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Title: Video surveillance reveals a community of largely nocturnal *Danaus plexippus* (L.) egg predators

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Abstract

Monarch butterfly (*Danaus plexippus* L.) declines in eastern North America have prompted milkweed host plant restoration efforts in non-agricultural grasslands. However, grasslands harbor predator communities that exert high predation pressure on monarch eggs and larvae. While diurnal monarch predators are relatively well known, no studies have investigated the contribution of nocturnal monarch predators. We used video cameras to monitor sentinel monarch eggs and fourth instars on milkweed in southern Michigan to identify predators and determine if nocturnally-active species impose significant predation pressure. We observed ten arthropod taxa consuming monarch eggs and larvae, with 74% of egg predation events occurring nocturnally. Taxa observed attacking monarch eggs included European earwigs (*Forficula auricularia* L.), tree crickets (*Oecanthus* sp.), lacewing larvae (Neuroptera), plant bugs (Miridae), small milkweed bugs (*Lygaeus kalmii* Stål), ants (Formicidae), spiders (Araneae: Salticidae and other spp.), harvestmen (Opiliones), and velvet mites (Trombidiformes: Trombidiidae). Larvae were attacked by ground beetles (*Calleida* sp.), jumping spiders (Araneae: Salticidae), and spined soldier bugs (*Podisus maculiventris* Say). Our findings provide important information about monarch predator-prey interactions that could be used to develop strategies to conserve monarchs through reducing predation on early life stages.

Keywords: predator-prey interactions, nocturnal predation, monarch butterfly, grasslands

Introduction

Population declines of monarch butterflies in eastern North America (*Danaus plexippus* L.) over recent decades have motivated efforts to restore milkweed within the monarch breeding range (Brower et al. 2012; Thogmartin et al. 2017). These efforts occur primarily within non-agricultural grasslands, including field edges, fallow fields, and roadsides (Thogmartin et al. 2017). This poses a challenge for monarch recovery, as these habitats represent a small portion of the former milkweed habitat lost to herbicide use (Pleasants and Oberhauser 2013; Pleasants 2017). Furthermore, grasslands are risky habitats for immature monarchs; monarch eggs on milkweed in corn and soybean experience lower predation (≤ 50%) in comparison to up to 90% mortality in prairie (Myers et al. 2019). Monarchs not only have less breeding habitat, but remaining habitat has increased predation pressure.

Monarchs experience high egg and larval mortality, and increasing their survival by modest levels could help to stabilize the population (Oberhauser et al. 2017). Such efforts would benefit from more knowledge about monarch predators. A review by Oberhauser et al. (2015) compiled a list of 12 known monarch egg and larval predators from field observations (Smithers 1973; Borkin 1982; Zalucki and Kitching 1982; Lynch and Martin 1993; De Anda and Oberhauser 2015), field experiments (Calvert 2004; Prysby 2004), and laboratory studies (Koch et al. 2003, 2005; Rayor 2004; Rafter et al. 2013; Oberhauser et al. 2015). Hermann et al. (2019) generated a more comprehensive list of potential monarch predators using laboratory trials with arthropods collected from common milkweed. Of the 75 taxa tested, 34 consumed eggs and 30 consumed neonates, suggesting monarch predators are quite diverse.

One knowledge gap regarding monarch predators is the role of nocturnal egg predation, which is significant for other lepidopterans. A study in row crop fields in Texas found nocturnal predation on sentinel eggs of *Helicoverpa zea* Boddie and *Spodoptera exigua* Hübner was equal to or greater than diurnal predation, with dominant predators differing by time of day (Pfannenstiel 2005). In a previous study, we found monarch eggs suffered significant nocturnal predation (Myers et al. 2019), but did not directly observe the predation events.

To increase knowledge of monarch predation, we used video surveillance to monitor monarch eggs and a small number of fourth instar larvae during the summers of 2017 and 2018 in southern Michigan. We sought to determine: 1) the proportion of monarch eggs consumed by grassland predators; 2) the identity of the predators; and 3) the relative proportion of predation occurring during day versus night.

