

Field Guide to Western North American Fireflies

By

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Fig. 1. *Photinus* firefly

I. Introduction & Starter Information

Fireflies are also known as **lightning bugs** or **glowworms** depending on region. They are popular insects because they produce their own light (bioluminescence). They are not “flies” or “bugs” but beetles (order Coleoptera) with leathery first wings (Fig. 1).

Fireflies belong to the family “Lampyridae”. Identify members of this family as follows:

- a. The head telescopes in and out under the pronotum (the head shield).
- b. They have an elongated body.
- c. The head shield is usually large and shield-like.
- d. The head shield often has colorful markings with yellow, tan, red, or orange pigment.
- e. Most species are 5-20 mm long.

This Field Guide is intended for those who would like to identify the different fireflies in Western North America. This guide covers the most common firefly species and is not intended to include all known species since many of them are uncommon (the uncommon species are considered in the last section).

North America is blessed with ca. 200 hundred species of Lampyrids. This Field Guide will focus on the flashing fireflies. However, I will present the most common “Glowworms” (Lampyrids (females) that glow from the ground) and the “Dark Fireflies” (non-glowing Lampyrids).

For research I am obliged to take voucher specimens. However, many western firefly populations are so small that losing even a few specimens can have negative effects on their populations. I would encourage firefliers not to take specimens, but to practice catch and release. Fireflies should not be collected by children to decorate their bodies etc.—**especially not in the west!** These are very fragile populations!

II. How to Identify Fireflies

Many fireflies can be identified by their flash patterns, but this is not as easy as it would seem. As in bird identification, many birds can be identified by their calls, but it takes practice and experience to do this effectively. For beginners it is easier to identify them with morphological clues and then one can learn to associate the flash pattern with the species. With fireflies it is often helpful to capture a specimen so one can see it and make sure it is what you think it is. But after you are familiar with fireflies in your area you will be able to identify them from the flash pattern. I once went to a new habitat and saw three flash patterns. Since I did not have a net I could not capture them to check my identification. I was sure there were three different fireflies present. The next visit I had a net and I found that the different flash patterns were being made by similar insects (a *Photuris*).

We need to explain how we describe firefly flashes. A “**glow**” is a light emission that lasts a few to many sec. The glow usually has a gradual on and a gradual off. The “**flash**” is a pulse of light, usually with a fast on and a fast off transition. The “**flash pattern**” is a flash or group of flashes that is repeated over and over as the firefly flies/hovers in its typical habitat. These advertising flashes are usually emitted slowly enough that they can be counted. The “**flicker**” is a group of fast flashes emitted so quickly that it is hard to count the individual flashes with the naked eye. Some flickers are so fast that it is hard to see the flicker with the naked eye. Some single flashes may appear to flicker when the insect wiggles its abdomen from side to side or when the wings flutter in front of the light organ. Be sure a flicker flash pattern is a real flicker. Multiple flash and flicker patterns are unusual in western fireflies.

Most firefly flashes are 0.2-0.3 sec long; however, it takes sophisticated equipment to measure such short intervals. So in practice I will use comparative descriptions. A “**normal flash**” is 0.2-0.3 sec long. A “**snappy flash**” is a faster/shorter than normal flash. A “**long flash**” is much longer than normal flash—0.5 to 2 sec long (the flash of the common “Big Dipper” (*Photinus pyralis*) lasts almost a sec).

The flash color can be helpful, but it can also be confusing. Fireflies active at dusk usually have a yellow-orange or amber colored flash. Many *Photuris* are active later and at night, after dark and have a yellow-green colored flash. However, flash color can appear different in different situations—a flash that looks yellow-orange at dusk can appear yellow-green later in the night. Color should be used with caution. It can be helpful in recognizing the flash of a second species that is flashing in the habitat.

The time between flashes (and flash patterns) is very useful in identifying fireflies. It is possible to make this estimate using the count to estimate the number of seconds, “one thousand, two thousand”. This is usually accurate enough for identifying common fireflies. In my research I record the flashes verbally on a voice recorder and then get the timing from the playback or I record flashes with a camera and get the timing from frame by frame analysis.

Three important flashing Firefly Genera:

The three genera of flashing fireflies are enumerated in Fig. 2. that the beginner can easily learn to recognize. This is equivalent to knowing if a bird is a sparrow, a woodpecker or a duck. This usually requires capturing a specimen. Capturing a firefly is usually not too difficult—this is usually easiest to do it with an insect net, however, one must be careful to capture the insect you intend to capture (you can get the wrong firefly). Flashing males can also be attracted to a penlight by flashing the female

response. You can identify the genus from the photos in figure 2 or by using the characteristics in the accompanying table. Knowing the genus usually reduces the number of choices under consideration. There will normally be only 2 or 3 common fireflies in each of these genera in any region/habitat). This allows one to state that he has a “double flashing Photuris” or a “single flashing Photinus”. If you can give the time intervals that will usually identify the firefly (note—there are fireflies that can only be identified by careful study of the male sexual organ). Other fireflies can only be identified by the flash pattern. There is a fourth genus, *Bicellonycha*, but it is found only in southern Arizona. It is long-legged like the *Photuris*.

Fig. 2. The three genera of flashing fireflies.



<i>Photinus:</i>	<i>Pyractomena:</i>	<i>Photuris:</i>
Shield —medium size, half-moon shape, center black bar, red & yellow/tan markings	Shield —larger size, pentagon shape, center & two side black bars, red & yellow/tan markings	Shield —Smaller size, half-moon shape, center black bar, red & yellow/tan markings
Body —flattened	Body —flattened	Body —cylindrical, hump-backed
Legs —short (2-4 mm)	Legs —short (2-4 mm)	Legs —long (5-10 mm)

III. Kansas—Eastern—(East of Hutchinson)

1. *Photinus pyralis* “The Big Dipper”:

This is a fairly **large** firefly, 9-15 mm (Fig. 1 & 3). It usually has black wing covers. It flies at dusk when people are out in their yards or in the park.

The **flash** is a **yellowish-orange single long flash** repeated every 4-6 seconds (Fig. 4). They make an exaggerated “J” motion as they flash, especially early in the evening. This behavior gives them their common name “Big Dipper”. Later in the evening the male flies a little higher and does not do the J as much. The female response is a medium flash (0.5 sec) ca. 2.5 sec after the male flash.

Occurrence: This is the most commonly seen firefly for the public. It is also widespread in Eastern North America. In Kansas it can be seen flying over suburban lawns, pastures, meadows and parks throughout eastern Kansas (Map 1).



Fig. 3. *Photinus* fireflies, (male) left female(right).

2. *Photinus punctulatus*

This is a larger firefly, 8.5-11 mm long. It usually has black wing covers. The **flash** is a standard yellowish-orange single flash repeated at about one second intervals. The female response is a short flash ca. 0.5 sec after the male flash (Fig. 4).

Occurrence: This was a common firefly in Eastern and Central Kansas. It was heavily collected and sold for one cent each for biochemistry research. It flies over lawns and meadows. I have not yet collected this species but the data in Lloyd 1966 suggest it should be here (Map 2).

3. *Photinus granulatus* “The Lawn Single Flash *Photinus*”

This is a small firefly, 5-9 mm. It usually has black wing covers. The **flash** is a fast yellowish-orange flash repeated at about one second intervals. The female response is a long flash (1 sec) ca. 0.5 sec after the male flash (Fig. 4).

