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William L. Grogan Jr.
Salisbury University, Salisbury, Maryland

Gustavo R. Spinelli
Museo de La Plata, La Plata, Argentina

Robert A. Phillips
Moab Mosquito Abatement District, Moab, Utah

David L. Woodward
Lake County Vector Control District, Lakeport, California

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THE MALE OF *CULICOIDES REEVESI* WIRTH, WITH A REDESCRIPTION OF THE FEMALE AND NEW SEASONAL ACTIVITY, DISTRIBUTION, AND BITING RECORDS (DIPTERA: CERATOPOGONIDAE)

William L. Grogan, Jr.[1], Gustavo R. Spinelli[2], Robert A. Phillips[3], and David L. Woodward[4]

ABSTRACT.—The previously unknown male of the biting midge, *Culicoides reevesi* Wirth, is described and illustrated; the female is also redescribed and this species is reassigned to the *leoni* group. Previously known from California, Arizona, and New Mexico, *C. reevesi* is recorded for the 1st time from Utah (**new record**). Females of this aggressive, hematophagous species were collected while biting humans during evening crepuscular periods in California. Females exhibited a strong attraction to CO_2 traps, and seasonal surveillance demonstrated that host-seeking occurred from late May until mid-October in both California and Utah. Small numbers of males were also collected in CO_2 traps; however, both sexes showed little attraction to ultraviolet and incandescent light traps.

Key words: Diptera, Ceratopogonidae, Culicoides reevesi, *biting midge,* leoni *group, nearctic, seasonal abundance.*

When Willis W. Wirth described the biting midge, *Culicoides reevesi*, as a new species in his classic monograph *The Heleidae of California* (Wirth 1952), the type series consisted of only females, from which he illustrated the wing. Wirth originally considered this species to be a member of the *debilipalpis* group due to its "nearly bare wings and one spermatheca." Soon thereafter, Wirth and Blanton (1956) reviewed 5 related species in the *debilipalpis* group of the subgenus *Oecacta* Poey, which they termed the *leoni* group: *C. benarrochi* Ortiz and Mirsa, from Venezuela; *C. fieldi* Wirth and Blanton, from Honduras; *C. glabellus* Wirth and Blanton, from Panama; *C. leoni* Barbosa, from Ecuador; and *C. reevesi*. Wirth and Blanton (1956, 1959) characterized the *leoni* group mainly by their small size (female wing length 0.63–0.75 mm), wings with sparse macrotrichia and extensive pale spots, antennal flagellum with sensilla coeloconica on flagellomeres 1, 5, or 6–8, flagellomere 9 shorter than flagellomere 8, a single spermatheca, and unique features of the male genitalia.

Wirth (1965) subsequently reported *C. reevesi* from Arizona and New Mexico, and Atchley (1967) redescribed the female and illustrated the wing, flagellomeres 7–11, palpus, hind tibial spur, and spermatheca. Interestingly, in his original description Wirth (1952) did not mention the very short flagellomeres 9 and 10, a major diagnostic feature of this species, but did so later (Wirth and Blanton 1956), as did Atchley. Atchley noted, "This is a man-biting species previously reported as attacking man in California. In New Mexico it has been collected biting man at three localities in the western portion of (t)he state. My own records indicate that this species is probably crepuscular, attacking at approximately sunset" (Atchley 1967:1003). More recently, Wirth et al. (1985) assigned this species to the subgenus *Haematomyidium* Goeldi and provided an excellent photograph of the female wing from a specimen from Needles, San Bernardino County, California.

Recent collections of *C. reevesi* in Lake County, California, by DLW and Grand County, Utah, by RAP with light and CO_2 traps have yielded several males and numerous additional females of this species. In this article we describe and illustrate the previously unknown male, once again describe and illustrate the female, and describe new distribution, seasonal activity, and biting records of this very small, but fierce, man-biting species.