Methods

Study Sites

In 2017 we performed preliminary video monitoring at two sites: 1) a residential garden in East Lansing, Michigan ("garden site"); and 2) a biofuels cropping experiment at the Michigan State University (MSU) Kellogg Biological Station ("KBS site") in Hickory Corners, Michigan. In 2018 monitoring occurred on the MSU campus in East Lansing, Michigan at four sites representing grassland habitats where monarchs breed (**Fig. S1**), including: 1) a grassy cornfield edge ("corn edge"); 2) an old field dominated by *Solidago canadensis* L. and cool season grasses ("old field"); 3) a marsh edge dominated by *Phalaris arundinacea* L. ("marsh edge"); and 4) a fencerow with shrubs and cool season grasses ("fencerow"). All four sites had naturally growing *A. syriaca* used for breeding by wild monarchs. Details regarding site vegetation and locations are included in **Table S1**.

Study Plants and Egg Placement

Monarch eggs were produced by lab colonies originating from locally-captured adults. All *A. syriaca* plants used for the study were 50–75 cm tall and in a pre-flowering stage. In 2017 at the KBS site, we monitored eggs placed on potted *A. syriaca* plants in the field. These plants were grown from seed from native Michigan genotypes (Wildtype Nursery, Mason, Michigan). At all other sites we used naturally occurring *A. syriaca* stems for video monitoring.

On each plant we affixed eggs on the central underside of one of the uppermost fully emerged leaves to mimic natural monarch oviposition (De Anda and Oberhauser 2015). In preliminary trials in 2017 we affixed 1–10 eggs/leaf 1 cm apart. In 2018, we affixed two eggs per leaf 1 cm apart to allow observation of multiple predation events within a camera frame. Although monarchs typically lay eggs singly, two eggs/stem is common at these sites, and we have observed as many as seven eggs on a single plant (unpublished data). Eggs were attached using a fine paintbrush and a small droplet of Elmer's ® Glue-All (Elmer's Products, Columbus, Ohio). A prior lab study confirmed predators readily eat eggs glued to leaves using this method

(Hermann et al. 2019). Preliminary field methods testing also showed that glued eggs rarely fall off plants and that naturally laid and glued eggs were consumed at equal rates.

Video Camera Setup and Monitoring

We used a camera setup modeled after Grieshop et al. (2012), which included a camera with infrared night vision recording to a memory card through a digital video recorder (see **Table S2** for equipment details). Cameras were mounted on rebar pounded into the ground (**Fig. 1**). To prevent eggs from moving out of focus, we secured leaves to cameras using twist-ties. To prevent image overexposure, we created a light diffusing shade by mounting a 0.5 x 0.5 m white corrugated plasti-board to step-in fence post behind the plant. We checked focus and position of the image frame using a portable liquid crystal display.

We deployed eggs and 1–3 cameras/site weekly, with adjustments to avoid rain. We revisited the cameras daily to change batteries and check eggs. Observations of each set of eggs continued until all eggs were gone or until the end of the week for a range of 24–96 h of video monitoring. We used the same plants each week unless leaves were damaged or plants grew too tall, in which case we selected a nearby comparable plant. The process was repeated weekly from 3 July 2018 to 4 September 2018, except for the week of 23 July. At the outset of the experiment we deployed cameras at the old field and fencerow sites, later adding the marsh edge and corn edge sites. On July 30 we removed the two cameras from the fencerow site due to limited predation events occurring there and increased the number of cameras monitoring at the old field. We monitored 29 eggs in 2017 and 123 eggs in 2018 for a mean of 59 hours/egg.

Fourth Instar Monitoring

On 18 September 2017 we performed a limited study to monitor fourth instar monarch larvae at the KBS site. We selected four larvae from a lab colony and individually tethered them onto potted *A. syriaca* plants so they stayed in the camera frame. Tethering involved loosely tying a 10 cm length of cotton sewing thread to the caterpillar between the legs and prolegs. We then applied a small drop of Krazy Glue® (Elmer's Products, Westerville, OH) to the thread to adhere it to the dorsal side of the caterpillar. We glued the other end of the thread to the underside of an upper leaf and placed the caterpillar on the leaf. Lab trials demonstrated tethered caterpillars fed and molted out of the tether seemingly unharmed. One plant/larva/camera unit was placed in each of the four prairie plots at the KBS site for 24 h of monitoring.

Video Processing and Data Analysis

To streamline processing of over 9000 hours of video footage generated, we only reviewed instances when eggs were found missing or empty at the end of the monitoring period. We viewed footage at 10x speed using VLC Media Player (VideoLan Organization) to locate predation events, then reviewed footage in real time to record predator identities, start and end times of predation events, and behaviors of interest. If multiple predators visited an egg, we only considered it a predation event if we could clearly see sustained feeding behavior. We tested for differences in the occurrence of predation between night and day using a G-test of independence (Sokal and Rohlf 1995) using R version 3.4.2 (R Core Team 2017) with a null hypotheses of equal numbers of eggs eaten during day versus night.

