (5).

Family *Teloganellidae* McCafferty and Wang, 2000

Genus *Teloganella* Ulmer, 1939

**Diagnosis.**—This genus may be distinguished from members of Neophemeridae and Caenidae by the widely separated operculate gills of segment 2. It may be distinguished from *Teloganodes* (Teloganodidae) by the presence of a median caudal filament and the posterior margins of abdominal terga 4–6, each of which has a pair of tubercles, thereby forming a series of mid-dorsal notches.

**Discussion.**—This genus had been placed previously in Ephemerellidae and more recently Tricorythidae (WANG ET AL., 1995). Nonetheless, family placement for the genus still is equivocal. The genus has been recorded from the Celebes, India, Borneo, Sabah, the Malay Peninsula (EDMUNDS & POLHEMUS, 1990), and Sumatra (ULMER, 1940). *Teloganella umbrata* Ulmer has been recorded from Malaysia (WANG ET AL., 1995). Our collections represent the first record of the genus *Teloganella* from Thailand.

**Material examined.**—NARATHIWAT Prov.: stream below Bacho Waterfall, 15-I-1995, Sites, Nichols, & Permkam, L-78 (1); SONGKHLA Prov.: Ton Nga Chang WS, 6-VII-1997, Sites & Permkam, stream at Buddhist temple, L-127 (1); YALA Prov.: Than To, Banglang NP, 14-I-1995, Sites & Nichols, riffles in stream, L-73 (2).

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