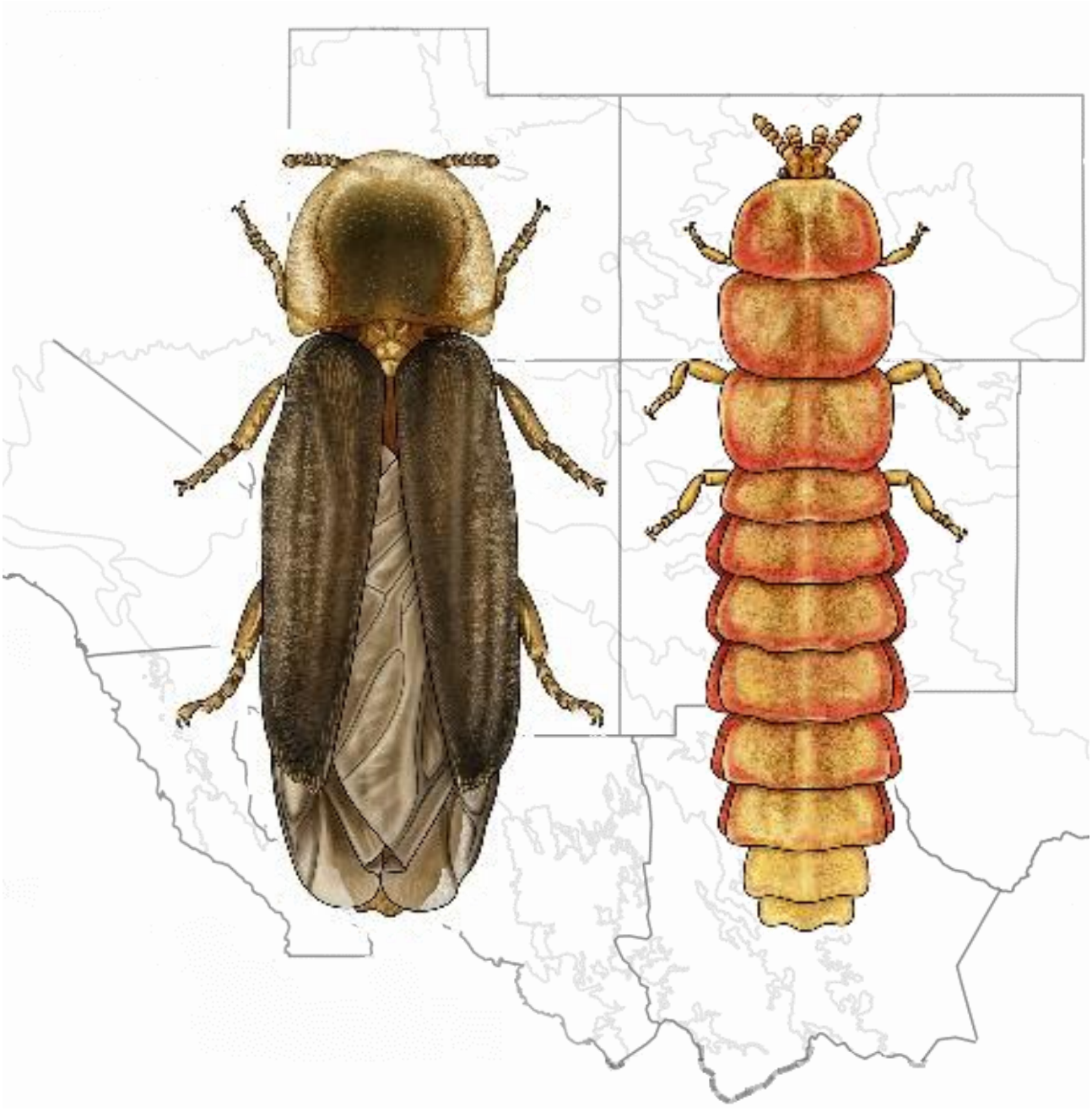
Guide to Fireflies of the Southwest

By Anna Walker



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New Mexico BioPark Society

February 2024

Acknowledgements

Exploring the world of fireflies is a true delight, not just because of the beauty of fireflies, but because of the wonderful community of researchers, friends, and naturalists I have met along the way. I will be forever grateful to Sara Lewis, who pulled me into this magical world to begin with. Larry Buschman was particularly instrumental in helping me find my feet in the field. Instead of wandering blindly into the dark, his knowledge of western fireflies gave me hope that there were plenty of firefly populations to be uncovered. Joe Cicero, Ben Pfeiffer, and Lynn Faust have also been exceptional mentors, always patiently responding to my queries. Candace Fallon, who has been a constant companion since the beginning of this firefly journey, helped compile much of the information you will find in the following pages as part of an effort to write conservation status assessments for North American firefly species. Earlier versions of this guide were greatly improved by suggestions and edits from Candace Fallon, Richard Joyce, Joe Cicero and Ben Pfeiffer. This guide would have been much less useful and extremely drab without the long list of photographers who generously agreed to let me use their photographs. They are too numerous to name here, but their names can be found in the captions that accompany their photographs. Each of these photographers also contribute greatly to the scientific understanding of fireflies and other taxa by submitting their detailed observations to iNaturalist, BugGuide, and Firefly Atlas. Photos not attributed to anyone, were taken by me. Finally, I am extremely grateful to the friends, family, and colleagues who have braved snakes, mosquitoes, the rain, the heat and the cold to join me in the field. The magic of fireflies it that much more enjoyable in good company.

Cover: Illustration of male and female *Microphotus dilatatus* was done by Audrey E. Bell. More of Audrey's work can be found at aebellillustration.com. The map was created in QGIS by the author.

Recommended Citation

Walker, A. 2024. *Guide to Fireflies of the Southwest*. New Mexico BioPark Society, Albuquerque, NM.

The **New Mexico BioPark Society** (NMBPS) is the nonprofit support organization for the ABQ BioPark, a zoo, botanic garden, and aquarium in Albuquerque, New Mexico. It also hosts the Center for Species Survival New Mexico (CSS New Mexico), which supports strategic species conservation through a partnership with the International Union for Conservation of Nature (IUCN) Species Survival Commission. From local to global, the CSS New Mexico utilizes the IUCN Red List to produce critical baseline data to guide conservation planning and action for invertebrates, plants, freshwater fishes, and reptiles. NMBPS has supported global firefly conservation efforts as well as firefly field surveys and research in the Southwest since 2020.

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Introduction

We are all familiar with fireflies. Around the globe, they light up the night with their delicate, awe-inspiring displays. As a child growing up Colorado, I only knew of this natural spectacle from books, movies, and one unforgettable summer vacation to the eastern United States. I had no idea that these incredible beetles were in fact, flashing away, illuminating the summer darkness within walking distance of my house. It is my hope that children, adults, and researchers across the Southwest, realize that witnessing this natural phenomenon is within reach, if they are willing to leave the lighted comfort of their homes, and venture out into the night.

I was shocked when I found out the western United States has fireflies. Searching for these enigmas across New Mexico, Arizona, Utah and Colorado, has truly been a delight. With this guide, I hope to share that delight with anyone who wants to go looking in the darkness. This guide is an introduction to the diversity of fireflies found in the Southwest, including the US states of Colorado, Utah, New Mexico, Arizona, and southern California, and the Mexican states of Sonora, Chihuahua, and Baja California. It was written for anyone who wants to better understand fireflies, though some sections of the guide are better suited for more serious students. I hope the more casual reader will be able to ignore the scientific references, dichotomous keys, and morphological jargon.

In the face of accelerating biodiversity loss driven by human activity, we are running out of time to understand the baseline condition of firefly population in the Southwest. In fact, the time may already have passed. Many populations have already been lost to misuse of water resources, drought, wildfire, and overgrazing. We must move fast to understand what remains intact, so we can take steps to prevent further losses. Programs like Firefly Atlas and the Western Firefly Project are making progress in filling some of the gaps in our understanding of southwestern fireflies. These programs rely on the help of hundreds of committed, diligent community scientists. This guide is designed to act as a tool for those wishing to better contribute to these programs. While guides to fireflies of the eastern (Faust 2017) and western (Buschman 2018) United States do exist, this guide focuses on the species from the Southwest region. Chapters divide the species into three major groups, based on their courtship behavior; flashing fireflies, glow-worms, and diurnal dark fireflies. Within each chapter, you will find detailed information on each genus, with a genus specific key to help the more serious students differentiate between related species. Accounts are then provided for each species, with photos and detailed information on distribution, habitats and ecology, and conservation status. Though there are no common names for fireflies yet recorded by the Entomological Society of America's common names of insects database, efforts have been made over the years to formalize the common names of many species. I have opted to use common names that have been published by other sources, including Lloyd (2018), Faust (2017), the IUCN Red List, or other publications. Where no common names were available, unofficial common names have been assigned. These are indicated with an asterisk. Where possible, they reflect a rough translation of the Latin name or refer in some way to the biology or ecology of the species.

CHAPTER 1: OVERVIEW

Introduction to Fireflies

Fireflies are beetles in the family Lampyridae. There are around 171 species in 21 genera in the United States, with new species still being described (Fallon *et al.* 2021, Heckscher 2021, Keller and Hinson 2023). Firefly abundance and diversity is higher in the eastern United States, where water is more plentiful. Most fireflies require moist conditions throughout their lifecycle to keep eggs and larvae from drying out, and to support soft bodied invertebrates, such as slugs and snails, which the larvae feed on at and below the soil surface (Lloyd 2018, Lewis 2016). Due in part to this reliance on permanent water sources, fireflies occur only sporadically in suitable habitats in the Southwest. They are generally found in small, scattered populations. As such, it is rare to encounter them and there are few experts who have spent their time studying fireflies in the region. It is unknown precisely how many species of firefly the Southwest hosts. So far, 33 species have been recorded, at least three of which may be new to science.

Figure 1. Southwest synchronous firefly (*Photinus knulli*) flashes under a cottonwood tree in southern Arizona. Photo: Scott Cylwik

Fireflies are beloved for their showy bioluminescent courtship signals. Here in the Southwest, we have a relatively high number of glow-worm and dark firefly species, and only a few species of the more widely recognized flashing fireflies. All fireflies exhibit bioluminescent glows in the egg, larval, and pupal stages, but not all adults flash or glow (Evans 2014, Lewis 2016). The protective glow communicates the presence of steroidal compounds called lucibufagins, which are distasteful to potential predators (Eisner 1978). In Southwestern glow-worm species, adult females are bioluminescent, but in most cases the males are not. Female glow-worms are generally flightless and resemble larval beetles. For this reason, they are referred to as larviform, or neotenous. Neotenous organisms retain larval or juvenile characteristics into adulthood. These larviform females glow from the ground to attract winged males flying overhead in the night. Dark fireflies are typically active during the day and with some exceptions, do not produce light as adults. The males instead are thought to locate mates with the use of pheromones, or scent cues. In the flashing species, both adult males and females produce flashes or glows. The males emit a species-specific courtship signal as they fly in search of a female to mate with. Females, which are generally found on the ground or in low lying vegetation, respond with a species-specific response flash to indicate they are receptive to prospective mates.

While these functional groups are helpful for creating a basic understanding of firefly diversity, there are species within each group that prove to be exceptions to the rule. In other cases, we have yet to discover the life history intricacies of many firefly species, and we only presume to know, based on our best guess. With further study, these details will continue to be filled in.

Other authors have covered firefly ecology and biology beautifully. For more in-depth information see *Fireflies, Glow-worms, and Lightning Bugs: Identification and Natural History of the Fireflies of the Eastern and Central United States and Canada* by Lynn Frierson Faust and *Silent Sparks* by Dr. Sara Lewis.

Firefly Conservation

Anecdotal reports of declining firefly populations abound across the globe. In story after story, people remember the magic of fireflies they saw as a child but cannot remember the last time they saw a summer light show. Many also report that fireflies have disappeared or are found in less impressive numbers in the places they do still see them. Scientific investigations to quantify whether these beetles are experiencing population declines is only now starting to catch up. Like many insect species, there are a lack of long-term data on firefly distributions and population sizes for US fireflies. Researchers are currently working to better understand and measure these trends. However, threats to fireflies are well documented, as are declines in their habitats. The main threats fireflies face around the world include habitat loss, light pollution, water mismanagement, and pesticide use (Lewis *et al.* 2020).

In 2021, conservation status assessments of 132 out of 171 North American (north of Mexico) firefly species and subspecies were published on the IUCN Red List of Threatened Species. Of the species assessed, 18 (14%) are considered at risk of extinction, 42 (32%) are thought to be of low conservation concern, and 72 (55%) did not have enough data to determine whether they are threatened (Fallon *et al.* 2021). Of those that are threatened, the main threats identified are habitat loss and degradation due to development, loss of wetlands, artificial light at night, and drought. In the Southwest, there are several threatened species, which face the common threats of drought, cattle grazing, mismanagement of water resources, wildfires, and mining. These species include the Southwest spring firefly (*Bicellonycha wickershamorum*) which was petitioned for protection under the Endangered Species Act in 2023 (Fallon *et al.* 2023) (and received a positive 90-day finding in early 2024 (USFWS 2024)), the synchronous Southwest firefly (*Photinus knulli*), and the Sky Island firefly (*Photuris falli*). Many of the other species found in the region may be at risk of extinction, due to loss of habitat and increasing incidence, duration, and severity of drought, but so far, we do not know enough about many of these species to assess whether they are threatened. Additional information on distribution, population size, threats, and in some cases basic habitat and ecology information, is needed for many species.

Observing and Recording Fireflies

Observing fireflies in the Southwest is not easy. Many species are found in low abundance in a small number of scattered populations that are easy to miss, even for the keen observer. Most sightings come from wet habitats, including along rivers and streams, at lake margins, in wet montane meadows, in irrigated fields, and other wetland areas. Therefore, it is most often the state's outdoor recreationists and naturalists that report having seen fireflies in the state. Otherwise, reports come from farming communities along rivers such as the Rio Grande in New Mexico and the Santa Cruz in Arizona. For the best chance of seeing adult fireflies, you need to go to a known site, at a specific time of year, and at a specific time of night. Even then, the phenological timing of many of our fireflies is not well understood, and depending on yearly fluctuations in temperature and precipitation, you may be too early, or too late.

As many Southwestern fireflies are rare, and are typically only found in small populations, collecting is not recommended. For most species, a close-up, in-focus photo of both the upper side (dorsal) and under side (ventral) surfaces is usually enough for

Figure 2. Kaitlin Hasse, Nav Khalsa, and the author during a firefly survey in northern New Mexico. Photo: Sarina Jepsen/The Xerces Society.

a positive identification of adults. For flashing fireflies, often a description of the flash pattern, or a video recording of the flash pattern, is also needed to positively identify a species. When recording information on the flash pattern, the temperature in the field must also be recorded, as flash pattern speed is affected by ambient temperature (flashes are quicker and the time between flashes is shorter at higher temperatures). An insect net is often needed in order to capture flashing species for photography. Diurnal species can often be found resting or crawling on vegetation, especially in proximity to water sources. Glow-worm males often come to UV light traps or lures, and females can be seen glowing from the ground in suitable habitats. In depth information on how to take field observations, including how to submit your observations so that they can be utilized by researchers, can be found on the Firefly Atlas website (https://www.fireflyatlas.org/).

How to Identify a Firefly

Firefly Morphology

Like all insects, fireflies have three main body parts: a head, thorax, and abdomen (Fig. 3). From above (dorsally), the head of most fireflies is hidden under a headshield (pronotum). The pronotum, wings, and legs are attached to the thorax, and the abdomen is concealed by the wings. Other notable features that can be seen dorsally, include the pronotum, the scutellum, the forewings, and hindwings (Fig. 3). The forewings on beetles are called elytra. They are hardened, or more sclerotized, than the wings of other insects. They are typically used for protection and are not used in flight.

On the ventral side (from below), we can see the details of the head (Fig. 3). Most fireflies have very large eyes, at least those that use bioluminescence in courtship. The male pictured (Fig. 3) is from the genus *Microphotus*. The mouthparts of species in this genus have migrated toward the top of the head. The mouthparts of most fireflies are below the eyes instead. The antennae of most fireflies are filiform, with a series of more or less uniform segments. There are a couple species that have serrated antennae (triangular shapes segments) or lamellate antennae (branched segments), but the majority of the time they are filiform with either long and slender segments or short and stout segments.

The legs also have three main sections, the femur, tibia, and tarsi. Sometimes the tarsal claws (the terminal segment of the tarsi) are important for identifying fireflies to genus.

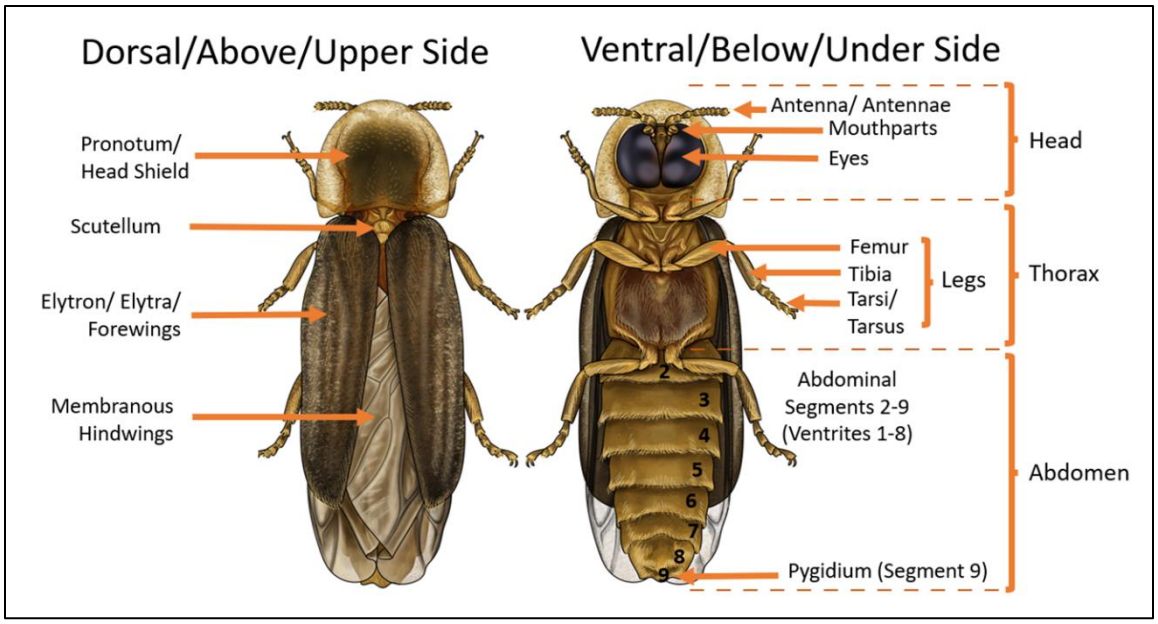


Figure 3. Firefly Morphology. Base illustration by Audrey E. Bell (aebellillustration.com).

Firefly Taxonomy

Fireflies are in the family Lampyridae, which is one of 17 beetle families in the superfamily Elateroidea. Only 12 of these families are found in the United States. There are several closely related beetles that can be easily confused with fireflies. They often look so similar because they employ mimicry to appear distasteful like their firefly cousins. The relationships between the families in this superfamily are not well understood, though it is likely that fireflies are most closely related to either the Phengodidae and Rhagophthalmidae (Martin 2020) or the Cantharidae (Kundrata *et al.* 2016) (Figure 4.).

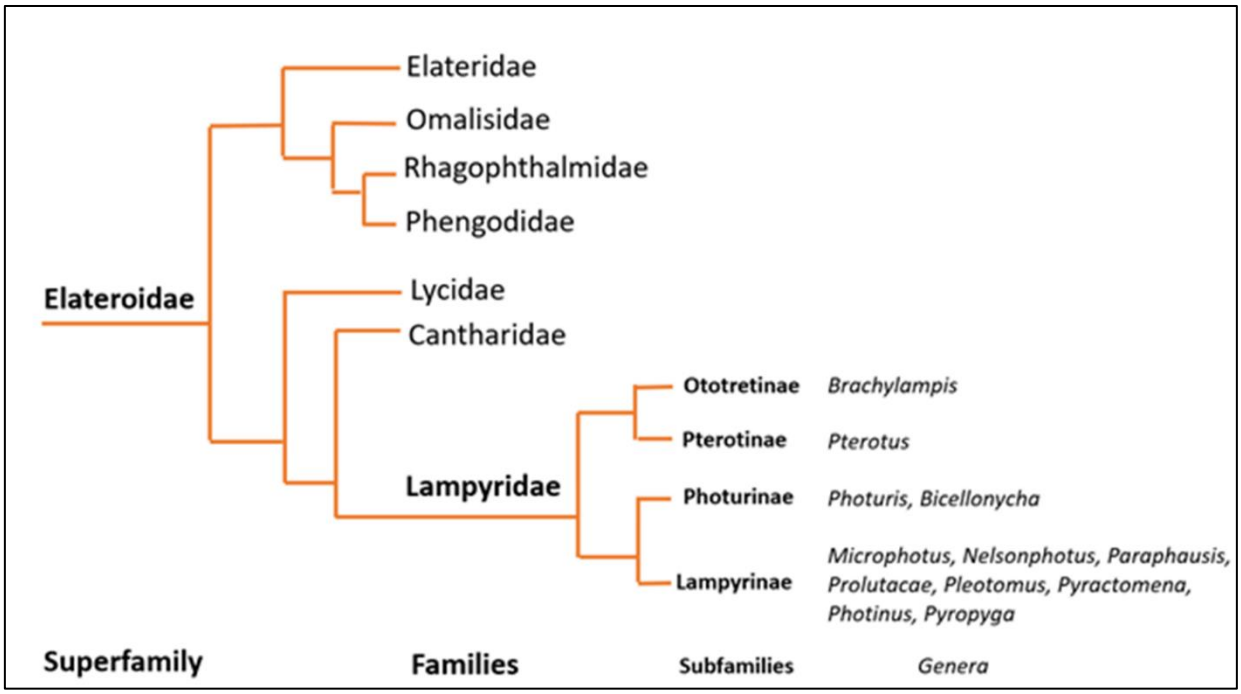


Figure 4. Firefly Taxonomy: Elateroidea Superfamily Tree. Family relatedness based on Kundrata *et al*. 2016. Lampyridae subfamily relatedness based on Martin 2020.

Fireflies are most often confused with soldier beetles (Family Cantharidae; Figure 5A.) and net-winged beetles (Family Lycidae; Figure 5B.) because male adults in all three groups are soft and somewhat flattened, with parallel sided wing coverings (known as elytra), long legs, and (in most species) threadlike antenna (Arnett *et al*. 2002) (Figure 5). They also all have a tarsal formula of 5-5-5. The tarsal formula is a characteristic that commonly differentiates beetle families. It refers to the number of segments, known as tarsi, on the end of the front, middle, and hind legs, respectively. All three groups also have numerous species that are aposematic, which means they exhibit warning coloration (black, red, and orange). However, in adult fireflies the head is usually concealed from above by the pronotum (headshield), and apart from the diurnal species, they often have abnormally large eyes and light-emitting organs on the last few ventral abdominal segments (segments 6 and 7/ ventrites 5 and 6) (Figure 5C.). Soldier beetles have a lobed fourth tarsal segment that is absent in fireflies (Arnett *et al*. 2002) while net-winged beetles, as the name suggests, have a lattice of raised lines, or ridges, on their elytra, and the elytra also characteristically widen from the base to the tips (Figure 5B.).

Figure 5. Beetles from three closely related families that employ aposematic coloring to avoid predation. A. *Atalantycha bilineata*, a soldier beetle (Family Cantharidae) from Maryland. Photo: Salvador Vitanza on BugGuide. B. *Plateros* sp., a net-winged beetle (Family Lycidae) from Florida. Photo: Chris Rorabaugh on https://roar.photos/. C. Dorsal and ventral views of *Photinus* species (Family Lampyridae) from Travis County, Texas. Photos: Mike Quinn (BugGuide observation 1532070).

The larvae of all three groups also look similar. However, in net-winged beetles, larvae have short, robust, two-segmented antennae, and usually a 9-segmented abdomen (if a 10th segment is present, it will be small, not visible dorsally, and heavily sclerotized). Soldier beetle larvae have heavily sclerotized heads that are fixed and immobile, in contrast to larvae of the other two families which have retractable heads. Firefly larvae often have elongated heads, with retractable 3-segmented antenna, and 10 abdominal segments (though the 10th segment is usually concealed and not visible dorsally) (Arnett *et al*. 2002).

Within this superfamily (Elateroidea), bioluminescence is also exhibited in some click beetles (Family Elateridae) and railroad worms (also confusingly referred to as glow-worms) (Family Phengodidae). Click beetles can be identified by the spine like projection on their prosternum (the front-most sclerite on the underside of the thorax), which fits into a groove on the mesosternum (the middle sclerite on the underside of the thorax) and creates the characteristic “click”, which is a snap and jump mechanism that keeps the insect safe from predators (Arnett *et al*. 2002). A sclerite is a chitinous plate that constitutes the hard surface of insects. Click beetles also have a distinct pronotal shape, with pointed hind angles. Adult male phengodids have branched antenna and adult females are larviform (Arnett *et al*. 2002). Larvae look like wireworms and often exhibit more colorful bioluminescence than firefly larvae.

State Overviews

Southwest Region

At least 35 species in 12 genera call the Southwest home. The region boasts high endemism, with 25 species found only in the Southwest. In this guide, the Southwest region is not defined by geopolitical borders, but instead by ecoregional types. The Southwest contains a variety of ecoregions, from deserts to mountains, with a plethora of habitat types harboring a diversity of organisms. In lowland areas, Cold Deserts, such as the Colorado Plateau, Arizona/New Mexico Plateau and Central Basin and Range, give way to Warm Deserts farther south. These Warm Deserts include the Sonoran Desert, the Chihuahuan Desert, the Mojave Basin and Range and the Baja California Desert (Wiken *et al*. 2011). These characteristically arid ecoregions host very few firefly species, except along major rivers or other water sources, which are scarce. Most firefly diversity in the region resides in mountainous areas, of which there are many, including the Rocky Mountains, the Wasatch and Uintah Mountains, the Arizona and New Mexico Mountains, the Madrean Sky Islands, and the Sierra Madre Occidental (Wiken *et al*. 2011) (Fig 6). Annual precipitation varies greatly across the region and is influenced both by altitude and seasonal climate conditions. The eastern aspect of the Southwest is flanked by the Great Plains and other grassland ecoregions. There are curiously few fireflies reported from this part of the region. Whether this reflects limited survey effort due to the large amount of private land in the area, loss of species due to agricultural intensification, or a true lack of occurrences, is unclear. In the western aspect, the Southwest includes the southernmost portions of California and northern Baja California, where the chaparral and oak-pine habitats support several glow-worms and diurnal fireflies, but no flashing species to date.

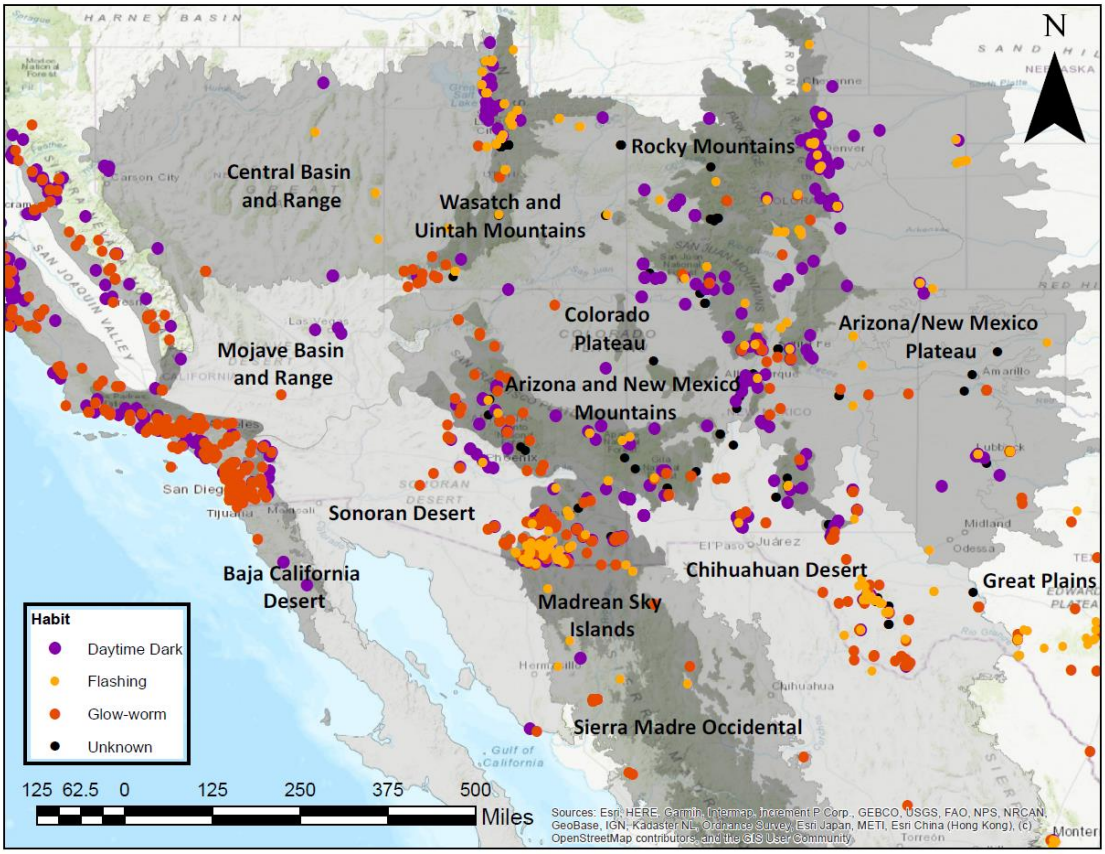


Figure 6. Occurrence records for all Southwestern firefly species. Data was compiled from the IUCN Red List of Threatened Species, GBIF.org (2023), iNaturalist (2024), description papers, scientific literature, personal observations, and personal communications.