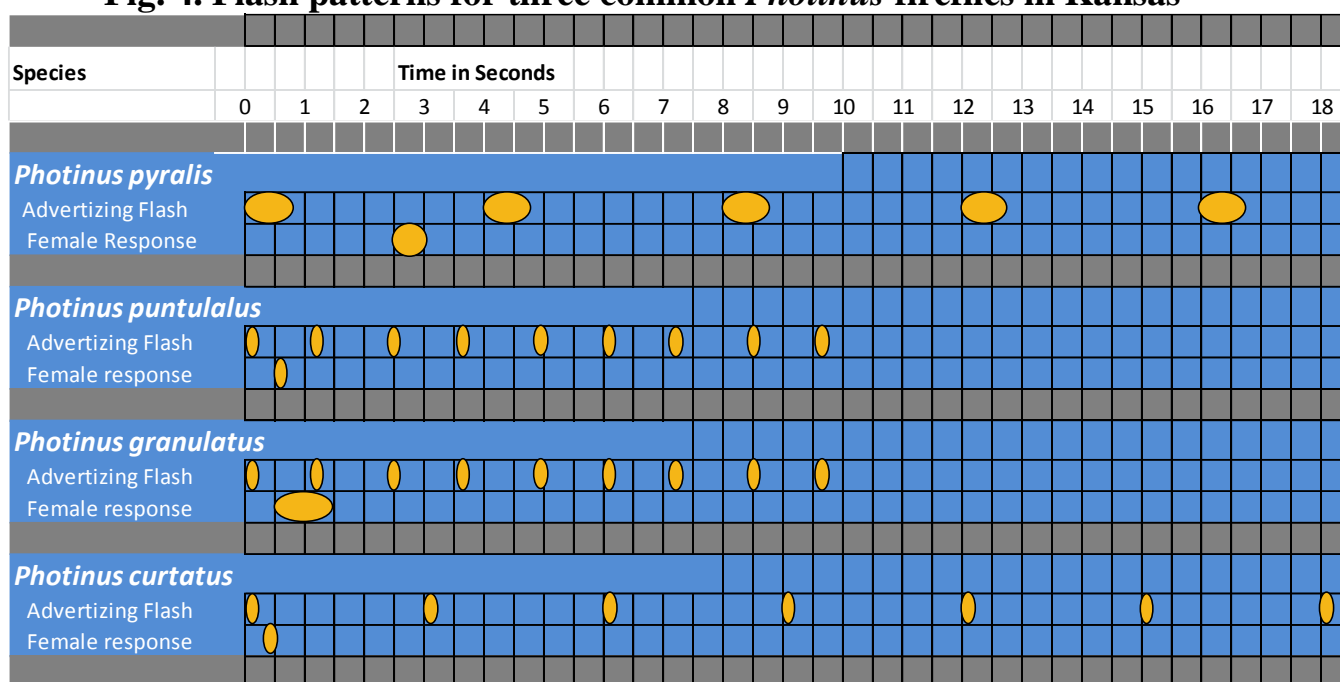
Occurrence: This is also a common firefly in Eastern and Central Kansas. It flies over lawns and meadows. I have seen it once in Hillsboro (Map 3).

4. *Photinus curtatus* “The Brush Single Flash *Photinus*”

This is a small firefly, 5-9 mm. It usually has brownish wing covers. The **flash** is a fast yellowish-orange single flash repeated at about three second intervals (Fig. 4). The female response is a short flash (0.2 sec) ca. 0.3 sec after the male flash.

Occurrence: This is also a common firefly in Eastern and Central Kansas. It flies among the brush and undergrowth in wooded habitats. I have seen it several times in brush/forested areas in Eastern KS (Map 4).

Fig. 4. Flash patterns for three common *Photinus* fireflies in Kansas



5. *Photuris divisa* “The Double Flash *Photuris*”:

This is medium sized brown firefly, 10-14 mm, with unique double black spots on the head shield and no red pigment (as opposed to the vertical black line and red pigment in Fig. 5).

The **male advertising flash pattern** is **two snappy yellowish or greenish flashes**, (ca. half sec apart) repeated every 4 sec. (Fig. 6) (single flashes found in south KS). It flies just over the tall prairie grass. The **female response** is 1-6 short flashes (0.1 sec) at 0.5 sec intervals starting ca. 1.5 sec after the male flash.

Occurrence: This is a common firefly in the tall grass prairie of the Flint Hills of Kansas. The Flint Hills cover ca. 80 mi wide north-south strip of limestone hills just east of Wichita (Map 5).

6. *Photuris versicolor* “The Triple-flash *Photuris*”

This is a **large firefly**. The male is 10-15 mm, the female is 15-18 mm (Fig. 5). They are early season fireflies—early to late June. There is usually a prominent **diagonal stripe** on the shoulder reaching toward the median line of each wing cover.

The **male advertising flash pattern** is a fast double/triple flash with each flash decreasing in intensity. The flashes are so fast they blend together and it is difficult to count them. The separate flashes can best be seen when the male is flying rapidly. This flash pattern is repeated every 3 sec. The flashes usually appear yellow-green. Males also produce cruising flashes which are single flashes repeated ca. every sec, usually while flying higher in the canopy. The **female response** is 1-6 long flash (0.5-6 sec) starting ca. 0.5 sec after the male flash.



Fig. 5. *Photuris* adult fireflies

Occurrence: This is probably the most widespread *Photuris* in Eastern North America. I have seen them at most firefly locations in Eastern Kansas (Map 6). This is one of the predator fireflies that we read about—the aggressive mimic (see discussion below). However, I have seen this behavior only occasionally in Kansas. This firefly occurs mostly along the edge of wooded areas, in clearings and along streams.

7. *Photuris lucicrescens* “The Long Crescendo *Photuris*”

This firefly looks a lot like *P. versicolor*, but it is bigger (Fig. 5). The male is 12-18 mm. They occur later in the season—present late June and early July, but not in early June. There is usually a prominent **diagonal stripe** on the shoulder toward the median line of each wing cover.

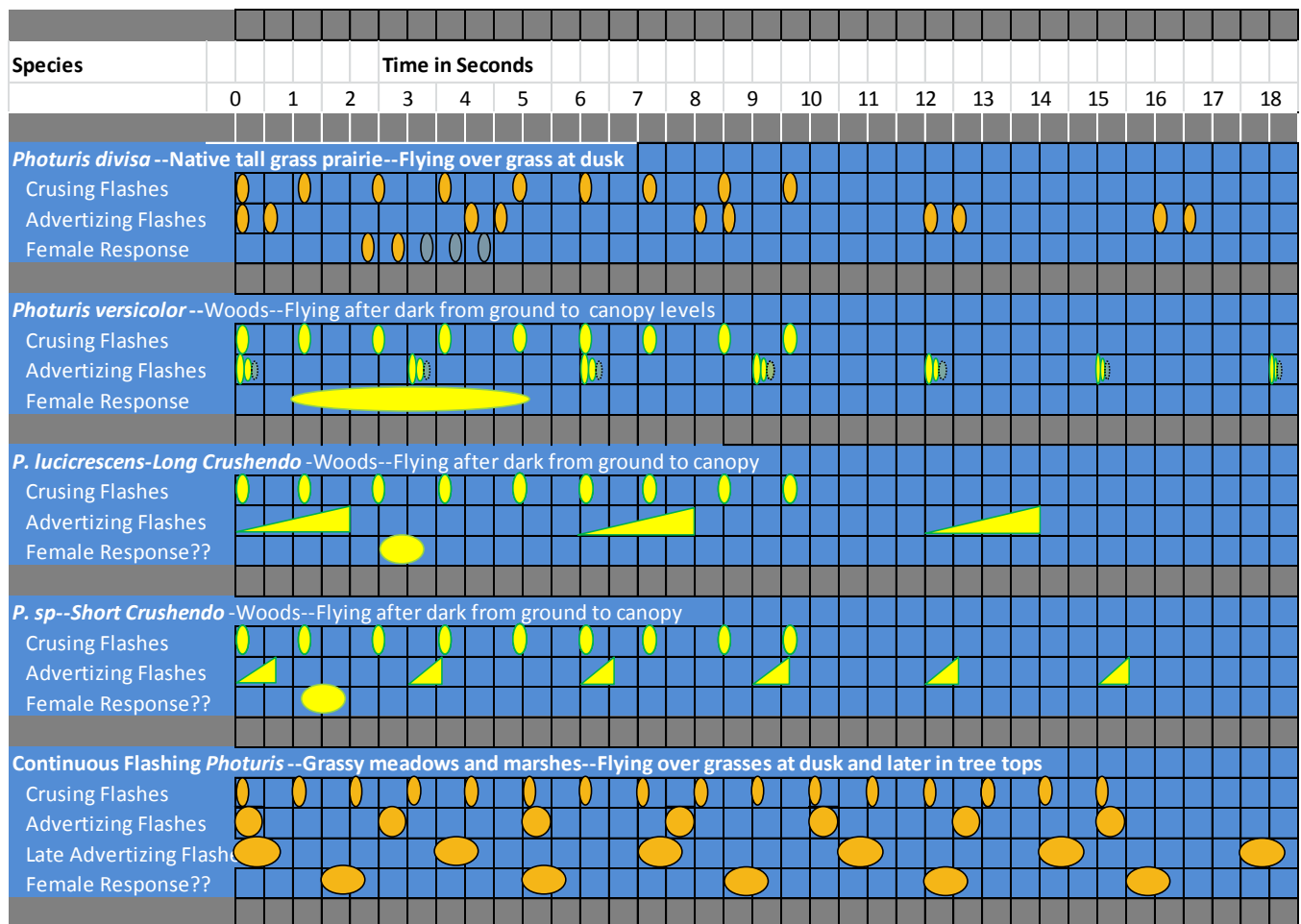
The **male advertising flash** is a long crescendo that lasts 1.0-2.5 sec and shuts off abruptly (Fig. 6). This flash is repeated at 3-4 sec. intervals. The males hover over the underbrush in wooded areas along larger streams/rivers with tall trees. The color is usually yellow-green and can be so bright it lights up a 3-4 ft diameter area below the male. Males also produce single flashes early in the evening as well as late in the evening. They produce cruising single flashes that are repeated ca. every sec while flying higher in the canopy. The **female response** is a single medium-long flash starting ca. 0.5 sec after the male flash.

