

# The Great Basin Naturalist

PUBLISHED AT PROVO, UTAH, BY  
BRIGHAM YOUNG UNIVERSITY

ISSN 0017-3614

VOLUME 57

31 OCTOBER 1997

No. 4

Great Basin Naturalist 57(4), © 1997, pp. 283–314

## MAYFLY FAUNA OF NEW MEXICO

W.P. McCafferty<sup>1</sup>, C.R. Lugo-Ortiz<sup>1</sup>, and G.Z. Jacobi<sup>2</sup>

**ABSTRACT.**—An inventory and analysis of the mayfly (Insecta, Ephemeroptera) fauna of New Mexico, based on the published literature and study of extensive materials from diverse collections, indicate the presence of 12 families, 37 genera, and 81 species. Of these species, 25 represent new state records: *Acentrella turbida*, *Ameletus falsus*, *A. sparsatus*, *Baetis adonis*, *B. bicaudatus*, *B. flavistriga*, *Baetodes deficiens*, *Caenis latipennis*, *Callibaetis fluctuans*, *Cinygmula par*, *Ephemerella simulans*, *Hexagenia bilineata*, *Isonychia sicca*, *Labiobaetis propinquus*, *Lachlania saskatchewanensis*, *Leptophlebia bradleyi*, *Leucrocota petersi*, *Neochoroterpes nanita*, *Paraleptophlebia debilis*, *P. heteronea*, *Proclonon conturbatum*, *Rhithrogena plana*, *R. robusta*, *R. vitta*, and *Thraulodes gonzalesi*. *Baetodes deficiens* represents a new USA record. For 37 of the 56 previously reported and confirmed species, 124 new county records are provided. With respect to continental affinities, 34 species are western, 27 southwestern, 13 widespread, 1 is a southern USA species, and 1 eastern. Of the major drainage systems in the state, the Gila system is the most species rich with 48 species, followed by the Rio Grande (46), Pecos (39), Canadian (28), and San Juan (25). Relationships between drainage systems and between New Mexico and broadly adjoining states are discussed. *Lachlania dencyannae*, the only endemic species in New Mexico, occurs in the Gila system and is rare and endangered. Certain other species from the Gila system are also noted as being at risk. From other drainages, *B. adonis*, *Ephemerella mollitia*, and *L. petersi* also are of some concern at the national level. Additional species that are rare in New Mexico and are of concern at least at the state level include *Ametropus albrighti*, *C. fluctuans*, *H. bilineata*, *L. bradleyi*, *N. nanita*, *P. conturbatum*, and *R. hageni*.

*Key words:* Ephemeroptera, New Mexico, species inventory.

The first report of a mayfly from New Mexico was that of *Ephemerella* sp. by Needham (1905), which was taken from the upper Pecos River in San Miguel County. This record later proved to be applicable to the common western mountain species *Drumella grandis* (Eaton). The next species was recorded when Banks (1924) described *Epeorus undulatus* [now *Rhithrogena undulata* (Banks)] from the Jemez River in Sandoval County. The discovery of additional species of mayflies in New Mexico has been

mainly piecemeal. First reports of species were contributed by 21 authors since the description of *R. undulata* (Needham 1927, Traver 1935, Allen and Edmunds 1959, 1961, 1963, 1965, Peters and Edmunds 1961, Koss 1966, 1972, Allen 1968, 1978, Koss and Edmunds 1970, Kilgore and Allen 1973, Allen and Chao 1978a, 1978b, Morihara and McCafferty 1979a, Pescador and Peters 1980, Allen and Murvosh 1983, Kondratieff and Voshell 1984, Waltz and McCafferty 1987, Provonsha 1990, Henry 1993,

<sup>1</sup>Department of Entomology, Purdue University, West Lafayette, IN 47907.

<sup>2</sup>Environmental Science and Management, New Mexico Highlands University, Las Vegas, NM 87701.

Durfee and Kondratieff 1995, Lugo-Ortiz and McCafferty 1995c, Zloty 1996). Based on reports of these workers, 56 species of mayflies have been known from New Mexico prior to this study.

Six species of mayflies were described originally from New Mexico and thus have their type localities within the state. These species are *Ametropus albrighti* Traver, *Cloeodes macrolamellus* Waltz and McCafferty, *Homoeoneuria alleni* Pescador and Peters, *Lachlania dencyannae* Koss, *Rhithrogena undulata* (Banks), and *Thraulodes brunneus* Koss. Only *L. dencyannae* has proven to be endemic to New Mexico.

Our interests in the New Mexico mayfly fauna first developed in the mid-1960s when one of us (WPM) became involved in extensive collecting excursions across the state with Arwin Provonsha and Dick Koss. All of the material from those trips eventually came into the possession of WPM and Purdue University in the 1970s. Those collections and another collection made by WPM, Arwin Provonsha, and Dan Bloodgood in the early 1980s have contributed significantly to previous published revisionary studies of mayflies as well as the present study. In the late 1970s another of us (GZJ) became involved with the New Mexico Environment Department and later joined the faculty of New Mexico Highlands University. GZJ, his students, and colleagues have sampled mayflies in New Mexico for several years, often in association with various ecological studies. Another of us (CRL) developed extensive expertise on the systematics of southwestern mayflies while conducting research on the mayflies of Mesoamerica, and his familiarity with the Mexican fauna has been invaluable in the assessment of New Mexico.

The aforementioned collections of mayflies along with materials loaned or donated to us from Brigham Young University, Colorado State University, and the University of Utah have provided a large body of material upon which we have based much of the present study. We also review all published data relevant to the New Mexico mayfly fauna, provide extensive new site records for those species previously known from New Mexico, and provide new state records for an additional 25 species. We offer commentary on drainage distribution of each of the New Mexico species and synthesize all specific data and analyze the fauna as a

whole with respect to faunal elements within it. Importantly, our data have served as the bases for evaluating a number of New Mexico species that can now be seen to be at environmental risk either within the state or nationally. A fine account of the history of New Mexico's hydrologic setting, beginning with the influences of the 12th-century pueblo-dwelling Native Americans, can be found in *The Fishes of New Mexico* by Sublette et al. (1990).

#### STUDY AREA

New Mexico (Fig. 1) is the 5th largest state in the USA, covering some 195,685 km<sup>2</sup>. It possesses a diverse geologic and topographic landscape, with elevations ranging from slightly less than 1050 m at Red Bluff Reservoir in the southeastern part of the state, where the Pecos River enters Texas, to over 4550 m at Wheeler Peak in the Sangre de Cristo Mountains, approximately 50 km south of the Colorado border. Although New Mexico is the 3rd most arid state in the USA, it does receive 108,176 hectare meters of water annually either as precipitation or inflow (Harris 1984). There is significant precipitation in some higher elevations, while lower elevations are typical of deserts (see Eisenhood 1979). For example, the eastern slopes of the Sangre de Cristo Mountains and Jemez Mountains in the north central part of the state receive over 180 cm of precipitation per year, mainly as snow; Mount Taylor in the western sector, the Mogollon Mountains in the southwestern sector, and the Sacramento Mountains in the south central sector of the state receive 80–120 cm of precipitation; and southern valleys such as the Rio Grande and Tularosa receive 40 cm or less.

Five major and 3 minor drainage systems in the southwestern USA have headwaters or near-headwater flow in New Mexico. An in-depth treatment of these systems has been given by Sublette et al. (1990); however, the following brief discussion will serve the immediate purposes of this study.

The Canadian River drainage system headwaters are in the northern Sangre de Cristo Mountains. The Canadian River flows eastward through the Canadian Escarpment from the Las Vegas and Raton plateaus into the northern panhandle of Texas. In the same area of New Mexico but north of the Canadian, the Dry Cimarron River (not to be confused with



the Rio Grande drainage system in northern New Mexico.

Two rivers in northwestern New Mexico are part of the middle Colorado River drainage system. The 640-km-long San Juan River, with headwaters in southern Colorado, flows for about 190 km in New Mexico (mainly San Juan County) to the four corners area of Utah, Colorado, New Mexico, and Arizona, and then through extreme southeastern Utah to Lake Powell and the Colorado River. The small Zuni River, which originates in the Zuni Mountains in New Mexico south of the San Juan River, flows mainly in southern McKinley County west to the Little Colorado River in northern Arizona.

Two main rivers in southwestern New Mexico are part of the lower Colorado River drainage system. The San Francisco River drainage system originates in eastern Arizona, but a major portion of it flows in southwestern New Mexico (Catron County) before returning to Arizona, where it joins the Gila River. Headwaters of the Gila River drainage system are located near Mogollon Baldy, a peak over 3500 m high in the Mogollon Mountains. The Gila River flows for about 160 km (mainly in Grant County) to the Arizona border and continues through southern Arizona until it joins the Colorado River in the extreme southwestern corner of Arizona. The Mimbres River is also in southwestern New Mexico (Grant and Luna counties) but is internally drained.

Four physiographic divisions (provinces and plateaus) are found in New Mexico (see Snead 1979). The Canadian, Cimarron, Dry Cimarron, and Pecos rivers are found in the Great Plains Province. These rivers have dissected lava-capped plateaus and buttes and have their lower courses on broad, alluvial plains. The lower two-thirds of the Rio Grande is in the Mexican Highlands section of the Basin and Range Plateau, where upper tributaries are in isolated block-faulted mountains separated by broad plains. The upper one-third of the Rio Grande is in the Rocky Mountain Province. There, tributary streams in the Jemez and south Sangre de Cristo Mountains are separated by lava plateaus and alluvial plains. The San Juan, Zuni, San Francisco, and Gila rivers are part of the Intermontane Plateau, where landforms consist of canyon and plateaus of sedimentary or igneous rock.

## METHODS AND PRESENTATION

Extensive collections of New Mexico mayflies were examined and material was identified to species whenever possible. Collections are noted in the data section with the following acronyms: BYU (Brigham Young University Collection, Provo, Utah), CSU (Colorado State University Collection, Fort Collins, Colorado), NMHU (New Mexico Highlands University Collection, Las Vegas, New Mexico), and PERC (Purdue Entomological Research Collection, West Lafayette, Indiana).

In the Species Accounts section of this work, species are presented alphabetically by family, genus, and species. Species that are newly reported for New Mexico are indicated with an asterisk. For each species, numerous data are given. First, useful descriptions of adults and larval stages of the species are referenced under the heading Descriptions. Such data are important because keys for the species are generally not available and such descriptions are part of the basis for species identification. In most cases the original description is noted and if a subsequent, more comprehensive and useful description is available, it is referenced also, as are published keys when pertinent. Historical names used in such works, if different from the current name, are also indicated so that descriptive data can be easily tracked.

If the species is newly reported for New Mexico, the complete locale data upon which the record is based are given under the heading New Records. The collection source acronym is always indicated first and if more than one collection is involved, data are presented alphabetically by collection source. If the species was a previously reported species, then the previous distributional data are given in short form under the heading Previous Records by noting only the county and body of water name and the bibliographic reference. If we have discovered additional county records, then these are given again in the same short form described above along with an indication of the collection source under the heading New County Records. Because these data are often extensive, the short form of new county records is used to conserve space. However, if the reader is interested in the entire locale information, it can be accessed from curators of the various collections indicated.

All species have a Remarks section associated with them. This generally includes a review of the overall distribution of the species, with particular attention to states surrounding New Mexico. Distribution of the species within New Mexico is also noted with respect to the drainage systems involved. Counties and drainage systems may be located using Figure 1. Other pertinent taxonomic or environmental information may also be included in the remarks.

The Faunistics section contains an analysis of the fauna in terms of its broad affinities, and inter- and intrastate relationships. Species of special note because of their rarity and environmental susceptibility are also noted here.

#### SPECIES ACCOUNTS

##### Ameletidae

##### *Ameletus doddsianus* Zloty, 1996

DESCRIPTIONS.—Adult: Traver (1935) as *A. subnotatus* Eaton; see also Zloty (1996). Larva: Allen and Chao (1981) as *A. velox* Dodds.

PREVIOUS RECORDS.—Zloty (1996): Taos Co.

NEW COUNTY RECORDS.—CSU: Sierra Co (N fork Palomas Cr). NMHU: Santa Fe Co (Rio en Medio). PERC: Grant Co (Cherry Cr).

REMARKS.—Zloty (1996) provided no details of his report of this species in Taos County, New Mexico; however, one of us (GZJ) has collected material of this species from the same county at a Rio Hondo (Lake Fork) beaver pond. Zloty also reported the species from Arizona, Colorado, and Utah. Certain specimens reported as *A. subnotatus* in Colorado by McCafferty et al. (1993) belong to this recently described species, and the historical confusion of what is now *A. doddsianus* and *A. subnotatus* was discussed by Zloty (1996). The occurrence of this species in New Mexico in the Gila River and upper Rio Grande drainage systems represents the southernmost part of its known range.

##### \**Ameletus falsus* McDunnough, 1938

DESCRIPTIONS.—Adult: McDunnough (1938); see also Zloty (1996). Larva: Allen and Chao (1981) as *A. sp. C*.

NEW RECORDS.—PERC: San Miguel Co, Pecos R, nr Cowles, 1-VIII-1944 (larvae); 2.2 mi N of Pecos, Pecos R, 13-VII-1969, R.W.

Koss, W.P. McCafferty, and A.V. Provonsha (exuviae, larvae).

REMARKS.—This species was described from Arizona by McDunnough (1938) and previous to this study has been known from only 3 counties in that state (see Zloty 1996). New Mexico specimens of *A. falsus* agree with the Allen and Chao (1981) description of *Ameletus* sp. C, and it is possible that larvae of *A. sp. B* Allen and Chao also belong to this species (Zloty 1996). *Ameletus* sp. B was reported from New Mexico by Allen and Chao (1981) from Rio Arriba County in the upper Rio Grande drainage in the Southern Rocky Mountain Province. Thus, in New Mexico, *A. falsus* apparently occurs in tributaries of the upper Rio Grande and headwaters of the Pecos River drainage system in the southern Sangre de Cristo Mountains.

##### \**Ameletus sparsatus* McDunnough, 1931

DESCRIPTIONS.—Adult: McDunnough (1931a); see also Zloty (1996). Larva: McDunnough (1935).

NEW RECORDS.—NMIIU: Otero Co, Agua Chiquita, nr Woods Canyon, 6-VIII-1980, G.Z. Jacobi and L. Smolka (larvae).

REMARKS.—This western species was reported from Alberta, British Columbia, Colorado, Idaho, and Montana by Zloty (1996). Lugo-Ortiz and McCafferty (1995a) reported it from Arizona. Records of *A. aequivocus* McDunnough in Colorado (McCafferty et al. 1993) are also applicable to this species. In New Mexico, *A. sparsatus* has been taken only from the far southeastern part of the state in the lower Pecos River drainage system.

##### Ametropodidae

##### *Ametropus albrighti* Traver, 1935

DESCRIPTIONS.—Adult: Allen and Edmunds (1976). Larva: Traver (1935); see also Allen and Edmunds (1976).

PREVIOUS RECORDS.—Traver (1935): San Juan Co (San Juan R).

REMARKS.—This psammophilous species was originally described from near Farmington, New Mexico, by Traver (1935). Since then it has been reported only from the Green River in southwestern Wyoming and northeastern Utah (Edmunds and Musser 1960) and the Yampa River in northeastern Colorado (Allen

and Edmunds 1976), both of which are part of the upper Colorado River drainage system. In New Mexico it is known from the San Juan River drainage system in the extreme northwestern corner of the state, which is associated with the middle Colorado River drainage system. It remains to be seen if the species still exists in New Mexico.

### Baetidae

#### *Acentrella insignificans* (McDunnough), 1926

DESCRIPTIONS.—Adult: McDunnough (1926) as *Baetis insignificans* McDunnough. Larva: Morihara and McCafferty (1979a) as *B. insignificans*.

PREVIOUS RECORDS.—Morihara and McCafferty (1979a) as *Baetis insignificans*: Grant Co (Gila R); Mora Co (Mora R); San Juan Co (San Juan R). Durfee and Kondratieff (1995): Catron Co (Taylor Cr).

NEW COUNTY RECORDS.—CSU: Dona Ana Co (Radium Springs). NMHU: Colfax Co (Cieneguilla Cr); Lincoln Co (Rio Ruidoso); San Miguel Co (Pecos R); Rio Arriba Co (Rio Chama); Sierra Co (Rio Grande). PERC: Catron Co (Cottonwood Cr, Gila R, Taylor Cr, Tularosa R, San Francisco R); San Miguel Co (Pecos R, Sapello R).

REMARKS.—This relatively common western species is known from all Mexican and USA states adjoining New Mexico, excluding Oklahoma (see McCafferty et al. 1993, Lugo-Ortiz and McCafferty 1995a, 1995b, McCafferty and Lugo-Ortiz 1996a). In New Mexico it is now known from throughout most of the state and all major drainage systems. It is very common in Catron County.

#### \**Acentrella turbida* (McDunnough), 1924

DESCRIPTIONS.—Adult: McDunnough (1924a) as *Pseudocloeon turbidum* McDunnough; see also McCafferty et al. (1994). Larva: McCafferty et al. (1994).

NEW RECORDS.—NMHU: Taos Co, Costilla Cr, 17-VIII-1989, G.Z. Jacobi (larvae). PERC: San Miguel Co, Pecos R, 29-VI-1939 (larvae); 5 mi N of Pecos, Pecos R at Dalton Fishing Site, 7300 ft, 13-VII-1969, R.W. Koss, W.P. McCafferty, and A.V. Provonsha (female adults); Pecos R, 1-VIII-1936 (female adult).

REMARKS.—*Acentrella turbida* is a widespread continental species that was recently treated by McCafferty et al. (1994). It is known

from all USA states bordering New Mexico (see McCafferty et al. 1993, Lugo-Ortiz and McCafferty 1995a, 1995b, McCafferty et al. 1997); however, it has not been taken in Mexico. In New Mexico, *A. turbida* has been found in the northern areas of both the Rio Grande and Pecos River drainage systems.

#### \**Baetis adonis* Traver, 1935

DESCRIPTIONS.—Adult: Traver (1935). Larva: unknown.

