

NEW SYNONYMS AND STAGE DESCRIPTION FOR THREE SPECIES OF LEPTOHYPHIDAE (EPHEMEROPTERA)

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Abstract.—*Vacupernius paraguttatus* (Allen) and *Allenhyphes michaeli* (Allen) are **new junior subjective synonyms** of *V. packeri* (Allen) and *A. vescus* (Allen), respectively. Larval characters such as abdominal maculation are shown to be variable and unreliable in separating these species. Maxillary palp segmentation is difficult to detect among immature larvae of both species and must be used with caution when identifying immature leptohiphid larvae to species. The adult stage of *Homoleptohiphes mirus* (Allen) is described for the first time based upon reared and field-associated specimens from southern Arizona.

Key Words: Ephemeroptera, Leptohiphidae, *Allenhyphes*, *Vacupernius*, *Homoleptohiphes*, taxonomy

The mayfly family Leptohiphidae (Ephemeroptera) is a New World family of mayflies distributed in North, Central, and South America, and the Carribean. Although the family is common and widely distributed, the species-level taxonomy of this family suffers from many problems that include a lack of larval and adult associations, larval characters that are variable within and among populations and discrepancies in original descriptions and figures of species (Baumgardner and McCafferty 2000). Allen (1978) provided keys and descriptions for species of *Leptohiphes*. Recent publications by Lugo-Ortiz and McCafferty (1995), Wang et al. (1998), Baumgardner and McCafferty (2000) and Wiersma and McCafferty (2000) provided new or revised descriptions of taxa, synonyms, and distributional data. Despite these recent advances, many species-level problems remain in Leptohiphidae.

As part of an ongoing revision and cladistic analysis of the family Leptohiphidae in North and Central America, two new ju-

nior subjective synonyms are presented for the family. *Vacupernius paraguttatus* and *Allenhyphes michaeli* are shown to be synonyms of *V. packeri* and *A. vescus*, respectively. In addition, the adult stage of *Homoleptohiphes mirus* is described for the first time based upon reared and field-associated specimens from Sonoita Creek, Santa Cruz County, in southern Arizona, near the type locality of the species.

Depositions (and their acronyms) of materials used in this study include: The California Academy of Science, San Francisco (CAS); Texas A&M University, College Station (TAMU); Florida A&M University, Tallahassee (FAMU); Southwest Texas State University, San Marcos (SWTS); and Wilbur R. Enns Entomology Museum, University of Missouri, Columbia (UMC).

Vacupernius packeri (Allen)
(Figs. 1, 2)

Leptohiphes packeri Allen 1967: 350.

Leptohiphes phalarobanchus Kilgore and Allen 1973: 328; Allen 1978: 552 (syn.).

Leptohyphes paraguttatus Allen 1978: 552.

New synonym.

Vacupernius paraguttatus: Wiersema and McCafferty 2000.

Vacupernius packeri: Wiersema and McCafferty 2000.

Vacupernius packeri was described by Allen (1967) from a series of larvae collected in Honduras, and has been shown to be widely distributed throughout the southwestern United States and Central America (Allen 1978, Henry 1986, Allen and Murvosh 1987, Lugo-Ortiz and McCafferty 1995). Henry (1986) associated the adult stage through rearing. In the larval stage, this species was distinguished from all other described species of *Leptohyphes* sensu lato by distinctive maculations on the operculate gills (see Allen 1967; fig. 14) and vertex of the head; the presence of a 3-segmented maxillary palp; and the absence of what Allen referred to as the basal spine on the operculate gill, which is actually a colorless outgrowth of the outer ventral lamellae of gill 2 (Baumgardner and McCafferty 2000).

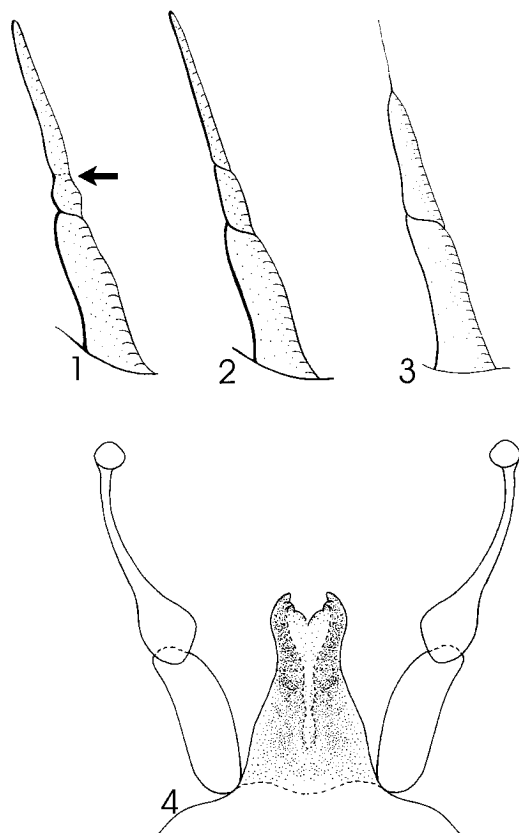
Vacupernius paraguttatus, also described by Allen (1978), was based upon a single, immature larval specimen from the Hill Country of central Texas. This species was distinguished from other species of *Leptohyphes* sensu lato based primarily upon abdominal maculations on terga 2–4 that formed a “V”-shaped pattern. Pale body and the presence of a 2-segmented maxillary palp were also considered important characters separating this species from others within the genus.

