Diversity of *Hemerodromia* Meigen, 1822 (Diptera: Empididae) in Thailand, the tip of a tropical iceberg?

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Abstract

The genus *Hemerodromia* in Thailand is revised and full descriptions and keys are provided for all 25 species. Twenty new species are recognised: *H. alphalutea* sp. nov., *H. anisoserrata* sp. nov., *H. anomala* sp. nov., *H. attenuata* sp. nov., *H. betalutea* sp. nov., *H. conspecta* sp. nov., *H. deltalutea* sp. nov., *H. deminuta* sp. nov., *H. demissa* sp. nov., *H. epsilutea* sp. nov., *H. etalutea* sp. nov., *H. gammallutea* sp. nov., *H. isochita* sp. nov., *H. namtokhinpoon* sp. nov., *H. ocellata* sp. nov., *H. orenis* sp. nov., *H. phahompokensis* sp. nov., *H. songsee* sp. nov., *H. systoechon* sp. nov. and *H. zetalutea* sp.
Five species known previously from China are recognised: *H. acutata* Grootaert, Yang & Saigusa, *H. flaviventris* Yang & Yang, *H. furcata* Grootaert, Yang & Saigusa, *H. fusca* Yang & Yang and *H. yunnanensis* Yang & Yang. *Hemerodromia songsee* sp. nov. and *H. fusca* Yang & Yang are also recorded from Vietnam. Distribution maps of all species are presented. Four categories of distribution patterns of apparently endemic species were identified in (1) the northern mountains (2) the northern lowlands (3) the south, and (4) east of Thailand. Some lowland species with wide distributions in eastern Asia were interpreted as ‘old Oriental elements’. Other montane species have wide distributions extending between the Himalayas and southeast China. Three lowland species have an apparently obligate association with alkaline, mineralised water courses where tufa deposition was evident. Tufa-linked assemblages of *Hemerodromia* may indicate a previously unrecognised and potentially diverse habitat for aquatic Empididae in Southeast Asia. Major historical factors determining contemporary distribution patterns were analysed in reference to a Climate History Model (Plant et al. 2012) and included (i) latitudinal migrations in response to climatically induced changes in the distribution of habitat; (ii) radiation of high-elevation endemics from more widespread lowland forms; (iii) historical connectivity and fragmentation of hydrological networks with possible marooning of taxa in stable tufa spring systems; (iv) persistence of lowland forms in climatically ‘buffered’ stream environments during progressive aridification. Analysis of sampling methodology concluded that hand collecting was 2,000X more efficient at collecting numbers of climatically ‘buffered’ stream environments during progressive aridification. Consideration of the climatic, ecological and biogeographic complexity of tropical Southeast Asia suggests that an extremely rich *Hemerodromia* fauna awaits discovery in the region.

**Key words:** Empididae, *Hemerodromia*, new species, distribution, endemism, sampling, Thailand
Introduction

Hemerodromia Meigen, 1822 is the largest genus of the Empididae subfamily Hemerodromiinae, comprising 150 described extant species with worldwide distribution. Hemerodromia is considered to be systematically placed in the tribe Hemerodromiini, in which, so far as is known, the immature stages are aquatic (Plant 2011), exhibiting specific adaptations to freshwater (Brammer et al. 2009) where their larvae prey on small invertebrates (Vaillant 1981; Hamada 1993; Harkrider 2011). Hemerodromia occur predominantly in association with often well oxygenated lotic habitats such as streams and rivers but some species may occasionally be found in lentic waters. As with other Hemerodromiinae, adults have raptorial forelegs (Figs 1–3, 6–8) with the fore femur inflated and bearing ventral setae (Fig. 2). Although these raptorial modifications are certainly associated with predatory activity, they may also be important in male antagonistic behaviour (Wagner & Gathmann 1996). Adults are seldom found away from water bodies and are usually encountered resting on marginal sediments, emergent rocks and timber and especially riverine vegetation along stream banks.

Yang et al. (2007) catalogued 34 species of Hemerodromia from the Oriental Realm. China is undoubtedly a centre of diversity of the genus with 25 species recorded (Yang & Yang 2004) although many more Oriental species await description, especially in Southeast Asia (Plant 2011; Plant et al. 2012). Hemerodromia is widespread and sometimes abundant in Thailand (Plant et al. 2011, 2012) with adults occurring near streams in a range of forest and agricultural biotopes. The present work utilized a wealth of material obtained from recent intensive collecting efforts in Thailand. New species are described and species known previously from elsewhere and now discovered in Thailand are redescribed in order to provide a comprehensive and consistent account of all the species occurring there. A summary of their distributions and habitat associations is provided and patterns of diversity, distribution and endemism are interpreted in reference to a Climate History Model (Plant et al. 2012) of the origin of Southeast Asian biota. The efficiency of different sampling techniques as a means of assessing diversity of Hemerodromia is evaluated.

Material and methods

This study is based on the examination of 1,055 specimens collected by the author or during several mass-sampling programs in Thailand (for details see Plant et al. 2011). Types and/or supplementary material are deposited in Queen Sirikit Botanic Garden (Entomology Section), Chiang Mai, Thailand (QSBG), National Museum of Wales, Cardiff, UK (NMWC), Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA), Mahasarakham University, Department of Biology, Maha Sarakham, Thailand (MSU), Muséum national d'Histoire naturelle, Paris, France (MNHN) and Royal Belgian Institute of Natural Sciences, Brussels, Belgium (RBINS). Locality data are given in full but holotype data frequently includes a number prefixed by ‘T’ or by ‘QSBG’. These numbers have an administrative function relating to material collected by the TIGER Project (Thailand Invertebrate Group for Entomological Research) and by staff at Queen Sirikit Botanic Garden, respectively (see Plant et al. 2011 for details of these projects, collecting methods etc.). T and QSBG numbers were not routinely reported for non-primary type material. Other abbreviations used include: NP, National Park; MT, Malaise trap; w/f, waterfall.

Male terminalia were macerated with hot 98% lactic acid. Morphological terms are essentially those of McAlpine (1981) and Stuckenberg (1999). Interpretation of genitalic homology follows Cumming et al. (1995) and Sinclair (2000). Morphological abbreviations used were: av, anteroventral; ocl, ocellar setae; pv, posteroventral; vtl, vertical setae; npl, notopleural setae; sc, apical scutellar setae (as distinguished from any present on the disc of the scutellum). C₁, C₂ and C₃ refer to fore, mid and hind coxae respectively, F₁, F₂ and F₃ to corresponding femora and T₁, T₂ and T₃ to corresponding tibiae. The fore femur bears two rows of long setae ventrally between which is a double row of much shorter peg-like setae (Fig. 2). This study follows Plant & Sinclair (2008) and Câmara et al. (2014) using the term spine to denote setae of the outer rows and denticle to describe the shorter setulae between these rows. The femoral formula (Plant 2007) records the number of spines or denticles in each series starting from the most anterior and continuing posteriorly. Thus a femoral formula of 6/15–19/17/5 indicates that there are 6 anteroventral spines, 15–19 anteroventral denticles, 17 posteroventral denticles and 5 posteroventral spines. Sometimes one or two basal denticles are more or less distinctly separated from others of the series in which case the femoral formula is modified (e.g. 6/15–19/17+1/5 indicates that one basal denticle of the posteroventral series
is so separated). The term denticle is otherwise used to denote a series of minute dentate setulae ventrally on the fore tibia. These tibial denticles often occur in two distinct rows but with the posterior row sometimes less strongly developed. In some species the posterior row is so undeveloped as to be indistinguishable from other undifferentiated setulae on the limb and in such cases the fore tibia is described as having only a single row of ventral denticles. The terms hair, bristle and spine are used somewhat loosely to indicate setae of increasing robustness and length present on other parts of the body other than the specialised ventral armature of the front femur and tibia.

The term scutoscutellar eye is used to indicate a sometimes strongly defined dark mark present in some species, running along the lateral part of the scutoscutellar suture for some distance towards the median point beyond which it is acutely deflected anterolaterally for a short distance over the intrapostalar area of the scutum. Viewed dorsally, it appears as a small 'V' or eye-shaped mark on the posterolateral margin of the scutum. Descriptions of colour always refer to ground colour (not surface colour due to pollinosity or iridescence) and are based on wet-preserved (aqueous ethanol) material.

Taxonomy


Diagnosis. A genus of Empididae, subfamily Hemerodromiinae distinguished from other genera of the tribe Hemerodromini (sensu Plant 2011) primarily by (1) vein Sc fused with C (2) vein h absent (3) cell cup absent, and (4) vein A₄ absent or very weak.

Key to species of Hemerodromia occurring in Thailand

In using the key it is important to recognise that while colouration provides useful characters to discriminate certain species, it can be variable. For example, species with thorax entirely black may appear brownish or reddish brown in teneral specimens and intraspecific variation in the strength of colour patterns sometimes occurs in species with a predominantly yellow thorax. The user is urged to confirm all determinations by reference to the detailed descriptions and using characters of the terminalia of males. In many cases, females are extremely difficult or impossible to identify with confidence. Caution is also needed as there are certainly other species occurring in Thailand that remain undescribed.

1 Wing with R₄₊₅ terminating in R₅ and strong black mark on membrane about R₅ (Figs 3, 4). Head with posterodorsal margin strongly quadrate in lateral view. Upper occiput shallowly concave (Fig. 5). Anterodorsal margin of thorax very distinctly quadrate in lateral view. Hemerodromia anomalala sp. nov.
   - Wing with R₄₊₅ terminating in C, membrane about R₅ hyaline (Figs 1, 6–8). Head with posterodorsal margin more rounded in lateral view (usually distinctly so). Upper occiput convex, at most somewhat flattened. Anterodorsal margin of thorax usually narrowing gradually towards front viewed in profile (Figs 6–8). 2

2 Wing (Figs 1, 7) with M₁₂ fork present (vein M₂ present); halter whitish, blackish or dusky (usually without marked contrast between anterior and posterior faces of knob). T1 with 1 or 2 rows of minute denticles ventrally (rows often subequal in strength). 4
   - Wing (Fig. 6) with M₁₂ fork absent (vein M₁₂ absent); halter with anterior face of knob black, posterior face pale (division between the two usually very distinct). T1 with a single row of minute denticles ventrally. 3

3 Male terminalia with cercus strongly curved dorsally on distal part (Fig. 18); surstylus very broad, its tip strongly reflexed dorsally. Hemerodromia attenuata sp. nov.
   - Male terminalia with cercus elongate, linear on distal part (Fig. 29); surstylus with tip slightly spatulate. Hemerodromia deminuta sp. nov.

4 Ground colour of anepisternum and katepisternum yellow or brownish yellow, sometimes heavily suffused brown or blackish but never distinctly black (underlying ground colour always yellowish) (Figs 1, 7, 8). 5
- Ground colour of anepisternum and katapisternum black or brown (underlying ground colour always black or brownish, sometimes variably suffused reddish, never distinctly yellow) (Figs 3, 5, 6)  
- Halter with knob black or at least distinctly darkened; wing distinctly and evenly dark greyish on distal 0.9  
  \textit{Hemerodromia furcata} Grootaert, Yang & Saigusa, 2000  
- Halter with knob whitish, yellowish or pale brownish yellow; wing usually less darkened or almost hyaline on distal 0.9 or with strong darkening restricted to area around apices of basal cells.  
- Scutum entirely yellow, at most a faint narrow median dark area in prescutellar area and/or more or less distinct darker lateral stripes on posterior 0.5 (males only)  
  \textit{Hemerodromia flaviventris} Yang & Yang, 1991  
- Scutum entirely brownish or black or with dark markings otherwise and more extensive  
- Scutum with anterior 0.5 clear yellow, posterior 0.5 blackish (Fig. 8)  
  \textit{Hemerodromia songsee} sp. nov.  
- Scutum entirely brownish or black or with dark markings otherwise  
  \textit{Hemerodromia namtokhinpoon} sp. nov.  
- Scutellum yellowish laterally, even if narrowly so, postpronotal area often yellow; laterotergite yellowish or sometimes suffused brownish black but never uniformly and intensely black  
  \textit{Hemerodromia isochita} sp. nov.  
- Scutellum yellow or yellowish, at least posteriorly; scutum with wide lateral yellow markings more extensive, especially anteriorly; often with a more or less well defined dark median stripe, narrowing anteriorly. Cell bm+dm short ending at level of R₄, or if ending distinctly beyond end of R₄ then a short stub of Cu₄, present  
- Scutellum entirely black; scutum with median dark stripe broad; prothoracic ‘collar’ broadly black dorsally. Wing with a short stub of vein Cu₄, present; length of C between ends of R₄, and R₄ long, ~1.8X long as R₄; cell bm+dm long, ending distinctly beyond level of R₄, Male cercus with complex process situated along inner face with convoluted tip bearing 4 blunt spines orientated internally (Fig. 52)  
  \textit{Hemerodromia acutata} Grootaert, Yang & Saigusa, 2000  
- Scutellum yellow or yellowish, at least posteriorly; scutum with dark median stripe narrower; prothoracic ‘collar’ with dorsal surface yellow, black only very narrowly at middle. Wing with no trace of vein Cu₄; length of C between ends of R₄, and R₄ short, ~1.0–1.2X long as R₄; cell bm+dm short, ending at about level of R₄. Male cercus (Figs 9, 10) elongate, with only short small strong setae on inner face apically  
  \textit{Hemerodromia asacata} Grootaert, Yang & Saigusa, 2000  
- Cell bm+dm long, ending beyond tip of R₄; sct present, distinct if small (if bm+dm short and sct present see \textit{Hemerodromia etalutea} sp. nov.)  
- Cell bm+dm short, ending near tip of R₄; sct absent, at most a few fine hairs on disc  
- F1 with ~3 spines of pv row between 0.2 and 0.7 from base obviously longer than limb is deep  
  \textit{Hemerodromia alphalutea} sp. nov.  
- F1 with spines of pv row obviously shorter than limb is deep (excepting 1–2 near base longer)  
- Scutum with more or less distinct dark lateral stripes posteriorly. Epandrium with small quadrate process apically bearing close ciliation of fine hairs (Fig. 20)  
  \textit{Hemerodromia betalutea} sp. nov.  
- Scutum plain yellow, any dark markings very obscure. Male terminalia otherwise  
- Mediotergite clear yellow (if somewhat vaguely obscured brownish see \textit{Hemerodromia deltalutea} sp. nov.)  
- Mediotergite black or brownish, sometimes with posterior or lateral margins yellow  
- Wing membrane brownish; veins brownish yellow, rather darker about junction of R₄, with C, base of R₄, and R₄, and cell bm+dm posteriorly. Abdomen with tergite 2 blackish (as are 3–5). Hypandrium and epandrium clear yellow  
  \textit{Hemerodromia epilutea} sp. nov.  
- Wing membrane yellowish; veins yellowish, not obviously darker about basal forks. Abdomen with tergite 2 yellow (sometimes narrowly darker medially) and 3–5 blackish. Hypandrium and epandrium black  
  \textit{Hemerodromia etalutea} sp. nov.  
- Epandrium very strongly concave on dorsal margin (Fig. 26). Tergites 2–6 mostly blackish. R₄ fork distal to M₄, fork by same or slightly greater than length of R₄  
  \textit{Hemerodromia deltalutea} sp. nov.  
- Epandrium convex on dorsal margin (Fig. 48). Tergites 2–5 mostly blackish; R₄ fork distal to M₄, fork by less than length of R₄  
  \textit{Hemerodromia gammalutea} sp. nov.  
- Sct absent; posterior margin of scutum with clearly defined black ‘scutocutellar eye’ marking; prothoracic collar dorsally with narrow dark median mark. Wing with veins blackish, membrane browner, both only slightly darkened at about level of cell bm+dm. Epandrium broad, if elongate then lacking very strong apical bristle
Species descriptions

Hemerodromia acutata Grootaert, Yang & Saigusa (Figs 9, 10, 73)

Hemerodromia acutata Grootaert, Yang & Saigusa, 2000: 73.

Diagnosis. Thorax yellow with broad dark median stripe on scutum; scutellum yellowish behind and metatergite black. Prothoracic ‘collar’ with dorsal surface yellow, black only very narrowly at middle. Cell bm+dm short, ending at about level of R3. Male terminalia with cerci and epandrium narrow; surstylus narrow with tip down curved, somewhat club-shaped, extending just beyond tip of epandrium.

Re-description. Male: Body length 2.8–2.9 mm; wing length 2.2–2.3 mm. Head. Black, dusted greyish; antenna and mouthparts pale whitish yellow, all setae pale; one pair reclinate ocl; postocular setae uniseriate, merging above with 1–2 pairs small vtl and several fine setulae on vertex; frontal setae apparently absent. Antenna with postpedicel 1.5–2.0X long as wide, stylus of similar length; scape with distinct fine dorsal seta. Thorax. Dusted greyish. Scutum with ground colour yellow; a broad black or brownish median stripe, very broad posteriorly, narrowing to 0.3X as wide anteriorly; sometimes with indications of two darker lateral stripes posteriorly within median stripe, broader and widely spaced posteriorly becoming somewhat narrower and converging anteriorly. Prothoracic ‘collar’ yellow with narrow black median dorsal mark. Scutellum yellowish, at

- Set present; posterior margin of scutum entirely yellow, lacking dark ‘scutoscutellar eye’; prothoracic collar dorsally entirely yellow. Wing veins yellowish grey, membrane yellowish brown, both darkened conspicuously at about level of cell bm+dm. Epandrium very elongate with strong apical bristle .......................... Hemerodromia nantokhinpooven sp. nov.

- Anterior spiracle narrowly (usually strongly) emarginated above with small linear diagonal black mark. Epandrium narrowly elongate in lateral view (Fig. 71) ................................. Hemerodromia zalumata sp. nov.

- Anterior spiracle lacking strong linear diagonal mark, at most with a small dark spot present. Epandrium subovate or subrectangular in lateral view (Figs 14, 55) ........................................ 19

- Epandrium truncate apically; narrow process (lower lobe of surstylus?) emerging beyond tip of epandrium below surstylus bent at 90° with 2 small leaf-shaped setae apically (Fig 14) .......................... Hemerodromia anisoserrata sp. nov.

- Epandrium less truncate apically (Fig. 55); narrow process (lower lobe of surstylus?) emerging beyond tip of epandrium below surstylus more or less linear with 2 large leaf-shaped setae apically (Fig. 57) ............... Hemerodromia ocellata sp. nov.

- Head with 4–5 pairs of distinct vtl distinguishable from other fine setulæ on vertex and upper occiput. Male terminalia (Figs 23–25) small and compact; cercus rather broad and simple in lateral view ........................ Hemerodromia conspecta sp. nov.

- Head with 1–2 pairs of indistinct vtl, not much stronger than other fine setulæ on vertex and upper occiput. Male terminalia larger; cercus narrowed in lateral view or if broad, with complex apical processes ........................................ 21

- Male cercus broad in lateral view with prominent apical downwardly directed process (Figs 32, 33) .............................................................. Hemerodromia demissa sp. nov.

- Male cercus elongate in lateral view (Figs 46, 58, 60, 68), sometimes with shorter dorsal lobe at about 0.5 from base (Fig. 46) ........................................ 22

- Male cercus moderately elongate in lateral view (Fig. 46), extending beyond tip of epandrium, a shorter dorsal lobe originating ~0.5 from base (sometimes twisted internally and inconspicuous in lateral view); surstylus large and conspicuous, broadly T-shaped apically (Fig 46) ............................... Hemerodromia fusca Yang & Yang, 1986

- Male cercus long and narrow in lateral view (Figs 58, 60, 68), without dorsal lobe; surstylus shorter or if elongate then a different shape apically .......................................................... Hemerodromia orientis sp. nov.

- Epandrium rather narrow in lateral view, apically pointed (Figs 58, 59); surstylus small, narrow, apically spatulate, incurved distally .............................................................. Hemerodromia orientis sp. nov.