Occurrence: This firefly is widespread in Eastern North America and I have seen it at several locations in eastern KS, in wooded habitats along large streams/ivers (Map 6).

8. *Photuris* sp. “The Short Crescendo *Photuris*”

This firefly is smaller than *P. versicolor*, and similar to the continuous flashing *Photuris* below. They are late season fireflies—late June and early July. They may have a faint light diagonal stripe from the shoulder toward the median line on each wing cover.

Fig. 6. Flash patterns for five common *Photuris* fireflies in Kansas



The **male advertising flash** is a crescendo that lasts 0.5-0.8 sec and shuts off abruptly (Fig. 6). This flash is repeated at 3-4 sec. intervals. These males hover in the underbrush in wooded areas often along streams. The color is usually yellow-green. Males also produce single flashes early in the evening

and they produce cruising single flashes repeated ca. every sec. The **female response** is believed to be a single medium flash starting ca. 0.5 sec after the male flash.

Occurrence: This firefly apparently is widespread in Eastern Kansas (not clear how far it occurs outside of KS). I have seen it at several locations in eastern KS in wooded habitats (Map 6).

9. “Variable Single Flash *Photuris*”

These are confusing fireflies—there may be a species complex that may include *Photuris missouriensis*, described from just across the border in Missouri. The original description is cryptic and does not match my observations. This may be a species complex with several cryptic species and research is continuing on this group.. These fireflies generally look like the other *Photuris*, but they often lack the diagonal line on the back.

The **male advertising flash** appears to be a single medium flash repeated at 1-4 sec intervals (Fig 6). The flash duration as well as the flash interval increases later in the evening. The flash can appear yellow-orange early in the evening. They advertise over meadows and marshy areas. They can spread out over cultivated fields; some populations fly up into the tree tops. They also produce cruising flashes. The **female response** is unknown, but may be a series of medium flashes produced in a duet with male flashes.

Occurrence: I have seen continuous flashing *Photuris* in many parts of the state (Map 5). They can be found on meadows near streams or wooded areas. There seem to be behavior differences from population to population. They can also be confused with other *Photuris* fireflies that produce single flashes early in the evening.

10. *Pyractomena borealis* “The Spring Tree-Top Flasher”

This is a large firefly, 12-15 mm, with a large head shield with black markings in the center and on both lateral edges (Fig. 7). These fireflies are best known because they occur so early in spring, April-May, when they are the only firefly flying. They usually occur in small numbers, several individuals visible at a time.



Fig. 7. *Pyractomena* fireflies; male on left & female on left

The **male advertising flash** is a single medium orange-yellow flash repeated every 4 sec (Fig. 8). These fireflies usually fly high in the tree-tops of the tallest trees. They seldom come down within reach of the insect net and are difficult to collect. The female response is a medium flash (0.5 sec) ca. 0.5 sec after the male flash.

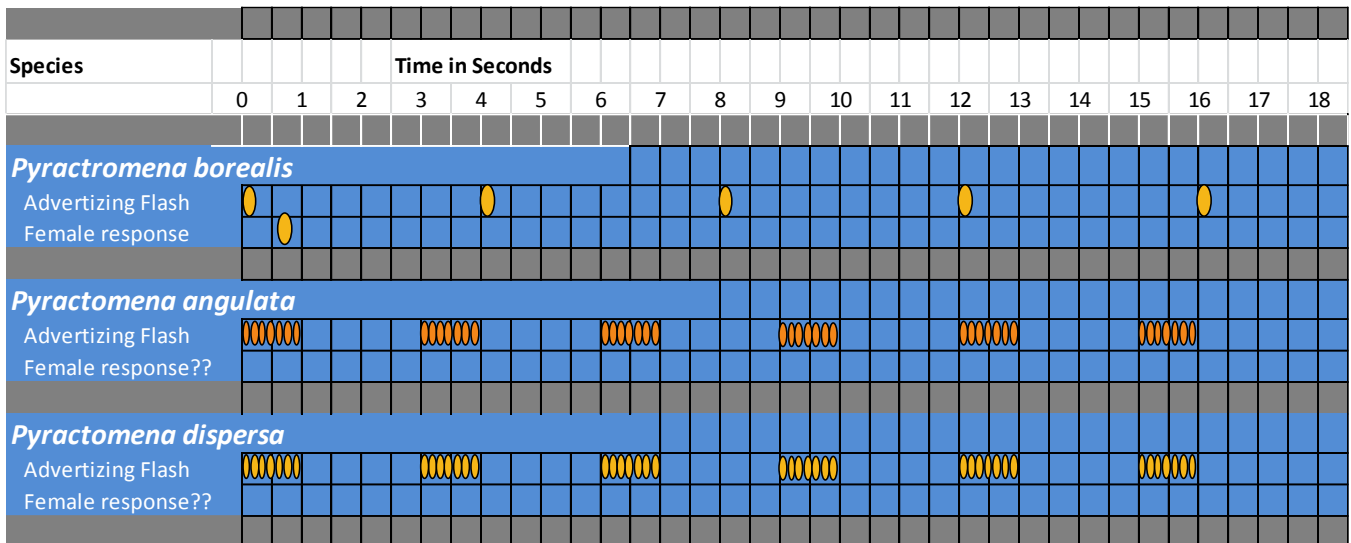
Occurrence: This firefly is widespread in Eastern North America. In Kansas this firefly has been found in several sites in eastern Kansas flying in tall cottonwood trees along the major rivers (Map 7).

11. *Pyractomena angulata* “The Candle Firefly”

This is a large firefly, a little wider than *Py. borealis* (Fig. 7). One usually sees only one or two individuals at a time.

The **male advertising flash** is a series of ca. 6 short orange-yellow flashes (0.08) that lasts up to a sec long (Fig. 8). The flash is repeated every 4-5 sec. The males hover at mid-levels in wooded areas, usually within the understory. They usually fly out of reach of the insect net, but they can be caught more readily than *Py. borealis*. The **female response** is unknown.

Fig. 8. Flash Patterns for 3 species of Pyractomena.



Occurrence: This firefly is widespread in Eastern North America. In Kansas this firefly has been found in several sites in eastern Kansas flying within the canopy in tall trees along the major rivers (Map 7).

12. *Pleotomus* sp:

The biology of *Pleotomus* glow worms is poorly understood. There are several species in the deserts of Southwest North America. The female is wingless with a large light organ near the tail (Fig. 9) The male is winged but non-luminous (although young males may show some light from larval light organs).

Occurrence: *Pleotomus* has been recorded from one site in the SE Kansas.



Fig. 9. Male *Pleotomus* firefly

13. *Pyropyga minuta* “Flower Elf” and *Ellychnia corrusca* complex “Winter Firefly”

These are **dark fireflies** are non-luminous as adults. They are active during the daytime. *P. minuta* is a small, ca 10 mm long, with black and red markings on the head shield (Fig. 10). *E. corrusca* spp are a little larger, ca. 15 mm, with black and red markings on the head shield. Both are active during the day. These fireflies can be fairly common.

Females use chemical pheromones to attract males and not bioluminescence.

Occurrence: *P. minuta* can be found in well irrigated yards and agricultural fields. *E. corrusca* spp. can be found in more wooded habitats. They overwinter as adults and can be found on warm days throughout the winter. They hide in the bark of large trees.



Fig. 10. Two non-luminous lampyrids, *Pyropyga* on left and *Ellychnia* on right

Kansas—Viewing Suggestions

Naturalist led tours at Nature Centers: None that I know of.

Parks and other areas open to the public: In Eastern Kansas fireflying opportunities are many. One or two species may even show up in suburban lawns and parks, but I believe most of these are overflow individuals from nearby natural areas. The best firefly opportunities are along hiking trails into undeveloped riparian areas of National, State and some city parks. A major limitation is that many parks have curfews that can prevent fireflying—a 10 pm curfew only allows 30 min of fireflying, but a dusk curfew allows none. I have had good fireflying experiences at the following Parks. This is a limited list. I am eager to hear about other parks where fireflies can be seen.

