California Fish and Game 99(4):176-192; 2013

Checklist of inland aquatic Isopoda (Crustacea: Malacostraca) of California

G. O. Graening* and D. Christopher Rogers

Department of Biological Sciences, California State University, Sacramento, 6000 J Street, Sacramento, CA 95819, USA (GOG)

Kansas Biological Survey and Kansas Natural History Museum (Biodiversity Institute), University of Kansas, Higuchi Hall, 2101 Constant Avenue, Lawrence, KS 66047, USA (DCR)

**Correspondent: graening@csus.edu*

We present the first comprehensive checklist of Isopoda in Californian inland waters. Isopod distribution records were based upon a thorough literature review, unpublished data of colleagues, and collections of the authors. We present 17 species in 12 genera and 7 families, with additional potentially new taxa awaiting formal description. Six species are exotic and five species are California endemics. At least four of the native species are subterranean obligates. Conservation status rank revisions are offered in order to update the California Natural Diversity Database and IUCN Red List.

Key words: biodiversity, conservation, endemic, estuarine, freshwater, invasive species, stygobiont

---

Aquatic isopods, commonly known as water slaters or aquatic pill bugs, are conspicuous components of aquatic biodiversity and function as important links in aquatic foodwebs by processing detritus and serve as an important dietary component for many predators (Vainola et al. 2008, Rogers et al. 2010). Assembled here for the first time is a comprehensive checklist of the stenohaline, freshwater inland isopod crustaceans of California. Although the marine fauna is not considered here, California hosts a diverse marine assemblage of approximately 190 named species from thirty-six families in eight suborders (see Brusca et al. 2010). The lack of a swimming phase may limit dispersal in the nonparasitic taxa and may explain high levels of isopod endemism (Brusca et al. 2010).

For a checklist limited to freshwater habitats, transitional habitats such as littoral, estuarine, and dunal ponds constitute problematic ecotones, and euryhaline taxa challenge the ability to separate freshwater (less than 500 ppm dissolved salts) from marine. Lake Merced on the San Franciscan peninsula, for example, has a diverse malacostracan assemblage tolerant of brackish water, where two amphipods (*Americorophium spinicorne*

[Stimpson, 1857] and *Hyalella* sp.), two isopods (*Caecidotea tomalensis*, *Gnorimosphaeroma oregonensis*), and a mysid shrimp (*Neomysis mercedis* Holmes, 1896) are sympatric (Miller 1958, White 2005). Likewise, California terrestrial isopods, including semi-aquatic forms such as *Ligidium* and *Ligia* (Ligiidae), are not considered here, nor are symbionts such as the commensal isopod *Phyllodurus abdominalis* Stimpson, 1857, which attaches to mud shrimps (*Upogebia* and *Callianassa*) (MacGinitie 1935). See Miller (1938) and Muchmore (1990) for a general summary of terrestrial isopoda.

Methods

We conducted an exhaustive literature review and examined private collections and gray literature for occurrences reported from Californian freshwaters. The following sources were consulted: California Academy of Sciences (CAS) Department of Invertebrate Zoology and Geology's Invertebrate Collection Catalog Database; California Department of Fish and Wildlife's (CDFW) Natural Diversity Database (CDFW 2011); CDFW's Aquatic Bioassessment Laboratory (ABL) database, which includes data from the State Water Board's Surface Water Ambient Monitoring Program, US Environmental Protection Agency's Environmental Monitoring and Assessment Program, and regional agency and citizen monitoring programs; California Department of Water Resources' (CDWR) Bay Delta and Tributaries Project, Interagency Information Systems Services Office and Bay-Delta Monitoring and Analysis Section (CDWR 2010); Sierra Nevada Aquatic Research Laboratory (SNARL); unpublished data of the Southwestern Association of Freshwater Invertebrate Taxonomists and of C. Barr and W. Shepard (Essig Museum of Entomology); University of California at Davis Bohart Museum of Entomology (BME); the United States Geologic Survey (USGS) Nonindigenous Aquatic Species Database (USGS 2010); and the collections database of the National Museum of Natural History, Smithsonian Institution (NMNH) as well as NMNH's World List of Marine, Freshwater and Terrestrial Isopod Crustaceans (Internet database available from: http://invertebrates.si.edu/Isopod/about.html).

All records not directly attributed to others are new records of the authors. Many of the specimens referenced in this checklist are, or will be, deposited in CAS or NMNH. Taxonomic keys consulted included Williams (1972), Iverson (1982), Smith (2001), Rogers (2005), Lewis (2009a), Carlton (2007), and Rogers et al. (2010).

Any aquatic species not found in strictly marine habitats were included in this checklist. Exotic and naturalized taxa are identified and ecological associations mentioned where known. Of special interest were the cold stenotherms that rely upon groundwater and display high specialization (i.e. troglomorphy) and narrow endemism (Figure 1) (Rogers et al. 2010). The term *stygobiont* was used for cavernicoles that are limited to, or adapted to, subterranean streams, while *phreatobiont* was applied to taxa occupying phreatic zones (or *nappe phréatique*), and are accessible only by sampling springs, seeps, wells, and bore holes, but not normally caves (Motas and Serban 1965, Holsinger 1967). This speleological term should not be equated with the phylogenetic term *phreatoicidean*, although there is some overlap in functional group and niche (see Wilson and Keable 2001). Lotic interstitial habitats, or hyporheos, are typically separated from these subterranean (or hypogean) classifications because interaction with surface waters introduces nutrient pulses, predators, and temperature fluctuations not typically experienced in subterranean habitats.

Troglomorphic isopods typically associated with hypogean streams may be found in epigean streams, either from accidental displacement from the subterranean environment,

or because the epigean stream functions as an extension of the subterranean environment. This is especially so where the epigean stream is influenced by groundwater and creates analogous habitat (e.g. rheocrene, hyporheos) (Barr 1960, Minckley 1961).

Results

Family ASELLIDAE Latreille, 1802

***Asellus hilgendorfii* Bouvallius, 1886** (exotic)

Records.—**Contra Costa, Sacramento, San Joaquin, and Solano counties**. Sacramento River-San Joaquin River Delta: Sacramento River, Sherman Lake, Frank's Tract, Old River, 53 sampling events from 1978 to 2006, over 300 specimens, collection by ponar grab (CDWR database); Mandeville Island, Mildred Island, and Venice Cut, 1998 (Toft 2000, Toft et al. 2002). **Contra Costa Co**. Pittsburgh Freshwater Marsh at Dow Chemical Plant, D. C. Rogers, 24 February 1998.