- Two processes projecting beyond tip of epandrium (Fig. 60); upper one (surstylus) conspicuously inflated and broadly L-shaped apically; lower process elongate hook-shaped apically (Fig. 70) .... Hemerodromia yunnanensis Yang & Yang, 1988

- Two processes projecting beyond tip of epandrium (Fig. 60); upper one narrow, apically spatulate with minute peg-like tubercles apically on inner face (Fig. 62); lower one rather digitiform, with dense brush of fine almost coalescent hairs apically ............... Hemerodromia phahompokensis sp. nov.
least broadly on posterior margin; often with darker area anteriorly, contiguous with and forming slight posterior extension of dark medium stripe on scutum. Mediotergite black or brownish. Pleura yellow; sutures about laterotergite and base of halter blackish. All setae yellowish; minute apart from pair of distinct set and one smaller npl. Legs. Whitish yellow with apical tarsal segments hardly darkened. C1 rather short — 1.1–1.2X longer than distance between C1 and C2, all setae minute excepting a few slightly longer apicals. F1 ~ 1.2–1.3X long as C1, ~ 5X long as wide, evenly inflated, hardly constricted on proximal 0.2–0.3; femoral formula ~ 6/14/16/0–1/6–7, denticles black, rows converging apically; spines yellow, pv and av rows similarly long, becoming somewhat longer proximally. T1 ~ 0.7X long as F1, evenly curved, ventral face shallowlly concave; with one row of ~ 15 sharply pointed spinose setae ventrally; a very small ventroapical spur with strong erect ventroapical black spinose seta arising from near base. Hind mid and legs slender with only small predominantly pale setae but mid metatarsus with somewhat longer setae ventrally, T3 with short row of small setae posterodorsally and ‘comb’ of short setae posteropaically. Wing. Membrane slightly darkened by rather even covering of greyish brown microtrichia but hyaline basally. Veins greyish yellow to blackish but whitish near base; R~n, and R~s often darker basally; C pale yellow with posterior margin very narrowly black. Marginal setae pale. R~n, linear before tip, rather long joining C ~ 0.7–0.8X distance between end of R and R~s; length of C between ends of R~s, and R~s short, ~1.0–1.2X long as R~s. R~s slightly S-shaped, angle with R~s at extreme base ~ 80°, becoming ~70–80° thereafter, joining C at ~ 80–90°; R~s ~ 2X long as R~s almost linear; R~s fork distal to M~1–2, fork by ~ 1.5X length of R~s, M~1 almost linear beyond base, even convergent distally with R~s; cell bm+dm short, ending at about level of R~s, Halter yellowish white. Abdomen. Yellow with tergites 1, 6 and 8 posteriorly black. Lacking strong setae except blackish bristles on posterior margin of tergite 8 and yellowish bristles on sternites 8. Terminalia. Deep black with dark setae. Cerci (Figs 9, 10) elongate, extending beyond tip of epandrium; slightly dorsoventrally flattened apically with some short small strong setae on inner face. Epandrium narrowed distally (Fig. 9). Hypandrium rather quadrate apically with cluster of strong setae ventroapically. Surstylus present, narrow, elongate; tip inflated, somewhat club-shaped, slightly down curved, extending just beyond tip of epandrium. Female. Similar to male but spine and denticles beneath F1 rather more numerous, femoral formula ~ 6–7/18/19/1/6–7. Abdomen yellow with tergites 2–5 and 6 on posterior margin black. Terminalia black. Material examined. 2♂, 1♀, THAILAND: Chiang Mai Province, Doi Inthanon NP, Siriphum w/f, 1,333 m, 18.5422°N, 98.5172°E, 23.xi.2012, 14.i.—3.iii.2014, netted and MT, A.R. Plant & W. Srisuka; 1♀, small stream in hill evergreen below checkpoint 2, 1,650 m, 18.516°N, 98.483°E, 6.x11.2013, netted, A.R. Plant; 1♀, Check point 2 trap 1, 1,639 m, 18°31′39.5"N, 98°29′59.7"E, 14.i.—3.iii.2014, MT, W. Srisuka; 1♂, Summit trap 1 (back of office), 2,534 m, 18°35′12.8″N, 98°29′14.2″E, 30.vii.—27.viii.2014, MT, W. Srisuka; 1♀, 8♂, Kamphaeng Phet Province, Mae Wong NP, Chong Yen, 1,306 m, 16°5.212′N, 99°6.576′E, 10.—17.ix.2007, 17.—24.ix.2007, 24.ix.— 1.x.2007, 17.—24.xii.2007, MT, C. Piluak & A. Intupung (OSBG & NMWC). One ♂ from Chong Yen, 24.ix.—1.x.2007 selected for DNA sequence analysis (INPA). Remarks. This species was described from two males collected in Yunnan, China (Grootaert et al. 2000) which were described as having “mesonotum with 2 blackish middle longitudinal stripes”. In specimens from Thailand, these two stripes are usually present but are superimposed upon and largely masked by a much broader blackish median stripe. However the male terminalia of Thai specimens match closely with the Chinese specimens (Grootaert et al. 2000, figs 4, 5) and there can be little doubt that Thailand material is correctly assigned to H. acutata. As with many other species of Hemerodromia, thoracic colour pattern is variable and in some Thailand specimens of H. acutata, the blackish median stripe is distinctly abbreviated anteriorly, fading out before the front margin of the scutum. The colour of the scutellum is also very variable and while it usually has a distinctly yellow posterior margin, can be almost entirely blackish. The thoracic colour pattern of H. acutata often approaches that of H. systoechon sp. nov., especially when the scutellum is dark. Males of the two species may readily be distinguished by their terminalia. For distinguishing characters of females, see notes under H. systoechon sp. nov. Hemerodromia acutata is also known from Himachal Pradesh in northwest India (Wagner et al. 2004) so its range is clearly large and its occurrence in Thailand is unsurprising. In Thailand the species has been found in the northern provinces of Kamphaeng Phet and Chiang Mai (Fig. 73) with 24 (88%) of a total of 27 specimens being taken from September to December coincident with the end of the Southwest Monsoon and with the cool dry season. It inhabits evergreen forest biotopes but is especially prevalent in hill evergreen forest.
FIGURES 1–5. Morphology of Hemerodromia spp. 1–2. *H. flaviventris* Yang & Yang. 1, ♂ habitus; 2, ♂ front leg (coxa not shown); 3–5. *H. anomala* sp. nov. 3, ♂ habitus; 4, apex of wing; 5, Head and anterior part of thorax. Veins $M_1$, $M_2$ and $R_4$ indicated.
FIGURES 6–8. Habitus of Hemerodromia spp. 6, H. attenuata sp. nov. ♂; 7, H. syxstechon sp. nov. ♂; 8, H. songsee sp. nov. ♀.
**FIGURES 9–10.** Male terminalia of *Hemerodromia acutata* Grootaert, Yang & Saigusa. 9, lateral view of terminalia; 10, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, pha = phallus.

**Hemerodromia alphalutea** sp. nov.
(Figs 11–13, 74)

**Diagnosis.** A species with scutum and scutellum yellow with mediotergite, laterotergite and metanepisternum on ventral part black. Scot present. Cell bm+dm long. Characteristically elongate pv spines on F1. Male terminalia with complex cercus and epandrium with narrow dorsoapical process bearing long setae.

**Description.** Male: Body length 2.5 mm; wing length 2.3 mm. **Head.** Black, dusted greyish; antenna and mouthparts pale whitish yellow, all setae pale; one pair reclinate ocl; postocular setae uniseriate, becoming 2–3 serial below, merging above with 1–2 pairs small vtl hardly distinguishable from fine setulae on vertex and upper occiput; frontal setulae apparently absent. Antenna with postpedicel ~1.8–2.0X long as wide, a few minute outstanding setulae subapically, stylus slightly shorter than postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Ground colour yellow with mediotergite, laterotergite and metanepisternum on ventral part black; scutum with vague indications of lateral stripes on posterior 0.4–0.5; prothoracic ‘collar’ yellow, narrowly blackish medially with suture between it and anterior margin of scutum dark; scutellum yellow, sutures at anterior and lateral margins dark. All setae yellowish; minute apart from a pair of distinct sct and one npl. **Legs.** Whitish yellow. C1 ~1.2X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer apicals and a posterior ciliation of fine proclinate hairs ~0.3X long as limb is deep. F1 ~ 1.2X long as C1, ~6X long as wide, evenly inflated, slightly constricted on proximal 0.2; femoral formula ~ 5–6/17–19/16–19+1/5–6, denticles black, rows converging apically; spines yellow, pv row with ~3 spines between 0.2 and 0.7 obviously longer than limb is deep, av row shorter, becoming stronger proximally. T1 ~ 0.8X long as F1, evenly curved, ventral face shallowly concave; with one row of ~ 17 sharply pointed spinose setae ventrally; a very small yellow ventroapical spur with distinct erect ventroapical blackish seta arising from near its base; a short ciliation of distinct procline hairs dorsally on distal 0.2. Mid and hind legs slender with only small pale setulae, somewhat longer dorsally on distal 0.3 of T3. **Wing.** Membrane slightly tinged brownish by rather even covering of greyish brown microtrichia but hyaline basally. Veins brownish yellow to brown but whitish near base; cell bm+dm long and veins R₂₃ and R₄₅ basally somewhat darker. Marginal setulae pale. R₂₃ linear on proximal 0.5, gently curved beyond, joining C ~ 0.6X distance between end of R₁ and R₉; length of C between ends of R₂₃ and R₉ ~1.7X long as R₉; Rₐ almost linear, very faintly curved (slightly convex in second submarginal cell, R₄); R₅ ~ 2.0–2.2X long as Rₐ, almost linear; R₄₅ fork distal to M₄₅ fork by ~ 0.8–1.1X length of R₅. M₄ almost linear beyond base, convergent distally with R₉; cell bm+dm moderately long, ending distinctly beyond tip of R₉. Halter yellowish white. **Abdomen.** Yellow with tergites 2–6 black. **Terminalia.** Black. Cercus (Figs. 11, 12) of complex structure; extending slightly beyond epandrium; distally spatulate in lateral view with strong apical setae; a dorsally projected semitransparent subovate process on inner margin near base, bearing close ciliation of fine even-sized hairs at
margin; immediately distal to this and originating from beneath it, a small inwardly directed club-shaped process bearing mostly lateroventrally and anteroventrally directed short spines; slightly distal to this a short rod-like process, inwardly directed, with 2 strong bristles apically. Epandrium rather rhomboid with distinct apical setae; a small narrow irregularly shaped lobe dorsoapically bearing long setae (Fig. 11). Hypandrium somewhat bluntly pointed apically in ventral view (Fig. 13); divided ventrobasally, fused ventroapically. Female: Unknown.

Type material. HOLOTYPE ♂, THAILAND: Chiang Mai Province, Doi Phahompok, Doi Phaluang, 1,449 m, 20°1.06'N, 99°9.581'E, 28.xi.–5.xii.2007, MT, P. Wongchai [T6211](QSBG). PARATYPES: 1♂, same data as holotype, (QSBG); 1♂, Kamphaeng Phet Province, Mae Wong NP, 1,306 m, 16°5.212'N, 99°6.576'E, 12–19.xi.2007, C. Piluek & A. Inpuang (NMWC).

Etymology. The specific epithet is a concatenation of the Latin luteus and the first letter of the Greek alphabet (alpha). It is used as a noun in apposition.

Remarks. This species may be separated from other predominantly yellow species by its characteristically elongate pv spines on F1 and male terminalia with complex cercus and epandrium with narrow dorsoapical process bearing long setae. It is only known from hill evergreen forests at 1,306–1,449 m in Khamphaeng Phet and Chiang Mai provinces in northern Thailand (Fig. 74). All specimens were captured in the cool dry season during November and December.

FIGURES 11–13. Male terminalia of Hemerodromia alphalutea sp. nov. 11, lateral view of terminalia; 12, dorsal view of cerci; 13, ventral view of hypandrium. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium.
**Hemerodromia anisoserrata** sp. nov.  
(Figs 14–15, 75)

**Diagnosis.** A species with yellow thorax and mediotergite darkened. Posterior margin of scutum with well defined black ‘scutoscutellar eye’. Set absent. Cell bm+dm short. Male terminalia with epandrium truncate apically, and surstylus elongate with almost circular apex; a narrow process emerging beyond tip of epandrium below surstylus bent at ~90°, with two minute dentate setulae at tip.

**Description. Male:** Body length 2.4 mm; wing length 2.1 mm. **Head.** Black, dusted greyish; antenna and mouthparts pale whitish yellow, all setae pale; one pair erect ocl; 1–2 pair of minute vtl, distinguishable from sparse scattered minute hairs on vertex; postocular hairs minute. Antenna with postpedicel ~2.5–3.0X long as wide, a few minute outstanding setulae subapically; stylus shorter, ~0.5X long as postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusty greyish. Ground colour yellow; mediotergite brownish yellow, prothoracic ‘collar’ very narrowly darkened medially; anterior spiracle not distinctly emarginated above with small diagonal dark mark; ‘scutoscutellar eye’ strongly defined, black; sutures between prothoracic ‘collar’ and anterior margin of scutum, at anterior margin of laterotergite and posterior margin of meron black. All setae yellowish, minute, a pair of distinct nl, set absent. **Legs.** Pale yellow. C1 ~1.1X longer than distance between C1 and C2, all setulae minute but with a few longer hairs dorsally. F1 ~ 1.1X long as C1, ~ 6X long as wide, evenly inflated, hardly constricted on proximal 0.3; femoral formula ~ 7/19–20/19+1/8–9, denticles black, rows converging apically; spines yellow, pv and av rows very short, hair like, with most basal spine strong. T1 ~ 0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with ~ 15 similarly sized sharply pointed spinose setae ventrally; a short ciliation of distinct proclinate hairs dorsally throughout length. Ventoapical spur very small with erect black spinose ventroapical seta arising from near its base. Mid and hind legs slender with only small pale setulae. **Wing.** Membrane distinctly darkened by brownish yellow microtrichia, hyaline basally. Veins blackish, hyaline basally, darker about base of R4+5 and M1+2, and posterior border of cell bm+dm. Marginal setulae pale. R4+5 almost linear, joining C ~ 0.7X distance between end of R4 and R5; length of C between ends of R5+1 and R5 ~1.1X long as R4; R5 almost linear, only slightly S-shaped; R5 ~ 2.1X long as R4, almost linear; R5 fork distal to M1+2, fork by ~ 1.0–1.2X length of R4. M4 almost linear beyond base, convergent distally with R4; cell bm+dm short, ending at tip of R4. Halter yellowish white. Squama with margin greyish yellow. **Abdomen.** Yellow with tergites 2–6 brown or blackish becoming somewhat paler on distal segments; tergite 7 and sternite 7 with distinct yellow setae, a fan of brownish setae on posterior margin of tergite 8. **Terminalia.** Black. Cercus elongate, extending beyond tip of epandrium (Figs. 14, 15); a small subapical thickening on inner face bearing strong spinose seta. Epandrium subquadrate with posterior margin almost linear for most of its length; three very strong bristly setae near pv margin (Fig. 14). Surstylus present, extending distinctly beyond tip of epandrium; almost circular apically with series of dense minute dentate setulae on inner margin ventrally and posteriorly. A narrow process emerging beyond tip of epandrium, below surstylus, sharply bent downwards at ~90°, with two minute dentate setulae at tip (possibly lower lobe of surstylus). Hypandrium large, rather keel-shaped with few distinct bristles but distinctly pilose distally. **Female:** Similar to male. F1 with basal spines of av and pv rows stronger. Vein R4 only ~ 1.8X long as R4. Abdomen yellow with tergites 2–7 brown or blackish, tergite 2 narrowly yellow anterolaterally; sternites 7 brownish posteriorly, a few distinct erect pale setae on disc; terminalia black.

**Type material.** HOLOTYPE ♂, THAILAND: Loei Province, Phu Reua NP, Song Kon w/f (waterfall with wet slabs), 743 m, 17.3521°N, 101.3540°E, 27.xi.2013, netted, A.R. Plant (QSBG). PARATYPE: 1♀, same data as holotype.

**Etymology.** The specific epithet is a concatenation of the Greek root aniso (not equal) and serrata in reference to this species not being identical with *H. serrata* Saigusa & Yang, 2002.

**Remarks.** The two known examples of this species were taken during November from the vicinity of a waterfall at 743 m in Loei Province, northeast Thailand (Fig. 75). *Hemerodromia anisoserrata* sp. nov. is clearly closely related to *H. serrata* Saigusa & Yang 2002 which was described from the Funui Mountains within the Qinling Range in central China. The terminalia of *H. anisoserrata* sp. nov. are similar to *H. serrata* (see Saigusa & Yang 2002, figs 53–54) excepting that the apical process of the surstylus is less rounded in *H. serrata* and the epandrium of *H. anisoserrata* sp. nov. is very different being apically truncate (distinctly pointed in *H. serrata*). In addition the scutum of *H. anisoserrata* sp. nov. is generally entirely yellow (three blackish longitudinal stripes in *H. serrata*) and *H. anisoserrata* sp. nov. has a yellowish mediotergite and lacks distinct scutellar setae. The present
species is also closely similar to \textit{H. ocellata} sp. nov. which has the narrow process emerging beyond the tip of the epandrium (lower lobe of surstylus?) linear rather than bent at 90° and bears two strong leaf-shaped specialised setae apically. \textit{Hemerodromia ocellata} sp. nov. also has a much smaller and differently shaped epandrium and a much larger hypandrium compared with \textit{H. anisoserrata} sp. nov.

**FIGURES 14–15.** Male terminalia of \textit{Hemerodromia anisoserrata} sp. nov. 14, lateral view of terminalia; 15, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, sur = surstylus.

**Hemerodromia anomala** sp. nov.
(Figs 3–5, 16, 17, 76)

**Diagnosis.** A blackish species characterised by having a quadrate head with upper occiput shallowly concave, antenna with stylus thickened and thorax distinctly quadrate anteriorly in lateral view. The wing has R\textsubscript{2+3} terminating in R\textsubscript{4} rather than in C and a strong black stigma about the length of R\textsubscript{4}.

**Description.** Male: Body length 2.5–2.7 mm; wing length 1.6–1.8 mm. \textbf{Head.} Elongate quadrate, angle between upper occiput and vertex a smoothed right angle in lateral view; upper occiput shallowly concave medially; lower occiput slightly bulging laterally (Fig. 5). Black, dusted greyish. Antenna and mouthparts pale yellowish white. One pair reclinate oc; 3 pairs distinct vtl, rather stronger than oc, positioned in linear series parallel with upper eye margin, clearly distinguishable from smaller minute hairs on vertex and occiput and from postocular setulae. Antenna with postpedicel ~1.8X long as wide, subovate, narrowing distally (hardly conical); stylus thickened, ~0.5X length of postpedicel (Fig. 5), apical mechanoreceptor apparently absent; scape with inconspicuous fine dorsal seta. \textbf{Thorax.} Distinctly quadrate anteriorly; anterior margin of scutum almost vertical in lateral view (Fig. 5) making distinct but smooth right angle with disc (not gradually curving). Ground colour reddish black or reddish brown. All setae pale; minute apart from one small and one minute npl; scutellum with a pair of small fine hairs and several smaller setulae on disc. \textbf{Legs.} Ground colour whitish with apical tarsomere darker, sometimes blackish. C\textsubscript{1} ~1.1X long as distance between C\textsubscript{1} and C\textsubscript{2}; all coxae with only minute setulae but with a few longer hairs dorsally and near tip of C\textsubscript{1}. F\textsubscript{1} ~1.1X long as C\textsubscript{1}, moderately inflated ~ 5X long as wide, not constricted on proximal 0.3; femoral formula ~ 6–7/17/16/6–7; denticles black, rows converging apically; spines whitish, rather evenly sized, not becoming distinctly longer proximally. T\textsubscript{1} ~ 0.8X long as F\textsubscript{1}, sublinear, ventral face only slightly concave; with one row of ~15–16 rather weak sharply pointed spinose setae ventrally; a distinct ventroapical erect black or yellowish spinose seta present; ventroapical spur very weakly developed. Mid and hind legs slender with only small setulae. \textbf{Wing.} Membrane distinctly darkened with greisy microtrichia, pale near extreme base; a strong black irregularly trapezoid stigma around R\textsubscript{4} (Figs. 3, 4). Veins greyish but C yellowish before junction with R\textsubscript{2+3} and R\textsubscript{2+3} yellowish distally. Marginal setulae pale grey. R\textsubscript{2+3} linear, joining R\textsubscript{4}; R\textsubscript{5} weakly S-shaped; slightly recurrent, outer angle with R\textsubscript{5} at extreme base ~ 90–95°; R\textsubscript{5} ~2.0, ~2.5X long as R\textsubscript{4}; R\textsubscript{6+7} fork
distal to M₁₂ fork by ~ 1X length of R₄; R₅ and M₁ slightly convergent, becoming faintly divergent at wing margin (Fig. 4). Cell bm+dm short, ending at or slightly beyond level of R₁. Halter whitish. Abdomen. Ground colour blackish or brownish, somewhat paler on vent; all setulae inconspicuous, mostly pale, very short dorsally, somewhat longer ventrally. Terminalia. Cercus and epandrium black with dark setae, hypandrium white. Cercus (Figs 16, 17) long and broad, extending a long distance past tip of epandrium; outer margin convex in dorsal view, inner margin concave with numerous fine marginal setae; apically shallowly bifid. Epandrium (Fig. 16) subcircular, dorsal margin bluntly triangular. Surstylus present, paler than epandrium, up curved, very long reaching to tip of cercus, bearing a few fine ventroapical setulae. Hypandrium long, narrow, divided ventrally at extreme base. Female: similar to male but antennae with stylus slightly less thickened, basal segments entirely and postpedicel dorsally darkened. F₁ with basal spine of pv series distinctly longer than others. Wing with extreme base of Cu distinctly blackish. Abdomen with longer setulae on distal segments.


**Etymology.** The specific epithet *anomala* (Latin) refers to the unusual morphology of head, thorax and wing venation which are anomalous within the genus *Hemerodromia*. It is used as a noun in apposition.

