



Revision of the *Empis (Enoplempis) mira* species group (Diptera: Empididae)

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Abstract

The *Empis (Enoplempis) mira* species group is revised and includes the type species of *Enoplempis* and four new species (*E. macdonaldi* sp. nov., *E. submira* sp. nov., *E. williamturneri* sp. nov., *E. winkleri* sp. nov.). A lectotype is designated for *Enoplempis mira* Bigot. The species group is defined by the yellow body colour, directionally asymmetrical male hindlegs and geniculate hindlegs in both males and females. The group has not been found outside of western North America and is known from California, Oregon, Idaho and Washington.

Key words: western North America, new species, balloon flies, type species, directional asymmetry

Introduction

The *Empis* L. subgenus *Enoplempis* Bigot is a diverse North American group that depending on the species, exhibits an interesting array of mating behaviours including swarming and the presentation of nuptial gifts from males to females ranging from secreted frothy balloons (with or without prey) to unwrapped prey (Sinclair *et al.* 2013; Alcock 2015). Two videos of *E. (Enoplempis)* swarming behaviours are available; one of *E. (En.) snoddyi* Steyskal in Great Smoky Mountains National Park carrying nuptial balloons (<https://www.youtube.com/watch?v=t0CjWcl4JuI>) and another of *E. (En.)* sp. 10, an undescribed species from the Santa Ana Mountains in California with unwrapped nuptial prey (<https://www.youtube.com/watch?v=wVmJngFAsBc>). Sinclair *et al.* (2013) revised the species east of the Rocky Mountains leaving the western North American species for subsequent revisionary work. This paper is the first of these western revisions and treats the *E. (Enoplempis) mira* species group, which includes four undescribed species and *E. mira* (Bigot), the type species of *Enoplempis*.

Material & methods

This study is based on material borrowed from or deposited in the following institutions: California Academy of Sciences, San Francisco, USA (CAS); Canadian National Collection of Insects, Ottawa, Canada (CNC); California State Collection of Arthropods, Sacramento, USA (CSCA); Essig Museum of Entomology, University of California, Berkeley, USA (EMEC); Oxford University Museum of Natural History, Oxford, UK (OUMNH); Oregon State Department of Agriculture, Salem, USA (ODAC); Bohart Museum of Entomology, University of California, Davis, USA (UCDC); United States National Museum of Natural History, Washington D.C., USA (USNM); William F. Barr Entomological Museum, University of Idaho, Moscow, ID, USA (WFBM); William J. Turner collection, Pullman, USA (WJTC).

Terms used for adult structures follow those of Cumming & Wood (2017). Label data for primary types are cited from the top downward, with the data from each label in quotation marks. Labels are cited in full with original

spelling, punctuation, and date, with label lines delimited by a slash (/). Additional information is included in square [] brackets. The repository of each type is given in parentheses. Secondary type data are abridged and listed alphabetically.

Male and female terminalia were macerated in 85% lactic acid heated in a microwave oven. Each microwave heating interval comprised 15–30 seconds and was followed by a 1–2 minute cooling period during which macerated muscle tissue was removed with a fine probe. Terminalia were subsequently examined in glycerin on a depression slide and illustrated. Photographs of pinned specimens were taken with a Leica camera model DFC5400 using Leica Application Suite X. Maps were constructed by using the location data on the specimen labels. If coordinates were not present on specimen labels, the collection locality data were used to estimate approximate coordinates, through the use of Google Maps and Google Earth. The internet software, SimpleMapp (Shorthouse 2010) was used to plot the distribution of each species.

The following abbreviations are used for frequent collector names: BJS – B.J. Sinclair, WJT – W.J. Turner. The following abbreviations are used in the descriptions for the following thoracic setae: acr – acrostichal setae, dc – dorsocentral setae, npl – notopleural setae, presut spal – presutural supra-alar setae; psut spal – postsutural supra-alar setae; pal – postalar setae, sctl – scutellar setae.

Empis (Enoplempis) mira species group

Diagnosis. This species group of *E. (Enoplempis)* is readily recognized by its yellow to brownish yellow body and leg colour (Figs 1–8), directionally asymmetrical male hind femur and tibia (Figs 12–31), geniculate male and female hind tibiae (Figs 12–35), male terminalia with pair of subepandrial processes (Figs 36–40), and tarsomeres without prominent spine-like ventral setae (Fig. 3) (Sinclair *et al.* 2013).

Empis (Enoplempis) macdonaldi sp. nov.

(Figs 10, 12, 13, 22, 23, 32, 36, 42)

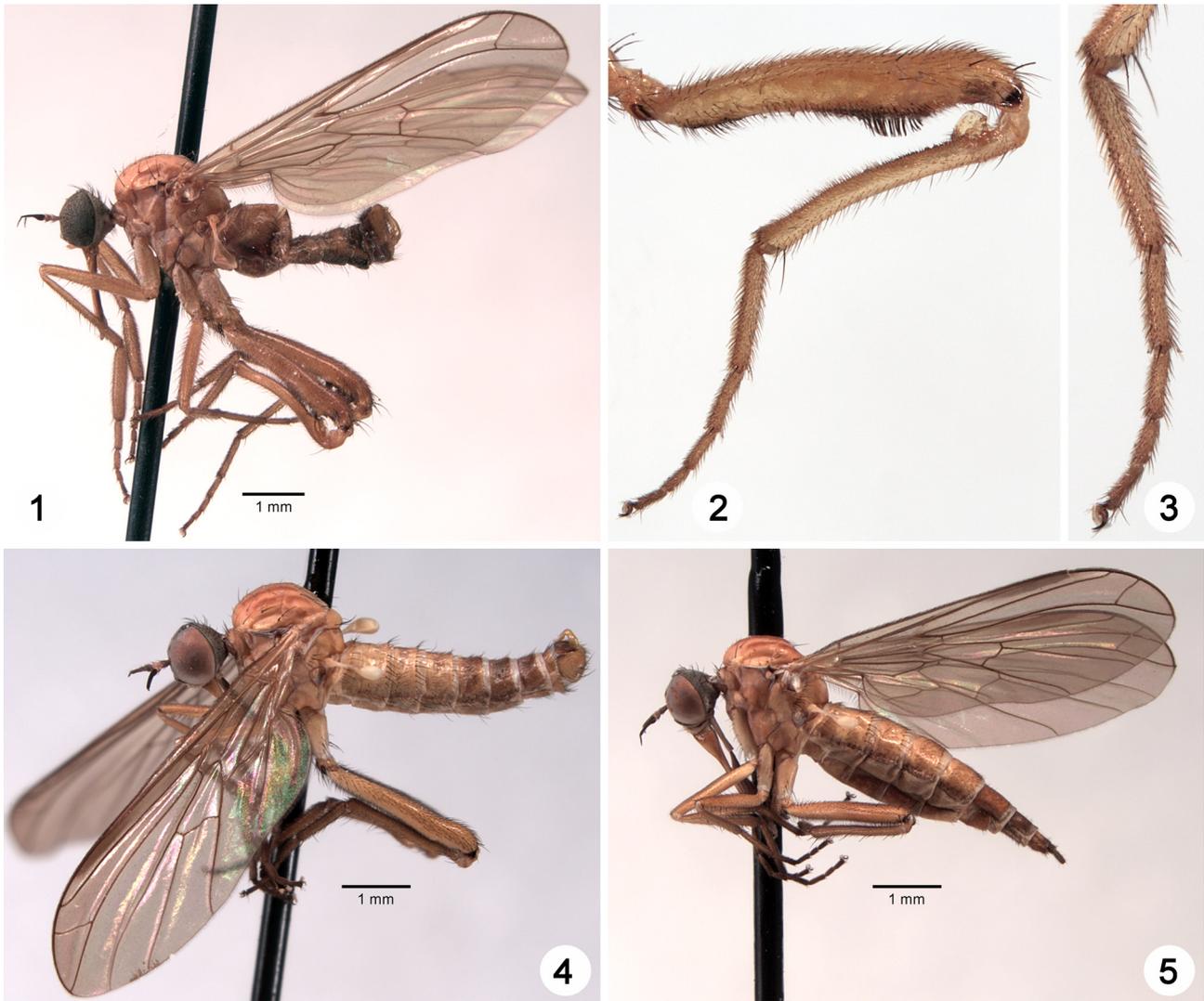
urn:lsid:zoobank.org:act: 04A03887-786A-4F41-956C-EC86CDA7C771

Type material. HOLOTYPE, ♂ labelled: “CA.Huntington L. [ca. 37°13'N 119°14'W]/Billy C. 2100m/ Fresno Co. 7.VIII/ J. MacDonald 1984”; “Empis/ (Enoplempis)/ Det. J.F. MacDonald”; “HOLOTYPE/ Empis (Enoplempis)/ macdonaldi Sinclair,/ Brooks, Cumming” (CNC). **PARATYPES: USA. California:** Same data as holotype except, 3.vii.1984 (1 ♀, CNC); Sequoia NP, Ash Mt. [36°29'15"N 118°50'09"W], 9.vi.1952, R.C. Bechtel (1 ♂, 1 ♀, UCDC); Tulare Co., Lodgepole [36°36'15"N 118°44'01"E], Sequoia Park, 26.vii.1984, J.F. MacDonald (1 ♂, 1 ♀, CNC); same data except, 21.vi.1984 (1 ♂, 2 ♀, CNC); same data except, 3.vii.1984 (1 ♂, CNC); same data except, 12.vii.1984 (1 ♀, CNC); same data except, 9.vi.1984 (1 ♂, 1 ♀, CNC); Tulare Co., Kaweah R. nr. Lodgepole [ca. 36°36'N 118°43'W], 14–21.vi.1984, D.J. Burdick (1 ♂, CNC); same data except, 19–26.vii.1984 (1 ♀, CNC).