Comments.— Introduced into the Delta probably by ballast discharge, but native to Asia (Magniez and Toft 2000, Toft et al. 2002, Schotte et al. 2009). The palearctic genus *Asellus* is not currently known from North America except for one species—*Asellus alaskensis* Bowman and Holmquist, 1975—endemic to Alaska (Bowman 1975a, Lewis 2009b).

***Bowmanasellus sequoiae* (Bowman, 1975)** (stygobiont)

Records and Comments.—**Tulare Co.** Lilburn Cave, type specimens collected by S. Shimek and P. Hara on 13 October 1974, described as *Caecidotea sequoiae* by Bowman (1975b), and confirmed as still present by Krejca (2006); additional Sequoia National Park sites discovered by J. Krejca et al. during 2003–2004 — Big Spring Cave, Crystal Cave, Hurricane Crawl Cave. Endemic to karst aquifers in Sequoia National Park (Krejca 2006, Lewis 2008).

***Caecidotea communis* (Say, 1818)** (exotic)

Records.—**Alameda Co.** "Berkeley, Court Pond, Life Sciences Building on U. of California Campus", 2 and 14 December 1994, 23 specimens, C. Hand and W. Burbank (NMNH database). **Marin Co.** "Tomales Bay, Paper Mill", 10 specimens (NMNH database).

Comments.—Introduced into the Pacific Northwest (California, Colorado, Oregon, Idaho, Washington, British Columbia), but native to eastern North America east of the Continental Divide (Richardson 1905, Mackin and Hubricht 1938, Hatch 1947, Williams 1970, 1972; Bowman 1975b, Robison and Schram 1987, Sovell and Guralnick 2005, Graening et al. 2007 2012a).

***Caecidotea occidentalis* (Williams, 1970)** (epigean)

Records.—**Humboldt Co.** Fern Lake outfall, 29 October 2006. J. Lee [det. D. C. Rogers]. **Lassen Co.** "drowned spring", near town of Karlo, 27 August 1979, L. Eng and J. Landye (CAS) [det. A. Baldinger]. East shore of Eagle Lake at elevation of 5,113 feet, 1 male, 3 ovigerous females (CAS) [det. J. Lewis]; Eagle Lake at Pelican Point, 21 May 1988, D. C. Rogers.

The following records are from D. C. Rogers' unpublished data and the ABL database from benthic sampling from 2002 to 2010, and may represent a significant range extension of this species: **Fresno Co**. San Joaquin and Kings River Canal. **Humboldt Co.** Bear Canyon, end of Bear Canyon Road, upstream of Eel River; Cooper Canyon Creek above Myrtle Ave.; South Fork Eel River, above Briceland Bridge. **Lake Co.** Bear Creek about 1.5 miles above Rice Fork Creek; Rice Fork Creek below Bear Creek. **Lassen Co.** Ash Creek W.A.; Lower Willow Creek. **Mendocino Co.** Navarro River about 0.7 miles below Indian Creek. **Merced Co**. El Capitan Canal. **Monterey Co.** Little Sur River above dam impoundment. **Napa Co**. Pickle Creek about 2.5 miles above Redwood Rd. **San Joaquin Co.** Port of Stockton. **Santa Clara Co.** Chestnut Picnic Area; Guadalupe Creek above reservoir; Los Gatos Creek below reservoir. **Santa Cruz Co.** San Lorenzo River at Crossing Street. **Shasta Co.** Pit River County Route 404, at Pittville; Sacramento River at Redding, north of Highway 44, 21 July 1990, D. C. Rogers; Sacramento River at Anderson River Park, 1 August 1992, D. C. Rogers; Cow Creek at Palo Cedro, just below Old Highway 44 Bridge, 6 June 1988, D. C. Rogers; Clear Creek above Seltzer Dam, 20 June 1991, D. C. Rogers; Battle Creek below Coleman Fish Hatchery, 26 May 1988, D. C. Rogers; Dog Creek, Old Shasta, 16 April 1989, D. C. Rogers. **Siskiyou Co**. Mt Shasta City Park, headwaters of the Sacramento River, 19 June 1994, D. C. Rogers. **Solano Co**. Putah Creek, below Monticello Dam, 8 September 1999, D. C. Rogers. **Sonoma Co.** Mark West Creek. **Stanislaus Co**. Orestimba Creek above Morris Rd; Orestimba Creek above Orestimba Rd.; Tuolumne River at Roberts Ferry. **Tehama Co**. Big Chico Creek at Chico State University, 5 April 1992, D. C. Rogers; Sacramento River at Dog Island, 12 June 1994, D. C. Rogers. **Trinity Co**. Brown's Creek, north of Sugar Loaf Peak, Brown's Creek Road, 2 July 1991, D. C. Rogers **Tuolumne Co.** Woods Creek below Hwy 49.

Comments.—*C. occidentalis* is also known from Oregon, Washington, and British Columbia (Williams 1970, 1972; Bowman 1974; Lewis 2001).

***Caecidotea racovitzai* (Williams, 1970)** (exotic)

Records.—**Contra Costa, Sacramento, San Joaquin, and Solano counties**. Sacramento River-San Joaquin River Delta, sampling events from 1995 to 2006, collection by ponar grab (CDWR database); Brown's Island, Lindsey Slough, Mildred Island, Old River, Sherman Island, Sand Mound Slough, Mandeville Island, Venice Cut, and West Canal at Clifton Court Forebay intake (Toft 2000, Toft et al. 2002, CAS database, CDWR database). **Merced Co**. Merced River (dredger tailing ponds), 12 September 2007, collected by Stillwater Sciences (2008) [det. J. Lewis].

Comments.—Introduced into the Pacific Northwest (California, Washington British Columbia), but native to eastern North America east of the Continental Divide (Williams 1970, Bowman 1975a, Lewis 2001, Toft et al. 2002). Established in the Sacramento-San Joaquin Delta probably by ballast water discharge (Toft 2000, Toft et al. 2002). Williams (1970) differentiated populations in the southern United States as *C. r. australis* and all others as *C. r. racovitzai*.