**Remarks.** *Hemerodromia anomala* sp. nov. differs from all other described species of *Hemerodromia* in having the head strongly quadrate with the upper occiput shallowly concave, the thorax distinctly quadrate anteriorly and in the wing vein R₂₃ joining R₄ rather than connecting with the costa as is characteristic in *Hemerodromia*. The species has been captured during February, August, November and December in lowland (210–627 m) forests in Loei and Kanchanaburi provinces (Fig. 76). The Loei localities were basic and mineral rich tufa streams. (Suan Hom, conductivity 414 μS/cm², pH 8.08; Suan Sawan conductivity 418 μS/cm², pH 7.84). The Khuan Srinagarindra localities in Kanchanaburi were close to streams cutting through the underlying limestones and tufa deposits are present in the area. *Hemerodromia anomala* sp. nov. thus appears to be a stenotopic tufa stream specialist.
**Hemerodromia attenuata sp. nov.**

*(Figs 6, 18, 19, 77)*

**Diagnosis.** A black species with vein M₁ absent (fork M₁₂ not present) and a single row of spinose setae ventrally on the front tibia. R₃₋₄ is short, joining C only about 0.5X the distance between end of R₁ and R₄ and cell bm+dm is long, ending beyond level of R₁. Male terminalia with cercus strongly curved dorsally on distal part and surstylus very broad, its tip strongly reflexed dorsally.

**Description. Male:** Body length 3.0 mm; wing length 2.8 mm. **Head.** Black, dusted brownish grey. Antenna and mouthparts entirely whitish. One pair reclinate ocl; two pairs small vtl distinguishable from smaller fine hairs on vertex and upper occiput; postocular and lower occipital setulae minute. Antenna with postpedicel ~2.5X long as wide, stylus rather shorter; scape with distinct fine dorsal seta.

**Thorax.** Black, very slightly paler in postpronotal area, dusted greyish (Fig. 6). All setae yellowish white; minute except one npl and one pair small sct. Length of R₁ ~0.6X as wide, stylus rather shorter; scape with distinct fine dorsal seta.

**Wing.** Membrane darkened with greyish microtrichia but hyaline basally. Veins greyish to brownish black but whitish near base. Marginal setulae greyish. R₃₋₄ sublinear, short, joining C ~0.5–0.6X distance between end of R₁ and R₄; length of C between ends of R₃₋₄ and R₁ ~1.9–2.0X long as R₄. R₃ slightly S-shaped, angle with R₁ at extreme base ~75°; R₄ ~2.0X long as R₂; R₃ and M₁ almost linear, parallel; M₁ absent, represented at most by a slight fold in wing membrane; cell bm+dm long, ending beyond level of R₁.

**Abdomen.** Brownish black dorsally, paler below, tergite 7 and sternite 7 paler still, dusted greyish; all setulae, small except posteriortly on sternite 7 and tergites 7 and 8, pale but darker on tergites 7 and 8. **Terminalia.** Brownish black with dark setae. Cercus moderately elongate in lateral view, extending well beyond tip of epandrium, strongly curved dorsally on distal part with narrow tip directed posteriorly (Figs 18, 19); broad on proximal part in dorsal view with distal part narrow, curved inwards, bearing conspicuous strong setae. Epandrium (Fig. 18) rather narrow, bluntly pointed apically with 2–3 strong setae apically. Hypandrium small and narrow, strongly divided ventrally on proximal 0.5, with a few distinct setae posterovertrally. Two internal process present; upper one (probably posterior process of subependral sclerite) narrow, incurred on distal part, a cluster of distinct short black spinose setae at tip; lower process (surstylus) broader, its tip strongly reflexed dorsally, bearing numerous fine setae along posterior margin. **Female:** similar to male but basal spines on F₁ rather stronger, abdomen with sternites whitish but with sternites 7 entirely and usually sternites 1 along margins darker.

Etymology. The specific epithet *attenuata* (Latin) meaning lessened or diminished, in reference to the simplified wing venation. It is used as a noun in apposition.

Remarks. *Hemerodromia attenuata* sp. nov. shares with *H. deminuta* sp. nov. the apomorphic loss of vein $M_2$ and presence of only a single row of denticles ventrally on the fore tibia. The two species are clearly closely related and may be separated most readily by differences in shape of the cercus, posterior process of the subependrial sclerite and surstylus. *Hemerodromia attenuata* sp. nov. has anterior and posterior faces of the knob of halter more strongly defined than in *H. deminuta* sp. nov. In *H. deminuta* sp. nov. cell bm+dm ends closer to the level of R, than in *H. deminuta* sp. nov. In *H. deminuta* sp. nov. tergite 7 and sternite 7 are pale and tergite 1 is dark whereas in *H. attenuata* sp. nov. tergite 7 and sternite 7 are dark and tergite 1 is pale. *Hemerodromia attenuata* sp. nov. is evidently widespread in Thailand (Fig. 77) occurring in the north (Chiang Mai, Kamphaeng Phet and Lampang provinces), northeast (Loei Province), south (Nakhon Si Thammarat and Surat Thani provinces) and in the southeast (Nakhon Nayok and Chantaburi Province). It occurs in a variety of lowland and mid elevation (99–1,413 m) forest biotopes between February and October (mostly July and August) during the Southwest Monsoon period.

**FIGURES 18–19.** Male terminalia of *Hemerodromia attenuata* sp. nov. 18, lateral view of terminalia; 19, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, pss = posterior process of subependrial sclerite (?), sur = surstylus (?).

*Hemerodromia betalutea* sp. nov.

(Figs 20–22, 78)

**Diagnosis.** A species with yellow thorax bearing more or less distinct dark lateral stripes on the scutum posteriorly and mediotergite blackish brown with posterior margin paler; anatergite mostly blackish and katatergite yellow. Sct present. Cell bm+dm long. Epandrium with small quadratic process apically bearing a close ciliation of fine hairs. Surstylus emerging slightly beyond with three groups of feather-like highly coalescent setae apically.

**Description.** Male. Body length 2.7 mm; wing length 2.7 mm. **Head.** Black, dusted greyish, frons slightly paler; antenna and mouthparts pale whitish yellow, all setae pale; one pair reclinate ocl; postocular setae uniseriate, becoming biseriate below, merging above with 2–3 pairs small vtl hardly distinguishable from fine setulae on vertex and upper occiput (but anterior pair behind ocelli rather stronger); frontal setulae apparently absent. Antenna with postpedicel ~2.0X long as wide, a few minute outstanding setulae subapically, stylus shorter than postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Ground colour yellow; mediotergite blackish brown with posterior margin paler; laterotergite with anatergite mostly blackish and katatergite yellow; metanepisternum yellow with suture along anterior margin (in front of posterior spiracle) narrowly blackish. Scutum with more or less distinct lateral stripes on posterior 0.4–0.5; prothoracic ‘collar’ yellow, narrowly blackish medially with suture.
between it and anterior margin of scutum dark; anterior spiracle narrowly emarginated above with elongate black mark more or less continued posteriorly along extreme lateral margin of scutum where weak but strengthening just in front of root of wing, forming a small dark spot below notopleural seta. Scutellum yellow, sutures at anterior and lateral margins dark. All setae yellowish; minute apart from a pair of distinct set and one npl. Legs. Whitish yellow. C1 ~1.2X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer apicals and a posterior ciliation of fine proclinate hairs ~0.2X long as limb is deep. F1 ~ 1.2X long as C1, ~ 6X long as wide, evenly inflated, almost indiscernibly constricted on proximal 0.2– 0.3; femoral formula ~ 6–7/16/15+1/5–7, denticles black, rows converging apically; spines yellow, pv and av rows similarly long, becoming somewhat longer proximally, shorter than limb is deep throughout. T1 ~ 0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with one row of ~ 20 sharply pointed spinose setae ventrally; a distinct ventroapical erect black or yellowish black spinose seta present; ventroapical spur very small, yellow; a short ciliation of distinct procline hairs dorsally on distal 0.2. Mid and hind legs slender with only small pale setulae, somewhat longer dorsally on distal 0.3 of T3. Wing. Membrane slightly darkened by rather even covering of greyish brown microtrichia but hyaline basally. Veins brownish, somewhat darker about base of R 2+3, R 4+5 and posterior margin of cell bm+dm but pale yellowish near base. Marginal setulae pale. R 23 gently curved, joining C ~ 0.5X distance between end of R 1 and R 4; length of C between ends of R 23 and R 4 ~2X long as R 4; R 5 slightly S-shaped; R 5 ~ 2.2–2.5X long as R 4, slightly downcurved; R 4 fork distal to M 5, fork by ~ 1X length of R 4, M 5 almost linear beyond base, distinctly convergent distally with R 3; cell bm+dm moderately long, ending distinctly beyond tip of R 4. A very faint vestigial ‘stump’ of vein CuA 2 present. Halter yellowish white. Abdomen. Yellow with tergites 2–6 and 8 black. All setae yellow, short but longer on sternites 6 and especially posterior margins of sternites 7 and tergite 8. Terminalia. Black. Cercus of complex structure (Figs 20, 21); about as long as epandrium; more weakly sclerotized proximally,
strongly sclerotized distally with tip slightly anteroventrally spatulate, interned, bearing strong setae; a group of 3 inwardly directed strong setae on inner face at ~0.5 from base. Epandrium (Fig. 20) somewhat subovate proximally in lateral view, becoming narrower distally, with small quadrate process apically bearing a close ciliation of fine hairs. Surstylus present, emerging slightly beyond epandrium and immediately ventral to tip; three groups of feather-like highly coalescent setae apically. Hypandrium rather triangular in ventral view (Fig. 22), with ~5 pairs strong setae on distal 0.5; divided ventrobasally, fused ventropapically. Female: similar to male but denticles and spines on F1 more numerous, femoral formula ~ 6/20/17+1/7; basal spines of pv and av rows stronger, as long as limb is deep. Abdomen with much shorter setae; terminalia black.

**Type material.** **HOLOTYPE** ♂, THAILAND: Chiang Mai Province, Doi Inthanon NP, Check point 2 trap 1, 1,639 m, 18°31′39.5″N, 98°29′59.7″E, 2–29.v.2014, MT, W. Srisuka et al. [QSBG-2014-130](QSBG).

**PARATYPES:** 1♂, same data as holotype; 1♀, Check point 2 trap 2, 1,639 m, 18°31′39.5″N, 98°29′59.7″E, 2–29.v.2014, MT, W. Srisuka et al. (QSBG).


**Etymology.** The specific epithet is a concatenation of the Latin *luteus* and the second letter of the Greek alphabet (*beta*). It is used as a noun in apposition.

**Remarks.** *Hemerodromia betalutea* sp. nov. is best recognised amongst other predominantly yellow species by having the epandrium with a small quadrate process apically bearing a close ciliation of fine hairs and with surstylus emerging slightly beyond with three groups of feather-like coalescent setae apically. It is only known from hill evergreen forests at 1,306–1,639 m in Kamphaeng Phet and Chiang Mai provinces in northern Thailand (Fig. 78). Adults have been taken from December to July during the cool dry season and first part of the Southwest Monsoon.

*Hemerodromia conspecta* sp. nov.

(Figs 23–25, 79)

**Diagnosis.** A blackish species with head and thorax rather quadrate, 4–5 pairs of distinct vertical setae and front tibia only slightly curved. The male terminalia are distinctively small with a broad cercus and small hypandrium and the epandrial lobes bear a distinct sharp spine apically. The female terminalia are elongate and developed as an ovipositor.

**Description. Male:** Body length 2.8 mm; wing length 1.8 mm. **Head.** Rather short, only slightly longer than deep, rather quadrate, upper occiput vertical in lateral view making distinct but smooth angle with vertex (not gradually curving). Black, dusted greyish. Antenna and mouthparts pale whitish yellow. One pair reclinate oc1; 4–5 pairs small distinct vtl, about as strong as oc1, positioned in linear series parallel with upper eye margin, clearly distinguishable from smaller minute hairs on vertex and from postocular setulae. Antenna with postpedicel ~1.5–1.8X long as wide, stylus very short only 0.2X length of postpedicel; scape with distinct fine dorsal seta.

**Thorax.** Distinctly quadrate anteriorly; anterior margin of scutum vertical in lateral view making distinct but smooth right angle with disc (not gradually curving). Ground colour blackish, reddish black or reddish brown, sometimes more distinctly reddish on pleura, dusted greyish (all specimens examined appear to be somewhat teneral and variable in colour). All setae yellowish; minute apart from one small npl anterior of which are a few very fine hairs; scutellum with a few fine hairs on disc. **Legs.** Ground colour yellowish white including apical tarsomers. C1 rather short, about as long as distance between C1 and C2; all coxae with only minute setulae but with a few longer hairs dorsally and especially near tip of C1. F1 ~1.0–1.1X long as C1, moderately inflated ~ 5X long as wide, not constricted on proximal 0.3; femoral formula ~ 6–7/18–21/17–21/6–8; denticles black, rows converging apically; spines yellow, pv slightly longer than av series, both longest proximally. T1 ~ 0.7X long as F1, sublinear, ventral face only slightly concave; with one row of ~16–20 sharply pointed spinose setae ventrally; ventroapical spur weakly developed; a distinct ventroapical erect black spinose seta present. Mid and hind legs slender with only small setulae. **Wing.** Membrane slightly to distinctly darkened with greyish microtrichia, paler along posterior margin and hyaline near extreme base. Veins greyish but paler near base and pale yellowish on costa basal to junction with R2+3. Marginal setulae pale grey. R2+3 linear but tip rather abruptly curved anteriorly to join C ~ 0.7–
0.8X distance between end of R₁ and R₂; length of C between ends of R₂, R₄ ~1.0–1.1X long as R₄. R₄ almost linear, only slightly S-shaped, angle with R₅ at extreme base ~ 65–70°; R₅ ~1.7X long as R₄; R₄ fork distal to M₁, fork by ~ 2X length of R₅; R₅ linear, M₁ slightly curved, almost parallel with R₅ distally; cell bm+dm short, ending near level of R₄. Halter greyish white. **Abdomen.** Ground colour blackish or brownish, somewhat paler on vent; all setulae inconspicuous, very short and brownish dorsally, slightly longer and pale ventrally. **Terminalia.** Black with dark setae. Small and compact. Cercus short and broad (Figs 23, 24), extending to tip of epandrium; broadly subtriangular in dorsal view (Fig. 24) with inner margin concave; mostly with short hairs but a few longer setae apically and dorsally; in ventral view epandrial lobes with one large sharply pointed apical spine directed internally and a shorter blunter process near to it (Fig. 25). Hypandrium small and short, rather strongly arched ventrally, distinctly divided ventrally near base. **Female:** similar to male but wing with extreme base of Cu thickened and distinctly blackish. Abdomen with segments 7 and 8 elongate, ovipositor-like.

**FIGURES 23–25.** Male terminalia of *Hemerodromia conspecta* sp. nov. 23, lateral view of terminalia; 24, dorsal view of cerci; 25, ventral view of epandrium. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium.


**Additional material.** 7♂, Loei Province, Wong Huy [Nong Hin], Suan Hom w/f, 579 m, 17.0415°N, 101.757°E, 22.xi.2013, netted, A.R. Plant (QSBG & NMWC); these specimens are teneral.
Etymology. From the Latin conspecta (conspicuous) in reference to the unusually well developed vertical setae. It is used as a noun in apposition.

Remarks. Hemerodromia conspecta sp. nov. should readily be recognised by its distinctly quadrate thorax and head (but not as strongly quadrate as in H. anomala sp. nov. which characteristically has R_{2+3} terminating in R_{4} rather than in C as in all other described species of Hemerodromia) H. conspecta sp. nov. is also distinctive in having 4–5 pairs of distinct vertical setae. The male terminalia are distinctively small and compact. Hemerodromia conspecta sp. nov. has been found around streams in lowland (579–649 m) forest in Loei Province, north-eastern Thailand (Fig. 79) during November. All but one of the 88 specimens examined were taken in close proximity to basic and mineral rich tufa streams. (Suan Hom, conductivity 414 μS/cm^2, pH 8.08; Suan Sawan conductivity 418 μS/cm^2, pH 7.84). The single specimen from Pla Ba was captured from a basic (pH 7.49) but less mineralised stream (conductivity 90 μS/cm^2) lacking in tufa formations.

Hemerodromia deltulatea sp. nov.
(Figs 26–28, 80)

Diagnosis. A yellow species with mediotope obscured brownish and sutures at anterior margin of scutum, between lateral margin of scutum and fused anepisternum + katepisternum, at anterior and lateral margins of scutellum, at anterior margin of laterotergite and immediately anterior of posterior spiracle, very narrowly black. Set present. Cell bm+dm long. Epandrium strongly concave on dorsal margin and surstylus with a ‘brush’ of very long black bristles apically.

Description. Male: Body length 2.8 mm; wing length 2.2 mm. Head. Black, dusted greyish, frons paler reddish black becoming paler near base of antennae; antenna and mouthparts pale whitish yellow, all setae pale; one pair reclinate ocl; postocular setae uniseriate, becoming biserial below, merging above with 2–3 pairs small vtl hardly distinguishable from fine setulae on vertex and upper occiput; frontal setulae apparently absent. Antenna with postpedicel ~2.0X long as wide, a few minute outstanding setulae subapically, stylus slightly shorter than postpedicel; scape with distinct fine dorsal seta. Thorax. Dusted greyish. Ground colour yellow with mediotergite variably obscured brownish; sutures between prothoracic ‘collar’ and anterior margin of scutum, between lateral margin of scutum and fused anepisternum + katepisternum, at anterior and lateral margins of scutellum, at anterior margin of laterotergite and immediately anterior of posterior spiracle, very narrowly black. All setae yellowish; minute apart from a pair of distinct set and one smaller npl. Legs. Whitish yellow. C1 ~1.2X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer apicals and a posterior ciliation of fine procline hairs ~0.2X long as limb is deep. F1 ~ 1.2X long as C1, ~ 6X long as wide, evenly inflated, slightly constricted on proximal 0.2–0.3; femoral formula ~ 6–7/17–20/17–20/2+6–7, denticles black, rows converging apically; spines yellow, pv and av rows similarly long, becoming somewhat longer proximally. T1 ~ 0.8X long as F1, evenly curved, ventral face shallowly concave; with one row of ~17 sharply pointed spinose setae ventrally; a very small yellow ventroapical spur with distinct ventroapical erect black or yellowish black spinose seta arising from near its base; a short ciliation of distinct procline hairs dorsally on distal 0.2. Mid and hind legs slender with only small pale setulae, somewhat longer dorsally on distal 0.3 of T3. Wing. Membrane slightly darkened by rather even covering of greyish brown microtrichia but hyaline basally. Veins brownish yellow, somewhat darker about base of R_{2+3}, R_{4+5} and distal part of cell bm+dm but pale yellowish near base. Marginal setulae pale. R_{2+3} linear on proximal 0.5, gently curved beyond, joining C ~0.7X distance between end of R_{1} and R_{2}; length of C between ends of R_{2} and R_{3} ~1.5–1.8X long as R_{2}; R_{3} almost linear, only very vaguely S-shaped; R_{3} ~ 2.0–2.2X long as R_{4} almost linear; R_{4+5} fork distal to M_{1+2} fork by ~ 1.0–1.2X length of R_{4}. M_{1} almost linear beyond base, convergent distally with R_{3}; cell bm+dm moderately long, ending distinctly beyond tip of R_{3}. Halter yellowish white. Abdomen. Yellow with tergites 4–6 entirely, 2–3 broadly on at least distal ~0.5 and 1 very narrowly on posterior margin black. Terminalia. Black or brownish-black with cercus paler, yellowish brown. Cercus (Figs 26, 27) of complex structure; about as long as epandrium; subtriangular in dorsal view. Apical lobe incurved; broad, sub-stellate or somewhat club-shaped in lateral view. Median lobe less strongly sclerotized, incurved, bearing a few fine bristly setae apically. Epandrium (Fig. 26) with dorsal margin strongly concave distally in lateral view; a short bluntly pointed dorsoapical projection appearing sharper and longer in posterior view. Surstylus present, emerging slightly beyond end of epandrium; with dense ciliation of black flattened...
specialised setae apically. Hypandrium rather triangular in ventral view (Fig. 28) with apex broadly rounded; very long black setae apically, becoming shorter and yellowish proximally, bare basally; fused ventroapically, divided ventrobasally. **Female**: Unknown.


**Additional material.** Three female *Hemerodromia* specimens collected at the same locality as the holotype male on 24–31.xii.2007 and 7–14.i.2008 (QSBG) may belong to this species but could not be confidently be assigned to it.

**Etymology.** The specific epithet is a concatenation of the Latin *luteus* and the fourth letter of the Greek alphabet (*delta*). It is used as a noun in apposition.

**Remarks.** The ‘brush’ of very long black bristles on the surstylus is a character that readily distinguishes *Hemerodromia deltalutea* sp. nov. from other predominantly yellow species of the genus in Thailand. The species is only known from a single locality in hill evergreen forest at 1,306 m in Kamphaeng Phet Province in northern Thailand (Fig. 80) during December and January in the cool dry season.

**Hemerodromia deminuta** sp. nov.

(Figs 29, 30, 81)

**Diagnosis.** A black species with vein M₂ absent (M₁+₂ fork not present) and a single row of spinose setae ventrally.
on the front tibia. R_{2+3} is short, joining C only about 0.5X the distance between end of R_1 and R_4 and cell bm+dm is rather long, ending just beyond level of R_4. Male terminalia with cercus elongate, linear on distal part. Surstylus with tip slightly spatulate.