Table 1. Number of firefly species currently known to occur in each state or region. Historical records that have not been verified recently were not included. Each year, as we learn more about firefly species in the region, these numbers continue to grow.

State	Number of Flashing Fireflies	Number of Glow-worm Fireflies	Number of Dark Fireflies	Total Number of Species
Arizona	3	7	10	20
Colorado	3	1	5	9
New Mexico	5	4	4	13
West Texas	4	4	5	13
Utah	2	3	2	7
Southern California	0	4	3	7
Northern Mexico	3	5	2	10
Southwest Region	7	11	14	33

Arizona

Arizona has relatively high Lampyrid diversity compared to other states in the region, particularly in the Madrean Sky Islands. There are likely a few reasons for this. First, Arizona is a biodiverse state generally, as it has many different ecoregions, a large range of elevations, and it acts as the northern boundary for many neotropical genera. Second, there has traditionally been high collection and research efforts for invertebrates across the state, primarily stemming from active entomology programs at both the University of Arizona and Arizona State University. Research on the firefly fauna of Arizona accelerated greatly in the 1980s, due in large part to the efforts of Dr. Joe Cicero, who described three new species and two new genera while he carried out his graduate work (Cicero 1982, 1984, 2006). Once Dr. Cicero left the state, there was a 30-year lull in research activity. However, starting in about 2020, an interest in the state's fireflies has been revived, and many naturalists, community scientists, and researchers have begun to again focus attention on the state's unique and under-researched firefly fauna. Most firefly diversity in the state resides in the mountain ranges of southern Arizona, which host at least 18 species, 7 of which are endemic to the region. Endemic species include *Microphotus fragilis, M. chiricahuae, Photinus bivulnerus, P. simplex, P. irrorata, Chespirito milleri,* and *Paraphausis eximius*. Farther north, the situation is not well understood, though many researchers are working to uncover what firefly species inhabit the region. In all, 20 species are known to occur in the state, though it is likely this number will continue to grow as the survey and inventory effort continues.

Southern California

Apart from a few unverified anecdotal reports of flashing fireflies in California, to date all species recorded from the state are glow-worms or daytime dark fireflies. A few observations of *Pyractomena* and *Photuris* species on iNaturalist need to be further investigated. There are quite a few species endemic to the West Coast (including Baja California, California, Oregon, Washington, and British Columbia, Canada) so there appears to be some sort of biogeographical break separating Southern California from the rest of the Southwest. The Sonoran and Mojave Deserts are likely to create this break; deserts are not favorable to fireflies, so dispersal over this arid expanse is likely limited. Species found in southern California, and not elsewhere in the region include *Photinus californica*, *Photinus megista, Pterotus obscuripennis*, *Pterotus curticornis*, and *Microphotus angustus*. Quite a few of the species found in the region, most notably *Pterotus curticornis*, have been collected very few times. Survey efforts are needed.

Colorado

Like other western states, Colorado has few firefly occurrences in the scientific record. Historical occurrences from the eastern plains to the Front Range are found in museum collections, though it appears some of the documented species have not been recorded for many years. For example, there are records of *Photinus pyralis* from Denver in

the 1950s, but apart from an introduced population on the western slope, the species has not been found in the state since (Buschman 2016). A renewed interest in fireflies has added many firefly populations to the map around major population centers such as Boulder and Fort Collins. Much of what has been found seems to be unique from the closest populations of fireflies in neighboring states to the east. As a result, our understanding of firefly diversity in the state will likely continue to evolve over the next couple years.

New Mexico

Until recently, there were only a few documented occurrences of fireflies in New Mexico. However, most New Mexicans who live along waterways in the state or spend a lot of time outdoors, have anecdotal reports of flashing fireflies and glow-worms. These reports abound from almost every corner of the state, though they are concentrated in mountainous areas. It is quite likely firefly diversity in New Mexico is second only to Arizona. It shares many species with southeastern Arizona, and a few of the Arizona endemics are likely to be found in New Mexico eventually. Concerted survey efforts are now underway, and since 2020, several new state records of firefly species have already been established by the author.

Utah

The diversity of fireflies in Utah is becoming increasingly revealed due to the Western Firefly Project. In 2014, researchers at Brigham Young University and The Natural History Museum of Utah set out to better understand the occurrence of flashing fireflies in the state. After several years of following up on sightings submitted by the community, numerous occurrences of mountain variety *Pyractomena dispersa,* as well as a few other species, have been verified. Researchers aim to use molecular techniques to determine if these mountain variety *Pyractomena dispersa* populations are genetically distinct enough to warrant species status. In the desert country of the southern parts of Utah, there are fewer flashing fireflies, and much like other Southwestern states, there is likely a higher diversity of glow-worms and diurnal fireflies that is not yet fully uncovered.

West Texas

Few surveys have been carried out for fireflies in West Texas, though the area has been of interest to other entomologists and collectors for decades. Much of the land in this region is privately owned, which can be a challenge when conducting surveys. Sky Island mountain ranges in the region, such as the Davis and Guadalupe Mountains, create suitable habitats where fireflies thrive.

Northern Mexico

Little is known about the firefly diversity in Northern Mexico, which for the purposes of this guide, includes Chihuahua, Sonora, and Baja California. Many of the species reported from the Southwest US have confirmed occurrences in northern Mexico, and many others, as well as new species and genera, are expected to be found in Mexico eventually. While this guide highlights species that occur both in the US and Mexico, it does not comprehensively address species that may be endemic to northern Mexico, or those that are found from northern Mexico south.

Distribution Summary Table

Table 2. Firefly species of the Southwest, where they are currently known to occur, and their conservation status.

Species	Life History	Females	Southwest Endemic	Distribution	IUCN Red List Status
Unknown Pyractomena spp.	Flashing Firefly	Monomorphic	Unknown	US: Colorado, New Mexico	Not Evaluated
Pyractomena dispersa (mountain variety)	Flashing Firefly	Monomorphic	No	US: Colorado, Utah, Nevada, Wyoming, Idaho, New Mexico, and Arizona	Data Deficient
Photinus stellaris	Flashing Firefly	Brachypterous	No	US: Texas	Least Concern
Photinus pyralis	Flashing Firefly	Monomorphic	No	US: New Mexico, Texas; widespread in Eastern US	Least Concern
Photinus knulli	Flashing Firefly	Monomorphic	Yes	US: Arizona; MEX: Sonora	Vulnerable
Bicellonycha wickershamorum	Flashing Firefly	Monomorphic	Yes	US: Arizona, New Mexico; MEX: Sonora	Vulnerable
Bicellonycha wickershamorum ssp. wickershamorum	Flashing Firefly	Monomorphic	Yes	US: Arizona; MEX: Sonora	Vulnerable
Bicellonycha wickershamorum ssp. piceum	Flashing Firefly	Monomorphic	Yes	US: Arizona, New Mexico	Endangered
Photuris falli	Flashing Firefly	Monomorphic	Yes	US: Texas	Vulnerable
Photuris versicolor complex spp.	Flashing Firefly	Monomorphic	No	US: Colorado, New Mexico, Texas; MEX: Sonora, Chihuahua; widespread eastern US, southeastern Canada, Mexico, and beyond	Not Evaluated
Prolutacea pulsator	Glowworm	Larviform	Yes	US: Arizona; MEX: Nayarit	Data Deficient
Microphotus dilatatus	Glowworm	Larviform	Yes	US: Arizona; MEX: Baja California Sur, Durango, Sonora	Data Deficient
Microphotus octarthrus	Glowworm	Larviform	Yes	US: New Mexico, Arizona, Utah, Texas; MEX: Sonora, Chihuahua, Coahuila	Data Deficient
Microphotus angustus	Glowworm	Larviform	No	US: California, Nevada	Least Concern
Microphotus fragilis	Glowworm	Larviform	Yes	US: Arizona	Data Deficient
Microphotus pecosensis	Glowworm	Larviform	Yes	US: New Mexico, Colorado, Arizona, Utah, Texas; MEX: Chihuahua	Data Deficient
Microphotus chiricahuae	Glowworm	Larviform	Yes	US: Arizona	Data Deficient
Pleotomus pallens	Glowworm	Larviform, brachypterous	No	US: Kansas, Oklahoma, Texas, New Mexico; Widespread in Central Mexico	Least Concern
Pleotomus nigripennis	Glowworm	Larviform, brachypterous	Yes	US: Arizona, New Mexico, Texas, California, Utah; MEX: Sonora	Data Deficient
Pterotus obscuripennis	Glowworm	Larviform	Yes	US: California, Oregon, Washington; MEX: Baja California	Least Concern
Pterotus curticornis	Glowworm	Larviform	Yes	US: California	Data Deficient
Photinus (=Ellychnia) bivulnerus	Dark Firefly	Monomorphic	Yes	US: Arizona	Data Deficient
Photinus (=Ellychnia) corrusca	Dark Firefly	Monomorphic	No	US: Colorado, Arizona, Texas; widespread in eastern US, Mexico, and Canada	Least Concern
Photinus (=Ellychnia) flavicollis	Dark Firefly	Monomorphic	Yes	US: New Mexico, Colorado, Oklahoma, Texas	Data Deficient
Photinus (=Ellychnia) simplex	Dark Firefly	Monomorphic	Yes	US: Arizona	Data Deficient
Photinus (=Ellychnia) irrorata	Dark Firefly	Monomorphic	Yes	US: Arizona	Data Deficient
Photinus (=Ellychnia) alexanderi	Dark Firefly	Monomorphic	Yes	US: Colorado, Utah, Arizona	Data Deficient
Photinus (=Ellychnia) californica	Dark Firefly	Monomorphic	Yes	US: California, Oregon, Wachington; CAN: B.C.	Least Concern
Photinus (=Ellychnia) megista	Dark Firefly	Monomorphic	Yes	US: California	Data Deficient
Pyropyga minuta	Dark Firefly	Monomorphic	No	US: Arizona, New Mexico, Colorado, Texas; widespread from southcentral United States through Central Mexico to Honduras	Least Concern
Pyropyga nigricans	Dark Firefly	Monomorphic	No	US: New Mexico, Colorado, Arizona, Utah, and Texas; MEX: Baja California, Sonora, Chihuahua; widespread central Canada, US (except southeast), and throughout Mexico	Least Concern
Pyropyga modesta	Dark Firefly	Monomorphic	No	US: New Mexico, Missouri, Texas, Oklahoma, Arizona; widespread in eastern and central Mexico	Data Deficient
Chespirito milleri	Dark Firefly (Presumed)	Unknown	Yes	US: Arizona	Not Evaluated
Paraphausis eximius	Dark Firefly (Presumed)	Unknown	Yes	US: Arizona	Data Deficient
Nelsonphotus aridus	Dark Firefly (Presumed)	Unknown	Yes	US: California; MEX: Sonora	Data Deficient

CHAPTER 2: Key to the Genera and Plates of Species

Dichotomous Key to the Southwestern Firefly Genera

This key is adapted from descriptions of genera and species in the scientific literature. Couplets refer to adult males, except where specified.

1. Males and females have pale or yellow light organs (lanterns), with an enamel-like cuticle, on ventral abdominal segments 6 and 7 (ventrites 5 and 6) (flashing fireflies/ lightning bugs) (Figs. 7A-D, 11)……**2**
- In males, light organs on abdominal ventrites either completely absent or reduced to small, median spot or pair of spots on one ventrite. Females may have lanterns (glow-worms and diurnal dark fireflies)……**5**

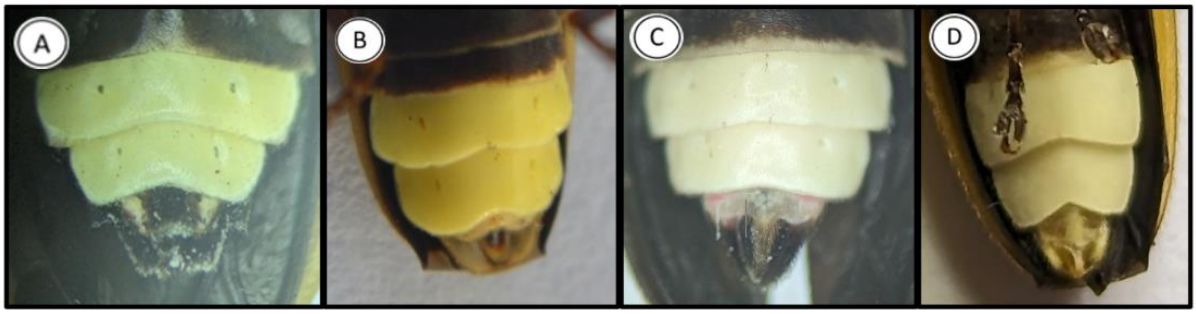


Figure 7. Lanterns of male flashing firefly species. A. *Pyractomena* spp. lantern. Final abdominal segment has pale lateral margins and pygidium is forked. B. *Photinus* spp. lantern. Notice the rounded pygidium and lobed light organs. C. *Bicellonycha* spp. lantern. D. *Photuris* spp. lantern. Notice lack of stigmatoform pores.

2. Has a keel, or ridge, along the midline of the pronotum (Lloyd 2018) (also referred to as median longitudinal carina (Green 1957)) (Fig. 8A); tarsal claws simple (Fig. 9A); male lantern extends the full length of abdominal segments 6 and 7; the final abdominal segment is dark except two pale lateral patches (Green 1957); pygidium is forked (Faust 2017) (Fig. 7A); female lantern consists of two pale, hourglass shaped light organs on the posterior half of ventral segments 6 and 7 (Green 1957)(Fig. 14A); individuals are calm in hand and rarely scramble around flashing (Lloyd 2018)……***Pyractomena* spp. (pg. 22)**
- No keel down the mid-line of the pronotum (Fig. 8B-D), tarsal claws may be simple or not, pygidium rounded at base (Fig. 7B)……**3**
3. All tarsal claws simple/entire (Fig. 9A); midline of pronotum may have groove or it may be smooth (Fig. 8B); elytral fold complete; head rarely visible from above, covered by pronotum; in hand usually calm (Lloyd 2018)……**(nocturnal/lanterned *Photinus* spp.) (pg. 29)**
- Not all tarsal claws simple/ entire (Fig. 9B); elytral fold incomplete; head sometime visible from above; has long slender legs, with hind legs extending back beyond the length of the body (Lloyd 2018)……**4**

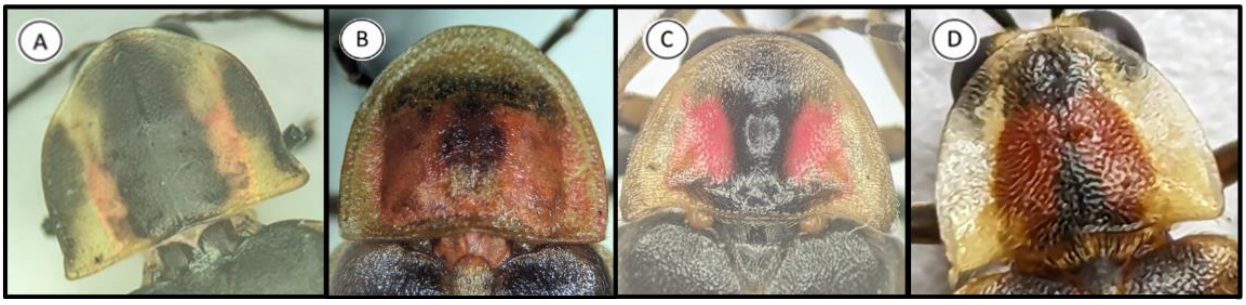


Figure 8. Pronota of flashing firefly species. A. Pronotum of *Pyractomena* spp. with ridge, or keel, down the midline B. *Photinus* spp. pronotum C. *Bicellonycha wickershamorum* pronotum with produced hind angles. D. Pronotum of *Photuris* spp. without median keel.

4. All tarsal claws apically cleft in male, entire in female (Olivier 1911) (Fig. 9B); no lateral processes on basal piece of genitalia (McDermott 1962); hind angles of pronotum produced (corners of the pronotum have sharply acute angles (Fig 8C) (Cicero 1982) .....***Bicellonycha* spp. (pg. 37)**

- Anterior outer tarsal claws apically cleft (2-pronged or bifid) in both sexes, inner claws entire (Fig. 9C); elytral epipleural fold not or poorly defined below humerus; genitalia with two long, slender lateral processes on basal piece; scramble and flash when caught (Lloyd 2018).....***Photuris* spp. (pg. 40)**

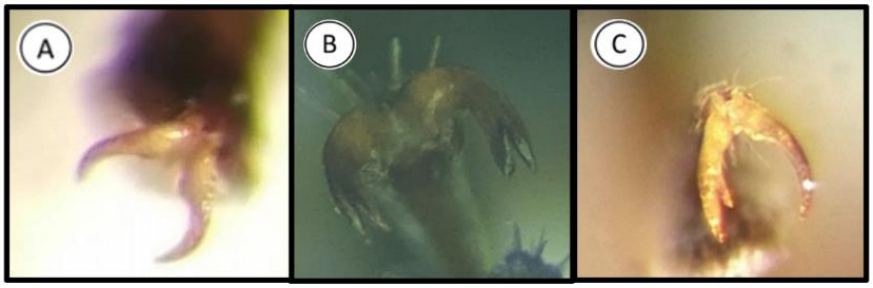


Figure 9. Tarsal Claws. A. Simple claw as seen in *Photinus* spp. and *Pyractomena* ssp. B. Tarsal claws of *Bicellonycha* spp. (both bifid). C. Tarsal claws of *Photuris* spp. (anterior claw bifid).

5. Sexual dimorphism extreme; males are winged and have no lantern (if present, very reduced); females are often larviform and alate (or at least brachypterous) and do have a lantern; males usually have enlarged eyes which are often close together (except in *Pterotus* spp.); morphology variable but characteristics typical of other fireflies usually absent (long filiform antenna (Fig. 10A), dark elytra, yellow and red pronotum with dark markings); nocturnal (glow-worms)(Fig 12).....**6**

- Little, if any, sexual dimorphism (except possibly in *Chespirito milleri*, *Paraphausis eximius* and *Nelsonphotus aridus* as the females are unknown); eyes not enlarged to the extent that they are touching, or nearly so; lantern on both males and females usually absent (very reduced in *Photinus (=Ellychnia) flavicollis, P. bivulnerus*, and *Paraphausis eximius*); elytra entirely dark (usually black); characteristics typical of other fireflies usually present (long filiform (Fig. 10A) or sub-serrate antenna (Fig. 10B), dark elytra, reddish (sometimes with yellow) pronotum with dark markings at least along median vitta (center stripe) and usually around margin (except in *Chespirito milleri*, *Paraphausis* eximius, and *Nelsonphotus aridus*); day active (diurnal dark fireflies) (Fig. 13).....**9**

6. Male antennae moniliform (Fig. 10A).....**7**

- Male antennae pectinate (Fig. 10C).....**8**

7. Antennae with 11 segments, scape of antenna three times longer than the length of the first flagellomere, distinct tuberculiform appendix absent from terminal segment; ventral abdominal segment 8 without apical process (Cicero 1984).....***Prolutacea pulsator* (pg. 46)**

- Antennae with less than 11 segments, antennomeres stout, terminal segment with distinct tuberculiform appendix (Fig. 10E); ventral abdominal segment 8 with apical process (Green 1959).....***Microphotus* spp. (pg. 48)**

8. Small, short and stout body; flagellomeres of the antenna with two short branches (Fig. 10D); eyes large; pronotum pale yellow with pink median vitta (center stripe) on anterior half; elytra truncate and pale brown with pale yellow margin, narrower apically.....***Pleotomus* spp. (pg. 56)**

- Large, elongate body; antennae brown, antennomeres 3-10 each with one long branch (LeConte 1959); eyes small compared to most other glow-worms; short, rectangular, uniformly testaceous pronotum; elytra uniformly dark with netlike surface .....***Pterotus* spp. (pg. 59)**

9. Long filiform or sub-serrate antenna (Fig. 10B), not strongly setose (hairy); elytra relatively smooth, not textured; dark pronotal markings present, at least along median vitta (center stripe) and usually around the margin……..**10**

- Antennae variable, either short filiform with flagellomeres squat but cylindrical, or long filiform and strongly setose; elytra have net-like texture; pronotum uniformly brown, reddish orange, or pink……..**11**

10. Light organs absent, though in some species glow can be seen from vestigial light organs at night (*Photinus (=Ellychina) flavicollis*, *P. bivulnerus* and *Paraphausis eximius*, appear to have reduced light organs); pronotum concolorous or pale flavate, usually with a hint of red, and has a well-defined median vitta (center stripe), more than a third to half the width of the pronotum, typically closely following line of convex median area (except in *P. bivulnerus*); third antennal segment shorter than fourth segment, antenna segments mostly parallel sided and typically not compressed (Fig. 10A); overall shape slightly oval, with sides of elytra slightly flared out; typically larger than 10 mm (Fender 1970)……..***Photinus* (*Ellychnia)* spp. (pg. 62)**

- Light organs entirely absent; entirely black or dark piceous, apart from the pronotum; pronotum is pale flavate, usually with a hint of red, and has a well-defined median vitta (center stripe), about a third to half the width of the pronotum, typically hourglass shaped or parallel sided; third antennal segment as long as or slightly longer than fourth segment, and antenna sub-serrate (segments widen from base to apex) and are slightly compressed; overall shape elongate and parallel sided; body length 2.5-8.5 mm (Green 1961)…….. ……..***Pyropyga* spp. (pg. 73)**

11. Antennae filiform and strongly setose, with antennomere 3 much smaller than all other antennomeres; pronotum constricted medially (Ferreira *et al.* 2020)……..***Chespirito milleri* (pg. 77)**

- Antenna short with flagellomeres squat but cylindrical (Fig. 10D), terminal segment has apical membranous tuberculiform appendix (Fig. 10E); pronotum not as above……..**12**

12. Anterior angles of pronotum rounded; lines of inflection of lateral pronotal flanges straight (Cicero 2006); size 4-4.5 mm (Green 1949)……..***Paraphausis eximius* (pg. 79)**

- Anterior angles of pronotum slightly acute, lines of inflection of lateral pronotal flanges curving inwardly at their anterior ends; size 3.7 mm or more (Cicero 2006)…… ***Nelsonphotus aridius* (pg. 80)**

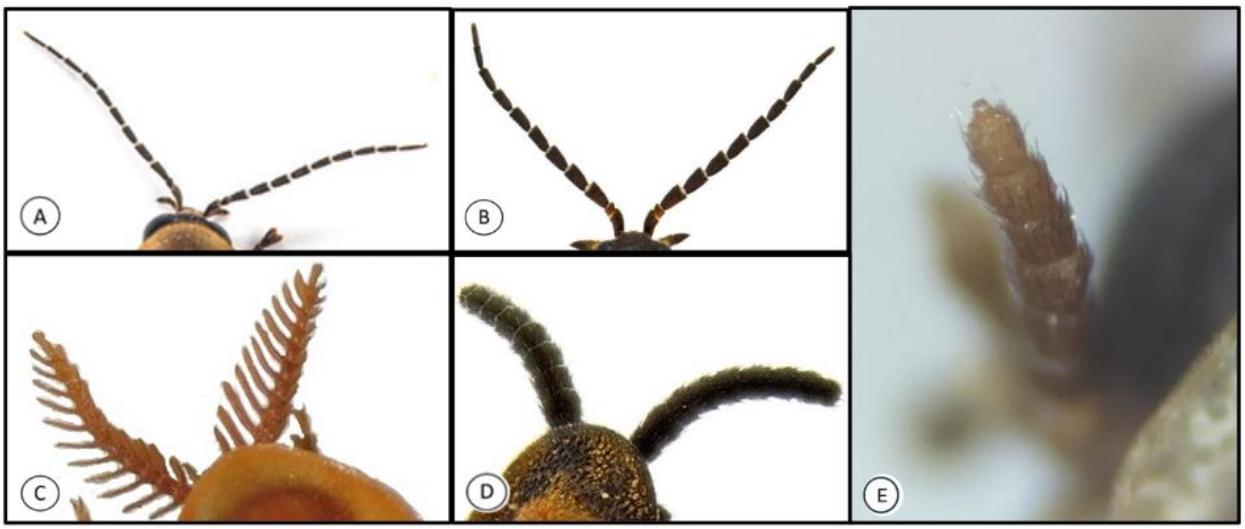


Figure 10. Variety of southwestern firefly antennae. A. Long filiform or moniliform antennae B. Sub-serrate antennae. C. Pectinate antennae, flagellomeres with two short branches D. Short moniliform antennae with flagellomeres squat and cylindrical. E. Apical membranous tuberculiform appendix on terminal segment of antenna.

Plates of Species

Plate 1: Flashing Fireflies

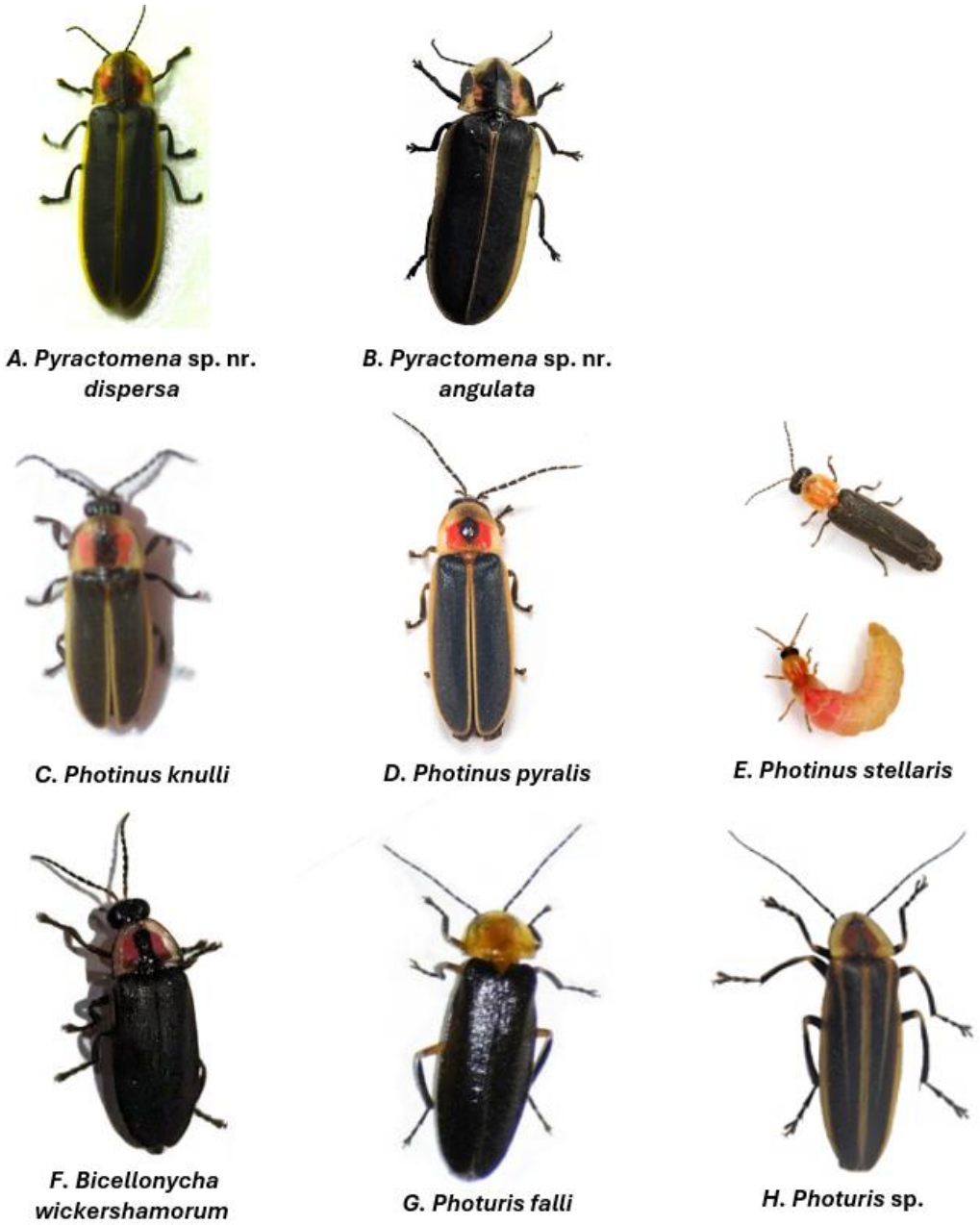


Figure 11. Plate 1: Southwestern Flashing Firefly Species. A. *Pyractomena* sp. nr. *dispersa* female from Utah. B. *Pyractomena* sp. nr. *angulata* from New Mexico. C. *Photinus knulli* from Arizona. D. *Photinus pyralis* from Texas. Photo: Mike Quinn. E. *Photinus stellaris* from Texas. Male above and brachypterous female below. Photos: Mike Quinn (BugGuide observations 1664585 and 1664721). F. *Bicellonycha wickershamorum* from New Mexico. G. *Photuris falli* from Texas. Photo: Jon McIntyre (2023) (iNaturalist observation 160936783). 27. H. *Photuris versicolor* complex species from New Mexico. Photos altered to remove background in some cases.