NEW RECORDS.—PERC: Miguel Co, 5 mi N of Pecos, Pecos R, at Dalton Fishing Site, 7300 ft, 13-VII-1969, R.W. Koss, W.P. McCafferty, and A.V. Provonsha (male and female adults).

REMARKS.—This poorly known species is a small-sized member of the *rhodani* group that was previously known only from the San Gabriel Mountains in California (Traver 1935). Its discovery in New Mexico in the northern Pecos River drainage system therefore represents a significant range extension.

#### \**Baetis bicaudatus* Dodds, 1923

DESCRIPTIONS.—Adult: Dodds (1923). Larva: Dodds (1923); see also Morihara and McCafferty (1979a).

NEW RECORDS.—NMHU: Mora Co, Jack's Cr, 3065 m, 18-VI-1991, M.D. Hatch (larvae). PERC: Catron Co, 42 mi N of Silver City, Rt 527 Gila R, at jct with Little Cr, 15-VII-1967, R. and D. Koss (female adult); Tularosa R, 2 mi above Aragon, 11-VI-1974, B. Stark (larvae); Lincoln Co, Sierra Blanca Ski Lodge, Rio Ruidoso, 27-VIII-1976, M.W. Sanderson (larvae); San Miguel Co., Panchuela Cr, 9-VII-1944 (larvae); Santa Fe Co, Big Tesuque Cr, Big Tesuque, 10-VI-1974, B. Stark and T.A. Wolff (larva); Little Tesuque Cr, nr Hyde Park, 2960 m, 20-IV-1973, B. Stark and T. Wolff (larva); Taos Co, Rio Trampas above El Valle, 9-VI-1974, B. Stark and T.A. Wolff (larva); Red River, 3 mi E of Questa, 9-VI-1974, B. Stark and T.A. Wolff (larvae).

REMARKS.—This relatively widespread western species is found in mountainous streams, and it reaches the southernmost limits of its range in New Mexico. Although common in Colorado (McCafferty et al. 1993), it has not been taken in Arizona, Mexico, or Texas. In New Mexico it has been collected from all major drainage systems except the San Juan

River in the extreme northwestern part of the state. With the exception of Alaska and parts of Canada, *Baetis bicaudatus* is most commonly confined to higher elevations.

*Baetis caelestis*

Allen and Murvosh, 1983

DESCRIPTIONS.—Adult: unknown. Larva: Morihara and McCafferty (1979a) as *B. sp. A*.

PREVIOUS RECORDS.—Morihara and McCafferty (1979a) as *Baetis sp. A*: Catron Co (San Francisco R); Otero Co (Penasco R).

NEW COUNTY RECORDS.—BYU: Grant Co (Sapillo Cr).

REMARKS.—*Baetis caelestis* is a relatively common southwestern species, presently known from Arizona (Lugo-Ortiz and McCafferty 1995a), Baja California (Allen and Murvosh 1983), Chihuahua (Lugo-Ortiz and McCafferty 1996a), and Texas (McCafferty and Davis 1992). In New Mexico, where it was originally found by Morihara and McCafferty (1979a), it is known from the Gila, lower Pecos, and San Francisco River drainage systems in the southern part of the state.

\**Baetis flavistriga*

McDunnough, 1921

DESCRIPTIONS.—Adult: McDunnough (1921). Larva: Ide (1937); see also Morihara and McCafferty (1979a).

NEW RECORDS.—PERC: San Juan Co, San Juan R, river mile 165, 1820 m, 29-VI-1960 (larva).

REMARKS.—This relatively widespread North American species is known mainly from the eastern half of the continent but also from the Black Hills of South Dakota (McCafferty 1990) and several localities in Colorado (see McCafferty et al. 1993); it was recently found in the Colorado drainage area of west central Utah (McCafferty and MacDonald 1994). McCafferty and Davis (1992) reported it from Texas, and Lugo-Ortiz and McCafferty (1994) found it in the adjoining Mexican state of Chihuahua. In New Mexico, *B. flavistriga* has been taken only in the San Juan River drainage system.

*Baetis magnus*

McCafferty and Waltz, 1986

DESCRIPTIONS.—Adult: Durfee and Kondratieff (1993). Larva: Morihara and McCafferty (1979a) as *B. sp. B*.

PREVIOUS RECORDS.—Morihara and McCafferty (1979a) as *Baetis sp. B*: Grant Co (Cherry Cr).

NEW COUNTY RECORDS.—NMHU: Colfax Co (Canadian R); Sicra Co (Main Diamond Cr); Torrence Co (Cañón de Tajique). PERC: Catron Co (Glenwood, Gila R, Pueblo Cr); Lincoln Co (Eagle Cr, Rio Ruidoso).

REMARKS.—This western species was originally described as *Baetis sp. B* by Morihara and McCafferty (1979a), based on larvae from New Mexico, and it was later named by McCafferty and Waltz (1986). Known from western Nebraska to Panama (Lugo-Ortiz and McCafferty 1993, 1996a), it appears to be particularly common in Arizona, New Mexico, and Colorado (see also McCafferty and Waltz 1986, Durfee and Kondratieff 1993). We have recently identified larvae of this species collected by Kondratieff and Baumann in March 1993 from the San Sabo River in Mcnard County, southwest central Texas. *Baetis magnus* is one of the few species of mayflies now known to occur in both the Nearctic and Neotropical biogeographic regions. In New Mexico it is now known from all major drainage systems except the San Juan River (part of the middle Colorado drainage system); however, it has been taken from the Colorado drainage system in Arizona and Colorado.

*Baetis notos*

Allen and Murvosh, 1987

DESCRIPTIONS.—Adult: Durfee and Kondratieff (1995). Larva: Morihara and McCafferty (1979a) as *B. sp. C*.

PREVIOUS RECORDS.—Morihara and McCafferty (1979a) as *Baetis sp. C*: Catron Co (Gila R). Durfee and Kondratieff (1995): Catron Co (Taylor Cr).

NEW COUNTY RECORDS.—NMHU: Colfax Co (Cieneguilla Cr); Grant Co (Gila R, Cieneguilla Cr). PERC: Grant Co (Gila R).

REMARKS.—This southwestern species is also known from Arizona (Morihara and McCafferty 1979a), Colorado (Ward and Stanford 1990), and Texas (McCafferty and Davis 1992). It was recently discovered in Veracruz by Lugo-Ortiz and McCafferty (1994) and thus is expected to occur in northern Mexico also. Durfee and Kondratieff (1995) reared this species from Taylor Creek in Catron County, New Mexico. It has been collected in New Mexico

only in the Gila, Canadian, and San Francisco River drainage systems.

*Baetis tricaudatus*  
Dodds, 1923

DESCRIPTIONS.—Adult: Dodds (1923). Larva: Dodds (1923); see also Morihara and McCafferty (1979a).

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Baetis intermedius*: San Juan Co (San Juan R). Morihara and McCafferty (1979a): Catron Co (San Francisco R); Mora Co (Mora R); Otero Co (Rio Penasco); Rio Arriba Co (Rio Brazos); San Miguel Co (Pecos R).

NEW COUNTY RECORDS.—BYU: Grant Co (Turkey Cr, Gila R, Sapillo Cr); Lincoln Co (Rio Hondo). NMHU: Colfax Co (Canadian R, Cieneguilla Cr); Eddy Co (Rio Penasco); Grant Co (Black Canyon, Cieneguilla Cr); Guadalupe Co (Pecos R); Lincoln Co (Rio Ruidoso); Sandoval Co (Rio Cebolla, San Antonio Cr); Santa Fe Co (Rio Grande); Sierra Co (Main Diamond Cr, South Diamond Cr); Taos Co (Red R, Rio Costilla). PERC: Colfax Co (Cimarron R); Grant Co (Cherry Cr); Lincoln Co (Eagle Cr, Rio Ruidoso); Sandoval Co (Jemez R); Santa Fe Co (Rio Grande, Tesuque Cr); Taos Co (Goose Cr, La Junta Cr, Pueblo Cr, Red R, Santa Barbara R).

REMARKS.—This species is known from throughout most of North America, including Mexico (Lugo-Ortiz and McCafferty 1994), and it is probably the most widespread and ubiquitous *Baetis* on the continent. Likewise, it is now known from all major drainage systems in New Mexico.

\**Baetodes deficiens*  
Cohen and Allen, 1972

DESCRIPTIONS.—Adult: unknown, but subimagos were described by Flowers (1987). Larva: Cohen and Allen (1972).

NEW RECORDS.—BYU: Grant Co, Sapillo Cr, jct with Gila R, 1555 m, 26-V-1985, B. Jensen (larvae).

REMARKS.—This is essentially a Mexican species. It has been known from the Mexican states of Guerrero, Jalisco, Morelos, Sonora, and Veracruz (see McCafferty and Lugo-Ortiz 1996). Its discovery in New Mexico is important because it represents a new USA record. In New Mexico it has been taken only from the Gila River drainage system in the Intermontane Plateau.

*Baetodes edmundsi*  
Koss, 1972

DESCRIPTIONS.—Adult: Koss (1972). Larva: Koss (1972).

PREVIOUS RECORDS.—Koss (1972): Grant Co (Gila R).

NEW COUNTY RECORDS.—NMHU: San Miguel Co (Canadian R).

REMARKS.—In addition to New Mexico, *Baetodes edmundsi* has been reported from Arizona (Koss 1972), Texas (Edmunds 1950), and the Mexican states of Sinaloa and Sonora (Allen and Murvosh 1987a). In New Mexico it has been taken only from the Gila and Canadian River drainage systems, in the far southwest and northeast regions of the state, respectively.

*Callibaetis ferrugineus hageni*  
Eaton, 1885

DESCRIPTIONS.—Adult: Eaton (1885) as *C. hageni* Eaton. Larva: Dodds (1923) as *C. fusca* Dodds.

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Callibaetis nigrinus*: San Juan Co (San Juan R).

NEW COUNTY RECORDS.—CSU: Catron Co (Wall Lake). NMHU: Taos Co (beaver pond on Rio Hondo-Lake Fork). PERC: Eddy Co (Sitting Bull Falls).

REMARKS.—This relatively widespread western subspecies ranges from Alaska southward to Arizona (Lugo-Ortiz and McCafferty 1995a) and New Mexico, and it is one of the most common mayflies in Colorado, where it was treated under the synonym *C. americanus* Banks by McCafferty et al. (1993). The extensive synonymy of the species can be found in McCafferty and Waltz (1990) and McCafferty (1996). *Callibaetis ferrugineus hageni* is not known from Texas, and therefore Arizona and New Mexico apparently represent its southeastern range limits. It has been taken in ponds and lakes in wide-ranging areas of New Mexico as well as from the San Juan River.

\**Callibaetis fluctuans*  
(Walsh), 1862

DESCRIPTIONS.—Adult: Walsh (1862) as *Cloe fluctuans*; see also Traver (1935). Larva: Burks (1953).

NEW RECORDS.—BYU and PERC: Eddy Co, Castle Cr, Black River Village, 14-I-1987, Baumann, Sargent, and Kondratieff (larvae).

REMARKS.—This species is known from across the continent but is most common in the Midwest. It has been taken as far west as California and Oregon in the north, but with respect to areas surrounding New Mexico, it has been reported only from Colorado (McCafferty et al. 1993) and Texas (Lugo-Ortiz and McCafferty 1995b). The isolated sample of this species from the extreme southern part of the Pecos River drainage system in New Mexico represents the southernmost limits of its western range. In southern Utah, *C. fluctuans* has historically been misidentified as *C. montanus* Eaton.

*Callibaetis montanus*  
Eaton, 1885

DESCRIPTIONS.—Adult: Eaton (1885). Larva: Lugo-Ortiz and McCafferty (1996b).

PREVIOUS RECORDS.—Traver (1935): San Juan Co (San Juan R); Socorro Co (Rio Grande).

NEW COUNTY RECORDS.—PERC: Catron Co (Gila R), Dona Ana Co (Rio Grande).

REMARKS.—*Callibaetis montanus* has been correctly reported from Arizona and New Mexico south to Nicaragua (Eaton 1885, 1892, Banks 1900, Traver 1935, McCafferty and Lugo-Ortiz 1992). Records of the species north of Arizona and New Mexico (e.g., Edmunds 1954, Newell 1970, Rahel and Kolar 1990) are evidently misidentifications of *C. fluctuans*, and records of it in Texas are probably all or mostly attributable to *C. punctilusus* McCafferty and Provonsha (see McCafferty and Provonsha 1993, Lugo-Ortiz and McCafferty 1994). In New Mexico it has been taken from diverse areas of the Gila River, San Juan River, and Rio Grande drainage systems.

*Callibaetis pictus*  
(Eaton), 1871

DESCRIPTIONS.—Adult: Eaton (1871) as *Baetis pictus* Eaton. Larva: Seemann (1927) as *C. pacificus* Seemann; see also Lugo-Ortiz and McCafferty (1996b).

PREVIOUS RECORDS.—Traver (1935) as *Callibaetis pacificus*: Sandoval Co (Jemez Springs). Traver (1935) as *Callibaetis signatus*: Socorro Co (Sabinal Cr).

NEW COUNTY RECORDS.—BYU: Grant Co (Turkey Cr); Rio Arriba Co (Vaceros Canyon). CSU: Sierra Co (Circle Seven Cr). PERC: Catron Co (Gila National Forest); Chaves Co (Roswell); Grant Co (Cherry Cr, Sapillo Cr,

Turkey Cr, Gila R); Lincoln Co (Tucson Mts); McKinley Co (Thoreau); Sandoval Co (Galisteo Cr); San Miguel Co (Pecos R); Santa Fe Co (Galisteo Cr).

REMARKS.—This species occurs throughout western North America as far east as South Dakota (McCafferty 1990) and Texas (McCafferty and Davis 1992), and south to Costa Rica (Lugo-Ortiz and McCafferty 1996b). It is apparently one of the most common species of *Callibaetis* in New Mexico, where it has been taken in the Gila River, Pecos River, Rio Grande, and Zuni River drainage systems.

*Camelobaetidius musseri*  
(Traver and Edmunds), 1968

DESCRIPTIONS.—Adult: unknown. Larva: Traver and Edmunds (1968) as *Dactylobaetis musseri* Traver and Edmunds; see also Lugo-Ortiz and McCafferty (1995c).

PREVIOUS RECORDS.—Lugo-Ortiz and McCafferty (1995c): Catron Co (San Francisco R, W fork Gila R, Gila R); Grant Co (E fork Gila R).

REMARKS.—This species is widespread in Mexico and Central America (Traver and Edmunds 1968, Lugo-Ortiz and McCafferty 1995c). Lugo-Ortiz and McCafferty (1995c) have recently shown that *C. salinus* Allen and Chao, which had been taken in the USA in Arizona and Nevada, is a junior synonym of *C. musseri*. In New Mexico the species appears to be restricted to the Gila and San Francisco River drainage systems in the southwestern portion of the state.

*Camelobaetidius warreni*  
(Traver and Edmunds), 1968

DESCRIPTIONS.—Adult: Traver and Edmunds (1968) as *Dactylobaetis warreni* Traver and Edmunds. Larva: Traver and Edmunds (1968) as *D. warreni*; see also Lugo-Ortiz and McCafferty (1995c).

PREVIOUS RECORDS.—Allen and Chao (1978a) as *Dactylobaetis navis*: San Juan Co (San Juan R); as *Dactylobaetis trivialis*: Colfax Co (Cimarron R).

NEW COUNTY RECORDS.—CSU and PERC: Catron Co (W fork Gila R, Gila R, San Francisco R). NMHU: Catron Co (San Francisco R); Grant Co (E Fork Gila R).

REMARKS.—This is the most common and widespread species of *Camelobaetidius* in the western USA (known from Arizona, California,

Colorado, Idaho, and Utah in addition to New Mexico), and it also ranges through Mexico (Baja California Sur, Chiapas, Chihuahua, Guerrero, Oaxaca, and Sonora) and Central America (Lugo-Ortiz and McCafferty 1995c). It has been known by many synonyms in the past as shown by Lugo-Ortiz and McCafferty (1995c), wherein *C. navis* (Allen and Chao) and *C. trivialis* (Allen and Chao), which had been reported previously from New Mexico, were synonymized with it. In New Mexico, *C. warreni* has been taken from the Canadian, Gila, San Juan, and San Francisco River drainage systems.

*Cloeodes macrolamellus*  
Waltz and McCafferty, 1987

DESCRIPTIONS.—Adult: unknown. Larva: Waltz and McCafferty (1987).

PREVIOUS RECORDS.—Waltz and McCafferty (1987): Grant Co (Cherry Cr).

REMARKS.—*Cloeodes macrolamellus* was originally described from New Mexico by Waltz and McCafferty (1987). More recently, it was shown also to occur in the northern Mexican states of Chihuahua and Durango (Lugo-Ortiz and McCafferty 1994) and in the USA in Arizona (Lugo-Ortiz and McCafferty 1995a). In New Mexico it is known only from the Gila River drainage system.

*Fallceon quilleri*  
(Dodds), 1923

DESCRIPTIONS.—Adult: Dodds (1923) as *Baetis quilleri* Dodds; see also Traver (1935). Larva: Morihara and McCafferty (1979a) as *B. quilleri*; see also Lugo-Ortiz et al. (1994).

PREVIOUS RECORDS.—Morihara and McCafferty (1979a) as *Baetis quilleri*: Catron Co (Gila R); Grant Co (Cherry Cr, Sapillo Cr).

NEW COUNTY RECORDS.—BYU: Eddy Co (Castle Cr). CSU: Sierra Co (Palomas Cr). PERC: Chaves Co (Rio Penasco); Dona Ana Co (small tributary of Rio Grande); Eddy Co (Castle Cr); Lincoln Co (Rio Ruidoso).

REMARKS.—This highly variable species is widespread in Central America, Mexico, and southwestern, central, and eastern USA (Lugo-Ortiz et al. 1994). In New Mexico it has thus far been taken only from the southern part of the state in the Gila River, Pecos River, and Rio Grande drainage systems. It is, however, known from the Colorado River drainage system in Colorado (McCafferty et al. 1993).

*Labiobaetis apache*  
McCafferty and Waltz, 1995

DESCRIPTIONS.—Adult: Durfee and Kondratieff (1997). Larva: McCafferty and Waltz (1995).

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Baetis propinquus* (Walsh): San Juan Co (San Juan R).