**FIGURES 29–30.** Male terminalia of *Hemerodromia deminuta* sp. nov. 29, lateral view of terminalia; 30, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, pss = posterior process of subepandrial sclerite (?), sur = surstylus (?).

**Description. Male:** Body length 3.0 mm; wing length 2.8 mm. **Head.** Black, dusted brownish grey. Antenna whitish but apical receptor of stylus blackish; mouthparts whitish. One pair reclinate ocl; one pair small but distinct and another smaller pair of vtl distinguishable from smaller fine hairs on vertex and upper occiput; postocular and lower occipital setulae minute. Antenna with postpedicel ~2.0–2.5X long as wide, stylus of similar length; scape with distinct fine dorsal seta. **Thorax.** Black, very slightly paler on scutellum, dusted greyish. All setae yellowish white; minute apart from one npl; scutellum with a few minute marginal seta. **Legs.** Ground colour whitish yellow, hardly darker on distal tarsomeres. C1 ~1.1X longer than distance between C1 and C2, all setulae minute except a few slightly longer apicals. F1 ~ 1.2X long as C1, ~ 5X long as wide, hardly constricted 0.3 from base; femoral formula ~ 7/16/16+1/8, denticles black, rows converging apically; spines yellow, shorter than limb is deep, longest basally, av and pv rows of similar strength. T1 ~ 0.6X long as F1, evenly curved, ventral face shallowly concave; with one row of ~12 sharply pointed spinose setae ventrally; ventroapical spur hardly developed; a strong ventroapical erect black spinose seta present. Mid and hind legs slender with only small setulae. **Wing.** Membrane darkened with blackish microtrichia but hyaline basally. Veins greyish black but whitish near base. Marginal setulae greyish. R_{2+3} sublinear, short, joining C ~ 0.5–0.6X distance between end of R_1 and R_4; length of C between ends of R_{2+3} and R_4 ~1.6–1.9X long as R_4. R_4 slightly S-shaped, angle with R_5 at extreme base ~ 75°; R_5 ~2.2X long as R_4; R_5 and M_1 almost linear, very slightly converging distally; M_2 absent, represented at most by a slight fold wing membrane; cell bm+dm rather long, ending just beyond level of R_4. Halter: knob with anterior face black weakly demarked from whitish grey posterior face; stem yellowish white. **Abdomen.** Brownish black dorsally with tergite 1 whitish, tergite 7 hardly paler than preceding segments; ventrally with sternites 1 and 2 largely pale, otherwise brownish black; all setulae, small becoming somewhat longer on distal segments. **Terminalia.** Brownish black with dark setae. Cercus (Figs 29, 30) elongate in lateral view, extending well beyond tip of epandrium, linear on distal part; rather evenly narrowing and curving inward from base to tip, bearing numerous fine setae. Epandrium (Fig 29) rather narrow, bluntly pointed apically with 2–3 strong setae apically and along ventral margin. Hypandrium moderately large, divided ventrally on proximal 0.5, with a few distinct setae posterovertrally. Two internal process present; upper one (probably posterior process of subepandrial sclerite) narrow, slightly constricted apically with a few minute peg-like tubercles subapically on inner face and a strong incurved apical seta; lower process (surstylus) broader, its tip slightly spatulate, bearing numerous fine setae along posterior margin. **Female:** Unknown.
**Type material.** **HOLOTYPE ♂,** THAILAND: Chiang Mai Province, Doi Inthanon NP, Checkpoint 2, 1,700 m, 18°31’.544”N, 98°29’.94’E, 29.iv.–6.v.2007, MT, Y. Areeluck [T1857](QSBG). **PARATYPE:** 1♂, same data as holotype (QSBG).

**Etymology.** The specific epithet is from the Latin *deminuta* meaning diminished or lessened, in reference to the simplified wing venation. It is used as a noun in apposition.

**Remarks.** *Hemerodromia deminuta* sp. nov. is most similar to *H. attenuata* sp. nov. and for differences between the two, see the species account for the latter. This species is only known from hill evergreen forest during April on the mountain Doi Inthanon, Chiang Mai Province, northern Thailand (Fig. 81).

**Hemerodromia demissa** sp. nov.  
(Figs 31–33, 82)

**Diagnosis.** A reddish black species with preapical abdominal segments contrastingly yellow. 2 pairs of apical sct present. Distinguished from *H. curvata* Grootaert, Yang & Saigusa, 2000 primarily by differences in male terminalia with inner margin of cercus distally not serrate and a prominent apical downwardly directed process narrower with stronger serrations on its posterior margin.

**Description.** **Male:** Body length 2.5 mm; wing length 2.0 mm. **Head.** Black, dusted greyish. Antenna pale whitish yellow, scape and pedicel slightly darker, Mouthparts yellowish white. Vertex with only minute setulae (ocl apparently lost in types); postocular and lower occipital setulae minute. Antenna with postpedicel ~2.5X long as wide, stylus ~0.5X as long; scape with small dorsal seta. **Thorax.** Dark reddish brown to reddish black, slightly paler in postpronotal area, dusted greyish. All setae yellowish; minute apart from one small npl (anterior of which are a few very fine hairs); 4 very small apical setae.

**Legs.** Ground colour yellow including apical tarsomeres. C1 ~1.1X longer than distance between C1 and C2; all coxae with only minute setulae except for a few distinctly longer anteroapicals. F1 ~1.1X long as C1, rather strongly inflated ~3.5–4.0X long as wide, distinctly constricted 0.15 from base; femoral formula ~6–7/15–18/12–18/1–2/7; denticles black, rows converging apically, basal denticle of pv series stronger, positioned basal to constriction of limb; spines yellow, av spines longer than pv series. T1 ~0.8X long as F1, evenly curved, ventral face shallowly concave; with 2 rows of ~16 sharply pointed spinose setae ventrally; ventroapical spur weakly developed; a strong ventroapical erect black spinose seta present. Mid and hind legs slender with only small setulae.

**Wing.** Membrane usually slightly but distinctly darkened with brownish microtrichia but hyaline near extreme base. Veins brownish but paler near base. Marginal setulae brownish. R2+3 linear, joining C ~0.8X distance between end of R and R3; length of C between ends of R2+3 and R4 ~1.2X long as R4; R4 almost linear, only slightly S-shaped, angle with R5 at extreme base ~75–80°; R5 ~2.2X long as R4; R4+5 fork distal to M1+2 fork by ~1.5X length of R4; R5 and M1 almost linear, convergent distally; cell bm+dm short, ending at level of R1. Halter entirely dirty whitish.

**Abdomen.** Black dusted greyish but tergite 7 and sternites 7 and 8 contrastingly yellow or sometimes yellowish brown; all setulae black, small except some long yellow bristles posteriorly on sternites 7 and 8 and darker yellowish bristles on tergites 7 and 8. **Terminalia.** Black with dark setae. Cercus rather broad in lateral view (Fig. 31), extending to tip of epandrium; a large broad (in lateral view) terminal process curved downwards bearing distinct serrations on posterior margin (Fig. 33); an inwardly directed rather pointed apical process (in dorsal view) (Fig. 32); inner margin of cercus otherwise lacking serrations or denticles. Epandrium bilobed distally; upper lobe short and blunt, bearing a few strong setae apically; lower lobe elongate, narrow with slightly expanded tip (surstylus ?) incurved and bearing a few short spinose setae on inner margin. Hypandrium narrow and short, reaching only as far as tip of upper lobe of epandrium; aedeagus short, with hook-like lateral projection. **Female:** Unknown.

**Type material.** **HOLOTYPE ♂,** THAILAND: Chiang Mai Province, Doi Inthanon NP, Wachirathan trap 1, 662 m, 18.542°N, 98.600°E, 2–29.v.2014, MT, W. Srisuka and R. Sawkord [QSBG-2014-134](QSBG). **PARATYPES:** 2♂, 1♀, same data as holotype, 3–31.iii.2014; Chiang Mai Province, Queen Sirikit Botanic Garden, deciduous forest, 620 m, 18.9007°N, 98.8551°E, 31.1.–2.ii.2007, flight interception trap, N. Buawangpong, J. Phasuk et al. (QSBG & NMWC).

**Etymology.** The specific epithet *demissa* (Latin) meaning dwelling in lowlands, refers to the lowland habitat in which this species has been found. It is used as a noun in apposition.
FIGURES 31–33. Male terminalia of *Hemerodromia demissa* sp. nov. 31, lateral view of terminalia; 32, dorsal view of cerci; 33, apex of right cercus, inner surface viewed in slightly anterior aspect. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium.

**Remarks.** *Hemerodromia demissa* sp. nov. is clearly closely related to *H. curvata* from Yunnan China, differing mostly in the shape of the distal processes of the cercus and small differences in shape of the tip of the lower epandrial process. *Hemerodromia demissa* sp. nov. lacks a deeply serrate margin on the inner face of the cercus distally (see Grootaert et al. 2000, fig. 11 and Yang & Yang 2004, fig. 113) but instead has a single strong rather pointed, incurved process at the apex (Fig. 32). Additionally the downcurved apical process of the cercus in *H. curvata* is rather quadrate in lateral view (see Grootaert et al. 2000, fig. 10 and Yang & Yang 2004, fig. 112) whereas in *H. demissa* sp. nov. it is more elongate, has stronger serrations on its posterior margin and its extreme apex is not produced dorsally (Figs 31, 33). The thorax of *H. curvata* is apparently black (Grootaert et al. 2000) whereas it is more reddish brown or reddish black in *H. demissa* sp. nov. The preapical abdominal segments of *H. demissa* sp. nov. are distinctly yellow, contrasting with much darker segments on the rest of the abdomen. The species is known from lowland (620–662 m) deciduous and dry evergreen forest biotopes in Chiang Mai Province, northern Thailand (Fig. 82). Adults were captured in February, March and May, coincident with the cool dry season.

*Hemerodromia epsultea* sp. nov.
(Figs 34–36, 83)

**Diagnosis.** A species with thorax entirely yellow with only sutures in front of root of halter and about laterotergite blackish. Sct present. Cell bm+dm long. Abdomen with tergite 2 blackish. Male terminalia with hypandrium and
epandrium clear yellow, surstylus broadly pointed emerging beyond tip of epandrium and bearing strong setae apically.

**FIGURES 34–36.** Male terminalia of *Hemerodromia epsilutea* sp. nov. 34, lateral view of terminalia; 35, dorsal view of cerci; 36, apex of phallus. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, sur = surstylus.

**Description.** Male: Body length 1.9 mm; wing length 1.8 mm. **Head.** Black, dusted greyish, frons slightly paler; antenna and mouthparts pale whitish yellow, all setae pale; one pair small reclinate ocl; postocular setae very small, becoming somewhat longer below, merging above with 1–2 pairs small vtl and a few fine hairs on vertex; frontal setulae apparently absent. Antenna with postpedicel ~2.5X long as wide, a few minute outstanding setulae subapically; stylus somewhat shorter than postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Ground colour clear yellow including mediogaster and prothoracic ‘collar’; only sutures in front of root of halter and about laterotergite blackish; anterior spiracle narrowly and faintly emarginated above with diagonal dark mark. All setae yellowish; minute apart from a pair of distinct set and one smaller npl. **Legs.** Pale yellow. C1 ~1.1–1.2X longer than distance between C1 and C2, all setulae minute. F1 ~ 1.2X long as C1, ~6X long as wide, evenly inflated, hardly constricted on proximal 0.3; femoral formula ~ 6/15/16+1/6, denticles black, rows converging apically; spines yellow, pv and av rows similarly very short and hair-like, becoming somewhat longer proximally. T1 ~ 0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with row of ~16 sharply pointed spinose setae ventrally (in the holotype T1 is tightly reflexed against F1 and it is uncertain if it bears 1 or 2 rows of setae); ventroapical spur small with distinct ventroapical erect black spinose seta arising from near its base. Mid and hind legs slender with only small pale setulae. **Wing.** Membrane faintly darkened by rather even covering of brownish yellow microtrichia but hyaline basally. Veins brownish yellow, somewhat darker about junction of R, and C, base of R2–3, R4+5, and cell bm+dm, but paler near base. Marginal setulae pale. R2–3 almost linear, joining C ~ 0.6–0.7X distance between end of R1 and R4; length of C between ends of R2+3 and R4 ~1.8–2.0X long as R4; R4 slightly S-shaped, angle with R5 at extreme base ~85°, becoming ~70–80° thereafter, joining C at ~85°. R5 ~ 2.8X long as R5, slightly curved; R4+5 fork distal to M1+2 fork by ~1X length of R4. M1 almost linear beyond base, convergent distally with R5; cell bm+dm long, ending beyond tip of R5. Halter yellowish white. Squama with margin greyish. **Abdomen.** Yellow with tergites 2–5 blackish; all setae yellow, short but slightly longer on distal segments, especially sternites 6 and 7. **Terminalia.** Epandrium and hypandrium clear yellow, cercus and surstylus black. Cercus distinctly angulate in dorsal view (Fig. 34), distal lobe incurved bearing numerous strong setae (Fig. 35). Epandrium sub-trapezoid, without strong setae on external face. Surstylus present, broad bluntly pointed apically.
with strong apical setae, partly fused with and emerging beyond epandrial lamella. Hypandrium narrow, with distinct setae distally. Phallus with sharply pointed apical processes (Fig. 36). Female: Unknown.


**Etymology.** The specific epithet is a concatenation of the Latin *luteus* and the fifth letter of the Greek alphabet (*epsilon*). It is used as a noun in apposition.

**Remarks.** The combination of male terminalia clear yellow and abdomen yellow with tergite 2 blackish serves to distinguish *H. epsilutea* sp. nov. from other yellow species of *Hemerodromia* occurring in Thailand although confirmation of identity requires more detailed examination of the male terminalia. The species is only known from a single lowland (662 m) site in dry evergreen forest during May in Chiang Mai Province, northern Thailand (Fig. 83).

**Hemerodromia etalutea** sp. nov.
(Figs 37–39, 84)


**Description. Male:** Body length 2.6–3.0 mm; wing length 2.5 mm. **Head.** Black, dusted greyish; frons paler, brownish in front of ocelli, becoming whitish near base of antenna; antenna and mouthparts pale whitish yellow, all setae pale; one pair procline ocl; postocular setae uniseriate, merging above with ~1–2 pairs small vtl and several fine setulae on vertex; frontal setulae apparently absent. Antenna with postpedicel ~2.5–3.0X long as wide, a few minute outstanding setulae subapically; stylus shorter, ~0.4–0.45X long as postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusty greyish. Ground colour clear yellow including mediotorgete and prothoracic ‘collar’; only sutures about laterotergite blackish. All setae yellowish; minute apart from a pair of distinct sct and one npl. **Legs.** Pale yellow. C1 ~1.2X longer than distance between C1 and C2, a few distinct setulae dorsally and apically. F1 ~1.2X long as C1, ~6X long as wide, evenly inflated, hardly constricted on proximal 0.3; femoral formula ~7–8:18–19:18–19+1–2:6–8, denticles black, rows converging apically; spines yellow, pv and av rows rather short, 0.3–0.5X long as limb is deep, becoming somewhat longer proximally with basal spine of pv row much stronger. T1 ~0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with one row of ~15 sharply pointed spinose setae ventrally; ventroapical spur extremely small with strong erect black spinose seta arising from near base; a ciliation of short setulae dorsally on distal 0.3. Mid and hind legs slender with only small pale setulae. **Wing.** Membrane with yellow microtrichia but hyaline basally. Veins yellow, paler near base of wing. Marginal setae pale. R2~5 almost linear, joining C ~0.6X distance between end of R4 and R5; length of C between ends of R1~5 and R1~8 ~1.8–2.0X long as R4; R4 slightly S-shaped, angle with R5 at extreme base ~85°, becoming ~70–80° thereafter, joining C at ~85°. R5 ~2.0–2.5X long as R4, almost linear; R4+5 fork distal to M1+3, fork by ~1X length of R4, M5 slightly curved, convergent distally with R5; cell bm+dm long, ending beyond tip of R5. Halter yellowish white. Squama with margin yellowish. **Abdomen.** Yellow with tergites 3–5 and 8 blackish; tergite 2 sometimes faintly darker medially. Tergite 8 with dark bristly setae on posterior margin; tergite 7 with a few smaller yellow setae on disc. **Terminalia.** Cercus of complex structure; slightly shorter than epandrium; narrow distally with tip upturned in lateral view (Fig. 37); 2 small subtriangular dorsal process on proximal 0.5 with a short row of very fine setulae adjacent on outer face (Figs 37, 38). Epandrium with upper margin distinctly and rather abruptly curved beyond middle; a cluster of 3–4 strong setae apically. Surstylus present, not reaching beyond tip of epandrium; apically inflated with several strong black peg-like modified setae around tip (Fig. 39). A pale yellowish (almost transparent) dorsoapically pointed process emerging slightly beyond tip of epandrium. Hypandrium small, angular, subquadrilateral with a few distinct setae proximally. **Female.** Similar to male; terminalia blackish.

**Type material.** HOLOTYPE ♂, THAILAND: Nakhon Si Thammarat Province, Namtok Yong NP, TV aerial, 966 m, 8°14.262′N, 99°48.289′E, 15–22.x.2008, MT, Paiboon [T4226](QSBG). **PARATYPES:** ♂, ♀, same data as holotype (QSBG & NMWC).

**Etymology.** The specific epithet is a concatenation of the Latin *luteus* and the seventh letter of the Greek alphabet (*eta*). It is used as a noun in apposition.
Remarks. *Hemerodromia etalutea* sp. nov. can be distinguished from other species with an unmarked yellow scutum by having the mediotergite clear yellow and the wing with both veins and membrane yellow but confirmation of identification requires examination of male terminalia. The species is only known from Nakhon Si Thammarat Province in southern Thailand (Fig. 84) at mid elevation (966 m) in October.

**FIGURES 37–39.** Male terminalia of *Hemerodromia etalutea* sp. nov. 37, lateral view of terminalia; 38, dorsal view of cerci; 39, apex of surstylus. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, sur = surstylus.

*Hemerodromia flaviventris* Yang & Yang (Figs 1, 2, 40–42, 85)

*Hemerodromia flaviventris* Yang & Yang, 1991: 236.

**Diagnosis.** Thorax yellow with scutum entirely black, hardly paler laterally or about notopleural area; scutellum, mediotergite, laterotergite and meron black. Wing with cell bm+dm short, ending as about level of R₁. Male cercus with small inwardly directed subapical process on inner face.

**Re-description.**

**Male:** Body length 2.8 mm; wing length 2.3 mm. **Head.** Black, dusted greyish, strongest on upper occiput; antenna and mouthparts yellowish white, all setae whitish; one pair reclinate ocl; postocular setae uniseriate, merging above with two pairs small vtl and numerous fine setulae on vertex; frontal setulae apparently absent. Antenna with postpedicel 1.5X long as wide, stylus of similar length; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Scutum with ground colour black or brownish black, at most extreme lateral margin of postpronotal area yellow. Scutellum, mediotergite, laterotergite, anepimeron and meron black. Fused anepisternum + katepisternum dark yellowish with small triangular area below root of wing blackish; sometimes obscurely darkened ventrally (Fig. 1) Proepimeron blackish ventrally behind insertion point of front legs. All setae yellowish; minute apart from a pair of distinct set and one smaller npl. **Legs.** Yellowish white, apical tarsal segment hardly darker. C₁ ~ 1.2–1.3X longer than distance between C₁ and C₂, all setulae minute excepting a few slightly longer apicals. F₁ ~ 1.2X long as C₁, ~ 5X long as wide, very slightly constricted 0.3 from base; femoral formula ~ 8/18–20/17–21+2/6–7, denticles black, rows converging apically; spines yellow (Fig. 2), pv row longer than av row , both rows becoming longer proximally. T₁ ~ 0.7X long as F₁, evenly curved, ventral face shallowly concave; with one row of ~ 22 sharply pointed spinose setae ventrally; ventroapical spur very weakly developed; a strong
ventroapical erect black spinose seta present. Mid and hind legs slender with only small setulae; T1 with somewhat longer setulae dorsally on distal 0.5; T3 with short row of small setae posterodorsally before tip and a ‘comb’ of short setae posteroapically. **Wing.** Membrane rather evenly covered with dark microtrichia but hyaline basally. Veins brownish to greyish black but whitish near base. Marginal setulae yellowish grey. R$_{2+3}$ evenly curved, rather long joining C ~ 0.7–0.75X distance between end of R$_1$ and R$_4$; length of C between ends of R$_{2+3}$ and R$_4$ short, ~1.2X long as R$_4$. R$_4$ slightly S-shaped, angle with R$_3$ at extreme base ~ 80–90°, becoming ~70–80° thereafter, joining C at ~ 90°; R$_5$ ~ 2.2X long as R$_4$, almost linear; R$_{2+5}$ fork distal to M$_{1+2}$ fork by ~ 1.2X length of R$_4$. M$_1$ almost linear beyond base, convergent distally with R$_5$; cell bm+dm short, ending as about level of R$_5$. Halter pale yellowish white. **Abdomen.** Black with tergites 1 and 7 and sternites 1–3 and 7 yellowish. Tergites with brownish hairs, sternites with yellowish hairs, very short on anterior segments becoming progressively longer on posterior segments. **Terminalia.** Black with dark setae. Cerci elongate, extending beyond tip of epandrium (Fig. 40); broader proximally in dorsal view (Fig. 41); with tip down-curved viewed laterally and a small inwardly directed subapical process on inner face (Fig. 42). Epandrium elongate ovoid with strong setae on outer face (Fig. 41). Hypandrium divided ventrobasally, fused ventroapically. Slender process with distal part emerging free between apex of cercus and epandrium; distally incurved, slightly inflated apically with 3–4 short tooth-like setae on inner face. Surstylus present, broad subovate, emerging beyond epandrial lamella; apical margin with inner face bearing numerous close-set inwardly directed setulae, becoming longer on pv margin. **Female:** similar to male but spines and denticles beneath F1 rather more numerous, femoral formula ~ 8/23/20–26+2/7–8. Abdomen dorsally with only tergite 1 yellowish; vent more extensively yellowish, only sternite 1 on posterior margin, sternite 7 and terminalia blackish.