Plate 2: Glow-worm Fireflies

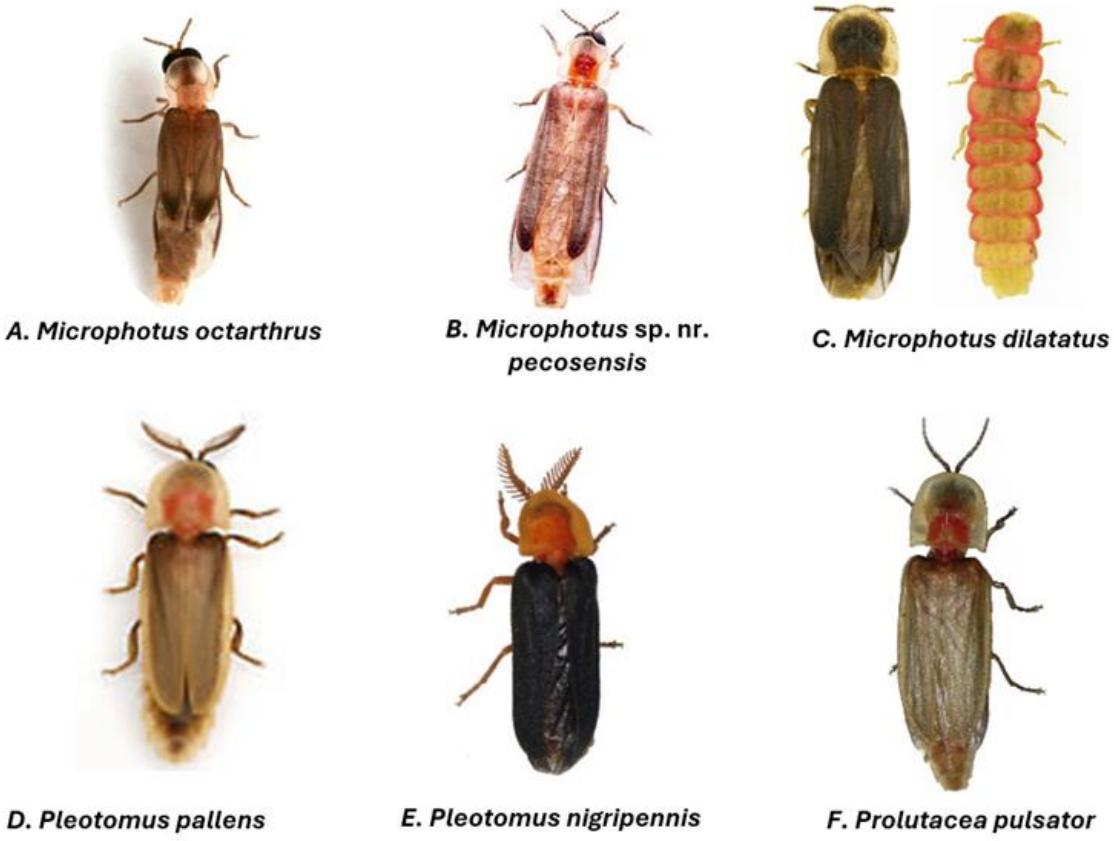


Figure 12. Plate 2: Southwestern Glow-worm Species. A. *Microphotus octarthrus* adult male from Brewster County, Texas. Photo: Mike Quinn (BugGuide observation 1059398). B. *Microphotus* sp. nr. *pecosensis* from Colorado. Photo: Josiah Kilburn (2023) (iNaturalist observation 169848554). C. *Microphotus dilatatus* adult male and female from Arizona. Photos: Salvador Vitanza on https://elp.tamu.edu/. D. *Pleotomus pallens* from Texas. Photo: Mike Quinn (BugGuide observation 1168898). E. *Pleotomus nigripennis* male from Arizona. Photo: C. Mallory (2019a) (iNaturalist observation 27405485). F. *Prolutacea pulsator* male from Arizona. Photo: C. Mallory (2019b) (iNaturalist observation 26448976). Photos altered to remove background in some cases.

Plate 3: Dark Fireflies

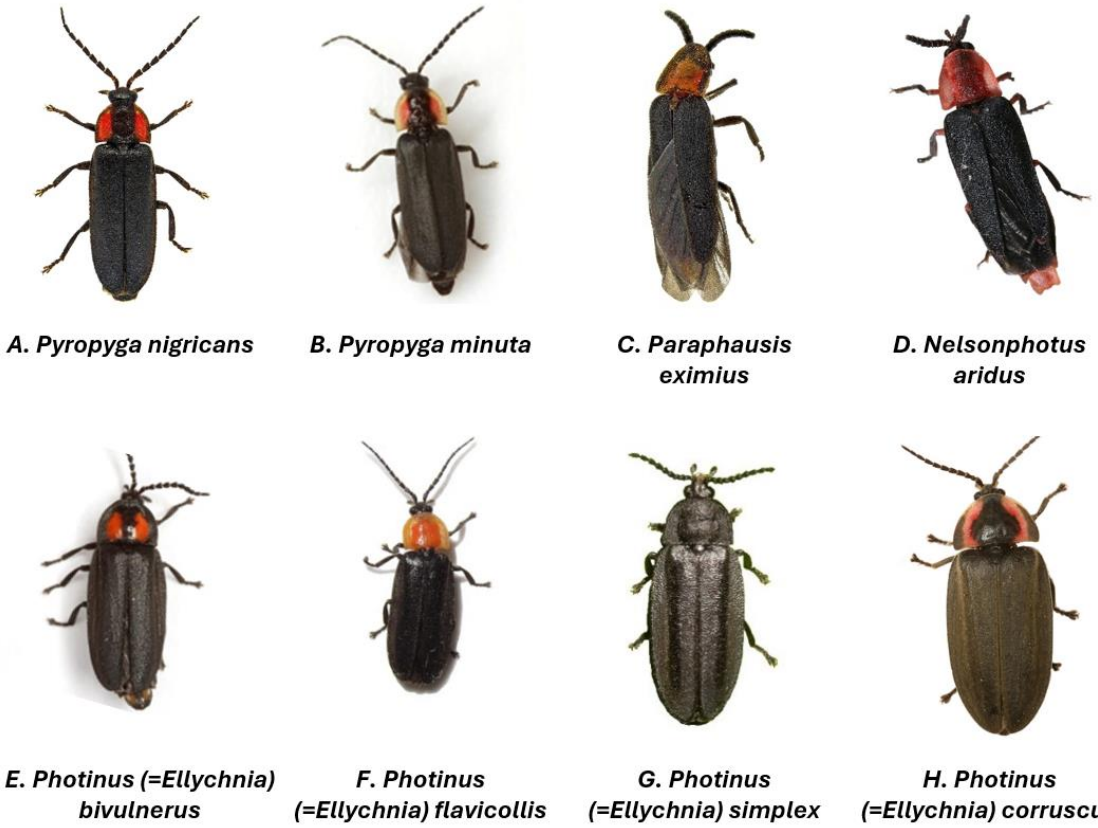


Figure 13. Plate 3: Diurnal Dark Firefly Species. A. *Pyropyga nigricans* from Arizona. Photo: Salvador Vitanza on https://elp.tamu.edu/. B. *Pyropyga minuta*. Photo: Mike Quinn (BugGuide observation 464863). C. *Paraphausis eximius* from Arizona. Photo: Salvador Vitanza on https://elp.tamu.edu/. D. *Nelsonphotus aridus*. Photo: Joyce Gross (BugGuide observation 36406). E. *Photinus (=Ellychnia) bivulnerus* from Arizona. Photo: Mike Quinn (BugGuide observation 820804). F. *Photinus (=Ellychnia) flavicollis* from Colorado. Photo: Eric R. Eaton (2019) (iNaturalist observation 28769052). G. *Photinus (=Ellychnia) simplex* from Arizona. Photo: Charles W. Melton (BugGuide observation 1101134). H. *Photinus (=Ellychnia) corruscus*. Photo: Mike Quinn (BugGuide observation 1120849). Photos altered to remove background in some cases.

CHAPTER 3: FLASHING FIREFLIES

Genus *Pyractomena* LeConte

There are 16 recognized species of *Pyractomena* in the United States. At least two species have been recorded in the Southwest, though it is unclear if these western populations belong to species that are already described, or if they might be something new (Fig. 15). *Pyractomena* species have a sculpted pronotum with a raised midline ridge, often referred to as a median keel (Lloyd 2018). The pronoun also has a slightly pointed anterior margin (Green 1957). The elytra are typically black with yellow borders and the body shape can be broad to elongate. The pattern of hairs on the elytra was used by Green (1957) to distinguish between species. The sex of an individual is revealed by the shape of the lantern, which covers the entire width of two abdominal segments in males, and only the outer edges of two abdominal segments in females (Fig. 14). *Pyractomena* fireflies are often associated with marshy habitats, such as wet fields, montane marshes, and wetland areas along streams. Some species are quite tolerant of cold weather. For example, the winter firefly (*Py. borealis)* is often the first firefly seen in North America in the spring, and *Py. dispersa* has been reported from high elevation sites in the Rocky Mountains. In some cases, the flash of fireflies in this genus appears amber or yellow.

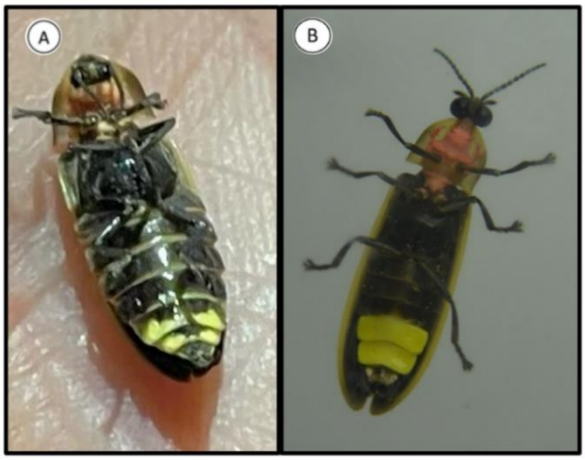


Figure 14. *Pyractomena* lanterns. A. Ventral view of female *P. dispersa*. B. Ventral view of male *P. dispersa*.

Key to male *Pyractomena* species of the Southwest

1. Black markings on margin of pronotum may be lacking, though often present on western specimens (Pacheco 2014); scutellum black but usually bordered by yellow elytral margins (Faust 2017); body length 9-12.5 mm; viewed ventrally, inner margins of lateral lobes of aedeagus not strongly diverging, apices not abruptly narrowed (*P. borealis* group)(Green 1957); male flash is half second or less, yellowish orange flicker flash, given off every four to seven seconds (at 65°F); flies 35 minutes to two hours after sunset; becomes active in early spring (April to July); habitat is wetlands or marshy fields (Faust 2017).....***Pyractomena* sp. nr. *dispersa* (pg. 24)**

- Yellow elytral margin very wide; side margins of pronotum with dark markings, usually wider toward the front; scutellum black; 7.5-13 mm in length; viewed ventrally, inner margins of lateral lobes of aedeagus strongly diverging and sinuate distally, apices abruptly narrowed (*P. lucifera* group)(Green 1957); male flash is half to one second orange flickering flash, given off every two to four seconds (at 68°F); flies one to three hours after sunset; seasonality June to early August; habitat is forest and forest margins, usually near water, from valleys to mountains (Faust 2017)……..***Pyractomena* sp. nr. *angulata* (pg. 26)**

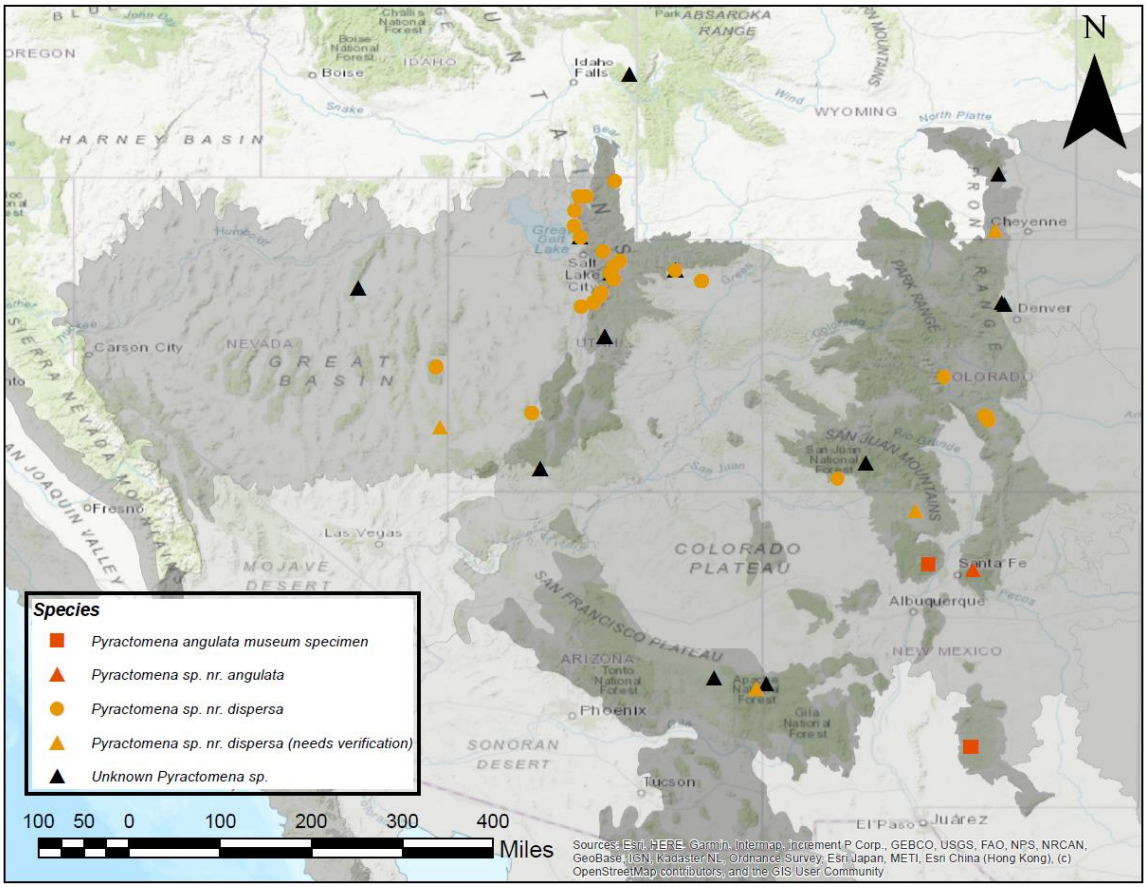


Figure 15. Known occurrences of *Pyractomena* species in the Southwest. Square occurrences represent museum specimens where identification needs to be verified in the field. Light and dark orange triangular occurrences are recent records, but species identification still needs to be determined. All *Pyractomena* sp. nr. *dispersa* represented here are "mountain variety *Pyractomena dispersa*". Black triangular occurrences are museum specimens identified only to genus.

Pyractomena sp. nr. *dispersa* (Mountain Variety Marsh Flicker*)

Description

In the eastern United States, *Pyractomena dispersa* Green, 1957 is fairly easy to identify because it usually does not have dark markings on the outer margins of its pronotum, as is seen in many other *Pyractomena* species (Faust 2017). In addition, the scutellum of *P. dispersa*, while mostly dark, has a slightly pale apex. It also has inconspicuous primary pubescence, which is sparse and short basally, but longer distally and the secondary pubescence covers the apical fourth of the elytral surface (Green 1957). Males are typically 9-12.5 mm in length, and females are 8-12.5 mm (Green 1957). In the western US, many populations of a certain *Pyractomena* firefly have, to date, been identified as *Pyractomena dispersa*. However, these western *Py. dipsersa*, dubbed "mountain variety *Py. dispersa*", or "The Wiggle Dancer" by Buschman (2016), have several differences from their eastern counterparts. Most notably, specimens from western populations often have a slight darkening along the margins of the pronotum (Fig. 16). There are also differences in the male genitalia, thorax, and labrum (Pacheco 2014).

Figure 16. *Pyractomena* sp. nr. *dispersa* male from Alpine, Apache County, Arizona.

Distribution

Pyractomena dispersa is widespread within the United States and Canada (Faust 2017). Its distribution is, however, very patchy, with few occurrences scattered in the Southeast, Northeast, Upper Midwest and Rocky Mountains (Lloyd 2018). In the West, something resembling this species has been recorded in mountainous wet habitats in Colorado, Utah, and Idaho, northern New Mexico and Arizona. Preliminary molecular evidence suggests these western populations show significant divergence from eastern populations, indicating they may soon be considered a new species (Pacheco 2014).

Habitats and Ecology

Adult *Pyractomena dispersa* are typically seen flying over wet habitats including swamps, marshes, river sloughs, low wet pastures where the water table prevents agricultural crops from growing, and other poorly drained areas (Lloyd 2018, Faust 2017). In the Rocky Mountain states, mountain variety marsh flickers occur in permanent marsh areas, such as wet pastures, at altitudes from 4,000-8,000 feet (Buschman 2016) (Fig. 17). This is one of the first flashing species to emerge in the Southwest region, with records spanning from late May to early July. In some populations, males have been observed flashing from the vegetation. This may happen when temperatures are too cold for flight. In early June, at altitude, temperatures can drop quickly. Females are winged, and with the exception of their lantern, look similar to males. Larval *Pyractomena* are predacious and due to their slender heads, appear to be uniquely adapted to feed on snails (Lewis 2016, Majka 2012, Lloyd 2018).

Besides morphological characters, there are several other differences between eastern and western populations of this species. First, the phenology of eastern *P. dispersa* populations seems to be much more predictable. Adults appear in the late spring around 719 growing degree days (GGD) and continue to be active through about 1,300 GGD (Faust 2017). For an explanation of growing degree days, see text box on page 25. In Utah and Idaho populations, individuals can be seen anywhere from 160 to 2,2291 GGD, making the emergence of adults in the west much less predictable (Pacheco 2014). In general, it seems that GGDs are not reliable predictors of phenological timing for western firefly populations (A. Walker pers. obs.). It is possible fireflies in the west are responding to a more complex suite of environmental cues, due to the aridity of the landscape; precipitation conditions as well as temperature accumulations may need to be just right for fireflies to emerge.

Growing Degree Days Explained: Insects are poikilotherms, which means they rely on ambient heat to regulate body temperature. In temperate regions, as temperatures increase in the spring, occasionally temperatures adequate for insect growth and development are reached. It takes a certain amount of time above a certain temperature for an insect to develop to adulthood. We can rely on a measure of accumulation of average daily temperatures, called a growing degree day, to predict when insects may become active in the season.

Flash Pattern

At dusk from late-spring though early summer, males of eastern *Pyractomena dispersa* perform flashing courtship displays, letting off a twinkling flicker-flash, often with several rapid peaks, which repeats every 4-7 seconds. Typically, they fly low over the vegetation while flashing (Faust 2017). In western populations, similar displays begin just before sunset and continue for an hour or two (Pacheco 2014).

Conservation Status: Data Deficient

Though widespread across the US, *Pyractomena dispersa's* distribution is very patchy, with few scattered occurrences. There is also some evidence of local extirpation in several different regions throughout its range. Declines are likely the result of habitat loss due to development, conversion of land for agricultural, and light pollution. *Pyractomena dispersa* was assessed as Data Deficient on the IUCN Red List, as research on the extent of decline is needed (Walker 2021a). Therefore, this species is a priority for further survey work and genetic studies. If the mountain variety *Pyractomena dispersa* is described as a new species, a conservation status assessment should be carried out. Given how fragile wetland habitats are in the western US, the species may be considered threatened.

Figure 17. Habitat of what appears to be mountain variety *Pyractomena dispersa*. Top: A wet horse pasture near Chama, Rio Arriba County, New Mexico. Bottom: Wet valley habitat in a ponderosa pine forest near Alpine, Apache County, Arizona.

Pyractomena sp. nr. *angulata* (Holy Ghost Firefly*)

Description

Pyractomena angulata (Say, 1825) is a typical looking *Pyractomena* species. Therefore, it is large (9-17 mm), it has a keel, or ridge, down the mid-line of its pronotum, the side margins of pronotum have dark markings, and the scutellum is dark. However, according to Lloyd (2018), it is quite distinct in the hand due to its usually colorful, broad form, its angular, pentagon-shaped pronotum, and very wide, pale lateral elytral margins. In the males, there is "a feeble modification of the anterior claw of the front and middle tarsi", which is seen otherwise only in *P. lucifera*, but this characteristic can be difficult to see unless the claws are extended (Green 1957). Green (1957) used elytral pubescence to differentiate *Pyractomena* species. In that regard, *P. angulata* has primary pubescence that is short and of average density, and is not notably conspicuous. The secondary pubescence covers the entire elytral surface and is equally dense to the extreme base. The pronotum is subglabrous, with minute inconspicuous hairs (Green 1957). Both sexes are 7.5- 13 mm in length. In the West, it can only be confused with mountain variety *Pyractomena dispersa*.

Figure 18. Specimen in collection at the Museum of Southwestern Biology at UNM (MSBA 52451). Erroneously identified as *Pyractomena angustata*, but it is likely the identifier meant *Pyractomena angulata*. Collected in July 1978 at Bandelier National Monument, Sandoval County, New Mexico.

Distribution

Pyractomena angulata is one of the most widespread flashing firefly species in North America. It is reported from every state east of the Mississippi, including into eastern Canada, and has also been reported from New Mexico, Saskatchewan, and North Dakota (Faust 2017). While these outlying records could be due to mislabeling (Lloyd 2018), there are several museum specimens from New Mexico that are at least morphologically close to *Py. angulata*. Green (1957) includes New Mexico (Frijoles Canyon, Bandelier National Monument, 6,600 ft.) in his list of occurrence localities for this species, and a specimen housed at the University of New Mexico likely represents another collection of this species from Bandelier National Monument (Fig. 18). There is also a record of this species in the Museum of Comparative Zoology (MCZ 683636) with a locality of Cloudcroft, NM in the Sacramento Mountains. Lloyd (2018) also mentions records from Santa Fe County and one unspecified county in western Colorado. Clearly, historical records of this species in the West need to be checked and flash patterns need to be observed. This will help clarify whether the western populations that museum

Figure 19. *Pyractomena angulata*-like specimens from the Pecos Wilderness in San Miguel County, New Mexico.

specimens were taken from match eastern *Pyractomena angulata.* Based on what I have seen so far, it is more likely western populations represent new species altogether. So far, no populations have been rediscovered at historical localities in the Sacramento Mountains or at Bandelier National Monument (A. Walker pers. obs.). However, an unknown *Pyractomena* species, resembling *P. angulata,* was found in the Pecos Wilderness of New Mexico (San Miguel County) in 2023 (Fig. 19). In addition, an unknown *Pyractomena* species of similar form has recently been observed in the Front Range of Colorado (R. Sarfati and L. Buschman pers. comm. 2023).

Habitats and Ecology

Pyractomena angulata is found in a variety of habitats including both moist and dry forests and forest margins, from valleys to high mountains over 6,000 feet (Fig. 20). Larvae and female adults are restricted to wet and mesic sites, whereas males have been seen in xeric sites as well (Faust 2017). During the adult season in the eastern United States, males are seen flying near treetops in almost any mesic forest, tree lined site, or creekside (Lloyd 2018). They are found in forested swamps and river bottoms in Florida and Georgia, tall cottonwood forests along major rivers in Kansas, and in wet meadows and valley marshes of the Rocky Mountains (Lloyd 2018, Buschman pers comm. 2019). Larval *Pyractomena* are predacious and due to their slender heads, appear to be exceedingly adapted to feed on snails (Lewis 2016, Majka 2012, Lloyd 2018). Larvae have been seen glowing along the substrate below understory shrubs on a wet evening in a mesic hammock in Florida (Lloyd 2018). In Florida, adults are seen as early as February, while in the northern portions of this species' range, they do not emerge until June, with peak activity in July (Lloyd 2018, Faust 2017).

Figure 20. Stream side habitat in the mountains of the Pecos Wilderness, where a *Pyractomena angulata*-like firefly species was observed, San Miguel County, New Mexico.

Flash Pattern

The males of this species have an unmistakable flash pattern, giving off an orange, half-second to one-second flicker-flash, at a frequency of two to four seconds, one to three hours after dark (Faust 2017). During the male displays, which take place at least six feet off the ground, nearby females perched on vegetation, respond with half-second to second long flashes (Faust 2017).

Conservation Status: Least Concern

As mentioned, *Pyractomena angulata* is one of the most widespread *Pyractomena* species. It is found across much of eastern North America, and in a few localities west of the Mississippi River. While there are some reports that this species has become less common and is possibly extirpated from large areas in the Mid-Atlantic, in most portions of its range, no declines have been reported. Possible threats include habitat loss due to development and conversion of land for agriculture as well as light pollution. It is considered a species of Least Concern on the IUCN Red List (Walker 2021b), but research on localized declines and possible threats is needed. While *P. angulata* may be secure in its eastern range, western *P. angulata*-like populations are likely quite fragile. There are very few known occurrences, and they are spread across vast distances. Any number of threats, including forest fire and subsequent flooding, drought, recreation within firefly habitats, and cattle grazing could lead to localized extirpations. It is likely that some populations have already disappeared. Surveys near historic occurrences in New Mexico's Sacramento Mountains and Jemez mountains have failed to rediscover the presence of these fireflies.

Species Highlight: *Pyractomena vexillaria* Gorham, 1881 (Amber Comet Firefly)

While not yet recorded in the Southwest, *Pyractomena vexillaria* has been recorded nearby in Val Verde County, Texas. Anyone out looking for fireflies in West Texas should be on the lookout for this species. It is highlighted here because it is considered one of the "Lost Species" of fireflies. It has not been recorded by science recently, despite search efforts. It seems to have disappeared from areas where it was once found in Texas, and it is likely highly threatened across its range. It is listed an Endangered on the IUCN Red List (Walker *et al.* 2022a).

Pyractomena vexillaria was originally described from a single specimen collected in Veracruz, Mexico (Gorham 1881). In the archive collections of three US museums, Green (1957) found five more specimens from localities within Val Verde and Comal Counties, in Texas. Lloyd (2018) also collected this species in Cardenas, Tabasco, Mexico, likely in 1980.

Lloyd (2018) looked for this species in Texas several times without success and it has not definitively been recorded there since 1940. A flash, which could have been the distinct amber courtship display of this species was observed in Comal County in 2017 (B. Pfeiffer pers. comm. 2020), but the individual emitting the flash was not caught, so the record cannot be verified. Surveys in Val Verde County have been carried out, without success (B. Pfeiffer pers. comm. 2020). This species has also not been verified in Mexico in decades, although no targeted survey efforts have taken place.

Lloyd (2018) observed *Pyractomena vexillaria* males flying low over a marsh in Cardenas, Mexico. In Texas, the habitat where the species has been recorded in Val Verde County is mixed semi-arid cenizo and guajillo brushland with limestone river basins, whereas Comal County is hill country with dominant vegetation of oak and cedar brush (Walker *et al.* 2022). Adults of this species fly in mid-summer. Male courtship displays begin half an hour after sunset, and consist of a single, short, amber colored flash, emitted at about two second intervals, while flying low over marshy vegetation (Lloyd 2018).

Figure 21. The Amber comet firefly, not recorded since approximately 1980. This species has conspicuous, long, dense hairs on the elytra. The yellow stripes on the elytra (referred to as discal costae) and the lack of a dark center spot on the pronotum, may also be diagnostic. If present this spot will be reduced to a small spot at the base of the pronotum. This specimen resides in the Triplehorn Insect Collection. Photo: Mike Quinn (BugGuide observation 1324166).

As this species has not been verified in Texas since 1940, it is possible that past declines were driven by habitat loss due to urban and agricultural development, light pollution, and misuse of water resources, including over pumping of ground water and damming of rivers. In the region between Veracruz and Tabasco, where this firefly was once recorded in Mexico, has recently experienced substantial agricultural and urban growth. From the 1950s to the 1970s, more than 80,000 hectares of marsh habitat was drained for agricultural and urban development in Cardenas, Tabasco and surrounding areas, as a result of the Plan Chontalpa governmental program (Lanza and Whittle 2017). A similar scenario happened in Veracruz during the past century. Now much of the region has been converted to sugar plantations and cattle pasture, with estimated wetland losses of 58-60% in both Mexican states (Landgrave and Moreno 2011).

Genus *Photinus* Laporte

Until recently, there were at least 34 species of *Photinus* in North America, north of Mexico, three of which have been documented in the Southwest. This number has increased substantially recently, because the genus *Ellychnia* has been synonomized with *Photinus* (see more on this in the section dedicated to *Photinus* (=*Ellychnia*), pg. 62) (Zaragoza-Caballero *et al.* 2023). This guide keeps the two groups separate, simply because their life histories are dissimilar (nocturnal flashing fireflies vs. diurnal, dark fireflies). Therefore, this section on *Photinus* deals only with the nocturnal flashing species.