***Caecidotea tomalensis* (Harford, 1877); Tomales Bay Isopod** (epigean)

Records.—Graening et al. (2012a) provided a detailed analysis of the current distribution of this taxon; an abbreviated version is presented here. **Del Norte Co.** Lagoon Creek (NMNH database). Unnamed tributary of upper Lopez Creek, 4.3 km northwest of

the town of Smith River (Graening et al. 2012a). **Humboldt Co.** "A well" (Holmes 1904); Ferndale, 10 males, 2 females (CAS) [det. J. Lewis]. **Marin Co.** Tomales Bay-Bolinas Lagoon area: a freshwater habitat described only as "Tomales Bay and vicinity" (type locality) (Harford 1877); "Tomales Bay, Dillon Beach, Rolland Pond, in mud . . . about 500 km N of Tumaco" (NMNH database); "In small creek on S side Dillon Beach Road, approx. 1 mile E of beach" (NMNH database); "Offshoot of Lagunitas Creek near Point Reyes Station" (NMNH database); lower Olema Creek (Graening et al. 2012a); "shallow pond adjacent to nearby Bolinas Lagoon" (Bowman 1974); "shallow freshwater pond on Audubon Canyon Ranch, Volunteer Canyon" (Bowman 1974; Serpa 1984, Graening et al. 2012a); "Polio Pond" at Stinson Beach (Graening et al. 2012). Point Reyes Peninsula: "pool in creek in Tomales Bay State Park" (NMNH database); lower Home Ranch Creek (Graening et al. 2012a); pond in Glenbrook Creek at Estero Trail bridge (Lobianco and Fong 2003, Graening et al. 2012a). Marin peninsula (Golden Gate National Recreation Area): Backdoor Pond, lower Elk/Tennessee Creek, Tennessee Cove Pond, Rodeo Creek, and Rodeo Lake (Graening et al. 2012a). **Mendocino Co**. Point Arena (Holmes 1904); "Pygmy Forest Preserve, in stream falls among decaying leaves" (NMNH database). Records from the Post (2010) study: Hans Jenny Pygmy Forest (University of California Natural Reserve System); Van Damme State Park; Mendocino Pygmy Forest (Jug Handle State Nature Reserve); "Pygmy Forest off Gibney Lane"; "Nature Conservancy Pygmy Forest near Ltl R. Airport". **Monterey Co**. Pacific Grove (NMNH). **San Francisco Co.** Lake Merced (Bowman 1974, Serpa 1984). **San Mateo Co.** "under boards in sag pond on east side of Skyline Blvd., 100 yards S. of Kings Drive, Sierra Monte development" (Bowman 1974, Serpa 1984); Pillar Point Marsh upstream of West Point Avenue (Graening et al. 2012a); Huddart Park, McGarvey Gulch (Graening et al. 2012a). **Sonoma Co**. "Cheney Gulch, 3 miles SE Bodega Bay, Highway 1" (NMNH); "Marshall Gulch, in stream" (NMNH); "Stempe Creek, about 2.5 km upstream of Walker Road" (NMNH); "Portuguese Beach - spring near N Parking Lot - E side Highway #1" (NMNH); "Schoolhouse Beach, spring at end of culvert" (NMNH); Fairfield Osborn Preserve, in Courtship Creek and Frog Heaven pond (Serpa 1984, Graening et al. 2012a).

Comments.—The Tomales Bay Isopod is restricted to California's northern Coast Ranges in perennial, shallow lentic habitats (e.g. sag ponds, springs, coastal lakes, acidic forest pools), but it can be found in ephemeral pools and moist mud where it burrows into the substrate during drought (Bowman 1974, Graening et al. 2012a).

***Caecidotea* sp.**

Records.—**Merced Co**. Merced River near Oakdale Road Bridge, 14 November 2002, R. Bottorff (unpublished data). **Stanislaus Co**. Tuolumne River, stations R4 and R23, 2000 and 2002, various collections from benthic sampling, N. Hume (unpublished data) [det. R. Bottorff].

Comments.—Wang and Holsinger (2001) reported that stygobiotic isopods of the genus *Caecidotea* were collected from a flooded chamber in Empire Cave (Santa Cruz Co.) during the collection of *Calasellus californicus* and *Stygobromus mackenziei* Holsinger, 1974 on 4 December 1983 by T. Briggs.

***Calasellus californicus* (Miller, 1933)** (phreatobiont)

Records.—**Alameda Co.** Livermore, Wente St. (Concannon St.), 5 November 2011 (ABL/SWAMP unpublished data). **El Dorado Co.** Unnamed spring tributary to Knickerbocker Creek near Cool, 1 mile west of Highway 49, 7 February 1988, R. Bottorff (unpublished data)[det. J. Lewis]; same locale, collections in 1976 and 2010, R. Bottorff (unpublished data). **Lake Co.** Near Kelseyville, unnamed well on W. Tuttle's ranch, syntypes collected by E. Essig in 1931, additional specimens in 1932, described as *Asellus californicus* by Miller (1933). **Marin Co.** 40 cm deep in gravel bed of Cronair [sic] Creek, 15 July 1997, Rosalie del Rosario (Lewis 2001). **Mendocino Co.** Sugar Creek, Angelo Coast Range Reserve, 30 January 1984, L. Serpa (Serpa 1984, NMNH Invertebrate Zoology Collections database), and also 31 May 2003 (C. Barr, unpublished data); Garcia Creek, coll. by L. Serpa. **Napa Co.** "Napa, mouth of spring under house" (Bowman 1975b); Napa River at Bale Lane, 18 April 2008 (ABL/SWAMP unpublished data); unnamed spring, 9 miles north of Napa, W. Shepard, 23 February 1991, prob. *C. longus* (CAS record). Benthic macroinvertebrate sampling in Napa River and tributaries, 2001-2003, Friends of Napa River and Institute for Conservation Advocacy, Research, and Education [det. R. Wisseman]: Bell (Canyon) Creek, 19 April 2002 and 15 May 2003, 1 female each; Cyrus Creek, 24 May 2003, 1 male; Diamond Mountain Creek, 23 April 2002, 1 male, 2 juveniles; Heath Canyon, 29 April 2004, 2 females; Milliken Creek at Westgate, 17 April 2001, 3 males, 1 juvenile; upper Napa River at Tubbs Lane (Calistoga), 20 April 2001, 1 male, 1 female; Nash Creek, 17 April 2002, 2 males, 1 female; Pickle Creek, 30 April 2003, 1 male, and 30 April 2006, 2 males; Rector [Canyon] Creek, 25 April 2001, 1 male, 1 female, 28 February 2002, 1 male and 1 juvenile, 28 April 2002, 1 male; Ritchey Creek, 25 April 2004, 1 male, 26 April 2006, 1 female; Soda Creek, 1 May 2002, 1 male, 11 females, 13 May 2002, 1 juvenile **Santa Clara Co.** "springs of Black Creek, on slope of Black Mountain" [SW of Los Gatos], 25 June 1967, R. Kenk (Bowman 1975b); Coyote Creek at Gilroy Hot Springs, 29 January 2005, S. Fend [det. D. C. Rogers]; Los Gatos Creek below reservoir, 3 February 2009, S. Fend and P. Weissich [det. D. C. Rogers]. **Santa Cruz Co.** UCSC Preserve, Empire Cave, 22 April 1979, D. Rudolph, B. van Ingen, and D. Cowan (NMNH Invertebrate Zoology Collections database), and 4 December 1983, 2 females, T. Briggs (Lewis 2001); Wilder Ranch State Park, Stump Spring, 26 July 2010, G. O. Graening.

