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Original paper

Insects in fireworks

Šestinožky a fejerverky

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ABSTRACT

Fireworks with entomological names were observed in order to examine how arthropods were represented. Hymenoptera were the most commonly occurring group, followed by Lepidoptera and Arachnida. Fountains were the most common type of entomological firework, followed by aerial spinners. The most frequent noise associated with insect fireworks was the crackle, followed by the hummer. Most fireworks examined depicted a swarm of insects on their packaging, and photorealistic images were common. Bees and wasps lend themselves well to these types of fireworks, as shooting sparks bear a passing resemblance to them. The similarities between fireworks and other entertainment media in terms of how insects are used was remarkable, suggesting a unified cultural perception of insects. As is common, many negative values were reinforced.

ABSTRAKCIJNY

V tom členku byli oględane fejerverky imajućе entomologične imena dabysmo prěględěli koliko imen proizhodi od členistonogyh. Hymenoptera byla najvyše čęsta grupa, a za njejų na vtorom městě Lepidoptera i Arachnida. Fejerverky-vulkany byli najvyše obyčny tip entomologičnogo fejerverka, a za njim na vtorom městě, fejerverky-pčely. Najčęstši tip šuma svęzany s "insektovymi" fejerverkami byl trěsk a poslě njego brěnčanje. Vęćšina prěględěnyh fejerverkov iměla na svojem opakovanju roj insektov, takože fotorealistične obrazy byli čęste. Pčely i osy javili sę mnogo upotrěbime v tom tipě fejerverkov, za to že strěljajućе iskry jim tvoręt kråtko podobenstvo. Ta shodnosť medžu fejerverkami, inymi srědstvami veselja i korišćenjem u njih insektov jest dostojna zrěnju i prědklada fenomen ujedninjenoj kulturnoj percepcije insektov. Kako byva obyčajno,osoblivo naznačene byli negativne svojstva.

Keywords: pyrotechnics, entomology, culture, bee, wasp, butterfly, spider

Introduction

Cultural entomologists examine the relationship between humans and insects[1,2,3,4]. One means of exploring this relationship is to observe how insects are represented in the products of human culture such as art, music, film, television and literature. Insects are used to represent a diversity of values through these media, including fear, beauty, strength, and ferocity[5,6,7,8,9,10,11,12,13,14]. Fireworks are a unique cultural phenomenon in which arthropods may play a role that has, as yet, been unexplored.

Fireworks are used for various purposes, including aesthetic, cultural, and religious reasons. Fireworks were invented in 7th century China[15]. In the United States of America, fireworks are most frequently used to celebrate the country's independence on July 4, but also may be used to enhance concerts, sporting events, and other special occasions. In England, fireworks are traditionally displayed on November 5, Guy Fawkes Day. Preliminary investigations showed that there were significant numbers of fireworks named for insects. Hence, fireworks might represent an interesting aspect of American culture that is worthy of investigation. However, because insects have played a significant role in Chinese culture for at least 2000 years[16], Asian cultures tend to view insects in a more positive fashion[17], and essentially all fireworks available in the U.S.A. are made in China, one might expect a moderating effect on typical American insect attitudes. Fireworks are quite a different medium from other types already explored, providing a relatively independent examination of themes in cultural entomology. This study was conducted to examine how human culture views insects as represented in fireworks.

Insects have played a small role but have a lengthy history in fireworks, as Kentish described several insect-related fireworks in 1878[18]. "Wasp light" is a kind of fuse used to ignite fireworks. "Glow worm" is another name for a black snake, which remains on the ground and smokes upon ignition, creating an expanding cylinder of ash resembling a snake or worm. A shell that creates an image in the sky that resembles the legs of a spider, as shown in Figure 1, is, in fact, called a "spider." More recently, a type of shell in which points of light disperse from the central point of explosion then change directions in an apparently random fashion is known as "bees"[20], as seen in Figure 2.

Fireworks are pyrotechnics that produce noise, light, smoke, and often sparks in many colors, providing delight to viewers. Fireworks may be classified as ground or aerial. Ground fireworks generally remain on the substrate, and may shoot their effects into the air, as is the case with a fountain, a simple cylinder on a base that shoots sparks and other effects out of its top[21]. Aerial fireworks may provide their own propulsion, as do skyrockets, or may be shot into the air by a separate charge, as in shells[18]. In aerial spinners, force generated by the burning propellant is translated into angular momentum by wing-like structures, which generate lift and stabilize the cylinder, preventing tumbling and producing a straighter flight.