Table 1. Firefly viewing sites in Kansas by region. Curfew notes: na=none, na-c=none with camping permit, 10 pm=curfew at 10 pm. Star notes: * =species present, ** =significant numbers present, *** =very large numbers present.

Location	Curfew	Pn. pyralis	Pn. granulatus	Pn. curtatus	Pr. divisa	Pr. versicolor	Pr. Long crescendo	Pr. Short crescendo	Pr. Cont. Flash.	Py. borealis	Py. angulata	
NE Kansas												
Tuttle Creek Lake	na	**		*	*	**	**	*	**	*	*	
Konza Prairie	10pm	*			**	**			*	*	*	
Fort Scott	na	**		**		*	*	*				
Marais des Cygnes	na	***							**			
SE Kansas												
Big Hill Lake	na-c	**			*	*	**			*		
C Kansas												
Marion Reservoir	na-c	**		*	*	*		*				
El Dorado Riverside Park	na	**		*			***					
Chisholm Creek Park Wichita	10pm	**							**			
W Kansas												
Prairie Dog State Park	na-c	*				*			*			
Cheyenne Bottoms WildlifeA	na	**				*			**			
Scott State Park	na-c	**				*			**			
Mead State Park	na-c	*							*			

North East KS: Tuttle Creek Lake—Rocky Ford Riverside Walking Trail; Konza Prairie Biological Station—nature trail; Fort Scott—Gunn City Park—hiking trails; Marais des Cygnes—south dike. **South East KS:** Big Hill Lake—campgrounds, outlet, creek bridge. **Central KS:** Marion Reservoir—Willow Walk Trail; El Dorado Riverside Park—hiking trails; Chisholm Creek Park (Wichita)—hiking trails. **Western KS:** Prairie Dog State Park—Lake Sebelius—South Shore; Cheyenne Bottoms Wildlife Area—West Equipment Storage Area; Scott State Park—lake shore, big spring; Meade State Park—lake shore.

Kansas—Western—(West of Hutchinson)

1. *Photinus pyralis* “The Big Dipper”:

This is a fairly large firefly, 9-15 mm. It flies at dusk when people are out in their yards or in the park (Fig. 3).

The **flash** is a yellowish-orange single long flash repeated every 4-6 seconds (Fig. 4). They make an exaggerated “J” motion as they flash, especially early in the evening. This behavior gives them their common name “Big Dipper”. The female will answer with a single medium flash 2.8 sec later. Later in the evening the male flies a little higher and does not do the J as much. The female response is a medium flash (0.5 sec) ca. 2.5 sec after the male flash.

Occurrence in Kansas: I have seen them in roadside ditches while driving from Wichita to Dodge City on US 50 and US 400 and from Great Bend and Fort Hays to the Finney Co. line on KS 156. Farther west this firefly occurs more sporadically in wet habitats to the border with Colorado (Map1).



Fig. 3. *Photinus* fireflies, (male) left female(right).

5. *Photuris versicolor* “The Multi-flash Predator *Photuris*”

Photuris versicolor is one of the largest fireflies in Kansas, the male is 10-15 mm, the female is 15-18 mm. It usually has a prominent diagonal stripe from the outside shoulder toward the median line on each wing cover (Fig. 5).

The **male advertising flash pattern** is a fast triple flash with each flash decreasing in intensity (Fig. 6). The flashes are so fast that they are difficult to count. The separate flashes can be seen more easily when the male is flying rapidly. This flash pattern is repeated every 3 sec. Males also produce cruising flashes which are single flashes repeated ca. every sec. The **female response** is 1-6 long flashes (0.5-6 sec) at 0.5 sec intervals starting ca. 0.5 sec after the male flash.



Fig. 5. *Photuris* adult fireflies

Occurrence in Kansas: This firefly occurs mostly at the edge of wooded areas flying near the edge of clearings (Map 6).

8. “Continuous Single Flashing *Photuris*”

These are confusing fireflies. This may be a species complex with several cryptic species and research is continuing on this group.. These fireflies generally look like the other *Photuris*, but they often lack the diagonal line on the back (Fig. 5).

The **male advertising flash** appears to be a single medium flash repeated at 1-4 sec intervals (Fig. 6). The flash duration as well as the flash interval increases later in the evening. They advertise over meadows and marshy areas even spreading out over cultivated fields and some populations fly up into the tree tops at some locations. They also produce cruising flashes. The **female response** is unknown, but may be a series of medium flashes produced in a duet with male flashes.

Occurrence: I have seen continuous flashing *Photuris* in many parts of the state, and they can be confused with other *Photuris* fireflies that produce single flashes early in the evening (Map 5). They can be found on meadows near streams or near wooded areas.

12. *Pyropyga minuta* “Flower Elf”

The **dark fireflies** are non-luminous as adults. They are active during the daytime. *P. minuta* is a small, ca 10 mm long, with black and red markings on the head shield (Fig. 10). These fireflies can be fairly common. The females use chemical pheromones to attract males and not bioluminescence. *P. minuta* can be found in well irrigated yards and agricultural fields.



Fig. 10. Two non-luminous lampyrids, *Pyropyga* on left and *Ellychnia* on right

IV. Colorado

1. *Photinus pyralis* “The Big Dipper”:

This is a fairly **large** firefly, 9-15 mm (Fig. 3). It flies at dusk when people are out in their yards or in the park. Female light organ is one spot on 7th segment.

The **flash** is a **yellowish-orange single long flash** repeated every 4-6 seconds (Fig. 4). They make an exaggerated “J” motion as they flash, especially early in the evening. This behavior gives them their common name “Big Dipper”. Later in the evening the male flies a little higher and does not do the J as much. The female response is a medium flash (0.5 sec) ca. 2.5 sec after the male flash.

Occurrence: This is the most commonly firefly in Eastern North America. In CO one needs to go to known firefly sites to see them—they seldom fly in urban yards like they do in eastern Kansas. In Colorado this firefly probably occurred along the Platte River and the Arkansas River all the way to the foothills until modern times. There are reports of fireflies, probably *P. pyralis*, in down town Denver in the 1950’s. The most recent collection was from the Comanche National Grassland—Picture Canyon PA. Currently there is only a small recently introduced population in a town in western CO where the lawns are very well irrigated. I am hoping there are other living populations along the Platte River (Map 8).

8. “Continuous Single Flash *Photuris*”

This may be a species complex with several cryptic species or sub-species and research is continuing on this group. These fireflies generally look like the other *Photuris*, but they often lack the diagonal line on the back. Female light organ is two spots on 7th and 8th segments.

The most common **male advertising flash** is a single medium flash repeated at 1-4 sec intervals. The flash duration as



Fig. 3. *Photinus* fireflies, (male) left female(right).



Fig. 5. *Photuris* adult fireflies

well as the flash interval increases later in the evening. They advertise over meadows and marshy areas and may spread out over cultivated fields and some eastern populations fly up into the tree tops. They also produce single cruising flashes, however, there is a population at Wray that also produces a flicker. The **female response** is unknown, but may be a series of medium flashes produced in a duet with male flashes.

Occurrence: This is the most common flashing firefly in Colorado. It normally occurs below 6000 ft, but can occur at higher elevations near hot springs. They are found only near permanent water: marshes, streams, springs, hot springs and water seeps such as around springs and below dams or irrigation ditches (Map 8). One needs to go to known firefly sites to see them—they do not fly in yards like they do in eastern Kansas.

10. *Pyractomena dispersa* complex: “The Wiggle Dancer”

This is a medium sized *Pyractomena* firefly. These fireflies can occur in small numbers flying over permanent marsh areas at high elevations. This appears to be a species complex with at least a western species and several eastern species. Female light organ is four spots.

The **male advertising flash** is a orange-yellow flicker flash repeated every 4-5 sec. The males hover in marshy areas. However, other flash patterns are recorded from other areas across eastern North America.

Occurrence: The western species occurs at high elevation, 7-8000 ft from south to north. It occurs in permanent marshy areas (Map 8).



Fig. 7. *Pyractomena* fireflies; male on left & female on left

11. *Microphotus pecosensis*: “Mountain Glow worm”:

The biology of western glow worms is poorly understood. There are several species from the deserts of Southwest US. The female is wingless with a large light organ on the tip of the abdomen (Fig. 9) The male is winged but non-luminous (although young males may show some light from larval light organs).



Fig. 9. Female *Microphotus* firefly



Fig. 9. Male mating with female *Microphotus* glow
Photo: Larry Buschman

Occurrence in Colorado: *Microphotus*

fireflies have been recorded from several sites in the mountains of Colorado. I have no viewing sites to recommend.