***Calasellus longus* (Bowman, 1981)** (phreatobiont)

Records and Comments.—**Fresno Co.** "Shaver Lake, in Sierra National Forest about 35 miles (56 km) northwest [sic] of Fresno, elevation 3500 ft (1068 m)…in spring box", April 1977 (Bowman 1981). This is a single-site endemic (Lewis 2001).

***Calasellus* sp.**

Records and Comments.—**Madera Co.** Rock Creek Spring, adjacent to Minarets Road near Rock Creek Campground, 1 male, 1 December 1998, C. Popelish; either *Calasellus* sp. nov. or a juvenile of *C. longus* (J. Lewis, unpublished data).

Genus undet.

Records.—From the ABL database, benthic sampling from 2002 to 2009: **Glenn Co**. Stoney Creek, Olive Rd. **Humboldt Co**. Eel River below Allen Creek. **Monterey Co**. Willow Creek at Highway 1. **Sonoma Co**. Felta Creek; Sheephouse Creek. **Stanislaus Co**. Orestimba Creek above River Rd.

Family CIROLANIDAE Dana, 1852

***Excirolana linguifrons* (Richardson, 1899)** (euryhaline)

Records and Comments.—**Contra Costa Co.** San Pablo Bay near Pinole Point, 25 April 2006, 1 specimen from ponar grab (CDWR database). This species ranges from Monterey Bay to southern California, and is primarily intertidal on sandy beaches (Richardson 1905, Brusca et al. 2007).

Family IDOTEIDAE Samouelle, 1819

***Synidotea laticauda* Benedict, 1897** (euryhaline)

Records.—**Contra Costa, Sacramento, San Joaquin, and Solano counties.** Grizzly Bay, San Pablo Bay, Suisun Bay, Sherman Lake, Sacramento River, San Joaquin River (reported as *S. laevidorsalis* in the CDWR database; specimens also in BME). Aldrich (1961) reported *Synidotea* from benthic samples in the San Joaquin River between Bradford and Twitchell Islands and also near the Antioch bridge. **Sonoma Co**. Sonoma Boat Harbor at mouth of Sonoma River, 13 January 1992, J. Chapman; Port Sonoma, 3 October 1993, J. Chapman et al. (Chapman and Carlton 1994, Poore 1996); Petaluma River, under pier, August 1967, A. Kuris and J. Born (BME).

Comments.—*Synidotea laticauda* is common in the San Francisco Bay, especially in warmer waters with reduced salinity; in contrast, *S. laevidorsalis* (Miers, 1881) occurs subtidally in marine algal and seagrass communities (Lee and Miller 1980, Poore 1996) in the northwest Pacific Coast (Kwon 1986).

Family JANIRIDAE Sars, 1897

Iais californica (Richardson, 1904) (exotic)

Records and Comments.—Distribution in California is identical to *Sphaeroma quoyanum*, with which it is ectocommensal; it is probably native to New Zealand (Rotramel 1972, 1975).

Family MUNNIDAE Sars, 1897

***Uromunna* sp.** (euryhaline)

Records and Comments.—**Contra Costa, Sacramento, San Joaquin, and Solano counties.** Franks Tract, Grizzly Bay, Old River, Sacramento River, Sherman Lake, Suisun Bay, West Canal at Clifton Court Forebay intake (CDWR database). This family is typically marine, although *Uromunna* has been reported from freshwater in the lower Sacramento and San Joaquin Rivers near the Delta and other large rivers around the world (Rogers 2005; G. Wilson, Australian Museum, Sydney, Australia, pers. comm. 2013).

Family PARANTHURIDAE Menzies and Glynn, 1968

***Paranthura elegans* Menzies, 1951** (euryhaline)

Records and Comments.—Primarily intertidal, this species has been reported from San Pablo Bay near Pinole Point and at mouth of Petaluma River (CDWR database); its range is Marin County and south (Brusca et al. 2007).

Family SPHAEROMATIDAE Latreille, 1825

***Gnorimosphaeroma insulare* (Van Name, 1940)** (euryhaline)

Records.—**Contra Costa, Sacramento, San Joaquin, and Solano counties**: Suisun Bay, Grizzly Bay, Sherman Lake, Sacramento River, Frank's Tract, Old River, San Joaquin River, and West Canal at Clifton Court Forebay intake; over 100 sampling events from 1978 to 2006, over 250 specimens collected from ponar grab (CDWR database). **Contra Costa Co.** Brown's Island (Toft 2000); Pittsburgh Freshwater Marsh at Dow Chemical Plant, 24 February 1998, D. C. Rogers. **Marin Co**. Millerton Gulch at Tomales Bay, 3 May 2004, D. C. Rogers and E.C.L. Rogers. **Mendocino Co**. Jug Handle Creek, 9 September 1998, D. C. Rogers. **San Joaquin Co.** Mildred Island, Mandeville Tip (Toft 2000). **San Luis Obispo Co**. Santa Rosa Creek at Highway 1, 23 July 2007, G. Challet [det. D. C. Rogers]. **Ventura Co.** San Nicolas Island, freshwater, reported as *Exosphaeroma insulare* (Van Name 1940, Menzies 1954).

***Gnorimosphaeroma oregonensis* (Dana, 1853)** (euryhaline)

Records.—**Alameda Co.** Berkeley Beach, Berkeley (Menzies 1954). **Contra Costa, Sacramento, and Solano counties**: San Pablo Bay, Suisun Bay, Grizzly Bay, Sacramento River, and Old River, numerous specimens collected from ponar grab from 1986 to 2006 (CDWR database). **Marin Co.** Point San Quentin (Menzies 1954); Walker Creek and Stemple Creek (Menzies 1954); Glenbrook Creek, 10 January 2010, Guy Graening and G. O. Graening; Shell Beach (Tomales Bay State Park), intertidal brackish water (Menzies 1954); and Schooner Creek, spring 2000, J. Lee and D. Fong (Jon Lee Consulting, unpublished data). **Monterey Co.** mouth of Salinas River, as *Neosphaeroma oregonensis* (Smith 1953, Filice 1958); Monterey Bay and Pacific Grove (Richardson 1905). **San Francisco Co.** Angel Island, San Francisco Bay (Dana 1852, Richardson 1905); Lake Merced (Johnson 1903, Menzies 1954, this study). **San Joaquin Co.** San Joaquin River at mouth of Mokelumne River (Menzies 1954); San Joaquin River estuary (Filice 1958, Aldrich 1961). **San Luis Obispo Co.** Oso Flaco Lake, as *G. o. lutea* (Eriksen 1968); Sweet Springs at Morro Bay, 18 June 2008, D. C. Rogers and M. Hill. **San Mateo Co.** La Honda (Menzies 1954). **Solano Co.** "Napa River at Mare Island, bridge on Black Point Road" (Menzies 1954). **Sonoma Co**. Goat Rock Beach estuary, 22 Oct 2007, D. C. Rogers.