Most species of *Photinus* can be distinguished from one another by their genitalia and their unique flash patterns. Researchers Green (1956) and Lloyd (1966) both contributed greatly to our current understanding of the species in this genus. In the eastern US, one *Photinus* species or another can usually be seen flying all summer long, though the activity period for any one species is usually only a few weeks. In some regions, these are the most commonly seen fireflies. One species, the Big Dipper firefly (*Photinus pyralis*), is tolerant of habitat degradation, and can still be seen in lawns, city parks, and even the occasional parking lot (Faust 2017). Within the Southwest region, the species of *Photinus* are quite restricted in distribution (Fig. 23). There are historic records of *P. pyralis* from several southwestern states (Arizona, Utah, and Colorado), though current populations have only been confirmed in Texas and New Mexico. The southwest synchronous firefly, *Photinus knulli*, is known from southern Arizona and northern Sonora, Mexico. This species is unique among its congeners because males exhibit lekking behavior and in large enough numbers, will flash in synchrony (Sarfati *et al.* 2022), as the name suggests. Lastly, *Photinus stellaris*, a small firefly with flightless females, is known only from Texas.

It is likely that additional *Photinus* species will be recorded in the Southwest in the coming years. For example, there is a recent record of an unknown *Photinus* species from the mountains of central Colorado (O. Martin pers. comm. 2023). Researchers are still trying to better understand what species it may be, though it is reportedly close to *P. obscurellus*. *Photinus concisus* may also be recorded in the region eventually. It is found in central Texas, as far west as Val Verde County, where it shares some habitats with *Photinus stellaris* (B. Pfeiffer pers. comm. 2023).

Photinus species can be anywhere from 6-19 mm long. They are slender and have short legs, the femora of which only slightly exceed the lateral body margin. The pronotum, which has a rounded front margin and occasionally a groove down the midline, typically also has a yellow margin and a central red area with a black spot or longitudinal stripe. The elytra are usually dark with yellow borders and are parallel sided. The male lantern occupies the entire ventral face of abdominal segments 6 and 7. The female lantern, while variable between species, typically occupies the central area on the antepenultimate abdominal segment (Green 1956).

As an aside, many western firefly species seem to have much darker elytra than their eastern counterparts. Species such as *Photinus stellaris* and *Photuris falli*, for example, have almost entirely black elytra. *Photinus concisus* in Texas, has several populations in the western portion of its range, where individuals have darkened elytra (B. Pfeiffer pers. comm. 2023). Whether this is due to unique environmental conditions or altered predator prey dynamics, is unknown.

Figure 22. *Photinus pyralis* on a dew-covered leaf in Harding County, New Mexico.

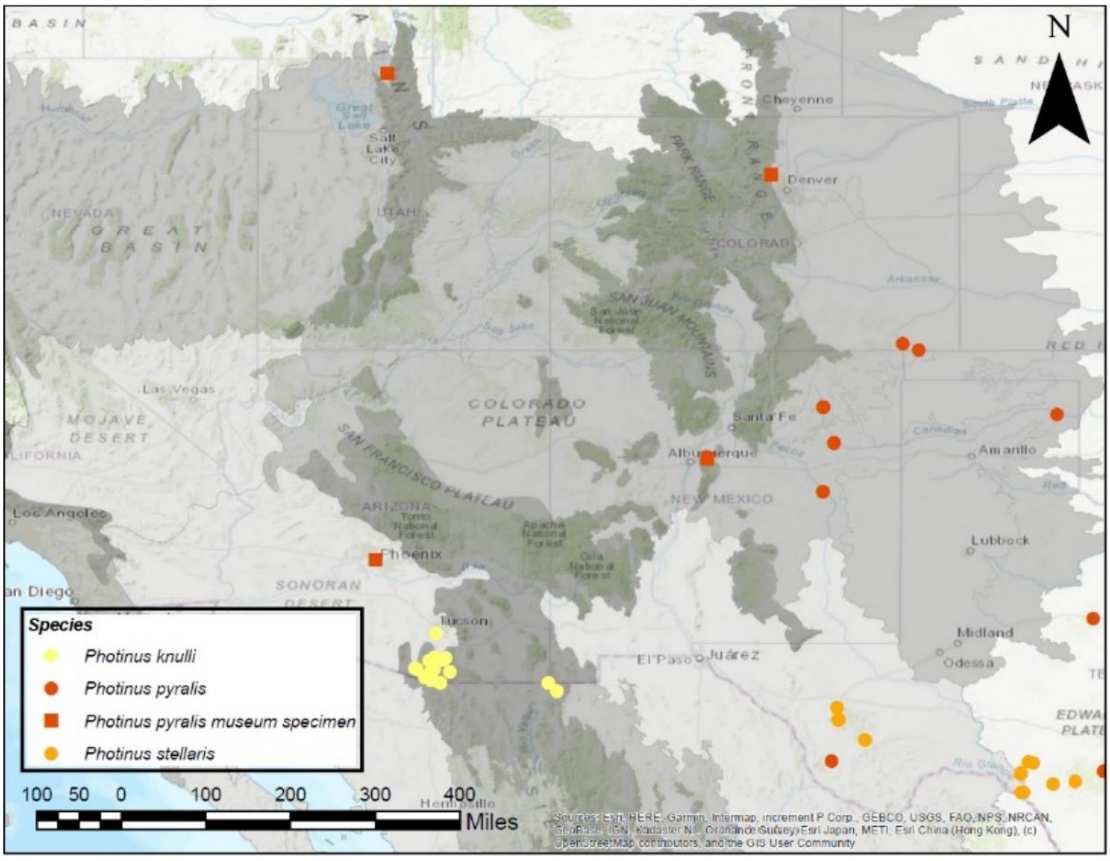


Figure 23. Occurrences of *Photinus* species in the Southwest. Squares represent museum specimens where recent occurrences have not been verified.

Key to male *Photinus* species of the Southwest

1. Body length 6.5-9 mm; elongate; elytra of males black; pronotum yellowish with pink convex disc, without dark markings; scutellum yellow; female brachypterous (Green 1956)……..***Photinus stellaris*** **(pg. 31)**

- Elytra black with yellow margins; sometimes there are dark markings on yellow to red pronotum; females winged……..**2**

2. Relatively large, body length 9-19 mm (Faust 2017); most specimens have prominent dark spot in the center of pronotum, surrounded by pink or red, though there is variability in this mark and it may be reduced or missing altogether (Green 1956); scutellum is pale; lower margin of abdominal segment 5 has pale border just above lantern (Faust 2017); both males and females have dark T-shaped marking on dorsal surface of pygidium (Green 1956); male flash is J-shaped, almost one second long yellow flash, given off every 6 seconds (at 73ºF) (Lloyd 1966); flies from sunset late into the night; seasonality is June to October (Faust 2017); habitat in Southwest is dry open areas usually in proximity to rivers, streams, lakes or reservoirs (A. Walker pers. obs.)…….. ……..***Photinus pyralis*** **(pg. 33)**

- Black side markings on margin of pronotum; scutellum black but usually bordered by yellow elytral margins; body length 8 mm (Green 1956); male flash is half second or less, yellowish-orange series of three flashes, given off every four to seven seconds (at 65ºF); flies 35 minutes to two hours after sunset; seasonality is July to August, depending on monsoon rains; habitat is riparian areas, dry desert washes, and canyon arroyos (A. Walker pers. obs.)……..***Photinus knulli*** **(pg. 35)**

Photinus stellaris Fall, 1927 (Starry Firefly)

Description

Male *Photinus stellaris* have entirely black elytra, sometimes with a faintly grey margin, and the pronotum is reddish-pink with a yellow margin, though occasionally a dark patch is present at the anterior margin (Fig 24C). This species ranges in size from 6.5 to 9 mm in length, appearing elongate, compared to other species. Females are brachypterous and have large, full abdomens (Green 1956). They are often rosy-pink to yellow in coloration and tend to be larger than males (Fig. 24A).

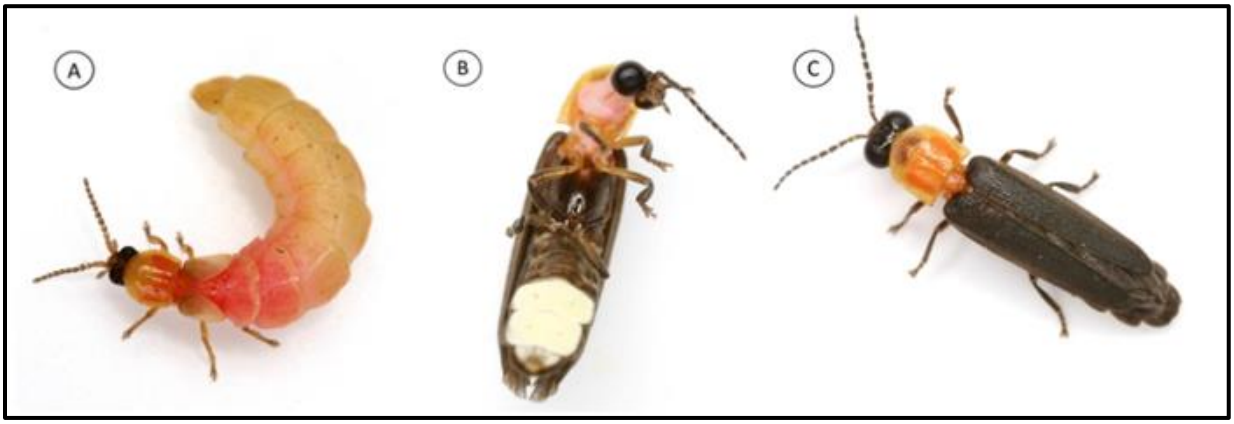


Figure 24. *Photinus stellaris* adults. A. Brachypterous female. B. Male ventral surface. C. Male dorsal surface. Photos: Mike Quinn (BugGuide observations A. 1664721, B. 1664590, and C. 1664585).

Distribution

Photinus stellaris is endemic to Texas, where it has been reported from the city of San Antonio, west across the Edwards Plateau region of central Texas, to the Davis Mountains in West Texas (Green 1956, B. Pfeiffer pers. comm. 2020) (Fig. 23).

Habitats and Ecology

Photinus stellaris is found along waterways (B. Pfeiffer pers. comm. 2020). Males of this species have been observed flashing in large swarms within tall sycamore trees, along a limestone riverbank or other wooded areas adjacent to riparian corridors (B. Pfeiffer pers. comm. 2020). At one site, Musquiz Creek, adults were seen flashing along the creek, as well as across the road on a dry rocky hillside (C. Fallon pers. comm. 2023) (Fig. 26). A female was found flashing in this dry habitat, under a juniper tree (R. Joyce pers. comm. 2023).

Figure 25. Adult male and female *Photinus stellaris* in copula. Note the tiny wing buds of the brachypterous, flightless female. Photo: Candace Fallon/Xerces Society.

Males start out the evening by roving low over vegetated areas. Around this time, females begin to emerge out of the leaf litter and slowly crawl up blades of grass or other vegetation. As

the night progresses and females have taken their perch, males begin to fly higher, so they are more visible to females. Females will typically choose the larger, brighter males, but smaller males will also try to mate with a female and are sometimes able to do so if they are quicker in locating her in the brush (B. Pfeiffer pers. comm. 2023).

The larvae of this species are unknown, but typically, *Photinus* larvae are subterranean, feeding on earthworms and other soft bodied invertebrates at or below the soil surface (Buschman and Faust 2014).

Flash Pattern

Unlike most other *Photinus*, males have been observed glowing slightly between flashes (Lloyd 2018). The spectacular male flashes resemble miniature bolts of lightning, as the males fly swiftly in erratic directions while flashing (Pfeiffer 2023). Flashes are about a half second in duration, with a quick 0.1-0.2 second interval (at 80°F) (The Xerces Society 2024). Displays start early in the evening (or up to 50 minutes after sunset), and last up to an hour under the right conditions (Pfeiffer 2023).

Conservation Status: Least Concern

This species is currently listed as Least Concern, as it is found in relative abundance at some sites and is fairly widespread across a remote region (Walker and Pfeiffer 2021a). Surveys and monitoring of this species would be helpful to better understand where the species occurs and to ensure populations remain stable. This species may be vulnerable to habitat loss because the flightless females are unable to disperse to new areas. This species is also a possible candidate for ecotourism, as its displays are impressive.

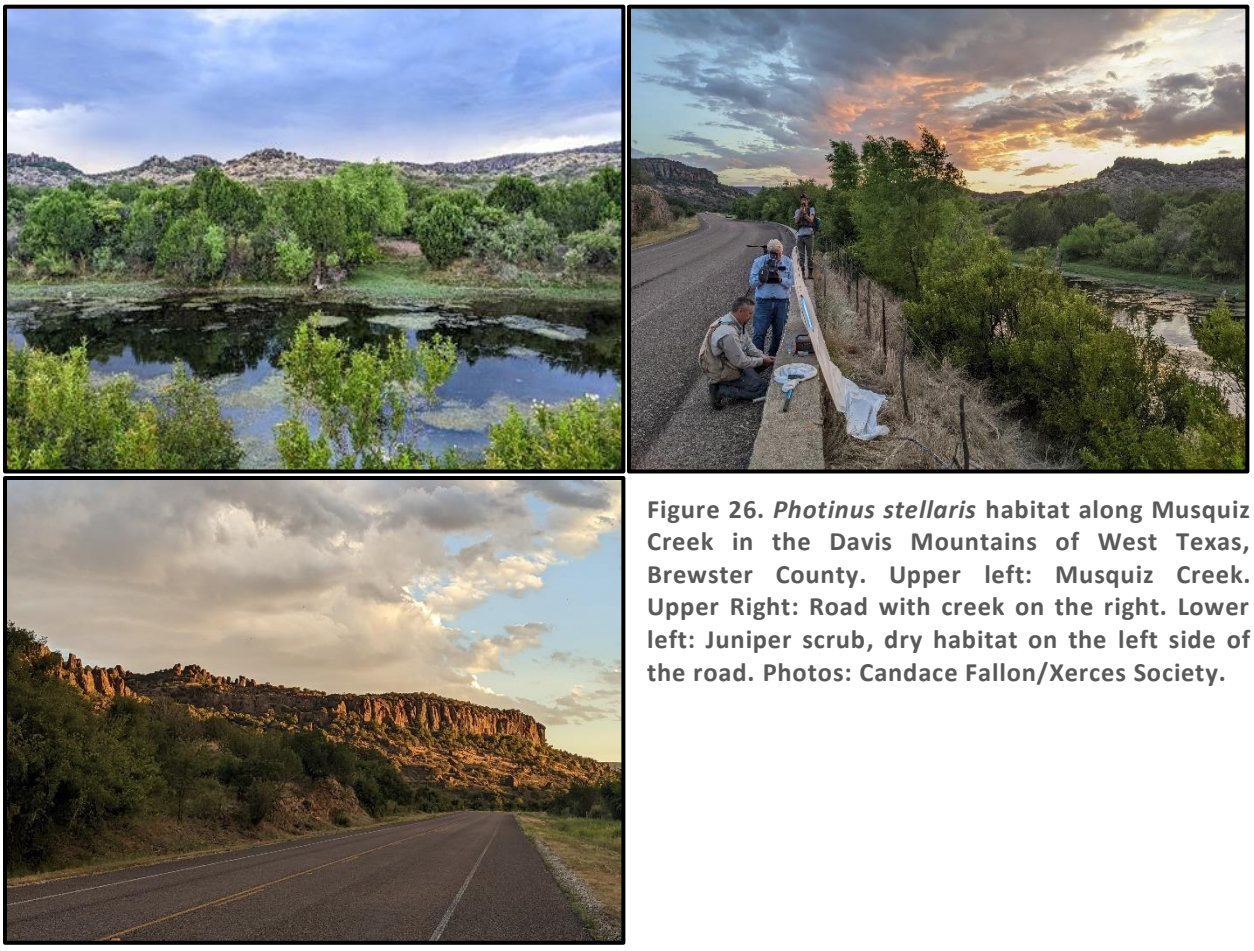


Figure 26. *Photinus stellaris* habitat along Musquiz Creek in the Davis Mountains of West Texas, Brewster County. Upper left: Musquiz Creek. Upper Right: Road with creek on the right. Lower left: Juniper scrub, dry habitat on the left side of the road. Photos: Candace Fallon/Xerces Society.

Photinus pyralis (Linnaeus, 1767) (Big Dipper Firefly)

Description

Photinus pyralis is relatively large for a *Photinus* species, with a body length of 9-19 mm (Faust 2017). In the West there appear to be two male morphs, that both emit the same flash pattern (Fig. 27). The first is typical of *P. pyralis* in the east; specimens are on the small side and have a prominent dark spot in the center of pronotum, surrounded by pink or red. The second morph, which is only found in some populations in Texas and New Mexico, is usually bigger in size and does not have the characteristic black dot in the middle of the red center of the pronotum. In both morphs, the scutellum is pale, the lower margin of abdominal segment 5 has a pale border just above the lantern, and both males and females have a dark T-shaped marking on the dorsal surface of the pygidium (Faust 2017). In Texas, *Photinus concisus* looks very much like the *P. pyralis* morph that lacks a black dot on the pronotum. *Photinus pyralis* can be distinguished from this species by its flash pattern (*P. concisus* emits a single flash at 2.0-2.2 second intervals) as well as several morphological features; *P. concisus* lacks the pale border posteriorly on abdominal segment 5 and it is slightly shorter and wider than *P. pyralis* (Pfeiffer 2023, B. Pfeiffer pers. comm. 2023).

Figure 27. *Photinus pyralis* males from the same site in Harding County, New Mexico. Left: Eastern morph. Right: Western morph.

Distribution

Very widespread across North America. In the United States this species has been reported from New Mexico to North Dakota in the west, and from Florida to New York in the east. There are also occurrences in Ontario Canada, and in Mexico, including in the states of Nuevo León, San Luis Potosi, Sinaloa, Morelos, Estado de México, Guerrero, Guanajuato, Michoacán, Colima, and Jalisco (C. Pérez pers. comm. 2020, GBIF 2023).

It is possible that this species was once quite widespread across the Southwest. In Colorado, this species was likely historically found along the Platte and Arkansas Rivers, all the way to the foothills. Researchers hope the species can still be found along the Platte River, in eastern Colorado. There is also an introduced population in irrigated lawns of an unspecified town in western Colorado. Fireflies recorded in downtown Denver (not since the 1950s) were likely this species (Buschman 2016). There was also one specimen collected in 1940, near Boulder, CO (UCMC 00009205, identified by J. Lloyd). Records as far west as Phoenix, Arizona, and as far north as Logan, Utah are curious. It is unclear if these records are from long lost populations, or if a few individuals somehow found their way to these far-off places. Prior to 2021, experts doubted the locality information of *P. pyralis* museum specimens that were collected in the Southwest. However, several populations of this species have been verified by molecular sequencing, as far west as eastern New Mexico (S. Lower pers. comm. 2022, A. Walker pers. obs.).

Habitats and Ecology

Across much of its distribution, *Photinus pyralis* is found in many open habitats, such as fields and lawns. It has also been observed in woodlands and near rivers and streams (Faust 2017). Unlike most firefly species, *P. pyralis* can tolerate relatively disturbed habitats, including yards, county parks, cemeteries, orchards, fields, and areas along roadsides, highways and railroads (Lewis 2016, Faust 2017). In the Southwest, this species has been observed in

relatively dry habitats, such as juniper savannas, but typically in proximity to healthy riparian areas or reservoirs (A. Walker pers. obs.) (Fig. 28).

Adults have been observed nectaring on milkweed (*Asclepias* spp.) flowers (Faust 2017). Larvae likely feed on earthworms and other soft bodied invertebrates at or below the soil surface (Buschman and Faust 2014). This species flies from mid-June to early-July, though in some years they may arrive as early as mid-May or fly as late as late October. There are likely two generations in southern portions of the range, but only one in northern states (Faust 2017).

Flash Pattern

The male flash of this species is a yellow, J-shaped flash, which is emitted at waist height over open areas (Faust 2017). On rare occasion, a temporary and localized synchrony has been observed (Copeland and Moiseff 1994). Flash activity typically begins before or around sunset and peaks shortly after. Sometimes a small number of flashers can still be seen as late as midnight (Faust 2017). Females respond by pointing their abdomen towards the male as they emit a single flash at a short delay.

Conservation Status: Least Concern

Photinus pyralis is likely the most widespread, commonly occurring, and abundant firefly species in the United States. While it is also found throughout much of Mexico, it is unclear how common it is there. Due to its ubiquity, it was likely the most common species of firefly commercially harvested from the 1940s through the 1980s, and it is still probably the most commonly caught firefly by curious children. This species is also impressively tolerant of habitat disturbance and light pollution. It is currently listed as Least Concern on the Red List (Walker 2021c). However, it has experienced decline at the periphery of its historical range, so monitoring to ensure population stability where it remains extant, is recommended, especially in the western portions of its range.

Figure 28. Photinus pyralis habitat along the Canadian River in Harding County, eastern New Mexico.

Photinus knulli Green, 1956 (Southwest Synchronous Firefly)

Description

Photinus knulli is a relatively small species (around 8 mm) with black markings along the margin of the pronotum, and a thick black stripe down the middle of the pronotum (Fig. 29). It also has a black scutellum that is usually bordered by yellow elytral margins (Green 1956).

Figure 29. Left: *Photinus knulli* male. Right: *Photinus knulli* habitat along a dry arroyo in Pena Blanca Canyon, Santa Cruz County, Arizona.

Distribution

This species is known mostly from scattered occurrences across southern Arizona, though some occurrences from northern Mexico and the border with New Mexico, suggest it may be more widespread within the Madrean Sky Islands than is currently documented. Most reported occurrences come from sites along the Santa Cruz River and its tributaries, in Pima and Santa Cruz Counties, Arizona (J. Cicero pers. obs., Buschman 2016). Specific occurrences in this area have been reported near the towns of Arivaca, Green Valley, Nogales, Tumacacori-Carmen, Amado, and Patagonia, as well as in Pena Blanca and Sycamore Canyons of the Atascosa Mountains (BugGuide 2023, Cicero 1983, Buschman 2016, C. Mollohan pers. comm. 2020, Green 1956). The species has also been observed as far north as Tucson (A. Walker pers. obs.) and in east-facing canyons of the Tucson Mountains, though it is unclear whether these records represent lone wandering females, or if the species is successfully breeding in the area. The rewatering of the Santa Cruz River through Tucson, as well as Tucson's wildlife friendly light ordinances, may help the species gain a foothold in the area. At the eastern extreme of the range, this species has been observed in the Guadalupe Mountains of Cochise County, Arizona. At the southern extreme, this species has been reported from one locality, Canjón Bonito, a few hours south of the US border, in Sonora, Mexico. Other unexplored mountain ranges that could harbour this species include the southern edge of the Santa Rita Mountains, where the Santa Cruz River originates, and in Sonora, Mexico, just south of the border, between the towns of Douglas and Nogales (J. Cicero pers. comm. 2020).

Habitat and Ecology

Photinus knulli is found along perennial riparian areas as well as seasonally wet desert canyons and washes (Fig. 29). This species has been observed in irrigated areas, such as farms and golf courses, though it is unlikely individuals can persist in such areas due to the use of insecticides, ploughing, and mowing (J. Cicero pers. comm. 2020). Larvae and pupae have been found at night by overturning large rocks (Cicero 1983). Typically, *Photinus*

larvae are suspected to be subterranean, feeding on earthworms and other soft bodied invertebrates at or below the soil surface (Buschman and Faust 2014).

Flash Pattern

Males of this specie give off a half second or less, yellowish-orange series of three flashes, every four to seven seconds (at 65^{o}F). Nighttime displays begin 35 minutes to two hours after sunset. In populations with high abundance, this species breeds within lek arenas, where males congregate and display, often in synchrony (Cicero 1983). After the monsoon rains have started, usually in late-July, adult males begin displaying. Activity peaks a week or two later, and a large number of males are seen displaying from leks, which are generally about 5 m^2 in size. The intricate display behaviour is complex. Several “anchor males” display characteristic triplet flashes (three consecutive quick flashes within a second) from the ground, while other “patrolling males” venture out along an established flyway, which usually is a straight line about a kilometer in length. The patrolling males fly a couple meters off the ground and emit triplet flashes about every six seconds. They often fly in schools of up to seven and emit triplet flashes in synchrony with each other. After patrolling for about an hour, males circle back toward the base arena where the “anchor males” are still on the ground, flashing. Males that locate the lek by passing over it and seeing activity below, will land and join in, while others that do not relocate it will form satellite leks (Cicero 1983).

Adult females begin to emerge about three days after the first males eclose, at which point the lekking behaviour is in full swing. Females join the anchor males in the arena as they produce single pulsed flashes either randomly or progressively. Once they are gravid, females are unable fly (Cicero 1983).

Conservation Status: Vulnerable

This species is found in a small number of occurrences that are at risk of drying out due to overuse of groundwater and increasing drought. The species is considered Vulnerable on the Red List of Threatened Species (Walker and Cicero 2022). For more information on the conservation status of this species, see the firefly species fact sheet on the Firefly Atlas (https://www.fireflyatlas.org/threatened-species-fact-sheets/) (Fallon 2024).

Genus *Bicellonycha* Motschulsky

Bicellonycha is predominantly a tropical genus, with only one known species in the United States. It is in the subfamily Photurinae, which also includes the genus *Photuris* (Cicero 1982). Both males and females of species within this genus are alate and luminous. The antenna is about half the length of the body. The base of pronotum is slightly emarginate and the hind angles are produced (pointed). Both tarsal claws are bifid at the tips in males and entire in females. The last ventral segment of the male abdomen has a long median point (Cicero 1982).

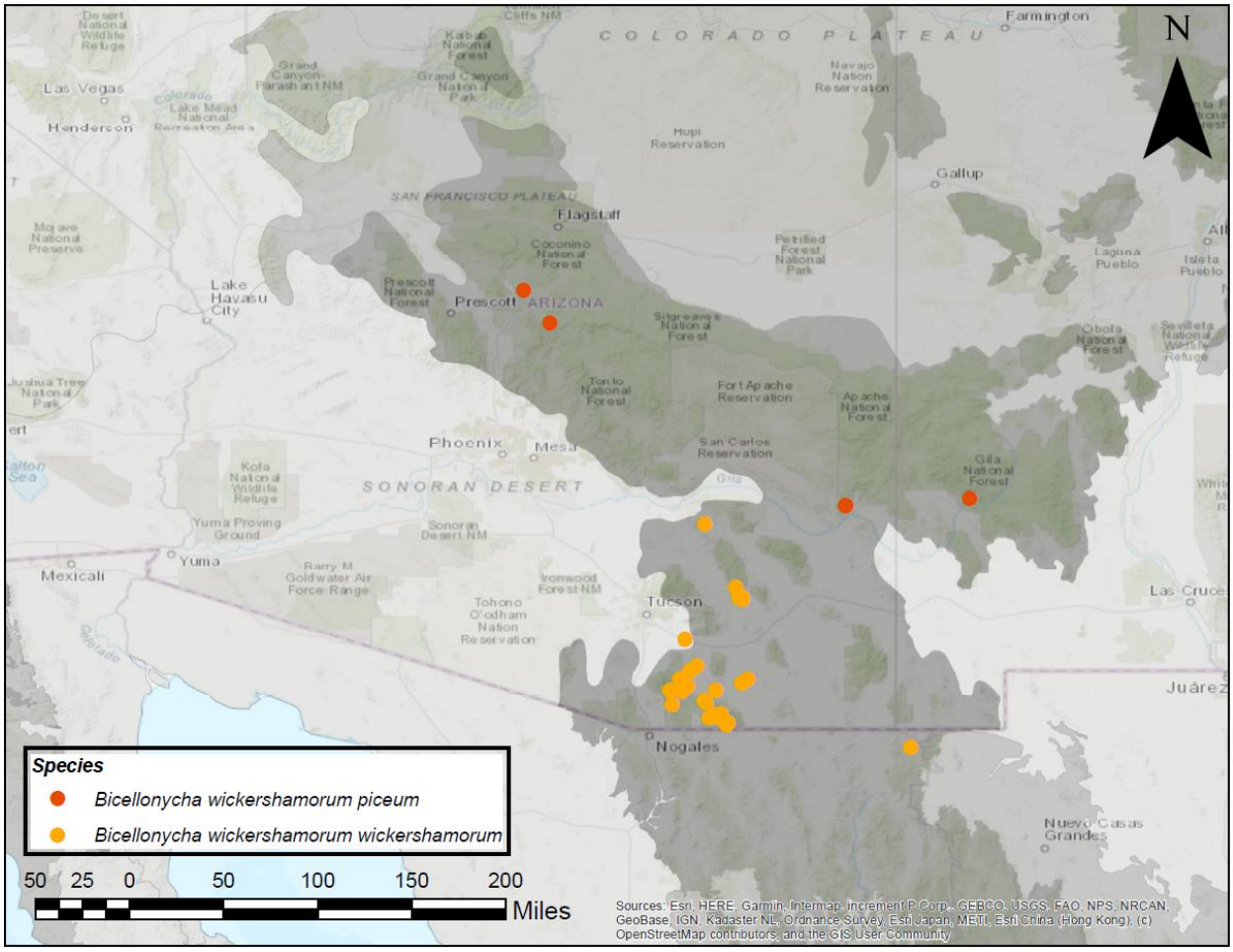


Figure 30. Known occurrences of *Bicellonycha wickershamorum wickershamorum* and *B. w. piceum*.

Bicellonycha wickershamorum Cicero, 1982 (Southwest Spring Firefly)

Description

This species is relatively easy to identify as it is the only firefly within this genus in the region. This species has black elytra, sometimes with yellow margins and a yellow elytral suture. In *B. w. piceum*, the yellow margins are absent. The median pronotal vitta (center stripe) is dark black and the hind corners of the pronotum have an acute angle (Fig. 31) and specimens are typically 8.9-10.3 mm (Cicero 1982). All tarsal claws of the males are bifid, or apically cleft (Olivier 1911), but it is difficult to see this characteristic without a hand lens. There is one site (Sonoita Creek Preserve) where *Bicellonycha wickershamorum* shares habitats with another flashing species, *Photunis knulli*, but *P. knulli* is usually found slightly later in the summer (Buschman 2016) and is morphologically dissimilar. *Photinus knulli* is much smaller and the pronotum has rounded hind angles.