**FIGURES 40–42.** Male terminalia of *Hemerodromia flaviventris* Yang & Yang 40, lateral view of terminalia; 41, dorsal view of cerci; 42, apex of left cercus in laterodorsal view. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, sur = surstylus.

**Material examined.** THAILAND: 23 ♂, 9♀, Chiang Mai Province, Doi Inthanon NP, small stream in hill evergreen forest below Checkpoint 2, 1,650 m, 18.516°N, 98.483°E, 6.xii.2013, netted, A.R. Plant; Checkpoint 2, 1,611 m, 18.520°N, 98.5208°E, 27.xi.2012, netted, A.R. Plant; Siriphum waterfall, 1,333 m, 18.5422°N, 98.5172°E, 23.xi.2012, netted, A.R. Plant; Pinus forest well below Checkpoint 2, 1,543 m, 18.5713°N, 99.0189°E, 23.xi.2012, netted, A.R. Plant; hill evergreen forest in Doi Inthanon NP [precise locality unrecorded], 27.xi.2012; 2♂, Chiang Mai Province, Doi Phahompok NP, *Pinus kesiya* forest, 1,476 m, 20.01722°N, 99.16166°E, 29.xi.2012,

**Remarks.** In darker individuals the dark ventral marking on the fused anepisternum + katepisternum is more pronounced forming a narrow blackish brown stripe along the lower part of the sclerites and sometimes the triangular dark patch under the root of the wing is enlarged to cover much of the posterior part of the pleura. *Hemerodromia flaviventris* was described from Guangxi, China (Yang & Yang 1991). In Thailand it has been noted from predominantly evergreen and *Pinus* forest biotopes at 1,141–1,650 m at localities in Nan and Chiang Mai provinces, northern Thailand (Fig. 85). It appears to favour small to medium-sized streams often in dense shade and adult emergence is apparently confined to November and December during the cool dry season.

*Hemerodromia furcata* Grootaert, Yang & Saigusa
(Figs 43–45, 86)

*Hemerodromia furcata* Grootaert, Yang & Saigusa, 2000: 77.

**Diagnosis.** Thoracic dorsum blackish. Laterotergite, meron and a small area of fused anepisternum + katepisternum below root of wing black; pleura otherwise yellow. Halter black. Cercus apically bifurcate.

**Re-description.** **Male:** Body length 2.2–2.6 mm; wing length 1.7–1.8 mm. **Head.** Black, dusted greyish; antenna pale yellow to brownish, apex of stylus darker; mouthparts yellowish white; all setae pale; one pair reclinate ocl; postocular setae very small, uniseriate, merging above with two pairs small vtl and several fine setulae on vertex; frontal setulae apparently absent. Antenna with postpedicel 2.0–2.5X long as wide, stylus shorter; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Scutum with ground colour dark yellowish brown to black, often somewhat more yellowish on postpronotal area. Anterior spiracle narrowly emarginated with elongate U-shaped black mark, opening posteriorly (clearly visible in paler specimens, more obscure in dark ones). Scutellum, mediotergite and laterotergite black; meron yellowish or considerably darkened, especially below. Fused anepisternum + katepisternum with yellow ground colour and small triangular area below root of wing blackish; sometimes obscurely darkened ventrally. Proepimeron darkened on pv margin. All setae yellowish; minute apart from a pair of distinct setae and one smaller npl. **Legs.** Varibly whitish yellow to brown; sometimes entirely pale but in dark individuals C1 and C2 and extreme base of C1, proximal 0.3 of F2 and F3 pale. Tarsal segments 4 and 5 sometimes darkened. C1 rather short ~ 1.1X longer than distance between C1 and C2, all setae minute excepting a few slightly longer apicals. F1 ~ 1.2X long as C1, ~ 5X long as wide, evenly inflated, hardly constricted on proximal 0.3; femoral formula ~ 7–8/22–28/24–30+1–2/6–7, denticles black, rows converging apically; spines yellow, pv and av rows similarly long, not becoming longer proximally. T1 ~ 0.7X long as F1, evenly curved, ventral face shallowly concave; with one row of ~ 15–19 sharply pointed spinose setae ventrally; ventroapical spur absent, a strong ventroapical erect black spinose seta present. Mid and hind legs slender with only small dark setulae; T3 with short row of small setae posteroventrally before tip and a ‘comb’ of short setae posteroapically. **Wing.** Membrane rather evenly covered with dark microtrichia but hyaline basally. Veins greyish to blackish but whitish near base; R2+3 and R4+5 often darker. Marginal setulae dark. R4+5, linear before tip, rather long joining C ~ 0.8X distance between end of R4 and R5; length of C between ends of R2+3 and R4 short, ~1.1X long as R4+5, slightly S-shaped, angle with R4 at extreme base ~ 80°, becoming ~70–80° thereafter, joining C at ~ 80–90°; R3 ~ 2.2X long as R4+5, almost linear; R4+5 fork distal to M1+2; fork by ~ 1.5X length of R4+5 fork, M1+2 almost linear beyond base, convergent distally with R4+5; cell dm with ~1 dm short, ending as about level of R4+5, Halter with knob black, stem sometimes paler. **Abdomen.** Black with tergites 1 and sternites 1–2 yellowish with dark posterior margins. Tergites with brownish hairs, sternites with yellowish hairs, very short on anterior segments becoming progressively longer on posterior segments. **Terminalia.** Black with dark setae. Cerci elongate, extending beyond tip of epandrium (Fig. 43); apically bifurcate with upper process bearing strong setae (Fig. 45), lower process longer with generally weaker setae except two inwardly curving bristles at extreme tip; basal part broader in dorsal view (Fig. 44), with long fine posteriorly directed setae. Epandrium elongate subovate, rather evenly covered with setae on outer face. Epandrium extending beyond tip of hypandrium. Surstylus present, reaching just beyond tip of epandrium, bilobed; dorsal lobe broad with apex inflated, almost shoe-shaped, with minute denticles and setulae on inner face; ventral lobe narrow, slightly inflated and upturned apically, bearing distinct apical setae. **Female:** similar to male but abdomen with sternites 1–6 yellow; sternite 7 with some long dark hairs on disc.

Remarks. Hemerodromia furcata was described from Menglun in Yunnan, China by Grootaert et al. (2000) from a single male specimen. The male terminalia of H. furcata (Grootaert et al. 2000, figs 16–18) appear to be extremely similar to those of H. menglunana Grootaert, Yang & Saigusa, 2000 (Grootaert et al. 2000, figs 19–21) with only slight differences in the depth of forking in the dorsal process of the cercus and shape of the tip of the aedeagus. In their diagnoses of the two species, the authors mention only one distinguishing feature; that the thoracic dorsum of H. furcata is ‘black’ whereas in H. menglunana it is ‘yellow excepting scutellum and metanotum brown’. The paratype of H. menglunana was taken at the same locality and date as the only known specimen of H. furcata and the holotype was taken in the same locality 3 days earlier. Differences in thoracic coloration are commonplace in Hemerodromia and only occasionally of diagnostic utility; indeed, Thailand specimens of H. furcata studied here from Nan Province are considerably darker than those from elsewhere. Similarly, minor differences in the shape of the cercus are apparent in different specimens. Given that all the Chinese specimens of the two species were collected in the same place, mostly at the same time, and that minor differences in colour or genital morphology are generally of dubious taxonomic value, there can be little doubt that

![FIGURES 43–45. Male terminalia of Hemerodromia furcata Grootaert, Yang & Yang. 43, lateral view of terminalia; 44, dorsal view of cerci; 45, apex of cercus. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, lsur = lower lobe of surstylus, usur = upper lobe of surstylus.](image-url)
they are a single species. However, having not examined the type material of either species I refrain from proposing a formal synonymy here. In the present work I apply the name *H. furcata* rather than *H. menglunana*.

In Thailand, *H. furcata* is widely distributed, and most frequent in the north (Fig. 86), occurring in a variety of mid to low elevation forest types at 51–1,476 m. Of 74 specimens examined, one was captured in March, 21 in July and 53 in October or November suggesting that peak adult activity may correlate with the start and end of the Southwest Monsoon rains.

**Hemerodromia fusca** Yang & Yang

(Figs 46, 47, 87)

*Hemerodromia fusca* Yang & Yang, 1986: 75.

**Diagnosis.** A species with thorax black, legs and antennae variably blackish to yellowish. Front femur often darker. The male cercus is elongate in profile with a distinct dorsal process 0.5 from base. Surstylus extending beyond tip of epandrium, very conspicuously inflated apically where broadly T-shaped.

**Re-description. Male:** Body length 2.3 mm; wing length 2.0 mm. **Head.** Black, dusted brownish grey. Antenna sometimes entirely pale but often with scape and pedicel pale brown, postpedicel paler and stylus usually blackish. Mouthparts yellowish white with tip of proboscis brownish. One pair reclinate ocl; two pairs small vtl distinguishable from smaller fine hairs on vertex and upper occiput; postocular and lower occipital setae minute. Antenna with postpedicel ~2X long as wide, stylus rather shorter; scape with distinct fine dorsal seta. **Thorax.** Black, dusted greyish. All setae yellowish; minute apart from one npl; set absent but scutellum with a pair of very small erect setulae on disc. **Legs.** Ground colour variably whitish yellow to dark blackish brown; often front legs (especially C1 and/or F1) darker than others, sometimes only C1 dorsally darkened. C1 ~1.2X longer than distance between C1 and C2, all setulae minute except a few slightly longer dorsoapicals. F1 ~ 1.1–1.2X long as C1, ~ 4–5X long as wide, not at all constricted 0.3 from base; femoral formula ~7–10/18–23/19–20+0/1–8–9, denticles black, rows converging apically; spines yellow, short, fine much shorter than limb is deep, longest basally, pv row somewhat longer than av row with basal spine of pv row longer still. T1 ~ 0.7X long as F1, evenly curved, ventral face shallowly concave; with 2 rows of ~19 sharply pointed spinose setae ventrally; ventroapical spur hardly developed; a strong ventroapical erect black spinose seta present. Mid and hind legs slender with only small setulae. **Wing.** Membrane usually conspicuously darkened with black microtrichia but hyaline basally. Veins blackish but whitish near base. Marginal setulae greyish. R2+3 linear, joining C ~ 0.7X distance between end of R and R; length of C between ends of R2+3 and R4 ~1.2–1.4X long as R; R4 almost linear, usually only slightly S-shaped, angle with R4 at extreme base ~70–80°, slightly swollen apically before junction with C; R4 ~ 2.0–2.2X long as R; R4+5 fork distal to M1+2 fork by ~1.2–1.4X length of R; R4 and M1 almost linear, convergent distally; cell bm+dm short, ending at level of R4. Halter variably blackish, paler on stem; sometimes entirely dirty white. **Abdomen.** Black dusted greyish but tergite 1 and occasionally tergite 2 paler; sternite 1 paler on disc, sternite 2 whitish with dark median line and posterolateral marks; all setae yellow, small except posteriorly and laterally on sternite 7. **Terminalia.** Black with dark setae. Cercus moderately elongate in lateral view, extending beyond tip of epandrium (Fig. 46), a shorter dorsal lobe originating ~0.5 from base (sometimes twisted internally and inconspicuous in lateral view) (Fig. 47). **Material examined.** 104♂, 102♀, Beung Kan, Chaiyaphum, Chantaburi, Chiang Mai, Kamphaeng Phet, Kanchanaburi, Khon Kaen, Lampang, Loei, Mukdahan, Nakhon Nayok, Nakhon Si Thammarat, Nan, Petchaburi and Surat Thani provinces (QSBG, NMWC, INPA, MSU, MNHN). Note, 1 ♂, 1♀ removed for DNA sequence analysis (INPA, MNHN); 24 specimens removed for population genetics studies (MSU).
**Remarks.** This species is very similar to *H. yunnanensis* Yang & Yang, 1988 and also to *H. phahompokensis* sp. nov. from which it differs primarily in morphology of the male terminalia (see discussion under *H. yunnanensis*). *Hemerodromia fusca* was described from Fujian, China (Yang & Yang 1986) but is also known from Yunnan (Grootaert et al. 2000) so may be widely distributed across southern China. The author and J. T. Câmara (pers. comm.) have also seen specimens of this species in collections from Vietnam but precise collection localities are not available. In Thailand *H. fusca* is present throughout the country (Fig. 87), occurring in vicinity of streams and rivers in a variety of forest types and in irrigation channels in rice fields at 95–1,306 m. It has been taken in every month of the year but appears to be most abundant from September to March.

**Hemerodromia gammalutea** sp. nov.  
(Figs 48–50, 88)

**Diagnosis.** A yellow species with mediotergite with variably brownish marking narrowing posteriorly to a broad point on posterior margin leaving posterolateral margins yellow. Sct present. Cell bm+dm long. Wing vein forks R$_{4+5}$ and M$_{1+2}$ rather close together, separated by less than length of R$_{4}$. Tergites 2–5 blackish, 6 yellow. Male terminalia with cercus of complex and characteristic structure.

**Description.** **Male:** Body length 2.5 mm; wing length 2.1 mm. **Head.** Black, dusted greyish, frons slightly paler; antenna and mouthparts pale yellowish white, all setae pale; one pair reclinate ocl; postocular setae uniseriate, becoming biserial below, merging above with 1–2 pairs small vtl hardly distinguishable from fine setulae on vertex and upper occiput; frontal setulae apparently absent. Antenna with postpedicel ~1.8–2.0X long as wide, stylus about as long as postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusty greyish. Ground colour yellow; mediotergite with variably brownish marking narrowing posteriorly to a broad point on posterior margin leaving posterolateral margins yellow; prothoracic ‘collar’ vaguely brownish medially; sutures between prothoracic ‘collar’ and anterior margin of scutum and lateral margins of scutellum very narrowly black. All setae yellowish; minute apart from a pair of distinct sct and one smaller npl. **Legs.** Whitish yellow. C1 ~1.2X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer apicals and a posterior ciliation of fine proclinate hairs ~0.2X long as limb is deep. F1 ~ 1.2X long as C1, ~ 6X long as wide, evenly inflated, almost indiscernibly constricted on proximal 0.2–0.3; femoral formula ~ 6–7/18–20/15+1/5, denticles black, rows converging apically; spines yellow, pv and av rows similarly long, becoming somewhat longer proximally. T1 ~ 0.7–0.8X long as F1, evenly curved, ventral face shallowly concave; with one row of ~ 16 sharply pointed spinose...
setae ventrally; a small yellow ventroapical spur with distinct ventroapical erect black or yellowish black spinose seta arising from near its base; a short ciliation of distinct proclinate hairs dorsally on distal 0.2. Mid and hind legs slender with only small pale setulae, somewhat longer on front metatarsus proximally and dorsally on distal 0.3 of T3. **Wing.** Membrane slightly darkened by rather even covering of yellowish brown microtrichia but hyaline basally. Veins brownish yellow, somewhat darker about base of R_{2+3}, R_{4+5} and distal part of cell bm+dm but pale yellowish near base. Marginal setulae pale. R_{2+3} almost linear, gently curved, joining C ~ 0.6X distance between end of R_{1} and R_{4}; length of C between ends of R_{2+3} and R_{4} ~ 2X long as R_{4}; R_{4} almost linear, only very vaguely S-shaped; R_{5} ~ 2.2–2.5X long as R_{4}, almost linear; R_{4+5} fork distal to M_{1,2}, fork by ~ 0.5–0.8X length of R_{4}. M_{1} very gently curved beyond base, convergent distally with R_{4}; cell bm+dm moderately long, ending distinctly beyond tip of R_{4}. Halter yellowish white. **Abdomen.** Yellow with tergites 2–5 brown; all setae yellow, short but longer on sternites 6–7 and posterior margins of sternites 7 and tergite 8. **Terminalia.** Cercus of complex structure; about as long as epandrium (Fig. 48); a basal subtriangular to quadrate lobe bearing numerous short spinose setae along inner margins; an elongate lobe, apparently originating beneath basal lobe, projecting posteriorly with extreme tip reflexed anteriorly and bearing 3–4 short black spines; a narrow process originating from outer margin just beyond 0.5 from base, curving dorsally and inwardly, with 2 short twisted spines at tip; apical lobe rather broad, slightly incurved, bearing short but distinct setae on outer face, almost bare on inner face (Fig. 49). Epandrium slightly concave dorsally in lateral view; a short pointed posterodorsal process bearing numerous fine setae behind; a fan of closely spaced fine setae emerging from behind posterior margin (probably arising from surstylus hidden beneath epandrium). Hypandrium rather triangular in ventral view (Fig. 50) distally rounded with pointed tip; fused ventroapically where covered with strong setae; divided ventrobasally, bare. **Female:** Unknown.

**FIGURES 48–50.** Male terminalia of *Hemerodromia gammalutea* sp. nov. 48, lateral view of terminalia; 49, dorsal view of cerci; 50, ventral view of hypandrium (semi-schematic, setae not shown). Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium.

**Etymology.** The specific epithet is a concatenation of the Latin *luteus* and the third letter of the Greek alphabet (*gamma*). It is used as a noun in apposition.

**Remarks.** *Hemerodromia gammalutea* sp. nov. is only known from moist hill evergreen forest at around 2,200 m on the mountains Doi Phahompok and Doi Inthanon in Chiang Mai Province, northern Thailand (Fig. 88). Adults were captured in May at the start of the Southwest Monsoon.

*Hemerodromia isochita* sp. nov. (Figs 51, 52, 89)

**Diagnosis.** Thorax yellow with sharply defined broad blackish median stripe; scutellum and mediogaster blackish; prothoracic ‘collar’ broadly black dorsally. Wing with a short stub of vein CuA3 present; cell bm+dm long, ending distinctly beyond level of R1. Cercus with complex process on inner face with convoluted tip bearing 4 blunt spines largely orientated internally.

**Description. Male:** Body length 2.0 mm; wing length 1.8 mm. **Head.** Black, dusted greyish, strongest on upper occiput; antenna and mouthparts yellow, all setae whitish; one pair reclinate ocl; postocular setae uniseriate below, becoming 2–3 serial above where merging with and hardly distinguishable from two pairs small vtl and several fine setulae on vertex; frontal setulae apparently absent. Antenna with postpedicel 1.8X long as wide, stylus slightly shorter; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Scutum with broad brownish black median stripe, about as wide as prothoracic ‘collar’ anteriorly, becoming broader posteriorly, leaving postpronotal area and lateral margins broadly clear yellow, boundary between dark and yellow pattern quite sharply defined. Prothoracic ‘collar’ broadly on dorsum, scutellum, mediotergite and sometimes dorsal part of anatergite brownish black. Pleura clear yellow (but sometimes with meron and fused anepisternum + katepisternum somewhat dusky); sutures about laterotergite and base of halter blackish. All setae yellowish; minute apart from a pair of distinct sct.

**Abdomen.** Tergites 1 and 7 yellow, 2–6 and 8 black; sternites yellow; posterior marginal and discal setae small and fine except longer and brownish on tergite 8 posteriorly. **Terminalia.** Black with dark setae. Cercus elongate, extending as far as tip of epandrium in lateral view with 4–5 strong outstanding spinose setae dorsally on proximal 0.6 and numerous fine longish setae dorsally and on outer face (Fig. 51); slightly in-turned distally with irregularly rounded blunt apex. A complex process situated along inner face of cercus along with convoluted tip bearing 4 blunt spines largely orientated internally (Fig. 52). Epandrium moderately elongate subrectangular with a few distinct setae on outer face and 4–5 narrow elongate processes apically (specialised setae?). Hypandrium rather narrow, largely obscured by epandrium. **Female:** Similar to male.

**Type material.** **HOLOTYPE** ♂, THAILAND: Chiang Mai Province, Doi Phahompok NP, Doi Phaluang, 1,449 m, 20°1.06′N, 99°9.581′E, 14–21.i.x.2007, MT, P. Wongchai, [T6164](QSBG). **PARATYPES:** 4♂, 1♀, same
HEMERODROMIA OF THAILAND

Etymology. The specific epithet *isochita* refers to this species' similarity to *H. chita* Smith, 1965 from Nepal.

