

## Taxonomy and Zoogeography of the Mayflies (Ephemeroptera: Insecta) of Baja California<sup>1</sup>

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**ABSTRACT** The mayfly fauna of Baja California is composed of at least 6 families, 11 genera, and 13 species. Descriptions are presented for *Baetis caelestis* n. sp., *B. byblis* n. sp., *Callibaetis* sp., "A," *Callibaetis* sp., "B" and *Caenis bajaensis* n. sp., and a genus and species of Baetidae described as *Genus incertae*. *Dactylobaetis navis* is redescribed, and new collection records are included for *Dactylobaetis navis*, *Choroterpes inornata*, *Drunella flavilinea*, *Iron margarita*, *Serratella micheneri*, *Thraulodes brunneus* and *Tricorythodes explicatus*. Illustrations of parts of some species, distribution maps, and a discussion of the zoogeography of Baja California mayflies are included.

Previous records of mayflies from Baja California were published by Allen and Edmunds (1962, 1963) for *Serratella micheneri* (Traver) and *Drunella (Myllonella) flavilinea* (McDunnough) from Baja California Norte, and by Allen (1977b) for *Choroterpes (Choroterpes) inornata* Eaton from Baja California Sur. Field studies in 1978-79 by the authors reveal that the number of species in Baja California is thirteen, and that they are included in eleven genera and six families.

Collection methods included hand picking from rocks and debris and with a standard hand screen. The stream temperatures were recorded from grab samples. Preservation is in 70% ethanol and slide mounting of parts is in Canadian balsam. The length of the body and caudal filaments of the nymphs was measured with a dissecting-scope micrometer. The length is recorded as the total observed variation (i.e., if the variation is more than 7.0 mm but less than 8.0 mm, it is recorded as 7.0-8.0 mm, and if it is more than 7.5 mm but less than 8.5 mm, it is recorded as 7.5-8.5 mm). Illustrations were prepared by the senior author with a camera lucida. Specimens are labeled R. K. Allen and C. M. Murvosh, collectors, and all specimens are deposited in the collection of the California Academy of Sciences, San Francisco, CA.

### Systematics

The families Baetidae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Tricorythidae, and Caenidae occur in Baja California.

#### Family Baetidae

Three described genera of baetids, *Baetis*, *Callibaetis*, and *Dactylobaetis*, are now known from Baja California. A fourth genus, treated as *Genus Incertae*, is described below.

#### Genus *Baetis* Leach

Moriyama and McCafferty (1979) published nymphal characters and keys for nymphs of some North American *Baetis*. Their keys were based on the work of Muller-

Liebenau (1969) for the European species. A study of the *Baetis* of Baja California reveals that there are at least two species in the springs and streams of this arid peninsula. They are described below.

#### *Baetis caelestis* n. sp.

*Mature female nymph.* Length: body 4.0-5.0 mm; caudal filaments 3.5-4.5 mm. Head light brown; antennal scapes simple, without distal lobe; maxillary palpi well-developed, extending to apex galea-lacinia; labial palpi second segment inner margin concave, median lobe well-developed; labial palpi second segment with 14-20 apical spines; labial palpi second segment slender, length twice width at base (Fig. 1). Thoracic terga brown to dark brown; thoracic sterna light brown; legs light brown, brown at apices of femora, tibiae, and tarsi; femora with long dorsal spines, without setae; tibiae and tarsi with dorsal and ventral spines, without discernible setae; claws with 8-10 denticles. Abdominal terga usually light brown; segments 2-8 usually with pale median longitudinal stripe and paired submedian dark brown maculae; gills round, with faint to barely discernible trachea; gill margins with small spines; posterior margins abdominal terga finely serrate; paraproct posterior margins with spines. Caudal filaments light brown; terminal filament 10-60% length cerci.

*Types.* Holotype: mature female nymph, Rio San Rafael, Mike's Sky Ranchero, Baja California Norte, 23-V-79.

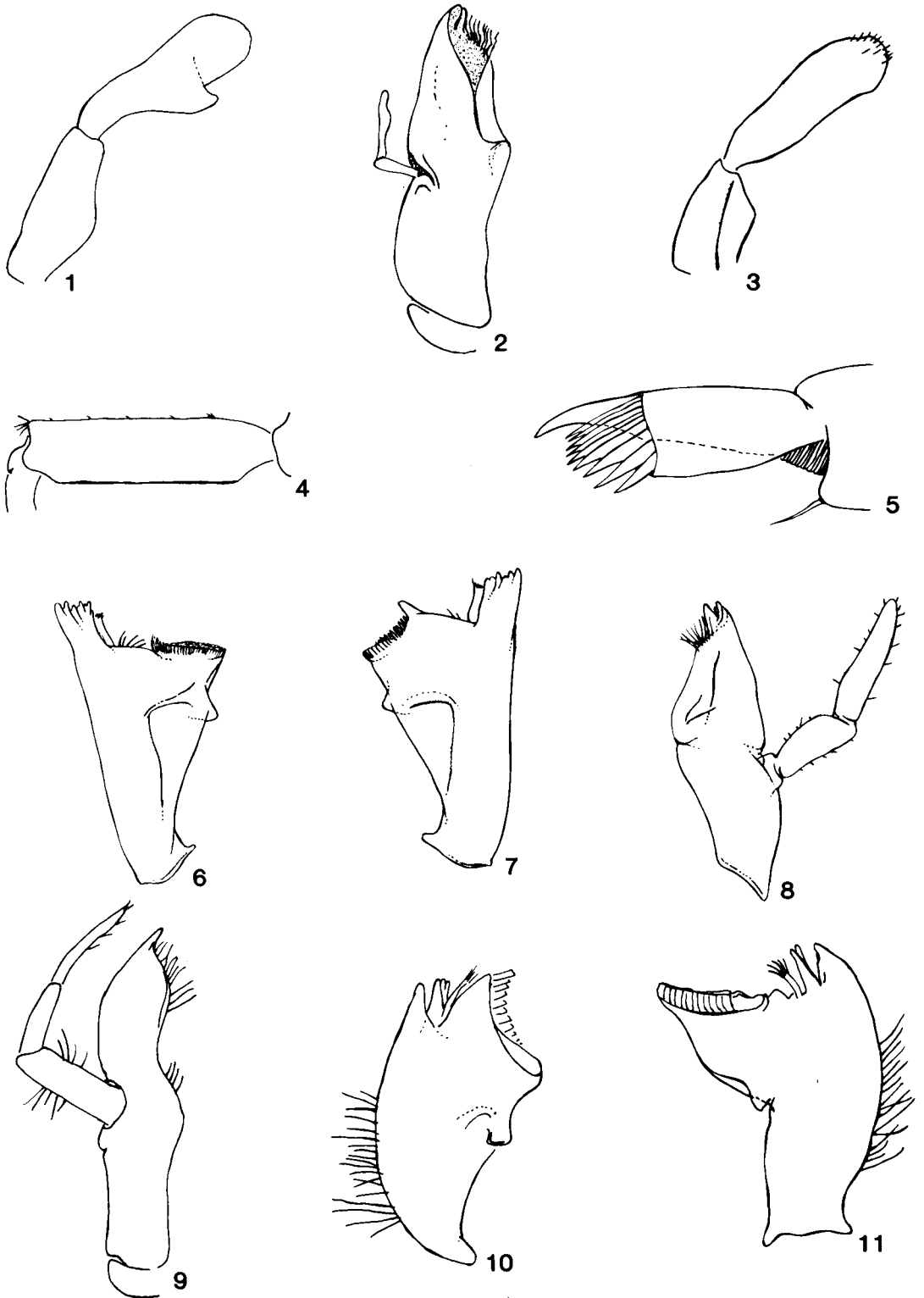
Paratopotypes: 11 female nymphs, 6 male nymphs, other data same as holotype.