REMARKS.—This distinctive species was recently described from the Colorado drainage system of northern Arizona and western Utah by McCafferty and Waltz (1995). We have acquired and studied the original material on which Peters and Edmunds (1961) based their record of *Baetis propinquus* (now *L. propinquus*) from the San Juan River in New Mexico, and it proved to be *L. apache*. Records of *L. propinquus* from Douglas Creek near Rangely, Colorado, in the Colorado drainage system (McCafferty et al. 1993) are also attributable to *L. apache* according to Durfee and Kondratieff (1997). The San Juan River drainage system in New Mexico is part of the middle Colorado drainage system, and thus *L. apache* remains known only from the greater Colorado drainage system in North America.

\**Labiobaetis propinquus*  
(Walsh), 1863

DESCRIPTIONS.—Adult: Walsh (1862) as *Cloe vicina* Walsh (nec Hagen); see also Morihara and McCafferty (1979b) as *Baetis propinquus* (Walsh). Larva: Berner (1940) as *Baetis spinosus* McDunnough; see also Morihara and McCafferty (1979b) as *B. propinquus*.

NEW RECORDS.—PERC: Colfax Co, Ponil Cr, 4.5 mi E Cimarron, 14-VII-1969, R.W. Koss, W.P. McCafferty, A.V. Provonsha (larvae); Otero Co, Rio Penasco, 12-VII-1969, R.W. Koss, W.P. McCafferty, A.V. Provonsha (larvae).

REMARKS.—This primarily central and eastern USA species evidently attains its westernmost range limits in eastern New Mexico, where we have seen it from the Canadian and Pecos River drainage systems. *Labiobaetis propinquus* was reported from Texas by McCafferty and Davis (1992) but is not known from Mexico. Published records of this species by Peters and Edmunds (1961) from the San Juan River in New Mexico are attributable to *L. apache* (see above).

\**Procloeon conturbatum*  
(McDunnough), 1929

DESCRIPTIONS.—Adult: McDunnough (1929) as *Centroptilum conturbatum* McDunnough;

see also Lowen and Flannagan (1991) as *C. conturbatum*. Larva: Lowen and Flannagan (1991) as *C. conturbatum*.

NEW RECORDS.—PERC: San Juan Co, San Juan R, T32N, R6W, Sec 27, river mi 165, 1820 m, 29-VI, 16-VII-1960, W.L. Peters (male adults).

REMARKS.—Specimens from the San Juan River drainage system of northeastern New Mexico agree with the redescription of this species by Lowen and Flannagan (1991). This species is known from western Canada (see Lowen and Flannagan 1991) and in the USA from California and Wyoming (Traver 1935) and Utah (Edmunds 1954). It represents a significant addition to the New Mexico mayfly fauna.

#### Caenidae

##### *Caenis bajaensis*

Allen and Murvosh, 1983

DESCRIPTIONS.—Adult: Provonsha (1990). Larva: Allen and Murvosh (1983); see also Provonsha (1990).

PREVIOUS RECORDS.—Provonsha (1990): Catron Co (Gila National Forest); Grant Co (Cherry Cr.).

NEW COUNTY RECORDS.—NMHU: Mora Co (Wolf Cr.).

REMARKS.—*Caenis bajaensis* is also known from Arizona, Colorado, northern Mexico, and Nebraska (Provonsha 1990). Larvae of this species are apparently restricted to sandy-bottomed areas of streams with slow to moderate current. In New Mexico it is now known from the Canadian and Gila River drainage systems.

##### \**Caenis latipennis*

Banks, 1907

DESCRIPTIONS.—Adult: Banks (1907); see also Provonsha 1990. Larva: Provonsha (1990).

NEW RECORDS.—NMHU: Eddy Co, Black R at Higby Hole, 7-VIII-1991, S.T. Pierce (larvae); Eddy Co, Delaware R above Pecos R confluence, 5-VIII-1991, G.Z. Jacobi (larvae).

REMARKS.—The range of this species extends across Canada and the USA to southern Mexico (Provonsha 1990, Lugo-Ortiz and McCafferty 1996a). With respect to areas adjacent to New Mexico, *C. latipennis* has been reported from Colorado (McCafferty et al. 1993), Oklahoma (Traver 1935), and Arizona and Texas (Provonsha 1990). Its presence in New Mexico,

where it has been taken only in the lower Pecos River drainage system, was expected.

#### Ephemerellidae

##### *Attenella margarita*

(Needham), 1927

DESCRIPTIONS.—Adult: McDunnough (1931b) as *Ephemerella margarita* Needham. Larva: Needham (1927) as *E. margarita*; see also Allen and Edmunds (1961) as *E. margarita*.

PREVIOUS RECORDS.—Allen and Edmunds (1961) as *Ephemerella margarita*: San Miguel Co (Pecos R).

NEW COUNTY RECORDS.—NMHU: Taos Co (Costilla Cr.).

REMARKS.—Western populations of this species range from British Columbia to New Mexico (Allen and Edmunds 1961, Argyle and Edmunds 1962). It has not, however, been taken from Arizona or Texas. In New Mexico it is now known from the upper Pecos River and upper Rio Grande drainage systems. This northern region in New Mexico represents the southernmost limits of the range of this species.

##### *Drunella coloradensis*

(Dodds), 1923

DESCRIPTIONS.—Adult: Dodds (1923) as *Ephemerella coloradensis* Dodds. Larva: Dodds (1923) as *E. coloradensis*; see also Allen and Edmunds (1962) as *E. coloradensis*.

PREVIOUS RECORDS.—Needham (1927) as *Ephemerella coloradensis*: San Miguel Co (Pecos R). Allen and Edmunds (1962) as *Ephemerella coloradensis*: Sandoval Co (Rock Cr.); Taos Co (Santa Barbara R).

REMARKS.—This relatively common western mountain species ranges from Alaska to Arizona and New Mexico (Allen and Edmunds 1962). It apparently is restricted in New Mexico to the northern mountain regions of the Pecos River and Rio Grande drainage systems.

##### *Drunella doddsi*

(Needham), 1927

DESCRIPTIONS.—Adult: Needham (1927) as *Ephemerella doddsi* Needham. Larva: Needham (1927) as *E. doddsi*; see also Allen and Edmunds (1962) as *E. doddsi*.

PREVIOUS RECORDS.—Traver (1935) as *Ephemerella doddsi*: Santa Fe Co (Santa Fe R). Allen and Edmunds (1962) as *Ephemerella doddsi*: San Miguel Co (Pecos R).

NEW COUNTY RECORDS.—NMHU: Catron Co (Gila R); Rio Arriba Co (Rio Brazos); San Miguel Co (Gallinas R, Sapello R); Taos Co (Rio Fernando de Taos). PERC: Taos Co (Rio Hondo Canyon).

REMARKS.—New Mexico is the southernmost range limit of this common western species (Allen and Edmunds 1962). It is not known from Arizona or Texas. In New Mexico it has been taken from the Canadian River, Gila River, Pecos River, and Rio Grande drainage systems.

*Drunella grandis grandis*  
(Eaton), 1884

DESCRIPTIONS.—Adult: Needham (1927) as *Ephemerella grandis* Eaton. Larva: Eaton (1884) as *Ephemerella*, *sedis incertae*, nymph #11; see also Allen and Edmunds (1962) as *E. grandis grandis*.

PREVIOUS RECORDS.—Needham (1905) as *Ephemerella* sp.?: San Miguel Co (Pecos R). Needham (1927) as *Ephemerella grandis*: Santa Fe Co (Santa Fe R). Kilgore and Allen (1973) as *Ephemerella grandis*: Lincoln Co (Rio Ruidoso).

NEW COUNTY RECORDS.—BYU: Colfax Co (Vermejo R). NMHU: Colfax Co (Cieneguilla Cr); Sierra Co (Main Diamond Cr); Taos Co (Costilla Cr, Red R). PERC: Taos Co (Rio Pueblo de Taos).

REMARKS.—This subspecies of this common western species occurs in Arizona, Colorado, New Mexico, Utah, and Wyoming (Allen and Edmunds 1962). In New Mexico it occurs in mountain tributaries mainly of the Canadian River, Pecos River, and Rio Grande drainage systems. In western drainages it is known only from Gila River drainage headwaters.

*Ephemerella altana*  
Allen, 1968

DESCRIPTIONS.—Adult: Allen (1968). Larva: Allen (1968).

PREVIOUS RECORDS.—Allen (1968): Colfax Co (Moreno Cr); Mora Co (Mora R); San Miguel Co (Pecos R); Taos Co (Rio Grande, Rio Hondo, Rio Pueblo).

NEW COUNTY RECORDS.—PERC: Catron Co (Gila R); Grant Co (Gila R).

REMARKS.—This species has been known from Arizona and New Mexico (Allen 1968), and Lugo-Ortiz and McCafferty (1994) reported it from Baja California. In New Mexico, *E.*

*altana* has been collected from the Canadian River, Pecos River, and Rio Grande drainage systems, and we provide the first records of it from the Gila River drainage system. In Arizona it has been collected from the middle Colorado River drainage system in the northeastern part of that state, and therefore it may eventually be found in all major drainages in New Mexico.

*Ephemerella inermis*  
Eaton, 1884

DESCRIPTIONS.—Adult: Eaton (1884). Larva: Traver (1935); see also Allen and Edmunds (1965) and Johnson (1978).

PREVIOUS RECORDS.—Traver (1935): Sandoval Co (Jemez Springs); San Miguel Co (Pecos R). Peters and Edmunds (1961): San Juan Co (San Juan R). Allen and Edmunds (1965): Taos Co (La Junta Cr).

NEW COUNTY RECORDS.—BYU: Hondo Co (Hondo R). NMHU: Colfax Co (Cieneguilla Cr); Lincoln Co (Rio Ruidoso). PERC: Catron Co (Gila R); Colfax Co (Cimarron R); Grant Co (Gila R); Lincoln Co (Eagle Cr, Rio Ruidoso); Mora Co (Mora R); Rio Arriba Co (Rio Brazos); San Miguel Co (Pecos R).

REMARKS.—*Ephemerella inermis* is a relatively common species that occurs throughout much of western North America, excluding Mexico (Allen and Edmunds 1965). Using only the keys of Allen and Edmunds (1965), one could easily confuse specimens of the mainly eastern species *E. dorothea* Needham, which we have seen in Texas, with this strictly western species. There are, however, unpublished discriminating characters in the larvae that can be used to separate the 2 species. It is for this reason that impending records of *E. inermis* from Texas require further substantiation. In New Mexico it is known from all major drainage systems.

*Ephemerella infrequens*  
McDunnough, 1924

DESCRIPTIONS.—Adult: McDunnough (1924b). Larva: Traver (1935); see also Allen and Edmunds (1965) and Johnson (1978).

PREVIOUS RECORDS.—Allen and Edmunds (1965): Taos Co (Red R, La Junta Cr).

REMARKS.—This western species does not occur in Arizona or Mexico, and its only records in New Mexico are from the northern part of the state in the upper Rio Grande drainage

system. We have not seen material of this species from New Mexico and therefore cannot be sure that previous reports were indeed of *E. infrequens*, rather than *E. inermis*, with which it has commonly been confused in the past (see Johnson 1978).

*Ephemerella mollitia*  
Seemann, 1927

DESCRIPTIONS.—Adult: Seemann (1927). Larva: Seemann (1927); see also Allen and Edmunds (1965).

PREVIOUS RECORDS.—Traver (1935): San Juan Co (San Juan R).

REMARKS.—This species has been known only from California and the northwestern corner of New Mexico (San Juan River drainage system). Allen and Edmunds (1965) questioned the validity of Traver's (1935) record, stating that she may have actually based the record on larvae of *E. inermis*. We have not seen the material and therefore can neither confirm nor refute the record at this time.

*Serratella micheneri*  
(Traver), 1934

DESCRIPTIONS.—Adult: Traver (1934) as *Ephemerella micheneri* Traver. Larva: Traver (1934) as *E. micheneri*; see also Allen and Edmunds (1963) as *E. micheneri*.

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Ephemerella micheneri*: San Juan Co (San Juan R). Allen and Edmunds (1963) as *Ephemerella micheneri*: Rio Arriba Co (San Juan R). Kilgore and Allen (1973) as *Ephemerella micheneri*: Catron Co (Negrito Cr); Colfax Co (Ponil Cr); Grant Co (Little Cr).

NEW COUNTY RECORDS.—NMHU: Lincoln Co (Rio Ruidoso); Sandoval Co (Rio Cebolla); Santa Fe Co (Rio Grande).

REMARKS.—This western species is known from Arizona, Baja California, California, Colorado, New Mexico, Oregon, Washington, and Wyoming (Allen and Edmunds 1963), but it is absent from Idaho, Nevada, and Utah (essentially the Great Basin). In New Mexico it occurs in all major drainage systems.

*Serratella tibialis*  
(McDunnough), 1924

DESCRIPTIONS.—Adult: McDunnough (1924b) as *Ephemerella tibialis* McDunnough. Larva: Walley (1930) as *E. tibialis*; see also Allen and Edmunds (1963) as *E. tibialis*.

PREVIOUS RECORDS.—Allen and Edmunds (1963) as *Ephemerella tibialis*: Taos Co (Red R).

REMARKS.—This species occurs throughout the western USA and Canada (Allen and Edmunds 1963), but it has rarely been taken in Arizona and New Mexico. In New Mexico, *S. tibialis* has been known only from the upper Rio Grande drainage system in the Rocky Mountain Province.

*Timpanoga hecuba hecuba*  
(Eaton), 1884

DESCRIPTIONS.—Adult: McDunnough (1935) as *Ephemerella hecuba* Eaton. Larva: Eaton (1884) as *Ephemerella, sedis incertae*, nymph #4; see also Allen and Edmunds (1959) as *E. hecuba hecuba*.

PREVIOUS RECORDS.—Allen and Edmunds (1959) as *Ephemerella hecuba hecuba*: San Miguel Co (Pecos R).

NEW COUNTY RECORDS.—NMHU: Rio Arriba Co (Rio Chama).

REMARKS.—This western species, which is conspicuously absent from most of the Great Basin and Arizona (Allen and Edmunds 1959), reaches the southernmost part of its range in northern New Mexico, where it is now known from the upper Pecos River and upper Rio Grande drainage systems.

Ephemeridae

\**Ephemerella simulans*  
Walker, 1853

DESCRIPTIONS.—Adult: Walker (1853); see also Traver (1935). Larva: Ide (1935); see also McCafferty (1975).

NEW RECORDS.—NMHU: Rio Arriba Co, Rio Chama, Hwy 84-64 bridge, 12-VI-1981, G.Z. Jacobi (female subimago).

REMARKS.—This widespread North American burrowing species was shown by McCafferty (1975) to occur from the east coast to Idaho and Utah. It is not known from Arizona, Mexico, or Texas. The new state record from the northern portion of New Mexico in the upper Rio Grande drainage system was somewhat unexpected, given the distribution pattern of this species (McCafferty 1994).

\**Hexagenia bilineata*  
(Say), 1824

DESCRIPTIONS.—Adult: Say (1924) as *Baetis bilineata* Say; see also Spieth (1941). Larva: Clemens (1913); see also McCafferty (1975).

NEW RECORDS.—Eddy Co, Black R, 7 mi W Malaga, 9-VII-1992, S.A. Sanders (male adult), 7-VIII-1992, S.A. Sanders, C. Gonzales, G.Z. Jacobi (larvae).

REMARKS.—The previous obscure record of this species by Spieth (1941) from the Red River, ostensibly in New Mexico, which was further recorded by McCafferty (1975), was apparently not valid. This conclusion is based on the fact that the only Red River in New Mexico is in Taos County and that stream does not have silt/marl substrate that would be required by *Hexagenia* larvae (see Keltner and McCafferty 1986). Furthermore, the material on which Spieth (1941) based his New Mexico record was from the Oklahoma Natural History Survey; and the Red River along the Oklahoma-Texas border in the eastern parts of those states does possess substrate types required by *Hexagenia* larvae. Nonetheless, we do provide the first valid record of this species in New Mexico. The male adult from Eddy County, New Mexico (lower Pecos River drainage system), clearly possesses the beaklike penes typical of *H. bilineata*; however, both the larvae and adult are very lightly pigmented, which is atypical of *H. bilineata*. Although *H. bilineata* is known from Texas and Oklahoma, it has not been found north, west, or south of New Mexico, with the exception of a record from the Mexican state of San Luis Potosí by McCafferty (1968). The most widespread species of *Hexagenia* in North America, *H. limbata* (Serville), has not been found in New Mexico but may eventually because it does occur in Colorado and Texas.

#### Heptageniidae

##### \**Cinygmula par* (Eaton), 1885

DESCRIPTIONS.—Adult: Eaton (1885) as *Cinygma par* Eaton. Larva: not published.

NEW RECORDS.—NMHU: San Miguel Co, Elk Mtn (elev. 3540 m), below springs, VII-1980, L.R. Smolka (male and female adults).

REMARKS.—This species occurs in the higher elevations throughout much of western North America, including Arizona (Eaton 1885) and Colorado (Dodds 1923). It is not known from Mexico or Texas. In New Mexico, *C. par* is the only species of the genus thus far taken, and it has been found only in mountain headwaters of the Pecos River.

##### *Epeorus albertae* (McDunnough), 1924

DESCRIPTIONS.—Adult: McDunnough (1924a) as *Iron albertae* McDunnough. Larva: Edmunds and Allen (1964).

PREVIOUS RECORDS.—Allen and Chao (1978b): Rio Arriba Co (Rio Chama).

REMARKS.—Ward and Berner (1980) indicated that this western species tended to replace other species of *Epeorus* at lower elevations. *Epeorus albertae* is relatively common in Colorado (McCafferty et al. 1993), but it has not been taken in Arizona, Mexico, or Texas. In New Mexico it has been taken only in the northern part of the state in the upper Rio Grande drainage system.

##### *Epeorus deceptivus* (McDunnough), 1924

DESCRIPTIONS.—Adult: McDunnough (1924a) as *Iron deceptivus* McDunnough. Larva: Edmunds and Allen (1964).

PREVIOUS RECORDS.—Allen and Chao (1978b): San Miguel Co (Pecos R).