Figure 31. *Bicellonycha wickershamorum piceum* from the Gila Wilderness, Grant County, New Mexico.

Distribution

Bicellonycha wickershamorum is found in Arizona, New Mexico, and Sonora, in northern Mexico (Fig. 30). The nominate subspecies, *B. w. wickershamorum* Cicero, 1982 (Southwest spring firefly) is endemic to the Madrean Sky Island mountain ranges of southern Arizona and northern Sonora. In the US, it has been reported from the Huachuca and Galliuro Mountains (Cicero 1982), where populations have been observed in Bear Canyon, Scotia Canyon, the Canelo Hills, the Mule Shoe, and Empire Gulch, as well as sites near Sonoita (Cicero 1982, BugGuide 2020, C. Mollohan pers. comm. 2020). In Sonora, it has been recorded only at Canjón Bonito (J. Cicero pers. comm. 2023). Prior to 2023, the other described subspecies, *B. w. piceum* Cicero, 1982 (Gila Southwest spring firefly), was known only from the type locality, near Morenci, Arizona. However, museum records from Arizona's Verde Valley surfaced recently, and the subspecies was also found in the Gila Wilderness of New Mexico. Concerted survey efforts around the Verde Valley have confirmed additional localities, so it appears the subspecies is relatively widespread across the Mogollon Rim in the Arizona and New Mexico Mountains Ecoregion, though the number of documented populations remains low.

Habitat and Ecology

Bicellonycha wickershamorum is found in montane desert habitats of the Madrean Sky Islands and the Arizona and New Mexico Mountains Ecoregions, at elevations ranging from 4,000-6,000 ft. (Cicero 1982, C. Mollohan pers. comm. 2020). This species typically occurs in marshy areas and other perennial wetland habitats along permanent streams and rivers (Cicero 1982, C. Mollohan pers. comm. 2020, A. Walker pers. obs.; Fig. 32). Adults of both sexes are winged and capable of flight, as are all known species of its subfamily, Photurinae. The breeding season for the nominate subspecies lasts from early June to late July, typically before the monsoon season starts (J. Cicero pers. comm.). The Gila southwest spring firefly has been observed from late May through August, but the phenology of this subspecies is not well understood. Adults are not known to feed. Larvae have been observed preying on snails at night and are typically found in riparian areas next to gentle streams (J. Cicero pers. comm. 2020). Late-instar larvae pupate in soil chambers they have constructed.

Figure 32. Spring fed marsh habitat along the banks of Turkey Creek, a tributary of the Gila River in the Gila Wilderness, Grant County, New Mexico.

Flash Pattern

The courtship flash pattern is a single, quick (about 0.14 seconds), greenish flash, emitted at intervals of about 0.8 seconds (Martin *et al.* 2023). Flashing displays begin at dusk and continue into the night, for up to two hours. Adults can often be found crawling up tall vegetation, in suitable habitats, before sunset (A. Walker pers. obs.). Adult males typically fly and flash along streams. At dusk males fly close to vegetation and often find females that have not produced response flashes. As the night goes on, males fly higher in the air and can only find females by their response flashes (J. Cicero pers. comm. 2020). Adults can sometimes be observed flying and flashing well away from streams (C. Mollohan pers. comm. 2020).

Conservation Status: Vulnerable

Bicellonycha wickershamorum was assessed as Vulnerable on the IUCN Red List (Fallon and Cicero 2021a) and is one of five firefly species in the United States to be petitioned for protections under the Endangered Species Act (Fallon *et al.* 2023). In January of 2024, it received a positive 90 day finding, which means the US Fish and Wildlife Service agrees that there is sufficient information to suggest the species may be threatened (USFWS 2024). This triggers an in-depth review process before a listing decision can be made. The species is threatened with extinction due to its limited distribution, with few localities, and because of its reliance on wetland habitats in an increasingly arid landscape. Major threats to the species include increasing drought due to climate change, overuse of groundwater, riparian corridor fragmentation, habitat degradation and direct trampling due to cattle, intrusive recreation, light pollution, and hydrological modifications for farming, ranching, and copper mining.

At the subspecies level, the nominate subspecies, *B. w. wickershamorum*, is listed as Vulnerable on the Red List (Fallon and Cicero 2021b) and *Bicellonycha wickershamorum piceum* is listed as Endangered (Fallon and Cicero 2021c). *Bicellonycha w. piceum* is not as well understood, and at the time the assessment was done, it was known from only the type locality. While it is now known from several localities across New Mexico and Arizona, most populations observed have very few individuals. This firefly is at high risk of habitat loss and more research is needed to better understand its conservation needs. For more information on the conservation status of this species, see the firefly species fact sheet on the Firefly Atlas (https://www.fireflyatlas.org/threatened-species-fact-sheets/) (Fallon and Walker 2024).

Genus *Photuris* Dejean, 1833

There are around 56 species of *Photuris* currently recognized in the United States and Canada, though the exact number remains unresolved. Species of *Photuris* can be split into two categories, Division I and Division II, with most species falling into the latter. The Division I *Photuris* are relatively easy to identify to species, but based on morphology alone, the taxonomy of the Division II *Photuris* remains mystifying. Some of the greatest firefly researchers of modern times spent their entire careers trying to untangle the complicated relationships of the Division II *Photuris*. As Herbert S. Barber (1951) put it in his posthumously published monograph, "All structures, even those of the male genitalia, appear identical in our numerous species". At one point in time, before this pioneering work of Barber (1951), the name *Photuris pennsylvanica* was given to most any Division II *Photuris* specimen that entered a museum collection, from Canada to Panama. In fact, most museum collections still hold drawers of specimens labeled *Photuris pennsylvanica*. Presently, *Photuris pensylvanica* (with the spelling returned to that originally assigned by DeGeer) is considered endemic to a small portion of the northeastern US (Barber 1951, Lloyd 2018). Barber (1951), Frank McDermott (1957), and Jim Lloyd (2018), meticulously split this species complex into a large number of species, by carefully examining habits, habitats, and primary flash patterns. Though the morphological differences between these species are minute, with careful study, differences can be found. In the preface to Barber (1951), McDermott wrote that upon being handed five vials of unlabeled *Photuris* fireflies from habitats around Wilmington, Delaware, Barber was able to correctly describe the flash pattern to expect from four of the five specimen vials.

Beyond morphology, the Division II *Photuris*, also often referred to as the *versicolor* group (McDermott 1967), *penn*-group (Lloyd 2018), or the *Photuris versicolor* complex (Lloyd 2018, Faust 2017), are difficult to differentiate because each species emits a dizzying array of flash patterns. While each species has a primary mating flash pattern, the females are predatory; they cleverly mimic the flash patterns of other firefly species in order to lure an unsuspecting male and score a meal. The conspecific males have caught on to this phenomenon and have figured out how to mimic the flash patterns of their females' prey, to attract females of their own species that are out on the hunt. Numerous different *Photuris* species may offer the same mimicry flash patterns, so it can be difficult to discern between *Photuris* species unless the primary flash pattern, or species-specific mating flash pattern, is seen. To make matters worse, *Photuris* males and females are not consistent in how or when they emit these mimicry flash patterns; it may depend upon the species, site, time of evening, or day (Lloyd 2018).

Photuris fireflies are generally larger and have longer legs than species in the other common flashing firefly genera *Photinus* and *Pyractomena*. Their legs extend well beyond the body laterally. They also aggressively flash when they are caught (Lloyd 2018). To date, only one described *Photuris* species has been documented in the Southwest. This species, *Photuris falli*, happens to be in the Division I *Photuris* and is therefore relatively distinct and easy to identify. Numerous Division II *Photuris* populations have been recorded across the region, but due to the difficulty in differentiating *Photuris*, these populations have not yet been identified to species and likely need to be described as new species (Fig. 33). Through the rest of this guide, the Division II *Photuris* will be referred to as *Photuris versicolor* complex species.

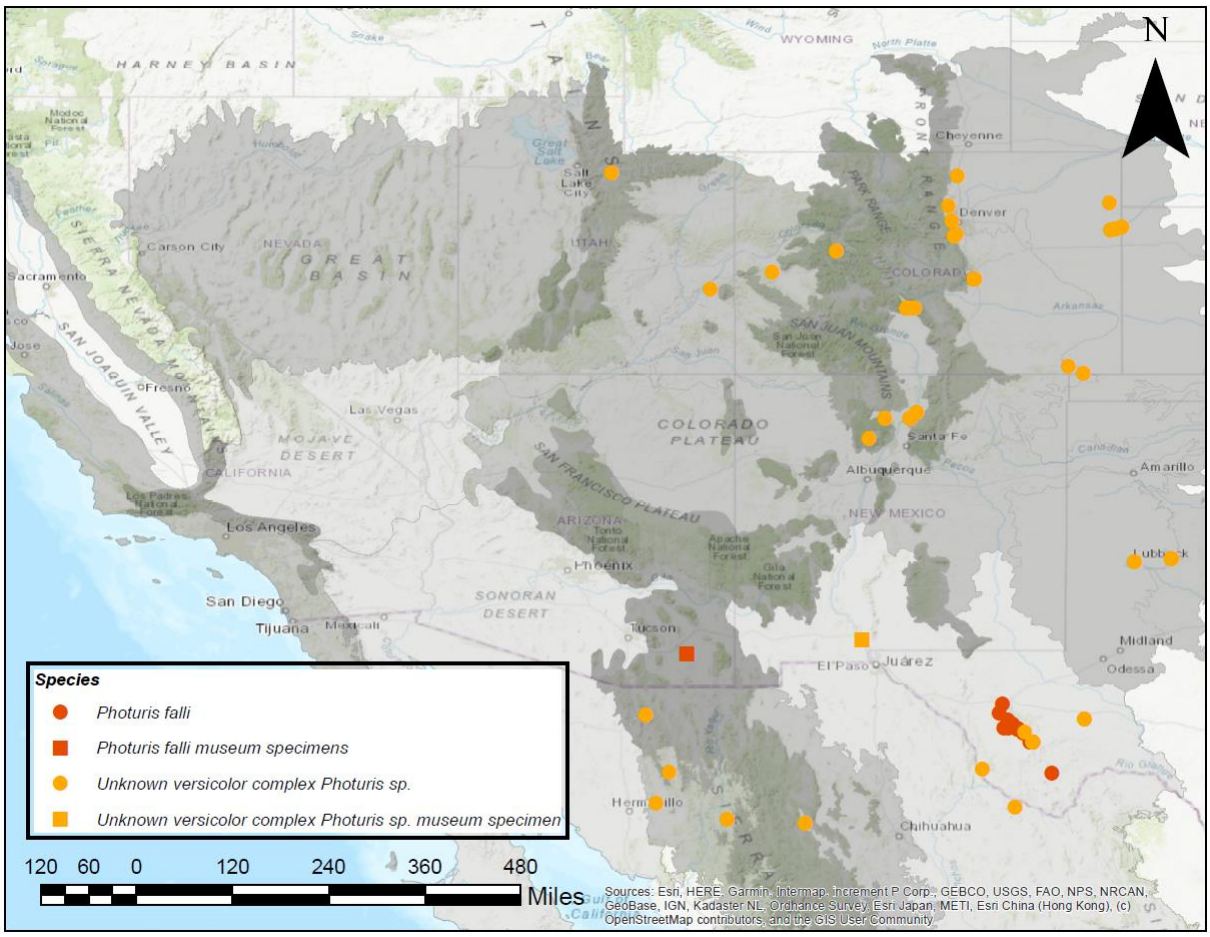


Figure 33. Known occurrences of *Photuris* species in the Southwest. Circles represent relatively recent observations. Squares represent historic occurrences that have not been verified recently.

Key to *Photuris* species of the Southwest

1. Pronotum entirely orangish-yellow; antenna, tibia, tarsi, and elytra entirely dark (black); head, scutellum, metasternum and femora are also yellow; labial margin triangulate (non-versicolor complex) (Fall 1927)……***Photuris falli*** **(pg. 42)**

- Large; hunched posture; long legs; elytra dark with yellow margin and often yellow stripes on either wing; pronotum usually yellow, with red center and dark hourglass or anchor shaped mark running through the center (Faust 2017)…… **(*Photuris versicolor* complex) (pg. 44)**

Photuris falli Barber, 1951 (Sky Island Firefly)

Description

According to Fall (1927), the prothorax of this species is orangish yellow, with paler yellow margins. The head, scutellum, metasternum and femora are also yellow, whereas the antenna, elytra, tibia, and tarsi are black (Fig. 34). The margin of the labrum is triangulate, and the head is broadly concave. The thorax has coarse, dense punctures. The elytra are entirely black with distinct punctures and black pubescence. Both sexes are 8.4 to 11.5 mm (Fall 1927). This species is very distinct and cannot be easily confused with any other species in West Texas. *Photinus (=Ellychnia) flavicollis* looks vaguely similar, but in the latter, the head, scutellum, femora, and metasternum are black and the lantern is reduced.

This species has been referred to by many names over the years, including *Photuris telephorinus flavicollis* Olivier, 1886 and *Photuris brunnipennis* var. *falli* Barber, 1951, among other names. Until very recently, it was referred to as *Photuris flavicollis* Fall 1927. Quite often, the scientific names of species change because of shifts in our understanding of the taxonomy of species. In this case however, the name *Photuris flavicollis* was already taken, or in nomenclatural jargon, there was a primary homonymy. The accepted name is now *Photuris falli* (Keller and Hinson 2023).

Figure 34. *Photuris falli* from near Fort Davis, Jeff Davis County, Texas. Photo: Oscar Johnson (2019) (iNaturalist observation 29930637).

Distribution

Photuris falli is found in the counties of Brewster and Jeff Davis, in West Texas, where it has been observed in the Davis Mountains, as well as adjacent mountain ranges (Lloyd 2018, B. Pfeiffer pers. comm. 2020). For a while there was also one occurrence from Pecos, New Mexico in museum collections, which was collected in 1927. However, photo verification of the specimen revealed it was actually *Photinus (=Ellychnia) flavicollis* (thanks to Crystal Meier at Harvard MCZ; R. Joyce pers. comm. 2022). It is possible this species is found elsewhere in the remote mountain ranges of West Texas, Chihuahua, and Coahuila, or the Guadalupe Mountains of neighbouring New Mexico. In fact, it could even be found as far west as Arizona. In 2023, three specimens, of what appears to be *P. falli*, were discovered in the Florida State Collection of Arthropods, from Cochise County, Arizona (the discovery was made by Oliver Keller, R. Joyce pers. comm. 2023). The first trip to the reported locality, “7 mi W Sunsites”, in July of 2023, came up empty for the species (A. Walker, C. Fallon, and T. Palmer pers. obs. 2023). Searches will continue.

Habitats and Ecology

Specific habitat associations of *Photuris falli* are not well documented, though it seems to occur in isolated pockets along streams and habitats where small spring complexes flow into dry creek beds (B. Pfeiffer pers. comm. 2020) (Fig. 35). For example, where it is found in the Davis Mountains State Park, it occurs in drainages where springs along Limpia Canyon flow into Limpia and Keesey Creeks. It has also been reported from a dry mesquite and bristle cone pine habitat (L. Buschman pers. comm. 2022) and north-facing slopes near the summit of Mt. Locke at the McDonald Observatory, with Ponderosa pines and bunch grasses (R. Joyce pers. comm 2023). Hence, their dependence on surface water is unknown.

The phenology of the adult flight season is not well understood, though records have been collected from early May to early August (GBIF.org 2023, iNaturalist 2023). This species is in the Division I *Photuris*, which are typically not predatory like *Photuris* fireflies in the *versicolor* complex (Lloyd 2018). However, in coloration *Photuris falli* looks similar to several neotropical *Photuris* species, with black elytra and orange pronota, such as *Photuris lugubris* and *Photuris fulvipes* (R. Joyce pers. comm. 2023). *Photuris lugubris* is predatory (Maquitico *et al.* 2022), so maybe we need to look more closely at the habits of *P. falli*. It is unknown what the larvae eat, but most species in this genus scavenge around damp areas at night looking to consume snails, worms, other soft-bodied invertebrates (Buschman 1984).

Flash Pattern

Males emit a continuous series of flashes at about 1.5 second intervals (L. Buschman pers. comm. 2023).

Conservation Status: Vulnerable

This species is listed as vulnerable on the IUCN Red List due to its restricted distribution and threats such as drought, which is expected to become more frequent, severe, and prolonged under most climate change scenarios. Light pollution, mostly from the growth of the oil and gas industry in this region, is also a growing threat. While the species is found in remote areas, oil refineries which are illuminated through the night, are encroaching on *Photuris falli* habitat in some areas (Pfeiffer and Walker 2021).

Figure 35. Likely habitat of *P. falli* along Limpia Creek in Davis Mountains State Park, Jeff Davis County, Texas. Photo: Candace Fallon/Xerces Society.

Unknown *versicolor* complex *Photuris* populations

Description

Populations of unknown *Photuris* species have been found in scattered occurrences in Texas, Colorado, New Mexico, Utah, and possibly even Arizona and California. Members of the "*penn*-group" or *versicolor* complex are notoriously difficult to identify. Morphologically they are identical, or have few subtle differences, so often flash pattern information is key to distinguishing between species (Lloyd 2018). However, *versicolor* complex *Photuris* females are predatory, and can mimic the flash patterns of conspecific and interspecific males and females. Therefore, courtship flash patterns can be hard to discern. Taxonomic work is ongoing to determine whether the populations in the West are undescribed species. As members of the *P. versicolor* complex, morphologically these species have a humpback posture, long legs, and a colorful pronotum that is yellow at the margins, with a red bordered black arrow, T, single bar, elongated triangle, or anchor shaped marking along the median vitta (center stripe) (Fig. 36) (Faust 2017). Sometimes this dark stripe is missing altogether (B. Pfeiffer pers. comm. 2023). The elytra are often striped. Dissection of adult male genitalia is not helpful for differentiation between species in this group, and even molecular analysis has not yet been able to solve these taxonomic issues. The lantern in males consists of two spots on abdominal segments 7 and 8 (Buschman 2016).

Figure 36. *Photuris versicolor* complex male from the Rio Grande Gorge, Taos County, New Mexico.

Distribution

So far, populations in this species complex have been found in West Texas, Colorado (Fort Collins, Boulder, Fountain, the San Luis Valley), New Mexico (along the Rio Grande and its tributaries, hot springs in the Jemez Mountains, historical records from Las Cruces), Utah (near Moab and in Kamas), and possibly northern Arizona and California, though records have not been confirmed in the latter two states (Bushman 2016).

Habitats and Ecology

Courtship displays have been observed in meadows, marshy areas, cultivated fields, and in riparian vegetation, always near permanent water sources. Most populations are found below 6,000 feet, though the species has been reported from higher elevations at hot springs, where individuals are shielded from extremely cold temperatures (Fig. 37). Rearing trials have revealed that some populations of this species complex spend at least two years as larvae.

Flash Pattern

The most common flash observed in these populations is a single flash, repeated every one to four seconds (Buschman 2016). In some cases, the flash duration and interval increase as the night goes on. In some cases, when the temperatures are too cold, males have been observed flashing from the ground.

Conservation Status: Not Evaluated

It is unclear whether these populations represent one or many undescribed species, or if they belong to already described species known to occur further east. Therefore, the conservation status has not yet been evaluated. Many of these populations are likely at risk of local extinction because they are isolated, reliant on wet habitats in an increasingly arid environment, and a few are in very close proximity to population centers, where light pollution and development are encroaching.

Figure 37. *Photuris versicolor* complex species habitats in New Mexico.

Top: A hot spring in the Jemez Mountains, Sandoval County.

Bottom: Along the Rio Grande in Taos County, New Mexico.

CHAPTER 4: GLOW-WORMS

Genus *Prolutacea* Cicero

Prolutacea is a monotypic genus, which means it contains only one species. *Prolutacea pulsator*, was originally described as *Lampyris pulsator* (Cicero 1984), which is an Old-World genus of glow-worm firefly species. This was done to be consistent with Green's (1959) placement of two similar Floridian species in that genus (*L. knulli* and *L. needhami*). Green (1948) originally erected the genus *Pleotomodes* when describing these two species before moving them to *Lampyris*. Geisthardt (1986) argued species in the genus *Lampyris* are only Palaearctic in origin and declared *Pleotomodes* a valid genus. Lloyd (2003) sustained Geisthardt's analysis and eventually placed *Prolutacea pulsator* in the genus *Pleotomodes* as well. Both *P. knulli* and *P. needhami* are myrmecophilic and endemic to Florida. Thereafter, Cicero (2006) recognized *P. pulsator's* affinity to Mexican species, and erected the genus *Prolutacea*, moving *Pleotomodes pulsator* directly into it.

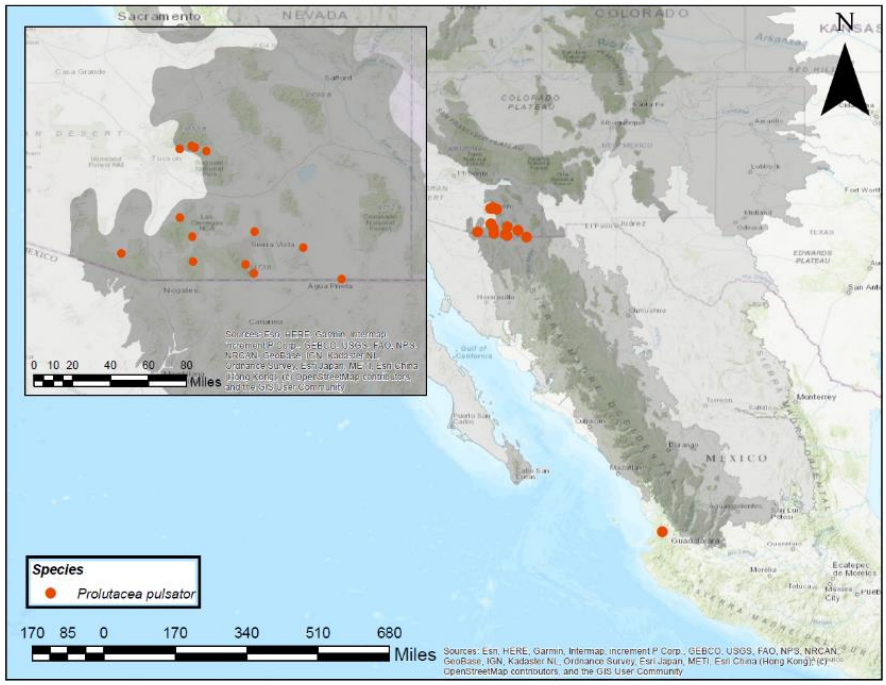


Figure 38. Known occurrences of *Prolutacea pulsator*.

Prolutacea pulsator (Cicero, 1984) (Pulsating Glow-worm*)

Description

The elytra of *Prolutacea pulsator* males are light brownish-yellow. The hindwings are visible from above because the elytra are translucent. The pronotum is yellowish with pink markings in the center and has a transparent quality (Fig. 39). The margins of the pronotum are flanged (curled up). The eyes are very large and close together, and can be seen from above through transparent, spectacle-like windows of the pronotum, much like males in the genus *Phausis* or the Old-World genus *Lamprohiza*.

Figure 39. *Prolutacea pulsator* male from Pima County, Arizona. Photo: C. Mallory (2019b) (iNaturalist observation 26448976).

The antennae have 11 antennomeres, the last of which is spindle-shaped, without an apical appendage (Zaragoza-Caballero *et al.* 2023). The scape of the antenna is three times longer than the length of the first flagellomere (antennomere 3). The eighth sternum of the abdomen does not have a terminal process. Females also have a transparent pronotum which is flanged at the margins, though it is more pinkish white in color than in males. Females are brachypterous, with stubby pink wings and pink body segments (Fig. 40). Females have antenna much like that of males (J. Cicero 2014 in BugGuide 2023).

Figure 40. *Prolutacea pulsator* female from Cochise County, Arizona. Photo: Charles W. Melton on BugGuide (observation 934925).

Distribution

Prolutacea pulsator is a very rare insect and has been recorded from few localities in southern Arizona. It was also recorded once, in 1935, in Compostela, Nayarit, Mexico (Cicero 1984) (Fig. 38). Whether or not it occurs in the Sierra Madre Occidental of Mexico, between the known records in Arizona and Nayarit, is unknown. In Arizona, it is known from sites in Pima County (in the Santa Catalina, on the western slope of the Santa Rita Mountains, and in the Rincon Mountains, as well as a site southeast of Arivaca), Santa Cruz County (in the Patagonia Mountains and on the eastern slope of the Santa Rita Mountains), and Cochise County (from the Huachuca Mountains, the San Pedro Riparian National Conservation Area, the Mule Mountains, and east of Douglas) (Fig. 38) (Cicero 1984, GBIF.org 2023, BugGuide 2023). It may be more widespread than is currently known.

Over the last 20 years, it is possible the species has disappeared from several known localities. For example, it has not been recorded recently at several historical collection sites including Molino Basin and Redding Pass, between the Santa Catalina and Rincon Mountains, and at a site along a tributary of the Babocomari River, in Cochise County (J. Cicero 2014 in BugGuide 2023).

Habitats and Ecology

Sites where this species has historically been collected are primarily oak woodlands near riparian areas and in montane canyons (Cicero 1984). Some recent collections are from well-watered residential gardens (J. Cicero 2014 in BugGuide 2023). Males of the species will come to blacklights. Females are larviform, brachypterous, and flightless, and pulse light in a steady pattern to attract male mates flying by in the night (J. Cicero 2014 in BugGuide 2023). The flight period is early in the spring, and adult records have been taken from late March to early June. Due to flightless females, dispersal ability of this species is limited (J. Cicero 2014 in BugGuide 2023).

Conservation Status: Data Deficient

This species is currently listed as Data Deficient on the IUCN Red List, as not enough is known about current distribution, population size, and threats to determine whether it may be at risk of extinction (Walker and Pérez-Hernández 2021a). However, additional research is urgently needed on this species, as it is rare, has a relatively restricted distribution, and appears to have been extirpated from some historic occurrence localities due to drought and cattle disturbance.

Genus *Microphotus* LeConte

Microphotus is a small genus, with only ten species currently recognized, six of which occur in the Southwest U.S. and northern Mexico (Green 1956, Usener and Cognato 2006) (Fig. 41). Species determination based on morphological characters alone can be problematic, as characteristics vary (are polymorphic) between different specimens of the same species (Usener and Cognato 2006). Though all species of M*icrophotus* are similar in morphology and coloration they can usually be differentiated by the male genitalia. Males have large eyes with barely visible reduced mouthparts between the eyes. Given their mouthparts, they likely do not feed as adults. The antennae are shorter than the pronotum, have less than eleven segments, and have a small bead-like process, called a tuberculiform appendix, on the tip of the terminal segment (Fig. 10E). Elytra are typically truncate, pale to dark brown, and in some specimens, they darken at the tips. Adult males have short, pale legs (femora do not extend beyond the margin of the body), and simple tarsal claws. The pronotum is pale but is often darker along the center line (Green 1959). All males also have a medial triangular or lobate process on the second to last abdominal ventrite (Usener and Cognato 2006). Males do have lights in the position of the larval lights (J. Cicero pers. comm. 2024), but they are not used in courtship and are difficult to see. Females are larviform without elytra or hindwings. They have small, elongate, retractable heads, with simple eyes, called lateral ocelli or stemmata. The antenna is similar to that of the male yet has fewer segments. The abdomen has eight segments, with ventral segment one fully visible, though smaller than the second segment. The light organs may not be apparent (Green 1959).

As female *Microphotus* are larviform and wingless, dispersal abilities are limited and populations in different mountain ranges are genetically isolated from one another (Usener and Cognato 2005). Genetic evidence, at least for *Microphotus octarthrus*, suggests that neighboring populations have been separated anywhere from 0.7 to 2.2 million years, since the beginning of the Pleistocene. Some of these disjunct populations may be comprised of cryptic species, but additional life history information, including mating behavior barriers such as female advertising posture, male approach, and coupling time is needed to further test this possibility (Usener and Cognato 2005).