Comments.— *G. oregonensis* is distributed along the Pacific Coast from California to Alaska (Richardson 1905, Eriksen 1968, Hoestlandt 1973, Lee and Miller 1980, Wones and Larson 1991). The taxonomy of this species has been greatly confused in the literature. Many forms were described that were subsequently synonymized under *G. oregonensis* (Riegel 1959, Hoestlandt 1973, Brusca et al. 2007). Menzies' (1954) *Gnorimosphaeroma oregonensis lutea* was actually *G. insulare* (Riegel 1959). Hoestlandt (1973) changed *G. oregonensis* to "*G. oregonense*" either by error or design: if the latter, no reasons were given. This unjustified emendation was followed by Brusca et al. (2007).

***Gnorimosphaeroma* sp.** (euryhaline)

Records.—**Contra Costa Co**. San Pablo Creek at 3rd Ave. Bridge, 2 June 2005, A. Madrone [det. R. Bottorff]. **Mendocino Co.** Irish Gulch Creek below Highway 1, collections by Bottorf and Bottorf (2007) during 2004 - 2006. **Santa Cruz Co**. Collections by K. Orr in 2001 in Baldwin Creek, Dairy Creek, Majors Creek, Peasley Creek, Sandy Flat Creek, and Wilder Creek [det. R. Bottorff].

The following are from the ABL database, benthic sampling from 2000 to 2009: **Mendocino Co**. Garcia River at Hathaway Creek. **Monterey Co**. Big Sur River; Carmel River; Salinas River at Davis Road. **San Mateo Co**. Headwaters; Jones Gulch; Oil Creek; Peters Creek; Tarwater Creek; Water Lane; Waterman Creek. **San Luis Obispo Co**. Arroyo de la Cruz at Highway 1; Arroyo De La Cruz; Arroyo Grande River; Pico Creek; Pismo Creek above Highway 101, Frady Lane Bridge; San Simeon Creek; Santa Rosa Creek; Scott Creek, at Swanton Ranch and at lagoon at Highway 1. **Santa Barbara Co**. Arroyo Burro at Cliff Drive; Carpinteria Creek; Refugio Creek at Refugio State Beach; Jalama Creek at County Park at railroad trussels; Tecolote Creek at Bacara Resort access road. **Santa Clara Co**. Alviso Slough about 0.5 miles below Highway 237 at Alviso. **Santa Cruz Co**. Aptos Creek at Spreckles Drive; Majors Creek about 0.9 miles below Smith Grade Rd.; Pajaro River; San Lorenzo Estuary at Laurel Street; Soquel Creek; Soquel Creek Lagoon at railroad trussels; Waddell Creek; Waddell Creek Lagoon at Highway 1.

***Sphaeroma quoyanum* Milne-Edwards, 1840** (euryhaline; exotic)

Records and Comments.—Humboldt Bay, Bodega Bay, Tomales Bay, Bolinas Lagoon, San Francisco Bay, San Pablo Bay (Carlton 1979); Grizzly Bay at Dolphin near Suisun slough (CDWR database). Also found in Baja California and may be native to New Zealand and Australia; it burrows in sediments, rock, wood, and other substrates of protected bays and estuaries (Rotramel 1972, 1975; Lee and Miller 1980). It is often found in the same burrows with *Gnorimosphaeroma* spp.; tiny species of the genus *Iais* (Janiridae) are ectocommensal with these sphaeromatids (Rotramel 1972, 1975).

***Pseudosphaeroma campbellensis* Chilton, 1909** (exotic, euryhaline)

Records and Comments.—An invasive species from New Zealand, reported from estuaries along the Pacific coast from Coos Bay, Oregon, south to San Francisco Bay (Brusca et al. 2007).

Discussion

California is not particularly rich in non-marine aquatic isopod diversity, having only 9% of the approximately 130 species known from freshwaters in the United States (Smith 2001). Seventeen species in 12 genera and 7 families are listed here, with several potentially new taxa to be determined. Five species are known only from California, and 4 of them are subterranean obligates. Six species are exotic introductions. Exotic isopods, such as *Asellus hilgendorfii*, not only threaten native biodiversity but may serve as intermediate hosts of a number of parasites that affect fish, including salmonids (reviewed by Toft 2000). *Lirceus* (Asellidae) is not known to occur naturally in western North America (Hubricht and Mackin 1949, Lewis 2001), but introductions or invasions are predicted by Rogers (2005). Rogers (2005) suggests (1): the genus *Sphaerolana* (Cirolanidae), known only from cave streams in Mexico, may be detected in the southwestern USA, when the hyporheic and phreatic zones are better inventoried; and (2) *Thermosphaeroma* (Sphaeromatidae), endemic to hot springs in the southern deserts of North America (Cole and Minckley 1972), may be detected west of the Continental Divide when these habitats are better inventoried.

The native freshwater isopod fauna is still under-inventoried, especially in springs and other subterranean habitats. The shortage of taxonomists, a global crisis (Agnarsson and Kuntner 2007), hampers the identification of additional, novel Californian taxa as well as the enumeration of true alpha richness. Based upon our current understanding of the distribution of isopods in California's inland waters, and the conservation status assessment criteria established by the International Union for Conservation of Nature and Natural Resources (IUCN 2001) and NatureServe (Master et al. 2012, Faber-Langendoen et al. 2012), new and revised conservation rankings are recommended (Appendix I) for the California isopod taxa. Based upon the IUCN criteria, several taxa are globally rare or endangered. We assumed that all locales were intrinsically vulnerable to the threat of hydromodification and habitat loss in their watersheds, and to competition and predation pressure from invasive species.