Remarks. The male terminalia are very similar to *H. chita* Smith, 1965 from Nepal in both colouration and form of cerci and epandrium. Both *H. chita* and *H. isochita* sp. nov. have a distinct ‘stump’ of vein CuA₂ present in the wing. *Hemerodromia isochita* sp. nov. is known only from the mountain Doi Phahompok, Chiang Mai Province, northern Thailand (Fig. 89). All but one of the 8 known specimens were taken in mid-elevation forest (1,449 m) from May to December with one captured in moist hill evergreen forest at 2,200 m in late January.

**FIGURES 51–52.** Male terminalia of *Hemerodromia isochita* sp. nov. 51, lateral view of terminalia; 52, Apex of right ‘complex process’ situated along inner face of cercus. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium.

**Hemerodromia namtokhinpoon** sp. nov.

(Figs 53, 54, 90)

Diagnosis. A species with thorax entirely yellow with only sutures in front of root of halter and between prothoracic ‘collar’ and front of scutum blackish, Sct present. Cell bm+dm short. Wing veins and membrane conspicuously darkened proximally about level of cell bm+dm. Epandrium very elongate with very strong apical bristle.

Description. Male: Body length 1.75–2.2 mm; wing length 1.9 mm. Head. Black, dusted greyish, frons paler; antenna and mouthparts pale whitish yellow, all setae pale; one pair reclinate ocl; postocular setae very small, becoming somewhat longer below, merging above with 2–3 pairs small vtl and a few fine hairs on vertex; frontal setulae apparently absent. Antenna with postpedicel ~2.5–2.8X long as wide, a few minute outstanding setulae subapically; stylus shorter, ~0.5X long as postpedicel; scape with distinct fine dorsal seta. Thorax. Dusted greyish. Ground colour clear yellow including mediotergite and prothoracic ‘collar’; only sutures in front of root of halter and between anterior margin of scutum and prothoracic ‘collar’ darkened. All setae yellowish; minute apart from a pair of distinct sct and one smaller npl. Legs. Pale yellow. C1 ~1.0–1.1X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer dorsals on distal 0.2. F1 ~ 1.2X long as C1, ~ 6X long as wide, evenly inflated, not constricted on proximal 0.3; femoral formula ~ 7–8/17–19/19/8–9, denticles black, rows converging apically; spines yellow, pv and av rows similarly very short and hair-like, becoming somewhat longer proximally. T1 ~ 0.7–0.8X long as F1, evenly curved, ventral face shallowly concave; with 2 rows of ~ 17 similarly sized sharply pointed spinose setae ventrally; ventroapical spur extremely small; a distinct ventroapical erect black
spinose present. Mid and hind legs slender with only small pale setulae. **Wing.** Membrane darkened by rather even covering of yellowish brown microtrichia, darker still in band across wing at level of cell bm+dm but hyaline basally. Veins yellowish grey, distinctly blackish about base of R\_2+3, R\_4+5 and cell bm+dm but pale yellowish near base. Marginal setulae pale. R\_2+3 almost linear, joining C \(\sim 0.7–0.8X\) distance between end of R\_1 and R\_3; length of C between ends of R\_2+3 and R\_4 \(\sim 1X\) long as R\_4; R\_5 slightly S-shaped, angle with R\_4 at extreme base \(\sim 80^\circ\), becoming \(\sim 70–80^\circ\) thereafter, joining C at \(\sim 80^\circ\). R\_5 \(\sim 2.2–2.5X\) long as R\_4, almost linear; R\_4 fork distal to M\_1, fork by \(\sim 0.8–1.0X\) length of R\_4. M\_1 almost linear beyond base, convergent distally with R\_5; cell bm+dm short, ending at tip of R\_5. Halter yellowish white. Squama with margin blackish.

**Abdomen.** Yellow with tergites 2–6 brown or blackish with 2, 5 and 6 variably yellowish anterolaterally; all setae yellow, short but longer on distal segments, especially sternites 6 and 7. **Terminalia.** Black, small. Cercus of complex structure (Fig. 53); about as long as epandrium; apically with two inwardly curving blunt spinose rather shallowly crenate lobes; broad proximally in dorsal view with a ciliation of short, stout, close-set posteriorly directed setae on inner face medially (Fig. 54). Narrow process with spatulate tip emerging below ventral margin of cercus (probably posterior process of subependial sclerite). Epandrium very narrow, elongate with strong incurved apical bristle and several smaller bristles on outer face. Hypandrium subovate, apparently lacking distinct setae.

**Female:** Similar to male but F1 with spines rather longer (especially proximal two of both av and pv rows). Abdomen with setae very small, inconspicuous.

**Type material.** **HOLOTYPE ♂, THAILAND:** Loei Province, Wong Huy [Nong Hin], Suan Hom w/f (tufa stream), 579 m, 17.0415°N, 101.757°E, 29.xi.2013, netted, A.R. Plant (QSBG). **PARATYPES:** 1♂, 4♀, same data as holotype; 2♂, 5♀, 22.xi.2013; 10 ♀ Nong Hin, Suan Sawan (tufa stream), 676 m, 17.0596°N, 101.7421°E, 26.xi.2013, netted, A.R. Plant; 2♂, Na Haeo, Phu Suan Sai NP, Tat Mueng, by w/f, 560 m, 17.561°N, 100.991°E, netted, A.R. Plant (QSBG & NMWC).

**Additional material.** 5♂, 5♀ (teneral), same data as holotype, 22.xi.2013; 2♂, 3♀ (teneral), Nong Hin, Suan Sawan (tufa stream), 676 m, 17.0596°N, 101.7421°E, 26.xi.2013, netted, A.R. Plant; 2♀ (teneral), Phu Suan Sai NP, Tat Mueng, by w/f, 560 m, 17.561°N, 100.991°E, netted, A.R. Plant (QSBG & NMWC).

**Etymology.** The specific epithet is a contraction of the Thai nam tok hin poon meaning tufa (literally ‘limestone waterfall’) in reference to the species’ clear preference for tufa habitats. It is used as a noun in apposition.

**Remarks.** This species may be distinguished from other predominantly yellow species of *Hemerodromia* occurring in Thailand by its complex crenate cercus and elongate epandrium which bears a very strong apical bristle. All but one of the 39 specimens of *H. namtokhinpoon* sp. nov. examined were taken in close proximity to basic and mineral rich tufa streams (Fig. 90) in Loei Province, northeast Thailand. (Suan Hom, conductivity 414...
HEMERODROMIA OF THAILAND

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μS/cm², pH 8.08; Suan Sawan conductivity 418 μS/cm², pH 7.84). The two specimens from Tat Mueng were captured from a basic (pH 7.21), but less mineralised stream (conductivity 77 μS/cm²), lacking in tufa formations. The tufa streams inhabited by *H. namtokhinpoon* sp. nov. flow through predominantly dry forest biotopes at low elevation (560–627 m). Adults have been captured in late November during the cool dry season.

**(Figs 55–57, 91)**

**Diagnosis.** A yellow species with mediotergite slightly obscured brownish. Posterior margin of scutum with well defined black ‘scutocellular eye’. Sct absent. Cell bm+dm short. Epandrium with cluster of strong bristles posteroventrally. Surstylus extending distinctly beyond tip of epandrium, upper process almost circular apically with minute dentate setulae on margins; lower process linear with two large leaf-shaped setae apically.

**Description.** **Male:** Body length 2.2 mm; wing length 1.7 mm. **Head.** Black, dusted greyish; antenna and mouthparts pale whitish yellow, all setae pale; one pair proclinate ocl; postocular setae uniseriate, merging above with 1–2 pairs small vtl and several fine setulae on vertex; frontal setulae apparently absent. Antenna with postpedicel ~3X as wide, a few minute outstanding setulae subapically; stylus shorter, ~0.3–0.4X long as postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusty greyish. Ground colour yellow; mediotergite rather vaguely obscured brownish but with yellow colour evident, prothoracic ‘collar’ very narrowly darkened medially; anterior spiral not distinctly emarginated above with small dark mark; ‘scutocellular eye’ strongly defined, black; sutures between prothoracic ‘collar’ and anterior margin of scutum, and at margins lateroventrally. All setae yellowish, minute, a pair of distinct npl, sct absent. **Legs.** Pale yellow. C1 ~1.2X longer than distance between C1 and C2, all setulae minute but with a few longer hairs dorsally. F1 ~ 1.1X long as C1, ~6X long as wide, evenly inflated, hardly constricted on proximal 0.3; femoral formula ~6/16/16+1/7, denticles black, rows converging apically; spines yellow, pv and av rows short, becoming somewhat longer proximally with basal spine longest. T1 ~0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with ~16 similarly sized sharply pointed spinose setae ventrally; short ciliation of distinct procline hairs dorsally on distal 0.3; ventroapical spur very small with ventroapical erect black spinose seta arising from near its base. Mid and hind legs slender with only small pale setulae. **Wing.** Membrane distinctly darkened by yellowish brown microtrichia, hyaline basally. Veins blackish, hyaline basally, darker about base of R₂+3 and M₁+2 and posterior border of cell bm+dm; veins C, R₄ and distal 0.5 of R₂+3 yellowish. Marginal setulae pale. R₂+3 almost linear, joining C ~0.7X distance between end of R₁ and R₂; length of C between ends of R₂+3 and R₁ ~1.1X long as R₂; R₃ almost linear; R₄ ~2.1X long as R₃, almost linear; R₄, fork distal to M₁, fork by ~1.2X length of R₄, M₁, almost linear beyond base, convergent distally with R₄; cell bm+dm short, ending at tip of R₄. Halter yellowish white. Squama with margin greyish yellow. **Abdomen.** Yellow with tergites 2–6 blackish, tergite 2 laterally yellow; a few distinct hairs on posterior margins of distal segments. **Terminalia.** Black. Cercus elongate (Figs 55, 56), extending beyond tip of epandrium, slightly inflated apically in lateral view; a small subapical thickening on inner face lacking strong seta. Epandrium (Fig. 55) small subquadrate with posterior margin almost linear for a short distance; several very strong bristly setae near pv margin. Surstylus present, extending distinctly beyond tip of epandrium; almost circular apically with series of dense minute dentate setulae on inner margin ventrally and posteriorly. A narrow process emerging beyond tip of epandrium, below surstylus (possibly lower lobe of surstylus), slightly curved, with distinct leaf-like setulae at tip and preapically (Fig. 57). Hypandrium very large, ~2X long as epandrium (Fig. 55); distinctly keel-shaped with few distinct bristles but distinctly pilose over much of its surface. **Female:** Unknown.

**Type material.** **HOLOTYPE ♂, THAILAND:** Surat Thani Province, Khao Sok NP, Bang Huaraed, 122 m, 8°54.555'N 98°30.522'E, 13–20.i.2009, MT, Pongphan [T3914](QSBG).

**Etymology.** The specific epithet is from the Latin *ocellata* (eye) in reference to the strongly defined ‘scutocellular eye’ marking.

**Remarks.** *Hemerodromia ocellata* sp. nov. is very similar to *H. anisoserrata* sp. nov. differing from it primarily in having a smaller epandrium, larger hypandrium, cercus somewhat narrower and lacking distinct setae on the subapical thickening of the inner face. The narrow process (lower process of surstylus?) emerging beyond the tip of epandrium is linear (sharply bent downwards at ~90° in *H. anisoserrata* sp. nov.) and bears 2 strong leaf-shaped specialised setae at its apex. The species is also similar to *H. serrata* Saigusa & Yang 2002. For further
discussion of the differences between these three species see notes under *H. anisoserrata* sp. nov. *Hemerodromia ocellata* sp. nov. is only known from the holotype male taken in January at one lowland (122 m) locality in Surat Thani Province, southern Thailand (Fig. 91).

**FIGURES 55–57.** Male terminalia of *Hemerodromia ocellata* sp. nov. 55, lateral view of terminalia; 56, dorsal view of cerci; 57, distal part of lower lobe of surstylus. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, lsur = lower lobe of surstylus, usur = upper lobe of surstylus.

*Hemerodromia oriens* sp. nov.
(Figs 58, 59, 92)

**Diagnosis.** A species with thorax black, legs and antenna yellowish. Male terminalia with cercus very narrow in profile but in dorsal view very broad proximally. Epandrium rather narrow, apically pointed. Surnstylus extending beyond tip of epandrium, small, narrow but apically spatulate, incurved distally.

**Description.** Male: Body length 2.3 mm; wing length 2.0 mm. Head. Black, dusted grey, strongest on upper occiput and vertex. Antenna entirely pale yellowish white. Mouthparts yellowish white. One pair reclinate ocl; 1–2 pairs small vtl distinguishable from smaller fine hairs on vertex and upper occiput; postocular and lower occipital setulae minute. Antenna with postpedicel ~2.5X long as wide, stylus rather shorter; scape with fine dorsal setulae. Thorax. Black, dusted greyish; scutellum somewhat paler brownish black; sometimes proepisternum and postpronotal area laterally somewhat paler. All setae yellowish; minute apart from one npl; sct absent but scutellum with a pair of very small erect setulae on disc.

Wing. Membrane conspicuously and uniformly darkened with black microtrichia but hyaline basally. Veins blackish but whitish near base. Marginal setulae greyish. R_{2+3} linear, joining C ~ 0.6X distance between end of R_{1} and R_{2}; length of C between ends of R_{2+3} and R_{4} ~1.7–1.8X long as R_{4}. R_{5} almost linear, only slightly S-
shaped; R₅ ~2.2X long as R₄; R₄₊₅ fork distal to M₁+₂ fork by ~ 1.5X length of R₄; R₄ and M₁ almost linear, convergent distally; cell bm+dm short, ending at level of R₄. Halter with knob variably whitish to blackish, stem paler. **Abdomen.** Tergites blackish but tergite 1 usually pale with very narrow transverse black fascia at middle; sternites paler (especially on segments 1 and 2), variable whitish to brown, often with anterior margins darker; all setulae small, becoming longer on distal segments. **Terminalia.** Brownish with admixed pale and dark setae. Cercus very elongate in lateral view (Fig. 58), extending beyond tip of epandrium, slightly narrowed subapically, somewhat spatulate apically; in dorsal view very broad on proximal 0.5 with distal lobe narrower and slightly incurved (Fig. 59). Epandrium rather narrow, apically pointed (Fig. 58). Surstylus present, extending beyond tip of epandrium, small, narrow but apically spatulate, incurred distally. Hypandrium narrow, strongly upcurved distally. A broad elongate inner process (probably representing posterior process of subepandrial sclerite) curved around tip of hypandrium distally; weakly sclerotized, especially distally; apex membranous bearing 5–6 minute black points. **Female:** Similar to male basal spines on F1 rather stronger; abdomen with sternites whitish but with sternites 7 entirely and usually sternites 1 along margins darker.

**FIGURES 58–59.** Male terminalia of *Hemerodromia oriens* sp. nov. 58, lateral view of terminalia; 59, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, ph = phallus.


**Etymology.** The specific epithet *oriens* (Latin) meaning eastern, reflects the only known occurrence of this species in the east of Thailand. It is used as a noun in apposition.

**Remarks.** *Hemerodromia oriens* sp. nov. is similar to many other Oriental *Hemerodromia* having a black thorax, pale legs and M₁+₂ fork present. The male cercus is narrow in profile but very broad, almost quadrate basally in dorsal view (Fig. 58), quite different from *H. yunnanensis* Yang & Yang, 1988, *H. fusca* Yang & Yang, 1986 and *H. phahompokensis* sp. nov. with which it might otherwise be confused. *Hemerodromia oriens* sp. nov. is only known from small shaded streams in lowland deciduous and dry evergreen forests in the eastern province of Mukdahan (Fig. 92). Adults have been captured during November at the start of the cool dry season.
Hemerodromia phahompokensis sp. nov.
(Figs 60–62, 93)

Diagnosis. A black species, slightly tinged reddish with basal sternites contrasting yellow. The male cercus is very elongate in profile and in dorsal view. Surstyrus with two elongate processes projecting beyond tip of epandrium; upper one narrow, apically spinate with minute peg-like tubercles apically on inner face; lower one digitiform, with dense brush of fine coalescent hairs apically.

Description. Male: Body length 2.2 mm; wing length 1.9 mm. Head. Black, dusted greyish. Antenna and mouthparts pale whitish yellow. One pair reclinate ocl; two pairs small vtl distinguishable from smaller fine hairs on vertex and upper occiput; postocular and lower occipital setulae minute. Antenna with postpedicel ~1.8X long as wide, stylus slightly shorter; scape with distinct fine dorsal seta. Thorax. Ground colour black, slightly tinted dark reddish especially on pleura and postpronotal are, dusted greyish. All setae yellowish; minute apart from one small npl; a pair of very small set. Legs. Ground colour yellow including apical tarsomeres. C1 ~1.1–1.2X longer than distance between C1 and C2; all coxae with only minute setulae. F1 ~1.1X long as C1, moderately inflated ~5X long as wide, hardly constricted at 0.25 from base; femoral formula ~6/15/16+1/5; denticles black, rows converging apically, pv spines slightly longer than av series, both becoming longer proximally. T1 ~0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with one row of ~15 sharply pointed spinose setae ventrally; ventroapical spur weakly developed, a strong ventroapical erect black spinose seta arising from near its base. Mid and hind legs slender with only small setulae. Wing. Membrane usually slightly but distinctly darkened with greyish microtrichia but hyaline near extreme base. Veins brownish grey but paler near base. Marginal setulae brownish. R2+3 linear, joining C ~0.7X distance between end of R1 and R2; length of C between ends of R2+3 and R4 ~1.5X long as R4, R4 almost linear, only slightly S-shaped, angle with R4 at extreme base ~70°; R1 ~2X long as R4; R4 fork distal to M1+2 fork by ~1.0X length of R4; R4 and M1 almost linear, somewhat convergent becoming slightly divergent distally; cell bm+dm rather long, ending at slightly beyond level of R4. Halter with knob brownish black, stem paler. Abdomen. Ground colour black, slightly tinted dark reddish, dusted greyish but sternites 1 and base of sternites 2 contrasting dirty yellow; all setulae pale, slightly stronger on sternites than on tergites. Terminalia. Black with dark setae. Cercus very elongate in lateral view (Fig. 60), extending well beyond tip of epandrium, bearing numerous distinct setae; in dorsal view (Fig. 61) distal lobe narrow, almost linear, slightly curved inwards near tip; basal lobe short, with small triangular process on inner posterior margin. Epandrium small, subcircular in lateral view, with a few distinct setae. Surstyrus with two elongate processes projecting beyond tip of epandrium; upper one narrow, apically spinate with minute peg-like tubercles apically on inner face (Fig. 62); lower one rather digitiform, with dense brush of fine almost coalescent hairs apically. Hypandrium rather strongly arched ventrally, distinctly divided ventrally near base. Female: Similar to male but basal spines on F1 and apical bristle on T1 rather stronger; femoral formula ~6/15/16+1/5. Abdomen with sternites whitish but with sternite 7 entirely and sternite 1 along posterior margin blackish; sternite 6 with 4 minute circular dark marks medially at base and irregularly darkened near posterior margin.

Type material. HOLOTYPE ♂, THAILAND: Chiang Mai Province, Doi Phahompok NP, Doi Phaluang, 1,449 m, 20°1.06'N 99°9.581'E, 7–14.x.2007, P.Wongchai, [T6186](QSBG). PARATYPES: 1♀, same data as holotype; 1♀, 28.xi.2007 (QSBG).

Etymology. The specific epithet refers to the mountain Doi Phahompok in northern Thailand which is the only known locality for this species.

Remarks. Hemerodromia phahompokensis sp. nov. is similar to many other Oriental Hemerodromia having a black thorax, pale legs and fork M1+2 present. The species might readily be confused with H. fusca Yang & Yang, 1986 or H. yunnanensis Yang & Yang, 1988 from which it differs by the shape of the cercus and of the two processes of the surstyrus projecting beyond the tip of the epandrium (see discussion under H. yunnanensis). The species is known from hill evergreen forest on the mountain Doi Phahompok in Chiang Mai Province, northern Thailand (Fig. 93), during October and November (during the cool dry season).
FIGURES 60–62. Male terminalia of *Hemerodromia phahompokensis* sp. nov. 60, lateral view of terminalia; 61, dorsal view of cerci; 62, apex of upper lobe of surstylus (inner face). Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, lsur = lower lobe of surstylus, usur = upper lobe of surstylus.

**Hemerodromia songsee** sp. nov.  
(Figs 8, 63–65, 94)

**Diagnosis.** Thorax with distinctive colour pattern; scutum yellow on anterior 0.5, black behind; scutellum, mediomera, laterotergite and meron black; fused anepisternum + katepisternum yellow. Male cercus elongate, extending beyond apex of epandrium, narrowed medially, apically spatulate in lateral view.

**Description.** Male: Body length 2.5–2.8 mm; wing length 2.3–2.5 mm. Head. Black, dusted greyish, strongest on upper occiput; antenna and mouthparts yellow, all setae whitish; one pair reclinate ocl; postocular setae uniseriate below, becoming 2–3 serial above where merging with two pairs small vtl; frontal setulae apparently absent. Antenna with postpedicel 1.5X long as wide, stylus of similar length; scape with distinct fine dorsal seta.