Results

We determined the fates of 145 out of 152 eggs deployed. Of these, 25% were predated before hatching (**Fig. 2**). The remaining eggs were intact at the end of the monitoring period (56%), hatched (13%), or visibly shriveled and desiccated (4%). Two eggs (1%) were on a host plant that was clipped off by a mammal, and one egg (< 1%) was dislodged from the plant by a milkweed tussock moth caterpillar (*Euchaetes egle* Dury). Of the 19 eggs that hatched, two on the same leaf were consumed as first instars by a single spined soldier bug nymph (*Podisus maculiventris* Say), 15 exited the camera frame (and thus their fates are unknown), and two were present at the end of the monitoring period. Fates could not be ascertained for seven eggs that were missing or empty at the end of the monitoring period, but for which no distinct predation event was confirmed. Egg predation rates were greatest in the old field (14/50 eggs predated) and lowest at the fencerow (1/14 eggs predated).

We observed 10 predatory taxa from eight orders consuming monarch eggs (**Table 1**) including obligate predators (orders Araneae, Opiliones, and Neuroptera, and family Trombidiidae) and omnivores (*Forficula auricularia* L.*, Lygaeus kalmii* Stål, *Oecanthus* sp., and families Miridae and Formicidae). European earwigs (*F. auricularia*) ate the most total eggs (10 eggs consumed over three events). However, spiders (Salticidae and other unidentifiable species) performed the greatest number of individual predation events (five eggs consumed over five predation events). Despite their presence on milkweed stems, only one ant (likely *Prenolepis imparis* Say) was observed consuming a monarch egg. Two out of the four fourth instar monarch caterpillars monitored were predated. One was attacked and consumed by a jumping spider (family Salticidae). The other was attacked, killed, and partially consumed by a beetle (*Calleida* sp.; family Carabidae) and subsequently fed upon by several other taxa including a meadow katydid (*Orchelimum* or *Conocephalus* sp.), cone-head katydid (*Neoconocephalus* sp.), yellow jacket (*Vespula* sp.), fly (likely Tachinidae), ground cricket (subfamily Nemobiinae), and a harvestman (details in **Table 2)**.

Predators consumed more eggs nocturnally than diurnally. Of the instances for which we could confirm the time of predation (35/36 eggs), significantly more eggs were consumed during night than day ($\chi^2 = 6.64$, df = 1, $p = 0.01$), with 71% of eggs consumed and 74% of predation events occurring between 20:00 and 6:00 (**Fig. 3**). For predator groups with multiple feeding observations, temporal feeding patterns were consistent; earwigs, tree crickets, and non-Salticidae spiders fed at night, while small milkweed bugs fed during the day. Predation on first instar monarch larvae by a spined solider bug and on fourth instars by a *Calleida* sp. beetle and Salticid occurred diurnally. We also observed noteworthy interactions that defy simple categorization including scavenging events, interactions between predators and scavengers, and mammal activity. Details regarding these events and of predation on first and fourth instar monarch caterpillars are included in **Table 2**.

Discussion

We documented multiple interactions between immature monarchs and predators, expanding knowledge of monarch predator-prey ecology. At least 77% (n = 36) of eggs that died before hatching did so because of predation, confirming results of past studies that use predator exclosures or anecdotal observations to infer that predation is the primary source of immature monarch mortality (Zalucki and Kitching 1982; Prysby 2004; De Anda and Oberhauser 2015; Myers et al. 2019). Most of the predation events we observed (74%) occurred nocturnally, consistent with other studies finding high nocturnal mortality on monarch and other lepidopteran eggs (Pfannenstiel 2005; Myers et al. 2019). Furthermore, distinct communities consumed monarch eggs at night versus during the day. This work added to the list of known monarch predators and was the first to record monarch egg predation in the field by *Prenolepis imparis*, *Lygaeus kalmii,* and Opiliones (Oberhauser et al. 2015; Hermann et al. 2019).