Additional material examined. USA. California: Fresno Co., Huntington Lake [ca. 37°13'N 119°14'W], 10.vii.1984, D.J. Burdick (1 ♀, CNC); Mariposa Co., Wawona, Yosemite NP [37°32'N 119°39'W], 21.v.1938, R.M. Bohart (1 ♀, UCDC); Tulare Co., Three Rivers [36°26'N 118°54'W], 19.vii.1984, D.J. Burdick (1 ♀, CNC).

Diagnosis. This species is distinguished from other species of the *E. (En.) mira* species group by the absence of spots beneath the dorsocentral setae and male mid femur with long posteroventral setae more than twice width of femur (Fig. 10).

Description. Wing length 5.8–6.2 mm. **Male.** Head with dense greyish pruinescence on face, frons, occiput and postgena. Narrowly dichoptic, eye with ommatidia slightly enlarged ventrally. Frons divergent towards antennae; below ocellar triangle narrower than width of anterior ocellus, bearing short setulae along inner margin of eye. Face slightly divergent towards mouthparts; bare, with oral margin dark and shiny. Ocellar triangle with greyish pruinescence, with pair of parallel ocellar setae and pair of shorter posterior setulae. Occiput bearing row of strong postocular setae; most occipital setae black, long and stout. Pedicel and scape pale brown; postpedicel and stylus dark brown. Scape about 2× longer than pedicel; postpedicel slightly more than 3× longer than basal width or slightly more than 2× longer than stylus. Palpus yellow, with dark setulae. Proboscis largely yellow; apex of labrum reddish brown; labellum with dark setae.



FIGURES 1–5. Habitus photographs and male hindleg of the *E. (Enoplempis) mira* species group. **1.** Male of *E. mira* (Bigot), left lateral view. **2.** Male left hindleg of *E. williamturneri* sp. nov., anterior view. **3.** Male left hind tarsus of *E. williamturneri* sp. nov., anterior view. **4.** Holotype male of *E. winkleri* sp. nov., left lateral view. **5.** Female of *E. winkleri* sp. nov., left lateral view.

Thorax yellow in ground-colour, largely clothed in whitish pruinescence; all major setae black. Scutum without vittae or spots. Pleura yellow, with thin whitish pruinescence. Proepisternum with several short, dark setae; prosternum bare. Anteprepronotum with row of stout dark setae. Postpronotum with 3–4 short, dark setae and 1 long seta. Scutum with short, fine biserial acr; dc uniserial, longer than acr, postsutural dc increasing in length posteriorly; 1 long posterior npl, with several shorter anterior and posterior setae; 1 presut spal; 1 psut spal; 1 pal. Scutellum with 2 pairs of sctl, apical pair stouter, twice length of lateral pair. Laterotergite with 2 long, dark setae and several shorter setae. Anterior and posterior spiracles pale.

Legs long, entirely yellow, except for dark ring at trochanter-femur junction and extreme apices of femora; apical tarsomeres slightly darker. Coxae with numerous dark lateral setae, longer and stouter along apical anterior margins. Hind trochanter unmodified. Femora with distinct white ventral pile. Fore femur with anteroventral and posteroventral row of fine setae. Fore tibia with pile of soft ventral setulae, with 2–3 anterodorsal and posterodorsal setae and several preapical setae. Fore tarsomere swollen, slightly broader than fore tibia; shorter than remaining tarsomeres combined; all tarsomeres with pile of soft ventral setulae. Mid femur with anteroventral row of setae of various lengths, some as long as femur width; posteroventral face with distinct row of well separated setae, more than twice as long as femur width (Fig. 10). Mid tibia with stout, dark ventral setae, shorter than width of tibia, stouter distally; 3–4 anterodorsal, 3–4 posterodorsal and several preapical setae. Hindlegs asymmetrical, tibiae

geniculate at base. Left hind femur with short, thick ventral setae beyond mid-length, extending onto short bilobed posteroventral lobe (Figs 12, 13). Left hind tibia sinuous, with preapical posteroventral flange (Fig. 12). Right hind femur with proximal three-quarters clothed in numerous short, black ventral setae; without short anteroventral digitiform lobe on apical third; shallowly attenuated opposite spiny tibial lobe; preapex with broad anteroventral knob with paint brush-like tuft of thickened setae (Fig. 22); apical third with tuft of black posteroventral setae, longer than width of femur, separated from distal cluster of thickened black setae (shorter than femur width) by short, spine-like setae (Fig. 23). Right hind tibia bent nearly at right angles, near mid-length, especially when viewed ventrally; distal to curve with large thumb-like anteroventral lobe with black spine-like apical projections; flattened preapical anteroventral flange folds up against paint brush-like setal tuft of femur (Figs 22, 23). Tarsomeres 1–5 of all legs without rows of anteroventral and posteroventral spine-like setae.

Wing clear with yellowish veins, mostly well sclerotized; CuA+CuP fading out prior to wing margin. Basal costal seta short, stouter and longer than surrounding costal setae. R_5 and M_1 parallel near wing margin; R_5 ending beyond wing tip; radial fork acute. Halter yellow.

Abdomen yellow with longest posteromarginal setae on tergite 2, decreasing in length posteriorly. Posteromarginal setae on segment 8 longer than length of sclerites. Pregenital segments unmodified; sclerites of segment 8 closely approximated anterolaterally. Terminalia (Fig. 36) yellow with cercus darker. Cercus narrow, linear, posterior third narrower and tapered, with setae on inner face; clothed in dark setae, longer than width of cercus. Hypoproct without setae. Subepandrial sclerite with process arching obliquely from ventral margin of cercus; long, extending more than half distance to epandrial margin. Epandrial lamella subtriangular, posterior margin broadly rounded, without process; setae moderately long, some about width of lamella. Hypandrium short, truncate, apical margin sinuous, about 0.5× as long as epandrium; base with 2–4 lateral setae, shorter than length of hypandrium. Phallus deeply attenuated near base, middle section broad and tapered apically; apical third strongly roundly re-curved; apex with short ladle-like expansion; apex not emerging beyond epandrium; ejaculatory apodeme broad, flattened plate, not Y-shaped, two-thirds length of epandrium.

Female. Similar to male, except as follows: frons nearly subequal to width of anterior ocellus; mid femur with similar long posteroventral setae; hindlegs symmetrical; hind femur swollen, wider than mid femur, with strong anteroventral and posteroventral setae on apical half, anteroventral setae longer than tibia width (Fig. 32); hind tibia geniculate at base; cercus long and slender, with short dark setae.

Etymology. This species is named in memory of John F. MacDonald, who collected most of the known specimens. John was a dedicated researcher and teacher who was a specialist on Hemerodromiinae.

Distribution. This species is confined to the Sierra Nevada Mountains in central California (Fig. 42).

Empis (Enoplempis) mira (Bigot)

(Figs 1, 6–9, 14, 15, 24, 25, 33, 37, 41)

Enoplempis mira Bigot, 1880: 63. Type locality: California [USA].

Empis mira: Coquillett, 1895: 397 (new combination); Melander, 1902: 319 (diagnosis); Melander, 1928: 164 (catalogue); Melander, 1965: 460 (catalogue).

Type material examined. **LECTOTYPE** (here designated in order to fix identity of the species) (Figs 6, 7, 8), ♂ labelled (Fig. 9): “Lecto-/ type [dark blue-bordered circle]”; “E. mira/ EX COLL. BIGOT”; “LECTOTYPE/ Enoplempis/ mira Bigot/ des. Sinclair, Brooks,/ Cumming & Turner 2014 [red label]” (OUMNH) [antennae missing]. **PARALECTOTYPE:** Same data as lectotype [dissected; left fore basitarsus and left hindleg glued to card below specimen] (1 ♂, OUMNH).

Taxonomic notes. Bigot (1880) based his description on an unspecified number of male specimens from California. The syntypes match Bigot’s brief description in terms of the yellowish colour, robust hind femur with pointed processes and dentation, infuscate wings and five-vittate scutum (acrostichal and dorsocentral rows and lateral infuscation when viewed dorsally).

Additional material examined. **USA. California:** Calaveras Co., West Point [38°23’57”N 120°31’39”W], 21.v.1953, H.H. Keifer (1 ♂, CSCA); Mono Co., Mono Lake [38°01’00”N 119°00’34”W], vi.1962 (1 ♂, WJTC); Placer Co., 5 mi NE Auburn [38°53’55”N 121°4’28”W], 30.iii.1963, L.G. Bock (1 ♂, WJTC); Tuolumne Co., 6 mi E Groveland [37°49’54”N 120°14’23”W], C.J. Horning (1 ♂, CAS); Tuolumne Co., Hwy 120, 2 mi W

Mather turnoff [37°48'52"N 119°52'28"W], 14.vi.1975, N.J. Smith (1 ♂, UCDC); Tuolumne Co., Basin Ck Cpgd [37.9933° -120.1815°], 31.v–2.vi.1963, P.H. Arnaud (11 ♂, USNM); Tuolumne Co., Buck Meadows [37°48'46"N 120°03'52"W], Mather site, No. 17112, 1970–71, A.R. Moldenke (1 ♀, CAS); same data except, No. 14397 (1 ♀, CAS); Tuolumne Co., Sonora [37°59'4"N 120°22'54"W], 27.v.1965, R.P. Allen (1 ♀, EMEC).