Paratypes: 3 female nymphs, Rio San Carlos off Hwy. #1 N. Maneadero, Baja California Norte, 9-VI-78; 32 female nymphs, 13 male nymphs, Rio Santo Domingo, 6 mi (9.7 km) N. Colonia Guerrero, Baja California Norte, 31-V/8-VI-78; 25 female nymphs, 17 male nymphs, Rio Poza, 5.2 mi (8.4 km) W. Loreto, Baja California Sur, 26-V-79; 32 female nymphs, 22 male nymphs, Rio San Ignacio at San Ignacio, Baja California Sur, 7-VI-78; 3 female nymphs, 1 male nymph, Rio Santo Tomas, 2 mi. S. Santo Tomas, Baja California Norte, 8-VI-78 (Fig. 12).

*Remarks.* Three formally described species, *B. insignificans* McDunnough, *B. tricaudatus* Dodds and *B. quilleri* Dodds, and three which are designated with informal epithets have been reported previously from the

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FIGS. 1-11. Parts of Mayfly Nymphs. (1) *Baetis caelestis*, labial palp.

FIGS. 2-4. Genus *incertae*. (2) Maxilla; (3) labial palp; (4) femur, second leg.

FIGS. 5-8. *Dactylobaetis navis*. (5) Claw, side view; (6) right mandible; (7) left mandible; (8) maxilla.

FIGS. 9-11. *Caenis bajaensis*. (9) Maxilla; (10) left mandible; (11) right mandible.

Southwest. *Baetis insignificans* is distinguished from all southwestern species as the terminal filament is only a stub of five segments or less. *Baetis* sp. "A" Morihara and McCafferty and *Baetis* sp. "B" Morihara and McCafferty possess robust setae on the gill margins which are absent in all other species presently known from the southwest. *Baetis tricaudatus* is unique in possessing heavy setae on the abdominal sterna, and the pronotum has paired submedian bilobed maculae. The median lobe of the labial palpi of *B. quillieri* and *Baetis* sp. "C" Morihara and McCafferty is poorly developed, whereas in *B. caelestis* n. sp. and *B. byblis* n. sp. the median lobe is well developed. The formerly mentioned *B. tricaudatus* and *B. quillieri* species are further distinguished from the latter as each has a distinctive marking on the pronotum. *Baetis caelestis* n. sp. and *B. byblis* n. sp. nymphs are readily distinguished from each other by color and structural characters. The abdominal terga of *B. caelestis* have paired submedian maculae on segments 2–8, the tracheal gills possess marginal spines, and the trachea are pale to barely discernable. The abdominal terga of *B. byblis* are without dark markings, the gills are without marginal spines, and the gill trachea are black.

There is a great preponderance of female nymphs to male nymphs in both new species of Baja California *Baetis* (125 female:42 male). The nymphs of both sexes of both species are all mature, or nearly mature, and it appears that the cause of this inequity in numbers is due to the early emergence of the male subimagos.

#### *Baetis byblis* n. sp.

*Mature female nymphs.* Length: body 2.0–4.0 mm; caudal filaments 1.0–3.0 mm. Head light brown with pale markings; antennal scapes simple, without distal lobe; maxillary palpi well developed; extending beyond galea-lacinia; second segment labial palpi concave; second segment labial palpi without discernable spines; labial palpi second segment slender length twice width at base as in Fig. 1. Thoracic terga light brown with irregular pale markings; thoracic sterna pale; legs pale; femora with long dorsal and ventral spines; tarsi without spines; claws with 10–12 denticles. Abdominal terga light brown, usually with pale median longitudinal stripe; gills round, with dark trachea; gill margins without small spines; posterior margins abdominal terga distinctly serrate; posterior margin paraproct with spines. Caudal filaments pale; terminal filament 50–60% length cerci.

*Types.* Holotype: Mature female nymph, Stream 8.0 km. N. El Sauzel off Hwy. #1, Baja California Norte, 9-VI-78.