Materials and Methods

In 2004 a preliminary study was undertaken at a local fireworks vendor. Most fireworks are legal to purchase in Missouri, unlike the neighboring states of Iowa and Illinois. Consequently, there are numerous fireworks vendors in Missouri along these state borders. Many such vendors appear as tents approximately one month before the fourth of July and are disassembled shortly afterward, while others are permanent structures. Dave's Fireworks (Canton, Missouri, USA) is a large warehouse, but not the largest in the region. It was chosen for this study in part because it is a permanent structure, has been in continuous operation for a relatively long time, and is conveniently located near the author's residence. Dave's Fireworks was searched for arthropod-related fireworks. The name of each was recorded and the taxonomy of arthropods in the name or displayed on the package was noted. Insect orders were identified individually, while all members of class

Fig. 1: A "spider" firework with streaks of light resembling spider legs. Photo by the author.
Obr. 1: „Pavụkovy" fajerverk s prụgami světla podobnymi pavụčnim nogam. Foto avtora.

Fig. 2: A "bees" firework, with characteristic random trails of light. Photo by the author.
Obr. 2: „Pčelny" fejerverk s osoblivymi slučajnymi slědami světla. Foto avtora.

Arachnida were lumped into a single group. For convenience, names of fireworks are herein represented with capital letters. In 2006, this procedure was repeated, except that each firework was purchased and photographed. Finding that there appeared to be sufficient material to warrant a more extensive study, a similar search was conducted in 2013. Again, one sample of each variety of firework was purchased and every package was individually photographed. Under safe, legal and controlled conditions, and in the presence of six firefighters, each firework was individually ignited. The display was video recorded in 1080p HD resolution using a tripod-mounted Canon EOS 7D digital SLR camera equipped with a Canon EF 24-105mm f/4 L IS USM lens. Videos were uploaded to YouTube™, and collected into a playlist here: https://www.youtube.com/playlist?list=PL-oBnDvw_PlstTSJ8qIio-rSPNE3FJAPo. The extreme brightness of the fireworks resulted in moderate overexposure of the videos; hence, most appeared more colorful in reality. Unfortunately, no videos were recorded of Spring Butterfly and Spring Butterflies because they failed to ignite.

For all sampling years, each depiction of arthropods on the firework package was briefly described and classified taxonomically. Fireworks that were collected in more than one year were counted only once in the analyses. For photographs of 2006 and 2013 samples, each image was also described as realistic, chimeric, demonstrating exaggerated ferocity, or neither. It was also noted whether insects appeared in great numbers (>4 individuals), or were made to appear gigantic relative to other objects in the image. Although all arthropods were included in the study, few non-insects were found, including arachnids and a crustacean. Photos of the package and a link to a video of each firework obtained in 2013 are available in the supplementary files.

The physical type of firework (fountain, aerial spinner, shell or skyrocket) was noted. If the firework was in the form of a cake (multiple units ignited by a single fuse), such was noted. The type of sound produced (see Phantom Fireworks 2017) was also recorded: crackle, hummer, report ("bang"), whistle, or none.

The percentage of insect fireworks directly sampled could not be calculated because the number of unique fireworks available at Dave's Fireworks was not known. Hence, to determine the degree of market penetration obtained by insects in the fireworks industry, several online sellers of fireworks were examined, including Phantom Fireworks (fireworks.com) and Brothers Pyrotechnics (brotherspyrotechnics.com). Both the total number and the number of arthropod-related fireworks were counted and recorded.

Results

Live Fireworks

The number of insect fireworks available through Dave's Fireworks decreased from 14 to 8 between 2004 and 2006, but increased to 27 in 2013. There was little overlap in samples between years. Both Killer Bee and Spring Butterflies were collected in 2004 and 2013. Butterflies Rocket and Yellow Bees were collected in 2004 and 2006. There is likely much turnover in names of fireworks, as 85% (23/27) of arthropod fireworks obtained in 2013 had not been found in the earlier samples.

Categories

According to their labels, all fireworks in the study were made in China. A majority of insect-named fireworks (15/27, or 56%) had >4 insects depicted on the package. Eight packages (30%) had realistic graphics. Three of these were fountains made by the same manufacturer, Mighty Max™. Bee Hive had easily identifiable honeybees (*Apis mellifera* L.), while Caterpillar appears to be a black swallowtail (*Papilio polyxenes*) larva. Others might also be identifiable given sufficient effort and taxonomic expertise. Six packages (22%) had chimeric features, most frequently vertebrate eyes, while another six had features that exaggerated ferocity. Some had both of these characteristics. For

example, Crickets displayed a cricket drawn with a ridiculously toothy open mouth. Only two (7%) had gigantic insects depicted. Sky Web showed a spider as wide as the skyscraper it was perched upon.