We employ the updated terminology of Ceratopogonidae as presented by Downes and Wirth (1981). Measurements and ratios are presented as mean (minimum–maximum values,

[1]Department of Biological Sciences, Salisbury University, Salisbury, MD 21801.
[2]Departamento Cientifico de Entomologia, Museo de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina.
[3]Moab Mosquito Abatement District, Box 142, Moab, UT 84532.
[4]Lake County Vector Control District, 410 Esplanade, Lakeport, CA 95453.

and number of specimens) measured. All specimens examined were mounted on microscope slides in phenol-balsam following the procedures of Wirth and Marston (1968). Voucher specimens are in the synoptic collections of biting midges of WLG at Salisbury University, Maryland; RAP at the Moab Mosquito Abatement District in Moab, Utah; and DLW at the Lake County Vector Control District in Lakeport, California; additional voucher specimens will be deposited in the U.S. National Museum of Natural History, Washington, DC (USNM), Museo de La Plata, Argentina (MLPA), University of California, Riverside Museum of Insects (UCRC), and the Canadian National Collection of Insects, Ottawa (CNCI).

Culicoides reevesi Wirth
(Figs. 1–8)

Culicoides reevesi Wirth, 1952:193 (female, California, fig. wing).

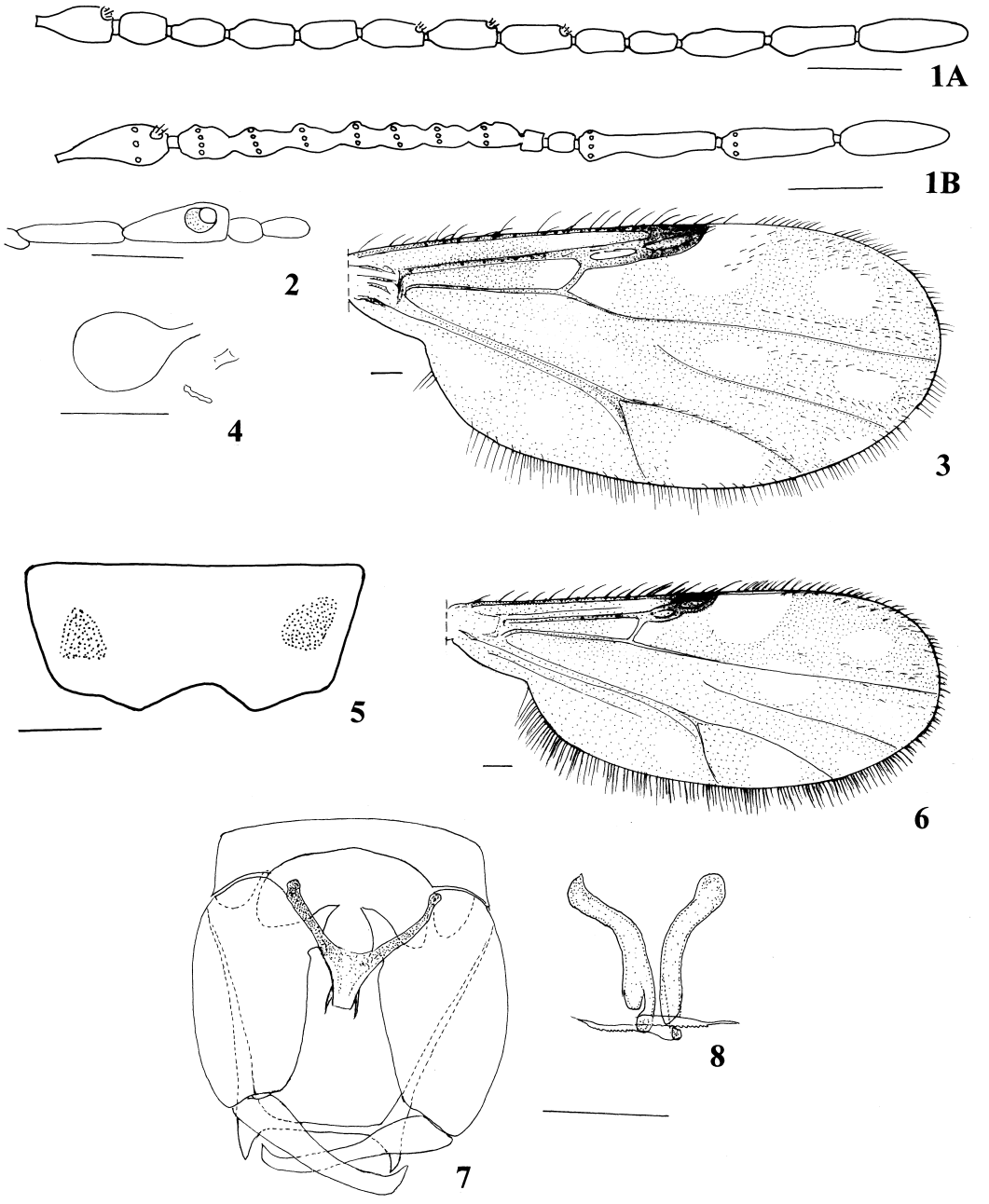
Culicoides reevesi: Wirth and Blanton, 1956:51 (assigned to *leoni* group of subgenus *Oecacta*; redescription; figs. wing, palpus, hind tibial comb, spermatheca, scutum and scutellum); Wirth and Blanton, 1959:426 (*leoni* group); Atchley, 1967:1002 (*leoni* group; redescription; Arizona, New Mexico; figs. wing, palpus, hind tibial comb, spermatheca, antennal flagellomeres); Borkent and Wirth, 1997:80 (in world catalog).