Critical examinations of series of *V. packeri* larval specimens showed that a few of these specimens have the distinctive “V”-shaped maculation that was believed by Allen (1978) to be diagnostic of *V. paraguttatus*. Unfortunately, the holotype of *V. paraguttatus* has become badly faded and no longer has the distinctive “V”-shaped pattern on the abdomen. However, this “V”-shaped pattern has been observed on

some immature larvae of *V. packeri*. This abdominal mark has only been observed on immature specimens of *V. packeri*, indicating developmentally influenced color pattern change. Abdominal larval markings similar to this have been found to be highly variable in other leptohyphid mayflies, such as *L. zalope* Traver, some of which display distinctive but variable abdominal markings (Baumgardner and McCafferty 2000). The distinctive maculations on the operculate gills of *V. packeri* are also absent in immature larvae, but begin to become visible in mature larvae. A few larvae of *V. packeri* were found to have both the abdominal “V”-shaped pattern and operculate gill maculation, providing the most compelling evidence to support the synonymy.

Although Allen (1978) indicated that *V. paraguttatus* had a 2-segmented maxillary palp, careful re-examination of the slide-mounted mouthparts of the holotype showed the maxillary palp to be 3-segmented, but the intersegmental suture between the second and third segment is difficult to detect (Fig. 1). Examination of immature specimens of *V. packeri* also showed that they have a maxillary palp that appears to be 2-segmented. However, under high magnification a very faint suture is visible on the middle of the apical maxillary palp segment, as it is in the holotype of *V. paraguttatus*. For mature larvae, this intersegmental suture is distinct. Other larval specimens having both the distinctive “V” maculation of *V. paraguttatus* and the operculate gill markings of *V. packeri* were observed to have this weak suture between the second and third maxillary palp segments. In mature specimens of *V. packeri* this suture is readily visible and distinct (Fig. 2).

The above observations clearly support the synonymy of *V. paraguttatus* with *V. packeri*. Also of importance is the wide variation that occurs in immature specimens of this species, such as abdominal maculation and maxillary palp segmentation, characters which have historically been used to sepa-



Figs. 1–4. 1, *Leptohyphes paraguttatus*, holotype larva, maxillary palp (arrow indicates location of weak suture line). 2, *Vacupernius packeri*, larva, maxillary palp (mature larvae). 3, *Allenhyphes vesus*, larva, maxillary palp. 4, *Homoleptohyphes mirus*, male adult, genitalia.

rate numerous species of leptohiphid mayflies. This indicates that these characters should be used with caution when determining species limits within the family Leptohiphidae.

Type material examined.—*Leptohyphes paraguttatus* Allen: HOLOTYPE larva: Geronimo Cr., Guadalupe Co., Tex., 18-v-73, Michael Peters; three associated slides (CAS #13603).

Other material examined.—(All larvae, unless otherwise indicated.) UNITED STATES: ARIZONA: Yavapai Co., Wet Beaver Ck. at Wet Beaver Ck. Campground, 24-25-v-1999, D.E. Baumgardner, (TAMU). TEXAS: Bandera Co., Winans

Creek, Hwy. 16 crossing, 12-iv-1992, Moulton & Stewart, 6 ♂, 2 ♀, (TAMU). Comal Co., Sattler, Río Raft Co., Guadalupe River at 5.5 mi. below Canyon Dam below 4th crossing., 26-x-1996, N. Wiersema, (TAMU). Comal Co., Guadalupe River at Hwy. 311, 20-vi-1993, J. L. Cook, (TAMU). Milam Co., Rockdale, San Gabriel River at Hwy. 487 crossing, 16-xi-1996, N.A. Wiersema, (TAMU). Hays Co., San Marcos R. at Co. Rd. 101 (Caners Crossing), 1 mi. below conf. with Blanco R., in San Marcos City Limits, at Hays/Caldwell Co. Line, 21-ii-1997, DE Baumgardner and DE Bowles, (TAMU). Medina Co., Seco Creek, 6 mi. S. of D'Hanis, 13-v-1993, L. Gilpin, V. Castillo, (SWTS, TAMU); Same but, 27-vi-1993, (SWTS, TAMU); Same but, 25-iv-1993, (SWTS, TAMU). Milam Co., Rockdale, San Gabriel R. at 487 crossing, 16-xi-1996, N. Wiersema. Williamson Co., Georgetown, San Gabriel Park, below little dam and bridge, 07-x-1996, N. Wiersema, (TAMU). BELIZE: STANN CK. DISTRICT, North Stann Creek, 2.7 mi. SE Middlesex on Hummingbird Hwy., 11-i-1996, R. W. Sites, (UM). MEXICO: NUEVO LEÓN, Cabazones R. at Hwy. 85, 15 mi. N. Linares, 16-v-1995, D. E. Baumgardner and B. C. Henry, (TAMU).