Scorpion was a skyrocket, but held no depiction of the animal on the package. Similarly, Butterfly & Flowers, a fountain, was lacking an insect graphic. Maneating Bee had yellowjackets (perhaps *Vespula*) on the outer package, but the four aerial spinners within were labeled "Sunflower", and displayed no arthropods, only geometric representations of flowers.

Taxonomy

The number of Hymenoptera, consisting of bees, wasps and ants (19), almost equaled all others combined (20). Lepidoptera (various butterflies and a caterpillar) were second most common, Arachnida third, while Coleoptera and Orthoptera tied for fourth (see Figure 3). There was considerable repetition of common names, as there were nine types of bees and three of hornets. There were two each of fireflies, ladybugs, spring butterflies and crickets, although it should be noted that Cricket (a fountain) actually had a grasshopper image on the package.

Physical type

Of those fireworks obtained in 2013, twelve out of 27 (44%, see Figure 4) were classified as fountains, such as the Caterpillar: https://youtu.be/n-7mNCAptAQ. Several fountain fireworks were of the cake type, several cylinders joined together, providing an experience of greater duration.

Nine out of 27 (33%) were classified as aerial spinners, including the Dancing Dragonfly: https://youtu.be/Dr4lqogTqsM.

Three out of 27 (11%) were classified as shells. For example, the Bee Hive was a cake of shells: https://youtu.be/gmrIjRcRM_s.

Three skyrocket fireworks (11%) were found, including the Scorpion: https://youtu.be/Of6Cewz62jQ.

Sound

Crackle was the most common sound produced (36%, Figure 5), followed by hummer (21%), none and report (each 18%) and whistle (7%). Four fireworks produced both hummer and crackle.

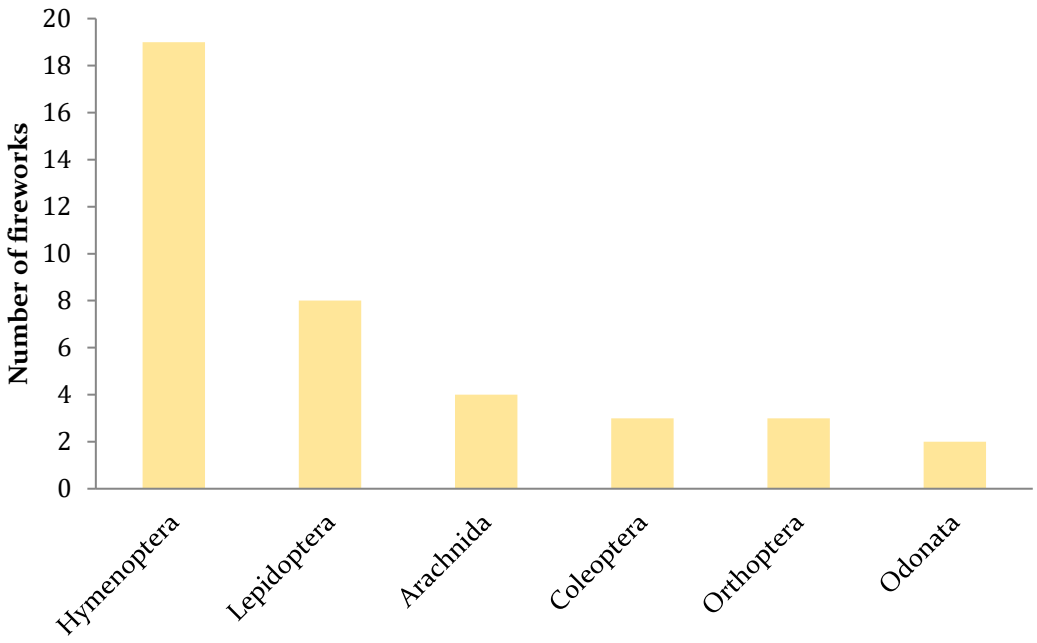

Fig. 3: Taxonomic distribution of arthropod fireworks.
Obr. 3: Taksonomsko prědstavjenje fejerverkov-insektov.