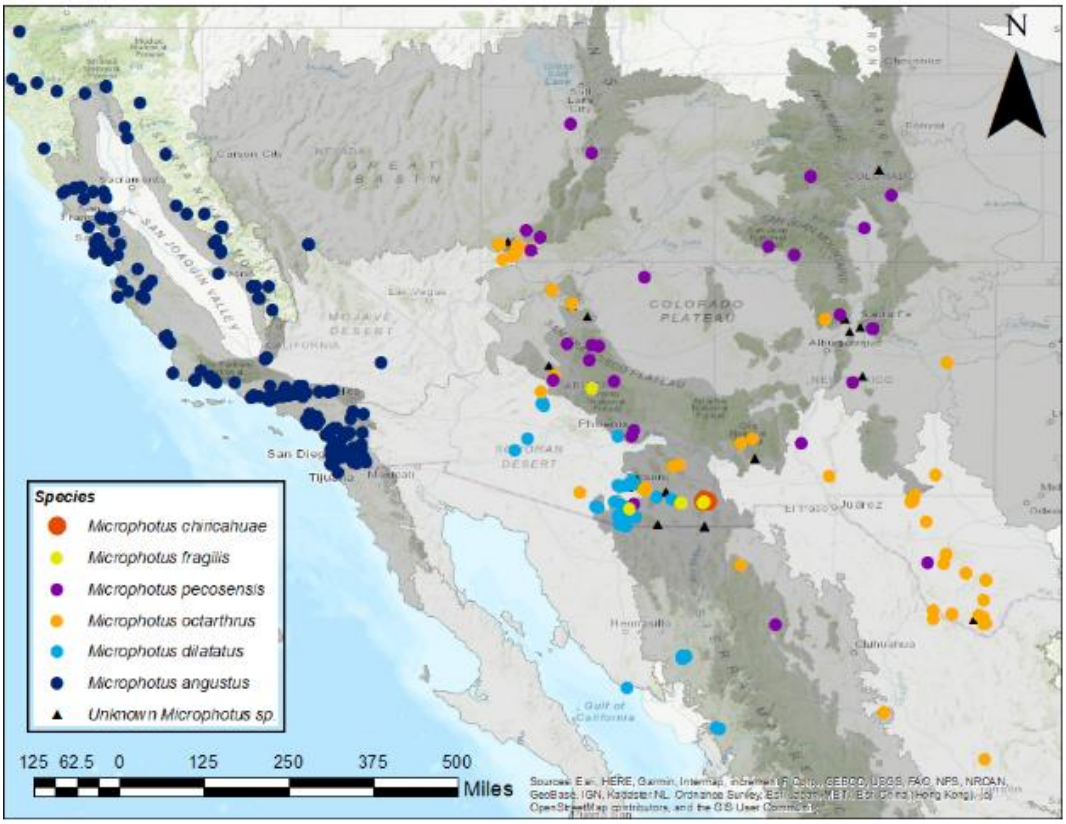


Figure 41. Known occurrences of *Microphotus* species in the Southwest.

Key to male *Microphotus* species of the Southwest (Adapted from Green 1959)

1. Elytra less than three times as long as pronotum (average about 2.5 times)…… **2**

- Elytra more than three times as long as pronotum……**3**

2. Antenna with eight or nine segments, pronotum posteriorly most prominent at hind angles, base slightly emarginate throughout width, larger in size, elytra is uniformly dark brown…... ***Microphotus dilatatus*** **(pg. 50)**

- Antenna with eight segments; pronotum truncate at base; smaller in size; elytra pale brown with infuscated tips…….. ***Microphotus octarthrus*** **(pg. 51)**

3. Antenna with more than 8 segments……..**4**

- Antenna with eight segments; median longitudinal line of pronotum not impressed…….. ***5***

4. Antenna with nine or ten segments; median longitudinal line of pronotum not impressed; genitalia differ from the following species……..***Microphotus angustus*** **(pg. 52)**

- Antenna with ten segments; median longitudinal line of pronotum strongly impressed; genitalia differ from the previous species…….. ***Microphotus fragilis*** **(pg. 53)**

5. Scutellum usually narrowly rounded at apex; genitalia differ from the following……

……..***Microphotus pecosensis*** **(pg. 54)**

- Scutellum usually with apical notch; genitalia also differ from the prior species……

……..…***Microphotus chiricahuae*** **(pg. 55)**

Microphotus dilatatus LeConte, 1866 (Sonoran Pink Glow-worm*)

Description

In the males, the elytra are less than three times as long as pronotum (averaging about two and a half times as long). Eyes beneath are broadly contiguous posteriorly. The antennae have eight or nine segments. The pronotum posteriorly is most prominent at the hind angles, base shallowly emarginate throughout its width. This species is generally larger than other species (5-8mm) and is uniformly dark brown, in most cases (Fig. 42). It also appears broader in form (Green 1959).

Figure 42. *Microphotus dilatatus* adults. A. Larviform adult female from Pima County, Arizona. B. Dorsal and ventral view of male from Santa Cruz County, Arizona. Photos: Salvador Vitanza on https://elp.tamu.edu/.

Distribution

Microphotus dilatatus has been recorded in southern Arizona, in the U.S.A., and Baja California, Baja California Sur, Durango, and Sonora, Mexico (Fig. 41) (Green 1959, Zaragoza-Caballero and Ramírez-García 2009, Zaragoza-Caballero *et al*. 2023). This is one of the most frequently encountered and easily identifiable *Microphotus* species (Green 1959).

Habitats and Ecology

Microphotus dilatatus adults are active in July and August, during the monsoon season (Green 1959, Zaragoza-Caballero and Ramírez-García 2009). Females have been observed using the burrows of spiders, ants, and rodents to escape extreme daytime temperatures. At dusk, females await nightfall at the entrance of their burrows. Once dark, they emerge just a few centimeters more and signal to passing males by twisting their abdomens 180° and waving (Cicero 1981). Larvae also become active at dusk, when they crawl out from the leaf litter or out of the bases of bunch grasses and wander around, occasionally emitting glows (Cicero 1981). This species is found in the Sonoran Desert, from lowlands to oak woodlands of the Sky Island mountain ranges (900 to 2,600 ft.).

Conservation Status

Microphotus dilatatus is listed as Data Deficient because there are few recent records for this species (Fallon *et al.* 2021b). If surveys in historic collection localities verify this species is extant across its historic range and populations are stable it would likely be considered Least Concern.

Microphotus octarthrus Fall, 1912 (Chihuahuan Pink Glow-worm*)

Description

Males of this species can appear narrower than other species. The elytra are less than three times as long as the pronotum (averaging about 2.5 times as long), the antennae have eight segments, the eyes beneath are broadly contiguous posteriorly, and the pronotum is truncate at the base. The median longitudinal line on the pronotum is not impressed. This species is also relatively small (4.25-6.25 mm) and the elytra is pale brown with darker tips (Fig. 43) (Green 1959).

Distribution

Microphotus octarthrus has been reported from southwest Utah, Arizona, New Mexico, and western Texas, and from Chihuahua and Coahuila, Mexico (Fig. 41) (Green 1959, Zaragoza-Caballero *et al*. 2023, GBIF. org 2023, BugGuide 2023).

Habitats and Ecology

Microphotus octarthrus is typically found in oak-pine transition zones, at least in southeastern Arizona (J. Cicero pers. comm. 2020). Populations in central and northern Arizona have different ecological niches that are uncharacterized. Like other fireflies, larvae in this genus have been observed feeding on snails, and may also feed on slugs, earthworms, and other soft bodied invertebrates. This species has been documented from several mountain ranges up to 6,000 feet in elevation (Green 1959). Collection records indicate that this species is active from April through September (Green 1959), depending on location.

Conservation Status: Data Deficient

This species is listed as Data Deficient on the IUCN Red List as it is unknown whether it remains extant across much of its distribution (Fallon 2021a). A few scattered, recent occurrences have been reported from central and southwestern New Mexico, west Texas and northern and Southern Arizona, but not elsewhere across the historic range. Additional survey efforts are needed.

Figure 43. *Microphotus octarthrus* adult male from Brewster County, Texas. Photo: Mike Quinn (BugGuide observation 1059398).

Microphotus angustus LeConte, 1874 (California Pink Glow-worm)

Description

The elytra in males of this species are more than three times as long as the pronotum. The antennae usually have nine segments, sometimes 10. Eyes beneath briefly contiguous. Body length ranges from 6.5-11 mm (Fig. 45) (Green 1959).

Figure 44. *Microphotus angustus* male from San Benito County, California. Photo: Paul G. Johnson (2022) (iNaturalist observation 119530448).

Distribution

Microphotus angustus is the most commonly recorded representative of this genus. It is the only *Microphotus* species found in California and Nevada (Green 1959), and it also occurs in Baja California, in Mexico (Zaragoza-Caballero *et al*. 2023) (Fig. 41). It has also been reported from a few occurrences in Arizona, New Mexico, and Sonora, but these records are likely misidentifications of other *Microphotus* species. One record from Klamath County, Oregon, is also likely erroneous (Green 1959). It has been suggested that closer inspection of California specimens may reveal cryptic species (J. Cicero on BugGuide 2023).

Habitats and Ecology

Microphotus angustus is most often found in oak, chaparral, and pine woodlands (BugGuide 2023). Females are frequently reported glowing from rocks and leaf litter (BugGuide 2023). Like other fireflies, larvae in this genus have been observed feeding on snails, and may also feed on slugs, earthworms, and other soft bodied invertebrates.

Conservation Status: Least Concern

Microphotus angustus is considered Least Concern on the IUCN Red List because of its broad distribution, and lack of specific threats (Fallon and Pérez-Hernández 2021a). Additional research is necessary to better understand the limits of this species distribution.

Microphotus fragilis E. Olivier, 1912 (Madrean Sky Island Pink Glow-worm*)

Description

In the males of this species, the elytra are more than three times as long as pronotum (typically about three and one-fourth times as long), often darkened at the tips. The antennae have ten segments. The eyes beneath are broadly contiguous. The median longitudinal line of pronotum is strongly impressed and the pronotum is relatively smooth, impunctate, and transparent on either side (Fig. 45). Body length ranges from 8.5-9 mm (Green 1959).

Distribution

Microphotus fragilis has a narrow distribution within Southeastern Arizona, where it is known from the Santa Rita Mountains, the Chiricahua Mountains, the Pinal Mountains, and the Santa Catalina Mountains (Fig.41) (Green 1959). The type specimen was collected in the Chiricahua Mountains by V.L. Clemence (Fall 1912). *Microphotus decarthrus* was once considered a unique species but has been synonymized with *M. fragilis* (Usener and Congnato 2006).

Habitats and Ecology

Microphotus fragilis is found in mid-elevation, open oak and juniper woodlands of southeastern Arizona (J. Cicero pers. comm. 2020). Like other fireflies, larvae in this genus have been observed feeding on snails, and may also feed on slugs, earthworms, and other soft bodied invertebrates.

Conservation Status: Data Deficient

This species is listed as Data Deficient on the IUCN Red List (Walker 2021d). However, as it is rarely encountered and is found in small populations over a relatively restricted distribution, additional surveys are needed to ensure the population is stable.

Figure 45. *Microphotus fragilis* male approaches larviform female to mate. Huachuca Mountains, Cochise County, Arizona. Photo: Charles W. Melton (BugGuide observation 923413).

Microphotus pecosensis Fall, 1912 (Rocky Mountain Pink Glow-worm*)

Description

The elytra in males are more than three times as long as the pronotum (average about three and a half times as long), eyes beneath are briefly contiguous posteriorly, the antennae have eight segments, and the median longitudinal line of pronotum is not impressed (Fig. 46). The body length is typically 6-8 mm. These characteristics are seen in *M. chiricahuae* as well, but the two species can be separated by features of the male genitalia. In addition, the scutellum in this species is usually narrowly rounded at the apex (Green 1959). The species are not known to be sympatric, so distribution will also be indicative.

Figure 46. Species near *Microphotus pecosensis* from Colorado. Specimens in this population are much more pink than other known populations of *M. pecosensis*. Photo: Josiah Kilburn (2023) (iNaturalist observation 169848554).

Distribution

Microphotus pecosensis was first collected by Fall (1912) in Pecos, New Mexico. This species has been collected across the southwest, including in Utah, Arizona, New Mexico, Colorado, and Texas in the US (Green 1959) and in Chihuahua, Mexico (Zaragoza-Caballero *et al*. 2023) (Fig. 41). Few of these occurrences have been verified recently, however, and it appears there are few collection records since the 1950s (Green 1959). It has recently been reported in the Gila National Forest in New Mexico (2004) (BugGuide 2023).

Habitats and Ecology

Microphotus pecosensis has been reported from desert canyons, oak-juniper transition zones, mixed conifer woodlands, and aspen groves (up to 9,000 ft.).

Adult activity period in this species begins in late June to early July. Around sunset females curl their two posterior segments toward the sky to attract males flying overhead. In one observation, females emerging in the evening displayed from rocks on the highest streamside banks (Cicero 1981). Like other fireflies, larvae in this genus have been observed feeding on snails, and may also feed on slugs, earthworms, and other soft bodied invertebrates.

Conservation Status: Data Deficient

This species is listed as Data Deficient on the IUCN Red List as it is unknown whether it remains extant across much of its distribution (Fallon and Pérez-Hernández 2021b). Recent occurrences have been reported from a few localities, but additional survey efforts are needed.

Microphotus chiricahuae Green, 1959 (Chiricahua Pink Glow-worm*)

Description

The elytra in males of this species are more than three times as long as the pronotum, the antennae have eight segments, the eyes beneath are briefly contiguous, and the median longitudinal line of pronotum is not impressed (Fig. 47) (Green 1959). These characteristics are seen in *M. pecosensis* as well. These two species can be separated by features of the male genitalia. In addition, the scutellum in this species usually has an apical notch, rather than a narrowly rounded apex (Green 1959).

Figure 47. What is likely *Microphotus chiricahuae* from Cochise County, Arizona. Photo: Jim Eckert (2021) (iNaturalist observation 102582442).

Distribution

Microphotus chiricahuae is likely the most range restricted *Microphotus* species. So far, it is known only from the Chiricahua Mountains of southern Arizona (Fig. 41). Similar specimens have been found in the Peloncillo Mountains to the north, so more research is necessary.

Habitats and Ecology

Microphotus chiricahuae is found in oak-pine woodlands from elevations of 5,400 to 9,500 feet (Green 1959, J. Cicero pers. comm. 2020). Little else is known about the ecology of this species, though its feeding habits and courtship behavior are likely similar to other species in this genus.

Conservation Status: Data Deficient

This species is listed as Data Deficient on the IUCN Red List because little is known (Fallon and Cicero 2021d). This species is a priority for surveys, as it has not been verifiably recorded since 1958.

Genus *Pleotomus* LeConte

Pleotomus are nocturnal glow-worm fireflies, with brachypterous, flightless, ground-dwelling females that appear to employ both pheromone cues and glows to attract male mates (Lloyd 2018). They exhibit extreme sexual dimorphism: *Pleotomus* males are small, short, and stout, and have wings, and females are grublike with brachypterous wings. Both sexes have characteristically double branched antenna (bipectinate). There are two recognized species globally, both of which are found in the southern United States and Mexico (Fig. 48). However, there is some morphological variability within both species, leading to lengthy debate about the taxonomic relationship of the species in this genus. For example, a third species, *P. davisii,* occurring in the Southeastern United States, was once recognized. Zaragoza-Caballero (1992) synonymized both *P. davisii* and *P. nigripennis* under *P. pallens*. This was reversed by Lloyd (2002) only to be subsequently reinstated for *P. pallens* and *P. divisii* by Zaragoza-Caballero and Ramirez (2009). Therefore, *P. nigripennis* remains a recognized species. Further taxonomic work is needed to explore whether disjunct populations, currently recognized as *P. nigripennis*, in Texas and California may be unique. Both molecular methods and studies of larvae may be necessary (Faust 2017).

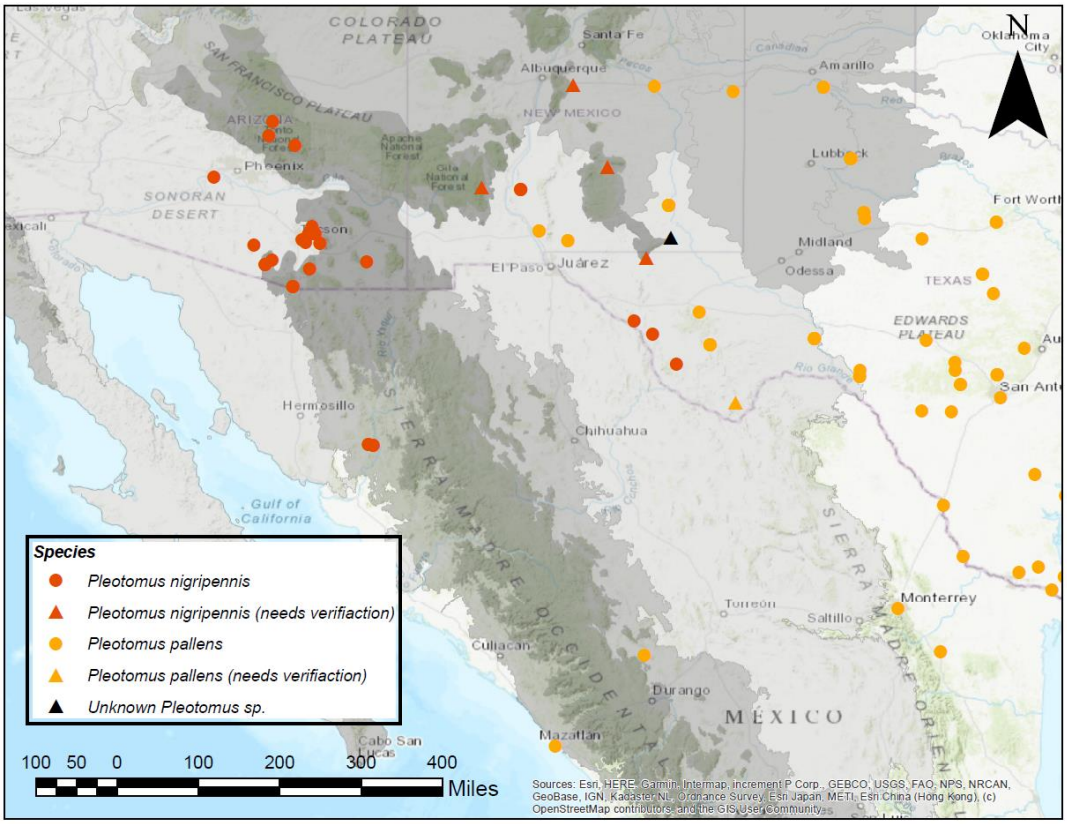


Figure 48. Known occurrences of *Pleotomus* species in the Southwest.

Key to *Pleotomus* species of the Southwest

1. Pronotum of males is pale yellow with pink median vitta (center stripe) on anterior half; elytra truncate and pale brown with pale yellow margin. Females are fat and uniformly soft pink in color…….***Pleotomus pallens*** **(pg. 57)**

- In male, pronotum yellow to orange, sometimes daker around median vitta (center stripe), pronotum slightly longer with apex less obtusely rounded; elytra concolorous, generally a darker grey or black, and not truncate (LeConte 1885). Females are uniformly bright pink except for dark brachypterous wings…….
  ……***Pleotomus nigripennis*** **(pg. 58)**

Pleotomus pallens LeConte, 1866 (Pale Combed Glow-worm*)

Description

The pronotum in *Pleotomus pallens* males is yellow with orange or pink median vitta (center stripe), and the pronotum is obtusely rounded apically. Elytra are brownish with yellow margins (Fig. 50). They are stouter than the sister species *P. nigripennis*. Females are uniformly pale pink, rather than bicolored, and are brachypterous (Fig. 51).

Figure 49. *Pleotomus pallens* adult male. Pontotoc County, Oklahoma. Photo: Mike Quinn (BugGuide observation 1168898).

Distribution

Pleotomus pallens has been recorded from much of the south-central United States, including Kansas, Oklahoma, New Mexico and Texas (GBIF.org 2023, Faust 2017). It has also been recorded throughout much of Mexico, including in Durango, Jalisco, Michoacán, Nayarit, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Sinaloa, Tamaulipas and Veracruz (Zaragoza-Caballero *et al*. 2023, GBIF.org 2023) (Fig. 48).

Habitats and Ecology

This species has been collected at UV lights in arid regions, often near oak forests, and usually in proximity to water (Faust 2017). Females are larviform, flightless, and ground-dwelling (Fig. 49). They do not feed as adults, and do not disperse very far from the spot where pupation takes place (King 1880). Males on the other hand, have been observed mouthing snails, possibly feeding on the flesh or at least the slime (King 1880). It is thought that males may use their conspicuous, branched antennae to detect female pheromones at a distance, and then hone in using the greenish bioluminescent glow of the female (Lloyd 2018). The males also emit a glow, although it is much dimmer than that of the females (King 1880) and only lasts for a few hours after eclosion (B. Pfeiffer pers. comm. 2023). In Texas, adults of this species appear in May (King 1880) and can often be found through the summer until September (B. Pfeiffer pers. comm. 2023). Adults typically eclose when humidity is high, which often happens when temperatures rise quickly, followed by heavy rain. Females emerge to the surface through warm moist soil from underground burrows. These environmental conditions likely allow females to be above the soil surface without desiccating too quickly (B. Pfeiffer pers. comm. 2023). Females lay eggs in moist soil, and larvae feed on snails (King 1880). Little else is recorded about the habitats and life history of this species.

Figure 50. Female *Pleotomus pallens* in a C-shaped posture for advertising to males. From Hays County, Texas. Photo: Joseph Lapp (BugGuide observation 664427).

Conservation Status

Pleotomus pallens, though not considered common, is found across a large region. No specific threats are known. It was recently assessed as Least Concern on the IUCN Red List, but more research is needed to better understand this species (Walker 2021e).

Pleotomus nigripennis LeConte, 1885 (Firey Combed Glow-worm*)

Description

Pleotomus nigripennis is similar in form to *P. pallens*, though both sexes differ markedly in color, with *P. nigripennis* having a uniformly dark elytra and bright yellow to orange pronotum (Fig. 51). The color of the male antenna, legs, and body seems to vary regionally, though some populations seem to contain multiple morphs (J. Cicero pers. comm. 2023). Most Arizona specimens tend to be mostly orange with only the elytra being dark, though one specimens with a dark abdomen has been collected within a population of males with orange abdomens (J. Cicero pers. comm. 2023). In Texas, the antennae, body, and legs may be dark (GBIF.org 2023). In California many specimens are similar to those in Arizona, but with black antenna and bioluminescence coming from a pair of spots on abdominal sternites three and four (Sleeper 1969) instead of one pair on the seventh sternite, which is more typical (J. Cicero pers. comm. 2023). Utah specimens also have black antennae (Fisher and Cicero 2022), and New Mexico specimens seem to be intermediary between Texas and Arizona forms (J. Cicero pers. comm. 2023). Work is needed to resolve the relatedness between specimens from these disjunct occurrences. Compared to *P. pallens*, which tends to have a yellow margin around the elytra, the pronotum is a little longer in shape with the apex less obtusely rounded (LeConte 1885). Body length of males is around 13 mm. Where the female has been observed, she was bright pink with dark wing buds (Fig. 52).

Figure 51. *Pleotomus nigripennis* adult male. Photo: C. Mallory (2019a) (iNaturalist observation 27405485).

Figure 52. Brachypterous adult female *Pleotomus nigripennis*. Photo: Alex Yelich

Distribution

Pleotomus nigripennis has been recorded in Arizona, Utah, Texas, New Mexico, California and Sonora (J. Cicero pers. comm. 2023, Fisher and Cicero 2022, GBIF.org 2023, and Zaragoza & Ramírez 2009) (Fig. 48).

Habitats and Ecology

Pleotomus nigripennis is found in a variety of arid ecoregions, comprising of scattered mountains, canyons, basins, bajadas, plains, and plateaus. In California they are reported from a creosote bush shrubland (Sleeper 1969), which seems to be a dominant plant across much of the range of the species (Fisher and Cicero 2022). They reportedly have a rather short mating period (B. Pfeiffer pers. comm. 2019). Males are typically collected at UV lights (Faust 2017). Larvae likely feed at least on snails (Faust 2017). Little else is recorded about the habitats and life history of this species.

Conservation Status: Data Deficient

This species is listed as Data Deficient on the IUCN Red List, as little is known about the limits of the distribution, population trend, threats, or basic ecology (Walker and Pérez-Hernández 2021b). Surveys are needed to fill these data gaps.

Genus *Pterotus* LeConte

Females in this genus are soft-bodied, ground dwellers that are generally brachypterous or flightless and often burrow underground (Lloyd 2018). Based on the antenna of males, females likely employ pheromone cues to attract males to their vicinity. They then guide the males, which are typically non-luminous, further by emitting a glow. There are two species globally in this genus (Fig. 53). *Pterotus obscuripennis*, the more common of the two species, is found along the Pacific coast from southern Washington to Baja California, Mexico. *Pterotus curticornis* is known only from southern California, though something resembling this species has been observed in West Texas.

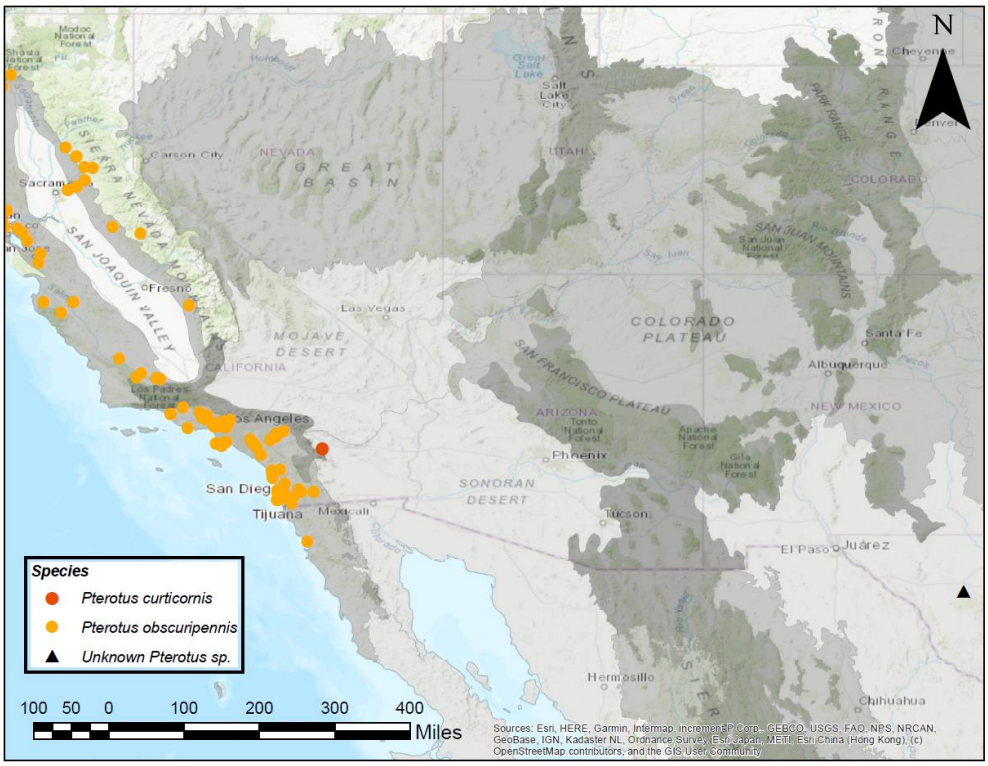


Figure 53. Known occurrences of *Pterotus* species in the Southwest. Black triangle represents sighting of a *Pterotus*-like firefly in West Texas, that needs to be further explored.

Key to *Pterotus* species of the Southwest

1. Antennae long with long and slender extensions (Fig. 54.3.); pronotum broad (width larger than length (Fig. 54.1)); legs infuscated (dark) (Chemsak 1978)…… ……***Pterotus obscuripennis*** **(pg. 60)**

- Antennae shorter with short, broad extensions, and broad segments (Fig. 54.4); pronotum with width and length subequal (Fig. 54.2; legs orange and reddish (Chemsak 1978)…… ***Pterotus curticornis*** **(pg. 61)**

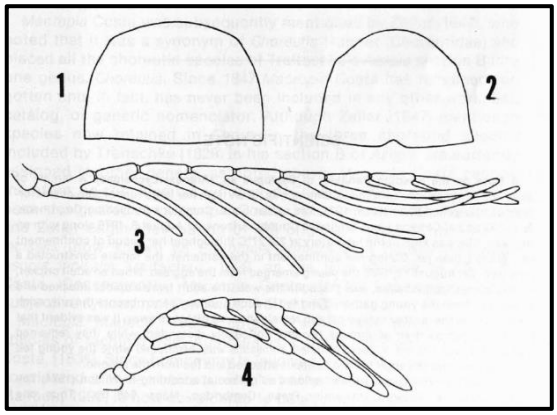


Figure 54. Illustrations from Chemsak 1978. Pronotal shape in 1. *P. obscuripennis* and 2. *P. curticornis*. Antenna form in 3. *P. obscuripennis* and 4. *P. curticornis*.

Pterotus obscuripennis LeConte, 1859 (Douglas Fir Glow-worm)

Description

This species has a large elongate body. The antenna are brown and antennomeres 3-10 each have a long branch (Le Conte 1859). The eyes are small compared to other glow-worms and the pronotum is short, rectangular, and uniformly testaceous (yellowish brown). The elytra are uniformly dark. Tibia and tarsi are infuscated (Fig. 55) (Chemsak 1978).

Distribution

Pterotus obscuripennis is found along the west coast of the United States and Mexico, from the southern tip of Washington to northern Baja California, Mexico (Chemsak 1978) (Fig. 53). It was described from a specimen collected at Fort Tejon, California, in 1859 (Chemsak 1978).

Habitats and Ecology

Pterotus obscuripennis occurs in chaparral foothills (Dean 1979). Larvae inhabit well-drained, yet moist habitats, such as fields or meadows surrounded by spruce, redwood, or fir forests (Dean 1979). Larvae hunt for food in open grassy areas and use grass roots to molt, pupate, and aestivate (Dean 1979). Females are larviform, concolorous white, soft-bodied, ground dwellers and often burrow underground (Lloyd 2018). They probably employ pheromone cues to attract males to their vicinity. They then guide the typically non-luminous males further by emitting a glow.

Conservation Status: Least Concern

Pterotus obscuripennis is fairly widespread and no range wide threats are known. This species is also reported frequently and is currently considered Least Concern on the IUCN Red List (Walker and Pérez-Hernández 2021c).