The prevalence of nocturnal monarch predation could explain why other studies found little correlation between diurnal predator numbers on milkweed and survival rates of monarchs (De Anda and Oberhauser 2015; Myers et al. 2019). De Anda and Oberhauser (2015) found spiders were the only predators correlated with monarch egg mortality in Minnesota grasslands, but only observed egg consumption by jumping spiders. They may have missed most spider predation events because they occurred nocturnally. Our findings also mirror recent work demonstrating the importance of nocturnal pollination (Macgregor et al. 2015;

Knop et al. 2017). Accounting for nocturnal egg predation would increase both the understanding of monarch mortality and monarch oviposition patterns often inferred from egg surveys (Myers et al. 2019).

We also documented non-consumptive interactions that could influence monarch survival, including plant clipping by vertebrates, eggs being dislodged by passing arthropods, and larvae silk-dropping when disturbed (**Table 2**). Both silk-dropping observations were caused by interactions with common milkweed herbivores. While dropping on a silk can be effective for avoiding predation, it often requires neonates to initiate new feeding sites, which is a dangerous activity due to milkweed chemical and latex defenses (Zalucki et al. 2001) and potential vulnerability to other predators. Future studies could investigate trade-offs associated with this behavior.

Since most monarchs are lost to predation as eggs and larvae, reducing predation pressure on early life stages represents a valuable monarch conservation opportunity. Immature monarch survival could be enhanced by prioritizing milkweed establishment in habitats with lower predation pressure (Pitman et al. 2018; Geest et al. 2019), managing milkweed in ways that reduce predator numbers (e.g. strategic mowing; Haan and Landis 2019), or by directly suppressing predator populations. Although previous diurnal studies suggest that ants consume most monarch eggs and larvae in grassland (Calvert 2004; Prysby 2004), our nocturnal observations suggest that spiders and earwigs are also important predators. As ants are known to suppress spider and other predator populations in grasslands (Wills and Landis 2018), our work suggests that ant suppression could inadvertently lead to greater monarch predation. More natural history information about monarch predator-prey interactions combined with field experiments manipulating predator communities would be very informative to monarch conservation efforts.

Compliance with Ethical Standards

This study was funded by the National Institute of Food and Agriculture, United States Department of Agriculture, award number 2017-68004-26323, by the National Science Foundation Long-term Ecological Research Program (DEB 1637653) at the Kellogg Biological Station, and by Michigan State University AgBioResearch. A.M. received additional support from the Kellogg Biological Station Long Term Ecological Research Graduate Student Fellowship (https://lter.kbs.msu.edu/), Kellogg Farm 2017 Graduate Student Mini-grant, and Ray and Bernice Hutson Memorial Entomology Endowment Fund Research Award.

Conflict of Interest: The authors declare that they have no conflict of interest

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Tables and Figures

Fig 1. Camera setup for monarch butterfly (*Danaus plexippus* L.) egg video surveillance study.

Fig 2. Fates of 152 monarch eggs monitored in video surveillance studies in 2017 and 2018. Eggs in the "other" category include two eggs on a plant clipped down by a mammal and one egg knocked off the plant by a milkweed tussock moth caterpillar (*Euchaetes egle* Dury). Not shown are the remaining seven eggs, whose fates could not be ascertained with certainty.

Fig 3. Number of monarch butterfly (*Danaus plexippus* L.) eggs (total = 35) observed through video surveillance consumed by predators during day (6:00–20:00) and night (20:00–6:00) on naturally growing common milkweed (*Asclepias syriaca* L.) in southern Michigan. Letters above bars represent a significant difference between the numbers of eggs predated during day versus night (G-test; $\chi^2 = 6.64$, df = 1, p = 0.01).

Table 1. Predatory taxa and details of predation events observed via video surveillance of 152 monarch eggs in 2017 and 2018.