12. *Pyropyga minuta* “Flower Elf” and *Ellychnia corrusca* complex “Winter Firefly”

The **dark fireflies** are non-luminous as adults. They are active during the daytime. *P. minuta* is a small, ca 10 mm long, with black and red markings on the head shield (Fig. 10). *E. corrusca* spp are a little larger, ca. 15 mm, with black and red marking on the head shield. Both are active during the day. These fireflies can be fairly common.

Females use chemical pheromones to attract males and not bioluminescence.

Occurrence: *P. minuta* can be found in well irrigated yards and agricultural fields. I have collected them in Denver. *E. corrusca* spp. can be found in more wooded habitats. They overwinter as adults and can be found on warm days throughout the winter. They hide in the bark of large trees.



Photo: Whitney Cranshaw



Photo: Whitney Cranshaw

Fig. 10. Two non-luminous lampyrids, *Pyropyga* on left and *Ellychnia* on right

Colorado Viewing Suggestions

Where to see Fireflies in Colorado:

Naturalist led tours (In the past programs have been offered in June and July):

Carbondale, CO Filoha Meadows, <http://www.roaringfork.org/sitepages/pid3.php>:

Denver, CO Audubon Nature Center: <http://www.denveraudubon.org/programs/local-field-trips/>.

Fountain, CO Fountain Nature Center: <http://adm.elpasoco.com/CommunityServices/RecandCulturalSvc/Pages/FCNCPrograms.aspx>

Parks and other areas open to the public:

Denver, CO Chatfield State Park, Plum Creek marsh and Audubon Nature Center:

Boulder, CO Sawhill Ponds County Open Space, near railroad tracks:

Fort Collins, CO Riverbend Ponds Natural Area on the boardwalk and other hiking trails.

Villa Grove, CO Valley View Hot Springs; http://www.tripadvisor.com/ShowUserReviews-g33680-d658090-r114584987-Orient_Land_Trust-Villa_Grove_Colorado.html

See Table 2 below.

This is a limited list. We are eager to hear about other tours and parks where fireflies can be seen.

Table 2. Firefly viewing sites in Colorado by River Basin. Curfew notes: na=none, na-c=none with camping permit, 10 pm=curfew at 10 pm. Star notes: * =species present, ** =significant numbers present, *** =very large numbers present.

Location:	Curfew	Photinus pyralis	Photuris Cont. Flash. complex	Pyractomena. dispersa complex	
Platt River Basin					
Chatfield State Park, Plum Creed marsh & Audubon Nature Center, Denver	10pm Na-c		*		
Riverbend Ponds Natural Area—boardwalk, Fort Collins	10pm		**		
Sawhill Ponds County Open Space—tracks, Boulder	10pm		**		
Prospect Park, Wheat Ridge	10 pm		*		
Wray Lake-outlet, Wray	na		**		
Colorado River Basin					
Filoha Meadows, Carbondale	Tour only		**		
Bridgeport, Gunnison River	na		*		
Anames River-south, Durango Need public access site	private			**	
Rio Grand River Basin					
Valley View Hot Springs (dress code), Villa Grove	na-c		**		
Arkansas River Basin					
Fountain Nature Center, Fountain	10pm		**		
Carrizo Canyon Picnic Area, Picture Canyon Picnic Area, Comanche N. Grassland	10pm	? ?	** ?		
De Weese Res. outlet, Westcliffe	na			*	
Buena Vista Gulf Course	privet			*	

V. Arizona

1. “Continuous Single Flash *Photuris*”

This may be a species complex with several cryptic species or sub-species and research is continuing on this group. These fireflies generally look like the other *Photuris*, but they often lack the diagonal line on the back. Female light organ is two spots on 7th and 8th segments.

The most common **male advertising flash** is a single medium flash repeated at 1-4 sec intervals. The flash duration as well as the flash interval increases later in the evening. They advertise over meadows and marshy areas and may spread out over cultivated fields and some eastern populations fly up into the tree tops. They also produce single cruising flashes. The **female response** is unknown, but may be a series of medium flashes produced in a duet with male flashes.

Occurrence: *Photuris* fireflies have not been documented in Arizona, but some of the flashing firefly reports in northern Arizona could be *Photuris*. I have documented this *Photuris* in Glenn Canyon National Park, just north of the Arizona border and I would expect them to occur in Arizona. I have no viewing sites to recommend.

2. *Pyractomena dispersa* complex: “The Wiggle Dancer”

This is a medium sized *Pyractomena* firefly. These fireflies can occur in small numbers flying over permanent marsh areas at high elevation. This appears to be a species complex with at least a western species and several eastern species. Female light organ is four spots.

The **male advertising flash** is a yellow-orange flicker flash repeated every 4-5 sec. The males hover in marshy areas. However, other flash patterns are recorded from other areas across eastern North America.



Fig. 5. *Photuris* adult fireflies



Fig. 7. *Pyractomena* fireflies; male on left & female on left

Occurrence: The western species occurs at high elevation, 7-8000 ft from south to north. It occurs in permanent marshy areas. I have no viewing sites to recommend.

3. *Photinus knulli*: “Fall Southwest Firefly” or “Southwest Synchronous Firefly”

This is a small *Photinus* firefly—some 5-8 mm long. These fireflies occur in late summer into fall (August-September) during the “monsoon rainy season”. They can occur in large numbers in permanent marsh areas along permanent streams.

The male advertising flash is a yellow-orange triple flash pattern that is repeated every 6 sec. However, male flash behavior can be complicated including synchrony (when there are large enough populations, flaring (long glow-like flashes) and female like flashing. This behavior has been described by Joe Cicero (1983) and will not be described in detail here.

This species occurs in southeast AZ and they can be seen in Patagonia in August

4. *Bicellonycha wickershamorum*: “Spring Southwest firefly”

This is a medium sized firefly related to the *Photuris* fireflies already described. These fireflies occur in spring (late May and June). They can occur in large numbers in marsh areas along permanent streams. They can occur in the same habitat as *P. knulli* but at different times of the year.

The flash behavior of this species is complex and apparently has not been described

This species also occurs in southeast AZ. I have no viewing sites to recommend.

5. *Glow Worms*

There are a number of species of firefly glow worms in the Arizona, but they are difficult for the layman to distinguish. I will simply list some of the species. *Microphotus pecosensis*, *Microphotus dilatatus*, *Pleotomus nigripennis*, *Nelsonphotus aridus*, *Prolutacea pulsator*, *Distremocephalus opacus*

The female is wingless with a large light organ covering two segments on the belly near the tail of the insect (Fig. 9). The female comes out at dusk and glows until a male finds her—she will quit glowing after an hour or two if no males



Fig. 9. Female *Microphotus* firefly

come. The male is winged, but non-luminous (although young males may show some light from larval light organs). The biology of glow warm fireflies is poorly understood.

Occurrence: Glow worms can be seen in natural areas throughout AZ. I have no viewing sites to recommend.

6. *Pyropyga nigricans* “Flower Elf” and *Ellychnia corrusca* complex “Winter Firefly”

The **dark fireflies** are non-luminous as adults. They are active during the daytime. *P. minuta* is a small, ca 10 mm long, with black and red markings on the head shield (Fig. 10). *E. corrusca* spp are a little larger, ca. 15 mm, with black and red marking on the head shield. Both are active during the day. These fireflies can be fairly common.

Females use chemical pheromones to attract males and not bioluminescence.

Occurrence: *P. nigricans* can be found in well irrigated yards and agricultural fields. *E. corrusca* spp. can be found in more wooded habitats. They overwinter as adults and can be found on warm days throughout the winter. They hide in the bark of large trees. I have no viewing sites to recommend.



Photo: Larry Buschman
Fig. 9. Male mating with female Microphotus glow worm



Photo: Whitney Cranshaw
Photo: Whitney Cranshaw
Fig. 10. Two non-luminous lampyrids, *Pyropyga* on left and *Ellychnia* on right

VI. Other States

I do not have as much information for fireflies in the other western states. However, I would expect that the above observations for Eastern and Western Kansas may be helpful for neighboring **Oklahoma** and **Nebraska** and perhaps even North and South Dakota—although there are several northern species that may need to be added to the list.