Paratopotypes: 2 female nymphs, other data same as holotype.

Paratypes: 2 female nymphs, Stream ca. 5 mi NE San Javier, Baja California Sur, 6-VI-78 (Fig. 12).

#### Genus *Callibaetis* Eaton

*Callibaetis* was erected by Eaton for *Baetis pictus* Eaton described from Texas. The other species of the genus that have been reported from the Southwest are *C. californicus* Banks from southern California, *C. pa-*

*cificus* Seemann and *C. signatus* Banks from southern California, Arizona, and New Mexico.

Two species are described below, but because reliable characters, useful in separating nymphs, have not been established for *Callibaetis* they are designated with informal epithets.

#### *Callibaetis* sp. "A"

*Mature female nymph.* Length: body 4.0–5.5 mm; caudal filaments 3.0–4.0 mm. Head pale to light brown; mouthparts typical for the genus. Thoracic nota pale to light brown, often with brown markings, especially on sutures; legs pale; femora with dorsal and ventral spines; tibiae and tarsi with ventral spines; claws with 9–12 paired denticles, denticles short near base increasing in size to apex; denticles extremely long at apex. Abdominal terga pale to light brown with brown markings; tergum 1 pale; terga 2–3 pale laterally, brown medially with pale spot on midline; terga 4–5 pale; tergum 6 pale with medioposterior brown marking; tergum 7 pale laterally, brown medially; terga 8–9 pale, washed with brown; tergum 10 pale; abdominal sterna pale. Caudal filaments pale, apices brown.

*Material.* Baja California Norte: 1 male and 8 female nymphs, Rio Santo Tomas, 2 mi S. Santo Tomas, 8-VI-78.

Baja California Sur. 2 male and 9 female nymphs, Arroyo Agua Caliente, 3 mi E. Ejido Agua Caliente off Hwy 1, 4-VI:78 (Fig. 12).

#### *Callibaetis* sp. "B"

*Mature female nymph.* Length: body 4.0–5.5 mm; caudal filaments 4.0–5.0 mm. Head light brown to brown with dotlike pale spots; mouthparts typical for the genus. Thoracic nota pale to brown; pronotum pale laterally with small sublateral dark spots and brown medially; legs unicolorous light brown; femora with dorsal and ventral spines; tibiae and tarsi with ventral spines; claws with 8–10 paired denticles, denticles short near base increasing in size to apex; denticles extremely long at apex. Abdominal terga brown, often with dark brown transverse mark on posterior margins terga 6–8; terga 2–8 with pale paired longitudinal pale line mesad to gills; terga 9–10 brown; sterna pale; sterna 4–8 with median light brown macula. Caudal filaments brown, darker at apices.

*Material.* Baja California Norte: 2 female nymphs, Rio Santo Tomas, 2 mi. S. Santo Tomas, 8-VI-78.

Baja California Sur: 3 female nymphs, Rio Poza, ca. 10 mi W. Loreto on Rd. to San Javier, 6-VI-78; 1 female nymph, Spring at San Javier 6-VI-78 (Fig. 12).

*Remarks.* *Callibaetis* spp. "A" and "B" nymphs are readily distinguishable from each other, and all other described *Callibaetis* nymphs, by the coloration of the abdominal terga and the caudal filaments. Both nymphs may eventually be found to be the immature stage of described southwestern species now known only from the male imago.

#### Genus *Incertae*

*Mature male nymph.* Length: body 2.5–4.0 mm; cau-

dal filaments 1.0–2.0 mm. Head brown; labrum with deep median notch; labrum with spines on lateral and anterior margins; maxillary palpi atrophied (Fig. 2); maxillae with 2 prominent teeth and row spines as in Fig. 2; labial palpi apical segment round at apices (Fig. 3). Pronotum brown with pale posterior paired submedian and sublateral pale maculae mesonotum with median paired oblique submedian pale streaks; metanotum without wing pads; legs light brown; femora with 5–10 dorsal spines and 1–3 prominent spines at apices (Fig. 4); tibiae and tarsi with 10–20 ventral spines; claws without denticles; claws long and slender, 30–35% as long as tarsi, Abdominal terga light brown; terga 2–7 with posterior transverse brown macula; terga 8–9 light brown; tergum 10 brown; abdominal sterna brown; sterna 4–7 with darker posterior margins; abdominal terga 9–10 with small marginal spines; gills obconic with prominent trachea; trachea mostly on mesad portion of gills. Caudal filaments light brown, apices darker; terminal filament subequal to cerci.

**Material.** Baja California Sur: 1 male, 18 female nymphs, Arroyo Agua Caliente, 3 mi E. Ejido Agua Caliente off Hwy. #1, 4-VI-78; 2 male, 5 female nymphs, Rio Poza, CA. 10 mi SW Loreto, on Rd. To San Javier, 4-VI:78 (Fig. 12).

**Remarks.** In the key to the genera in Edmunds et al., (1976) these nymphs key to an impass at couplet 42. Their claws are long, but much less than 50% as long as their tarsi. They differ from all known described genera of Baetidae by the following combination of characters: 1) without wing pads; 2) labial palpi are round at apices and without a median lobe (Fig. 3); 3) claws are long and slender, without denticles, and 30–35% as long as tarsi; 4) abdominal terga without postero-lateral projections; 5) maxillary palpi atrophied (Fig. 2); 6) maxillae with 2 prominent teeth and row of spines (Fig. 2); and 7) terminal filament subequal to cerci.

#### Genus *Dactylobaetis* Traver and Edmunds

Four species of *Dactylobaetis* are currently known from the Southwest. *D. navis* Allen and Chao is known from New Mexico and Baja California; *D. salinus* Allen and Chao is known from Arizona; *D. trivialis* Allen and Chao is known from Arizona and New Mexico; and *D. mexicanus* Traver and Edmunds is known from central Texas and Mexico.