Acknowledgments

We are indebted to the scientists who graciously shared their unpublished data or queried institutional databases, especially: Cheryl Barr and William Shepard (Essig Museum of Entomology, U.C. Berkeley); Rachel Barnett (CDWR); Richard Bottorff; Friends of Napa River, Institute for Conservation Advocacy, Research, and Education; Noah Hume (Stillwater Sciences, Inc.); Jean Krejca (Zara Consulting, Inc.); Tom King (BioAssessment Services); Chris Malan (Institute for Conservation Advocacy, Research and Education); Darlene McGriff (CNDDB); Peter Ode, Dan Pickard, and Doug Post (CDFW Aquatic Bioassessment Laboratory); and Robert Wisseman (Aquatic Biology Associates, Inc.). We also acknowledge the fieldwork and literature review performed by CSUS graduates (Alex Keith, Alex Mercado, Jeff Flores, Nick Macias, Navneet Sharma) and National Speleological Society members (Ron Davis, Guy Graening, and David Hunter). We also thank reviewers Larry Serpa, Joseph Slusark, and George Wilson for constructive criticism, Jack Smith and Astra Gleason (CSUS Interlibrary Services Department) for literature acquisition, and the many land managers and landowners for granting access to their lands and for protecting their aquatic resources. Collections by Graening were performed under USNPS Scientific Research and Collecting Permits PORE-2010-SCI-0014 and GOGA-2010-SCI-0009 and CDFW Scientific Collecting Permit No. SC-006802.

Literature Cited

Agnarsson, I., and M. Kuntner. 2007. Taxonomy in a changing world: seeking solutions for a science in crisis. Systematic Biology 56:531-539.

Aldrich, F. A. 1961. Seasonal variations in the benthic invertebrate fauna of the San Joaquin River estuary of California with emphasis on the amphipod *Corophium spinicorne* Stimpson. Proceedings of the Academy of Natural Sciences of Philadelphia 113:21-28.

Barr, Jr., T. C. 1960. Symposium. Speciation and raciation in cavernicoles: introduction. American Midland Naturalist 64:1-9.

Bottorff, R. L. and L. D. Bottorff. 2007. Phenology and diversity of adult stoneflies (Plecoptera) of a small coastal stream, California. Illiesia 3:1-9.

Bowman, T. E. 1974. The California freshwater isopod, *Asellus tomalensis*, rediscovered and compared with *Asellus occidentalus*. Hydrobiologia 44:431-441.

Bowman, T. E. 1975a. *Asellus* (*Asellus*) *alaskensis*, n. sp., the first Alaskan *Asellus*, with remarks on its Asian affinities (Crustacea: Isopoda: Asellidae). Proceedings of the Biological Society of Washington 88:59-72.

Bowman, T. E. 1975b. Three new troglobitic asellids from western North America (Crustacea: Isopoda: Asellidae). International Journal of Speleology 7:339-356.

Bowman, T. E. 1981. *Calasellus longus*, a new genus and species of troglobitic asellid from Shaver Lake, California. (Crustacea: Isopoda: Asellidae). Proceedings of the Biological Society of Washington 94:866-872.

Brusca, C. B., V. R. Coelho, and S. Taiti. 2007. Isopoda. Pages 503-542 *in* J. T. Carlton, editor. The Light and Smith manual: intertidal invertebrates from central California to Oregon. Fourth edition. University of California Press, Berkeley, USA.

Brusca, R., V. R. Coelho, and S. Taiti. 2010. Guide to the coastal marine isopods of California. Tree of Life Web Project (Internet database). Available from: http://tolweb.org/notes/?note_id=3004 (Accessed May 2012).

Carl, G. C. 1937. Flora and fauna of brackish water. Ecology 18:446-453.

Carlton, J. T. 1979. History, biogeography and ecology of the introduced marine and estuarine invertebrates of the Pacific coast of North America. Ph.D. Dissertation, University of California, Davis, USA.

Carlton, J. T. (editor). 2007. The Light and Smith manual: intertidal invertebrates from central California to Oregon. Fourth edition. University of California Press, Berkeley, USA.

Chapman, J. W., and J. T. Carlton. 1991. A test of criteria for introduced species: the global invasion by the isopod *Synidotea laevidorsalis* (Miers, 1881). Journal of Crustacean Biology 11:386-400.

Cole, G. A., and W. L. Minckley. 1972. Stenasellid isopod crustaceans in the Western Hemisphere — a new genus and species from Mexico — and a review of other North American freshwater isopod genera. Proceedings of the Biological Society of Washington 84:313-326.

Dana, J. D. 1856. Catalogue and descriptions of Crustacea collected in California by Dr. John L. LeConte. Proceedings of the Philadelphia Academy of Natural Science VII:175-177.

Ellis, R. J. 1971. Notes on the biology of the isopod *Asellus tomalensis* in an intermittent pond. Transactions of the American Microscopal Society 90:51-61.

Eriksen, C. H. 1968. Aspects of the limno-ecology of *Corophium spinicorne* Stimpson (Amphipoda) and *Gnorimosphaeroma oregonensis* (Dana) (Isopoda). Crustaceana 14:1-12.

Faber-Langendoen, D., J. Nichols, D. Master, K. Snow, A. Tomaino, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, A. Teucher, and B. Young. 2012. NatureServe conservation status assessments: methodology for assigning ranks. NatureServe Report, revised edition June 2012. Arlington, Virginia, USA.

Fee, A. R. 1926. The Isopoda of Departure Bay and vicinity with descriptions of new species, variations, and colour notes. Contributions to Canadian Biology and Fisheries: being studies from the Biological Stations of Canada, n.s. 3:13-46.

Filice, F. P. 1954. A study of some factors affecting the bottom fauna of a portion of the San Francisco Bay Estuary. Wasmann Journal of Biology 12:257-292.

Graening, G. O., M. E. Slay, D. B. Fenolio, and H. Robison. 2007. Annotated checklist of the Isopoda (Subphylum Crustacea: Class Malacostraca) of Arkansas and Oklahoma, with emphasis upon subterranean habitats. Proceedings of the Oklahoma Academy of Science 87:1-14.

Graening, G. O., D. Fong, L. Serpa, N. Sharma, and G. J. Graening. 2012a. Conservation status of the Tomales Bay isopod *Caecidotea tomalensis* (Malacostraca: Isopoda). California Fish and Game 98:202-213.

Graening, G. O., D. C. Rogers, J. Holsinger, C. Barr, and R. Bottorf. 2012b. Checklist of inland aquatic amphipoda (Crustacea: Malacostraca) of California. Zootaxa 3544:1-27.

Harford, W. G. 1877. Description of a new genus and three new species of sessile-eyed crustacea. Proceedings of the California Academy of Sciences,Volume VII, Part I, 1876:53-55.

Hatch, M. H. 1947. The Chelifera and Isopoda of Washington and adjacent regions. University of Washington Publications in Biology 10:155-274.

Henry, J. P., and G. Magniez. 1970. Contribution á la systématique des Asellides (Crustacea Isopoda). Annales de Spéléologie 25:335-367.

Henry, J. P., and G. Magniez. 1995. Nouvelles données sur les Asellidae épigés d'Extrême-Orient (Crustacea, Isopoda, Asellota). Contributions to Zoology 65:101-122.