Allenhyphes vesus (Allen)

(Fig. 3)

Leptohyphes vesus Allen 1978: 555.

Leptohyphes michaeli Allen 1978: 549.

New synonym.

Allenhyphes michaeli: Wiersema and McCafferty 2000.

Allenhyphes vesus: Wiersema and McCafferty 2000.

Allenhyphes vesus was described by Allen (1978) from the Hill Country of Texas based on a larva. Henry (1986) described the adults through rearing. The thin, delicate body and 2-segmented maxillary palp were considered diagnostic for the larval stage. Although not mentioned by Allen

(1978), the maxillary palp also has a diagnostic terminal seta.

In the same publication that Allen (1978) described *A. vescus* he also described *A. michaeli*, based on a single larva from the Hill Country of Central Texas. *Allenhyphes michaeli* was distinguished from other larvae then placed in *Leptohyphes* sensu lato by having a dark, median longitudinal line on abdominal terga 1–6, and a 1-segmented maxillary palp with a distinct apical seta.

A careful study of numerous specimens of *Allenhyphes vescus* from the Hill Country of Texas has clearly shown much variability in the median longitudinal line character. Specimens both with and without the median longitudinal line on abdominal terga 1–6 were observed. Moreover, this abdominal feature gradually disappears as the larvae develop and no mature larvae of *A. vescus* were found to have the longitudinal line on abdominal terga 1–6.

Although Allen considered *A. michaeli* to have a 1-segmented maxillary palp, a careful re-examination of the holotype maxillae under high magnification indicated that a small intersegmental suture is present, and the palp is actually 2-segmented, as in *A. vescus*.

In summary, larvae of *Allenhyphes vescus* have 2-segmented maxillary palps with an apical seta. The morphological details of the palp can most easily be observed under high (400×) magnification (Fig. 3). Although both species were described in the same publication, *A. vescus* was chosen to be the senior name as the prerogative of the first revisor.

Allenhyphes vescus is known from throughout much of central Texas and is often associated with streams in the Balconian ecoregion. It is also known from Nuevo Leon and Tamaulipas, Mexico.

Type material examined.—*Leptohyphes vescus* Allen: HOLOTYPE larva: Río Sabinal at Utopia, Uvalde Co., Texas., 2-viii-68, R. K. Allen; 2 slides (CAS #13607). *Leptohyphes michaeli* Allen: HOLOTYPE larva: North Fork Guadalupe Riv., 4 mi W.

Hunt, Kerr Co., Tex., 27-vii-73, Michael Peters; 3 slides (CAS #13602).

Other material examined.—UNITED STATES: TEXAS: Kimble Co., Llano R. @ Texas Tech Field Station, 07-xi-1998, DE Baumgardner, 1 male (reared), (TAMU). Val Verde Co., Dolan Falls Preserve, Devils River; The Nature Conservancy, 08-xi-1998, DE Baumgardner, 1 male (TAMU). Comal Co., Honey Ck. in Honey Ck. St. Natural Area in Guadalupe R. State Pk, 08-iii-1997, DE Baumgardner & DE Bowles, 1 male (reared), larvae (TAMU). Williamson Co., Georgetown, San Gabriel Park, riffles below the little dam on the San Gabriel River, 2-x-1996, N. Wiersema, larvae (TAMU). Val Verde Co., Devils River, Dolan Falls, 19-x-1993, C. R. Nelson & S. M. Stringer, larvae (TAMU). MEXICO: TAMAULIPAS, spring (at local park) (at Hidalgo Ave?) near town of Jaumave, off Hwy. 101; 16-v-1995, 2 males, BC Henry & DE Baumgardner. TAMAULIPAS, R. Guayaalejo (Tamasí) off Hwy 247 nr. San Ignacio, 26-v-1993, B. Henry, larvae.

Homoleptohyphes mirus (Allen)
(Fig. 4)

Leptohyphes mirus Allen 1967: 353.

Homoleptohyphes mirus: Wiersema and McCafferty 2000.