Culicoides (Haematomyidium) reevesi: Wirth et al., 1985 (subgeneric reassignment, wing photo).

DIAGNOSIS.—A typical species of the *leoni* group of the subgenus *Oecacta* as defined by Wirth and Blanton (1956, 1959), distinguished from other members of the group by the following combination of characters: antennal flagella of both sexes with flagellomeres 9–10 distinctly shorter than flagellomeres 8 or 11; female with sensilla coeloconica present on flagellomeres 1 and 6–8, third palpal segment with moderately deep sensory pit, proboscis/head ratio 0.94–1.00, wing with sparse macrotrichia restricted to distal sections of veins and apical wing margin, poststigmatic pale spot in cell m_1 separsated from wing margin by distance shorter than spot length, 1 spermatheca; male lacking sensilla coeloconica on distal flagellomeres, wing characters similar to female, parameres with well-defined ventral lobe and fine fringe of denticles on distal portions, aedeagus broader than long with high basal arch (0.55 of total length) and pair of small subapical lateral processes, tip truncate.

FEMALE.—Wing length 0.75 (0.65–0.84, $n = 25$) mm; breadth 0.38 (0.32–0.43, $n = 25$) mm. Head: dark brown. Eyes narrowly separated by distance equal to diameter of 1–1.5 ommatidia, with short pubescence. Antennal flagellum (Fig. 1A) light brown with flagellomeres 1–10 vasiform, 11–13 more elongated, 9–10 distinctly shorter than 8 or 11; multiple sensilla coeloconica on flagellomere 1, usually a single sensilla on flagellomeres 6–8; total flagellum length (minus interflagellar spaces) 0.45 (0.38–0.52, $n = 24$) mm, lengths of flagellomeres (in micrometers) of a typical specimen 46-26-28-33-31-33-33-33-26-26-41-42-51; antennal ratio 0.70 (0.63–0.77, $n = 24$). Palpus (Fig. 2) slightly paler than flagellum; 3rd segment moderately swollen with large, deep, subapical pit with smaller diameter opening, pit with numerous capitate sensilla; palpal ratio 1.99 (1.70–2.30, $n = 24$). Proboscis long; proboscis/head ratio 0.90 (0.75–1.00, $n = 24$); mandible with 16–19 fine teeth. Thorax: dark brown, scutal pattern not apparent in slide-mounted specimens. Legs brown; tibiae with subbasal pale bands; hind tibial comb with 4 spines, longest nearest spur; proximal 4 hind tarsomeres lack apical spine. Wing (Fig. 3) with sparse macrotrichia restricted to distal portions of posterior veins and apical wing margin; 2nd radial cell in dark spot; large pale spot over r-m crossvein, poststigmatic area of cell r_5, and distal portion of cell m_4, with smaller pale spots as follows: 1 in subapical portion of cell r_5, 2 in cell m_1, distal one separated from wing margin by distance shorter than spot length, 1 on extreme distal portion of cell m_2 that abuts wing margin, 2 poorly developed in anal cell; costal ratio 0.56 (0.54–0.59, $n = 25$). Halter pale. Abdomen: light brown. Segment 8 a complete ring, heavily sclerotized; sternite 8 (Fig. 5) with 2 subcuticular, darkly pigmented, submarginal areas. A single pyriform spermatheca (Fig. 4) with well-developed, narrow neck, measurements of typical specimen 0.042 × 0.038 mm, neck 0.012 mm; a rudimentary 2nd spermatheca and sclerotized ring also present.