**Thorax.** Dusted greyish. Scutum with ground colour clear yellow or yellowish orange on anterior ~ 0.5 (excepting extreme anterior margin blackish); posterior 0.5 black or brownish black with dark markings often extending forward a short distance along line of dorsocentrals and along lateral margin to level of anterior spiracle (Fig. 8). Prothoracic ‘collar’ dorsally, scutellum, mediomera, metanotum, laterotergite and meron black. Fused anepisternum + katepisternum and anepimeron clear yellow, sometimes somewhat darkened, especially posteroventrally. All setae yellowish; minute apart from a pair of set and one npl. **Legs.** Yellowish white, apical tarsal segments hardly darker. C1 ~ 1.2X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer apicals. F1 ~ 1.2X long as C1, ~ 4X long as wide, slightly constricted 0.4 from base; femoral formula ~ 6–8/19–21+1/20–23/5–6, denticles black, rows converging apically; spines yellow, longest basally. T1 ~ 0.65X long as F1, evenly curved, ventral face shallowly concave; with one row of 17–18 sharply pointed spinose setae ventrally; a small bluntly pointed ventroapical spur with strong ventroapical erect black spinose seta arising from near its base. Mid and hind legs slender with only small setulae but T3 with a short row of small setae posterodorsally and a ‘comb’ of short setae posteroapically. **Wing.** Membrane with dark microtrichia, especially about apices of basal cells but hyaline basally. Veins blackish but yellowish near base and C pale yellow with posterior margin very narrowly black. Marginal setulae pale yellow. R2+3 slightly curved, joining C ~ 0.6X distance.
between end of R₁ and R₄; length of C between ends of R₂+3 and R₄ quite long, ~1.5–1.8X long as R₄. R₄ slightly S-shaped, angle with R₅ at extreme base ~ 80°; R₅ ~2X long as R₄; R₄+5 fork distal to M₁+2 fork by ~ 0.5–1X length of R₄; R₅ and M₅ linear, convergent distally; cell bm+dm short, ending at or slightly beyond level of R₄. Halter pale yellowish. Abdomen. Tergites 1 and 7 yellow, 2 yellow laterally, 3,4,5,6 and 8 blackish; only indistinct setulae on posterior margins, becoming longer on 7 and conspicuous on 8. Sternites yellowish; setae on posterior margins yellow becoming longer on posterior segments where also present on disc. Terminalia. Black with dark setae. Cercus elongate, extending beyond apex of epandrium (Figs 63, 64); narrowed medially; apically spatulate in lateral view; distinctly setose dorsally. Epandrium elongate subrectangular, slightly pointed apically, with strong setae on distal 0.5. Hypandrium hemispherical, with distinct setae posteroventrally. Subepandrial sclerite subquadrate (Fig. 65); bacilliform sclerite elongate, reaching beyond end of epandrium; surstylus present, expanded and strongly spatulate apically in lateral view; with numerous fine setae on inner face. Female: Similar to male but abdomen with less conspicuous setae distally but tergite 7 blackish and sternite 7 brown.

FIGURES 63–65. Male terminalia of *Hemerodromia songsee* sp. nov. 63, lateral view of terminalia; 64, dorsal view of cerci; 65, subepandrial and bacilliform sclerites, ventral view. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, pha = phallus, sur = surstylus.


Etymology. The specific epithet is a concatenation of the Thai *song* (two) and *see* (colour) in reference to the bicoloured thorax. It is used as a noun in apposition.
Remarks. The pattern of rather clearly marked black and yellow on the thorax of this species appears to be relatively stable and is a useful identification aid for _H. songsee sp. nov_. Although the fused anepisternum + katepisternum is usually clear yellow, it and the anepimeron are not infrequently darkened, especially posteroventrally. In Thailand, _H. songsee sp. nov._ is known from hill evergreen and moist hill evergreen forests at 1,449–2,210 m on two mountains in Chiang Mai Province, northern Thailand (Fig. 94). 58% of all specimens were captured in April or May, at the end of the hot dry period preceding the onset of the Southwest Monsoon. The remaining specimens were taken in February, September, November and December. Two specimens are known from northwestern Vietnam, captured at 1,900m between late October and early November.

**Hemerodromia systoechon sp. nov.**  
(Figs 7, 66, 67, 95)

**Diagnosis.** Scutum black with lateral margins narrowly and postpronotal area yellowish; Prothoracic ‘collar’ dorsally, scutellum and mediogiterge black; pleura yellowish but sutures about laterotergite and base of halter blackish. Wing with cell bm+dm long, ending distinctly beyond level of R1; distance between ends of R5+ and R1 long, ~1.8X long as R1. Male cercus with distinctly spinose process on inner face.

**Description. Male:** Body length 2.2–2.5 mm; wing length 1.8–2.2 mm. **Head.** Black, dusted greyish, strongest on upper occiput; antenna and mouthparts yellow; all setae white; one pair reclinate ocl; postocular setae uniseriate, merging with two small vtl; a few very fine setulae behind vtl; frontal setulae apparently absent. Antenna with postpedicel 1.5X long as wide, stylus of similar length; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Scutum with ground colour brown or brownish black, usually with markedly darker area posterolaterally immediately above root of wing (viewed laterodorsally, appearing somewhat triangular with posterior apex darker); lateral margin distinctly yellowish, becoming wider anteriorly to include postpronotal area, demarcation between brown and yellow parts well defined; posterior margins laterally, narrowly diffuse yellowish. Prothoracic ‘collar’ dorsally, scutellum and mediogiterge black. Pleura yellow (Fig. 7), fused anepisternum + katepisternum and meron sometimes vaguely darkened ventrally; sutures about laterotergite and base of halter blackish. All setae yellowish; minute apart from a pair of distinct set and one smaller npl. **Legs.** Yellowish white, apical tarsal segment hardly darker. C1 ~1.2X longer than distance between C1 and C2, all setulae minute excepting a few slightly longer apicals. F1 ~1.2X long as C1, ~4–5X long as wide, slightly constricted 0.2–0.4 from base; femoral formula ~5–7/18–20+1–2/16–20/6–7, denticles black, rows converging apically; spines yellow, longest basally with several additional distinct spines at base. T1 ~0.7X long as F1, evenly curved, ventral face shallowly concave; with one row of ~16–20 sharply pointed spinose setae ventrally; a very small bluntly pointed ventroapical spur with strong ventroapical erect black spinose seta arising from near its base. Mid and hind legs slender with only small setulae but mid metatarsus with somewhat longer setulae ventrally, T3 with a short row of small setae posterodorsally and a ‘comb’ of short setae posteroapically. **Wing.** Membrane with dark microtrichia but hyaline basally. Veins dark but whitish near base and C yellowish brown with posterior margin very narrowly black. Marginal setulae pale yellow. R5+ slightly curved, joining C ~0.6–0.7X distance between end of R1 and R2; length of C between ends of R5+ and R1 quite long, ~1.8X long as R1. R4 sublinear, only slightly S-shaped, angle with R5 at extreme base ~70°; R5 ~2.0–2.2X long as R1; R4+ fork distal to M1+ fork by ~1X length of R4; R4 and M1 slightly curved, convergent distally; cell bm+dm long, ending distinctly beyond level of R1. Halter pale yellowish white. **Abdomen.** Tergites black with tergite 1 yellow; vent blackish becoming progressively yellowish basally on sternites 1–3; tergites with only indistinct setulae on posterior margins, but long brown setae on tergite 8 posteriorly. Stermites with setae on posterior margins brownish, becoming longer on posterior segments where also present on disc. **Terminalia.** Black with dark setae. Cercus elongate, extending as far as tip of epandrium in lateral view (Fig. 66); broad proximally in dorsal view (Fig. 67); distinctly setose on outer face distally. Viewed dorsally an elongate inner process apparently originating from inner face of cercus bearing 5–6 short strong spines. Epandrium elongate, bluntly pointed apically, with 1–2 strong setae subapically and numerous smaller setae on distal 0.5. Hypantrium elongate hemispherical, with distinct setae posteroventrally. **Female:** Similar to male but F1 without additional yellow spines at base or spines indistinct; abdomen more extensively yellowish proximally on vent, often only darkened on sternites 6 laterally and 7 laterally and medially. Terminalia blackish.
FIGURES 66–67. Male terminalia of *Hemerodromia systoechon* sp. nov. 66, lateral view of terminalia; 67, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium.


**Etymology.** The specific epithet is from the Greek *systoechon* (single row) in reference to the single row of ventral setulae on the front tibia. It is used as a noun in apposition.

**Remarks.** The thoracic colour pattern of this species and *H. acutata* Grootaert, Yang & Saigusa is quite similar in some individuals, especially in females of the latter species in which the scutellum is dark. In such cases *H. systoechon* sp. nov. can be distinguished from *H. acutata* by having cell bm+dm long, obviously reaching beyond the apex of R₃ (level with R₄ in *H. acutata*) and length of C between ends of R₂+3 and R₄ quite long, about 1.8X long as R₄. Both *H. acutata* and *H. systoechon* sp. nov. have a single row of denticles ventrally on the front tibia. *H. systoechon* sp. nov. is only known from the mountain Doi Inthanon, Chiang Mai Province, northern Thailand (Fig. 95). 95% of specimens were captured at 2,200–2,500 m in moist hill evergreen forest or *Rhododendron* / *Sphagnum* biotopes close to the summit. All specimens have been taken between April and September (mostly April–July) thus adult phenology correlates with the late hot dry period and Southwest Monsoon rainy season.

*Hemerodromia yunnanensis* Yang & Yang (Figs 68–70, 96)

*Hemerodromia yunnanensis* Yang & Yang, 1988: 283.
**FIGURES 68–70.** Male terminalia of *Hemerodromia yunnanensis* Yang & Yang. 68, lateral view of terminalia; 69, dorsal view of cerci; 70, apex of lower narrow process (lower lobe of surstylus?). Abbreviations: cer = cerci, epa = epandrium, hyp = hypandrium, sur = surstylus (upper lobe?).

**Diagnosis.** A species with thorax black, legs and antennae variably blackish to yellowish. Front femur often blackish. The male terminalia are distinctive in having cercus narrow, epandrium bluntly pointed ovoid and surstylus large, extending beyond tip of epandrium, conspicuously inflated and broadly L-shaped apically.

**Re-description.**

**Male:** Body length 2.3 mm; wing length 2.0 mm.

**Head.** Black, dusted brownish grey, strongest on upper occiput and vertex. Antenna sometimes entirely pale but usually with scape and pedicel pale brown, postpedicel paler; stylus blackish. Mouthparts yellowish white with tip of proboscis brownish. One pair reclinate ocl; two pairs small vtl distinguishable from smaller fine hairs on vertex and upper occiput; postocular and lower occipital setulae minute. Antenna with postpedicel ~2X long as wide, stylus rather shorter; scape with distinct fine dorsal seta.

**Thorax.** Black, dusted greyish. All setae yellowish; minute apart from one npl; sct absent but scutellum with a pair of very small erect setulae on disc. **Legs.** Variable ground colour; generally brownish yellow with C2, C3 and C1 basally whitish (C1 occasionally blackish distally) and F1 blackish anteriorly and posteriorly (sometimes only vaguely so). C1 ~ 1.2X longer than distance between C1 and C2, all setulae minute except a few slightly longer dorsoapicals. C2 and C3 with a few fine setulae anteriorly and C3 with distinct yellowish dorsoapical. F1 ~ 1.0–1.1X long as C1, ~ 4–5X long as wide, not at all constricted 0.3 from base; femoral formula ~ 8–11/18–19/17–19/0–1/7–8; denticles black, rows converging apically; spines yellow, short, fine much shorter than limb is deep longest basally, basal spine of pv row longer. T1 ~ 0.7X long as F1, evenly curved, ventral face shallowly concave; with 2 rows of ~19 sharply pointed spinose setae ventrally; ventroapical spur hardly developed; a strong ventroapical apical erect black spinose seta present. Mid and hind legs slender with only small setulae.

**Wing.** Membrane conspicuously darkened with black microtrichia but hyaline basally. Veins blackish but whitish near base. Marginal setulae greyish. R<sub>2+3</sub> linear, joining C ~ 0.7X distance between end of R<sub>4</sub> and R<sub>5</sub>; length of C between ends of R<sub>2+3</sub> and R<sub>4</sub> ~1.1–1.2X long as R<sub>4</sub>; R<sub>4</sub> almost linear, only slightly S-shaped, angle with R<sub>3</sub> at extreme base ~ 70–80°, slightly swollen apically before junction with C; R<sub>5</sub> ~ 2.2X long as R<sub>4</sub>; R<sub>4+5</sub> fork distal to M<sub>1+2</sub> fork by ~ 1.2X length of R<sub>5</sub>; R<sub>5</sub> and M<sub>1</sub> almost linear, convergent distally; cell bm+dm short, ending at level of R<sub>1</sub>. Halter variably blackish, somewhat paler dorsally and on stem; sometimes entirely dirty white. **Abdomen.**
Black dusted greyish but sternite 1 with at least proximal 0.5 whitish, sternite 2 whitish with dark median line and posterolateral marks; all setae small except posteriorly and laterally on sternite 7. **Terminalia.** Black with dark setae. Cercus elongate (Figs 68, 69), extending well beyond apex of epandrium; narrowly in lateral view; distinctly setose dorsally. Epandrium bluntly pointed ovoid, with strong setae distally. Hypandrium, with strong setae posteroventrally. Surstylus present, extending beyond tip of epandrium, conspicuously inflated apically where broadly L-shaped with close set minute black setulae in inner face. An elongate apically hook-shaped process (possibly lower lobe of surstylus) emerging just beyond tip of epandrium (Fig. 70). **Female:** Similar to male but F1 with femoral formula 7–9/16–17/14–18+1/10; basal spine of pv row much stronger, at least as long as limb is deep. Abdomen with less conspicuous setae distally but tergite 7 blackish and sternite 7 brown.

**Material examined.** 179♂, 99♀, Beung Kan, Chaiyaphum, Chantaburi, Loei, Nan, Phayao and Surat Thani provinces (QSBG & NMWC); 1♂ removed for DNA sequence analysis (INPA); 14 specimens removed for population genetics studies (MSU).

**Remarks.** There is considerable variation in the colour of the antenna, legs and halter in *H. yunnanensis*. In particular both front femur and halter vary from yellowish to deep black. In Thailand this species is most similar to *H. fusca* Yang & Yang, 1986 and *H. phahompokensis* sp. nov. from which it may be distinguished most readily by the shape of the cercus and surstylus. *Hemerodromia yunnanensis* is clearly closely related to *H. serpa* Smith, 1965 from Nepal which has similarly L-shaped surstylus but with black setae on the outer face. In *H. serpa* the lower elongate process has two apical hook-like structures (only one in *H. yunnanensis*). *Hemerodromia yunnanensis* was described from Yunnan, China (Yang & Yang 1988). Its distribution in Thailand shows an eastern bias (Fig. 96) where it is known from numerous localities in Loei and Chaiyaphum provinces in the Petchabun Mountains, Phayao and Nan provinces in the north, Sisaket Province in the Dong Rak range and from mountains along the west bank of the Mae Nam Kong river (Mekong) in Bueng Kan Province. It has also been found in the southeast and south in Chantaburi and Surat Thani provinces respectively. The species has been found at 51–1,152 m, mostly around streams and rivers in a variety of forest types but also in agricultural areas (rice fields). Adults are active during the cool dry season with 254 (91%) of 278 individuals being captured during October and November but small numbers have also been taken in January, May, July and September.

**Hemerodromia zetalutea** sp. nov.  
(Figs 71, 72, 97)

**Diagnosis.** A yellow species with mediotergite darkened, prothoracic ‘collar’ dark medially. anterior spiracle narrowly but strongly emarginated above with small diagonal blackish mark; Posterior margin of scutum with well defined black ‘scutoscutellar eye’. Sct absent. Cell bm+dm short. Epandrium elongate with a row of minute inwardly directed dentate setulae dorsoapically.

**Description. Male:** Body length 2.5 mm; wing length 2.0 mm. **Head.** Black, dusted greyish, frons hardly paler; antenna and mouthparts pale whitish yellow, all setae pale; one pair reclinate ocl;1–2 pair of minute vtl, hardly distinguishable from sparse scattered minute hairs on vertex; postocular hairs minute but a few longer ones on lower occiput. Antenna with postpedicel ~1.8–2.0X long as wide, a few minute outstanding setulae subapically; stylus shorter, ~0.5X long as postpedicel; scape with distinct fine dorsal seta. **Thorax.** Dusted greyish. Ground colour yellow; mediotergite brownish black with yellow margin posterolaterally and prothoracic ‘collar’ very narrowly darkened medially; anterior spiral narrowly but strongly emarginated above with small diagonal blackish mark; ‘scutoscutellar eye’ strongly defined, black; sutures between prothoracic ‘collar’ and anterior margin of scutum, at anterior margin of laterotergite and posterodorsal margin of meron black. All setae yellowish, minute, a pair of distinct npl, stdc absent. **Legs.** Pale yellow. C1 ~1.2X longer than distance between C1 and C2, all setae minute F1 ~ 1.2X long as C1, ~ 6X long as wide, evenly inflated, not constricted on proximal 0.3; femoral formula ~ 5–6/17/14–16/5, denticles black, rows converging apically; spines yellow, pv and av rows short, becoming somewhat longer proximally with most basal spine strong. T1 ~ 0.6–0.7X long as F1, evenly curved, ventral face shallowly concave; with two rows of ~ 14 similarly sized sharply pointed spineose setae ventrally; a short ciliation of distinct proximate hairs dorsally on distal 0.2; ventroapical spur small but distinct with ventroapical erect black spineose seta arising from near its base. Mid and hind legs slender with only small pale setulae. **Wing.** Membrane almost clear, faintly darkened by brownish yellow microtrichia, hyaline basally. Veins
yellowish, hyaline basally, M₁+₂ and cell bm+dm darker yellowish grey. Marginal setulae pale. R₂+₃ almost linear, joining C ~ 0.7X distance between end of R₁ and R₄; length of C between ends of R₂+₃ and R₄ ~1.2X long as R₄; R₅ almost linear, only slightly S-shaped; R₅ ~ 2X long as R₄, almost linear; R₄+₅ fork distal to M₁+₂ fork by ~ 1.3–1.5X length of R₄. M₁ almost linear beyond base, convergent distally with R₅; cell bm+dm short, ending at tip of R₁. Halter yellowish white. Squama with margin greyish. **Abdomen.** Yellow with tergites 2–6 brown or blackish; all setae yellow, short but longer on distal segments, especially sternite 7. **Terminalia.** Black. Cercus elongate (Figs 71, 72); about as long as epandrium; slightly expanded apically with two inwardly curving spinose setae at tip; a row of distinct bristly setae dorsally; basal lobe moderately broad in dorsal view, with numerous minute hairs dorsally. Epandrium elongate (Fig. 71), rounded apically; a row of minute inwardly directed dentate setulae dorsoapically; pilose minute setulae on outer face, strongest posteroapically, absent at tip. Two narrow internal processes; upper process with one preapical and 2 short black apical inwardly directed apical dentate spines, lower process somewhat broader with cluster of fine setulae apically. Hypantrium broad, sparsely pilose with few distinct setae. **Female:** Similar to male. Terminalia brown with sternites 8 yellowish basally; a few distinct bristly setae laterally on tergite 8.

**FIGURES 71–72.** Male terminalia of *Hemerodromia zetalutea* sp. nov. 71, lateral view of terminalia; 72, dorsal view of cerci. Abbreviations: cer = cerci, epa = epandrium, hyp = hypantrium.

**Type material.** **HOLOTYPE ♂, THAILAND:** Petchabun Province, Khao Kho NP, mixed deciduous forest, 168 m, 16°39.589'N, 101°8.185'E, 19–26.i.2007, MT, Somchai Chachumnan & Saink Singtong [T1398](QSBG).

**PARATYPES:** 2♂, 1♀, same data as holotype, 12–19.i.2007, MT; 6–7.i.2007, 9–10.i.2007, pan trap (QSBG & NMWC).

**Additional material.** 1♂, Kanchanaburi Province, Khuean Srinagarindra NP, Tha Thung-na /Chong Kraborg, 210 m, 14°38.123’N, 98°59.657’E, 16–23.x.2008, MT, Boonnam & Phumarin: 1♂, Chiang Mai Province, Doi Chiangdao Wildlife Sanctuary, Nature Trail, 491 m, 19°24.278’N 98°55.311’E, 7–14.x.2007, MT, Songkran & Apichart; 1♂, 1♀, Doi Chiangdao NP, Headquarters, 491 m, 19.40496°N, 98.92061°E, 2–9.xi.2007, 3–9.vi.2008, MT, S. Jugsu & A. Watwanich; 1♂, Queen Sirikit Botanic Garden, Semi-evergreen forest, 633 m, 18°54’00.0”N, 98°51’86.4”E, 2–9.i.2007, MT, R. Sawkord & W. Srisuka; 1♂, Queen Sirikit Botanic Garden, deciduous forest, 620 m, 18°54’02.7”N, 98°51’78.6”E, 31.i.–2.ii.2007, flight interception trap, N. Buawangpong, J. Phasuk et al.; 1♂, Queen Sirikit Botanic Garden, Semi-evergreen forest, 704 m, 18°53’74.8”N, 98°51’86.4”E, 16–19.ii.2007, flight interception trap, J. Phasuk (QSBG & NMWC).