NEW COUNTY RECORDS.—NMHU: Sierra Co (South Diamond Cr). PERC: Taos Co (Rio Hondo).

REMARKS.—Edmunds and Allen (1964) indicated that this species was confined to the intermountain western USA, and those authors were the first to indicate its occurrence in New Mexico, but they did not provide any specific locale data. Allen and Chao (1978b) recorded it from Gila County, Arizona. In New Mexico we know of this species from the upper Pecos River and upper Rio Grande drainage systems, as well as the Gila River drainage system in the southwestern part of the state.

##### *Epeorus longimanus* (Eaton), 1885

DESCRIPTIONS.—Adult: Eaton (1885) as *Iron longimanus* Eaton. Larva: Dodds (1923) as *Iron nymph #1*; see also Edmunds and Allen (1964).

PREVIOUS RECORDS.—Allen and Chao (1978b): Rio Arriba Co (Canjilon Cr); San Miguel Co (Pecos R, Winsor Cr); Taos Co (Red R, Rio Pueblo, Rio Chiquito). Durfee and Kondratieff (1995): Catron Co (Taylor Cr).

NEW COUNTY RECORDS.—NMHU: Lincoln Co (Rio Ruidoso). PERC: Lincoln Co (Eagle Cr).

REMARKS.—*Epeorus longimanus* is the most widespread of the western species of *Epeorus*

(Edmunds and Allen 1964). It is very common at higher elevations in Colorado and Utah, but somewhat less common in Arizona and New Mexico. In New Mexico it has been taken from the Gila River, upper Pecos River, and upper Rio Grande drainage systems.

*Epeorus margarita*  
Edmunds and Allen, 1964

DESCRIPTIONS.—Adult: Edmunds and Allen (1964). Larva: Edmunds and Allen (1964).

PREVIOUS RECORDS.—Durfee and Kondratieff (1995): Catron Co (Taylor Cr).

NEW COUNTY RECORDS.—PERC: Grant Co (Gila R); Rio Arriba Co (Rio Brazos).

REMARKS.—We have numerous samples of *Epeorus margarita* from Catron County collected in the 1960s and 1980s. The species is by far the most common species of *Epeorus* found in the Gila River drainage system, and except for the Rio Brazos, a headwater stream in the upper Rio Grande drainage system, it has not been taken from the other major drainage systems in the state. *Epeorus margarita* was recently reported from numerous localities in the Mexican state of Chihuahua by Lugo-Ortiz and McCafferty (1996a), and the species has been known from a few localities in Arizona (Edmunds and Allen 1964) and Baja California (Allen and Murvosh 1983).

*Heptagenia elegantula*  
(Eaton), 1885

DESCRIPTIONS.—Adult: Eaton (1885) as *Rhithrogena elegantula* Eaton. Larva: Needham and Christenson (1927) as *R. elegantula*; see also Bednarik and Edmunds (1980).

PREVIOUS RECORDS.—Peters and Edmunds (1961): San Juan Co (San Juan R). Allen and Chao (1978b): Colfax Co (Cimarron R, Ponil Cr).

REMARKS.—This species is known from throughout much of western North America, including Arizona and Colorado (Eaton 1885) and Utah (Edmunds 1954). It has not been found in Mexico, Oklahoma, or Texas. Larvae of *Heptagenia elegantula* can be distinguished from the somewhat similar *H. solitaria* (see below) with the use of the key by Bednarik and Edmunds (1980). The species prefers silted streams at lower elevations, and in New Mexico it is known only from the Canadian and San Juan River drainage systems in the northern part of the state.

*Heptagenia solitaria*  
McDunnough, 1924

DESCRIPTIONS.—Adult: McDunnough (1924a). Larva: Bednarik and Edmunds (1980).

PREVIOUS RECORDS.—Peters and Edmunds (1961): San Juan Co (San Juan R).

NEW COUNTY RECORDS.—PERC: Catron Co (Gila R); Colfax Co (Canadian R, Cimarron R); Grant Co (Gila R); Mora Co (Coyote Cr); Sandoval Co (Rio Grande).

REMARKS.—McCafferty et al. (1993) noted that in Colorado this western species was found primarily on the western slope of the Colorado Plateau. It is one of the most common species of *Heptagenia* in the West and has also been found in the Gila River and middle Colorado drainage systems in Arizona (Lugo-Ortiz and McCafferty 1995a). It is not known from Mexico or Texas. In New Mexico it has been taken in the Canadian River, Gila River, Rio Grande, and San Juan River drainage systems.

\**Leucrocuta petersi*  
(Allen), 1966

DESCRIPTIONS.—Adult: Allen (1966) as *Heptagenia petersi* Allen. Larva: Bednarik and Edmunds (1980) as *H. petersi*.

NEW RECORDS.—NMHU: Colfax Co, Six-mile Cr, nr Hwy 64, 2530 m, 9-IX-93, G.Z. Jacobi (larvae). PERC: Catron Co, 2 mi N Silver City, Rt 527, Gila R at jct with Little Cr, 15-VII-1967, R. and D. Koss (female adults); Gila Cliff Dwellings National Monument, Gila R at jct with Little Cr, 15-VII-1967, R. and D. Koss (male and female adults); N Silver City, middle fork Gila R, .25 mi above jct with W fork, 9-VII-1969, R.W. Koss, W.P. McCafferty, and A.V. Provonsha (female adult); Grant Co, 65 km N Silver City, Rt 527, E fork Gila R, 15-16-VII-1967, R. and D. Koss (larva).

REMARKS.—This species was previously known only from the Green River (upper Colorado Drainage) in southwestern Wyoming and northeastern Utah (Allen 1966). New records from New Mexico are therefore significant. In New Mexico, *L. petersi* has been taken in the Canadian and Gila River drainage systems. It is possible that this species presently occurs only in New Mexico because of its possible extirpation in Utah and Wyoming.

*Nixe criddlei*  
(McDunnough), 1927

DESCRIPTIONS.—Adult: McDunnough (1927)

as *Heptagenia criddlei* McDunnough. Larva: Bednarik and Edmunds (1980) as *H. criddlei*.

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Heptagenia* sp.: San Juan Co (San Juan R). Allen and Chao (1978b) as *Heptagenia criddlei*: Catron Co (San Francisco R); Colfax Co (Cimarron R, Moreno Cr); Grant Co (Sapillo Cr); Lincoln Co (Bonito Cr, Cr at Pine Lodge); Mora Co (Mora R); Rio Arriba Co (Wolf Cr); Taos Co (Rio Hondo); Valencia Co (Blue Water Cr).

NEW COUNTY RECORDS.—CSU: Sierra Co (Palomas Cr). PERC: Sandoval Co (Jemez R); San Miguel Co (Pecos R).

REMARKS.—This relatively common species is known from throughout the western USA (McDunnough 1927, Traver 1935, Edmunds 1954, Peters and Edmunds 1961, Allen and Chao 1978b). *Nixe criddlei* has been taken from all major drainage systems within New Mexico.

*Nixe simplicioides*  
(McDunnough), 1924

DESCRIPTIONS.—Adult: McDunnough (1924a) as *Heptagenia simplicioides* McDunnough. Larva: Bednarik and Edmunds (1980) as *H. simplicioides*.

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Heptagenia simplicioides*: San Juan Co (San Juan R).

NEW COUNTY RECORDS.—BYU: Grant Co (Gila R, Turkey Cr); Sandoval Co (Jemez R). NMHU: Rio Arriba Co (Rio Chama). PERC: Catron Co (Gila R); Lincoln Co (Bonito Cr); Mora Co (Coyote Cr); San Miguel Co (Pecos R).

REMARKS.—This species is known from the western USA (Traver 1935, Edmunds 1954, Peters and Edmunds 1961, Allen and Chao 1978b, Bednarik and Edmunds 1980) and Alberta (McDunnough 1924a). Previously, it was known from New Mexico only from the San Juan River drainage system in the northwest corner of the state. We report it from all major drainage systems in New Mexico.

*Rhithrogena hageni*  
Eaton, 1885

DESCRIPTIONS.—Adult: Eaton (1885). Larva: not described, but keyed by Day (1963).

PREVIOUS RECORDS.—Allen and Chao (1978b): Taos Co (Red R).

REMARKS.—This western USA species is also known from Colorado (Dodds 1923) and

Utah (Needham and Christenson 1927), and it is relatively common in southern areas of Colorado (e.g., McCafferty et al. 1993). In Arizona and New Mexico, *R. hageni* is known from only a single locality in each state (Allen and Chao 1978b). In New Mexico it is known from the upper Rio Grande drainage system.

*Rhithrogena morrisoni*  
(Banks), 1924

DESCRIPTIONS.—Adult: Banks (1924) as *Epeorus morrisoni* Banks; see also Traver 1935. Larva: Seemann (1927) as *Iron petulans* Seemann; see also key by Allen and Chao (1978b).

PREVIOUS RECORDS.—Allen and Chao (1978b): Colfax Co (Cimarron R); San Miguel Co (Pecos R); Taos Co (Red R, Rio Chiquito).

NEW COUNTY RECORDS.—NMIIU: San Juan Co (San Juan R).

REMARKS.—This species is known from much of the West, from Alberta (McDunnough 1934) to Baja California in northern Mexico (Lugo-Ortiz and McCafferty 1994). With respect to the states adjacent to New Mexico, it is known only from Arizona (see Lugo-Ortiz and McCafferty 1995a). Although McCafferty et al. (1993) did not record *R. morrisoni* from Colorado, they noted that materials commonly identified as *R. undulata* (Banks) in Colorado and elsewhere were probably referable to this species. In New Mexico it has been taken in the northern part of the state, in the Canadian River, Pecos River, Rio Grande, and San Juan River drainage systems.

\**Rhithrogena plana*  
Allen and Chao, 1978

DESCRIPTIONS.—Adult: unknown. Larva: Allen and Chao (1978b).

NEW RECORDS.—PERC: Grant Co, Duck Cr at Cliff, US 180, 5-V-1981, W.P. McCafferty, A.V. Provonsha, and D. Bloodgood (larva); Gila R at US 180, nr Cliff, 5-V-1981, W.P. McCafferty, A.V. Provonsha, and D. Bloodgood (larva); Taos Co, S fork of Red R, Carson National Forest, 27-VII-1937, C. Tarzwell (larvae).

REMARKS.—This species was previously known only from Arizona (Allen and Chao 1978b), where it was described from the White River in Navajo County. We report it for the first time from New Mexico from the Gila River and Rio Grande drainage systems. McCafferty et al. (1993) indicated that *R. plana* may eventually prove to be a variant of *R. morrisoni*.

*\*Rhithrogena robusta*  
Dodds, 1923

DESCRIPTIONS.—Adult: Dodds (1923). Larva: Dodds (1923); see also key by Allen and Chao (1978b).

NEW RECORDS.—NMHU: Santa Fe Co, Rio En Medio, 2990 m, 13-V-1992, G.Z. Jacobi (larvae). PERC: Grant Co, 1 mi S Cliff, tributary to Gila R, 14-VII-1967, R. and D. Koss (larvae); Taos Co, creek in Hondo Canyon, nr Taos Ski Valley, 22-III-1967, R.W. Baumann (larvae).

REMARKS.—The new New Mexico state records of the distinctive *R. robusta* represent the southernmost limits of the known range of this boreal western species. In New Mexico it has been taken in the Gila River and upper Rio Grande drainage systems. It co-occurs with *R. plana* in Grant County, where the species are distinct from each other. Cohabitation by *Rhithrogena* species is often common (Leonard and Leonard 1962, McCafferty et al. 1997).

*Rhithrogena undulata*  
(Banks), 1924

DESCRIPTIONS.—Adult: Banks (1924) as *Epeorus undulatus* Banks. Larva: not published, but keyed by Flowers and Hilsenhoff (1975) and Allen and Chao (1978b).

PREVIOUS RECORDS.—Banks (1924) as *Epeorus undulatus*: Sandoval Co (Jemez R). Peters and Edmunds (1961): San Juan Co (San Juan R). Allen and Chao (1978b): Colfax Co (Cimarron R); San Miguel Co (Pecos R); Taos Co (Red R).

NEW COUNTY RECORDS.—NMHU: Rio Arriba Co (Rio Chama). PERC: Grant Co (Gila R); Rio Arriba Co (Rio Brazos).

REMARKS.—*Rhithrogena undulata* is a western and central North American species, but it was originally described from New Mexico (Banks 1924). With respect to states adjacent to New Mexico, the species has been reported from Arizona (Allen and Chao 1978b) and Colorado (Peters and Edmunds 1961), but it is not known from Mexico, Oklahoma, or Texas. McCafferty et al. (1993) indicated that this species was confined to the western slope of the Colorado Plateau, and Lugo-Ortiz and McCafferty (1995a) indicated that in Arizona it was restricted to the Colorado River drainage system. However, it is not confined to the San Juan River drainage system (middle Colorado River drainage system) in New Mexico but is relatively widespread, being found in all main drainage systems.

*\*Rhithrogena vitta*  
Allen and Chao, 1978

DESCRIPTIONS.—Adult: unknown. Larva: Allen and Chao (1978b).

NEW RECORDS.—BYU: Grant Co, Gila R, above mouth Turkey Cr, 1455 m, 27-V-1985, B. Jensen (larvae). PERC: Grant Co, E fork of Gila R at Rd 15, Gila National Forest, 6-V-1981, W.P. McCafferty, A.V. Provonsha, and D. Bloodgood (larvae).

REMARKS.—This species was previously known only from Arizona, where it was described from the White River in Apache and Navajo counties (middle Colorado drainage system) by Allen and Chao (1978b). In New Mexico we found it in the southwestern portion of the state in the Gila River drainage system (also a part of the greater Colorado River drainage system).

Isonychiidae

*Isonychia intermedia*  
(Eaton), 1885

DESCRIPTIONS.—Adult: Eaton (1885) as *Chironetes intermedius* Eaton. Larva: Kondratieff and Voshell (1984).

PREVIOUS RECORDS.—Kondratieff and Voshell (1984): Catron Co (San Francisco R); Dona Ana Co (Rio Grande); Grant Co (Gila R).

NEW COUNTY RECORDS.—NMHU: Socorro Co (Rio Grande).

REMARKS.—*Isonychia intermedia* is known from several localities in Arizona and Chihuahua (Kondratieff and Voshell 1984, Lugo-Ortiz and McCafferty 1995a), in addition to those localities in New Mexico noted above. In New Mexico it has been taken from the Gila River, Rio Grande, and San Francisco River drainage systems in the southern part of the state. We do not expect it to be found in either the Rocky Mountain or Great Plains provinces.

*\*Isonychia sicca*  
(Walsh), 1862

DESCRIPTIONS.—Adult: Walsh (1862) as *Baetis sicca* Walsh; see also Kondratieff and Voshell (1984). Larva: Allen and Cohen (1977) as *I. sicca manca* (Eaton); see also Provonsha and McCafferty (1982).

NEW RECORDS.—BYU: Sandoval Co, Rio Grande, Coronado State Park, Bernalillo, 21-VIII-1985, Baumann and Whiting (larvae).

REMARKS.—*Isonychia sicca* is a relatively widespread species in North America (Kondratieff and Voshell 1984), being especially common in the Midwest, but extending to Central America. With respect to areas adjacent to New Mexico, it is common in Texas (Lugo-Ortiz and McCafferty 1995b), but has also been reported from Chihuahua (Lugo-Ortiz and McCafferty 1996a) and Oklahoma (McCafferty et al. 1997). Its discovery in New Mexico, where it is thus far known only from the Rio Grande drainage system, is somewhat expected. Larvae of *I. sicca* and *I. campestris* McDunnough, of which the latter occurs in Alberta, Saskatchewan, Wyoming, northeast Utah, and northwest Colorado (Woodbury and Argyle 1963), cannot be distinguished confidently (Kondratieff and Voshell 1984). Therefore, although there is the possibility that larvae we have seen belong to *I. campestris*, the Sandoval County record would appear more consistent geographically with the range of *I. sicca*. Also, the *I. sicca* identification is more consistent with larvae taken from the Rio Grande. Yanoviak and McCafferty (1995) showed that *I. sicca* is typically found in very long stream regions (>200 km), whereas *I. campestris* is known only from stream regions 100–200 km in length.

#### Leptohyphidae

##### *Leptohyphes apache*

Allen, 1967

DESCRIPTIONS.—Adult: unknown. Larva: Allen (1967).

PREVIOUS RECORDS.—Allen (1967): Rio Arriba Co (Taylor Cr). Allen (1978): Catron Co (San Francisco R); Grant Co (Gila R).

REMARKS.—This southwestern species is known from Arizona and southern Utah (Allen 1967, 1978, Lugo-Ortiz and McCafferty 1995a) and Chihuahua (Lugo-Ortiz and McCafferty 1994), in addition to New Mexico. In New Mexico, *L. apache* is known only from the Intermontane Plateau in the western part of the state, including the Gila, San Francisco, and San Juan River drainage systems.

##### *Tricorythodes condylus*

Allen, 1967

DESCRIPTIONS.—Adult: Allen (1967). Larva: Allen (1967).

PREVIOUS RECORDS.—Kilgore and Allen (1973): Catron Co (Gila R); Grant Co (Sapillo Cr).

REMARKS.—*Tricorythodes condylus* is a southwestern species known from Arizona, Chihuahua, New Mexico, and Sonora (Allen 1967, Kilgore and Allen 1973, Lugo-Ortiz and McCafferty 1994). In New Mexico it is known only from the Gila River drainage system.

##### *Tricorythodes corpulentus*

Kilgore and Allen, 1973

DESCRIPTIONS.—Adult: unknown. Larva: Kilgore and Allen (1973).

PREVIOUS RECORDS.—Kilgore and Allen (1973): Catron Co (Gila R).

REMARKS.—This species is known only from the Gunnison River in Colorado (Ward and Stanford 1990) and Gila River in New Mexico. McCafferty et al. (1993) pointed out that *T. corpulentus* was only tentatively valid. We have not seen specimens of this species.

##### *Tricorythodes dimorphus*

Allen, 1967

DESCRIPTIONS.—Adult: Kilgore and Allen (1973). Larva: Allen (1967).