#### *Dactylobaetis navis* Allen and Chao

This species has a moderately wide latitudinal distribution in western North America from southern Utah (37°06' north latitude) in the Middle North Temperate Zone to Southern Baja California Sur (26°00' north latitude) near the upper limits of the Lower North Temperate Zone (Fig. 12).

**Mature male nymph.** Length: body 5.0–7.0 mm; caudal filaments 1.0–2.0 mm. General color pale with brown markings. Head brown, vertex pale; mandibles of the compacted type, grade II (Figs. 6 and 7); maxilla the subequal type, palpi type I (Fig 8); labium *warreni* type. Thoracic nota light brown with irregular brown markings; legs pale with brown markings; femora pale with

median longitudinal brown stripe, brown at apices and dorsal margins; tibiae pale; tarsi pale, apices brown; tibiae-tarsi with 12–14 spines; claws with 8–9 denticles of the *warreni* type (Fig. 5). Abdominal terga pale with brown markings; terga 2–7 with transverse inverted U-shaped marking, often absent on tergum 4; terga 8–10 with brown submedian open V-shaped markings; abdominal gills pale, trachea dark, gills with dorsal chitinized band; abdominal sterna pale. Caudal filaments light brown.

**New records.** Baja California Sur: 16 male and 14 female nymphs, Rio Calamajue, 14 mi. (22.5 km) E. Hwy #1 at El crucero, N. Hwy. #1 Bahia de Los Angeles, 25-V-79; 1 male and 3 female nymphs, Rio San Jorge at mouth San Jorge Canyon, 6 mi (9.7 km) NW Santiago off Hwy. #1, 4-VI-78; 1 male and 2 female nymphs, Rio San Ignacio at San Ignacio, 7-VI-78.

#### Genus *Iron* Eaton

Four species of *Iron* are known from the Southwest. *Iron margarita* (Edmunds and Allen) is known from Arizona and Baja California; *I. longimanus* Eaton and *I. deceptivus* McDunnough are known from Arizona and New Mexico; and *I. albertae* McDunnough is known from northern New Mexico.

#### *Iron margarita* (Edmunds and Allen)

The following records of this species increases the known latitudinal distribution from central Arizona (ca. 35°00' north latitude) in the Middle North Temperate Zone to northern Baja California Sur (26°00' north latitude) near the upper limits of the Lower North Temperate Zone (Fig. 12).

**New records.** Baja California Norte: 2 male nymphs, Rio San Rafael, Mike's Sky Ranchero, 3-V-78.

Baja California Sur: Rio Poza, 5.2 mi (8.4 km) E. Loreto, 26-V-79.

**Remarks.** *Iron margarita* occurs with *Baetis caelestis* n. sp., *Callibaetis* sp. "B", Genus *incertae*, *Choroterpes* (*C.*) *inornata*, *Serratella micheneri*, *Drunella* (*m.*) *flavilinea*, *Tricorythodes explicatus* and *Caenis bajaensis* n. sp. Nymphs were collected from streams with a water temperature between 17°–23°C and at elevations between 680–4, 750 feet (207–1448 m). The pH of the water in the Rio San Rafael was 7.8.

#### Family Leptophlebiidae

#### Genus *Choroterpes* Eaton

*Choroterpes* (*C.*) *inornata* Eaton was described from northern Sonora and Arizona and has been reported from Colorado, New Mexico and Baja California; *C.* (*C.*) *territoma* Seemann was described from southern California; *C.* (*C.*) *nanita* Traver and *C.* (*C.*) *oklahoma* were described from Texas and Oklahoma, respectively. *Choroterpes* (*Neochoroterpes*) *mexicana* Allen was described from Mexico and Texas; *C.* (*N.*) *kossi* Allen was described from Texas and Arizona; and *E.* (*N.*) *crocatus* Allen was described from Texas.