**Etymology.** The specific epithet is a concatenation of the Latin *luteus* and the sixth letter of the Greek alphabet *(zeta)*. It is used as a noun in apposition.
FIGURES 73–81. Distribution of *Hemerodromia* spp. in Thailand at a resolution of 0.25° and symbols sized to 0.5° of latitude and longitude. 73, *H. acutata* Grootaert, Yang & Saigusa; 74, *H. alphalutea* sp. nov.; 75, *H. anisoserrata* sp. nov.; 76, *H. anomalala* sp. nov.; 77, *H. attenuata* sp. nov.; 78, *H. betalutea* sp. nov.; 79, *H. conspecta* sp. nov.; 80, *H. deltalutea* sp. nov.; 81, *H. deminuta* sp. nov.
FIGURES 82–90. Distribution of Hemerodromia spp. in Thailand at a resolution of 0.25° and symbols sized to 0.5° of latitude and longitude. 82, H. demissa sp. nov.; 83, H. epsilutea sp. nov.; 84, H. etalutea sp. nov.; 85, H. flaviventris Yang & Yang; 86, H. furcata Grootaert, Yang & Saigusa; 87, H. fusca Yang & Yang; 88, H. gammalutea sp. nov.; 89, H. isochita sp. nov.; 90, H. namtokhinpoon sp. nov.
FIGURES 91–98. Distribution of *Hemerodromia* spp. in Thailand at a resolution of 0.25° of latitude and longitude with symbols scaled to 0.5°. 91, *H. ocellata* sp. nov.; 92, *H. oriens* sp. nov.; 93, *H. phahompokensis* sp. nov.; 94, *H. songsee* sp. nov.; 95, *H. systoechon* sp. nov.; 96, *H. yunnanensis* Yang & Yang; 97, *H. zetalutea* sp. nov.; 98, Species richness of *Hemerodromia* spp. in Thailand at a resolution of 1° with symbols plotted at same resolution.
Remarks. The dark mark about the anterior spiracle can be absent and in such cases the dark areas around the sutures of the meron and laterotergite and the ‘scutocutellar eye’ are less strongly defined. There are also small differences in male terminalia from different geographical areas; for example, in specimens from Chiang Mai Province the epandrium is slightly inflated apically with stronger setae compared with the type specimens from Petchabun Province. *Hemerodromia zetalutea* sp. nov. is widely distributed in Thailand with records from the north (Chiang Mai) northeast (Petchabun) and western (Kanchanaburi) regions (Fig. 97). It has been found in a variety of lowland (168–627 m) deciduous and evergreen dry forest types. All but one specimen were captured between October and February during the cool dry season.

Discussion

**Phylogenetic relationships.** Species assigned to *Hemerodromia* form a monophyletic clade within the tribe Hemerodromiini (Plant 2011), but the phylogenetic relationships within the genus are not understood and are an area of current active research. While most of the species dealt with here conform entirely with current concepts of the genus, three species from Thailand exhibit two different types of anomalous wing venation characters.

1. In *H. anomala* sp. nov. *R*$_{2+3}$ joins *R*$_4$ rather than terminating in the costa as is ‘typical’ in the genus. This species is also unusual in having a distinctly quadrate thorax and especially in having a quadrate head with a shallowly concave occiput (in most *Hemerodromia* the thorax is narrowed anteriorly and the head, whilst sometimes rather quadrate, has a convex occiput).

2. In *H. attenuata* sp. nov. and *H. deminuta* sp. nov. *M*$_{1+2}$ fork is absent (vein *M*$_1$ absent).

In the absence of a formal phylogenetic analysis of *Hemerodromia* it would be unwarranted to conjecture systematic relationships of these species with others of the genus. It is worth noting however that at least one undescribed Neotropical species is known in which *R*$_{2+3}$ joins *R*$_4$ (J.T. Câmara pers. com.) and several undescribed Oriental and Neotropical species are known in which the *M*$_{1+2}$ fork is absent (pers. obs., J.T. Câmara, R. Wagner pers comm.). More detailed evaluation within a wider phylogenetic framework, of characters such as male terminalia, head and thorax shape will be required to ascertain if these forms represent valid species-groups of *Hemerodromia* or are merely geographically isolated autapomorphies.

Comparison of characters of the male terminalia suggests that some species occurring in Thailand have affinities with others occurring elsewhere in Asia. For example, *H. isochita* sp. nov. has marked similarities with *H. chita* Smith from Nepal. Similarly *H. fusca* Yang & Yang, *H. yunnanensis* Yang & Yang and *H. songsee* sp. nov. have an apically inflated surstylus similar in general form to the condition found in *H. serpa* Smith from Nepal and *H. digitata* Grootaert, Yang & Saigusa, 2000 from southern China (Yunnan). I have seen undescribed forms, similar to *H. fusca* but probably undescribed species, from Vietnam, Singapore and Pulau Tioman (Malaysia), perhaps indicating that this group of species has radiated in southeast Asia. However, formal recognition of species-groups within *Hemerodromia* awaits completion of ongoing phylogenetic studies.

**Diversity, distribution and endemicity.** In the following discussion the different geographical regions of the country as delimited by Plant *et al.* (2011) are used and are identified as ‘Central’ ‘East’, ‘North’, ‘Northeast’, ‘South’, ‘Southeast’ and ‘West’. As the immature stages are strictly aquatic and most adults were caught in proximity to streams and rivers, descriptions of forest types in which a species occurs should be regarded as references to the larger scale habitats within which watercourses are present. Species richness is summarised in Figure 98 and is greatest in North (17 spp.), but lower in West (8 spp.), Northeast (7 spp.), East (8 spp.), Southeast (4 spp.), South (6 spp.) and Central (1 spp.) regions. The distribution of all species of *Hemerodromia* occurring in Thailand is shown in Figures 73–97 from which it is possible to make a preliminary assessment of patterns of diversity, distribution and habitat usage.

1. **Northern montane apparently endemic species.** The most frequent distribution pattern of *Hemerodromia* spp. was exhibited by nine species with ranges that embraced the forested mountains of the North and West. Species of this group are all apparently endemic to Thailand and all confined to predominantly evergreen forest biotopes (especially hill evergreen and moist hill evergreen) at higher elevations (mostly above 1,300 m). Some appear to be widespread in the North and West while others have more restricted distributions, e.g. *H. deltalutea* sp. nov. is confined to the northern Tenasserim Hills, *H. deminuta* sp. nov. and *H. systoechon* sp. nov. to the Thanon Thongchhai Range, while *H. isochita* sp. nov. and *H. phahompokensis* sp. nov. are restricted to the Daen...
Lao Range. *Hemerodromia zetalutea* sp. nov. occurs in the major ranges of the North and West, but has also been found in the Northeast region in the Petchabun Mountains. The richness of these northern montane evergreen forests has been noted by many authors (e.g. Pattanavibool & Dearden 2002) and recent work has revealed that the Daen Lao, Thanon Thongchai and Tenasserim ranges in particular have an extremely diverse fauna of Empidoidea containing many endemic taxa and others with Indo-Burmese of Sino-Japanese (*sensu* Holt et al. 2013) affinities (e.g. Plant et al. 2011, 2013; Plant 2015). The finding of a rich fauna of *Hemerodromia* in northern Thailand is not unexpected.

2. **Northern lowland apparently endemic species.** *Hemerodromia demissa* sp. nov. and *H. epsilutea* sp. nov. have a similar North and West distribution as Group (1) but are lowland species occurring below ~700 m in association with streams and rivers flowing through seasonally arid deciduous or dipterocarp biotopes.

3. **Northern montane widespread species.** Three species found at mid to high elevation (~1,100–2,200 m) in northern Thailand have distributions extending into various parts of the vast extent of forested mountains extending from the Greater Himalaya to southeast China. *Hemerodromia acutata* has been reported from southern China (Yunnan) and north-western India. *Hemerodromia flaviventris* is known from southeast China (Guangxi), while *H. songsee* sp. nov. is present in the mountains of northern Vietnam and may be Sino-Japanese elements of the fauna. It is of course possible that more intensive sampling in countries adjacent to northern Thailand will reveal that at least some of the apparently endemic northern montane species in Group [1] will have wider distributions and be more properly reassigned to the distribution pattern characteristic of Group [3].

4. **Southern apparently endemic species.** *Hemerodromia etalutea* sp. nov. and *H. ocellata* sp. nov. appear to be confined to southern peninsular Thailand, south of the Isthmus of Kra, in the Nakhon Si Thammarat and Phuket ranges respectively.

5. **Eastern apparently endemic species.** *Hemerodromia anisoserrata* sp. nov. and *H. oriens* sp. nov. appear to be confined to the East region of Thailand in the Petchabun Mountains of Loei and eastern outliers of the Phu Pan Range in Mukdahan provinces, respectively. The streams about which they have been found are tributaries of the Mae Nam Kong (Mekong) River, whereas almost all of the streams draining North, Northeast, West, Central and the western part of Isaan in the East region discharge into the Chao Phraya River. Considering that immature stages of *Hemerodromia* are strictly aquatic, a lack of contemporary connectivity between the Mae Nam Kong and Chao Phraya river systems may present a barrier to dispersal and have resulted in historical isolation of populations. Further work will be required to determine if the *Hemerodromia* fauna of the East region is a distinct faunistic element.

6. **Widespread lowland species.** *Hemerodromia fusca* is widespread and often abundant throughout the lowlands of Thailand. It is clearly able to adapt to a wide range of environments being found; for example, in irrigation channels in rice field as well as about streams and small rivers in a variety of lowland forest types. It is widely distributed outside Thailand being also recorded from China (Yunnan & Fujian) and Vietnam. *Hemerodromia yunnanensis* and *H. furcata* are also widespread in Thailand and the range of both extends into southern China (Yunnan). Both are lowland species and *H. yunnanensis*, like *H. fusca*, has been found in agricultural as well as forest biotopes. Plant (2014, 2015) considered that many species that are widespread in the eastern Oriental Realm and are restricted to seasonal arid lowlands are ‘old’ Oriental elements that have achieved wide geographical distributions by niche-tracking shifts in habitat distribution mediated by climatic changes in response to glacial episodes and the onset of a monsoon climate.

7. **Limestone tufa specialist species.** Three species (*H. anomalala* sp. nov., *H. namtokhinpoon* sp. nov. and *H. conspecta* sp. nov.) have restricted distributions apparently associated with alkaline, mineralised water courses, often with thick tufa deposition present in Loei (East region) and Kanchanaburi (West region). In Loei Province two of the sites (Suan Sawan and Suan Hom) are in the E-Lert Formation (*sensu* Ueno & Charoentitirat 2011) of the Loei Group of Permian rocks which comprises shale, siliceous shale and sandstone with locally developed impure bedded limestone and various-sized limestone blocks. The steams at these localities are ~ pH 8, are highly mineralised (conductivity ~420 μS/cm²) and have deep deposits of tufa, often several metres thick. Also in Loei, the Pla Ba and Tat Mueng locations are streams on sandstone bedrock with no obvious development of tufa formations. Their waters are less strongly basic (pH 7.2–7.5) and less mineralised (conductivity 77–90 μS/cm²) but are probably considerably influenced by the nearby Pha Dua Formation (*sensu* Ueno & Charoentitirat 2011) of the Loei Group. Precise details of the Kheun Srinagarindra sites for *H. anomalala* sp. nov. are not available but tufa deposits are present in the vicinity (C. Hutacharrern *pers. comm.*), which has a surface geology of Permian and
Or dovician limestones (Ridd 2011; Pfeffer 2013). Although many Hemerodromia species occur on tufa systems elsewhere, the association is not obligate (M. Ivković pers. comm.). The discovery of apparently obligate ‘tufa-linked’ assemblages of Hemerodromia in Loei and Kanchanaburi is interesting as although stenotopy to tufa environments in Thailand does occur; for example, in the dipteran family Simuliidae (P. Pramual pers. comm.), this is the first report of such an association in aquatic Empididae. I am unable to ascertain the geographical distribution of tufa habitats in Thailand but Permian and Ordovician limestones are scattered but widespread throughout much of the country (Pfeffer 2013), sometimes occurring in localised formations and often associated with karstic landforms. They may represent a previously unrecognised and potentially diverse habitat for aquatic Empididae.

This study found that 18 (72%) of the 25 species of Hemerodromia reported here are apparently endemic to Thailand although it is highly likely that some of these species have ranges that will eventually be found to overlap into adjacent or nearby territories of Burma (Myanmar), China, Laos, Vietnam, Cambodia or Malaysia. The Empidoidea of Thailand is rich in endemics at a national scale and Plant (2015) reported values of endemcity varying from 50–83% for speciose genera of Empididae and Hybotidae for which modern revisionary data are available. Plant (2015) concluded that, in general, endemism in Thailand’s Empidoidea is focussed at high elevation on mountains (especially in evergreen forests and particularly in the North and West), whereas many lowland species have wider distributions often extending beyond the boundaries of the country. The distribution data reported here provide general support for this hypothesis although there are some clear exceptions (e.g. the three lowland species associated with tufa biotopes and the two eastern endemic species in Group [5] above. Patterns of diversity and endemism in Thailand’s biota can be understood by reference to a Climate History Model (CHM) advanced by Plant et al. (2012) in which diversity hotspots on mountains are seen as a consequence, in part, of (i) historical altitudinal partitioning between seasonally arid lowlands and aseasonal highlands in response to increasing aridity arising from the development of a monsoon climate and Pleistocene climatic drying episodes with taxa that have niche-tracked upwards becoming isolated and radiating on nascent mountains, and (ii) immigration, primarily from the northwest and south along ‘corridors’ of montane moist forest on nascent mountains. A detailed evaluation of the applicability of the CHM to understanding Hemerodromia distribution is beyond the scope of the present work but attention is drawn to three related issues arising from it.

(A) The CHM predicts that some local high-elevation endemics might have radiated historically from more widespread lowland forms. This may be the case for H. phahompokensis sp. nov., which is confined to hill evergreen forest on the Daen Lao Range in northern Thailand, but is very similar and presumably closely related to two widespread lowland species, H. yunnanensis and H. fusca. Similarly, H. attenuata sp. nov. is widespread in Thailand in seasonal forests below ~1,400 m (this altitude approximately correlates with the transition between lower, seasonally arid deciduous and dipterocarp forest types and upper aseasonal evergreen forest biotopes), whereas the very similar H. deminuta sp. nov., is known only from far less seasonally water stressed high-elevation hill evergreen forest at one locality in the Thanon Thongchai Range.

(B) The CHM predicts not only that some taxa became buffered to climatic drying by niche-tracking altitudinally into newly formed moist forest biotopes on uplifting mountains, but also that others made latitudinal migrations in response to climatically induced changes in the distribution of forest habitat. Strictly aquatic taxa such as Hemerodromia might be an exemption to this general mechanism as, so long as streams and rivers persisted in an increasingly arid landscape, by remaining in strict association with lotic environments, they would have been buffered against increased seasonal drying of the wider landscape at lower elevations. It may be worth noting that while adults of Hemerodromia inhabiting moist montane biotopes in Thailand can sometimes be found resting on forest vegetation several metres away from stream banks, lowland species are very strictly confined to deep shade in very close proximity to the water and appear to be intolerant of more open and less humid conditions. Whereas other non-aquatic but still moisture sensitive Heterodromininae such as Achelipoda Yang, Zhang & Zhang, Anaclastoctedon Plant and Chelipoda Macquart are now more or less restricted to less seasonal moist montane forests (Plant 2009a, 2009b 2010; Plant et al. 2011, 2012), Hemerodromia has been able to persist in the lowlands on account of its strict association with streams and rivers flowing through them.

(C) Historical connectivity and fragmentation of hydrological networks is probably important in shaping contemporary patterns of diversity and endemism in aquatic Empididae (Ivković & Plant 2015) and may well account for distribution patterns of some species of Hemerodromia in Thailand too. For example, the possible existence of a lowland group of species apparently endemic to eastern Thailand (Group [5] above) might relate to the contemporary isolation of the Mae Nam Kong river system from other drainage networks in Thailand. Also, the
unique assemblage of lowland tufa specialist species (Group [7] above) may have radiated following being marooned in isolated but relatively stable and essentially epigean drainage networks.

**Influence of sampling methods on estimation of species richness.** This study examined a total of 1,055 specimens of which 936 (88%) were assigned to known species or described as new. A total of 20 new and 5 previously described species were recorded. Although undoubtedly new species were represented in the residue of 119 specimens, they were either damaged or teneral and were not treated further.

Various collecting techniques were employed and the number of specimens and percentage of the total collected by each was as follows: hand collecting by the author (601, 56.9%); Malaise trap (372, 35%); flight interception trap (68, 6%); pan trap (13, 1.2%) light trap (2, 0.2%). Hand collecting by the author caught 12 species, whereas combined trapping methods captured 20 species; 5 species were only caught by hand collection, 7 by both methods and 13 only by trapping. All species caught by flight interception, light and pan traps were also caught in Malaise traps. The collecting effort for trapping (all methods) is estimated at >120 trap years (TY) with 90 TY being contributed by one project alone (Borkent & Brown 2015). Hand collecting by the author is estimated to have involved a total of just ~672 hours (0.077 TY) of active searching. It is clear from these data that trapping methods were grossly inefficient (3.8 specimens / year; 0.2 species / year) compared with hand collecting (7,800 specimens / year; 155 species / year). Thus hand collecting was more than 2,000X as efficient in terms of number of individuals caught and 775X more efficient in terms of the rate at which species were discovered as compared with combined trapping methods.

The difference in capture efficiency between hand collecting and trapping methods almost certainly relate to the dispersal range of adults being essentially limited to the immediate vicinity of streams and rivers. Active searching along water courses by a specialist with knowledge of microhabitat requirements of *Hemerodromia* is far more effective than passive traps which are mostly sited away from water and probably only capture occasional ‘wandering’ or wind-blown specimens. Even when traps are set-up over streams (which is usually only possible outside the rainy season as monsoon spates frequently wash them away), it is far from certain that they would intercept the likely very short dispersal range of adults. Hand sampling generally involves the collector wading in the stream, sweep netting over wet rocks, mud, overhanging or nearby vegetation and while specimens are sometimes taken from foliage several metres above a stream, most are encountered in humid areas of dense shade closer to the water. Indeed, in the seasonally arid lowlands, I have never taken *Hemerodromia* away from heavily shaded and presumably humid locations situated very close to free water.

While hand collecting is clearly the most efficient way to collect *Hemerodromia*, it should be noted that some species were only taken by trapping and others only by hand collecting. One suspects that the higher species discovery rate of hand collecting would with increased effort, eventually lead to all species being found, including those currently only known from trap catches. However, both trapping and hand collecting programs are expensive to operate (costs of traps & access, sample sorting time, hand collection time, specialist expertise, etc.) and it is not clear how the economics of the two approaches compare. Nevertheless, it is clear that any practical attempt to assess species richness of *Hemerodromia* (and most likely many other taxa restricted to environmental space not intercepted by trapping methods) must necessarily involve a combination of specialist collecting and trapping. Species richness would not be revealed by a campaign of ‘blanket’ Malaise trapping alone.

Are the 25 species of *Hemerodromia* reported here an accurate reflection of species richness of the genus in Thailand? Although collecting efforts have been widespread, Plant (2015) noted a distinct bias towards the north and west with southern parts of the country, the central plane and much of the Issan Plateau in the east, for example, being relatively under-sampled. In general, patterns of local endemicity and diversity in Thailand are superimposed upon background of Indo-Burmese faunistic affinities in the Northwest, Indo-Chinese in the East and Northeast and southern (often Sundaic) influences in the South so it seems likely that components of the fauna with the latter two affinities are underrepresented in the samples. Additionally, the interplay of latitude, climatic, ecological and geological history has resulted in an extremely complex mosaic of habitats (for review see Plant et al. 2011), many of which have been examined cursorily, if at all. Studies of the detailed patterns of diversity and endemicity of Empidoidea in Thailand are still in their infancy but endemicity hotspots have been identified, for example, in the northern and western mountains (Tenasserim Hills, Daen Lao & Thanon Thongchai ranges), the Cardamom Mountains in the Southeast Region and in the Dong Paya Yen – Khao Yai Forest Complex along the western edge of the Issan Plateau (Plant 2014, 2015) and this study has suggested endemicity hotspots for *Hemerodromia* might exist in the East region and around tufa stream systems, at least in Loei Province. Even within endemicity hotspots,
local areas of microendemicty are evident, for example in the Daen Lao hotspot where the two mountains, Doi Phahompok and Doi Chiangdao each have distinctive empidoid faunas. It is concluded that the diversity of Hemerodromia reported here is likely an underestimation of the true diversity of the genus in Thailand. Furthermore the climatic, ecological and biogeographic complexity of tropical Southeast Asia leads one to expect that an extremely rich and varied fauna of Hemerodromia awaits discovery elsewhere in the region. The species richness of Hemerodromia in Thailand is indeed likely to be but the tip of a tropical iceberg of diversity.

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