Video

Subjective examination reveals that the physical types of fireworks closely resemble each other, e.g., all aerial spinners look very much the same, and all fountains appear largely alike. Hence, many fireworks bore no resemblance to their insect namesakes. There were several, however, that conveyed a semblance of the insect. Both Hornet's Nest and Hornet Jamboree featured energetic, popping stars that could be considered as representing hornets. Yellow Bee was a fountain that produced individual "bees" that shot up within the shower of sparks, and Clustering Bees resembled a cluster of actual flying bees at the end. New Small Bees, tiny aerial spinners, resembled actual bees when ignited, spinning into the air with a buzzing sound and emitting a trail of sparks. Scorpion was a skyrocket that curled over at apogee, creating an image like a scorpion's tail. The fountain Crickets produced crackling sounds that could be interpreted as cricket stridulation.

Internet sources

At Phantom Fireworks arthropods were represented in 11 of 893 fireworks, or 1.23%. At Brothers Pyrotechnics insectile fireworks comprised 5 of 474, or 1.05% of the total. The two sites combined thus yield 1.16% penetration of the fireworks available by insect themes.

Discussion

Numbers

The absolute number of insect fireworks represents only a small sample of fireworks available, as online suppliers carried only slightly more than 1% of their inventory as entomological products. While this level of representation seems miniscule, it is an order of magnitude higher than that estimated for insects in popular music[7]. It appears that, despite the abundance of insects on Earth, most people either do not think about them much, or actively avoid them.

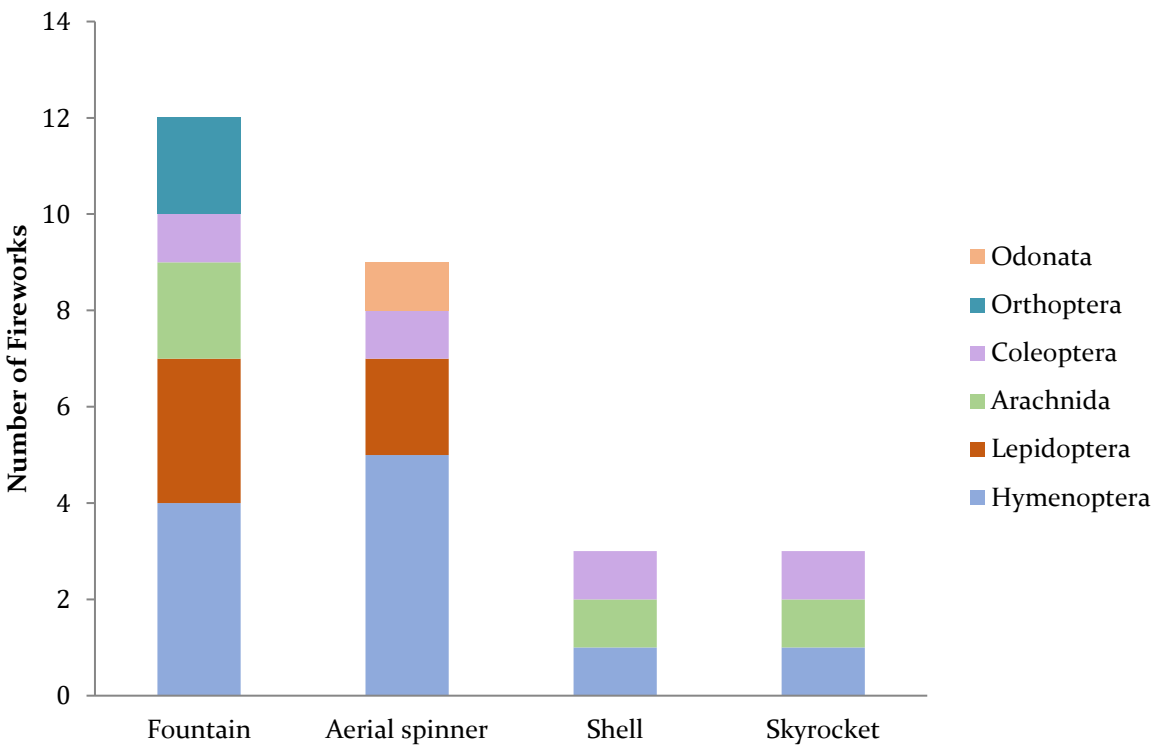

Fig. 4: The physical types of arthropod fireworks.
Obr. 4: Fizične rody fejerverkov-insektov.