I would expect these observations on fireflies of Colorado may be helpful in neighboring states to the west and north like **Utah, Idaho, Wyoming and Montana**. I have reports of small populations of flashing fireflies in all these states. I would expect these to be continuous flashing *Photuris* or flicker flashing *Phractomena* fireflies. I would expect **New Mexico** could be similar to the observations for Arizona, although there are no reports of flashing fireflies in the south so the two southern species may not be there. There are reports of flashing fireflies in the north that could be similar to southern CO. There are also reports of flashing fireflies in **Washington, Oregon and Northern California**. I would expect these fireflies to be similar to the flashing fireflies reported from **British Colombia, Canada**, to the north. I have observed a continuous flashing *Photuris* and the marshland *Photinus ardens* in BC. Cannings et al (2010) has reported a number of locations for flashing fireflies in BC. The state of **Texas** will be more difficult since I expect there will be many additional southern and eastern firefly species.

I would like to hear about good public access firefly viewing sites in these states. I may need to check them out when I work on these states.

VII. Biology Observations

Life History: Firefly larvae are predators of snails, slugs, earthworms and soft-bodied insects. They typically hunt in marsh areas near springs, ponds and creeks. Most fireflies spend the winter in the larval stage, but the *Ellychnia* spend the winter as adults. In northern climates like Kansas larvae may need several years to complete development. Most fireflies pupate and emerge as adults in late spring, June



and

July.

Fig. 11. Firefly larvae: *Photinus* (left), *Pyractomena* (center) and *Photuris* (right).

Adult fireflies generally do not feed except to drink and take in nectar and honeydew. Only the females of *Photuris* are known to be predators. Some of these females are able to attract males of other firefly species and prey on them. Those species that produce light are active at night while the non-luminescent species are day active. After mating eggs are laid in moist soil.

Bioluminescence: All known Lampyrid larvae glow from a pair of oval light organs near the tail. Adults usually have a larger light organ near the tail, but the light organ may have various shapes—usually not the pair of round light organs seen in larvae. The ability of fireflies to produce light is achieved by specialized cells in the light organ. Light production comes from a chemical reaction between luciferin and luciferase with the participation of oxygen, ATP, water and various enzymes and cofactors. The light production is so efficient that there is little heat released. Fireflies are able to produce glows,

flashes and flickers. Males usually have light organs on two enlarged segments on the abdomen. Females usually have smaller light organs that have different shapes in different firefly groups.

Courtship Communication: Most fireflies use light flashes as signals for courtship communication between male and female. There are four communication systems. Many lampyrids use a **Pheromone System** in courtship communication. The female waits on the ground or vegetation and releases a chemical pheromone. The male flies about searching for the pheromone. These males will have large branched antenna to detect the pheromone. When the male detects the



Fig. 12. Firefly flashes in the dark. Photo Hugh Faust

pheromone, he flies up wind to locate the female. These “**dark fireflies**” can conduct their courtship either during the daytime or after dark. Other lampyrids use **Signal System I** where the female is a **glow worm** and has the large light organ which she shines after dusk. Males patrol looking for glowing females and will fly to the glow and mate with her. These males have large eyes and may lack light organs entirely. Glow worms may also use a pheromone to help attract the male from a distance. Other lampyrids use **Signal System II** where the male has the larger light organ and flies about in the habitat producing the species specific advertising flash pattern. The female waits quietly on the vegetation and when she sees the right flash signal she responds with a species specific flash response. If the male sees the response he will fly and crawl towards the female to mate with her. This is the courtship system that is common in *Photinus*, *Pyractomena* and some *Photuris* fireflies. I am proposing a **Signal System III** where the male flies about in the habitat producing the species specific advertising flash pattern. The female waits in the vegetation and responds to the male flash pattern, but this time the male and female start a **fast flash duet** which they continue until the male finds the female and mounts her to mate with her. This is the system I am finding in the other group of *Photuris* fireflies. Understanding these flash signals is important when studying fireflies and it is essential for identifying firefly species.

Aggressive Mimicry: Jim Lloyd first reported that female *Photuris* fireflies were aggressive mimics. He called these females “*femmes fatales*”. In aggressive mimicry, females answer the flashes of other male fireflies to lure them to come closer so they can pounce on them and consume them as prey. Lloyd reported that aggressive mimicry had been observed in at least 12 *Photuris* species and it appeared to be widespread among *Photuris* fireflies. He also reported that females of *P. versicolor* could attract prey males of at least five species of firefly. However, Lloyd (1985) noted that there were some *Photuris* that may not be aggressive mimics.

Lloyd’s observations have received a lot of attention, probably because “*femmes fatales*” relates to human feelings about morality. In the scientific community there has also been controversy relative the precision of this mimicry and exactly how the mimicry relates to courtship communication. There is a lot of room for research on this topic.

Why do some fireflies have several flash patterns? Jim Lloyd also came to the conclusion that some *Photuris* fireflies produce several different flash patterns as they flew about in their habitat. For example, *Photuris quadrifulgens* produces 3 types of flash patterns while flying in its habitat: a characteristic 4-pulsed flash pattern, a flicker flash pattern and a single flash pattern. He surmised that the 4-pulsed flash pattern was the species specific advertising flash pattern and suggested that the flicker flash pattern was a mimic of similar flicker flashes of other fireflies in the area on which his females preyed. He thought that females would answer the flicker flash as an aggressive mimic and this would help the *Photuris* male to locate the female. The male might be able to get more matings this way. However, this suggestion has also been controversial since there is no evidence that *P. quadrifulgens* actually practices aggressive mimicry (beyond predation in a jar). Recent observations also suggest the flicker flash is not involved in courtship communication. Therefore the role of alternate flash patterns remains controversial.

Why are fireflies disappearing? There seems to be a consensus both among the public and scientific communities that there are fewer fireflies now than there used to be. However, there is little imperial evidence to prove or disprove this consensus. However, the discussion quickly moves to possible causes of the disappearance. Here I will discuss the most important factors affecting firefly populations.

Changes in water management/availability. This factor may be the most important factor in the western part of North America. It may not be as important in the eastern part of the country. **Water**

wells for agriculture and cities withdraw thousands of gallons of water from underground aquifers. These aquifers feed the springs that provide moisture to sustain fireflies. Lowering of the water table is a serious threat to firefly populations in the west. Over the last 50 years the water table along the Arkansas River has fallen dramatically so that many of the springs and marshes that used exist along the river have dried up. The fireflies populations in these areas are now gone. The water table along the Platte River is still relatively high and the fireflies can still be found in that area. The transfer of **water from the west slope** into the Platte River (after use by cities) probably goes a long way in preserving this system. **Dams and other impoundments** also have a significant effect. They prevent flooding so the marshes and wetlands along the river dry up. The marshes and wetlands associated with the first impoundments on the river system may get populated by fireflies. However, the marshes and wetlands downstream now dry up and the fireflies disappear. Future impoundments built along that river will not have firefly populations because they are no longer present in marshes along the river. Extended episodes of **drought** also contribute to the loss of firefly populations. In the east the loss of a population can be restored by re-infestation from neighboring stable populations. However, in the west the relic populations have little chance of re-infestation from neighboring stable populations. Any population lost is a permanent loss.

Suburban development. Habitat destruction is probably the most important factor associated with loss of firefly populations in the eastern part of the country. Most fireflies need undisturbed natural habitat; however, there are a few fireflies that can survive in suburban lawns. When we bulldoze natural habitat to build homes and businesses we are often destroying firefly habitat. It is possible to minimize this damage if we try. We may even be able to remedial work to restore firefly populations. This kind of work is being done in Japan and SE Asia.

Pesticide use: The loss of firefly populations is often blamed on the use of insecticides—especially mosquito fogging in urban areas. As someone who has spent a lot of time trying to control insect pests with insecticides, I find this accusation weak. It is never that easy to kill beetles. The mosquito fogging insecticides are not insecticides that are effective on beetles and the dosage used is ridiculously too low. The insecticides that we need to be worried about are those that target other beetles in the yard—for example the insecticides that are used to control white grubs. I have seen preliminary data that mosquito fogging is safe for fireflies, but I don't know if anyone has checked out the role of insecticides that control grub worms.

Light Pollution: There are several reports that show a correlation between increased light pollution at night and lower numbers of fireflies. Unfortunately, it is difficult to separate the effects of urbanization (habitat destruction) from the effects of light pollution on firefly populations. I note that the effects of light pollution are significant on the human observer so that the lower populations could also represent a loss of sensitivity in the human observer. It is important to remember that some fireflies are adapted to be active at dusk when the level of light is not that different from that of light pollution conditions. I would expect the effects of light pollution would be greater on deep woods fireflies than on dusk flying species that are active in grassy habitats. Glow worms may be impacted more than flashing fireflies. There is need for more research on light pollution, but we need to pay attention to which firefly species might be affected and which are not affected. However, we should not forget the factors listed above which I believe are more critical—particularly in the USA.