FIGURES 6–9. Male lectotype of *E. (Enoplempis) mira* (Bigot). 6. Habitus, left lateral view. 7. Habitus, right lateral view. 8. Right hindleg, anterior view. 9. Lectotype labels. Photographs courtesy of Oxford University Museum of Natural History.



FIGURES 10–11. Male left midlegs of the *E. (Enoplempis) mira* species group, posterior view. 10. *E. macdonaldi* sp. nov. 11. *E. winkleri* sp. nov.

Diagnosis. This species is distinguished from other species of the *E. (En.) mira* species group by the spots beneath the dorsocentral setae, right hind femur with anteroventral digitiform lobe on apical third (Fig. 24) and shape of the phallus (Fig. 37).

Redescription. Wing length 6.2–7.1 mm. **Male** (Figs 1, 6, 7). Head with dense greyish pruinescence on face, frons, occiput and postgena. Narrowly dichoptic, eye with ommatidia slightly enlarged ventrally. Frons divergent towards antennae; below ocellar triangle as wide as anterior ocellus, bearing short setulae along inner margin of eye. Face slightly divergent towards mouthparts; bare, with oral margin pale and shiny. Ocellar triangle with greyish pruinescence, with pair of parallel ocellar setae and pair of shorter posterior setulae. Occiput bearing row of postocular setae, 2–3 stout, black setae on upper section; shorter and more slender on lower section; remaining upper occipital setae black, long and stout. Pedicel and scape pale brown to dark brown; postpedicel and stylus dark brown. Scape about 2× longer than pedicel; postpedicel nearly 4× longer than basal width, or 2.5× longer than stylus. Palpus yellow, with dark setulae. Proboscis largely yellow; apex of labrum reddish brown; labellum with dark setae.

Thorax yellow in ground-colour, largely clothed in whitish pruinescence; all major setae black. Scutum with dark brown median vitta and pair of less distinct vittae along dc row, more distinct in posterior aspect; lateral vitta reduced to dark spots beneath dc setae in anterior aspect. Pleura yellow, with thin whitish pruinescence. Proepisternum with several short, dark setae; prosternum bare. Anteprepronotum with row of stout dark setae. Postpronotum with 3–4 short, dark setae and 1 long seta. Scutum with short, fine biserial acr; dc uniserial, similar to acr, first anterior dc nearly twice length of posterior dc, postsutural dc increasing in length posteriorly; 2–3 posterior npl, with several shorter anterior setae; 1 presut spal; 1 psut spal; 1 pal. Scutellum with 2 pairs of sctl, apical pair stouter, less than twice length of lateral pair. Laterotergite with 4 long, dark setae and several shorter setae. Anterior and posterior spiracles pale.

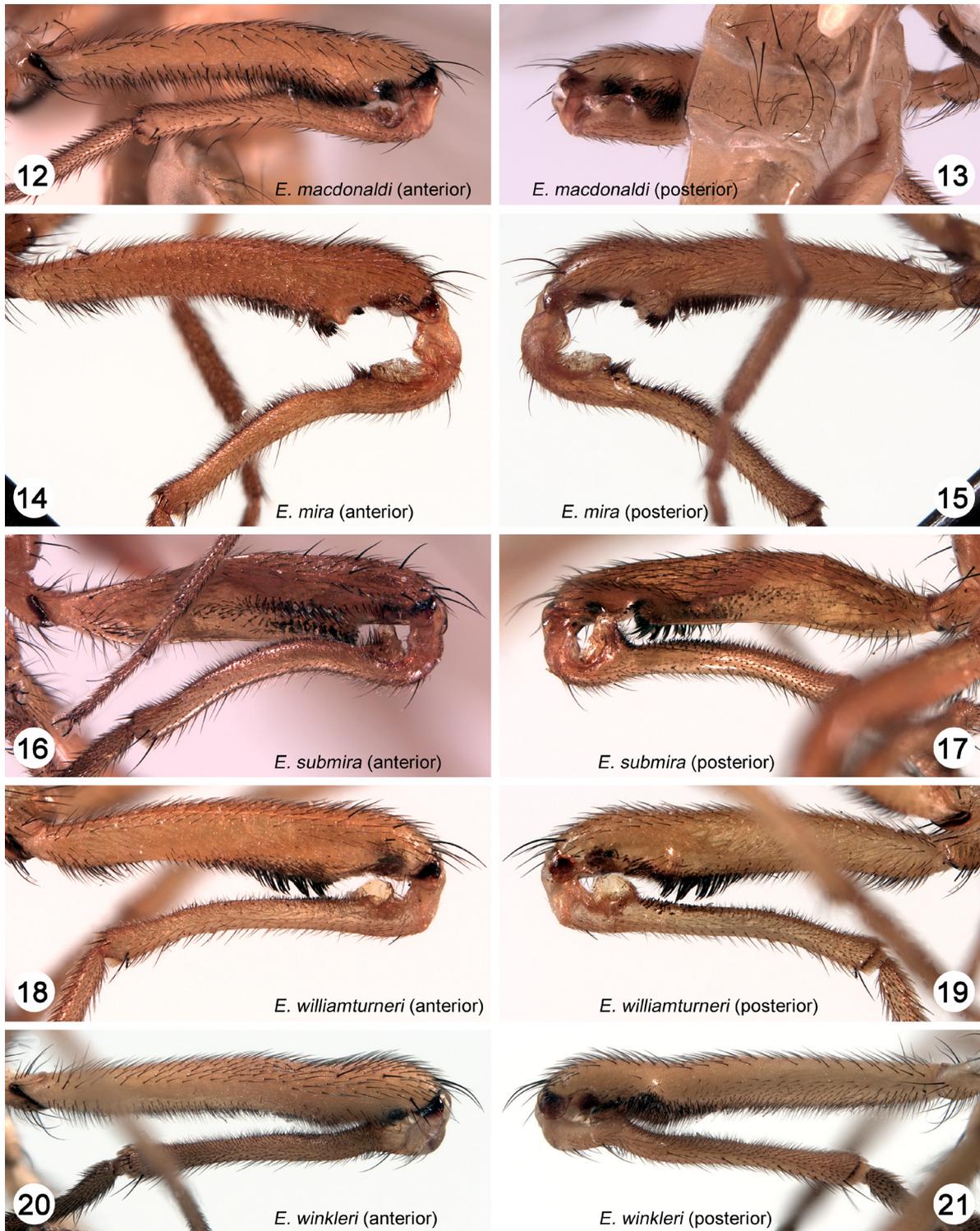
Legs long, entirely yellow, except for dark ring at trochanter-femur junction and extreme apices of femora; tarsomere 5 darkened. Coxae with numerous dark lateral setae, longer and stouter along apical anterior margins. Hind trochanter unmodified. Femora with distinct white ventral pile. Fore femur with anteroventral and posteroventral rows of fine setae, posteroventral setae longer. Fore tibia with pile of soft ventral setulae, with 2–3 anterodorsal and posterodorsal setae and several preapical setae. Fore tarsomere swollen, distinctly broader than fore tibia, subequal to remaining tarsomeres combined; all tarsomeres with pile of soft ventral setulae. Mid femur with anteroventral row of setae of various lengths, with cluster of longer basal setae; posteroventral face with distinct row of well separated setae, nearly longer than femur width. Mid tibia with pale and dark, stout ventral setae intermixed, shorter than width of tibia; 3–4 anterodorsal, 3–4 posterodorsal and several preapical setae. Hindlegs asymmetrical, tibiae geniculate at base. Left hind femur with brush of short, thick ventral setae beyond mid-length, extending onto short posteroventral lobe (Figs 14, 15). Left hind tibia sinuous with dense black ventral setae, with posteroventral row of short black spines on distal half; preapex with pair of thin posteroventral flanges (Figs 14, 15). Right hind femur with proximal two-thirds clothed in numerous short, black ventral setae; short anteroventral digitiform lobe on apical third, clothed in short setae (Figs 8, 24); shallowly excavated ventrally distal to digitiform lobe, with transverse ridge bearing long tuft of black anteroventral setae; apical third with tuft of black posteroventral setae, longer than width of femur; apical third with long posterior setae (Fig. 25). Right hind tibia bent nearly at right angle, distal to mid-length, especially when viewed ventrally; distal to curve with large thumb-like anteroventral lobe with black spine-like apical projections; flattened preapical anteroventral flange folds up against setal tuft of femur (Figs 24, 25); posteroventral thumb-like lobe distal to bend with apical ridge of stiff setae. Tarsomeres 1–5 of all legs without rows of anteroventral and posteroventral spine-like setae.

Wing clear with yellowish veins, mostly well sclerotized; CuA+CuP fading out prior to wing margin. Basal costal seta short, stouter and longer than surrounding costal setae. R_5 and M_1 parallel near wing margin; R_5 ending beyond wing tip; radial fork acute. Halter yellow.