There was some tendency for the insect fireworks to be on the smaller end of the size range, as large shells were not generally insect-related. This fact probably accounts for the absence of bee- and spider-type shells in the data. Only two giant insects were depicted on packaging, with scale provided by other depicted objects. Buildings were shown for the giant spider in Sky Web, and woman riding a blue butterfly in Butterfly Rocket. The former looks threatening while the latter looks somewhat pleasant.

However, packaging was created with inflammatory imagery in ways similar to those on music album covers[8], with swarms, photorealistic images, chimeric animals, anthropomorphic faces and exaggerated features frequently used to enhance the threatening nature of some insects. Thus, it seems that when we do think of insects, we primarily consider their most negative characteristics[5]. On the other hand, most depictions of Lepidoptera and ladybugs (Coccinellidae) were neutral, and some of the bee packaging (Mad Bee, Yellow Bee, Clustering Bees) showed anthropomorphic, almost silly-looking bees. These taxa enjoy favorable reputations[7,8,22], probably for their aesthetic and economic value.

Taxonomy

Hymenoptera were the most abundant insect represented in fireworks. This taxon is perhaps best known for bearing stings, which makes Hymenoptera natural targets for fireworks, as sparks can sting and flying sparks (stars) can resemble these insects. Furthermore, spinners present a simplistic approximation of bees and wasps, making Hymenoptera common among them. Butterflies are bright and colorful, like fireworks. Arachnids are sufficiently threatening to add an air of excitement. Coleoptera of few types were found. Lightning bugs (Lampyridae) were represented, perhaps because they produce light. Even Storm Over Swarm (fireworks.com) showed a photoshopped lightning bug. Ladybugs enjoy a favorable reputation, appearing in diverse products[22]. Curiously, bombardier beetles (Carabidae), the only insects capable of producing something like fireworks[23], were not represented in the data. Common hymenopterans, such as bees, wasps and hornets, are well known to lay people[24]. Furthermore, Hymenoptera are viewed both among the most liked and most disliked of arthropods, which is perhaps why they are the most common in popular music[7] and

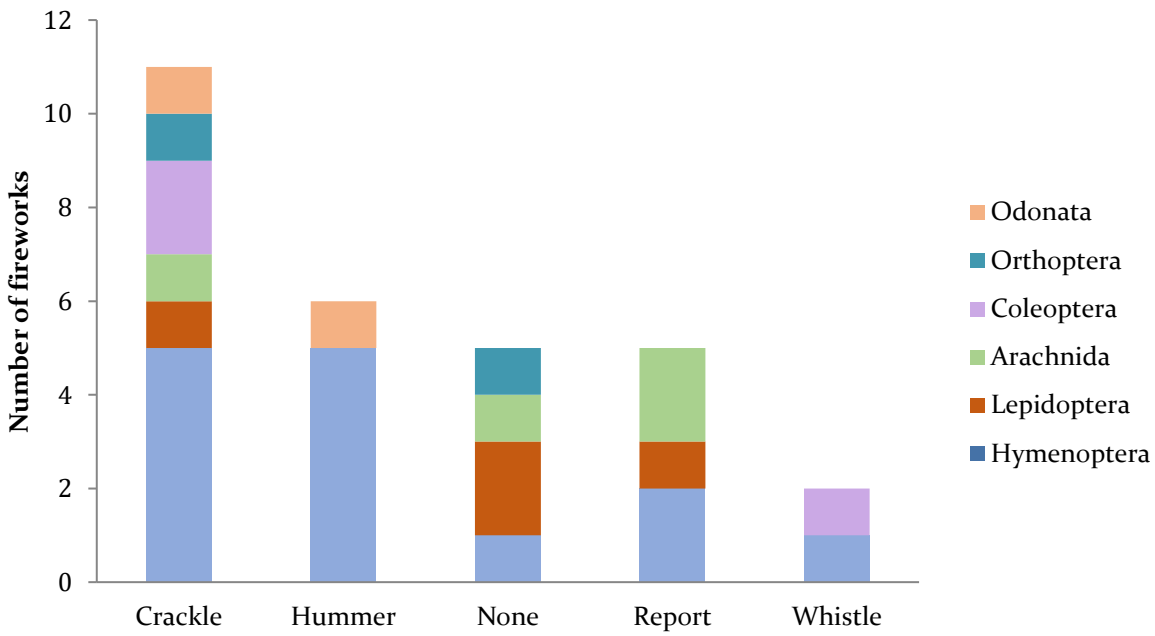

Fig. 5: Types of sounds produced by arthropod fireworks.
Obr. 5: Rody zvụkov tvorenyh fejerverkami-insektami.

many other media. Arachnids, coleopterans and orthopterans are also among the best known to the entomologically uneducated, where arachnids are disliked and the others are liked[24]. Given the apparently intrinsic stress response to spiders[25], it is surprising that they were not used more in fireworks.