Figure 55. Dorsal and ventral sides of *Pterotus obscuripennis* from Los Angeles County, California. Photo: Scott Logan (BugGuide observations 1203670 and 1203671).

Pterotus curticornis Chemsak, 1978 (Short-horned Glow-worm*)

Description

This species has a large (11-12 mm) elongate body. The antennae are brown and antennomeres 3-10 each have a branch, which is shorter and stouter than that of *P. obscuripennis* (Fig. 56). The eyes are small and the pronotum is square and uniformly testaceous (yellowish brown). The elytra are uniformly dark with a netlike surface. The legs are orange and reddish throughout (Chemsak 1978).

Figure 56. *Pterotus curticornis* holotypes in the California Academy of Sciences collection (GBIF.org 2023). Photo: California Academy of Sciences (CC0 Public-Domain).

Distribution

Pterotus curticornis is confirmed only from the type locality at the Boyd Deep Canyon Research Center in Riverside County, southern California (Chemsak 1978) (Fig. 53). In 2018, a specimen which was very similar to this species, came to a UV light trap at Fox Canyon Ranch in the Davis Mountains of Texas (B. Pfeiffer pers. comm. 2023). The specimen escaped before it could be collected and confirmed. This record may turn out to be a new *Pterotus* species, as a disjunct distribution between the montane desert regions of southern California and the Davis Mountains of West Texas is unlikely, especially because the species has not been recorded in between. Others looking at taxa being described as limited to disjunct occurrences in the Davis Mountains and the Madrean Sky Islands, have often found specimens from the different regions are in fact sister taxa rather than conspecific (D. Yanega pers. comm. 2023).

Habitats and Ecology

The Boyd Deep Canyon Research Center in California, the type locality for the species, encompasses a major drainage system at the foot of the Santa Rosa Mountains. The habitat types range from montane forest and pinyon-juniper chaparral to sandy washes across a broad alluvial fan where the canyon meets the valley. While there are a few permanent pools in the upper reaches of the canyon, the lower reaches are typically dry, except when monsoon rains bring large flood events (University of California Riverside 2023). Unfortunately, it is impossible to know where the species was found within the Research Center, as locality information is imprecise. The *Pterotus curticornis*-like specimen observed in West Texas, was found in protected canyons of the Davis Mountains, a Chihuahuan Desert Sky Island mountain range. Further details on the life history and adult and larval habitats of *P. curticornis* are unknown, though like *Pterotus obscuripennis*, females are likely larviform ground dwellers that often burrow underground (Lloyd 2018). They probably employ pheromone cues to attract males to their vicinity. They then guide the typically non-luminous males further by emitting a glow.

Conservation Status: Data Deficient

This species was assessed as Data Deficient on the IUCN Red List as it has been collected very few times, and little is known about its distribution, population size, habitats and ecology or threats (Walker and Pfeiffer 2021b). Additional research is necessary.

CHAPTER 5: DAYTIME DARK FIREFLIES

Genus *Photinus (=Ellychnia)* (Blanchard)

There are 27 known species of daytime, dark *Photinus* species distributed throughout North America. Six of these species are found in the Southwest (Fig. 58). Until recently, these dark fireflies were in the genus *Ellychnia.* In 2020, *Ellychnia* was synonymized under *Photinus* (Zaragoza-Caballero *et al.* 2020) based on similarities in the genitalia (Zaragoza-Caballero *et al.* 2023). Molecular studies have also revealed that the species formerly under *Ellychnia* do not form a monophyletic group, but instead are nested within the *Photinus* phylogenetic tree (Martin 2020). The main difference between the two groups is their habits, with most *Photinus (=Ellychnia)* species being day active, and lacking lanterns. There are several large species complexes within this group, including *Photinus corruscus*, *Photinus autumnalis*, and *Photinus lacustris*, that both J. W. Green and K. M. Fender spent a decade trying to reconcile (Fender 1970). These complexes, primarily distributed in eastern North America, remain mostly unresolved. Western species on the other hand, can be split into more or less recognizable species, though the encroaching *P. corruscus* species complex still results in confusion in some places.

Figure 57. *Photinus (=Ellychnia) alexanderi* from Garfield County, Utah. Photo: Joshua Verde (2021) (iNaturalist observations 89722461).

Photinus (=Ellychnia) are generally dark colored fireflies, with black or brown, mostly concolorous elytra (Fig. 57). Their eyes are much smaller than those of their nocturnal cousins. Their antennae have eleven segments, are slender (in contrast to that of *Pyropyga* and *Lucidota*, which have sub-serrate antenna and are often mistaken with *Photinus (=Ellychnia)*), typically not compressed, and the third segment is elongate, similar in size to the fourth. The pronotum is more or less semi-elliptical with mostly square hind angles. Occasionally the pronotum is concolorous, but often it is pale or reddish with a black center stripe (vitta) covering the convex median area, and the border is typically dark around the entire margin. Occasionally the pale markings go all the way to the anterior or basal margin. The epipleura (or elytra margin) is moderately wide and well defined, which gives most *Photinus (=Ellychnia)* species an oval shape. Adults of both sexes are winged and otherwise similar in appearance.

Unlike their nocturnal counterparts, this group of species do not use bioluminescent light in courtship, but instead rely on sex pheromones to communicate with potential mates (Ming and Lewis 2010). *Photinus (=Ellychnia) bivulnerus* may be an exception to this. Individuals produce a dim light, in the same position as the larvae do, but the purpose of this light is not known. *Photinus (=Ellychnia) flavicollis* may also produce light as adults, as their abdominal segments are light in color, but these fireflies have not been observed at night, so more research is needed. Larval *Photinus (=Ellychnia)* are thought to be carnivorous (Lewis 2016), likely feeding on a variety of soft bodied invertebrates such as snails, slugs, and earthworms.

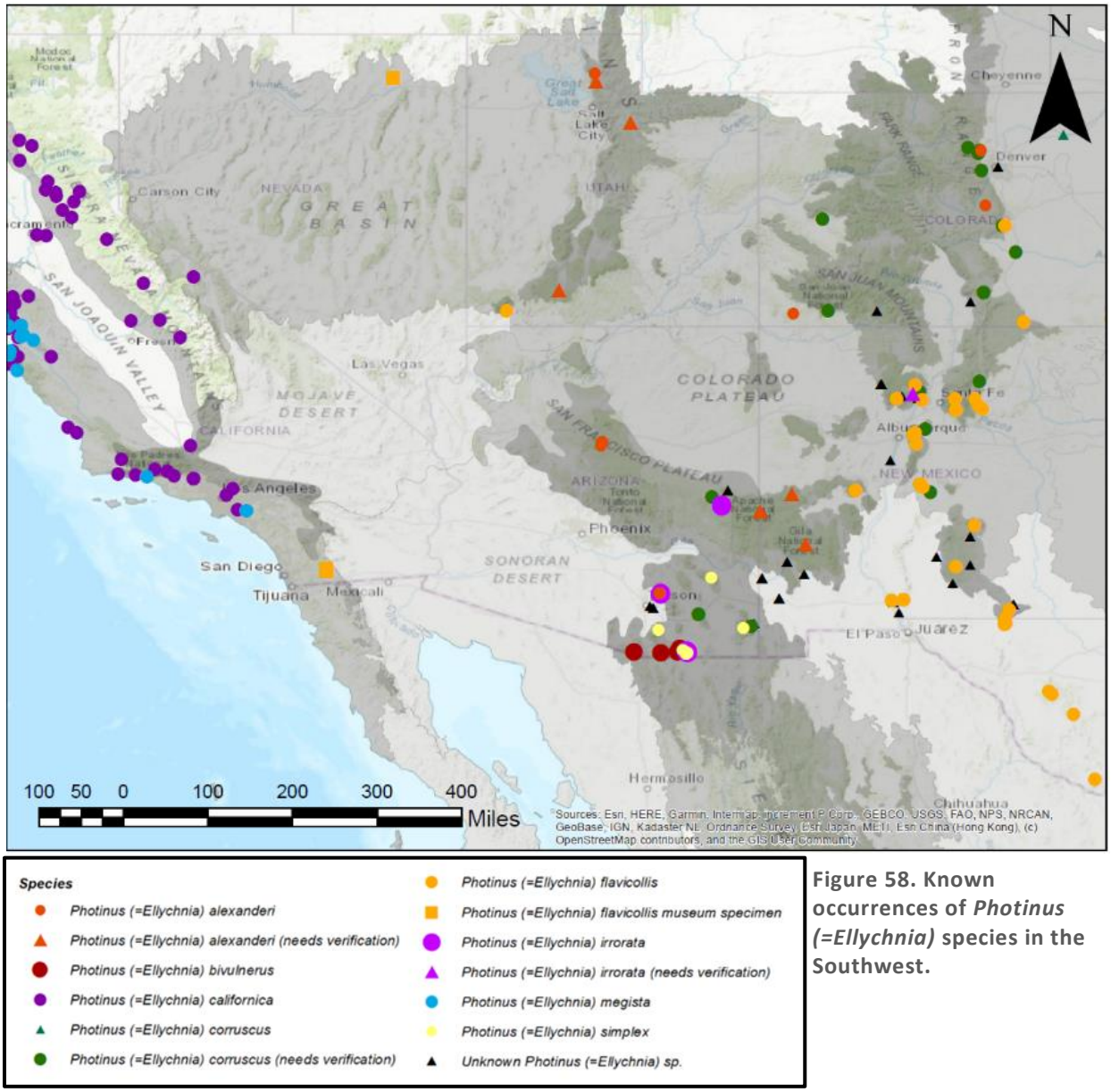


Figure 58. Known occurrences of *Photinus (=Ellychnia)* species in the Southwest.

Key to *Photinus (=Ellychnia)* species of the Southwest

1. Orange to red dots on either side of pronotal vitta (center stripe) (Fender 2070) (Fig 59.1)…… ……***Photinus (=Ellychnia) bivulnerus*** **(pg. 65)**
- Various color pattern on the pronotum, but never two distinct dots on either side of dark vitta……**2**
2. Pubescence grayish brown making the body appear dusty (Fender 1970)…… ……***Photinus (=Ellychnia) corruscus*** **(pg. 66)**
- Pubescence black, so body does not appear dusty……**3**
3. Pronotum unicolored……**4**
- Pronotum bicolored……**5**
4. Pronotum brownish yellow (in dead specimens) or orange to red (in live specimens); last two abdominal sternites flavous (yellow) (Fender 1970)…… ***Photinus (=Ellychnia) flavicollis*** **(pg. 67)**
- Pronotum entirely black (Fender 1970)……***Photinus (=Ellychnia) simplex*** **(pg. 68)**

5. Convex median area of pronotum closely granulate, at least in the anterior half, granules separated by less than their individual diameters; rosy pronotal vitta are contained within the dark pronotal margin (do not reach the edge of the margin either apically or basally) (Fender 1970) (Fig. 59.6)……
……***Photinus (=Ellychnia) irrorata*** **(pg. 69)**

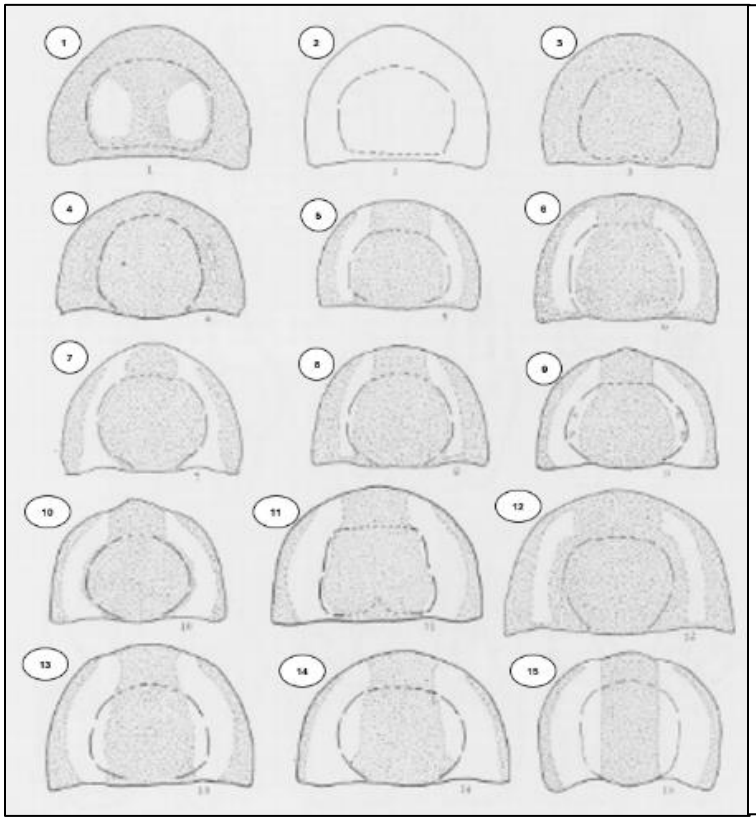
- Convex median area of pronotum more finely punctured, if granulate in anterior half, granules separated by more than their individual diameters; rosy pronotal vitta reach both the apical and basal margins of the pronotum……**6**

6. Rosy sublateral vittae of pronotum narrowed in median portions; pronotum extends forward in the center at the anterior edge (Fender 1970) (Fig. 59.7), body length typically 10 mm or less……
……***Photinus (=Ellychnia) alexanderi*** **(pg. 70)**

- Sides of median black area of pronotum straight throughout most of their length (Fender 1970) (Fig. 59.14); body length usually 10 mm or more…….. ***7***

7. Sides of median black area of pronotum straight, and more or less divergent to the basal fifth of pronotum, intruding into the rosy area as a semicircular globe; pronotum semi-circular (Fender 1970) (Fig 59.14)……
……***Photinus (=Ellychnia) californica*** **(pg. 71)**

- Sides of median black area of pronotum straight and nearly parallel to the base where they are slightly extended; pronotum not semi-circular in shape (Fender 1970) (Fig. 59.15)……
…… ***Photinus (=Ellychnia) megista*** **(pg. 72)**



59.1. *Photinus (=Ellychnia) bivulnerus* (AZ)

59.2. *P. flavicollis* (NM, CO)

59.3. *P. simplex* (AZ)

59.4. *P. obscurevittata* (OR)

59.5. *P. granulicollis* (OR, MT)

59.6. *P. irrorata* (AZ)

59.7. *P. alexanderi* (AZ, CO, UT)

59.8. *P. greeni* (OR, WA, n. CA, BC)

59.9., 60.10. *P. facula* (OR, WA, BC, ID, MT)

59.11. *P. capitosa* (CA)

59.12., 58. 13. *P. hatchi* (OR, WA, n. CA, BC)

59.14. *P. californica* (CA)

59.15. *P. megista* (CA)

Figure 59. General pronotal shapes and marking of western *Photinus (=Ellychnia)* species directly modified from Fender (1970). Pronotal shapes and markings vary widely within species, so other characteristics must be checked to positively identify species.

Photinus (=Ellychnia) bivulnerus (Green, 1949) (Twice Wounded Dark Firefly)

Description

Photinus (=Ellychnia) bivulnerus is easily distinguishable because of the reddish dots on either side of the pronotal vitta (center stripe) (Fig. 60). *Photinus bivulnerus, P. flavicollis,* and *P. simplex* are separate from all other *Photinus (=Ellychnia)* based on the elytral pubescence as well. These three species have "longer and finer suberect elytral pubescence…and more conspicuous minute secondary pubescence covering most of the elytral surface. The two complexes known as [*corruscus*] and *californica* have the primary elytral pubescence coarser and decumbent, and the secondary pubescence excessively minute and difficult to perceive, and generally confined to the elytral flanks" (Green 1949).

Figure 60. *Photinus bivulnerus* from the Huachuca Mountains in Cochise County, Arizona. Photo: Mike Quinn (BugGuide observation 820804).

Distribution

Photinus bivulnerus is known only from several mountain ranges in southern Arizona, including the Patagonia, Huachuca, and Pajarito Mountains (Green 1949, Fender 1970) (Fig. 58). It is likely this species also occurs in northern Mexico, but it has not yet been documented there.

Habitats and Ecology

Photinus bivulnerus appears to be restricted to a sub-set of the Madrean Sky Islands in southern Arizona, which are typically characterized by oak-pine woodlands. Adults reportedly have tiny lanterns left over from the larval stage, where light can pass through a small gap in the abdomen (J. Cicero pers. comm. 2020). However, this species is diurnal, so it is unlikely this light is used in courtship. Instead, this species likely uses pheromones in courtship, as do other *Photinus (=Ellychnia)* species (J. Cicero pers. comm. 2020). The larvae have never been recorded but may feed on invertebrates within the soil, as other firefly larvae do (Lewis 2016, J. Cicero pers. comm. 2020). The habitat for this species is not well understood, though it has been recorded from 4,000 to 6,000 ft. (Fender 1970). At one locality, Sycamore Canyon in Santa Cruz County, the site is described as a dry slope in young oak woodlands (J. Cicero pers. comm. 2020). This is different from the habitats of most *Photinus (=Ellychnia)* which tend to be found closer to moist habitats. This species has been recorded on July 20th and August 3rd (Fender 1970).

Conservation Status: Data Deficient

Other than the collection information provided by (Fender 1970), this species has been recorded very few times. Joe Cicero reported seeing this species from the 1970s through the 1990s at a site in the Pajarito Mountains of southern Arizona, but it is unclear whether this species has been recorded more recently. Where the species was once found in Sycamore Canyon, several large oak trees were removed, and the species has not been recorded since. Because so little is known about this species, it is listed as Data Deficient on the IUCN Red List (Fallon and Cicero 2021e). This species is a priority for survey efforts.

Photinus (=Ellychnia) corruscus (Linnaeus, 1767) (Winter Firefly)

Description

Compared to other *Photinus (=Ellychnia)* species*, P. corruscus* is covered in brownish pubescence that tends to give it a dusty appearance (Fig. 61). The pronotal vitta is usually relatively narrow and obscured towards the middle (medially). They are moderately large (9-13.5mm) and the elytra have obvious costae (raised stripes) (Fender 1970).

Figure 61. Representative of the *Photinus (=Ellychnia) corruscus* sp. complex. Specimen from Pueblo County, Colorado. Photo: Van Truan (2008) (iNaturalist observation 30458472).

Distribution

Photinus (=Ellychnia) corruscus is common and widespread across eastern North America, in Canada, the US, and Mexico, from the Rocky Mountains in the west to the Atlantic coast in the east (Fender 1970, Lloyd 2003, Faust 2017, C. Pérez Hernández pers. comm. 2020) (Fig. 58). West of the Continental Divide, it is unclear if records labelled as *P. corruscus* actually represent this species, or if they are other species of western *Photinus (=Ellychnia)* that have been misidentified. There do appear to be at least a few accurate records of *P. corruscus* in Colorado and possibly Arizona (Fender 1970), but more work is needed to better understand the western distribution of this and other *Photinus (=Ellychnia)* species.

Habitats and Ecology

Photinus corruscus can be found in a wide variety of habitat types, including hardwood, coniferous, and mixed forests, along streams, rivers, and ponds, in orchards and agricultural fields, wet meadows, along seashores in salt marshes, and in yards and open parks (Faust 2012, Majka 2012, Deyrup *et al.* 2017, Faust 2017). Like other species in this group adults are diurnal, use pheromones rather than bioluminescent light signals to communicate with potential mates, and the larvae likely feed on other invertebrates at or below the soil surface. Adults have been observed at sap flows on maple trees (*Acer* spp.) (Rooney and Lewis 2000, Evans 2014). They have also been observed nectaring on the flowers of maple, aster, and goldenrod (*Solidago* sp.) (Rooney and Lewis 2000).

Unlike many other firefly species, this species overwinters in the adult stage. Adults emerge in the fall or early winter and nestle into furrows on the bark of overwintering trees. Deyrup *et al.* (2017) found that tree species with more deeply furrowed bark, such as oaks (*Quercus* spp.) and ash (*Fraxinus* spp.) were more often used by overwintering adults. At sites in eastern Tennessee, Faust (2012) found colonies at the same locations every year, sometimes on the same trees. This firefly withstands freezing temperatures in a state of diapause throughout the winter. Once temperatures begin to warm up in the spring, adults emerge to mate, slowly crawling up the trunks of their overwintering trees (Faust 2017). Up to two hundred individuals may crawl up their colony trees during mass emergence events (Faust 2017). Because of its tolerance for cold weather, the winter firefly is often among the first fireflies seen in the spring. Breeding season length can vary depending on location and local conditions, but typically starts early to late spring (mid-March through mid-May) (Rooney and Lewis 2000, Faust 2012).

Conservation Status: Least Concern

Photinus corruscus is widespread and common. While taxonomic work on this species complex may one day reveal additional species, as it is currently understood, *P. corruscus* is considered Least Concern (Fallon 2021b).

Photinus (=Ellychnia) flavicollis (LeConte, 1868) (Yellow-tailed Firefly*)

Description

Ellychnia flavicollis is unique among other diurnal members of the genus *Photinus (=Ellychnia)*, as it has a relatively well-developed lantern. In addition, it has a uniformly orangish pronotum, which makes it easy to identify (Fig. 62). The lanterns of the males and females have not been compared, courtship has not been observed, and the larvae are unknown. It is possible this species will eventually be moved to a new genus.

Figure 62. *Photinus (=Ellychnia) flavicollis* from Big Bend national Park in Brewster County, Texas. Photo: David Sarkozi (2019) (iNaturalist observation 28943995).

Distribution

Photinus (=Ellychnia) flavicollis is found in New Mexico, Colorado, Oklahoma, and Texas (LeConte 1868, Fender 1970, Lloyd 2003, BugGuide 2023, GBIF.org 2023) (Fig. 58). There is also one record each, in California and Nevada from 1924 and 1882 respectively, though no recent records have been taken in either state (GBIF.org 2023).

Habitats and Ecology

Very little is known about the habitat and ecology of this species. Both males and females are winged, but mating behavior is unknown. It is unclear if adults use their lanterns in courtship, or if like most *Photinus (=Ellychnia)*, pheromones are used instead. Specimens have been collected at UV lights (BugGuide 2023), suggesting adults may be attracted to light. The larvae are unknown, but like other firefly species, those of *P. flavicollis* are likely carnivorous, feeding on soft bodied invertebrates such as snails, slugs, and earthworms (Lewis 2016). Very little has been documented about the habitat associations of this species, although it appears to be associated with lower elevation pine forests of mountainous areas, often in proximity to water (LeConte 1868, Fender 1970, BugGuide 2023). LeConte (1968) describes individuals as “found clinging to plants.”

Conservation Status: Data Deficient

Very little is known about this species. It is currently listed as Data Deficient on the IUCN Red List, so a better understanding of distribution, population, habitats and ecology, and threats is needed (Fallon 2021c).

Photinus (=Ellychnia) simplex (LeConte, 1885) (Simple Dark Firefly*)

Description

Photinus (=Ellychnia) simplex is pure black, lacking any red or orange on the pronotum or elsewhere, apart from the eight abdominal sternite, which is slightly testaceous (Fender 1970). The body shape is elongate-oval and the pronotum is semi-elliptical. Costa, or longitudinal lines on the elytra, are evident, and elytra have a finely granulate texture. Antennae are strongly impressed beyond the second segment (Fig. 63).

Distribution

Photinus (=Ellychnia) simplex has been reported only from Cochise County, Arizona (LeConte 1885, Fender 1970, Lloyd 2003, BugGuide 2023) (Fig. 58). Details of the type locality are not available, but a single male examined by Fender (1970) was collected at Miller Canyon in the Huachuca Mountains. No other records for this species were known until observations in 2014 and 2015 confirmed this species' presence in Miller Canyon and documented a new locality in adjacent Carr Canyon at Comfort Springs (BugGuide 2023).

Habitats and Ecology

The habitats and ecology of *Photinus simplex* are not well studied, and specific details are unavailable. Descriptions of the female have not been published, though it is likely adults of both sexes are winged. Like other fireflies in this group, *P. simplex* is diurnal, likely employing pheromones to find mates. Juveniles have not been described, and the dietary preferences of the larvae are unknown. However, firefly larvae in general are carnivorous, with most species feeding on soft bodied invertebrates such as snails, slugs, and earthworms (Lewis 2016). This species is known from two canyons in the Huachuca Mountains, where it was found in pine-oak woodlands near creeks at an elevation of 2,134 meters (7,000. ft.) (J. Cicero pers. comm. 2020).

Conservation Status: Data Deficient

Very little is known about this species. It has been collected or observed very few times and likely has a very restricted distribution. It is currently listed as Data Deficient on the IUCN Red List (Fallon 2021d). Further research is needed.

Figure 63. *Photinus (=Ellychnia) simplex* from the Huachuca Mountains in Cochise County, Arizona. Photo: Charles W. Melton (BugGuide observation 1101134).

Photinus (=Ellychnia) irrorata (Fender 1970) (Sprinkled Dark Firefly*)

Description

This species has yellow or reddish pink sublateral vittae, which are contained within the dark pronotal margin (do not reach the edge of the margin either apically or basally) (Fender 1970). These markings are reminiscent of parenthesis, as they form even arcs around the median convex area of the pronotum. They can be thin or thick. Pronotum is roughly semi-circular. The pubescence is lighter in areas where the integument is lighter, dark in black areas of the pronotum and elytra, and greyish on the body beneath. This species is elongate-oval in shape: 7.5-11 mm in length and 3.75-5.5 mm in width (Fender 1970). The elytra have a finely granulate texture, but no costae.

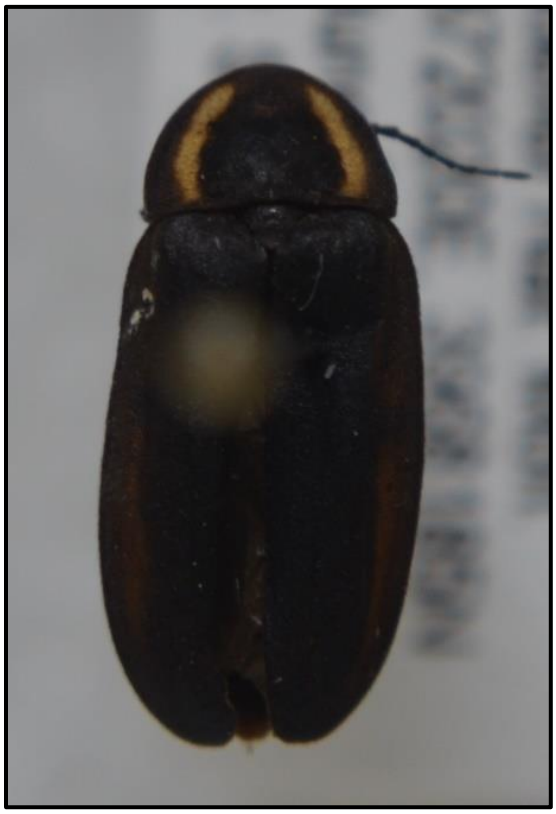


Figure 64. Possibly *P. irrorata* from northern New Mexico. Photo of UNM-MSBA 46974.

Distribution

So far, *Photinus (=Ellychnia) irrorata* is known only from Arizona (Fender 1970), though some specimens from Bandelier National Monument in northern New Mexico, resemble this species (Fig. 64). It has been documented in several mountain ranges in eastern and southern Arizona, including the White Mountains, the Huachuca Mountains, and the Santa Catalina Mountains (Fender 1970) (Fig. 58).

Habitats and Ecology

Very little is known about the habitats and ecology of *P. irrorata* because it has been collected very few times. Like other species in the genus, it is diurnal, and adults likely use pheromones rather than bioluminescent light signals to communicate with potential mates. The larvae likely feed on other invertebrates at or below the soil surface. This species has only been recorded in montane areas, up to 8,000 feet in elevation. It has been collected from May 24th through September 15th.

Conservation Status: Data Deficient

Other than collection information provided by Fender (1970), there are few reports of this species in the literature. It has not been reported in iNaturalist, BugGuide, or GBIF.org, suggesting it is rare and difficult to identify. Because so little is known about this species, it was listed as Data Deficient on the IUCN Red List (Fallon 2021e). This species is a priority for survey efforts.

Photinus (=Ellychnia) alexanderi (Fender 1970) (Alexander's Dark Firefly*)

Description

The pronotum of this species has reddish pink sublateral vittae (stripes), which reach both the apical and basal margins of the pronotum (Fender 1970). The sublateral stripes are usually narrower in the median portions of pronotum. Compared to *P. irrorota*, the pronotum may be less semi-circular and instead extends further forward in the center at the anterior edge. Otherwise, this species is dark, with dark pubescence. In shape, this species is elongate-oval: typically 7.5- 10mm long and 3.5-5mm wide. The elytra have a finely granulate texture, and two or three slightly elevated discal costae (Fender 1970).

Figure 65. Photo of a specimen in the Museum of Southwestern Biology at the University of New Mexico (UNM-MSBA 61573). Specimen remains unidentified, but pronotal shape matches the description of *P. alexanderi* (Fender 1970).

Distribution

This species has been recorded in Oak Creek Canyon in Arizona, Pike National Forest and Boulder in Colorado, and Liberty in Utah (Fender 1970) (Fig. 58). There is also a specimen in the collection at the Museum of Southwest Biology from Quemado Lake in Catron County, New Mexico (not far from Arizona occurrence), which resembles this species (Fig. 65).

Habitats and Ecology

Very little is known about the habitats and ecology of *P. alexanderi* because there are few verified records of the species. Like other species in the genus, it is likely diurnal, adults likely use pheromones rather than bioluminescent light signals to communicate with potential mates, and the larvae likely feed on other invertebrates at or below the soil surface. This species has only been recorded in lower montane areas, from about 4,600 to 6,800 feet. One specimen in Utah was found on a willow (*Salix* sp.) and many of the other occurrences are in canyons, so it is likely this species relies on permanent water sources. It has been collected from May 9th through September 4th.