Abdomen yellow with longest posteromarginal setae on tergite 2, decreasing in length posteriorly. Posteromarginal setae on segment 8 longer than length of sclerites. Pregenital segments unmodified; sclerites of segment 8 narrowly fused anterolaterally. Terminalia (Fig. 37) yellow with cercus darker. Cercus narrow, linear, posterior end tapered with setae on inner face; clothed in dark setae, longer than width of cercus. Hypoproct without setae. Subepandrial sclerite with process arching along ventral margin of cercus, extending beyond cercus nearly one-third length of cercus. Epandrial lamella subtriangular, posterior margin broadly rounded, without process; setae moderately long, some about width of lamella. Hypandrium short, truncate, apical margin sinuous, about 0.5× as long as epandrium; base with several setae, slightly shorter than length of hypandrium. Phallus deeply attenuated near base, middle section broad and tapered apically; apical third deeply attenuated, flexed nearly at right angle, forming bowl-like apex, with well-sclerotized anterior margin; apex not emerging beyond epandrium; ejaculatory apodeme broad, flattened plate, not Y-shaped, two-thirds length of epandrium.

Female. Similar to male, except as follows: frons slightly narrower than ocellar triangle; mid femur with row of 5 widely spaced, strong posteroventral setae, weaker on anteroventral row; hindlegs symmetrical; hind femur swollen, wider than mid femur, with strong anteroventral and posteroventral setae on apical half (Fig. 33); hind tibia geniculate at base; cercus long and slender, with short dark setae.

Distribution. This species is confined to the Sierra Nevada Mountains in central California (Fig. 41).



FIGURES 12–21. Male left hindlegs of the *E. (Enoplempis) mira* species group. 12. *E. macdonaldi* sp. nov., holotype, anterior view. 13. *E. macdonaldi* sp. nov., holotype, posterior view. 14. *E. mira* (Bigot), anterior view. 15. *E. mira* (Bigot), posterior view. 16. *E. submira* sp. nov., holotype, anterior view. 17. *E. submira* sp. nov., holotype, posterior view. 18. *E. williamturneri* sp. nov., anterior view. 19. *E. williamturneri* sp. nov., posterior view. 20. *E. winkleri* sp. nov., anterior view. 21. *E. winkleri* sp. nov., posterior view.

***Empis (Enoplempis) submira* sp. nov.**

(Figs 16, 17, 26, 27, 39, 42)

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Type material. HOLOTYPE, ♂ labelled: “CALIF:Sierra Co./ Shenanigan Flat/ 2 mi W Indian Vy. [ca. 39°30'N 121°01'W]/ 17-VI-[19]67 P. Opler”; “UC Berkeley/ EMEC 1188984/ [data matrix code]”; “HOLOTYPE/ *Empis* (*Enoplempis*)/ *submira* Sinclair,/ Brooks, Cumming” (EMEC).

Diagnosis. This species is most similar to *E. (En.) mira* and is distinguished by the right hind femur without an anteroventral digitiform lobe (Fig. 26) and right hind tibia with subapical swelling directed horizontally, without black thorn-like setae.

Description. Wing length 5.7 mm. **Male.** Head with dense greyish pruinescence on face, frons, occiput and postgena. Narrowly dichoptic, eye with ommatidia slightly enlarged ventrally. Frons divergent towards antennae; below ocellar triangle slightly wider than anterior ocellus, bearing short setulae along inner margin of eye. Face slightly divergent towards mouthparts; bare, with oral margin pale and shiny. Ocellar triangle with greyish pruinescence, with pair of divergent ocellar setae and pair of shorter posterior setulae. Occiput bearing row of slender postocular setae; remaining upper occipital setae black, long and stout. Scape pale brown; pedicel, postpedicel and stylus dark brown. Scape about 2× longer than pedicel; postpedicel nearly 4× longer than basal width, or 2.3× longer than stylus. Palpus yellow, with dark setulae. Proboscis largely yellow; apex of labrum reddish brown; labellum with dark setae.

Thorax yellow in ground-colour, largely clothed in whitish pruinescence; all major setae black. Scutum with narrow dark brown median vitta and row of dark spots at base of dc, with dark spot at base of npl and pal. Pleura yellow, with thin whitish pruinescence. Proepisternum with several short, dark setae; prosternum bare. Anteprepronotum with row of stout dark setae. Postpronotum with 3–4 short, dark setae and 1 long seta. Scutum with short, fine biserial acr; dc uniserial, similar to acr, first anterior dc longer than posterior dc, postsutural dc increasing in length posteriorly; 3 posterior npl, with several shorter anterior setae; 1 presut spal; 1 psut spal; 1 pal, with 1 short setula. Scutellum with 2 pairs of sctl, apical pair stouter, less than twice length of lateral pair. Laterotergite with 3 long, dark and several shorter setae. Anterior and posterior spiracles pale.

Legs long, entirely yellow, except for dark ring at trochanter-femur junction and extreme apices of femora; tarsomere 5 darkened. Coxae with numerous dark lateral setae, longer and stouter along apical anterior margins. Hind trochanter unmodified. Femora with distinct white ventral pile. Fore femur with anteroventral and posteroventral rows of fine setae, posteroventral setae longer. Fore tibia with pile of soft ventral setulae, with 2–3 anterodorsal and posterodorsal setae and several preapical setae. Fore tarsomere not swollen, narrower than fore tibia, shorter than remaining tarsomeres combined; all tarsomeres with pile of soft ventral setulae. Mid femur with anteroventral row of setae of various lengths, with cluster of longer basal setae; posteroventral face with distinct row of well separated setae, shorter than femur width. Mid tibia with pale ventral setae and darker setae intermixed, shorter than width of tibia; 2–3 anterodorsal, 2–3 posterodorsal and several preapical setae. Hindlegs asymmetrical, tibiae geniculate at base. Left hind femur with brush of short, thick ventral setae beyond mid-length, extending onto short posteroventral lobe (Figs 16, 17). Left hind tibia sinuous with dense black ventral setae, with posteroventral row of short black spines on distal half; preapex with thin posteroventral flange (Figs 16, 17). Right hind femur with proximal two-thirds clothed in numerous short, black ventral setae; without short anteroventral digitiform lobe on apical third; deeply excavated ventrally beyond mid-length, with only a few scattered setae (Fig. 26); apical fourth with paint-brush-like tuft of black posteroventral setae on short prominence (Fig. 27); apical third with tuft of black posteroventral setae, longer than width of femur; apical third with long posterior setae. Right hind tibia with large thumb-like anteroventral lobe distal to mid-length without spine-like apical projections; flattened preapical anteroventral flange folds up against setal tuft of femur (Figs 26, 27); transverse ridge distal to thumb-like projection with short spine-like setae, longer on posterior side. Tarsomeres 1–5 of fore and hind legs without rows of anteroventral and posteroventral spine-like setae; tarsomere 1 with several pairs of spine-like anteroventral and posteroventral setae on midleg.

Wing clear with yellowish veins, mostly well sclerotized; CuA+CuP fading out prior to wing margin. Basal costal seta short, but stouter and longer than surrounding costal setae. R₅ and M₁ parallel near wing margin; R₅ ending beyond wing tip; radial fork acute. Halter yellow.

Abdomen yellow with longest posteromarginal setae on tergite 2, decreasing in length posteriorly. Postero-marginal setae on segment 8 longer than length of sclerites. Pregonital segments unmodified; sclerites of segment 8 narrowly fused anterolaterally. Terminalia (Fig. 39) yellow with cercus darker. Cercus narrow, linear, posterior end tapered to narrow tip, with setae on inner face; clothed in dark setae, longer than width of cercus. Hypoproct without setae. Subepandrial sclerite with process projecting obliquely from ventral margin of cercus; short, less than half distance to epandrial margin. Epandrial lamella subrectangular, posterior margin straight, without process; setae moderately long, some about half width of lamella. Hypandrium short, apical margin slightly rounded, about 0.5× as long as height of epandrium; base with several setae, shorter than length of hypandrium. Phallus deeply attenuated near base, middle section broad and parallel-sided; apical third deeply attenuated, flexed nearly at right angle, forming narrow bowl-like apex, with well sclerotized anterior margin; apex not emerging beyond epandrium; ejaculatory apodeme broad, flattened plate, not Y-shaped, one-half length of epandrium.

Female. Unknown.

Etymology. This species name is in reference to its similar colour and male terminalia to the species, *E. mira*.

Distribution. This species is known only from the type locality in Sierra County, California (Fig. 42).