MALE.—Slightly smaller, similar to female with the following notable sexual differences. Wing length 0.67 (0.65–0.72, $n = 7$) mm; breadth 0.30 (0.29–0.32, $n = 7$) mm. Antennal



Figs. 1–8. *Culicoides reevesi*: 1, antennal flagella: A, female, B, male; 2–5, female structures; 6–8 male structures: 2, palpus; 3, 6, wings; 4, spermatheca plus rudimentary 2nd spermatheca and sclerotized duct; 5, sternite 8; 7, genitalia, parameres removed; 8, parameres. Scales = 0.05 mm.

flagellum (Fig. 1B) with flagellomeres 2–9 fused; flagellomere 1 with single sensilla coeloconica, distal flagellomeres apparently lacking sensilla; total flagellum length (minus interflagellar spaces) 0.53 (0.48–0.57, $n = 8$) mm; antennal ratio 0.67 (0.64–0.70, $n = 8$). Third palpal segment broader; palpal ratio 1.70 (1.50–1.88, $n = 6$). Proboscis shorter; mandible vestigial, without teeth. Wing (Fig. 6) with fewer macrotrichia, restricted to apical margin of cell r_5, on and along distal section of vein M_1; proximal pale spot in cell m_1 straddles vein M_1 into cell r_5, a single distal pale spot on anal cell; radial cells shorter; costa shorter, costal ratio 0.50 (0.48–0.51, $n = 7$). Genitalia as in Figures 7–8. Sternite 9 with broad, shallow caudomedian excavation, ventral membrane non-spiculate; tergite 9 long, tapering slightly distally with stout, triangular apicolateral processes that are slightly curved medially. Gonocoxite nearly twice as long as broad; ventral root large, foot-shaped, posterior heel well developed, pointed; dorsal root slender; gonostylus slender, slightly curved distally, tip abruptly curved, sharply pointed. Aedeagus broader than long, length 0.8 of breadth; basal arch 0.55 of total length; basal arm heavily sclerotized, slender, long, bent proximally with knob-like tip; distal portion tapering gradually distally to truncate tip with pair of small, slender, sharply pointed lateral subapical processes (these difficult to discern on some specimens). Parameres (Fig. 8) separate; proximal portions stout, heavily sclerotized, with broadly separated basal knobs, nearly straight on distal halves with well-developed ventral subapical lobes; distal portions slender, tapering to finely pointed tips with lateral fringe of very fine denticles.

DISTRIBUTION.—Southwestern United States. Specimens known from Arizona, California, New Mexico, and Utah (**new record**).

