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# Conspecific kleptoparasitism in Pacific cicada killers, *Sphecius convallis* (Hymenoptera : Crabronidae): Partially provisioned nest cells are appropriated *in situ* by other females.

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## Introduction

The mining ghost town of Ruby, AZ, has been known at least since the 1950s to have a large, regularly present population of the Pacific cicada killer, *Sphecius convallis*. We used this population to study several aspects of the wasp's biology. Here we report the results of experiments performed at Ruby in the summer of 2009, in which we used trapnests to determine the extent to which female cicada killers steal partially provisioned nest cells from each other (conspecific kleptoparasitism). Also reported are additional experiments done on kleptoparasitism by Eastern cicada killers, *Sphecius speciosus*, in Easton, PA, in the summer of 2010.

Cicada killers are large crabronid wasps which mass provision their eggs with one or more paralyzed cicadas placed in underground nest cells, each connected to a burrow. If more than one cicada is used to provision an egg, the burrow and nest cell are left open by the female wasp as she forages for additional cicadas. Female cicada killers often enter nest burrows of other females for up to an hour and are frequently evicted by the resident female if she is present. This behavior indicates the possibility of competition between conspecific females for the use of nest cells, particularly if they are provisioned with one or more paralyzed cicadas. The digging of a burrow and nest cell and the provisioning of it with one or more paralysed cicadas carried back to the burrow in flight from at least 50 meters represents a huge investment of time and effort (several hours of digging the burrow and nest cell and up to four hours of hunting for each cicada). Thus, kleptoparasitism should be a strongly selected behavior in female cicada killers which routinely dig their nesting burrows in large aggregations in which the burrows are often separated by a meter or less.

**Our results are consistent with the hypothesis that conspecific kleptoparasitism is common in both Pacific and Eastern cicada killers. In each population studied, it occurred in approximately half of the open artificial nest cells "baited" with paralyzed cicadas in trap nest burrows left open to simulate the open natural burrows of foraging female wasps.**

## Study Sites and Methods

The study area in Ruby, AZ, is located in south central Arizona 8 km north of the Mexican border at 31.459583 deg. N, 111.233658 deg. W, 1265 m above sea level. The Pacific cicada killer breeding aggregation there is located on an approximately 5 ha flat of very fine sand tailings from an abandoned lead mine which operated there from the 1850s until 1940.

The Easton, PA, study area is located on a grassy architectural berm at the southeast corner of Pardee Hall on the campus of Lafayette College at 40.697796 deg. N, 75.207702 deg. W at an elevation of 103 m above sea level. A permanent Eastern cicada killer breeding aggregation has been at this site at least since the 1970s and, possibly, since Pardee Hall was built in 1872.

We used trap nests to test the hypothesis that female cicada killers visiting nesting burrows of other females were engaging in kleptoparasitism of paralyzed cicadas left in open nest cells by their owners while foraging for one or more additional cicadas with which to provision their eggs. Trap nests were constructed from 76 cm lengths of 8.6 cm diameter white PVC water pipe cut in half lengthwise to allow them to be opened easily; the halves were joined along their lengths with cellophane tape. Once assembled, the trap nests were filled with damp tailings (Ruby) or damp sand (Easton), lightly tamped, and a simulated burrow was created down the center of the trap nest by pushing the 1.8 cm diameter handle of an insect net through it. At the bottom end of each trap nest was placed a 4 oz plastic disposable individual portion cup filled with damp tailings/sand. In each cup a simulated nest cell was created by pressing the rounded end of the 3 cm diameter handle of a garden trowel into the tailings/sand, forming a 3cm diameter hemisphere in it. The tailings/sand in the lower end of the trap nest tube was then chamfered to simulate the upper half of a natural nest cell. Finally, a paralyzed cicada taken from a female cicada killer returning to her natural burrow was placed in the nest cell in the cup and the cup was secured to the lower end of the trap nest, forming a nearly spherical simulated natural nest cell opening into the simulated burrow and containing a freshly paralyzed cicada.

Trap nests were placed in the ground at a 45 deg. angle with their openings flush with the surface and a tumulus was fashioned at one edge of the burrow opening, as shown in the picture below.

## Results/Discussion

Kleptoparasitism was common at both Ruby and Easton. After 24 h, aproximatey half of the nest cells containing cicadas were appropriated by female cicada killers, eggs were laid on them, and their nest cells were closed by backfilling the burrow where it connected to the nest cell.