***Empis (Enoplempis) williamturneri* sp. nov.**

(Figs 2, 3, 18, 19, 28, 29, 34, 38, 42)

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Type material. HOLOTYPE, ♂ labelled: “USA: ID: Latah Co./ St. Joe NF; W Laird Pk/N46°57.631' W116°35.852'/ 13.vii.2012; meandr. str./ B.J. Sinclair; 856 m”; “HOLOTYPE/ *Empis (Enoplempis) williamturneri* Sinclair/ Brooks, Cumming” (CNC). **PARATYPES: USA. Idaho:** Adams Co., Ballards Ferry [ca. 45°02'N 116°48'W], 15.vi.1926, R.W. Haegele (1 ♀, WFBM); Boise Co., Lowman, 11.vii.1926, R.W. Haegele (1 ♀, WFBM); Boundary Co., Meadow Ck Cpgd nr Bonners Ferry [ca. 48°49'N 116°08'W], 27.viii.1975, D.D. Wilder (1 ♂, CAS); Idaho Co., Clearwater NF, Hwy 12, Apgar Ck, 13.vi.2014, 46°12.858'N 115°32.179'W, 465 m, BJS (1 ♂, CNC); Idaho Co., 7 mi NNE Moscow [ca. 46°48'N 116°56'W], 2700 ft, 29.vi.1975, WJT (1 ♀, WJTC); Latah Co., 7 mi N Moscow, nr Paradise Pt [ca. 46°48'N 116°56'W], MT, 20.vi.1972, WJT (1 ♀, WJTC); Latah Co., 7 mi SE Harvard, Little Band Ck [ca. 46°55'N 116°43'W], 22.vi.1973, WJT (1 ♂, WJTC); Latah Co., Moose Ck Res., St. Joe NF, 21.vi.2014, 887 m, 46°52.524'N 116°25.363'W, forest tr, BJS (3 ♂, CNC); Latah Co., 12 mi ENE Potlatch, Lost Ck [ca. 46°57'N 116°40'W], 5.viii.1979, sweeping, WJT (1 ♂, 1 ♀, USNM; 1 ♂, 2 ♀, WJTC); same data except, 16 mi E Potlatch, Little Sand Ck, nr. Bonami Ck [46°55'N 116°37'W], 2900 ft, 9.viii.1979 (3 ♂, 1 ♀, WJTC); same data except, 5.viii.1979 (1 ♂, WJTC); Latah Co., 7 mi N Troy nr Big Meadow Rec. Area [ca. 46°48'N 116°48'W], 3000 ft, 31.vii.1979, WJT (1 ♂, WJTC); same data as holotype (1 ♂, 2 ♀, CNC); same data except, 46°58.180'N 116°35.120'W, 880 m, stream (1 ♀, CNC); Latah Co., Moscow Mt., Moscow Mtn Rd, 46°47.721'N 116°54.093'W, 22.vi.2014, 1000 m, cascading str., BJS (1 ♀, CNC); Latah Co., Moscow Mt. [ca. 46°48'N 116°52'W], 28.viii.1916, A.L. Melander (1 ♂, USNM). **Oregon:** Baker Co., 9 mi W Unity [ca. 44°26'N 118°11'W], 4500 ft, MT, 2.vii.1965 (1 ♂, CNC); Baker Co., Elkhorn Ridge, Upper Pine Ck [ca. 44°50'N 118°03'W], 25.vii.1968, Goeden & Westcott (1 ♂, ODAC); Baker Co., 34 mi SE Union, U. Goose Ck [ca. 44°56'N 117°25'W], 4160 ft, MT, 9.vi–5.vii., 13–19.vii.1975, E.J. Davis (3 ♂, WJTC); Baker Co., 36 mi SE Union, L. Goose Ck [ca. 44°56'N 117°25'W], 4000 ft, MT, 9–12.vi.1976, E.J. Davis (1 ♀, WJTC); same data except, Wallowa-Whitman NF, 9.vi.1976, WJT (2 ♂, WJTC); Union Co., 14 mi S La Grande, Ladd Cyn [ca. 45°09'N 118°03'W], 4280 ft, MT, 24–26.vii.1977, E.J. Davis (1 ♂, WJTC); Wallowa Co., Minam SP [ca. 45°38'N 117°43'W], 9.vi.1971, WJT (1 ♂, 2 ♀, WJTC). **Washington:** Asotin Co., Field's Spr SP [46°04'53"N 117°10'14"W], 31.viii.1971, WJT (2 ♀, WJTC); same data except, 30.vi.1975 (1 ♂, WJTC); same data except, 15,27.vi.1972 (2 ♂, 1 ♀, WJTC); same data except, 20.vii.1966, R.L. Westcott (1 ♀, WFBM); Asotin Co., 4 mi S Anatone, nr Field's Spr SP [ca. 46°05'N 117°10'W], MT, 3600 ft, 10.vi., 12.viii.1980, WJT (2 ♀, WJTC); Whitman Co., 8 mi SW Pullman, Lyle Grove Biol. Area [ca. 46°42'N 117°12'W], 2100 ft, MT, 2–29.vii.1979, L. Corpus (6 ♂, 4 ♀, WJTC); SCS Pond nr WSU Campus, Pullman [ca. 46°43'N 117°11'W], 2500 ft, 19.vi.1976, WJT (1 ♂, WJTC).

Diagnosis. This species is the only species of the *E. (En.) mira* species group found in Idaho, Oregon and Washington and is distinguished by the single median brown vitta on the scutum, male right hind femur with two elongate posteroventral tufts, as long as width of femur (Fig. 29) and hypandrium with medial apical notch.

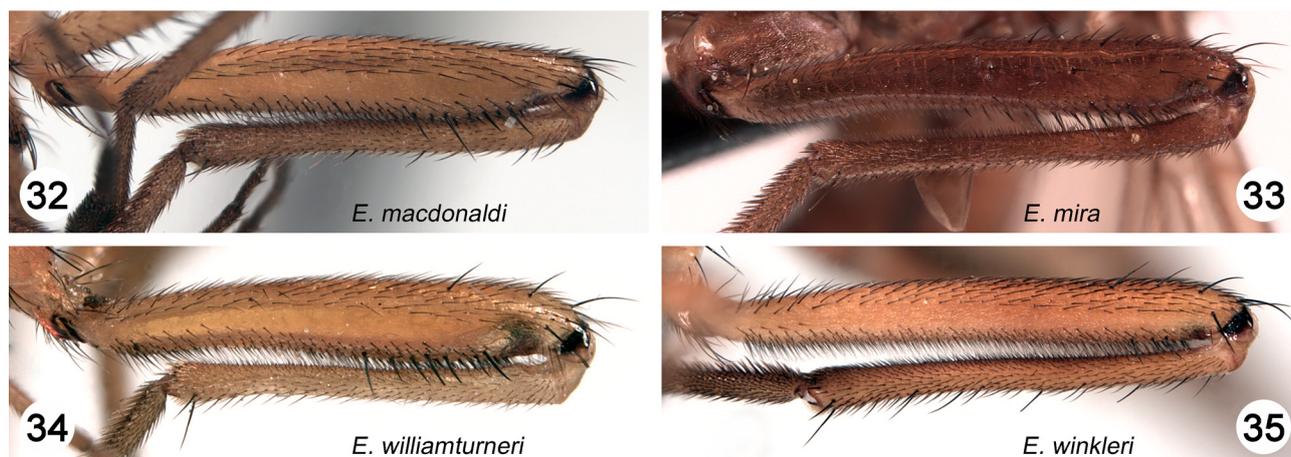


FIGURES 22–31. Male right hindlegs of the *E. (Enoplempis) mira* species group. 22. *E. macdonaldi* sp. nov., holotype, anterior view. 23. *E. macdonaldi* sp. nov., holotype, posterior view. 24. *E. mira* (Bigot), anterior view. 25. *E. mira* (Bigot), posterior view. 26. *E. submira* sp. nov., holotype, anterior view. 27. *E. submira* sp. nov., holotype, posterior view. 28. *E. williamturneri* sp. nov., anterior view. 29. *E. williamturneri* sp. nov., posterior view. 30. *E. winkleri* sp. nov., anterior view. 31. *E. winkleri* sp. nov., posterior view.

Description. Wing length 5.8–6.5 mm. **Male.** Head with dense, dark greyish pruinescence on face, frons, occiput and postgena. Narrowly dichoptic, eye with ommatidia slightly enlarged ventrally. Frons divergent towards antennae; below ocellar triangle slightly narrower than width of anterior ocellus, bearing short setulae along inner

margin of eye. Face slightly divergent towards mouthparts; bare, with oral margin dark and shiny. Ocellar triangle with greyish pruinescence, with pair of parallel ocellar setae and pair of shorter posterior setulae. Occiput bearing row of postocular setae, 2–3 strong, black setae on upper section; shorter and more slender on lower section; remaining upper occipital setae black, long and strong. Pedicel, scape and inner base of postpedicel pale brown to dark brown; postpedicel and stylus dark brown. Scape about 2× longer than pedicel; postpedicel 5× longer than basal width, or 2.5× longer than stylus. Palpus yellow, with dark setulae. Proboscis largely yellow; apex of labrum reddish brown; labellum with dark setae.

Thorax yellow in ground-colour, largely clothed in thin whitish pruinescence; all major setae black. Scutum usually with narrow, dark brown median vitta. Pleura yellow, with thin whitish pruinescence. Proepisternum with several short, dark setae; prosternum bare. Anteprepronotum with row of stout dark setae. Postpronotum with 3–4 short, dark setae and 1 long seta. Scutum with short, fine biserial acr; dc uniserial, longer than acr, postsutural dc increasing in length posteriorly; 2–3 posterior npl, with several shorter anterior setae; 1 presut spal; 1 psut spal; 1 pal. Scutellum with 2 pairs of sctl, apical pair stouter, less than twice length of lateral pair. Laterotergite with 3 long, dark setae and several shorter setae. Anterior and posterior spiracles pale.