SPECIMENS EXAMINED.—**California:** Lake County, Anderson Marsh St. Pk., Lower Lake, CO_2 trap, 12-VII-2002, 3 males, 31-VIII-2002, 4 females, D.L. Woodward; Konocti Conservation Camp, Lower Lake, CO_2 trap, 3-VII-2002, D.L. Woodward, 4 females; Lakeport, CO_2 trap, 20-VIII-2000, D. Woodward, 2 males; Lakeport, 457 Woodward Way, CO_2 trap, 1-VIII-2002, D. Woodward, 3 females, 9-VIII-2002, 4 females; Lakeport, 39°01′24″N, 122°55′14″W, CO_2 trap, D. Woodward, 3 females, 2 males; Riverside County, Deep Creek, 18-V-1964, M.E. Irwin, 1 female (UCRC); Riverside, 10-VII-1984, B.A. Federici, biting man, 1 female (UCRC). **New Mexico:** Cherry Creek, Pinos Altos, 22-VI-1953, W.W. Wirth, biting man, 1 female. **Utah:** Grand County, Moab, CO_2 trap, 24-VI-1999, R.A. Phillips, 4 females; 4 km SE Moab, CDC LT, 7-VIII-2001, R.A. Phillips, 1 male; 4 km SW Moab, CO_2 trap, 1-VIII-2000, 1 female, CDC LT, 14-IX-2001, 1 female, UVLT, 24-VII-2002, 1 female, R.A. Phillips; 8 km SE Moab, CO_2 trap, 13-VI-2002, R.A. Phillips, 1 female.

TAXONOMIC DISCUSSION.—Wirth et al. (1985) inexplicably placed this species in the subgenus *Haematomyidium.* We disagree with this reassignment and are convinced that *C. reevesi* is a typical member of the *leoni* group in the subgenus *Oecacta* as defined by Wirth and Blanton (1956, 1959), an arrangement with which Atchley (1967) concurred. Subsequently, however, Wirth et al. (1988) considered the *leoni* group unplaced to subgenus.

Among the other species in the *leoni* group, *C. leoni* Barbosa is most similar to *C. reevesi* but differs in its smaller size (female wing length 0.63 mm), sensilla coeloconica on flagellomeres 1 and 5–8, a broader 3rd palpal segment (palpal ratio 1.7), wing pattern with smaller pale spot on r-m crossvein, poststigmatic pale spot not oblique, distal pale spot in anal cell abutting wing margin, and male parameres without ventral lobe and simple, filiform tips.

SEASONAL ACTIVITY AND BITING HABITS.—There are no previous reports describing the seasonal activity periods of *C. reevesi* adults because prior collections have been almost entirely limited to females caught while biting man (Wirth 1952, Wirth and Blanton 1959, Atchley 1967). We used CDC-style suction traps (John W. Hock Co., Gainesville, FL), modified by removal of the light, but with carbon dioxide released as an attractant (CO_2 traps), to monitor the seasonal abundance of host-seeking females. These CO_2 traps were operated from April through October 1 day per week in 2 blue oak (*Quercus douglasii* Hooker and Arnott) woodlands (425 m elevation) near Clear Lake, Lake County, California, during 2001 and 2002. Traps were also employed on 1 or more days per week in suburban, agricultural, desert, riparian, marsh, and scrub oak (*Q. gambelii* Nuttall) habitats (1205–1390 m elevation) near Moab, Grand