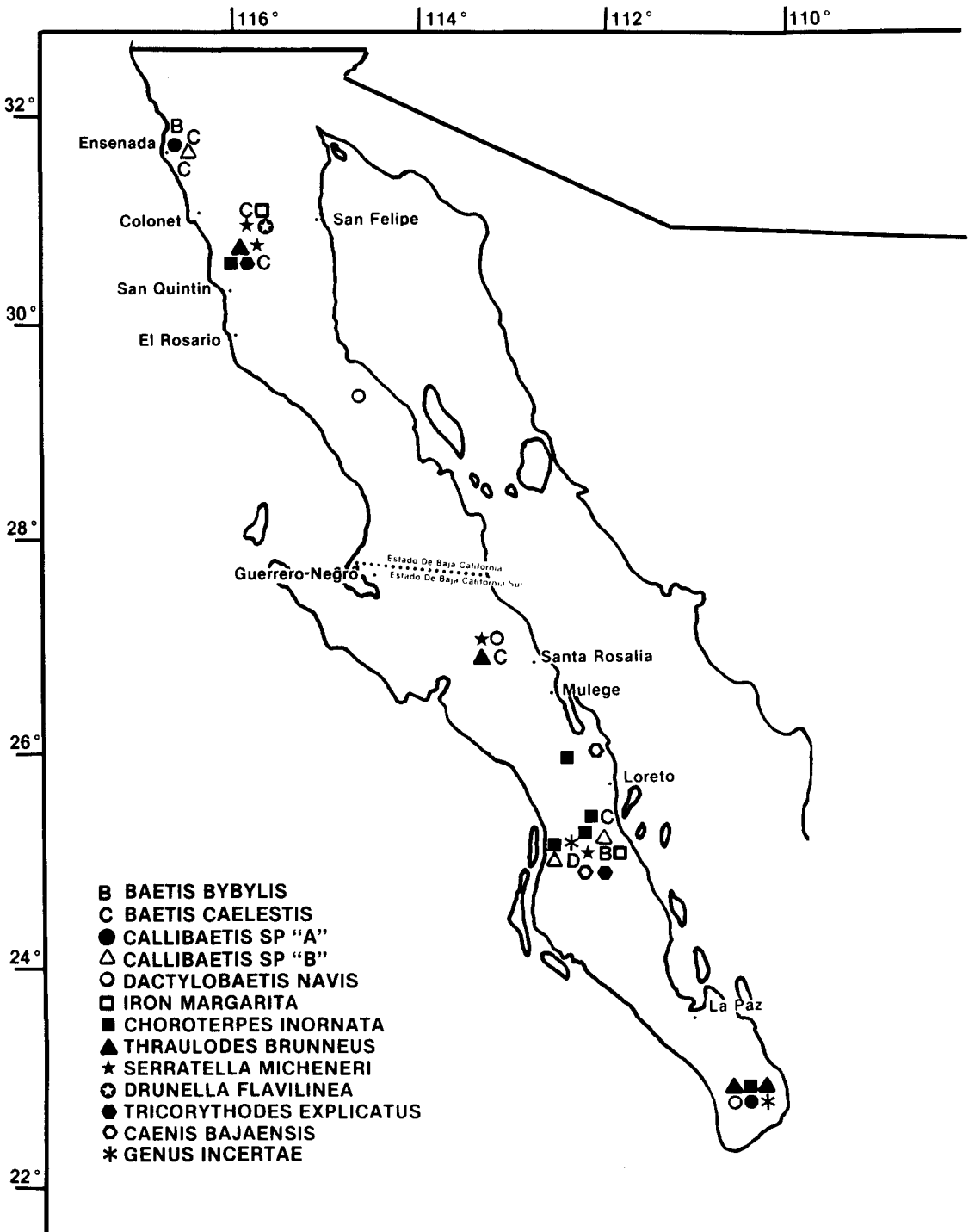


FIG. 12. Distribution of mayflies of Baja California.

***Choroterpes (Choroterpes) inornata* Eaton**

This species has a moderately wide latitudinal distribution in western North America as it is known from

southern Colorado (36°16' north latitude) in the Middle North Temperate Zone to northern Baja California Sur (26°00' north latitude) near the upper limits of the Lower North Temperate Zone (Fig. 14).

*New records.* Baja California Norte: 2 female nymphs, Rio Santo Domingo, 6 mi (9.7 km) N. Colonia Guerrero, 31-V-78.

Baja California Sur: 2 female nymphs, Rio Poza, 5.2 mi (8.4 km) SW Loreto, Rd. to San Javier, 6-VI-78; 21 male and 42 female nymphs, Rio Poza, 5.2 mi (8.4 km) SW Loreto, Rd. to San Javier, 26-V-79; 17 male and 37 female nymphs, stream on Rd. to San Miguel Comondu, 26-V-79; 1 male and 1 female nymphs, Rio Agua Caliente, 3 mi (4.8 km) E. Ejido Agua Caliente, off Hwy. #1, 4-VI-78; 5 male and 12 female nymphs, Stream ca. 5 mi (8 km) NE San Javier, 6-VI-78; 1 male and 1 female nymphs, spring at San Javier, 6-VI-78.

*Remarks.* *C. inornata* has been collected from five different localities in Baja California (Fig. 12). Nymphs were collected in water between 18°–27°C and at elevations between 100–1,440 feet (30–134 m).

### Genus *Thraulodes* Ulmer

*Thraulodes arizonicus* McDunnough, *T. salinus* Kilgor and Allen and *T. speciosus* Traver are known only from Arizona; *T. brunneus* is known from Arizona, New Mexico and Baja California; and *T. gonzalesi* Traver and Edmunds is known from Texas.

### *Thraulodes brunneus* Koss

*T. brunneus* has a rather narrow latitudinal distribution from central Arizona (34°35' north latitude) in the Middle North Temperate Zone to near the tip of the Baja California Peninsula (23°50' north latitude) in the Lower North Temperate Zone (Fig. 12).

*New records.* Baja California Norte: 3 female nymphs, Rio Santo Domingo, 6 mi (9.7 km) N. Colonia Guerrero 31-V/8-VI-78.

Baja California Sur: 7 male and 15 female nymphs, Rio Agua Caliente, 3 mi (4.8 km) E. Ejido Agua Caliente, off Hwy. #1, 4-VI-78; 1 male and 1 female nymphs, Rio San Ignacio at San Ignacio, 7-VI-78; 11 male and 35 female nymphs, Rio San Jorge at mouth San Jorge Canyon, 6 mi (9.7 km) SW Santiago off Hwy. #1, 4-VI-78.

*Remarks.* It appears the nymphs of this species are restricted to habitats with a narrow temperature range, as they have been collected from streams with temperatures between only 25°–27°C. The streams were at elevations between 100–600 feet (30–183 m).

### Family Ephemerellidae

### Genus *Serratella* Edmunds

Three species of *Serratella* have been reported from the Southwest. *S. tibialis* (McDunnough) is known from southern California, Arizona, and New Mexico; *S. tersa* (Traver) is known from southern California; and *S. micheneri* (Traver) is known from southern California, Arizona, New Mexico, northern Mexico, and Baja California.

### *Serratella micheneri* (Traver)

The latitudinal range of this species in western North America is from central Washington (46°40' north lat-

itude) in the Upper North Temperate Zone to central Baja California Sur (26°00' north latitude) near the upper limits of the Lower North Temperate Zone (Fig. 13)

*New records.* Baja California Norte: 3 male and 15 female nymphs, Rio San Rafael, Mike's Sky Ranchero, 31-V-78; 7 male and 8 female nymphs, Rio Santo Domingo, 6 mi (9.7 km) N. Colonia Guerrero, 31-V/8-VI-78.

Baja California Sur: 4 female nymphs, Rio Poza, 5.2 mi (8.4 km) SW Loreto, 26-V-79; 2 female nymphs, Rio San Ignacio at San Ignacio, 7-VI-78.