Year	Order	Taxon	Locations	Number eggs eaten	Number events	Date(s)	Time	Mean time on egg (H:M:S) ± SEM
2017	Dermaptera	European earwig (*Forficula auricularia*)	KBS, Garden	9	2	6/11–9/5	22:51–23:14	0:23:00 *
	Hemiptera	Plant bug (Miridae, sp. unknown)	Garden	2	1	7/8	20:11–20:59	0:47:30 ± 0:00:30
2018	Dermaptera	European earwig (*Forficula auricularia*)	Garden	1	1	6/11	22:54–23:00	0:06:00 *
	Orthoptera	Tree cricket (*Oecanthus* sp.)	Old field	5	3	7/17–8/22	22:31–01:10	0:07:36 ± 0:02:12
	Neuroptera	Lacewing (Chrysopidae or Hemerobiidae, sp. unknown)	Old field	1	1	7/4	23:46–23:47	0:01:00 *
	Hemiptera	Plant bug (Miridae, sp. unknown)	Fencerow	1	1	6/25	unclear	unclear *
		Small milkweed bug (*Lygaeus kalmii*)	Old Field, Marsh Edge	6	3	9/4–9/6	12:55–19:52	0:09:50 ± 0:01:08
	Hymenoptera	Ant (Formicidae, likely *Prenolepis imparis*)	Corn Edge	1	1	9/6	21:31–22:27	0:56:00 *
	Araneae	Jumping spider (Salticidae, unknown sp.)	Corn Edge	1	1	8/22	10:01–10:07	0:06:00 *
		Other Spider (unknown sp.)	Old field, Marsh Edge	4	4	8/2–8/21	22:19–3:12	1:21:15 ± 0:05:27
	Opiliones	Harvestman (unknown sp.)	Garden	1	1	6/9	23:23--23:43	0:20:00 *
	Trombidiformes	Mite (unknown sp.)	Old field	2	1	8/30	11:03--14:52	1:54:00 ± 0:29:00

* SEM not included for predator taxa that ate only one egg or when exact timing of predation was indeterminable.

Table 2. Unique interactions between monarch (*Danaus plexippus* L.) and various predators observed during egg and larva video surveillance.

Year	Date	Number and life Stage	Location	Species Involved	Interaction Description
2017	9/5	2 eggs	KBS Site	Thirteen-lined ground squirrel	The upper half of the milkweed stem was found on the ground adjacent to the pot with both eggs still intact. The stem was excised by a chewing mammal, likely a thirteen-lined ground squirrel (*Ictidomys tridecemlineatus*), which were very common at the KBS site.
	9/18	1 fourth instar	KBS site	Ground beetle Meadow katydid Yellow jacket Fly (likely Tachinid) Cone-head katydid Harvestman Ground cricket	At 16:17 the caterpillar was attacked by a ground beetle (*Calleida* sp.), and dropped from the leaf hanging by the tether. The beetle then reached the caterpillar and dragged it back to the leaf and began consuming it. At 16:42 a meadow katydid arrived, chased away the beetle and began consuming the caterpillar, shortly after which the beetle returned and fed on the caterpillar alongside the katydid until 16:57, when both abruptly departed. During the following hours the caterpillar remains were scavenged by meadow katydid(s) (*Orchelimum* or *Conocephalus* sp.) at 17:38, 3:56, and 5:15, yellow jacket(s) (*Vespula* sp.) at 17:39, a fly (likely Tachinidae) at 17:41, a cone-head katydid (*Neoconocephalus* sp.) at 20:44, a harvestman (Opiliones: family unknown) at 1:51, and a ground cricket (subfamily Nemobiinae) at 3:11.
	9/18	1 fourth instar	KBS Site	Jumping spider Meadow katydid	Caterpillar was killed and eaten by a jumping spider (Salticidae) from 14:43–15:13. The caterpillar remains were later scavenged by at least two meadow katydids from 16:52–17:22.

Table 2. (Cont'd).

2018	6/12	1 egg	Garden Site	Earwig Tree cricket Harvestman	The egg was inspected by potential predators four times within three hours, with the true time of predation indeterminable. Predator visits were: earwig (*Forficula auricularia*) at 23:14; tree cricket (*Oecanthus* sp.) at 23:30; harvestman at 00:40; and earwig at 1:33.
	8/9	1 first instar	Marsh Edge	Milkweed weevil	At 23:40 milkweed weevil (*Rhyssomatus lineaticollis*) walked past a first instar larva, brushing up against it. The larva dropped on a silk thread, which subsequently adhered to the weevil. The larva was then pulled along on the silk by the weevil for several cm until the silk stuck to the leaf and the larva was eventually able to climb back to the leaf and resume feeding.
	8/17	1 egg	Old field	Milkweed tussock moth larva	A milkweed tussock moth caterpillar (*Euchaetes egle*) walked across the leaf and passed over the monarch egg at 00:40, after which the egg was no longer visible, apparently having been dislodged by the caterpillar as no evidence of feeding was observed.
	8/20	1 egg	Old field	Spider Slug	After egg was consumed by a spider (Araneae: unknown sp.) with only the empty chorion remaining, a slug (likely *Deroceras reticulatum*) arrived 17:20 and consumed the chorion leaving no discernable remnant of the egg.
	8/20	1 first instar	Corn Edge	Small milkweed bug	At 17:14 the first instar dropped on a silk from lower leaf surface when a small milkweed bug (*Lygaeus kalmii*) crawled onto the upper leaf surface. At 17:30 it reappeared back on the leaf.
	9/7	2 first instars	Old field	Spined soldier bug	From 11:11–13:34 a spined soldier bug nymph (*Podisus maculiventris*) consumed both first instar larvae. The first predation event lasted 1 h 6 m and the second lasted 1 h 9 m.