PREVIOUS RECORDS.—Allen (1967): Taos Co (Red R). Kilgore and Allen (1973): Catron Co (N Glenwood); Grant Co (Sapillo Cr); Sierra Co (Rio Grande).

REMARKS.—This southwestern species is known from Arizona (Allen 1967, Kilgore and Allen 1973, Gray 1981, Lugo-Ortiz and McCafferty 1995a), Chihuahua, and New Mexico (Lugo-Ortiz and McCafferty 1994). In New Mexico it has been taken from the Gila and Rio Grande drainage systems.

##### *Tricorythodes explicatus*

(Eaton), 1892

DESCRIPTIONS.—Adult: Eaton (1892) as *Tricorythus explicatus* Eaton. Larva: Allen and Murvosh (1987c).

PREVIOUS RECORDS.—Allen and Murvosh (1983): Dona Ana Co (trib Rio Grande).

NEW COUNTY RECORDS.—NMHU: Colfax Co (Cieneguilla Cr, Six-mile Cr); Eddy Co (Penasco R); Lincoln Co (Rio Ruidoso); Rio Arriba Co (Rio Chama); Sierra Co (Rio Grande). PERC: San Juan Co (San Juan R).

REMARKS.—This species is known from Arizona and throughout northern Mexico (see Lugo-Ortiz and McCafferty 1995a, McCafferty and Lugo-Ortiz 1996). In New Mexico, *T. explicatus* is relatively common and is now known from the Canadian River, Pecos River,

Rio Grande, and San Juan River drainage systems. Lugo-Ortiz and McCafferty (1995a) indicated some possibility that *T. explicatus* and *T. minutus* Traver were synonymous.

*Tricorythodes minutus*  
Traver, 1935

DESCRIPTIONS.—Adult: Traver (1935). Larva: Kilgore and Allen (1973).

PREVIOUS RECORDS.—Kilgore and Allen (1973): Catron Co (San Francisco R); Chaves Co (Rio Penasco); Colfax Co (Ponil Cr); Grant Co (Gila R); Lincoln Co (Rio Ruidoso); Mora Co (Mora R); Rio Arriba Co (Rio Chama); Sandoval Co (Jemez R); San Juan Co (San Juan R); Sierra Co (Rio Grande); San Miguel Co (Sapello Cr); Santa Fe Co (Rio Grande); Taos Co (Taos Cr).

REMARKS.—*Tricorythodes minutus* is apparently widespread and ubiquitous in much of Canada and the USA. It has not been found in Mexico or Texas. It was reported as common throughout much of Colorado by McCafferty et al. (1993). In New Mexico, Kilgore and Allen (1973) have reported it from all major drainage systems, although we have not seen any material of this species from the many collections we have examined. Lugo-Ortiz and McCafferty (1995a) indicated that *T. minutus* could be easily confused with *T. explicatus* (see above).

Leptophlebiidae

*Choroterpes inornata*  
Eaton, 1892

DESCRIPTIONS.—Adult: Eaton (1892). Larva: Kilgore and Allen (1973).

PREVIOUS RECORDS.—Kilgore and Allen (1973): Catron Co (San Francisco R); Colfax Co (Cimarron R); Grant Co (Sapillo Cr); San Miguel Co (Windsor Cr).

NEW COUNTY RECORDS.—NMHU: Sandoval Co (Rio Cebolla). PERC: Mora Co (Coyote Cr).

REMARKS.—In addition to New Mexico, the southwestern species *C. inornata* is known from Arizona and northern Mexico (Eaton 1892), including Chihuahua (Allen and Murvosh 1987b), Colorado (Ward and Berner 1980), and more recently in Texas (Lugo-Ortiz and McCafferty 1995b) and Utah (McCafferty and MacDonald 1994). In New Mexico, *C. inornata* is now known from all major drainage systems except the San Juan River drainage system. Since it is found in the greater Colorado River

drainage system in Arizona, Colorado, and Utah, it could eventually also be found in that drainage system in New Mexico.

\**Leptophlebia bradleyi*  
Needham, 1932

DESCRIPTIONS.—Adult: Needham (1932). Larva: Berner (1975).

NEW RECORDS.—CSU: Eddy Co, Sitting Bull Falls, 16-I-1993, S. Fitzgerald and S. Hoffman (larvae, male adults).

REMARKS.—This species is known from the southeastern USA and Texas (Henry and Kondratieff 1982). Here we report it from New Mexico near Texas in the lower Pecos River drainage system. The New Mexico record represents the westernmost limits of its presently known range.

*Neochoroterpes kossi*  
(Allen), 1974

DESCRIPTIONS.—Adult: Henry (1993). Larva: Allen (1974) as *Choroterpes kossi* Allen; see also Henry (1993).

PREVIOUS RECORDS.—Henry (1993): Catron Co (San Francisco R).

NEW COUNTY RECORDS.—PERC: Grant Co (Cherry Cr, Little Cr).

REMARKS.—In addition to New Mexico, *N. kossi* has been known from Arizona (Allen 1974), from where it was originally described, and Texas (Henry 1993). Previous and new records from New Mexico are confined to the Gila River drainage system.

\**Neochoroterpes nanita*  
(Traver), 1934

DESCRIPTIONS.—Adult: Traver (1934) as *Choroterpes nanita* Traver; see also Henry (1993). Larva: Allen (1974) as *C. nanita*; see also Henry (1993).

NEW RECORDS.—NMHU: San Miguel Co, Canadian R at Sanchez, 21-III-1988, L.R. Smolka (larvae).

REMARKS.—This species was previously known only from Texas (Traver 1934). In New Mexico it has been taken in the Canadian River drainage system, which continues east into Texas.

*Neochoroterpes oklahoma*  
(Traver), 1934

DESCRIPTIONS.—Adult: Traver (1934) as *Choroterpes oklahoma* Traver; see also Henry

(1993). Larva: Allen (1974) as *C. mexicanus* Allen; see also Henry (1993).

PREVIOUS RECORDS.—Henry (1993): Chaves Co (Rio Penasco); Eddy Co (Sitting Bull Falls).

NEW COUNTY RECORDS.—CSU: Colfax Co (Vermejo R). NMHU: Otero Co (Dog Canyon). PERC: Mora Co (Coyote Cr).

REMARKS.—This species, which has been known more commonly by the synonyms *Choroterpes mexicanus* Allen or *Neochoroterpes mexicana* (Allen) (see McCafferty et al. 1993 and Henry 1993), is known from Colorado, parts of Mexico (including Chihuahua), Oklahoma, and Texas (see Henry 1993, McCafferty et al. 1993, Lugo-Ortiz and McCafferty 1996a). In New Mexico this species is now known from the eastern part of the state in both the Canadian and Pecos River drainage systems.

\**Paraleptophlebia debilis*  
(Walker), 1853

DESCRIPTIONS.—Adult: Walker 1853 as *Baetis debilis* Walker; see also key of Harper and Harper (1986). Larva: Ide (1930) as *Leptophlebia debilis*.

NEW RECORDS.—BYU: Eddy Co, Castle Cr, Black River Village, 14-I-1987, Baumann, Sargent, and Kondratieff (larvae). PERC: Grant Co, N of Silver City, Cherry Cr, 2.4 mi N of Cherry Creek Campgrounds, 7-VII-1969, R.W. Koss, W.P. McCafferty, and A.V. Provonsha (larvae); Sandoval Co, ca 32 km W of Los Alamos, Santa Fe National Forest, Las Conchas Picnic Site, E fork Jemez R, 1-IX-1969, R. and D. Koss; San Miguel Co, 1 mi N of Pecos, Pecos R, just below Lisboa Springs Fish Hatchery, 31-VIII-1969, R. and D. Koss (larvae).

REMARKS.—This transcontinental species is known from Colorado (Ward and Stanford 1990) and Utah (Edmunds 1954) but no other states adjoining New Mexico. Its presence in New Mexico therefore appears to represent the southernmost range limits in western North America. In New Mexico, *P. debilis* is presently known from all major drainage systems with the exception of the San Francisco and San Juan River drainage systems.

\**Paraleptophlebia heteronea*  
(McDunnough), 1924

DESCRIPTIONS.—Adult: McDunnough (1924a) as *Leptophlebia heteronea* McDunnough; see also key of Harper and Harper (1986). Larva: not published.

NEW RECORDS.—NMHU: Mora Co, Jack's Cr, 10,650 ft, 18-VI-1991, M. Hatch (larvae); Rio Arriba Co, San Pedro Park, south entrance, 13-VI-1981, S. Cary (male and female adults).

REMARKS.—McDunnough (1924a) first described *Paraleptophlebia heteronea* from Alberta. The species was misidentified from Colorado as *Leptophlebia pallipes* Hagen [now *P. memorialis*, see below] by Dodds (1923) and was similarly misidentified from Utah somewhat later by Needham and Christenson (1927). However, it was correctly reported from those states by Ward and Berner (1980) and Edmunds (1954), respectively. Our new records of this species in New Mexico are based on both the more identifiable adults as well as larvae. In New Mexico it has been taken in the northern part of the state in the Canadian River and Rio Grande drainage systems.

*Paraleptophlebia memorialis*  
(Eaton), 1884

DESCRIPTIONS.—Adult: Eaton (1884) as *Leptophlebia memorialis* Eaton; see also key of Harper and Harper (1986). Larva: Seemann (1927) as *Leptophlebia rufivenosa* Eaton 1884; see also Kilgore and Allen (1973).

PREVIOUS RECORDS.—Peters and Edmunds (1961) as *Paraleptophlebia pallipes*: San Juan Co (San Juan R). Kilgore and Allen (1973): Catron Co (Whitewater R); Lincoln Co (Cr at Pine Lodge).

NEW COUNTY RECORDS.—BYU: Sandoval Co (Jemez R). PERC: Colfax Co (Cimarron R); San Miguel Co (Pecos R); Rio Arriba Co (Rio Brazos); Taos Co (Pueblo Cr).

REMARKS.—This common western species is known from all USA states adjacent to New Mexico, except Oklahoma and Texas (Edmunds 1954, Argyle and Edmunds 1962, Kilgore and Allen 1973). *Paraleptophlebia memorialis* has often been recorded under its junior synonym *Leptophlebia pallipes* Hagen, which proved to be an unavailable name because it was a homonym of *L. pallipes* (Walker), 1875. *Paraleptophlebia memorialis* has been taken in Mexico only in Baja California (Lugo-Ortiz and McCafferty 1994). In New Mexico it is now known from all major drainage systems.

*Thraulodes brunneus*  
Koss, 1966

DESCRIPTIONS.—Adult: Koss (1966). Larva: Kilgore and Allen (1973).

PREVIOUS RECORDS.—Koss (1966): Grant Co (N Silver City).

NEW COUNTY RECORDS.—PERC: Catron Co (Gila R).

REMARKS.—*Thraulodes brunneus* is known from Arizona and New Mexico, and throughout much of Mexico including Chihuahua (Allen and Murvosh 1987b). In the USA it has been taken only from the Gila River drainage system.

\**Thraulodes gonzalesi*

Traver and Edmunds, 1967

DESCRIPTION.—Adult: Traver and Edmunds (1967). Larva: Traver and Edmunds (1967).

NEW RECORDS.—BYU: Grant Co, Sapillo Cr, jct with Gila R, 1555 m, 26-V-1985, B. Jensen (larva). NMHU: Grant Co, E fork Gila R, nr Grapevine, 1950 m, 12-X-1993, P. Stewart (larvae). PERC: Grant Co, Sapillo Cr, Rd 15, Gila National Forest, 7-V-1981, W.P. McCafferty, A.V. Provonsha, and D. Bloodgood (larvae).

REMARKS.—*Thraulodes salinus* Kilgore and Allen was recently shown by Lugo-Ortiz and McCafferty (1995a) to be a junior synonym of *T. gonzalesi*. Therefore, in addition to the new New Mexico distribution, the species is known from Arizona (Kilgore and Allen 1973), Mexico (including Chihuahua; Allen and Brusca 1978), and Texas (Traver and Edmunds 1967). In New Mexico it has been taken only in the Gila River drainage system.

*Thraulodes speciosus*

Traver, 1934

DESCRIPTIONS.—Adult: Traver (1934). Larva: Mayo (1969).

PREVIOUS RECORDS.—Durfee and Kondratieff (1995) as *T. arizonicus*: Catron Co (Taylor Cr).

NEW COUNTY RECORDS.—BYU: Grant Co (Turkey Cr).

REMARKS.—*Thraulodes arizonicus* Kilgore and Allen was recently shown to be a junior synonym of *T. speciosus* by Lugo-Ortiz and McCafferty (1995a). This species previously has been known only from Arizona (Traver 1934) and northern Mexico (Allen and Murvosh 1987b, Lugo-Ortiz and McCafferty 1996a), including Chihuahua. Allen and Brusca (1978) may have seen material from New Mexico because they plotted the species in New Mexico on a range map but presented no substantiating data for it. In addition to the new county

record cited above, we have seen this species in Catron County from the west fork of the Gila River and White Water Creek. In New Mexico the species is known only from the Gila River drainage system.

*Traverella albertana*

(McDunnough), 1931

DESCRIPTIONS.—Adult: McDunnough (1931a) as *Thraulodes albertanus* McDunnough; see also Traver and Edmunds (1967). Larva: Edmunds (1948).

PREVIOUS RECORDS.—Kilgore and Allen (1973) as *Traverella castanea*: Catron Co (San Francisco R); Grant Co (Gila R).

NEW COUNTY RECORDS.—NMHU: Santa Fe Co (Rio Grande).

REMARKS.—*Traverella castanea* Kilgore and Allen was shown to be a junior synonym of *T. albertana* by Lugo-Ortiz and McCafferty (1995a). This western species, therefore, is known from Alberta and Saskatchewan south to Chihuahua (see Allen 1973, Allen and Murvosh 1987b, Lugo-Ortiz and McCafferty 1995a, 1996a). Although it is known from the surrounding areas of Arizona, Chihuahua, and Colorado, it is not known from Texas. In New Mexico it has been taken only in the Gila River, upper Rio Grande, and San Francisco River drainage systems.

Oligoneuriidae

*Homoeoneuria alleni*

Pescador and Peters, 1980

DESCRIPTIONS.—Adult: unknown. Larva: Pescador and Peters (1980).

PREVIOUS RECORDS.—Pescador and Peters (1980): Dona Ana Co (Rio Grande).

REMARKS.—This species was originally described from New Mexico by Pescador and Peters (1980), and those authors also reported it from Chihuahua and Utah. It has since been found in Colorado by Durfee and Kondratieff (1994). In New Mexico it is known only from the lower Rio Grande.

*Lachlania dencyannae*

Koss, 1970

DESCRIPTIONS.—Adult: Koss and Edmunds (1970) as *L. dencyanna*. Larva: Koss and Edmunds (1970) as *L. dencyanna*.

PREVIOUS RECORDS.—Koss and Edmunds (1970): Grant Co (Gila R).

REMARKS.—This is the only species of North American mayflies known exclusively from

New Mexico and therefore endemic to the state and the Gila River drainage system. It may eventually be found in the Gila River drainage system area of eastern Arizona. We consider this species rare and endangered (see Species of Special Concern below). The ending of the specific epithet of this species has been emended to conform to rules of nomenclature because it was based on a modern female name (Dency Anne) latinized by the original author and thus should have further been given the appropriate genitive ending.

\**Lachlania saskatchewanensis*  
Ide, 1941

DESCRIPTIONS.—Adult: Ide (1941); see also Edmunds (1951) as *L. powelli* Edmunds. Larva: Edmunds (1951) as *L. powelli*.

NEW RECORDS.—PERC: San Juan Co, San Juan R, Blanco, State Hwy 17 bridge, 10-VIII-1961, D.W. Argyle (larva); San Juan Co, Animas R, Hwy 17 bridge, Farmington, 25-X-1961, D.W. Argyle (larva).

REMARKS.—McCafferty (1996) recently showed *S. powelli* Edmunds from Utah (Edmunds 1951) and Mexico (Lugo-Ortiz and McCafferty 1994) to be a junior synonym of *L. saskatchewanensis*. Thus, *L. saskatchewanensis* occurs from Saskatchewan to Guerrero in Mexico. It is known from the adjacent state of Colorado (McCafferty et al. 1993) but is not reported from Arizona, Chihuahua, or Texas. In New Mexico it has been taken only in the San Juan River drainage system.

#### Siphonuridae

*Siphonurus occidentalis* (Eaton), 1885

DESCRIPTION.—Adult: Eaton (1885) as *Siphonurus occidentalis* Eaton. Larva: Clemens (1915).

PREVIOUS RECORD.—Traver (1935): Santa Fe Co (Santa Fe R). Peters and Edmunds (1961): San Juan Co (San Juan R). Durfee and Kondratieff (1995): Catron Co (Taylor Cr).

NEW COUNTY RECORDS.—BYU: Grant Co (Gila R, Turkey Cr). NMHU: Otero Co (Agua Chiquita); Taos Co (Rio Hondo). PERC: Grant Co (Buck Cr, Cherry Cr, Little Cr, Sapillo Cr); San Miguel Co (Pecos R); Taos Co (Rio Grande).

REMARKS.—McCafferty et al. (1993) indicated that *S. occidentalis* was the most common species of *Siphonurus* in western North America. It is known from all USA states adjoining New Mexico except Texas, and was reported

from Mexico in adjacent Chihuahua (Lugo-Ortiz and McCafferty 1994) and as far south as Hidalgo (Lugo-Ortiz and McCafferty 1996a). In New Mexico it has been taken in all major drainage systems except the Canadian River drainage system.

#### FAUNISTICS

##### Regional Affinities

We have categorized New Mexico mayflies by their general regional geographic affinities and present this data in Table 1. *Western* species are those that have a considerable north-south distribution pattern in western North America. Only those New Mexico mayflies found north of Colorado and Utah and not in Texas (unless restricted to west Texas) are considered in the western species category. Two subcategories of such western mayflies are informative with respect to faunistics. These subcategories segregate those species in which New Mexico is the southern limit of their ranges, and those that occur further south than New Mexico and Arizona. *Southwestern* species are the 2nd main distributional category for New Mexico mayflies. These species occur no further north than Colorado or Utah, and no further east than Oklahoma or Texas. *Widespread* species are the 3rd main distributional category. These are New Mexico species that are western but also occur in at least 1 other large region of the continent, i.e., central, northeastern, or southeastern. *Mexican* species constitute a 4th category. New Mexico species placed in this category are distributed mainly through Mexico and occur no further north than Arizona, New Mexico, or Texas. *Southern* species constitute a 5th category. New Mexico species placed in this category are distributed in the southern USA further east than Texas, and range no further north than New Mexico in the West. *Eastern* species constitute a 6th category. These species occur in the central and northeastern USA in addition to New Mexico.