FIGURES 32–35. Female left hindlegs of the *E. (Enoplempis) mira* species group in anterior view. 32. *E. macdonaldi* sp. nov. 33. *E. mira* (Bigot). 34. *E. williamturneri* sp. nov. 35. *E. winkleri* sp. nov.

Legs long, entirely yellow, except for dark ring at trochanter-femur junction and apices of femora; tarsomere 5 usually darkened. Coxae with numerous dark lateral setae, longer and stouter along apical anterior margins. Hind trochanter unmodified. Fore and mid femora with distinct white ventral pile. Fore femur with anteroventral and posteroventral rows of fine setae, posteroventral setae longer. Fore tibia with pile of soft ventral setulae, with 2–3 anterodorsal and posterodorsal setae and several preapical setae. Fore tarsomere slightly swollen, slightly broader than fore tibia; shorter than remaining tarsomeres combined; all tarsomeres with pile of soft ventral setulae. Mid femur with anteroventral row of setae of various lengths, with cluster of longer basal setae; posteroventral face with distinct row of well separated setae, shorter than femur width. Mid tibia with dark, short, thickened ventral setae, shorter than width of tibia; 3–4 anterodorsal, 3–4 posterodorsal and several preapical setae. Hindlegs asymmetrical, tibiae geniculate at base. Left hind femur with slight basal swelling with long, dark setae, less than half width of femur; posteroventral row of thickened, erect black setae beyond mid-length (Figs 2, 18), when hindleg closed, row fits along posterior face of curved tibia; short posteroventral swelling on apical third with short, spine-like setae (Fig. 19). Left hind tibia sinuous with black ventral spine-like setae beyond mid-length; preapex with thin posteroventral flange (Figs 18, 19). Right hind femur with proximal two-thirds clothed in numerous short, black ventral setae; without short anteroventral digitiform lobe on apical third; apical fourth shallowly excavated ventrally with transverse ridge bearing brush of thick setae, ending at long tuft of fused, black anteroventral setae (Fig. 28); apical third with pair of tufts of black posteroventral setae, longer than width of femur; apical third without lengthened posterior setae (Fig. 29). Right hind tibia strongly bent at distal third, with saucer-like ridge arched into femur; anterior face of ridge with spine-like setae; flattened preapical anteroventral flange folds up against setal tuft of femur; saucer-like ridge on posteroventral face expanded into setae lobe, dividing paired tufted setae of femur (Figs 28, 29). Tarsomeres 1–5 of fore and hind legs without rows of anteroventral and posteroventral spine-like setae (Fig. 3); tarsomeres 1 and 2 of midleg with several pairs of spine-like anteroventral and posteroventral setae.

Wing clear with yellowish veins, mostly well sclerotized; CuA+CuP fading out prior to wing margin. Basal costal seta short, stouter and longer than surrounding costal setae. R₅ and M₁ parallel near wing margin; R₅ ending beyond wing tip; radial fork acute. Halter yellow.

Abdomen yellow with longest posteromarginal setae on tergite 2, decreasing in length posteriorly. Postero-marginal setae on segment 8 longer than length of sclerites. Pregonital segments unmodified; sclerites of segment 8 closely approximated laterally. Terminalia (Fig. 38) yellow with cercus brown. Cercus narrow, linear, posterior end tapered with setae on inner face; clothed in dark setae, anterior setae longer than width of cercus. Hypoproct without setae. Subepandrial sclerite with process arching obliquely from ventral margin of cercus, extending more than one-third length of cercus; apex slightly upturned. Epandrial lamella subtriangular, posterior margin broadly rounded, without process; setae moderately long, some about width of lamella. Hypandrium short, truncate, apical margin with median notch, more than 0.5× as long as epandrium; base with several setae, shorter than length of hypandrium. Phallus deeply attenuated near base, middle section broad and tapered apically; apical third deeply attenuated, flexed at right angle, forming narrow bowl-like apex, with well sclerotized anterior margin; apex not emerging beyond epandrium; ejaculatory apodeme broad, flattened plate, not Y-shaped, three-quarters length of epandrium.

Female. Similar to male, except as follows: frons slightly narrower than ocellar triangle; mid femur with row of 5 widely spaced, strong posteroventral setae, weaker on anteroventral row; hindlegs symmetrical; hind femur swollen, wider than mid femur, with strong anteroventral and posteroventral setae on apical half (Fig. 34); hind tibia geniculate at base; cercus brown, long and slender, with short dark setae.

Etymology. This species is named after William (Bill) J. Turner, an empidid specialist with a keen interest in western North American *Empis* and who collected long series of *Enoplempis*.

Distribution. This species is known from the extensive Columbia Plateau region of eastern Oregon, eastern Washington and northern Idaho (Fig. 42).

***Empis (Enoplempis) winkleri* sp. nov.**

(Figs 4, 5, 11, 20, 21, 30, 31, 35, 40, 41)

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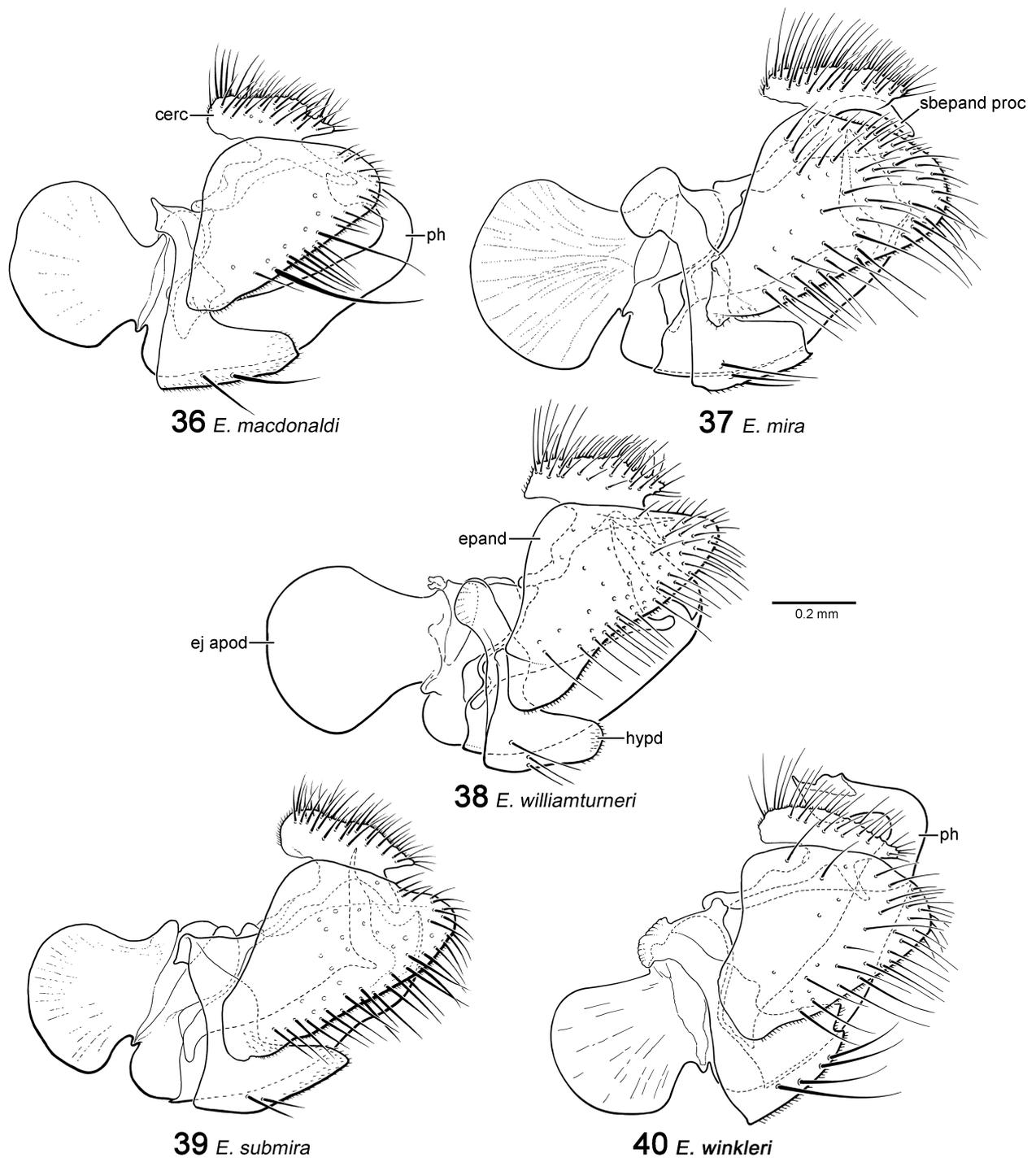
Type material. HOLOTYPE (Fig. 4), ♂ labelled: “USA: CA: Fresno Co. E11-27/ Peterson Rd. 4 mi S Shaver/Lake, at mile marker 5;3.vi.2011/ 37.03928 N, 119.3158 W/ I. Wink[l]er, S. Turner, Turcate[?]; “HOLOTYPE/ Empis (Enoplempis)/ winkleri Sinclair,/ Brooks, Cumming” (CNC). PARATYPES: USA. California: Same data as holotype (3 ♂, 3 ♀, CNC).