Supplementary Material

Fig S1. Grassland study sites used for monarch butterfly egg video surveillance on the Michigan State University campus in East Lansing, Michigan: a) corn edge; b) old field; c) marsh edge; d) fencerow.

Table S1. Site locations and descriptions for monarch butterfly egg video surveillance studies in 2017 and 2018.

Site name	Coordinates	General description	Dominant vegetation[a]
KBS Site Corn treatment	42.407, -85.374	Four 9.1 x 27.4 m plots of conventionally managed corn in the Kellogg Biological Station Cellulosic Biofuels Diversity Experiment.	Corn (*Zea mays*)
KBS Site Prairie treatment	42.407, -85.374	Four 9.1 x 27.4 m plots of "low diversity prairie" in the Kellogg Biological Station Cellulosic Biofuels Diversity Experiment.	*Andropogon gerardii*, *Panicum virgatum, Sorghastrum nutans*, *Elymus canadensis*, *Schizacyrium scoparium*, *Koeleria cristata*, *Desmodium canadense*, *Rudbeckia hirta*, *Monarda fistulosa*, *Solidago rigida*
Garden	42.743, -84.486	Residential back yard garden adjacent to mowed lawn.	Poa sp., *Aegopodium podagraria*, *Cichorium intybus*, *Asclepias syriaca*, *Asclepias incarnata*, Taraxacum *officinale*
Corn edge	42.691, -84.490	Annually mowed strip of vegetation between a conventionally managed cornfield and a gravel road.	*Poa* sp., *Phalaris arundinacea*, *Asclepias syriaca*, *Amaranthus* sp., *Chenopodium berlandieri*, *Taraxacum officinale*
Old field	42.692, -84.491	Fallow field with cool season grasses and forbs.	*Poa* sp. and, *Solidago canadensis*, *Asclepias syriaca*, *Plantago lanceolata*, *Elytrigia repens*, *Taraxacum officinale*, *Cirsium arvense*
Marsh Edge	42.689, -84.475	Un-mowed cool season grasses (*Phalaris arundinacea*) adjacent to a cattail (*Typha* sp.) marsh.	*Phalaris arundinacea*, *Solidago canadensis*, *Symphyotrichum pilosum*, *Asclepias syriaca*, *Sonchus asper*, *Euthamia graminifolia*
Fencerow	42.679, -84.477	Un-mowed vegetation growing along a fence running between a seldom mowed lawn and a gravel road.	*Poa* sp., *Asclepias syriaca*, *Setaria* sp., *Daucus carota*, *Elaeagnus umbellata*, *Syringa vulgaris*

[a] In order of decreasing cover

Table S2. Components of camera setups used for monarch butterfly egg video surveillance studies in 2017 and 2018

Year	Component	Name/Model	Manufacturer
2017 & 2018	LCD screen	model S801H	Shenzhen Eyoyo Tech. Co., Ltd, Los Angeles, CA
2017	Camera	Q-See model QOCDC36	QOCDC36 Digital Peripheral Solutions Inc., Anaheim CA
	DVR	FPV Mini C-DVR	Jingxinhong Model Co., LTD. Shenzhen, China
	Battery	12 v 8 Ah sealed lead acid, model ML8-12 (2 per camera)	Mighty Max Battery, Brooklyn, NY
2018	Camera	1080P HD Security Camera, model HN-IA60E200FS	Honic Electronic Technology Co., Ltd, Zhongshan, Guangdong, China
	DVR	HD Micro SD DVR, model ADIB00UMZM2IG	Coomatec Intelligence, Ltd, Shenzhen, China
	Battery	12 v 18 Ah sealed lead acid, EXP 12 180 (2 per camera)	ExpertPower Direct, Paramount, CA, USA