*Remarks.* *S. micheneri* nymphs exist in streams with broad latitudinal and temperature range in Baja California. They have been collected in waters with temperatures between 17°–26°C, and at elevations between 100–4,750 feet (30–1,448 m).

### *Drunella (Myllonella) flavilinea* (McDunnough)

This species has one of the widest latitudinal distributions of all Baja California mayflies. It is known from Alberta and British Columbia, Canada (ca. 49°00' north latitude) in the Upper North Temperate Zone to northern Baja California (ca. 30°50' north latitude) in the Middle North Temperate Zone (Fig. 14).

*New record.* Baja California Norte: 28 male and 37 female nymphs, Rio San Rafael, Mike's Sky Ranchero, 31-V-78, 23-V-79 (Fig. 12).

*Remarks.* Nymphs of *D. flavilinea* occur with *S. micheneri* and *I. margarita* in the Rio San Rafael. The water temperature in the river was 17°C in 1978 and 22°C in 1979. The pH both years was 7.8.

### Family Tricorythidae

### *Tricorythodes explicatus* (Eaton)

This species has a narrow latitudinal distribution. It is known from northern New Mexico (36°28' north latitude) in the Middle North Temperate Zone to south-central Baja California Sur (26°00' north latitude) near the upper limits of the Lower North Temperate Zone (Fig. 12).

*New records.* Baja California Norte: 2 female nymphs, Rio Santo Domingo, 6 mi (9.7 km) N. Colonia Guerrero, 3-V-78.

Baja California Sur: 2 female nymphs, Rio Poza, 5.2 mi (8.4 km) SW Loreto, Rd. to San Javier, 6-V-78, 26-V-79.

Additional new records of *T. explicatus* are in the senior author's collection and because they constitute broad range extensions it seems useful to publish them now as follows:

*Mexico.* Chihuahua: Rio Papaquchic, 4 km E. Ciudad Guerro on Hwy. #16, 13-VIII-77, R. K. Allen; Stream 8 km S. Colonia Alvera Obregon on Hwy. #28, 13-VIII-77, R. K. Allen; Rio Satevo at Gral Trias on Hwy. #16, 13-VIII-77, R. K. Allen; Rio San Pedro at Meoqui on Hwy. #45, 14-VIII-77, R. K. Allen.

*Sonora.* Rio de Bavispe, 64 mi (103 km) SSE Aqua Prieta (30°46' north, 109°05' west), 9-IV-72, V. Roth.

*New Mexico.* Dona Ana Co. Trib. Rio Grande at Carralillo Dam, 11-VIII-77, R. K. Allen.

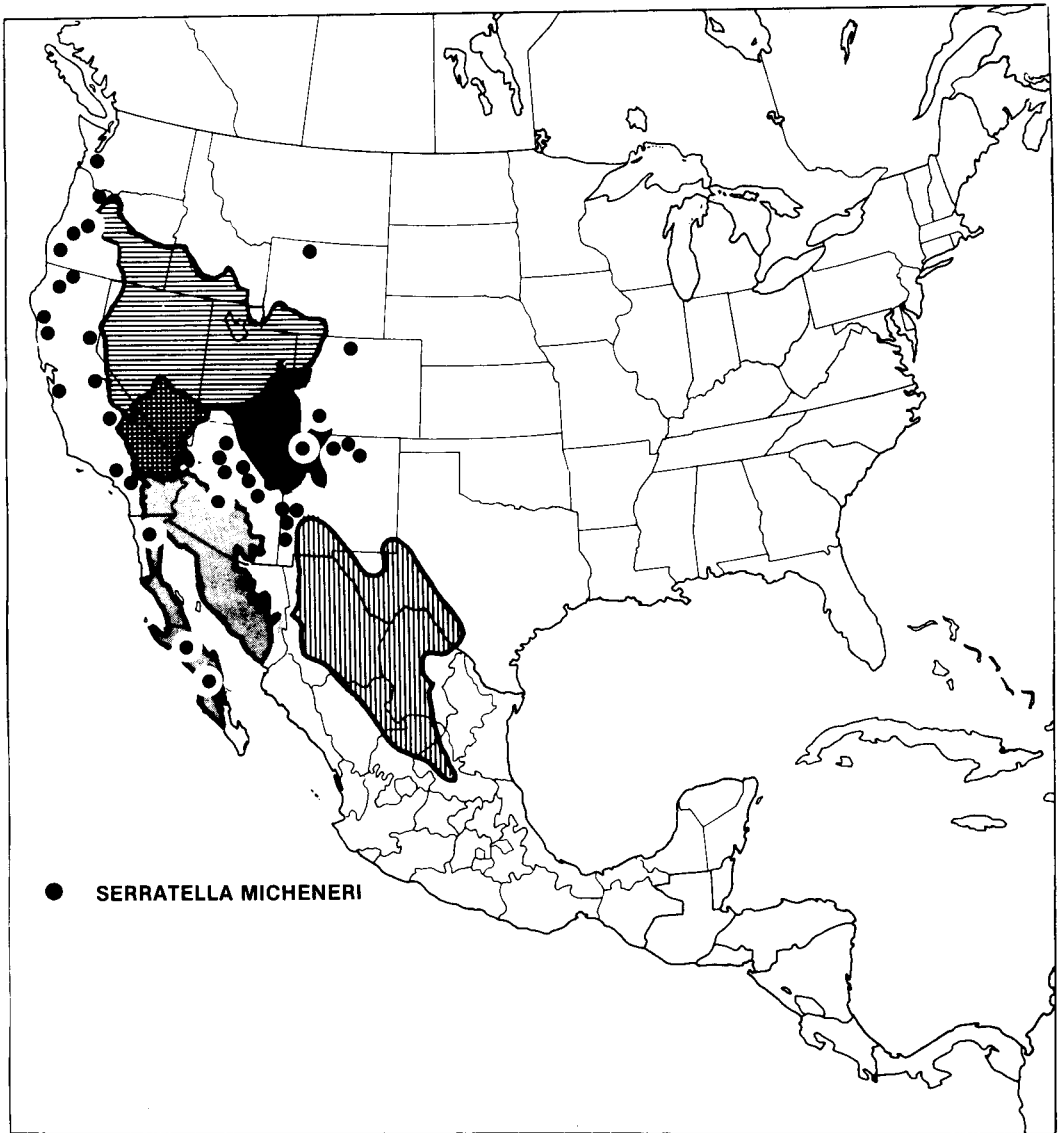


FIG. 13. Distribution of *Serratella micheneri* and desert areas of western North America and Mexico.