Hoestlandt, H. 1973. Etude systématique et génétique de trois espèces pacifiques Nord-Américaines du genre *Gnorimosphaeroma* (Isopodes Flabellifères). I Considération Générales et Systématique. Archives de Zoologie Expérimentale and Générale 114:349-395.

Holmes, S. J. 1904. On some new or imperfectly known species of West American Crustacea. Proceedings of the California Academy of Sciences 3:307-324.

Hubricht, L., and J. G. Mackin. 1949. The freshwater isopods of the genus *Lirceus* (Asellota, Asellidae). American Midland Naturalist 42:334-349.

IUCN (International Union for the Conservation of Nature and Natural Resources). 2012. IUCN red list categories and criteria. Second edition. Version 3.1. IUCN Council, Gland, Switzerland.

Iverson, E. W. 1982. Revision of the isopod family Sphaeromatidae (Crustacea: Isopoda: Flabellifera) I. Subfamily names with diagnoses and key. Journal of Crustacean Biology 2:248-254.

Johnson, H. P. 1903. Fresh-water nereids from the Pacific Coast and Hawaii, with remarks on fresh-water Polychaeta in general. Henry Holt and Company, New York, USA.

Krejca, J. K. 2006. Final report for inventory of karst fauna in Sequoia, Kings Canyon and Yosemite National parks. Prepared for Sequoia, Kings Canyon and Yosemite National Parks, California. Contract number P8558022608. Zara Environmental LLC, Buda, Texas, USA.

Kwon, D. H. 1986. Some idoteid isopods (Crustacea) from Korea. Inje Journal 2:107-121.

Lee, W. L., and M. A. Miller. 1980. Isopoda and Tanaidacea: the isopods and their allies. Pages 536-558 *in* R. H. Morris, D. P. Abbott, and E. C. Haderlie, editors. Intertidal invertebrates of California. Stanford University Press, Stanford, California, USA.

Lee, J. 2001. Spring 2000 benthic macroinvertebrate analysis of twelve sites in Point Reyes National Seashore using the California Stream Bioassessment Procedure. Prepared for National Park Service Point Reyes National Seashore Point Reyes Station, California, USA.

Lewis, J. J. 2001. Three new species of subterranean asellids from western North America, with a synopsis of the species of the region (Crustacea: Isopoda: Asellidae). Texas Memorial Museum Speleological Monographs 5:1-15.

Lewis, J. J. 2008. *Oregonasellus* and *Bowmanasellus*, two new subterranean isopod genera from the western United States (Crustacea: Isopoda: Asellidae). Subterranean Biology 6:23-30.

Lewis J. J. 2009a. Isopoda (aquatic sowbugs). Pages 346-355 *in* G. E. Likens, editor. Encyclopedia of inland waters, volume 2. Elsevier, Oxford, United Kingdom.

Lewis, J. J. 2009b. Zoogeography and evolution of the subterranean asellid isopods of North America. Pages 1309-1314 *in* W. B. White, editor. Proceedings of the 15th International Congress of Speleology, Kerrville, Texas. International Congress of Speleology and the National Speleological Society, Huntsville, Alabama, USA.

Lobianco, R. M., and D. Fong. 2003. 2002 California freshwater shrimp (*Syncaris pacifica*) surveys within Point Reyes National Seashore and Golden Gate National Recreation Area. Prepared for U.S. National Park Service and U.S. Fish and Wildlife Service. Division of Natural Resource Management and Science, Golden Gate National Recreation Area, San Francisco, California, USA.

MacGinitie, G. E. 1935. Ecological aspects of a California marine estuary. American Midland Naturalist 16:629-765.

Mackin, J. G., and L. Hubricht. 1938. Records of distributions of species of isopods in central and southern United States, with descriptions of four new species of *Mancasellus* and *Asellus* (Asellota, Asellidae). American Midland Naturalist 19:628-637.

Magniez, G. J. 1996. *Asellus aquaticus* et se proches parents: un étranger parmi la faune asellidienne d'Europe. Mémoires de Biospéologie 23:181-187.

Magniez, G. J., and J. Toft. 2000. Présence d'un asellide épigé originaire d'Extrême-Orient en Californie. Bulletin Mensuel de la Société Linnéenne de Lyon 69:127-132.

Master, L. L. 1991. Assessing threats and setting priorities for conservation. Conservation Biology 5:559-563.

Master, L. L., D. Faber-Langendoen, R. Bittman, G. A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012. NatureServe conservation status assessments: factors for evaluating species and ecosystem risk. NatureServe Report, revised April 2012. Arlington, Virginia, USA.

Menzies, R. J. 1954. A review of the systematic and ecology of the genus "*Exosphaeroma*", with the description of a new genus, a new species, and a new subspecies (Crustacea, Isopoda, Sphaeromidae [sic]. American Museum Novitates 1683:1-24.

Miller, M. A. 1933. A new blind isopod, *Asellus californicus*, and a revision of the subterranean asellids. University of California Publications in Zoology 39:97-110.

Miller, M. A. 1938. Comparative ecological studies on the terrestrial isopod Crustacea of the San Francisco Bay region. University of California Publications in Zoology 43:113-142.

Miller, R. C. 1958. The relict fauna of Lake Merced, San Francisco. Journal of Marine Research 17:375-381.

Minckley, W. L. 1961. Occurrence of subterranean isopods in epigean waters. American Midland Naturalist 66:452-455.

Muchmore, W. B. 1990. Terrestrial Isopoda. Pages 805-817 *in* D. L. Dindal, editor. Soil Biology Guide. John Wiley and Sons, New York, USA.

National Museum of Natural History. 2009. World list of marine, freshwater and terrestrial isopod crustaceans. Department of Systematic Biology - Invertebrate Zoology, National Museum of Natural History, Smithsonian Institute. Compiled by B. Kensley, M. Schotte, and S. Schilling. Available at http://www.nmnh.si.edu/iz/isopod/

NatureServe, Inc. 2013. NatureServe Explorer: an online encyclopedia of life, Version 7.1. NatureServe, Arlington, Virginia. Available from: http://www.natureserve.org/explorer. (Accessed 1 August 2013).

Poore, G. C. 1996. Species differentiation in *Synidotea* (Isopoda: Idoteidae) and recognition of introduced marine species: a reply to Chapman and Carlton. Journal of Crustacean Biology 16:384-394.

Richardson, H. E. 1900. Synopses of North-American invertebrates. VIII. The Isopoda. Part II. American Naturalist 34:295-309.

Richardson, H. E. 1904a. Isopod crustaceans of the northwest coast of North America. Harriman Alaska Expedition 10:213-230.