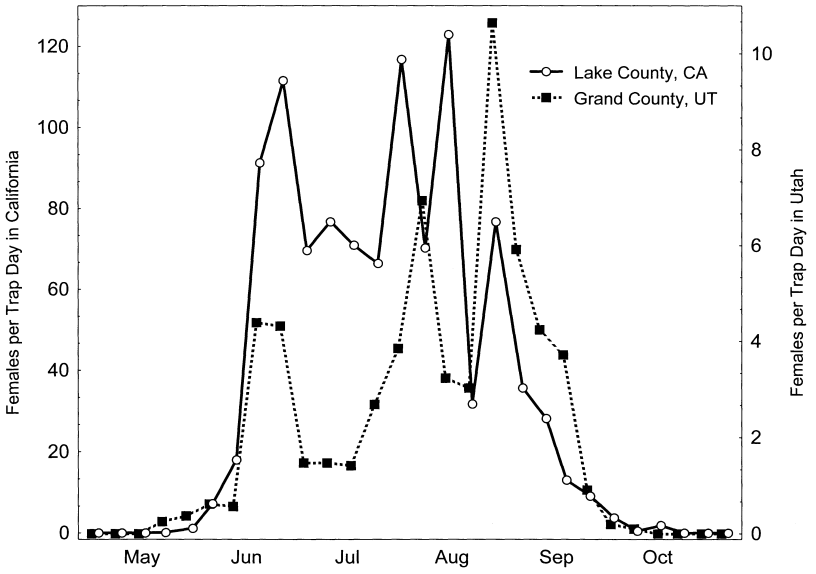


Fig. 9. Seasonal abundance of host-seeking females of *Culicoides reevesi* in Lake County, California, and Grand County, Utah. Mean numbers of females caught in California by operating 4 CO_2 traps per week in 2 blue oak (*Quercus douglasii*) woodlands during 2001 and 2002 are scaled on the left y-axis. Mean numbers of females caught in Utah by operating 2–12 CO_2 traps per week in various habitats during 1999 through 2002 are scaled on the right y-axis.

County, Utah, from 1999 through 2002. On each trap-day traps were hung from tree limbs with their entrances 1.3–1.6 m aboveground, baited with dry ice and operated from mid-afternoon until the morning of the following day.

A total of 8181 female and 7 male *C. reevesi* adults were caught during 206 CO_2 trap-days in California, whereas 1701 female and no male *C. reevesi* were caught during 736 CO_2 trap-days in Utah. Only 20% of the sampled habitats in Utah included an overstory of scrub oak, but 84% of the *C. reevesi* females caught in CO_2 traps were collected from these oak habitats. Although the study sites in the 2 states were separated by a distance of 1160 km and by more than 780 m in altitude, the seasonal activity patterns of *C. reevesi* females were quite similar in both states (Fig. 9). In both localities host-seeking females were first captured in late May, peaked in abundance during late June, diminished in abundance through July with another activity peak through August, and gradually declined to no individuals by mid-October.

In addition to surveillance by CO_2 traps, all Utah habitats were concurrently sampled with CDC-style light traps operated without the use of CO_2 as an attractant during an additional 312 trap-days. Adult *C. reevesi* showed little, if any, attraction to either incandescent or ultraviolet light traps as catches for 177 light trap-days using incandescent light yielded only 4 females and 1 male, and 135 light trap-days with ultraviolet light produced only 2 females.

Additional studies of *C. reevesi* in oak woodlands in Lake County, California, supported Atchley's (1967) conclusion that females readily bite humans, particularly during the evening crepuscular period. We used a CO_2 trap with a time-segregated collection system (John W. Hock Co., model 1512 collection bottle rotator) over a 10-day sample period and collected host-seeking *C. reevesi* females (n = 1565) throughout diurnal periods. More than 72% of females were caught during the interval from 2 hours before sunset until sunset. Biting studies conducted during evening crepuscular periods in the same habitats resulted in the collection of *C. reevesi* females (n = 27) that were biting humans on the arms, hands, forehead, and scalp. In some cases the bites of *C. reevesi* females resulted in raised, red welts on human skin that itched intensely for several days. Although collections of *C.*

reevesi from humans were not attempted in Grand County, Utah, CO_2 trap catches of host-seeking females in that locality have been correlated with biting midge complaints by local residents.

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