*Remarks.* In Baja California, nymphs were collected in water with temperatures between 18°–24°C, and at elevations between 100–600 feet (30–183 m).

*Family Caenidae*

**Genus *Caenis* Stephens**

*Caenis* has not been reported from Mexico prior to this report and the specimens collected in southern Baja California Sur constitute an undescribed species which is described below.

***Caenis bajaensis* n. sp.**

*Mature female nymph.* Length: body 4.0–5.0 mm; caudal filaments 2.5–3.5 mm. General color pale to light brown with brown markings. Head light brown, dark

transverse band between compound eyes and ocelli; antennae pale; maxilla delicate; maxillary palpi well developed and with segmental spines (Fig. 9); mandibles as in Figs. 10 and 11. Thoracic nota light brown with dark brown markings; pronotum light brown often with medium brown macula; mesonotum light brown often with paired small anteromedian dark lines and paired anterolateral dark maculae; legs pale; trochanters, femora, tibiae, and tarsi with long spine-like setae; femora with transverse band of setae on anterior surface near proximal end; tibiae and tarsi with longitudinal band of spines on inner margin; claws without denticles. Abdominal terga pale; terga 3–6 washed with brown in median area under gills, margins pale; anterior portion tergum 7 washed with brown in median area under gills, posterior portion and margins pale; abdominal segments

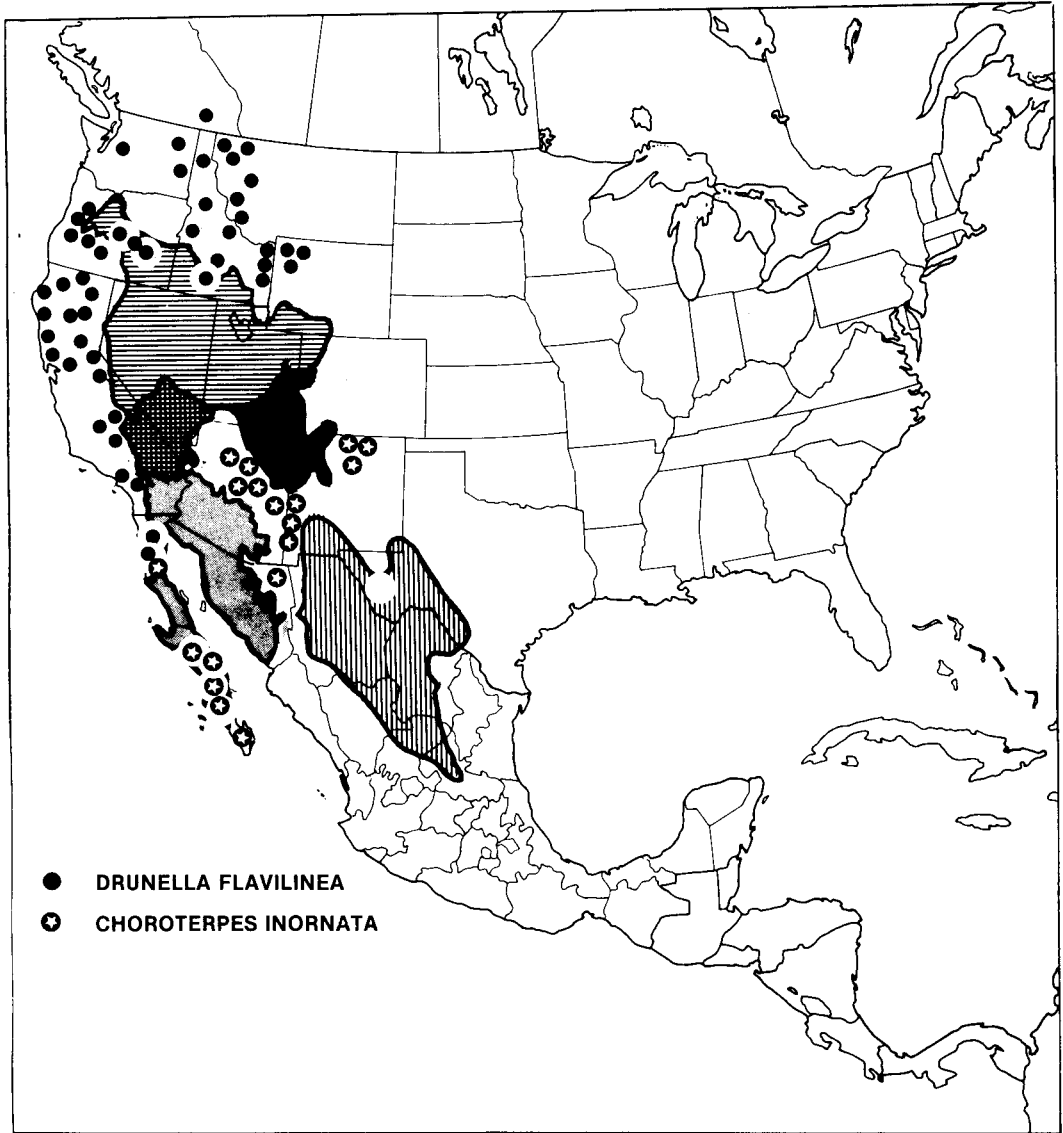


FIG. 14. Distribution of *Drunella flavilinea* and *Choroterpes inornata* and desert areas of western North America and Mexico.