Table 1 shows that the largest component of the New Mexico mayfly fauna is made up of species generally well represented in the West. Most of these western species are restricted to the USA and Canada, with New Mexico, or New Mexico and Arizona, representing their southern range limit. Moreover, many of these latter species (e.g., *Drunella grandis*, *Epeorus*

TABLE 1. Major geographic affinities of the New Mexico mayfly species. See text for detailed definitions of the distributional categories.

Western species		
Southern limits at NM		Southern limits south of NM
<i>Ameletus sparsatus</i>	† <i>Ephemerella infrequens</i>	<i>Acentrella insignificans</i>
‡ <i>Ametropus albrighti</i>	<i>Heptagenia elegantula</i>	<i>Baetis magnus</i>
† <i>Attenella margarita</i>	<i>Heptagenia solitaria</i>	<i>Caenis bajaensis</i>
† <i>Baetis bicaudatus</i>	<i>Leucrocota petersi</i>	<i>Callibaetis pictus</i>
† <i>Cinygmula par</i>	<i>Nixe criddlei</i>	<i>Camelobaetidium warreni</i>
† <i>Drunella coloradensis</i>	<i>Nixe simplicioides</i>	<i>Lachlania saskatchewanensis</i>
† <i>Drunella doddsi</i>	† <i>Paraleptophlebia heteronea</i>	<i>Paraleptophlebia memorialis</i>
† <i>Drunella grandis</i>	<i>Procloeon conturbatum</i>	<i>Rhithrogena morrisoni</i>
† <i>Epeorus albertae</i>	† <i>Rhithrogena robusta</i>	<i>Serratella micheneri</i>
† <i>Epeorus deceptivus</i>	† <i>Serratella tibialis</i>	<i>Siphonurus occidentalis</i>
† <i>Epeorus longimanus</i>	† <i>Timpanoga hecuba</i>	<i>Traverella albertana</i>
<i>Ephemerella inermis</i>		
Southwestern species		
<i>Ameletus doddsianus</i>	<i>Epeorus margarita</i>	<i>Neochoroterpes oklahoma</i>
<i>Ameletus falsus</i>	<i>Ephemerella altana</i>	<i>Rhithrogena hageni</i>
<i>Baetis adonis</i>	<i>Ephemerella mollitia</i>	<i>Rhithrogena plana</i>
<i>Baetis caelestis</i>	<i>Homoeoneuria alleni</i>	‡ <i>Rhithrogena vitta</i>
<i>Baetis notos</i>	<i>Isonychia intermedia</i>	<i>Thraulodes gonzalesi</i>
<i>Baetodes edmundsi</i>	‡ <i>Labiobaetis apache</i>	<i>Tricorythodes condylus</i>
<i>Camelobaetidium musseri</i>	‡ <i>Lachlania dencyannae</i>	<i>Tricorythodes corpulentus</i>
<i>Choroterpes inornata</i>	<i>Neochoroterpes kossi</i>	<i>Tricorythodes dimorphus</i>
† <i>Cloeodes macrolamellus</i>	<i>Neochoroterpes nanita</i>	<i>Tricorythodes explicatus</i>
Widespread species		
<i>Acentrella turbida</i>	<i>Callibaetis fluctuans</i>	<i>Isonychia sicca</i>
<i>Baetis flavistriga</i>	<i>Ephemera simulans</i>	<i>Paraleptophlebia debilis</i>
<i>Baetis tricaudatus</i>	<i>Fallceon quilleri</i>	<i>Rhithrogena undulata</i>
<i>Caenis latipennis</i>	<i>Hexagenia limbata</i>	<i>Tricorythodes minutus</i>
<i>Callibaetis ferrugineus</i>		
Mexican species		
<i>Baetodes deficiens</i>	<i>Thraulodes brunneus</i>	<i>Thraulodes speciosus</i>
<i>Callibaetis montanus</i>		
Southern species		
<i>Leptophlebia bradleyi</i>		
Eastern species		
<i>Labiobaetis propinquus</i>		

†Species restricted to mountain streams.

‡Found only in the greater Colorado River drainage system.

*longimanus*) are restricted to mountain streams, and some have their southern range limit in the Rocky Mountain Province of northern New Mexico (e.g., *Serratella tibialis*). None of the western species whose ranges extend into Mexico are restricted exclusively to mountain streams.

The more geographically restricted, southwestern species in New Mexico make up almost as large a component as the western species in New Mexico. None of these species are restricted to mountain streams except *Cloeodes macrolamellus*, but that species is not found at high altitudes. The southwestern species *Labiobaetis apache* and *Lachlania dencyannae* are

restricted to the greater Colorado River drainage system.

Thirteen species in New Mexico are considered widespread. Some of these are relatively ubiquitous (e.g., *Baetis tricaudatus*, *Callibaetis ferrugineus*, *Tricorythodes minutus*). *Ephemera simulans* has its southwestern range limit represented in New Mexico. On the other hand, *Caenis latipennis* and *Fallceon quilleri* are widely distributed in much of the USA but also occur through Mexico and Central America. *Acentrella turbida* is widespread but generally found in cool, well-oxygenated water and thus, in New Mexico, is found in mountain streams.

Four species represent an essentially Mexican fauna in New Mexico. Of these, all but *Callibaetis montanus* are restricted in distribution in New Mexico to the Gila River drainage system. Although *C. montanus* has invaded other drainage systems in the state besides the Gila, it is restricted to lower lying areas (San Juan River and southernmost area of the Rio Grande drainage system). *Baetodes deficiens* is notable because its presence in Sapillo Creek (Gila River drainage system) is its only known occurrence in the USA.

Two species show atypical distribution patterns by their presence in New Mexico. *Lep-tophlebia bradleyi* is a southern species that reaches its westernmost limits in extreme southeastern New Mexico. *Labiobaetis propinquus* is a mainly central USA species that has its southwestern range limit in northeastern and south central New Mexico. We regard its distribution in New Mexico as anomalous since it does not fit any predictable pattern. However, the species may prove to be more widespread in North America than now thought and therefore fall into the widespread category.

We have documented the occurrence of a total of 12 families, 37 genera, and 81 species of mayflies in the state of New Mexico. By comparison with broadly adjoining states, 9 families, 28 genera, and 66 species have been recorded for Arizona (see Lugo-Ortiz and McCafferty 1995a, Zloty 1996); 5 families, 14 genera, and 27 species have been recorded for Chihuahua (see Lugo-Ortiz and McCafferty 1995d, 1996a, McCafferty and Lugo-Ortiz 1996); 14 families, 44 genera, and 100 species for Colorado (see McCafferty et al. 1993, Durfee and Kondratieff 1994); and 11 families, 34 genera, and 92 species for Texas (see Lugo-Ortiz and McCafferty 1995b). The low number of taxa for the Mexican state of Chihuahua is due to the more restricted availability of freshwater habitats in that primarily desert area and also the fact that collecting efforts there have not been on a par with those in the other states mentioned. On the other hand, the relatively high mayfly taxa number in Colorado is due to the diverse topography and array of freshwater habitats available in that state as well as the fact that Colorado has been one of the better worked North American regions with respect to sampling of aquatic macroinvertebrates.

A more informative comparison of the New Mexico mayfly fauna with that of other regions

can be made with a comparative index that takes into account the degree of similarity and difference in the faunas of any 2 regions. We have used Sorensen's coefficient of similarity (SC) to compare New Mexico more thoroughly with each of its broadly adjoining states [ $SC = 2a/(2a + b + c)$ , where  $a$  = number of species in common between New Mexico and a comparative state,  $b$  = the number of species in New Mexico, and  $c$  = the number of species in the comparative state]. The results of such calculations, taking into consideration any recent taxonomic revisions such as Zloty (1996), are as follows: for New Mexico and Arizona, there are 52 species in common and  $SC = 0.41$ ; for New Mexico and Chihuahua, 18 species in common and  $SC = 0.35$ ; for New Mexico and Colorado, 48 species in common and  $SC = 0.35$ ; and for New Mexico and Texas, 22 species in common and  $SC = 0.20$ .

To a large extent, Arizona mirrors the aquatic environment of New Mexico. The shared mayfly fauna of the 2 states is mainly southwestern but also contains many of the western mountain species (Table 1). This accounts for the high coefficient of similarity for these 2 states. Eighteen of the 27 species thus far known from Chihuahua occur in New Mexico, and this is the main reason for considerable similarity between these states. With respect to relationships with Colorado, just as with Arizona, over half of the New Mexico species are found in Colorado also. However, less than half of the Colorado species are found in New Mexico; this is because of a considerable number of more boreal transcontinental species that occur in Colorado (McCafferty et al. 1993) but not New Mexico. The large number of shared mountain species (all those mountain-restricted species shown under the Western [southern limits New Mexico] categories of Table 1) is offset by the fact that many of the southwestern species in New Mexico do not reach Colorado, thus giving a basically intermediate coefficient of similarity between the 2 states. The low coefficient of similarity between New Mexico and Texas is explained by the fact that only one of the basically eastern and southeastern species of east and central Texas (see Lugo-Ortiz and McCafferty 1995b) reaches New Mexico, and in the same respect, western mountain species of New Mexico do not reach Texas. The vast majority of the 22 species shared by New Mexico and Texas are southwestern or

Mexican species, but some are widespread. *Acentrella insignificans* represents a rare case of a species distributed mainly in the Northwest, but which has also penetrated west Texas, evidently via the Canadian and Pecos River drainage systems.

#### Drainage System Relationships

In Table 2 we have sorted the New Mexico mayfly species by major drainage system. Species richness is greatest in the Gila system (49 species), followed closely by the Rio Grande (46 species), then Pecos (39 species), Canadian (29 species), and finally San Juan (25 species). The Gila, although not large compared with some other drainages, does have a unique complex of both western mountain species and species that could be considered lowland species, many of which are southwestern or Mexican. The species richness of the Rio Grande and Pecos systems is in large part due to the western mountain species present in headwaters and mountain tributaries, and the range of habitats represented over their relatively long courses, including large, low-lying rivers. The Canadian and San Juan systems are somewhat restricted both in area and in habitats, both primarily with low-lying courses with considerable silting, particularly the San Juan. A number of species collected from the San Juan River prior to 1961 may no longer be present there (see Species of Special Concern below).

If intrastate comparisons of the drainage-system mayfly faunas are made by calculating Sorensen's coefficients (see formulation above), it becomes apparent that the greatest similarity of any 2 systems is that shown by the Gila and Rio Grande systems (Fig. 2), which also happen to be the richest systems. The Pecos system is also relatively similar to both the Gila and Rio Grande (Fig. 2). The least similarity is shown between the Gila and Canadian systems, probably due to the distance between them, compounded by the fact that one is a western drainage and the other an eastern drainage, and by their overall dissimilarity in habitat availability. The Canadian system has only 14 species in common with the San Juan system and another 14 in common with the Gila system. Factoring in the faunal size of the systems in question, however, shows that the Canadian and San Juan systems have a greater similarity than the Canadian and Gila systems

(Fig. 2). By summing all intra-drainage coefficients for each of the drainage systems, we can see that the Rio Grande system fauna is most representative of the entire New Mexico fauna, whereas the San Juan and Canadian system faunas are least representative of the state.

Eighteen New Mexico mayfly species are known exclusively from western drainages in the state (San Juan, Zuni, San Francisco, Gila), and 23 species are known exclusively from eastern drainages (essentially all drainages east of the continental divide: Dry Cimarron, Canadian, Rio Grande, Pecos; see Table 2, Fig. 1). The genera to which these exclusive drainage system species belong can be considered with respect to their recent biogeographic origins (Edmunds et al. 1976, McCafferty et al. 1992). Twelve of the 18 species confined to the western drainage systems are species that are members of genera that have recent Neotropical biogeographic origins (*Baetodes*, *Camelobaetidius*, *Leptohyphes*, *Tricorythodes*, *Thraulodes*, *Lachlunia*). On the other hand, nearly all species (22 of 23) that are found exclusively in eastern drainages in New Mexico belong to genera that have boreal Nearctic biogeographic origins (*Ameletus*, *Baetis*, *Labiobaetis*, *Caenis*, *Attenella*, *Drunella*, *Ephemerella*, *Serratella*, *Timpunoga*, *Ephemerella*, *Hexagenia*, *Cinygmula*, *Epeorus*, *Rhithrogena*, *Isonychia*, *Neochoroterpes*, *Leptophlebia*, *Paraleptophlebia*, *Homoeoneuria*). This comparison suggests that the greater Colorado drainage system has been a major northern dispersal corridor for mayflies during its 3.5-million-year existence. It also suggests that the greater Rio Grande drainage system has not been amenable to northern dispersal of austral taxa, but has been primarily colonized from the north. However, mountain species found exclusively in the eastern drainage systems (there are 9 of these) evidently have been limited to the northern part of the state by topography. The 38 species of New Mexico mayflies that occur in both eastern and western drainage systems in the state belong to a mix of Nearctic and Neotropical genera and demonstrate that none of the drainage systems in New Mexico should be considered one-way corridors.

#### Species of Special Concern

Recent studies of the mayflies of the Southwest indicate that only 1 endemic species occurs in New Mexico. It is *Lachlania dencyannae*, a

TABLE 2. Drainage system distributions of New Mexico mayfly species.

	San Juan (including Zuni)	
<i>Acentrella insignificans</i>	<i>Ephemerella mollitia</i>	<i>Paraleptophlebia memorialis</i>
<i>Anetropus albrighti</i>	<i>Heptagenia elegantula</i>	<i>Proclaeon conturbatum</i>
<i>Baetis flavistriga</i>	<i>Heptagenia solitaria</i>	<i>Rhithrogena morrisoni</i>
<i>Baetis tricaudatus</i>	<i>Labiobaetis apache</i>	<i>Rhithrogena undulata</i>
<i>Callibaetis ferrugineus</i>	<i>Lachlania saskatchewanensis</i>	<i>Serratella micheneri</i>
<i>Callibaetis montanus</i>	<i>Leptohyphes apache</i>	<i>Siphonurus occidentalis</i>
<i>Callibaetis pictus</i>	<i>Nixe criddlei</i>	<i>Tricorythodes explicatus</i>
<i>Camelobaetidius warreni</i>	<i>Nixe simplicioides</i>	<i>Tricorythodes minutus</i>
<i>Ephemerella inermis</i>		
	Gila (including San Francisco)	
<i>Acentrella insignificans</i>	<i>Drunella doddsi</i>	<i>Paraleptophlebia debilis</i>
<i>Ameletus doddsianus</i>	<i>Epeorus deceptivus</i>	<i>Paraleptophlebia memorialis</i>
<i>Baetis bicaudatus</i>	<i>Epeorus longimanus</i>	<i>Rhithrogena plana</i>
<i>Baetis caelestis</i>	<i>Epeorus margarita</i>	<i>Rhithrogena robusta</i>
<i>Baetis magnus</i>	<i>Drunella grandis</i>	<i>Rhithrogena undulata</i>
<i>Baetis notos</i>	<i>Ephemerella altana</i>	<i>Rhithrogena vitta</i>
<i>Baetis tricaudatus</i>	<i>Ephemerella inermis</i>	<i>Serratella micheneri</i>
<i>Baetodes deficiens</i>	<i>Fallceon quilleri</i>	<i>Siphonurus occidentalis</i>
<i>Baetodes edmundsi</i>	<i>Heptagenia solitaria</i>	<i>Thraulodes brunneus</i>
<i>Caenis bajaensis</i>	<i>Isonychia intermedia</i>	<i>Thraulodes gonzalesi</i>
<i>Callibaetis ferrugineus</i>	<i>Lachlania dencyannae</i>	<i>Thraulodes speciosus</i>
<i>Callibaetis montanus</i>	<i>Leptohyphes apache</i>	<i>Traverella albertana</i>
<i>Callibaetis pictus</i>	<i>Leucrocuta petersi</i>	<i>Tricorythodes condylus</i>
<i>Camelobaetidius musseri</i>	<i>Neochoroterpes kossi</i>	<i>Tricorythodes corpulentus</i>
<i>Camelobaetidius warreni</i>	<i>Nixe criddlei</i>	<i>Tricorythodes dimorphus</i>
<i>Choroterpes inornata</i>	<i>Nixe simplicioides</i>	<i>Tricorythodes minutus</i>
<i>Cloeodes macrolamellus</i>		
	Canadian (including Dry Cimarron)	
<i>Acentrella insignificans</i>	<i>Drunella grandis</i>	<i>Nixe simplicioides</i>
<i>Baetis bicaudatus</i>	<i>Ephemerella altana</i>	<i>Paraleptophlebia debilis</i>
<i>Baetis magnus</i>	<i>Ephemerella inermis</i>	<i>Paraleptophlebia heteronea</i>
<i>Baetis notos</i>	<i>Heptagenia elegantula</i>	<i>Paraleptophlebia memorialis</i>
<i>Baetis tricaudatus</i>	<i>Heptagenia solitaria</i>	<i>Rhithrogena morrisoni</i>
<i>Baetodes edmundsi</i>	<i>Labiobaetis propinquus</i>	<i>Rhithrogena undulata</i>
<i>Caenis bajaensis</i>	<i>Leucrocuta petersi</i>	<i>Serratella micheneri</i>
<i>Camelobaetidius warreni</i>	<i>Neochoroterpes nanita</i>	<i>Tricorythodes explicatus</i>
<i>Choroterpes inornata</i>	<i>Neochoroterpes oklahoma</i>	<i>Tricorythodes minutus</i>
<i>Drunella doddsi</i>	<i>Nixe criddlei</i>	

notably distinct and unique mayfly with a restrictive habitat (Koss and Edmunds 1970). Most other species once thought to be endemic to New Mexico have eventually been found in Arizona, often in the same drainage system (middle or lower Colorado River drainage system). *Lachlania dencyannae* deserves special attention for other reasons, beside its being endemic. It is limited in distribution to the Gila River drainage system. *Camelobaetidius musseri*, *Cloeodes macrolamellus*, *Rhithrogena vitta*, *Tricorythodes condylus*, *T. corpulentus*, *Neochoroterpes kossi*, *Thraulodes brunneus*, *T. gonzalesi*, and *T. speciosus* are additional New Mexico species that are found only in the Gila River drainage system. This drain-

age system can therefore be viewed as a refuge in New Mexico for certain southwestern species. In addition, *Lachlania* is a highly unusual group of mayflies with rapid flight habits and associated wing morphology unique among the Ephemeroptera (see Edmunds et al. 1976) and a molting process unique among all insects (see Edmunds and McCafferty 1988). Given the highly restricted range and remarkable nature of this mayfly species, we recommend that *L. dencyannae* be given special consideration as a rare and endangered species, both at the state and federal levels. Because of the degradation of the Gila River, especially in Arizona (see e.g., McNamee 1994), and impending degradation in New Mexico, we suggest

TABLE 2. Continued.