Diagnosis. This species differs from other species of the *E. (En.) mira* species group by the absence of dark spots at the base of the dorsocentral setae, male right hind femur without anteroventral setae opposite subapical swelling on tibia (Fig. 30) and male and female mid femur with long posteroventral setae at most slightly longer than width of femur (Fig. 11).

Description. Wing length 5.9–6.7 mm. **Male.** Head with dense greyish pruinescence on face, frons, occiput and postgena. Narrowly dichoptic, eye with ommatidia slightly enlarged ventrally. Frons divergent towards antennae; below ocellar triangle narrower than width of anterior ocellus, bearing short setulae along inner margin of eye. Face slightly divergent towards mouthparts; bare, with oral margin pale and shiny. Ocellar triangle with greyish pruinescence, with pair of divergent ocellar setae and pair of shorter posterior setulae. Occiput bearing row of slender postocular setae; remaining upper occipital setae black, long and stout. Pedicel and scape pale brown; postpedicel and stylus dark brown. Scape about 2× longer than pedicel; postpedicel nearly 4× longer than basal width, or 2.3× longer than stylus. Palpus yellow, with dark setulae. Proboscis largely yellow; apex of labrum reddish brown; labelum with dark setae.

Thorax yellow in ground-colour, largely clothed in whitish pruinescence; all major setae black. Scutum usually with blackish median vitta and pair of broad brownish vittae on either side of dc row. Pleura yellow, with thin whitish pruinescence. Proepisternum with several short, dark setae; prosternum bare. Antepronotum with row of stout dark setae. Postpronotum with 3–4 short, dark setae and 1 long seta. Scutum with short, fine biserial acr; dc uniserial, slightly longer than acr, first anterior dc longer than posterior dc, postsutural dc increasing in length

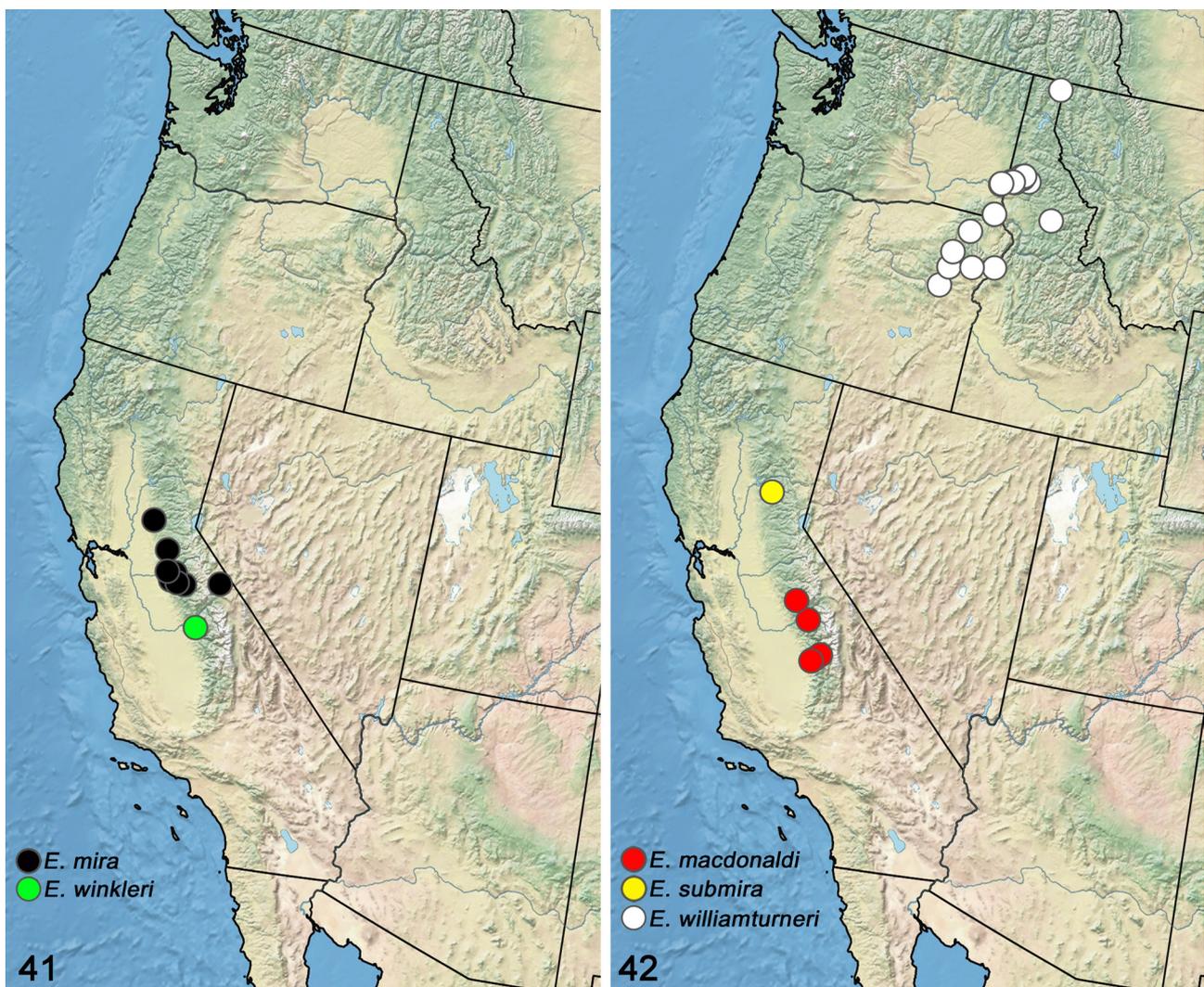
posteriorly; 2–3 posterior npl, with several shorter anterior setae; 1 presut spal; 1 psut spal; 1 pal and 1 short setula. Scutellum with 2 pairs of sclt, apical pair stouter, more than twice length of lateral pair. Laterotergite with 3–4 long, dark and several shorter setae. Anterior and posterior spiracles pale.



FIGURES 36–40. Male terminalia of the *E. (Enoplempis) mira* species group in left lateral view. **36.** *E. macdonaldi* **sp. nov.** **37.** *E. mira* (Bigot). **38.** *E. williamturneri* **sp. nov.** **39.** *E. submira* **sp. nov.** **40.** *E. winkleri* **sp. nov.** Abbreviations: cerc – cercus; ej apod – ejaculatory apodeme; epand – epandrium; hypd – hypandrium; ph – phallus; sbepand proc – subepandrial process.

Legs long, entirely yellow, except for dark ring at trochanter-femur junction and apices of femora; apical tarsomeres darkened. Coxae with several dark lateral setae, all of similar size. Hind trochanter unmodified. Fore and mid femora with distinct white ventral pile. Fore femur with anteroventral and posteroventral rows of fine setae, posteroventral setae longer. Fore tibia with pile of soft ventral setulae, with 2–3 anterodorsal and posterodorsal setae and

several preapical setae. Fore tarsomere swollen, distinctly broader than fore tibia, subequal to remaining tarsomeres combined; all tarsomeres with pile of soft ventral setulae. Mid femur with anteroventral row of setae of various lengths, with cluster of longer basal setae; posteroventral face with distinct row of well separated setae, some about as long as femur width (Fig. 11). Mid tibia with pale ventral and stout, darker setae intermixed, shorter than width of tibia; 2–3 anterodorsal, 2–3 posterodorsal and several preapical setae. Hindlegs asymmetrical, tibiae geniculate at base. Left hind femur densely clothed with fine ventral setae (similar to right hind femur), setae stouter beyond mid-length extending onto short posteroventral lobe (Figs 20, 21). Left hind tibia sinuous apically with dense black ventral setae shorter than ventral setae on femur, with short posteroventral preapical flange (Figs 20, 21). Right hind femur with proximal three-quarters densely clothed in fine ventral setae; without short anteroventral digitiform lobe on apical third; distally shallowly excavated ventrally, with transverse ridge bearing long paint-brush tuft of black anteroventral setae (Fig. 30); apical fourth with tuft of black posteroventral setae, longer than width of femur; distal to tuft with long posteroventral setae (Fig. 31). Right hind tibia bent nearly at right angle, distal to mid-length, especially when viewed ventrally; distal to curvature with large thumb-like anteroventral lobe with crown of minute black spine-like apical projections; flattened preapical anteroventral flange folds up against setal tuft of femur (Figs 30, 31). Tarsomere 1 of midleg and tarsomeres 1–3 of hindleg with rows of anteroventral and posteroventral spine-like setae; hind tarsomere 1 somewhat inflated.



FIGURES 41–42. Known geographical distribution of the *E. (Enoplempis) mira* species group. 41. *E. mira* (Bigot) and *E. winkleri* sp. nov. 42. *E. macdonaldi* sp. nov., *E. submira* sp. nov. and *E. williamturneri* sp. nov.

Wing clear, with yellowish veins, mostly well sclerotized; CuA+CuP fading out prior to wing margin. Basal costal seta short, but stouter and longer than surrounding costal setae. R_5 and M_1 parallel near wing margin; R_5 ending before wing tip; radial fork acute. Halter yellow.