Male adult.—Body length: 3.0–4.5 mm. Forewing length 4.5–5.0 mm. Hindwing absent. Cerci length 8.0–10.0 mm. Overall coloration dark reddish brown with pale lateral markings. Head dark brown, with black over shading. Compound eyes large; width of one eye greater than distance between eyes. Antenna brown at base, pale apically. Pro- and mesonotum reddish brown with pale lateral markings. Metanotum shiny reddish brown to dark brown. Forefemur pale with dark brown stippled longitudinal bands; apical segments pale. Meso- and metafemora pale with dark brown to black longitudinal bands; apical segments pale with brown stippling. Foreclaws similar and blunt. Forewings translucent with darkened

subcostal vein. Abdomen pale to dark reddish brown, similar in color to thorax; cerci pale with grey over shading. Genitalia as in Fig. 4; penes with shallow emargination and scattered small spines; subgenital plate with shallow emargination, covered with minute spines (Fig. 4).

Female adult.—Body length: 3.0–4.0 mm. Forewing length 4.5–5.0 mm. Hindwing absent. Cerci missing. Body coloration and markings similar to male. Compound eyes small and widely separated.

Comments.—In both the larval and adult stages, *H. mirus* is most similar to *H. dimorphus* (Allen), because male larvae and adults have large compound eyes. These are the only two known species of Leptohiphidae in North or Central America that have this feature. In the larval stage, *H. mirus* can be differentiated from *H. dimorphus* by the presence of short spines on the forefemur of *H. mirus*. In contrast, *H. dimorphus* has long setae on the forefemur. Differentiating adults of *H. mirus* from *H. dimorphus* can be difficult without associated larvae. Adults of *H. mirus* apparently can be separated from those of *H. dimorphus* by the mostly solid dark red-brown coloration of the abdominal sternites, with limited black overshadowed stippling. In *H. dimorphus*, coloration of the abdominal sterna is pale yellow to reddish brown, overshadowed by extensive, fine black stippling.

Homoleptohiphes mirus is known only from the southwestern United States (far west Texas and southern Arizona) and northwestern Mexico, from the states of Sonora, Chihuahua and Sinaloa. Larvae can be found in small, apparently permanent, spring-fed desert streams. Upon reexamination, the specimen identified by Allen (1978) as *L. ferruginus* Allen and Brusca (now a synonym of *L. zalope*) from the Río Sonora, Sonora, Mexico is clearly that of *H. mirus* and not *L. zalope*.

Type material examined.—*Leptohiphes mirus* Allen: HOLOTYPE: Río Blanco, Arizona, 3-iv-37, J. G. Needham, 1 male larva (FAMU). ALLOTYPE: Río Blanco, Ari-

zona, 3-iv-37, J. G. Needham, 1 female larva (FAMU). PARATOPOTYPES: Río Blanco, Arizona, 3-iv-37, J. G. Needham, 2 larvae (CAS), 4 larvae (FAMU).

Other material examined.—UNITED STATES: ARIZONA: Santa Cruz Co., Son-oita Cr., nr. Patagonia, 15-iii-1997, J. Slusark and K. Byrnes, 38L, 4 males (TAMU); Santa Cruz Co., Sonita Cr. at Blue Haven Rd., ca. 1 mi. SW Patagonia (31°30'57"N; 110°47'35"W), 06-vi-2000, DE Baumgardner, 52 larvae 3 males (reared) and 2 females (reared) (TAMU). TEXAS, Brewster Co., Calamity Cr. at TX Hwy 118, ca. 22 mi. S. Alpine, 24-viii-1996, DE Baumgardner & DE Bowles, 2 larvae (TAMU); Jeff Davis Co., H.C. Espy Ranch, Farm Rd. 1832, 14-v-1973, RG McClure, 20 larvae (TAMU). MEXICO: CHIHUAHUA, Río San Pedro at Meoqui on Hwy. 45, 14-viii-77, R. K. Allen, 6 larvae (CAS); CHIHUAHUA, Río Satevo at Gral. Tris on Hwy. 16, 13-viii-77, RK Allen, 9 larvae (CAS); CHIHUAHUA, Río Papagochic, 4 mi. E. Ciudad Guerrero on Hwy 16, 13-viii-77, R. K. Allen, 2 larvae (CAS); SINALOA, Río Baluarce at Rosarito, 13-i-83, Allen, Murvosh, 1 larva (CAS); SINALOA, stream 1 mi. N. El Viola, 18-I-83, Allen and Murvosh 6 larvae (CAS); SONORA, Río Sonora 2 mi. SE Rte. 21 between Uras & Mazocahui, 14-i-83, Allen & Murvosh, 1 larva (1 slide) (CAS) (record previously published as *L. ferruginus* by Allen 1978); SONORA, Río Bavispe, 3 mi. SW Colonia Moralia at dam, 2-i-1983, Allen, Murvosh, 12 larvae (CAS); SONORA, Río Altas at Tubutama, 13-I-83, Allen and Murvosh, 5 larvae (CAS).

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