Rio Grande		
<i>Acentrella insignificans</i>	<i>Epeorus deceptivus</i>	<i>Paraleptophlebia heteronea</i>
<i>Acentrella turbida</i>	<i>Epeorus longimanus</i>	<i>Paraleptophlebia memorialis</i>
<i>Ameletus doddsianus</i>	<i>Epeorus margarita</i>	<i>Rhithrogena hageni</i>
<i>Ameletus falsus</i>	<i>Ephemera simulans</i>	<i>Rhithrogena morrisoni</i>
<i>Attenella margarita</i>	<i>Ephemerella altana</i>	<i>Rhithrogena plana</i>
<i>Baetis bicaudatus</i>	<i>Ephemerella inermis</i>	<i>Rhithrogena robusta</i>
<i>Baetis magnus</i>	<i>Ephemerella infrequens</i>	<i>Rhithrogena undulata</i>
<i>Baetis tricaudatus</i>	<i>Fallceon quilleri</i>	<i>Serratella micheneri</i>
<i>Callibaetis ferrugineus</i>	<i>Heptagenia solitaria</i>	<i>Serratella tibialis</i>
<i>Callibaetis montanus</i>	<i>Homoeoneuria alleni</i>	<i>Siphonurus occidentalis</i>
<i>Callibaetis pictus</i>	<i>Isonychia intermedia</i>	<i>Timpanoga hecuba</i>
<i>Choroterpes inornata</i>	<i>Isonychia sicca</i>	<i>Traverella albertana</i>
<i>Drunella coloradensis</i>	<i>Nixe criddlei</i>	<i>Tricorythodes dimorphus</i>
<i>Drunella doddsi</i>	<i>Nixe simplicioides</i>	<i>Tricorythodes explicatus</i>
<i>Drunella grandis</i>	<i>Paraleptophlebia debilis</i>	<i>Tricorythodes minutus</i>
<i>Epeorus albertae</i>		
Pecos		
<i>Acentrella insignificans</i>	<i>Callibaetis pictus</i>	<i>Leptophlebia bradleyi</i>
<i>Acentrella turbida</i>	<i>Choroterpes inornata</i>	<i>Neochoroterpes oklahoma</i>
<i>Ameletus falsus</i>	<i>Cinygmula par</i>	<i>Nixe criddlei</i>
<i>Ameletus sparsatus</i>	<i>Drunella coloradensis</i>	<i>Nixe simplicioides</i>
<i>Attenella margarita</i>	<i>Drunella doddsi</i>	<i>Paraleptophlebia debilis</i>
<i>Baetis adonis</i>	<i>Drunella grandis</i>	<i>Paraleptophlebia memorialis</i>
<i>Baetis bicaudatus</i>	<i>Epeorus deceptivus</i>	<i>Rhithrogena morrisoni</i>
<i>Baetis caelestis</i>	<i>Epeorus longimanus</i>	<i>Rhithrogena undulata</i>
<i>Baetis magnus</i>	<i>Ephemerella altana</i>	<i>Serratella micheneri</i>
<i>Baetis tricaudatus</i>	<i>Ephemerella inermis</i>	<i>Siphonurus occidentalis</i>
<i>Caenis latipennis</i>	<i>Fallceon quilleri</i>	<i>Timpanoga hecuba</i>
<i>Callibaetis ferrugineus</i>	<i>Hexagenia bilineata</i>	<i>Tricorythodes explicatus</i>
<i>Callibaetis fluctuans</i>	<i>Labiobaetis propinquus</i>	<i>Tricorythodes minutus</i>

that the other Gila River drainage system mayfly species, mentioned above, minimally be considered at risk.

We consider the following mayfly species rare or, in some cases, possibly recently extirpated in New Mexico. *Ametropus albrighti* is a sand-dwelling mayfly with very specific habitat requirements (see Clifford and Barton 1979) that has been taken only in the San Juan River in New Mexico and the Green River system in the region where Colorado, Wyoming, and Utah meet (Allen and Edmunds 1976). Although such sand-dwelling species can be difficult to sample (McCafferty 1991), *A. albrighti* has not been taken in New Mexico since 1935. Sublette et al. (1990) discussed the changes to the San Juan River related to a recent host of large-scale irrigation facilities in the San Juan Basin and construction of the Navajo Dam. *Callibaetis fluctuans* is a common species elsewhere, but in New Mexico it has been taken only from a single sample from Castle Creek in Eddy

County (lower Pecos River drainage system). It may have only recently invaded the state, and we expect that it may become more widespread if it is relatively vagile as is typical of other species in the genus (McCafferty et al. 1992). *Procloueon conturbatum* is known in New Mexico only from adult males taken at the San Juan River. *Leptophlebia bradleyi* is known only from a single sample from Eddy County, which apparently is the westernmost record of this southern USA species. *Neochoroterpes nanita* is known from only 1 sample from the Canadian River in San Miguel County. Otherwise, it is known only from central and east central Texas (Henry 1993, Lugo-Ortiz and McCafferty 1995b). *Rhithrogena hageni* is known only from an isolated fringe population in the Red River in Taos County, upper Rio Grande drainage system. Although also rare in Arizona, it is relatively common in Colorado.

*Hexagenia bilineata* is a large, common, and well-known species in eastern and central areas

	G	C	R	P
S	15[.29]	13[.33]	16[.31]	14[.27]
G		13[.25]	30[.39]	22[.36]
C			17[.31]	15[.31]
R				25[.37]

Fig. 2. Matrix of New Mexico species shared by, and Sorensen's coefficients of similarity [in brackets] between, major drainage systems in New Mexico. S = San Juan + Zuni, G = Gila + San Francisco, C = Canadian + Dry Cimarron, R = Rio Grande, P = Pecos.

of North America. In New Mexico, however, its distribution is disjunct, the population is unusual (see Species Accounts above), and the single habitat where it is found is a one-of-a-kind area in the state. It consists of a 1-km-long, 2-m-deep pool with fine, calcareous sediments. It is located just upstream from Harkey crossing on the Black River (Eddy County). We doubt there is another habitat with this type of burrowing substrate (required by *Hexagenia* mayflies) in New Mexico. The road crossing mentioned above acts as a partial dam across the limestone basin, and any alteration of the crossing or roadwork would seriously affect the depositional nature and sediment trapping feature of the extensive pool.

*Homoeoneuria alleni* is known somewhat north and south of New Mexico. In New Mexico it has been taken only once from the lower Rio Grande in Dona Ana County. However, we expect that this sand-dwelling species is difficult to collect in larger rivers. Likewise, *Lachlania saskatchewanensis*, known only from the San Juan River drainage system in New Mexico, is also difficult to sample and in reality may not be rare.

*Baetis adonis*, *Ephemerella mollitia*, and *Leucrocuta petersi* are apparently rare North American species. *Baetis adonis* is known only from the San Gabriel Mountains of southern California and the upper Pecos River in the foothills of the Sangre de Cristo Mountains in San Miguel County, New Mexico. *Ephemerella mollitia* is also known only from California and New Mexico. Although it has not been reported from the San Juan River since 1935 and this

singular New Mexico record was questioned by Allen and Edmunds (1965), the fact that the species is also known in California from the San Gabriel Mountains (as is *B. adonis* above) would possibly add credence to the New Mexico report. If it was taken from New Mexico, it may now be extirpated there due to alteration of habitats in the San Juan River that have occurred in the last half of this century. It is possible that *Leucrocuta petersi* presently occurs only in New Mexico. Outside of New Mexico the species has been known only from the Green River of northeastern Utah and southwestern Wyoming. However, the species may now be extirpated in these latter states because the construction of Flaming Gorge Dam has had some detrimental effects on mayflies of that area (Edmunds personal communication), and *L. petersi* has not been found there subsequent to the collections of the type material (1945, 1962; Allen 1966). The species apparently is common in the Gila River drainage system in New Mexico, and it has also been taken in a sample from the Canadian River drainage system in another part of the state.

#### ACKNOWLEDGMENTS

We thank Dick Baumann (Provo, Utah), George Edmunds (Salt Lake City, Utah), and Boris Kondratieff (Fort Collins, Colorado) for the loan and donation of collections of New Mexico mayflies. We also thank Arwin Provonsha (West Lafayette, Indiana) for the artwork. To all those who have collected mayflies in New Mexico beginning in the 1960s and whose names appear in the New Records sections of this paper, we offer our sincere gratitude for making this study possible. We also thank S.L. Joseph and A.R. Alexander, who collected new county records, but whose names did not appear in the text. The research was supported in part by a grant from the American Philosophical Society. Additional financial support for some collections since 1991 was provided in part by Grant F-59-R through the Federal Aid in Sport Fish Restoration Program administered by the New Mexico Department of Game and Fish and the U.S. Fish and Wildlife Service for development of an index of biotic integrity (IBI) for surface waters of New Mexico. The study has been assigned Purdue Agricultural Research Program Journal Number 15347.

## LITERATURE CITED

- ALLEN, R.K. 1966. New species of *Heptagenia* from western North America (Ephemeroptera: Heptageniidae). *Canadian Entomologist* 98:80-82.
- \_\_\_\_\_. 1967. New species of New World Leptohyphinae (Ephemeroptera: Tricorythidae). *Canadian Entomologist* 99:350-375.
- \_\_\_\_\_. 1968. New species and records of *Ephemerella* (*Ephemerella*) in western North America (Ephemeroptera: Ephemerellidae). *Journal of the Kansas Entomological Society* 41:557-567.
- \_\_\_\_\_. 1974. *Neochoroterpes*, a new subgenus of *Choroterpes* Eaton from North America (Ephemeroptera: Leptophlebiidae). *Canadian Entomologist* 106:161-168.
- \_\_\_\_\_. 1978. The nymphs of North and Central American *Leptohyphes* (Ephemeroptera: Tricorythidae). *Annals of the Entomological Society of America* 71:537-558.
- ALLEN, R.K., AND R.C. BRUSCA. 1978. Generic revisions of mayfly nymphs. II. *Thraulodes* in North and Central America (Leptophlebiidae). *Canadian Entomologist* 110:413-433.
- ALLEN, R.K., AND E.S.M. CHAO. 1978a. Mayflies of the Southwest: new species and records of *Dactylobaetis*. *Pan-Pacific Entomologist* 54:300-304.
- \_\_\_\_\_. 1978b. Mayflies of the Southwest: new species and records of Heptageniidae (Ephemeroptera). *Pan-Pacific Entomologist* 54:311-315.
- \_\_\_\_\_. 1981. Mayflies of the Southwest: new records and notes of Siphonuridae. *Pan-Pacific Entomologist* 57:449-456.
- ALLEN, R.K., AND S.D. COHEN. 1977. Mayflies (Ephemeroptera) of Mexico and Central America: new species, descriptions, and records. *Canadian Entomologist* 109:399-414.
- ALLEN, R.K., AND G.F. EDMUNDS, JR. 1959. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae). I. The subgenus *Timpanoga*. *Canadian Entomologist* 91:51-58.
- \_\_\_\_\_. 1961. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae). III. The subgenus *Attenuatella*. *Journal of the Kansas Entomological Society* 34:161-173.
- \_\_\_\_\_. 1962. A revision of the genus *Ephemerella* (Ephemeroptera, Ephemerellidae). V. The subgenus *Drunella* in North America. *Miscellaneous Publications of the Entomological Society of America* 3:147-179.
- \_\_\_\_\_. 1963. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae). VI. The subgenus *Serratella* in North America. *Annals of the Entomological Society of America* 56:583-600.
- \_\_\_\_\_. 1965. A revision of the genus *Ephemerella* (Ephemeroptera, Ephemerellidae). VIII. The subgenus *Ephemerella* in North America. *Miscellaneous Publications of the Entomological Society of America* 4:243-282.
- \_\_\_\_\_. 1976. A revision of the genus *Ametropus* in North America (Ephemeroptera: Ametropodidae). *Journal of the Kansas Entomological Society* 49:625-635.
- ALLEN, R.K., AND C.M. MURVOSH. 1983. Taxonomy and zoogeography of the mayflies (Ephemeroptera: Insecta) of Baja California. *Annals of the Entomological Society of America* 76:425-433.
- \_\_\_\_\_. 1987a. New Baetidae from the southwestern United States and northern Mexico (Insecta: Ephemeroptera), with notes. *Canadian Entomologist* 119:1095-1099.
- \_\_\_\_\_. 1987b. Leptophlebiidae of the southwestern United States and northwestern Mexico (Insecta: Ephemeroptera). *Great Basin Naturalist* 47:283-286.
- \_\_\_\_\_. 1987c. Mayflies (Ephemeroptera: Tricorythidae) of the southwestern United States and Northern Mexico. *Annals of the Entomological Society of America* 80:35-40.
- ARGYLE, D.W., AND G.F. EDMUNDS, JR. 1962. Mayflies (Ephemeroptera) of the Curecanti Reservoir Basin, Gunnison River, Colorado. *University of Utah Anthropological Papers* 59:178-189.
- BANKS, N. 1900. New genera and species of Nearctic neuropteroid insects. *Transactions of the American Entomological Society* 26:239-259.
- \_\_\_\_\_. 1907. A new mayfly of the genus *Caenis*. *Entomological News* 18:13-14.
- \_\_\_\_\_. 1924. Descriptions of new neuropteroid insects. *Bulletin of the Museum of Comparative Zoology, Harvard University* 62:2-22.
- BEDNARIK, A.F., AND G.F. EDMUNDS, JR. 1980. Descriptions of larval *Heptagenia* from the Rocky Mountain region (Ephemeroptera: Heptageniidae). *Pan-Pacific Entomologist* 56:51-62.
- BERNER, L. 1940. Baetine mayflies from Florida (Ephemeroptera). *Florida Entomologist* 23:33-45, 49-62.
- \_\_\_\_\_. 1975. The mayfly family Leptophlebiidae in the southeastern United States. *Florida Entomologist* 58:137-156.
- BURKS, B.D. 1953. The mayflies or Ephemeroptera of Illinois. *Illinois Natural History Survey Bulletin* 26:1-216.
- CLEMENS, W.A. 1913. New species and new life histories of Ephemeridae or mayflies. *Canadian Entomologist* 45:246-262, 329-341.
- \_\_\_\_\_. 1915. Mayflies of the *Siphonurus* group. *Canadian Entomologist* 47:245-260.
- CLIFFORD, H.F., AND D.R. BARTON. 1979. Observations on the biology of *Ametropus neavei* (Ephemeroptera: Ametropodidae) from a large river in northern Alberta, Canada. *Canadian Entomologist* 111:855-858.
- COHEN, S.D., AND R.K. ALLEN. 1972. New species of *Baetodes* from Mexico and Central America. *Pan-Pacific Entomologist* 48:123-135.
- DAY, W.C. 1963. Ephemeroptera. Pages 79-105 in R.L. Usinger, editor, *Aquatic insects of California*. University of California Press, Berkeley.
- DODDS, G.S. 1923. Mayflies from Colorado, descriptions of certain species and notes on others. *Transactions of the American Entomological Society* 69:93-116.
- DURFEE, R., AND B.C. KONDRATIEFF. 1993. Description of adults of *Baetis magnus* (Ephemeroptera: Baetidae). *Entomological News* 104:227-232.
- \_\_\_\_\_. 1994. New additions to the inventory of Colorado mayflies (Ephemeroptera). *Entomological News* 105:222-227.
- \_\_\_\_\_. 1995. Description of adults of *Baetis notos* (Ephemeroptera: Baetidae). *Entomological News* 106:71-74.
- \_\_\_\_\_. 1997. Description of adults of *Labiobaetis apache* (Ephemeroptera: Baetidae) with additions and corrections to the inventory of Colorado mayflies. *Entomological News* 108:97-101.
- EATON, A.E. 1871. A monograph of the Ephemeridae. *Transactions of the Entomological Society of London* 19:1-164.