**<u>% Apparent Kleptoparasitism</u>**

***S. convallis*** **at Ruby, AZ: 13/29 = 45%**

***S. speciosus*** **at Easton, PA: 27/52 = 52%**

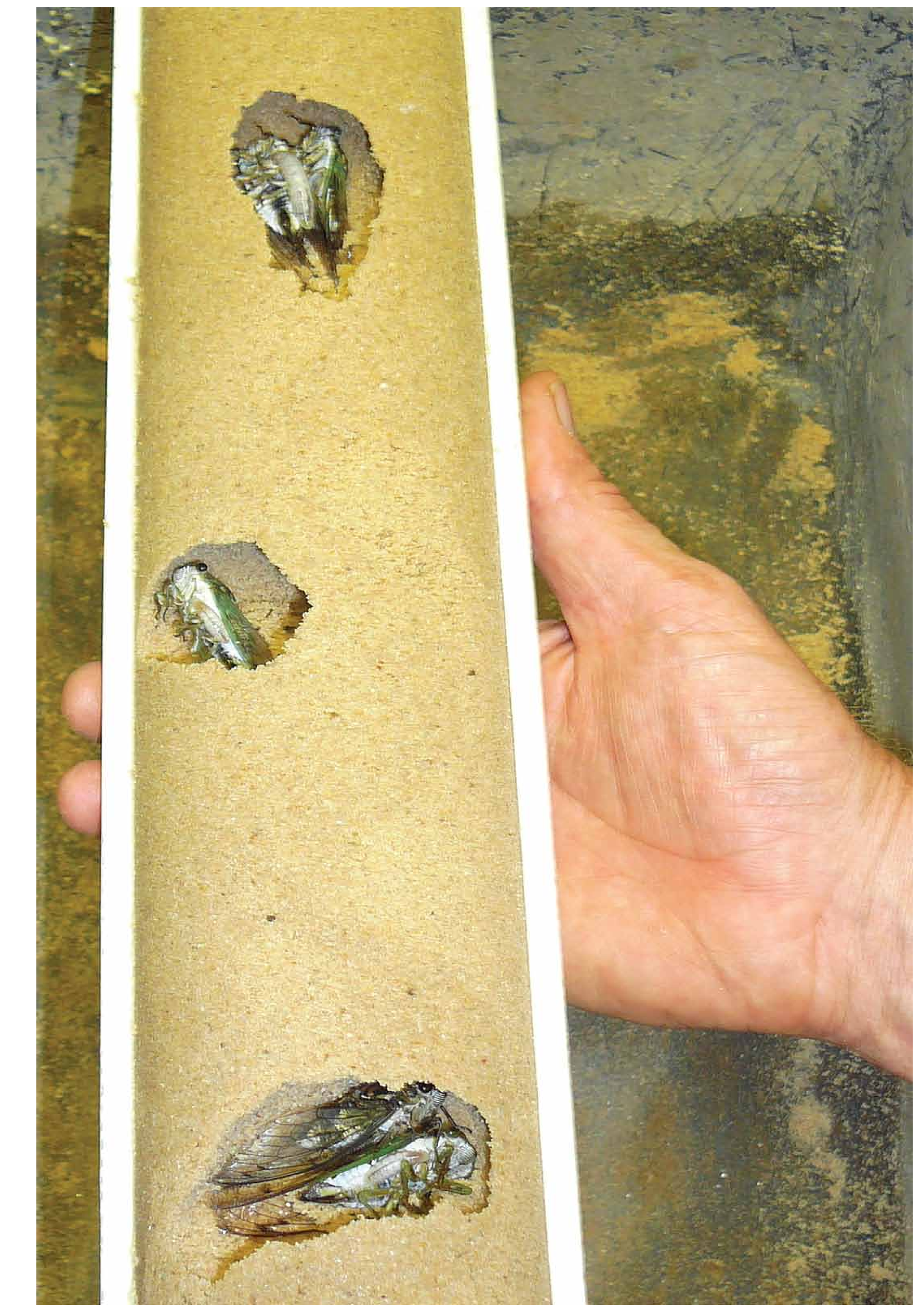
At both areas, female wasps backfilled the burrows above the kleptoparasitized nest cells for a distance of 2 to 48 cm. Further, females appropriating the nest cell sometimes added one or two paralyzed cicadas to such cells before ovipositing and closing the nest cell by backfilling the burrow above them. In several cases, either the same female or a different one added one or more new nest cells above the original one in the trap nest, provisioned them, oviposited and closed the cell (s); one such trapnest is shown in the picture on the right.

Further experiments were done with the Easton population of *S. speciusosus* to determine how quickly kleptoparasitism would occur after the resident female left her partially provisioned burrow to hunt for a second cicada. As shown below, other females quickly entered the trap nest burows and appropriated the cicada and its nest cell.

***S. speciosus*** **at Easton, PA**

| Time | % Kleptoparasitism |
|---|---|
| 25 min. | 9/49 = 18% |
| 45 min. | 10/37 = 27% |
| 24 h. | 27/52 = 52% |

**These data clearly show that females in both areas readily oviposit in open trap nest cells containing freshly paralyzed cicadas. Assuming that our trap nest model system adequately mimics natural burrows, kleptoparasitim is a very common occurence in cicada killer breeding aggregations. Given the large energy and time expenditures made by females to, 1) dig burrows and nest cells (1-6 hours) and, 2) hunt, paralyze and carry in flight back to the burrow one or more cicadas (5 to 240 minutes), it seems very likely that there is strong selective pressure favoring kleptoparasitism.**



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