Richardson, H. E. 1904b. Contributions to the natural history of the Isopoda, V. Isopod crustaceans of the northwest coast of North America. Proceedings of the United States National Museum 27:657-681.

Richardson, H. E. 1905. A monograph on the isopods of North America. Bulletin of the United States National Museum 54.

Riegel, J. A. 1959. A revision in the sphaeromid genus *Gnorimosphaeroma* Menzies (Crustacea: Isopoda) on the basis of morphological, physiological and ecological studies on two of its "subspecies." Biological Bulletin 177:154-162.

Robison, H. W., and M. D. Schram. 1987. Checklist of the aquatic isopoda of Arkansas. Arkansas Biota Survey Checklist 48. Arkansas Academy of Science, Little Rock, USA.

Rogers, D. C. 2005. Identification manual to the freshwater Crustacea of the western United States and adjacent areas encountered during bioassessment. EcoAnalysts Technical Publication Series # 1. EcoAnalysts, Inc., Moscow, Idaho, USA.

Rogers, D. C., A. P. Covich, and J. H. Thorp. 2010. Introduction to the subphylum Crustacea. Pages 695-724 *in* J. H. Thorp and A. P. Covich, editors. Ecology and classification of North American freshwater invertebrates. Third edition. Academic Press (Elsevier), San Diego, California, USA.

Rotramel, G. L. 1972. *Iais californica* and *Sphaeroma quoyanum*, two symbiotic isopods introduced to California (Isopoda, Janiridae, Sphaeromatidae). Crustaceana (Suppl. 3):193-197.

Rotramel, G. L. 1975. Observations on the commensal relations of *Iais californica* (Richardson, 1904) and *Sphaeroma quoyanum* H. Milne Edwards, 1840 (Isopoda). Crustaceana 28:247-256.

Schotte, M., B. F. Kensley, and S. Shilling. 2009. World list of marine, freshwater and terrestrial isopod crustaceans. National Museum of Natural History Smithsonian Institution, Washington D. C., USA. Available at: http://invertebrates.si.edu/isopod/

Serpa, L. 1984. The status of *Caecidotea tomalensis* (Asellidae). Unpublished report to California Department of Fish and Game. Fairfield Osborn Preserve, The Nature Conservancy, Penngrove, California, USA.

Smith, D. G. 2001. Pennak's freshwater invertebrates of the United States: Porifera to Crustacea. Fourth edition. John Wiley and Sons, Hoboken, New Jersey, USA.

Smith, R. I. 1953. The distribution of the polychaete *Neanthes lighti* in the Salinas River Estuary, California, in relation to salinity, 1948-1952. Woods Hole Marine Biological Laboratory Biological Bulletin 105:335-347.

Smith, R. I., and J. T. Carlton, editors. 1989. Light's manual: intertidal invertebrates of the central California coast. Third edition. University of California Press, Berkeley, USA.

Sovell, J. R., and R. Guralnick. 2005. Montane mollusc and crustacean survey of western Colorado. Colorado Division of Wildlife, Denver, USA.

Stillwater Sciences, Inc. 2008. The Merced River Alliance Project final report. Volume II: biological monitoring and assessment report. Stillwater Sciences, Inc., Berkeley, California, USA.

Stillwater Sciences, Inc. 2009. Aquatic invertebrate monitoring reports and summary updates. Published in: Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299, report years 2003 to 2009. Stillwater Sciences, Inc., Berkeley, California, USA.

Toft, J. D. 2000. Community effects of the non-indigenous aquatic plant water hyacinth (*Eichhornia crassipes*) in the Sacramento/San Joaquin Delta, California. Thesis, University of Washington, Seattle, USA.

Toft, J. D., J. R. Cordell, and W. C. Fields. 2002. New records of crustaceans (Amphipoda, Isopoda) in the Sacramento/San Joaquin Delta, California, and application of criteria for introduced species. Journal of Crustacean Biology 22:190-200.

Van Name, W. G. 1936. The American land and fresh-water isopod Crustacea. Bulletin of the American Museum of Natural History 71.

White, N. 2005. The biogeography of Lake Merced: invertebrate fauna of Lake Merced. Friends of Lake Merced, San Francisco State University, California, USA. Available at http://www.lmtf.org/FoLM/Data/SFSUReports/invertebrates.htm

Williams, W. D. 1970. A revision of North American epigean species of *Asellus* (Crustacea: Isopoda). Smithsonian Contributions to Zoology 49.

Williams, W. D. 1972. Freshwater isopods (Asellidae) of North America. Biota of freshwater ecosystems. Identification Manual 7. U.S. Environmental Protection Agency, Washington, D. C., USA.

Wilson, G. D. F., and S. J. Keable. 2001. Systematics of the Phreatoicidea. Pages 175 to 194 *in* B. Kensley, editor. Crustacean issues 13: isopod systematics and evolution. A. A. Balkema Publishers, Rotterdam, Netherlands.

Winger, P. V., E. J. Peters, M. J. Donahoo, J. R. Barnes, and D. A. White. 1972. A checklist of the macroinvertebrates of the Provo River, Utah. Great Basin Naturalist 32:211-219.

Wones, A. G. and G. L. Larson. 1991. The benthic macroinvertebrate community in a coastal sand dune lake relative to habitat and changing lake levels. Hydrobiologia 213:167-181.

Received 2 October 2013
Accepted 15 December 2013
Associate Editor was J. Harrington

Appendix I. Current IUCN Red List and Natural Heritage Program conservation status ranks and suggested revisions for those freshwater taxa having sufficient data, and notes on endemism and population trends.

The full rationale and explanation for these conservation status ranking systems is detailed in IUCN (2012) for the Red List and in Faber-Langendoen et al. (2012) for the Natural Heritage Program, but briefly, for the Red List, VU = vulnerable to extinction, CR = critically endangered, and for the Heritage Program, G = global rank, S = subnational rank, and the numbers range from 1 = critically impaired to 5 = secure. Exotic species (not listed here) should be assigned the Red List category "LC" (i.e., of least conservation concern) and Natural Heritage rank "SNA" to indicate that they have no applicable conservation status in California.

Taxon	Current Red List Rank	Suggested Red List Rank	Current Heritage Rank	Suggested Heritage Rank	Notes
Bowmanasellus sequoiae	not listed	VU-B2	G1S1	no change	known from only 4 locales globally: restricted to karst aquifers in Sequoia Nationa Park
Caecidotea tomalensis	not listed	VU-B2,D1	G2S2	no change	see Graening et al. (2012a) for details
Calasellus californicus	not listed	VU-D2	G2S2	no change	20 locales in 8 counties
Calasellus longus	not listed	CR-B2,D1	G1S1	no change	single-site endemic dependent upon a single groundwater resurgence