Troudet et al.[26] suggest that societal preferences drive biodiversity research, leading to taxonomic bias. Although insects in general are grossly neglected as research subjects relative to their diversity, it would appear that societal choices also drive which insects are used in popular media. Chouvenc and Su[27] provide data on publication rates of various insect taxa, which, with slight simplification, show that Diptera are the most commonly studied taxon, followed by Hymenoptera. The complete absence of Diptera from fireworks is surprising considering the ability of many species to bite, but perhaps informing, as they lack aesthetic appeal and ability to sting, which is seen in most other species represented. Hymenoptera is second in publications, followed by Hemiptera and Lepidoptera. The predominance of Hemiptera in entomology and comparative absence in fireworks is perhaps understandable because, like Diptera, they lack characteristics that easily transfer. Though bed bugs are well known, and complained of in folk music[28], it makes little sense to append them to any firework.

The taxonomic distribution of insect fireworks is remarkably similar to those demonstrated in other entertainment media, such as music and film[7,8,9,11,12]. It would seem that the same values are expressed: menacing ferocity of bees and wasps, and the aesthetic beauty of butterflies. Duplicates of some taxa suggest that the most familiar insects are used repeatedly despite the tremendous diversity of insects available. As is similarly typical, there were a considerable number of errors in matching the package illustration to a taxonomically appropriate name.

Noise

Report is the most common sound among fireworks in general[20]; however, crackle was most common among insect fireworks, perhaps because crackling noises are more reminiscent of insects. Report was relatively uncommon in insect fireworks, most likely because the sound cannot be readily associated with insects. Hymenoptera were commonly affiliated with the hummer sound, which approximates the buzzing sound commonly associated with bees and wasps. Crackle most resembles crepitation among band-winged grasshoppers, yet none were represented among fireworks. This disconnection is similar to that in music, where sound-producing Orthoptera and Hemiptera (cicadas) are paradoxically uncommon[7].

Physical types/video

Many of the fireworks, upon ignition, had only the most passing resemblance to the insect depicted on the packaging or in the name. The physical type was the primary determinant of appearance. Fountains shoot sparks that may resemble swarms of insects such as bees or wasps. Indeed, four fountains were named for such Hymenoptera. However, the majority were named for harmless forms such as caterpillars, ladybugs and crickets. It was expected that the aerial spinners would be abundant in the data set, as most insects can fly. Spinners also generally produced a buzzing sound that may resemble some flying insects. Unlike the other spinners, the Dancing Dragonfly package had the appearance of four wings (with realistic venation), providing a greater resemblance to its namesake insect. Similarly, the Spring Butterfly and Spring Butterflies aerial spinners had a single pair of wings on the packages shaped to look like those of an actual butterfly. Notably, the scorpion rocket had a trajectory that curled over at the apogee, like the tail of a scorpion.

Conclusion

Fountains and aerial spinners were the most common physical type of firework, perhaps because the most commonly observed insect characteristics, such as swarming groups and crackling sounds, go hand in hand with these. The most popular taxon, Hymenoptera, perhaps best known from social bees and wasps, is consistent

with this suite of visual and auditory characteristics. Sparks can cause a burning sting, and vaguely resemble swarms. Fountains shoot sparks that may resemble swarms of insects such as bees or wasps. Indeed, four fountains were named for such Hymenoptera. Remarkable similarities occur between fireworks and other media, especially music[7,28]. There is even a crossover between the two, as Small Bee Helicopter Type is an aerial spinner firework that provides an album title and cover art by the band Paper Tulips[7,8]. It seems that our current culture views insects through approximately the same lenses, no matter which medium is expressing that perception. It is perhaps via these media that many negative insect stereotypes are perpetuated. Tiny solitary wasps that comprise most of their order are largely unknown to lay people. Lesser known taxa are completely ignored. Though the importance of pollinators and the ecological and economic importance of insects is perhaps beginning to be appreciated, these values are not yet adequately expressed in popular culture.

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Supplementary files

File 1: Fireflies

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