Abdomen yellow with longest posteromarginal setae on tergite 2, decreasing in length posteriorly. Posteromarginal setae on segment 8 longer than length of sclerites. Pregenital segments unmodified. Terminalia (Fig. 40) yellow with cercus darker. Cercus narrow, linear, posterior end tapered to narrow tip, with setae on inner face; clothed in dark setae, longer than width of cercus. Hypoproct without setae. Subepandrial sclerite with process projecting obliquely from ventral margin of cercus; short, less than half distance to epandrial margin. Epandrial lamella subtriangular, posterior margin rounded, without process; setae moderately long, some about half width of lamella. Hypandrium short, apical margin with broad rectangular notch, about 0.5× as long as height of epandrium; base with several setae, nearly as long as hypandrium. Phallus deeply attenuated near base, middle section broad and slightly tapered; apical third deeply attenuated, flexed at right angle, forming narrow bowl-like apex, with well sclerotized ventral margin; apex emerging beyond epandrium; ejaculatory apodeme broad, flattened plate, not Y-shaped, nearly one-half length of epandrium.

Female. Similar to male, except as follows (Fig. 5): frons slightly narrower than ocellar triangle; mid femur with row of 5 strong, widely spaced posteroventral setae, nearly as long as width of femur, weaker on anteroventral row; hindlegs symmetrical; hind femur somewhat swollen, parallel-sided, wider than mid femur, with several strong anteroventral and posteroventral preapical setae, ventrally densely clothed in fine setae (Fig. 35); hind tibia weakly geniculate at base; cercus long and slender, with short dark setae; tarsomere 1 on fore and hind legs slender.

Etymology. This species is named after one of the collectors of the type series, Issac Winkler (Cornell College, Mount Vernon, Iowa), who was also one of the principal investigators who initiated our study of *E. (Enoplempis)*.

Distribution. This species is known only from the type locality in Fresno County, California (Fig. 41).

Key to species of the *Empis (Enoplempis) mira* species group

- 1 Scutum usually with single median brown vitta (sometimes not clearly visible due to preservation); male right hind femur with two elongate posteroventral tufts, as long as width of femur (Fig. 29); hypandrium with medial apical notch (Idaho, Oregon, Washington) *E. williamturneri* sp. nov.
- Scutum usually with or without several vittae; male right hind femur with one elongate posteroventral tuft as long as width of femur (Figs 23, 25, 27, 31); hypandrium without median apical notch (California) 2
- 2 Scutum with row of dark spots at base of the dorsocentral setae [females unknown for *E. submira*] 3
- Scutum with dark or pale vitta at base of the dorsocentral setae 4
- 3 Male right hind femur with anteroventral digitiform lobe on apical third, clothed in short setae (Figs 8, 24); right hind tibia with subapical swelling directed vertically, with black thorn-like setae (Fig. 24) *E. mira* (Bigot)
- Male right hind femur without anteroventral digitiform lobe (Fig. 26); right hind tibia with subapical swelling directed horizontally, without black thorn-like setae (Fig. 26) *E. submira* sp. nov.
- 4 Male right hind femur without anteroventral setae opposite subapical swelling on tibia (Fig. 30); male and female mid femur with long posteroventral setae at most slightly longer than width of femur (Fig. 11); hypandrium with broad rectangular apical notch; subepandrial process short, extending less than half distance to epandrial margin (Fig. 40); female hind femur with anteroventral preapical setae not longer than hind tibia width (Fig. 35) *E. winkleri* sp. nov.
- Male right hind femur with long anteroventral setae opposite subapical swelling on tibia (Fig. 22); male and female mid femur with long posteroventral setae more than twice width of femur (Fig. 10); hypandrium with arched apical margin; subepandrial process long, extending more than half distance to epandrial margin (Fig. 36); female hind femur with anteroventral preapical setae longer than hind tibia width (Fig. 32) *E. macdonaldi* sp. nov.

Discussion

The *Empis (Enoplempis) mira* species group is one of three broad groups (see Sinclair *et al.* 2013) that traditionally have been placed together in the large North American subgenus *Enoplempis* as defined by Melander (1928). The monophyly of the subgenus has not yet been demonstrated, but many included species (including all species of the *E. mira* group) possess a pair of subepandrial processes (Fig. 37) on the male terminalia that are apparently not found in other *Empis* subgenera (Igor Shamshev, pers. comm.). At present this is the only morphological feature that we know of, which suggests *Enoplempis* is monophyletic. Turner (2012) provided a preliminary molecular cladogram of *Empis* using several *Enoplempis* exemplar species, including *E. (En.) mira*, which also indicates that *Enoplempis* is probably monophyletic. The five included species in the *E. (En.) mira* species group together form a well-supported monophyletic group based on the possession of geniculate hindlegs in both sexes and highly modified directionally asymmetrical hindlegs in males.

Conspicuous directional (left-right axis) asymmetry such as that displayed by the male hind legs of the *E. (En.) mira* species group, is extremely rare in insects. We know of only one other case of conspicuous non-genitalic directional asymmetry in insects, interestingly in males of another empidoid species, *Erebomyia exalloptera* Runyon & Hurley (Dolichopodidae) (Runyon & Hurley 2004). In this species the male right wing is a different size and shape than the left wing and males use their wings to fan females during courtship (Hurley & Runyon 2009). A brief review and examples of directional asymmetry were provided by Runyon & Hurley (2004). Unfortunately we don't have any observations on courtship and mating in the *E. (En.) mira* species group so we don't know the function of the highly modified directionally asymmetrical male hindlegs. The differently modified symmetrical male hindlegs that characterize many other *Enoplempis* species (see Sinclair *et al.* 2013) are thought to be used by the male to provide tactile stimuli to the female's abdomen while mating, based on Alcock's (1973) detailed observations on the courtship behaviour of *E. (En.) poplitea* Loew. It is therefore possible that the geniculate directionally asymmetrical male hindlegs of the *E. (En.) mira* species group have a similar function and are not used solely to grasp females during copulation. We continue to need additional observations on the mating habits of additional members of *E. (Enoplempis)* such as those published by Alcock (1973, 2015), in order to understand the evolution of the complex mating behaviours that characterize the subgenus.

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References

- Alcock, J. (1973) The mating behaviour of *Empis barbatoides* Melander and *Empis poplitea* Loew (Diptera: Empididae). *Journal of Natural History*, 7, 411–420.
<https://doi.org/10.1080/00222937300770301>
- Alcock, J. (2015) A note on the mating behavior of *Empis gulosa* Coquillett (Diptera: Empididae). *Northeastern Naturalist*, 22 (4), N24–N26.
<https://doi.org/10.1656/045.022.0401>
- Bigot, J.M.F. (1880) [Diagnoses de trois genres nouveaux de diptères]. *Bulletin Bimensuel de la Société Entomologique de France*, 1880 (6), 62–63.
- Coquillett, D.W. (1895) Revision of the North American Empidae—A family of two-winged insects. *Proceedings of the United States National Museum*, 18 (1896), 387–440.
<https://doi.org/10.5479/si.00963801.18-1073.387>
- Cumming, J.M. & Wood, D.M. (2017) [Chapter] 3. Adult morphology and terminology. In: Kirk-Spriggs, A.H. & Sinclair, B.J. (Eds.), *Manual of Afrotropical Diptera. Volume 1. Introductory chapters and keys to Diptera families. Suricata 4*. South African National Biodiversity Institute, Pretoria, pp. 89–133.
- Hurley, R.L. & Runyon, J.B. (2009) A review of *Erebomyia* (Diptera: Dolichopodidae), with descriptions of three new species. *Zootaxa*, 2054 (1), 38–48.
<https://doi.org/10.11646/zootaxa.2054.1.2>
- Melander, A.L. (1902) Monograph of the North American Empididae. Part I. *Transactions of the American Entomological Society*, 28, 195–367, 5 pls.
- Melander, A.L. (1928) Diptera, Fam. Empididae. In: Wytzman, P. (Ed.), *Genera Insectorum. Fasc. 185. "1927"*. Louis Desmet-Verteneuil, Bruxelles, pp. 1–434.
- Melander, A.L. (1965) Family Empididae (Empidae, Hybotidae). In: Stone, A., Sabrosky, C.W., Wirth, W.W., Foote, R.H. & Coulson, J.R. (Eds.), *A Catalog of the Diptera of America north of Mexico. United States Department of Agriculture, Agri-*

- culture Handbook No. 276*. U.S. Government Publishing Office, Washington, D.C., pp. 446–481.
- Runyon, J.B. & Hurley, R.L. (2004) A new genus of long-legged flies displaying remarkable wing directional asymmetry. *Proceedings of the Royal Society of London, Series B (Supplement)*, 271, S114–S116.
<https://doi.org/10.1098/rsbl.2003.0118>
- Shorthouse, D.P. (2010) SimpleMappr, an online tool to produce publication-quality point maps. [Retrieved from <http://www.simplemappr.net> (accessed 8 October 2020)]
- Sinclair, B.J., Brooks, S.E. & Cumming, J.M. (2013) Revision of the *Empis* subgenus *Enoplempis* Bigot, east of the Rocky Mountains (Diptera: Empididae). *Zootaxa*, 3736 (5), 401–456.
<https://doi.org/10.11646/zootaxa.3736.5.1>
- Turner, S.P. (2012) The evolution of sexually selected traits in dance flies. Unpublished PhD thesis, North Carolina State University, Raleigh, North Carolina. Available from: <http://repository.lib.ncsu.edu/ir/bitstream/1840.16/8076/1/etd.pdf> (accessed 9 September 2013)

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