3-9 with row spine-like setae on outer margins. Caudal filaments pale.

*Types.* Holotype: mature female nymph, Stream, Rd. to Comondu, Baja California Sur, 26-V-79.

*Paratopotypes:* 5 female nymphs, same data and deposition as holotype.

*Paratype:* immature female nymph, Rio Poza, 5.2 mi (8.4 km) SW Loreto, Rd. to San Javier, Baja California Sur (Fig. 12).

*Remarks.* *Caenis bajaensis* is the only species of the genus known from the Southwest. *Caenis delicata* Traver was described from Oklahoma. Specimens assigned as this species by the senior author from Texas were compared with *C. bajaensis*. The nymphs were found to be very different, and they are easily distinguishable from each other. *Caenis simulans* McDunnough is a northern

North American species that is known to occur only as far south as northern Utah. The senior author has an undescribed *Caenis* from Southern California.

#### Zoogeography

The mayfly fauna of Baja California is diverse in origin as six of the thirteen known species appear to be endemic, the genera of three species are of boreal origin and the genera of four are of austral origin.

Endemism is high among the mayflies as almost half of the known species appear to be completely confined to the peninsula. The nymphs herein reported as Genus *Incertae* have not been reported from other parts of western North America or Mexico and the genus and the species appear to be endemic. The nymphal taxonomy of *Callibaetis* is unknown and the assumption that



*Callibaetis* sp. "A" and sp. "B" are endemic is only that. *Baetis caelestis* n. sp., *B. byblis* n. sp., and *Caenis bajaensis* n. sp. are almost certainly endemic to Baja California.

*Serratella*, *Drunella*, and *Iron* are boreal in origin. *S. micheneri* has two allopatric populations. A coastal population in western Washington and Oregon to southern California and Baja California, and an inland population in Wyoming, central Colorado, Arizona and New Mexico and Arizona (Fig. 13). These populations appear to be geographically isolated by the Great Basin to the north, the Mojave Desert in California and Nevada, and the Sonoran Desert to the south. The presence of isolated populations in the Painted Desert in southern Colorado, Arizona, and New Mexico, and in the Sonoran Desert in Arizona and Baja California, suggests that the species was in western North America before the desert formed (Fig. 13). *Drunella flavilinea* occurs in British Columbia and Alberta, Canada, Washington, Idaho, Montana, northern Wyoming, Oregon, to southern California and Baja California (Fig. 14). It appears that the western North American deserts, especially the Great Basin (and the Columbia Plateau) have restricted the distribution of this species, as there is suitable habitat, at the present time, for nymphs in Utah and central Arizona and New Mexico. The genus *Iron* is unquestionably boreal in origin. It is known from central Alberta and Saskatchewan, Canada to Arizona and New Mexico, and has a disjunct distribution from central Mexico to Panama. Three species of *Iron*, *I. albertae*, *I. deceptivus*, and *I. longimanus*, are widely distributed in western North America from southern Canada to Arizona and New Mexico, but none of the three have been collected in Baja California. *I. margarita* is known only from Arizona and Baja California; because it is closely related to *E. albertae* it is assumed that they had a common ancestor.

*Choroterpes*, *Dactylobaetis*, *Thraulodes*, and *Tricorythodes* are of austral origin. *Choroterpes* (*Choroterpes*) *inornata* is known from central Colorado, eastern Arizona and western New Mexico, Baja California and northern Sonora, Mexico (Fig. 14). *Choroterpes* (*Neochoroterpes*) *kossi* occurs in central Arizona and western Texas and these species of *Choroterpes* are completely allopatric. This is also true of the species of the two subgenera in Oklahoma, central Texas and Mexico. *C. (C.) oklahoma* occurs north of the known range of *C. (N.) mexicana* and *C. (N.) crocatus* which is in central Texas and Mexico; *C. (C.) naniata* occurs east of the range of the *Neochoroterpes* species in eastern Texas; and *C. (C.) oaxacaensis* Brusca and Allen occurs south of the known distribution of *Neochoroterpes* in southern Mexico (Allen 1974: Map 1). *Dactylobaetis navis* superficially appears to be most closely related to *D. mexicanus* Traver and Edmunds, described from Mexico, and reported recently from Texas. *Thraulodes brunneus* and *T. speciosus* belong to the *brunneus* group of Allen and Brusca (1978) and since the nymphs appear to be closely related it is assumed that they had a common ancestor. The other species known from the Southwest, *T. salinus* belongs to the *gonzalesi* group and

appears to be closely related to *T. gonzalesi* Traver known from Texas and northern Mexico. *Tricorythodes explicatus* and *T. minutus* belong to the *albilineatus* group of Allen (1977a), and since the nymphs and male imagoes of these species appear to be closely related it is assumed that they had a common ancestor. The presence of isolated populations in the Sonoran and Chihuahuan Deserts suggests that *T. explicatus* was in western North America before desertization. *Dactylobaetis navis* also appears to have been present in western North America before desertization. The species was described from within the Painted Desert (Shiprock, New Mexico) and is herein reported from the Sonoran Desert in Baja California.

In conclusion, the species of *Baetis*, *Callibaetis*, and *Caenis* are considered to be endemic to Baja California. These genera are widely distributed in the New World, from Canada and Alaska to South America. It is impossible at this time to ascertain whether they are austral or boreal in origin. The genera *Serratella*, *Drunella* and *Iron* are widely distributed in northern North America and certainly are boreal in origin. *Serratella micheneri* and *D. flavilinea* are distributed widely in western North America, whereas *I. margarita* is restricted to the Southwest. The species of the genera of austral origin, *C. inornata*, *D. navis*, *T. brunneus* and *T. explicatus*, all have narrow latitudinal distributions from southern Colorado to Baja California. The relationship of the Baja California species is therefore, unquestionably with species from the Southwest to the north and not with Mexican species to the south.

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