Conservation Status: Data Deficient

Other than the collection information provided by (Fender 1940), there are few reports of this species in the literature. It has not recently been reported on BugGuide or GBIF.org, suggesting it is rare, though more likely it is just overlooked. Recent iNaturalist records may be valid, but additional taxonomic work is required on the species to be sure. Because so little is known about this species, it was listed as Data Deficient on the IUCN Red List (Fallon 2021f). This species is a priority for survey efforts.

Photinus (=Ellychnia) californica (Motschulsky, 1854) (California Dark Firefly*)

Description

The pronotum of this species has very broad, reddish pink sublateral vittae (stripes) which reach both the apical and basal margins of the pronotum. The sides of the black center stripe are almost straight, and because they are diverging, the stripe is triangular (Fender 1970). In shape, this species is elongate-oval: typically 9.5- 16 mm long and 5-8.5 mm wide. The elytra have a finely granulate texture, each with two lightly indicated costae (discal and subsutural) (Fender 1970).

Figure 66. *Photinus (=Ellychnia) californica* from Byrne-Milliron Forest, Watsonville, Santa Clara County, California. Photo: Irene Rosen (2023) (iNaturalist observation 163226667).

Distribution

This species is found along the West Coast, from California to Vancouver, Canada. There are disjunct records from New Mexico and Mexico, but these are likely misidentified. Fender (1970) notes that the species appears to be more common from Sacramento south to the San Bernardino Mountains. It is also common in the Santa Monica Mountains (Fallon and Cicero 2021f).

Habitats and Ecology

Like other species in the genus, *P. californica* is diurnal, adults likely use pheromones rather than bioluminescent light signals to communicate with potential mates, and the larvae likely feed on other invertebrates at or below the soil surface. This species is confined to riparian areas. In southern California, it uses willow-lined riparian oak woodlands at 3,000-4,000 ft. in elevation (Fallon and Cicero 2021f).

Conservation Status: Data Deficient

This species is currently listed as Data Deficient on the IUCN Red List because little is known about its conservation status (Fallon and Cicero 2021f). While it is widespread and relatively common, more information on population size, population trend, and threats is needed.

Photinus (=Ellychnia) megista (Fender 1970) (Majestic Dark Firefly*)

Description

The pronotum of this species has very broad, reddish pink sublateral vittae (stripes), which reach both the apical and basal margins of the pronotum. The sides of the black center stripe are straight and almost parallel sided. The black side margins are very thin (Fig. 67). In shape, this species is elongate-oval: typically 13.5- 18 mm long and 6-7.5 mm wide. The elytra have a finely granulate texture, without obvious costae (Fender 1970).

Distribution

Photinus (=Ellychnia) megista is endemic to California, found from the Bay Area south to Los Angeles and east to the western slopes of the Sierra Nevada (Fender 1970, Fallon 2021g) (Fig. 58).

Habitats and Ecology

Like other species in the genus, *P. megista* is diurnal. Adults likelyuse pheromones rather than bioluminescent light signals to communicate with potential mates, and the larvae likely feed on other invertebrates at or below the soil surface. Although no information has been published on the habitat associations of this species, it has been reported from riparian oak woodlands and probably occurs in other forested habitats from coastal California to the foothills of the Sierra Nevada (Fallon 2021g).

Conservation Status: Data Deficient

This species is currently listed as Data Deficient on the IUCN Red List because little is known about its conservation status (Fallon 2021g). Additional information on population size, population trend, and threats is needed.

Figure 67. *Photinus (=Ellychnia) megista* from Sam McDonald County Park, San Mateo County, California. Photo: Theo Summer (2022) (iNaturalist observation 14042508).

Genus *Pyropyga* Motschulsky

Pyropyga is a small genus, containing only ten species worldwide. Four of these species are found in the United States, while the rest are found in Central America, South America, and the West Indies. There are three species known to occur in the Southwest. All species are united by specific features of the genitalia. Two widespread species, *P. minuta* and *P. nigricans*, have a large variability in the morphology of the aedeagi, which suggests these two species may in fact be complexes, though no correlations between geographic distribution or habitat type and genitalic variation have yet been identified (Green 1961). In addition, all known members of this genus are entirely black or dark piceous, apart from the pronotum. The pronotum is pale flavate, usually with a hint of red, and has a well-defined median vitta (center stripe), about a third to half the width of the pronotum.

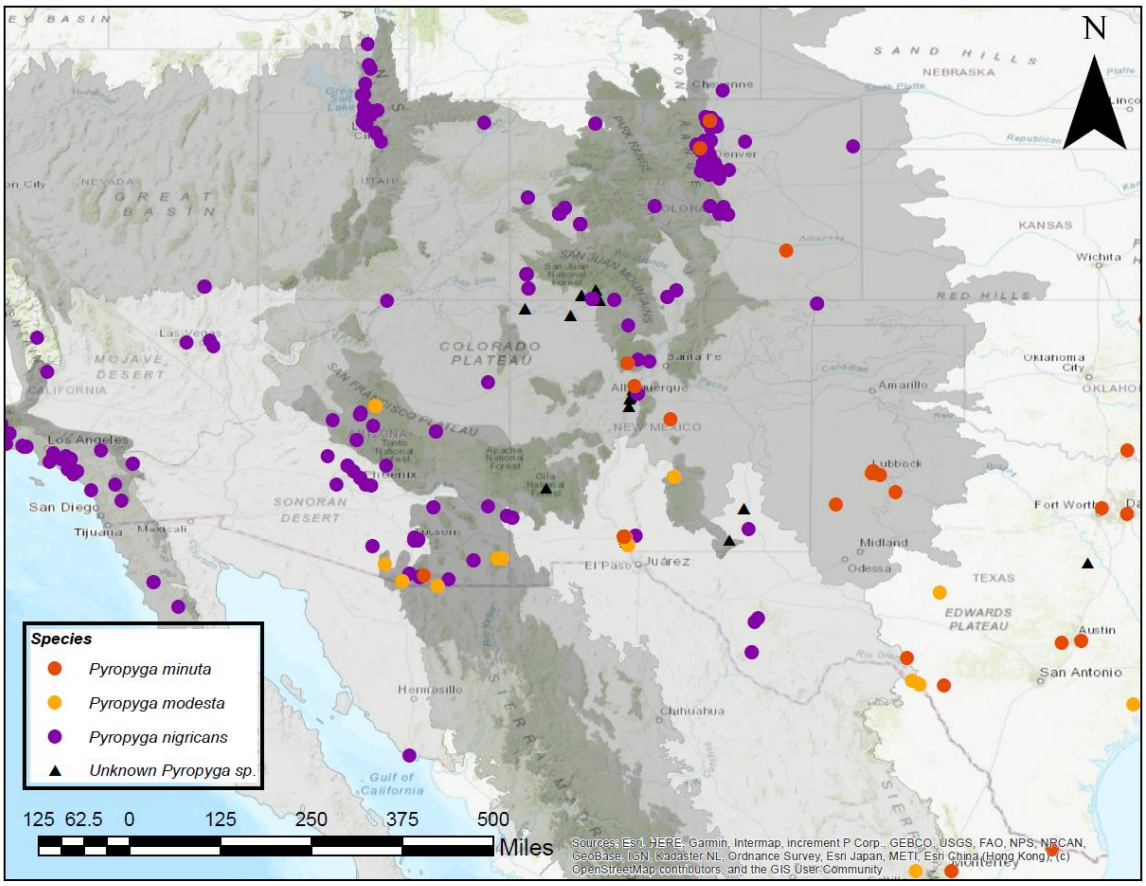


Figure 68. Known occurrences of *Pyropyga* species in the Southwest.

Key to the *Pyropyga* species of the Southwest

1. Median lobe of genitalia, when viewed laterally, without sinuate tipped lower margin; relatively small, body length 2.5-5.5 mm; no dark borders on pronotum; pronotum pale with median vitta (center stripe) sub-parallel-sided, usually expanded toward base (Green 1961)……..***Pyropyga minuta*** **(pg. 74)**

- Median lobe of genitalia with lower margin sinuate near tip, when viewed laterally; generally slightly larger, body length 4.2-8.5 mm; dark borders on pronotum, or not……..**2**

2. Pronotum with dark borders, rarely lacking; median lobe of genitalia broader at base and with basal angles nearly right, when viewed dorsally (Green 1961)…….. ***Pyropyga nigricans*** **(pg. 75)**

- Pronotum without dark borders, though occasionally border can appear faintly darker, especially in specimens from AZ; median lobe of genitalia narrower at base (Green 1961)……..***Pyropyga modesta*** **(pg.76)**

Pyropyga minuta (LeConte, 1852) (Flower Elf)

Description

This is the smallest species of *Pyropyga*, ranging from 3.0-5.5 mm. It has a black body and is usually narrowly elongate. The median vitta on the pronotum is sub-parallel sided, expanding somewhat at the base (Fig. 69).

Distribution

Pyropyga minuta is widespread throughout the southeastern United States, from Colorado and New Mexico east to the Atlantic Coast (Fig. 68). Its range extends south through eastern and central Mexico to Honduras (Green 1961). It is also found as an invasive species in Japan (Faust 2017).

Habitats and Ecology

Pyropyga minuta is a day active, dark firefly. Adults are found in a variety of habitats on vegetation, tall grasses, flowers, and leaves in gardens, parks, lawns, and roadside ditches (Faust 2017, Lloyd 1990). Larvae may be predaceous, feeding on soft bodied invertebrates, like the closely related *P. dicipiens* (Majka 2012). Adults have been observed nectaring on common milkweed (*Asclepias syriaca*) and mouthing the leaves of willows (*Salix* sp.) (Faust 2017, Zaragoza-Caballero 2004). Courtship is likely achieved through pheromone cues, rather than flashing or glowing signals, as this species lacks a lantern and is diurnal (Lloyd 2018, Buschman 2016). Adult *P. minuta* have been seen as early as April and as late as August and September but are most common in June and July (Faust 2017).

Conservation Status: Least Concern

Pyropyga minuta is widely distributed and commonly encountered. Threats to the species are not well documented and are probably localized in nature. The species is listed as Least Concern on the IUCN Red List (Walker and Pérez Hernández 2021d).

Figure 69. *Pyropyga minuta* from Albuquerque, Bernalillo County, New Mexico.

Pyropyga nigricans (Say, 1823) (Dark-margined Dark Firefly*)

Description

This species is generally 4.25-8.5 mm in length, and often though not always, can be distinguished by the dark border around its pronotum (Fig. 70). In many cases however, the genitalia are the only sure way to identify this species. It has an inner process, a relatively broad median lobe (when viewed dorsally), and the basal angles are almost right (Green 1961). As mentioned, the genitalia in this species can be quite variable between specimens, suggesting it may be a species complex. A unique wing polymorphism has also been observed: in most populations, both adults are fully winged but in one locality, both sexes exhibited reduced or shortened wings, and in another, females were brachypterous, but males were not (Green 1961).

Figure 70. *Pyropyga nigricans* from Santa Cruz County, Arizona. Photo: Salvador Vitanza on https://elp.tamu.edu/.

Distribution

Pyropyga nigricans is found throughout much of North America, except in the southeastern United States. It is most common from the Rocky Mountains to the Pacific Coast, in the United States (Green 1961) (Fig. 68). It is also found in Canada, from British Columbia to the Atlantic Coast, and throughout much of eastern and central Mexico (Green 1961, Faust 2017, Gorham 1881, Zaragoza 1993).

Habitats and Ecology

Pyropyga nigricans is a day active, dark firefly found in a variety of moist habitats including wet forests, creek margins, well irrigated lawns, and agricultural fields (Archangelesky and Branham 2001, Majka 2012, Bushman 2016). The larvae in particular are found in close association with water, and are possibly semi-aquatic. They can be found along riparian areas and the sandy shores of lakes and streams (Lloyd 2018). Larvae are predaceous, feeding on earthworms, gastropods, and moth larvae (Majka 2012, Faust 2017). Because the adults are diurnal, courtship is not achieved though flashing or glowing signals, but rather pheromone cues (Lloyd 2018, Buschman 2016, Faust 2017).

Conservation Status: Least Concern

Pyropyga nigricans is widely distributed and commonly encountered in a variety of different habitat types, especially in the western portions of its range. Threats to the species are not well documented and are probably localized in nature. The species is listed as Least Concern on the IUCN Red List (Walker 2021g).

Pyropyga modesta Green, 1961 (Modest Dark Firefly*)

Description

Like other members of the genus, this species has a black body and the pronotum is pale with a median vitta (Fig. 71). Ranging from 5 to 7.5 mm, it is typically slightly larger than *P. minuta* and does not have obvious black borders on its pronotum like *P. nigricans*. However, as some variability in morphological features is seen, the only way to confidently identify this and other *Pyropyga*, is by looking at the genitalia. In Arizona in particular, *P. modesta* can resemble *P. nigricans* due to black borders on the pronotum.

Figure 71. Holotype of *Pyropyga modesta* at the California Academy of Sciences (GBIF.org 2023). Photo: California Academy of Sciences (CC0 Public-Domain).

Distribution

Pyropyga modesta has been found in the southern Great Plains and Southwestern United States (Missouri, Oklahoma, Texas, Arizona and New Mexico) (Fig. 68), as well as much of eastern and central Mexico, as far south as Oaxaca and Chiapas (Green 1961, Zaragoza 1993, Zaragoza *et al.* 2020). The exact distribution of this species is unknown, as it is difficult to identify and can easily be mistaken for other species.

Habitats and Ecology

Little is known about *Pyropyga modesta.* Like other species of *Pyropyga*, the adults are diurnal, so courtship is likely achieved through pheromone cues, rather than flashing or glowing signals (Buschman 2016). Larvae of species within this genus are generally predaceous, feeding on soft bodied invertebrates (Majka 2012, Faust 2017).

Conservation Status: Data Deficient

Though seemingly widespread, the distribution of *Pyropyga modesta* is slightly obscured, as it is commonly mistaken for closely related species. Threats to the species are not well documented and are probably localized in nature. Due to these difficulties in proper identification, the conservation status is difficult to assess, and the species is listed as Data Deficient on the IUCN Red List (Walker 2021f).

Genus Chespirito Ferreira, Keller and Branham

The genus *Chespirito* exhibits a unique combination of characteristics that set it apart from all other genera in the family Lampyridae. As a result, upon its description, a new subfamily, Chespiritoinae, was also described (Ferriera *et al.* 2020). It remains the only genus in the subfamily, which now includes six species, five of which are endemic to Mexico and one that has been found only in southern Arizona (Ferriera *et al.* 2022). Members of this genus have strongly setose (hair covered), filiform antenna, with antennomere 3 much smaller than the other antennomeres. The pronotum is often constricted in the middle (though not in *C. ballantyneae* or *C. milleri*), the area next to the central disc is covered in dimples, and there is a prominent longitudinal carina (keel like ridge). The elytra are separated along the midline, and they are smooth and weakly sclerotized (Fig. 73). In addition, the male genitalia are uniquely shaped. The genus is named after the Mexican screen writer, director, actor and comedian, Roberto Gomez Bolanos, known by the stage name Chespirito (Ferriera *et al.* 2020).

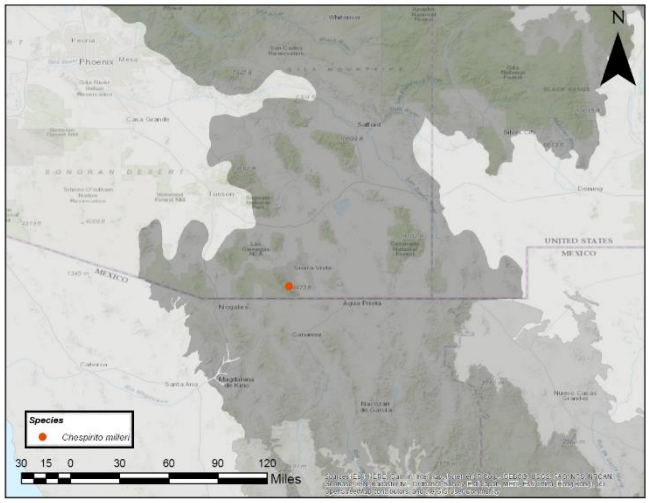


Figure 72. Only known occurrence of *Chespirito milleri*.

Chespirito milleri Ferreira, Keller & Ivie, 2022 (Miller's Chespirito Dark Firefly*)

Description

Chespirito milleri is a small firefly, around 3.3 mm in length. The pronotum and elytra are uniformly dark brown, while the mandibles, elytral insertions, trochanters, tarsi, and the last three segments of the abdomen are yellow (at least in preserved specimens). The pronotum is not constricted in the middle, the anterior angles are round, the posterior margin is bisinuate, and the median longitudinal carina is strongly visible throughout. The elytra are three times the length of pronotum, they do not meet along the inner margins), and each elytron has one weakly developed elytral costa, or stripe (Ferriera *et al.* 2022) (Fig. 73).

Figure 73. *Chespirito milleri* Photo: Vinicius S. Ferreira (Ferriera *et al*. 2022).

Distribution

This species is only known from one locality in the Huachuca Mountains of southeast Arizona (Ferriera *et al.* 2022) (Fig. 72). It is unclear whether it may be more widespread, and it has not been recorded since 1993.

Habitats and Ecology

Little is known about the habitats and ecology of this species. Type specimens were collected at 5,700 feet in Ramsey Canyon, in the Huachuca mountains. They were collected on August 7th of 1993. This canyon has high walls and a spring fed stream that keeps the environment cool and moist. The banks are lined with sycamores and maples and cacti, yucca and agaves can be found nearby as well. Plant communities in the vicinity range from semi-desert grassland to pine-fir forest (The Nature Conservancy 2024).

Conservation Status: Not Evaluated

As this species is newly described, it has not yet been assessed on the IUCN Red List of Threatened Species. However, as the species has not been seen since the type series was collected in 1993, surveys are needed.

Genus Paraphausis Green

Paraphausis is a monotypic genus containing only the species *Paraphausis eximius*. When first described, Green (1949) suggested *Paraphausis* is most closely related to the genus *Phausis*, which has no representatives known from the southwestern US. Compared to *Phausis*, which have well developed, arcuate, and decussate mandibles with acute tips, the mandibles in *Paraphausis* are small, nearly straight, distant, subconical, and blunt tipped (Green 1949). In addition, *Paraphausis* lacks the two anterior vitreous (translucent) spots on the pronotum, which are characteristic of *Phausis*. More recently, it has been suggested that *Paraphausis* is more closely related to another recently described genus *Nelsonphotus*, whose single species, *Nelsonphotus aridus*, is found in the deserts of California, US and Sonora, Mexico (Cicero 2006). Genetic work also shows *Paraphausis* is closely related to *Microphotus* (Stranger-Hall *et al.* 2007). Members of both genera have a minute membranous appendix on the last antennal segment, which J. Cicero (BugGuide 2023) interprets as an interflagellar segment, and very similar genitalic features (Green 1959).

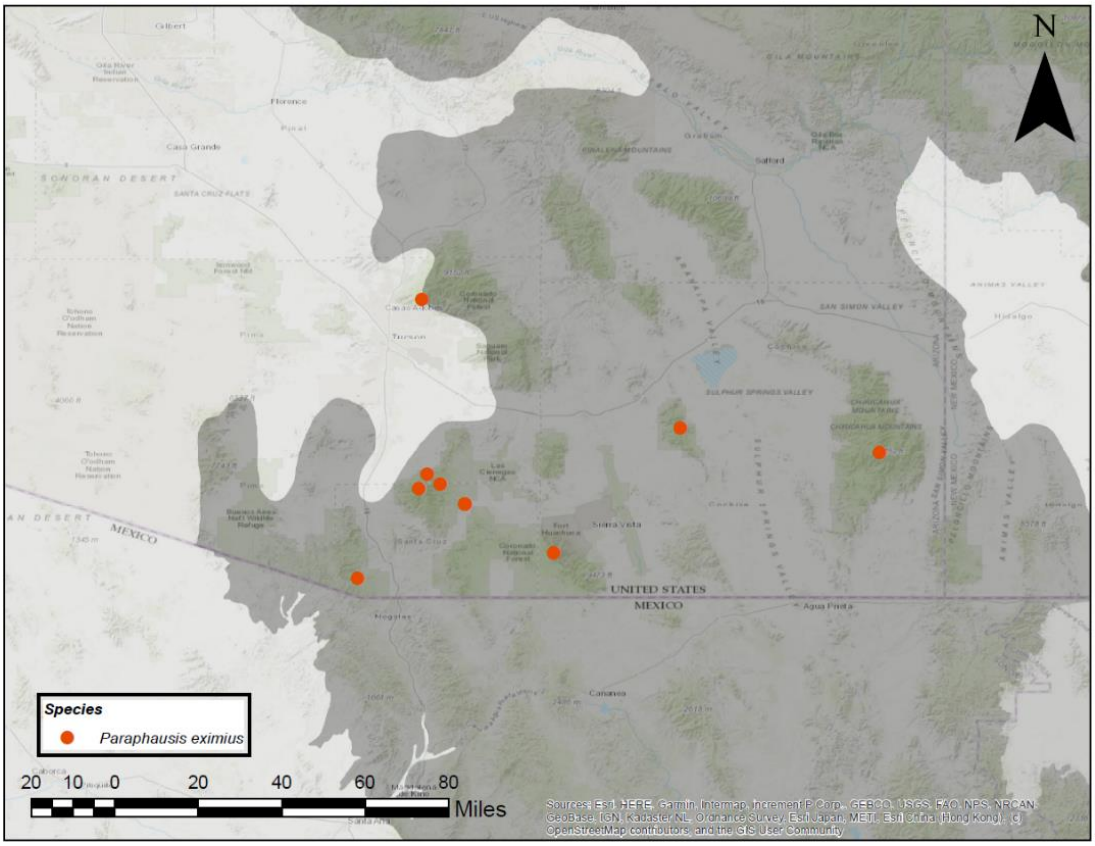


Figure 74. Known occurrences of *Paraphausis eximius*.

Paraphausis eximius Green, 1949 (Distinguished Firefly*)

Description

Only the males of this species are known. Male *Paraphausis eximius* are small (4-4.5 mm), with black or piceous elytra and a dull yellowish-orange pronotum (Fig. 75). Their heads are transverse and they have small but prominent eyes. Their antennae are slightly longer than the pronotum, the first joint is wider than it is long, the second is strongly transverse, the third is triangular, and the fourth through eleventh are quadrate, subequal and taper slightly toward the apex. The surface of the elytra is rugulose, forming dense, shallow punctiform impressions (Green 1949). Though diurnal, males do have two tiny lanterns on the last abdominal segment.

Figure 75. Dorsal and ventral view of *Paraphausis eximius* from Madera Canyon, Santa Cruz County, Arizona. Attracted to mercury vapor and ultraviolet lights. Photo: Salvador Vitanza on https://elp.tamu.edu.

Distribution

Paraphausis eximius occurs in numerous mountain ranges of southeastern Arizona, including the Huachuca Mountains (Copper Canyon), Chiricahua Mountains (Paradise), the Santa Rita Mountains (Madera and Montosa Canyons), Pajarito Mountains (Pena Blanca Canyon), and Catalina Mountains (Ventana Canyon) (Green 1949, J. Cicero 2015 in BugGuide 2023) (Fig. 74). It is found in numerous localities over a vast area, with the potential for additional occurrences in other Sky Islands of southern Arizona, western New Mexico, and northern Mexico.

Habitats and Ecology

Paraphausis eximius is a diurnal, desert montane firefly, likely endemic to the Madrean Sky Islands ecoregion. Females are unknown but are presumed to be flightless. Males of this species have much smaller eyes than the males of glow-worm species, so it is unlikely females use bioluminescence to attract males. Although males lack adult lanterns, it has been reported that they can glow in the dark using their vestigial larval light organs (J. Cicero 2015 in BugGuide 2023). Males fly by day, gravitating toward bunchgrass species such as *Erigrostis intermedia* (Plains lovegrass), which suggests that females could be found at the base (J. Cicero 2012 in BugGuide 2023), potentially releasing pheromones to attract the males. This species has been found in many localities, across different ecotones, from desert to pine forests up to 6,000 feet in elevation (J. Cicero 2012 in BugGuide 2023). Adult males have been recorded in July and August (BugGuide 2023, iNaturalist 2023).

Conservation Status: Data Deficient

This species is listed as Data Deficient by the IUCN Red List as not enough is known about current distribution, population size, and threats to determine whether it may be at risk of extinction (Fallon and Cicero 2021g). Research is needed to discover females and larvae and better understand the habitat needs and ecology of this species.

Genus Nelsonphotus Cicero

Nelsonphotus is a monotypic genus containing the species *Nelsonphotus aridus*. Little is known about this genus, as *N. aridus* has been collected very few times and representation in museum collections is very poor.

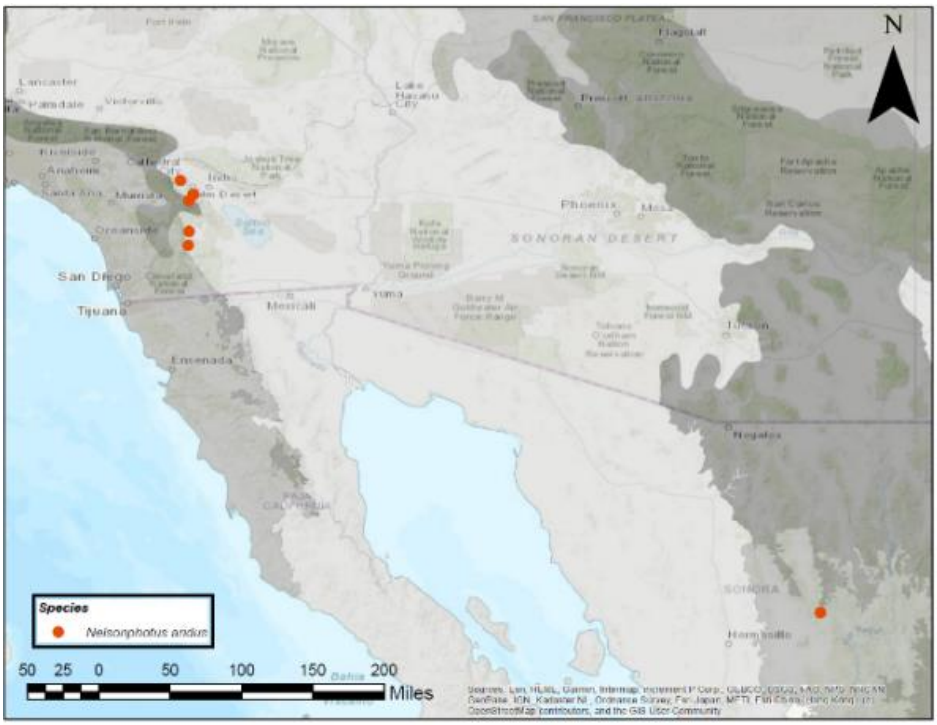


Figure 76. Known occurrences of *Nelsonphotus aridus*.

Nelsonphotus aridus Cicero, 2006 (Mojave Desert Firefly*)

Description

According to the original description (Cicero 2006) this species has black elytra that are coarsely rugulose-punctate and pubescent. The elytra do not meet each other along the midline of the beetle. The pronotum of this species is pinkish red and has slightly acute anterior angles, in contrast to the rounded hind angles of *Paraphausis eximius*. The margins of the pronotum are upwardly flanged and the posterior half of the inflection is parallel sided but anteriorly inflection is rounded to accommodate the shape of the eyes underneath (Fig. 77). The size of this species is at least 3.7 mm. Antenna are short with flagellomeres squat, but cylindrical (Fig. 10D), and the terminal segment has an apical membranous tuberculiform appendix (Fig. 10E).

Figure 77. *Nelsonphotus aridus* adult male from San Diego County, California. Photos: Joyce Gross (BugGuide observations 36406, 248640, 36407).

Distribution

Nelsonphotus aridus has been recorded in Southern California (San Diego and Riverside Counties) and Sonora, Mexico (Cicero 2006) (Fig. 76). Only five occurrence localities have been found so far (Cicero 2006). Most recently (February of 2005), the species was recorded in the Anza-Borrego Desert, in San Diego County, California (BugGuide 2023).

Habitats and Ecology

The behavior of this rare species is unknow in part because females and larvae are unknown. Without knowledge of females, in some cases habits can be inferred from the size of the eyes in males. For example, in glow-worm species like *Microphotus* and *Prolutacea*, males have enlarged eyes which take up almost the entire mass of the head, and the pronotum is convex anteriorly to accommodate the enormous eyes beneath. Conversely, in the diurnal species *Paraphausis eximius*, the eyes are relatively reduced and there is no associated convexity in the pronotum. The size of the eyes and associated pronotal convexity are intermediate in *Nelsonphotus aridus*, suggesting the species may be diurnal or nocturnal. Similarly, the form of the female could be adultiform or larviform and she may or may not be luminous. Known records for this species originate in lower reaches of the Sonoran Desert Ecoregion, anywhere from 1,800-3,497 ft. above sea level (Cicero 2006).

Conservation Status: Data Deficient

Nelsonphotus aridus is a poorly understood firefly reported from very few sites. The last known collection record of this species is from 1980. This species is considered Data Deficient by the IUCN Red List (Fallon and Cicero 2021h). Additional research is urgently needed to better understand the status of this incredibly rare species.

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Appendix A: Table of Figures