Are Colorado Fireflies a Recent Arrival? There is a proposal that fireflies are recent arrivals to Colorado, since all reports of fireflies are recent reports. This would be hard to prove, since a lack of evidence does not prove it--just because there were no reports of fireflies this does not prove they were not here. Even now most entomologists are not aware of flashing fireflies in Colorado when they are present. There is a suggestion that the increased water added to the Platte River drainage system by the diversion tunnels from the west side of the mountains has made the area more suitable for fireflies. That is true and we can see that *Photuris* fireflies do spread among the wetlands associated with the Platte River. However, *Photuris* fireflies do not spread across miles of dry country and there is no way they could spread across the continental divide at this time. See also the discussion on “Changes in water management/availability” above.

It is important to realize that flashing populations of *Photuris* and *Pyraclomena* fireflies occur as scattered populations all the way to the Pacific coast. These populations could not have arrived in the last century. These fireflies cannot disperse across the dry country, let alone cross the continental divide. Many of the firefly locations in the west are extremely remote and can be reached only by backpack hiking into the wilderness. These populations do not look like human introductions which would be expected to be associated with human activity: roads, railroads or settlements.

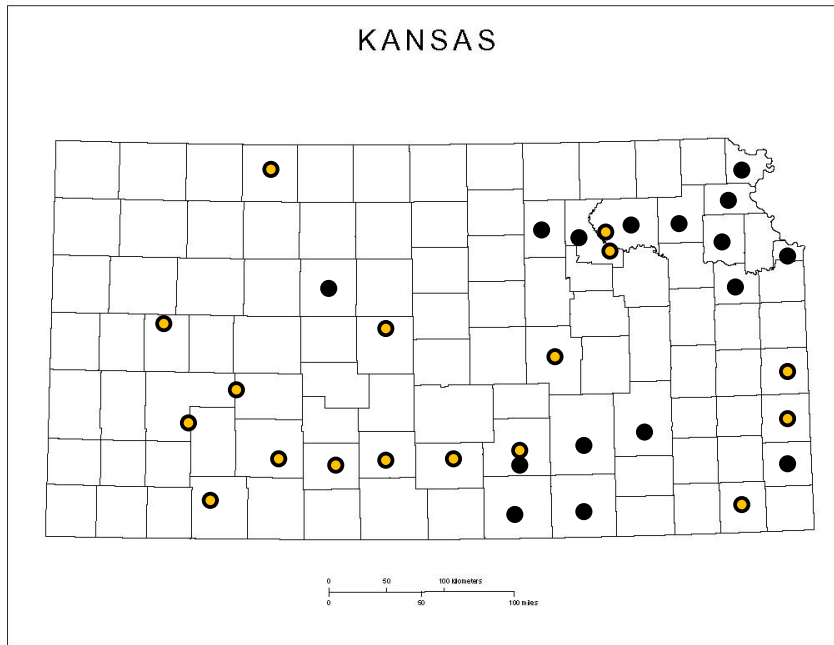
I suggest that flashing fireflies, have been here a long time and that no one bothered to report them until recently. Even now most entomologists are not aware of flashing fireflies in the west. I would suggest the following scenario: there was a time in the geologically recent past, like during the recent ice

age ten thousand years ago, when the climate in this area was much wetter than it is now. At that time one *Photuris* species and one *Pyrractomena* species were able to spread across the continental divide and disperse across the west in the damp forests and wetlands of the time. Since that time, this area has dried up leaving remnant firefly populations that survive in permanent wet areas like springs and wetlands associated with rivers.

This scenario has several important consequences. First, all these populations are extremely vulnerable to extinction. We are currently losing firefly populations one at a time as springs and wetlands dry up as the water tables keep going down. For example, I can find only one population of *Photuris* along the Arkansas River in Colorado, and that is on a tributary. The springs and wetlands that used to exist along that river have dried up. There are reports and museum specimens that show that fireflies used to be found along this stretch of the Arkansas River. The invasive salt cedar or tamarisk trees are also responsible for wetlands drying up.

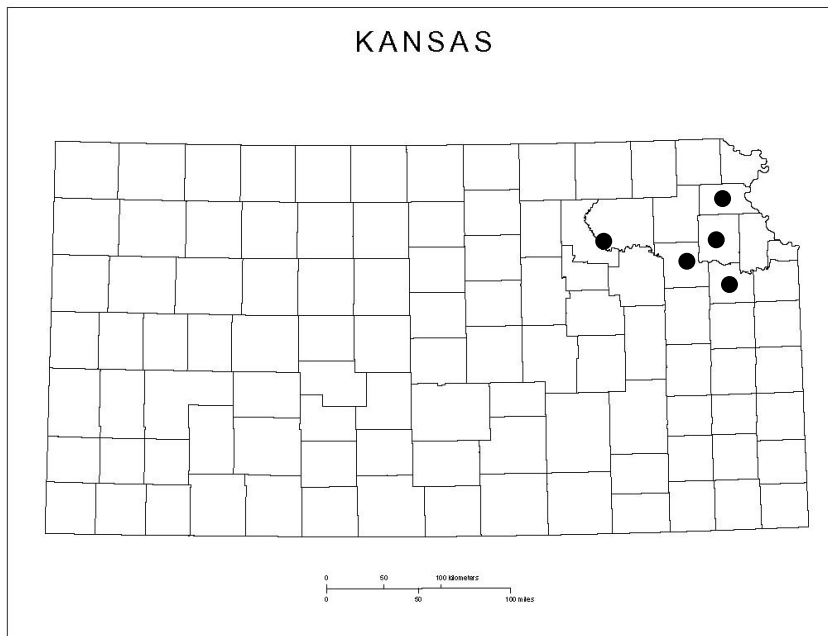
The second consequence is that these western populations are isolated populations that have started the process of speciation. It is likely that many of these populations are well on the way to becoming separate sub-species and even species. This will be a productive research subject well into the future—I have only scratched the surface of this subject.

IX. Range Maps: Map 1.



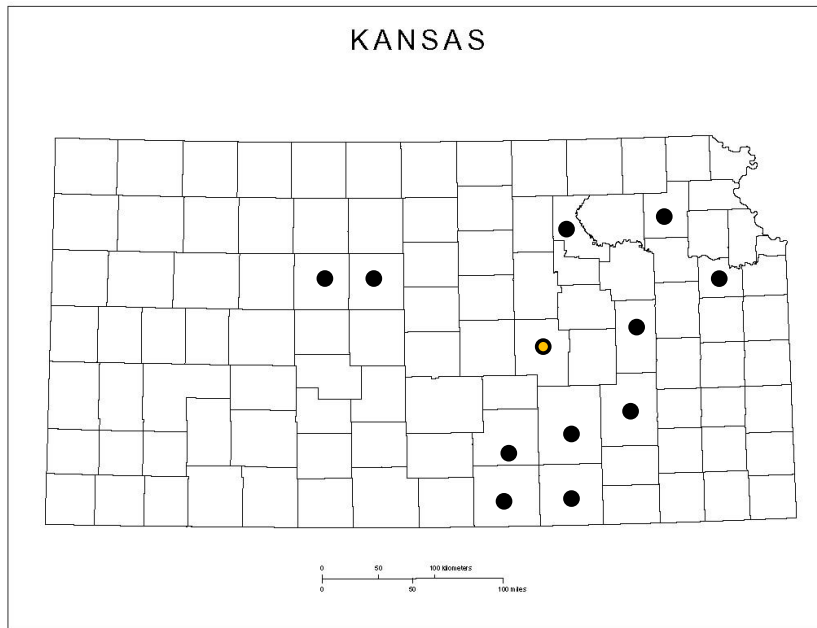
● *Photinus pyralis*-LLB observations ● specimens (Lloyd 1966)

IX. Range Maps: Map 2.



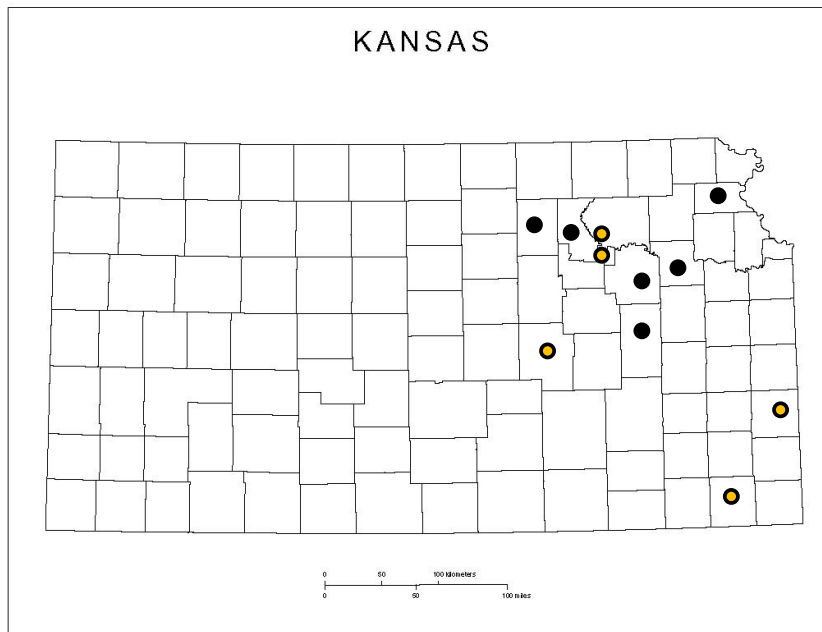
● *Photinus punctulatus*—specimens (Lloyd 1966)