- \_\_\_\_\_. 1883–88. A revisional monograph of recent Ephemeridae or mayflies. Transactions of the Linnaean Society of London, Zoological Series 3:1–352.
- \_\_\_\_\_. 1892. *Biologia Centrali-Americana*, Insecta, Neuroptera, Ephemeridae. Bernard Quaritch, London.
- EDMUNDS, G.F., JR. 1948. A new genus of mayflies from western North America (Leptophlebiinae). Proceedings of the Biological Society of Washington 61: 141–148.
- \_\_\_\_\_. 1950. New records of the mayfly genus *Baetodes*, with notes on the genus. Entomological News 61: 203–205.
- \_\_\_\_\_. 1951. New species of Utah mayflies. I. Oligoneuriidae (Ephemeroptera). Proceedings of the Entomological Society of Washington 53:327–331.
- \_\_\_\_\_. 1954. The mayflies of Utah. Proceedings of the Utah Academy of Sciences, Arts and Letters 31:64–66.
- EDMUNDS, G.F., JR., AND R.K. ALLEN. 1964. The Rocky Mountain species of *Epeorus* (*Iron*) Eaton (Ephemeroptera: Heptageniidae). Journal of the Kansas Entomological Society 37:275–288.
- EDMUNDS, G.F., JR., AND W.P. MCCAFFERTY. 1988. The mayfly subimago. Annual Review of Entomology 33: 509–529.
- EDMUNDS, G.F., JR., AND G.G. MUSSER. 1960. The mayfly fauna of Green River in the Flaming Gorge Basin, Wyoming and Utah. University of Utah Anthropological Papers 48:111–123.
- EDMUNDS, G.F., JR., S.L. JENSEN, AND L. BERNER. 1976. The mayflies of North and Central America. University of Minnesota Press, Minneapolis.
- EISENHOD, W. 1979. Precipitation. Page 10 in J.L. Williams and P.E. McAllister, editors, New Mexico in maps. Technology Application Center, University of New Mexico, Albuquerque.
- FLOWERS, R.W. 1987. The adult stage of three Central American *Baetodes* (Ephemeroptera: Baetidae) with notes on the genus. Aquatic Insects 9:1–10.
- FLOWERS, R.W., AND W.L. HILSENHOFF. 1975. Heptageniidae (Ephemeroptera) of Wisconsin. Great Lakes Entomologist 8:201–218.
- GRAY, L.J. 1981. Species composition and life histories of aquatic insects in a lowland Sonoran Desert stream. American Midland Naturalist 106:229–242.
- HARPER, E., AND P.P. HARPER. 1986. An annotated key to the adult males of the northwestern Nearctic species of *Paraleptophlebia* Lestage (Ephemeroptera: Leptophlebiidae) with the description of a new species. Canadian Journal of Zoology 64:1460–1468.
- HARRIS, L.G. 1984. New Mexico water rights. New Mexico Water Resources Research Institute, Las Cruces.
- HENRY, B.C. 1993. A revision of *Neochoroterpes* (Ephemeroptera: Leptophlebiidae) new status. Transactions of the American Entomological Society 119:317–333.
- HENRY, B.C., AND B.C. KONDRATIEFF. 1982. New state records of the mayfly *Leptophlebia bradleyi* Needham. Entomological News 93:125–126.
- IDE, F.P. 1930. Contribution to the biology of Ontario mayflies with descriptions of new species. Canadian Entomologist 62:204–213.
- \_\_\_\_\_. 1935. Post embryonic development of Ephemeroptera (mayflies). External characters only. Canadian Journal of Research 12:433–478.
- \_\_\_\_\_. 1937. Descriptions of eastern North American species of baetine mayflies with particular reference to the nymphal stage. Canadian Entomologist 69: 219–231, 235–243.
- \_\_\_\_\_. 1941. Mayflies of two tropical genera, *Lachlania* and *Campsurus*, from Canada with descriptions. Canadian Entomologist 73:153–156.
- JOHNSON, S.C. 1978. Larvae of *Ephemerella inermis* and *E. infrequens* (Ephemeroptera: Ephemerellidae). Pan-Pacific Entomologist 54:19–25.
- KELTNER, J., AND W.P. MCCAFFERTY. 1986. Functional morphology of burrowing in the mayflies *Hexagenia limbata* and *Pentagenia vittigera*. Zoological Journal of the Linnacian Society 67:139–162.
- KILGORE, J.I., AND R.K. ALLEN. 1973. Mayflies of the Southwest: new species, descriptions, and records (Ephemeroptera). Annals of the Entomological Society of America 66:321–332.
- KONDRATIEFF, B.C., AND J.R. VOSHELL, JR. 1984. The North and Central American species of *Isonychia* (Ephemeroptera: Oligoneuriidae). Transactions of the American Entomological Society 110:129–244.
- KOSS, R.W. 1966. A new species of *Thraulodes* from New Mexico (Ephemeroptera: Leptophlebiidae). Michigan Entomologist 1:91–94.
- \_\_\_\_\_. 1972. *Baetodes*: new species and new records for North America (Ephemeroptera: Baetidae). Entomological News 83:93–102.
- KOSS, R.W., AND G.F. EDMUNDS, JR. 1970. A new species of *Lachlania* from New Mexico with notes on the genus. Proceedings of the Entomological Society of Washington 72:55–65.
- LEONARD, J.W., AND F.A. LEONARD. 1962. Mayflies of Michigan trout streams. Cranbrook Institute of Science, Bloomfield Hills, MI.
- LOWEN, R.G., AND J.F. FLANNAGAN. 1991. Four Manitoba species of *Centroptilum* Eaton (Ephemeroptera: Baetidae) with remarks on the genus. Pages 189–205 in J. Alba-Tercedor and A. Sanchez-Ortega, editors, Overview and strategies of Ephemeroptera and Plecoptera. Sandhill Crane Press, Gainesville, FL.
- LUGO-ORTIZ, C.R., AND W.P. MCCAFFERTY. 1993. Genera of Baetidae (Ephemeroptera) from Mexico. Entomological News 104:193–197.
- \_\_\_\_\_. 1994. New records of Ephemeroptera from Mexico. Entomological News 105:17–26.
- \_\_\_\_\_. 1995a. Annotated inventory of the mayflies (Ephemeroptera) of Arizona. Entomological News 106: 131–140.
- \_\_\_\_\_. 1995b. The mayflies (Ephemeroptera) of Texas and their biogeographic affinities. Pages 151–169 in L. Corkum and J. Ciborowski, editors, Current directions in research on Ephemeroptera. Canadian Scholars' Press, Toronto.
- \_\_\_\_\_. 1995c. Taxonomy of the North and Central American species of *Camelobaetidius* (Ephemeroptera: Baetidae). Entomological News 106:178–192.
- \_\_\_\_\_. 1995d. New species, stage descriptions, and records of *Baetodes* (Ephemeroptera: Baetidae) from Mexico and Central America. Entomological News 106:81–86.
- \_\_\_\_\_. 1996a. New Central American and Mexican records of Ephemeroptera species. Entomological News 107:303–310.
- \_\_\_\_\_. 1996b. Contribution to the taxonomy of *Callibaetis* (Ephemeroptera: Baetidae) in southwestern North America and Middle America. Aquatic Insects 18: 1–9.
- LUGO-ORTIZ, C.R., W.P. MCCAFFERTY, AND R.D. WALTZ. 1994. Review of the Panamerican genus *Fallceon*

- (Ephemeroptera: Baetidae). *Journal of the New York Entomological Society* 102:460–475.
- MAYO, V.K. 1969. Nymph of *Thraulodes speciosus* Traver with notes on a symbiotic chironomid. *Pan-Pacific Entomologist* 45:103–112.
- MCCAFFERTY, W.P. 1968. The mayfly genus *Hexagenia* in Mexico. *Proceedings of the Entomological Society of Washington* 70:358–359.
- \_\_\_\_\_. 1975. The burrowing mayflies (Ephemeroptera: Ephemeroidae) of the United States. *Transactions of the American Entomological Society* 101:447–504.
- \_\_\_\_\_. 1990. Biogeographic affinities of the Ephemeroptera of the Black Hills, South Dakota. *Entomological News* 101:193–199.
- \_\_\_\_\_. 1991. Comparison of Old and New World *Acanthametropus* (Ephemeroptera: Acanthametropodidae) and other psammophilous mayflies. *Entomological News* 102:205–214.
- \_\_\_\_\_. 1994. Distributional and classificatory supplement to the burrowing mayflies (Ephemeroptera: Ephemeroidae) of the United States. *Entomological News* 105:1–13.
- \_\_\_\_\_. 1996. The Ephemeroptera species of North America and index to their complete nomenclature. *Transactions of the Entomological Society of America* 122:1–54.
- MCCAFFERTY, W.P., AND J.R. DAVIS. 1992. New and additional records of small minnow mayflies (Ephemeroptera: Baetidae) from Texas. *Entomological News* 103:199–209.
- MCCAFFERTY, W.P., AND C.R. LUGO-ORTIZ. 1992. Registros nuevos y notas sobre los Ephemeroptera de Nicaragua. *Revista Nicaragüense de Entomología* 19:1–7.
- \_\_\_\_\_. 1996. Ephemeroptera. Pages 133–145 in J.E. Llorente-Bousquets, A.N. García-Aldrete and E. González-Soriano, editors, *Biodiversidad, taxonomía y biogeografía de artrópodos de México: hacia una síntesis de su conocimiento*. Universidad Nacional Autónoma de México, México D.F.
- MCCAFFERTY, W.P., AND J.F. MACDONALD. 1994. New records of Ephemeroptera in Utah with notes on biogeography. *Entomological News* 105:217–221.
- MCCAFFERTY, W.P., AND A.V. PROVONSHA. 1993. New species, subspecies, and stage descriptions of Texas Baetidae (Ephemeroptera). *Proceedings of the Entomological Society of Washington* 95:59–69.
- MCCAFFERTY, W.P., AND R.D. WALTZ. 1986. *Baetis magnus*, new species, formal new name for *Baetis* sp. B of Morihara and McCafferty (Ephemeroptera: Baetidae). *Proceedings of the Entomological Society of Washington* 88:604.
- \_\_\_\_\_. 1990. Revisionary synopsis of the Baetidae (Ephemeroptera) of North and Middle America. *Transactions of the American Entomological Society* 116:769–799.
- \_\_\_\_\_. 1995. *Labiobaetis* (Ephemeroptera: Baetidae): new status, related new genus, and new North American species. *Entomological News* 106:19–28.
- MCCAFFERTY, W.P., R. DURFEE, AND B.C. KONDRATIEFF. 1993. Colorado mayflies (Ephemeroptera): an annotated inventory. *Southwestern Naturalist* 38:252–274.
- MCCAFFERTY, W.P., R.W. FLOWERS, AND R.D. WALTZ. 1992. The biogeography of Mesoamerican mayflies. Pages 173–193 in S.P. Darwin and A.L. Weldon, editors, *Biogeography of Mesoamerica: proceedings of a symposium*. Tulane Studies in Zoology and Botany, Supplemental Publication 1.
- MCCAFFERTY, W.P., R.K. HETH, AND R.D. WALTZ. 1997. The Ephemeroptera of Spring Creek, Oklahoma, with remarks on notable records. *Entomological News* 108:193–200.
- MCCAFFERTY, W.P., M.J. WIGLE, AND R.D. WALTZ. 1994. Systematics and biology of *Acentrella turbida* (McDunnough) (Ephemeroptera: Baetidae). *Pan-Pacific Entomologist* 70:301–308.
- MCDUNNOUGH, J. 1921. Two new Canadian mayflies (Ephemeridae). *Canadian Entomologist* 53:117–120.
- \_\_\_\_\_. 1924a. New Canadian Ephemeridae with notes, II. *Canadian Entomologist* 56:90–98, 113–122, 128–133.
- \_\_\_\_\_. 1924b. New North American Ephemeridae. *Canadian Entomologist* 56:221–226.
- \_\_\_\_\_. 1926. New Canadian Ephemeridae with notes IV. *Canadian Entomologist* 58:296–303.
- \_\_\_\_\_. 1927. A new *Heptagenia* from the Yellowstone region (Ephemeroptera). *Canadian Entomologist* 59:261.
- \_\_\_\_\_. 1929. Notes on North American Ephemeroptera with descriptions of new species, II. *Canadian Entomologist* 61:169–180.
- \_\_\_\_\_. 1931a. New species of North American Ephemeroptera. *Canadian Entomologist* 63:82–93.
- \_\_\_\_\_. 1931b. The eastern North American species of *Ephemerella* and their nymphs (Ephemeroptera). *Canadian Entomologist* 63:187–197, 201–219.
- \_\_\_\_\_. 1934. New species of North American Ephemeroptera IV. *Canadian Entomologist* 66:154–164, 181–188.
- \_\_\_\_\_. 1935. Notes on western species of Ephemeroptera. *Canadian Entomologist* 67:95–104.
- \_\_\_\_\_. 1938. New species of North American Ephemeroptera with critical notes. *Canadian Entomologist* 70:23–34.
- MCNAMEE, G. 1994. Gila, the life and death of an American river. Orion, New York.
- MORIHARA, D.K., AND W.P. MCCAFFERTY. 1979a. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). *Transactions of the American Entomological Society* 105:139–221.
- \_\_\_\_\_. 1979b. Systematics of the *propinquus* group of *Baetis* species (Ephemeroptera: Baetidae). *Annals of the Entomological Society of America* 72:130–135.
- NEEDHAM, J.G. 1905. Ephemeroptera. Pages 17–62 in J.G. Needham, K.J. Morton, and O.A. Johannsen, editors, *Mayflies and midges of New York*. New York Museum Bulletin 86:1–352.
- \_\_\_\_\_. 1927. The Rocky Mountain species of the mayfly genus *Ephemerella*. *Annals of the Entomological Society of America* 20:107–117.
- \_\_\_\_\_. 1932. Three new American mayflies (Ephemeroptera). *Canadian Entomologist* 64:273–276.
- NEEDHAM, J.G., AND R.O. CHRISTENSON. 1927. Economic insects in some streams of northern Utah. *Bulletin of the Utah Agricultural Experiment Station* 201:6–16.
- NEWELL, R.L. 1970. Checklist of some aquatic insects from Montana. *Proceedings of the Montana Academy of Science* 30:45–56.
- PESCADOR, M.L., AND W.L. PETERS. 1980. A revision of the genus *Homooneuria* (Ephemeroptera: Oligoneuriidae). *Transactions of the American Entomological Society* 106:357–393.
- PETERS, W.L., AND G.F. EDMUNDS, JR. 1961. The mayflies (Ephemeroptera) of the Navajo Reservoir Basin, New

- Mexico and Colorado. University of Utah Anthropological Paper 55, Upper Colorado Series 5:107-111.
- PROVONSHIA, A.V. 1990. A revision of the genus *Caenis* in North America (Ephemeroptera: Caenidae). Transactions of the American Entomological Society 116: 801-884.
- PROVONSHIA, A.V., AND W.P. McCAFFERTY. 1982. New species and previously undescribed larvae of North American Ephemeroptera. Journal of the Kansas Entomological Society 55:23-33.
- RAHEL, F.J., AND C.S. KOLAR. 1990. Trade-offs in the response of mayflies to low oxygen and fish predation. Oecologia 84:39-44.
- SAY, T. 1924. In: Narrative on an expedition to the source of the St. Peters River, Lake Winnipeg, Lake of the Woods, etc. Performed in the year 1823, by order of the Hm. J.C. Calhoun, Secretary of War, under the command of Stephen H. Long, Major U.S.T.E. by W.M. Keating. Philadelphia 2:268-378.
- SEEMANN, T.M. 1927. Dragonflies, stoneflies, and mayflies of southern California. Journal of Entomology and Zoology 19:40-51.
- SNEAD, R.E. 1979. Landforms. Page 6 in J.L. Williams and P.E. McAllister, editors, New Mexico in maps. Technology Applications Center, University of New Mexico, Albuquerque.
- SPIETU, H.T. 1941. Taxonomic studies on the Ephemeroptera. II. The genus *Hexagenia*. American Midland Naturalist 26:233-280.
- SUBLETTE, J.E., M.D. HATCH, AND M. SUBLETTE. 1990. The fishes of New Mexico. University of New Mexico Press, Albuquerque.
- TRAVER, J.R. 1934. New North American species of mayflies (Ephemeridae). Journal of the Elisha Mitchell Scientific Society 50:189-254.
- \_\_\_\_\_. 1935. Part II, Systematic. Pages 237-739 in J.G. Needham, J.R. Traver, and Y.C. Hsu, editors, The biology of mayflies with a systematic account of North American species. Comstock Publishing Co., Ithaca, New York.
- TRAVER, J.R., AND G.F. EDMUNDS, JR. 1967. A revision of the genus *Thraulodes* (Ephemeroptera: Leptophlebiidae). Miscellaneous Publications of the Entomological Society of America 5:349-395.
- \_\_\_\_\_. 1968. A revision of the Baetidae with spatulate-clawed nymphs (Ephemeroptera). Pacific Insects 10: 629-677.
- WALKER, F. 1853. Catalogue of the specimens of neuropterous insects in the collection of the British Museum. Part 3:477-585.
- WALLEY, G.S. 1930. Review of the *Ephemerella* nymphs of western North America (Ephemeroptera). Canadian Entomologist 62:12-20.
- WALSH, B.D. 1862. List of the Pseudoneuroptera of Illinois, contained in the cabinet of the writer, with descriptions of over forty new species, and notes on their structural affinities. Proceedings of the Academy of Natural Sciences of Philadelphia 13-14:361-402.
- \_\_\_\_\_. 1863. Observations on certain N.A. Neuroptera, by H. Hagen, M.D. of Koenigsberg, Prussia; translated from the original French MS., and published by permission of the author, with notes and descriptions of about twenty new N.A. species of Pseudoneuroptera. Entomological Society of Philadelphia Proceedings 2:167-272.
- WALTZ, R.D., AND W.P. McCAFFERTY. 1987. Revision of the genus *Cloeodes* Traver (Ephemeroptera: Baetidae). Annals of the Entomological Society of America 80:191-207.
- WARD, J.V., AND L. BERNER. 1980. Abundance and altitudinal distribution of Ephemeroptera in a Rocky Mountain stream. Pages 169-186 in J.F. Flannagan and K.E. Marshall, editors, Advances in Ephemeroptera biology. Plenum, New York.
- WARD, J.V., AND J.A. STANFORD. 1990. Ephemeroptera of the Gunnison River, Colorado, USA. Pages 215-220 in I.C. Campbell, editor, Mayflies and stoneflies life histories and biology. Kluwer, Dordrecht, The Netherlands.
- WOODBURY, A.M., AND D.W. ARGYLE. 1963. Ecology and limnology of Green River. Pages 7-48 in Studies of biota in Dinosaur National Monument Utah and Colorado. University of Utah Division of Biological Sciences Miscellaneous Paper 1, Salt Lake City.
- YANOVIK, S.P., AND W.P. McCAFFERTY. 1995. Stream size and the distribution of selected Ephemeroptera. Pages 225-236 in L. Corkum and J. Ciborowski, editors, Current directions in research on Ephemeroptera. Canadian Scholars' Press, Toronto, Ontario.
- ZLOTY, J. 1996. A revision of the Nearctic *Ameletus* mayflies based on adult males, with descriptions of seven new species (Ephemeroptera: Ameletidae). Canadian Entomologist 128:293-346.

Received 8 April 1997  
Accepted 27 May 1997