IX. Range Maps: Map 3.



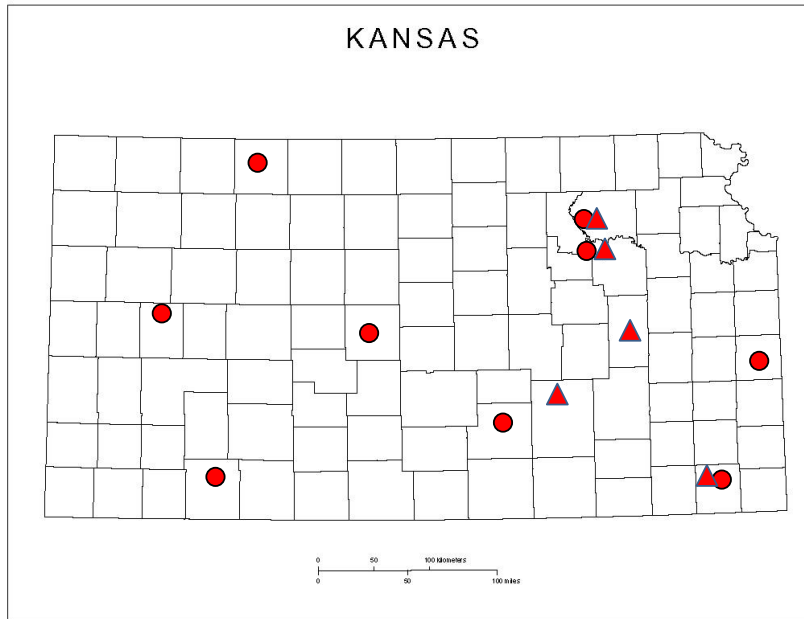
● *Photinus granulatus*-LLB observations ● specimens (Lloyd 1966)

IX. Range Maps: Map 4.



● *Photinus curtatus*-LLB observations ● specimens (Lloyd 1966)

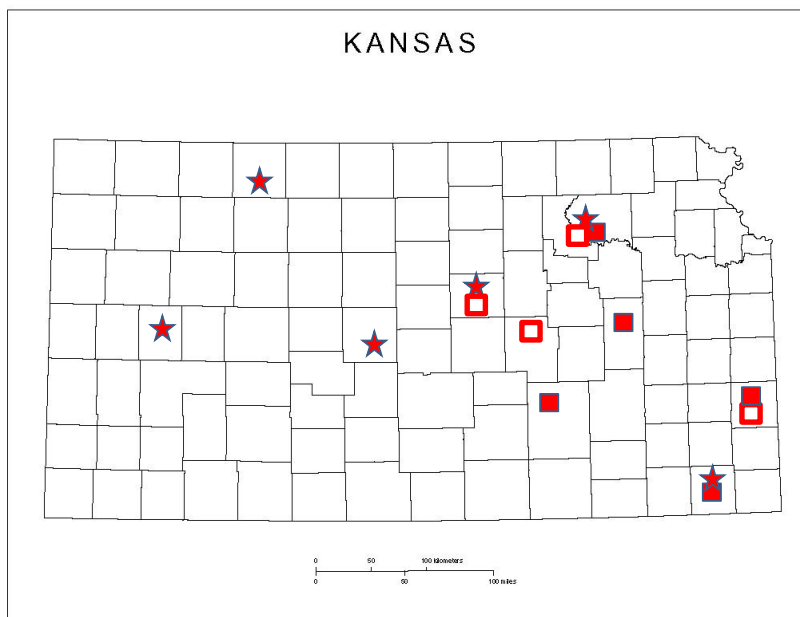
IX. Range Maps: Map 5.



● Photuris single flasher—LLB observations

▲ Photuris divisa—LLB observations

IX. Range Maps: Map 6.

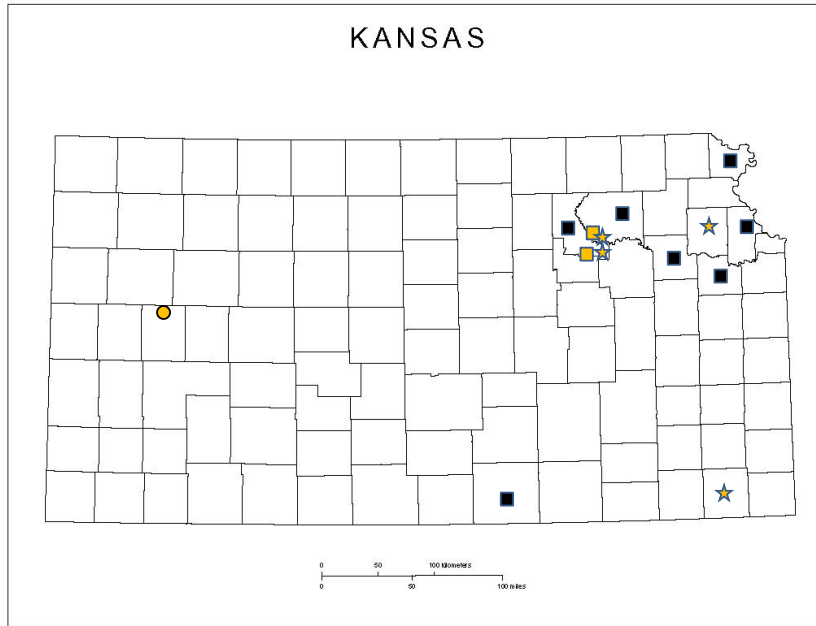


■ Photuris lucicrescens—Long Crescendo—LLB observations

□ Photuris sp.—Short Crescendo—LLB observations

★ Photuris versicolor—LLB observations

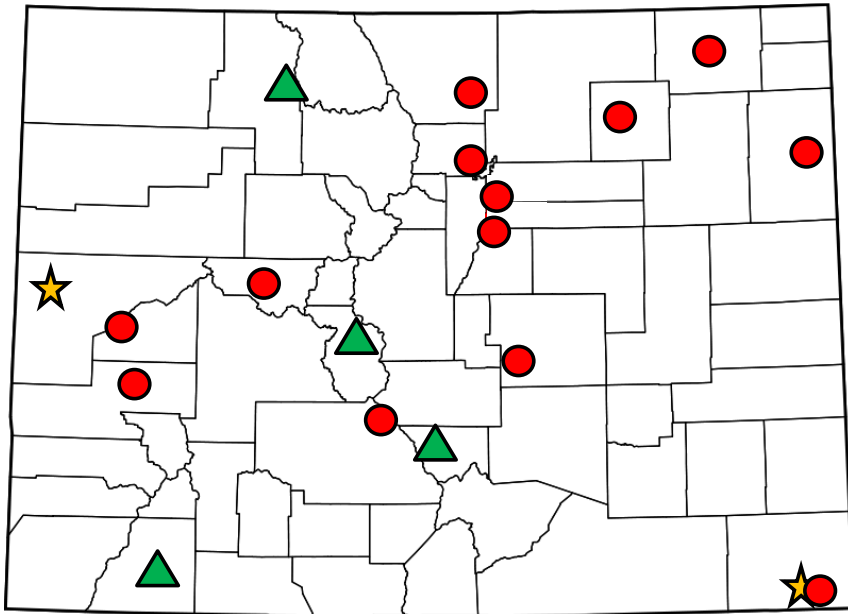
IX. Range Maps: Map 7.



- *Pyractomena dispersa*—LLB observations
- *Pyractomena angulate*—LLB observations ■ specimens (Lloyd 1966b)
- ★ *Pyractomena borealis*—LLB observations

IX. Range Maps: Map 8.

Colorado



- ★ *Photinus pyralis* ▲ *Pyractomena dispersa* ● *Photuris* single flasher (all LLB Observations)