



Cleptoparasitic Spider Wasps (Pompilidae): An Interesting Case of Convergent Evolution

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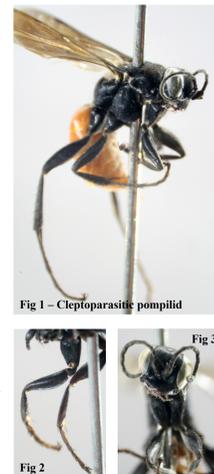


Abstract

Specimens of a new species of spider wasp (Hymenoptera: Pompilidae) from Bolivia and Argentina were found. This species is cleptoparasitic based on morphology and shares similarities with the cleptoparasitic genera *Evagetes* and *Aridestus*. The questions our analyses will attempt to answer include: **1) Is this new species a member of the known genera of closed-cell cleptoparasites (*Aridestus* or *Evagetes*), or does it belong to another group? 2) Do the cleptoparasites form a monophyletic group** (i.e. did cleptoparasites evolve only once in Pompilinae), and, if not, how many times has this behavior evolved within the Subfamily? To answer these questions, we used phylogenomics and ultra conserved elements. We extracted and sequenced the DNA from these species and performed phylogenetic analyses to continue previous research. This analysis unexpectedly shows that this new species is not a member of either cleptoparasitic genus (*Aridestus* or *Evagetes*), but, rather, is a new species in the genus *Anoplius* that currently has no known cleptoparasitic species.

Introduction

Cleptoparasitic behavior likely has evolved with in spider wasp family (Hymenoptera: Pompilidae) multiple times. Most spider wasps capture and paralyze a single spider and lay a single egg on it. Within spider wasps two different types of cleptoparasites have evolved, open-cell cleptoparasites and closed-cell cleptoparasites. Open-cell cleptoparasites are represented by the single subfamily Ceropalinae, which contains only two genera: *Ceropales* and *Irenangelus*. Closed-cell cleptoparasites have evolved in two genera, *Evagetes* and *Aridestus*, in the Subfamily Pompilinae. These behaviors are different from open-cell cleptoparasites and have been named closed cell. The difference between these two types of cleptoparasitism is that open-cell cleptos steal the spider before the nest of the host wasp is closed, while the host female prepares the burrow for her offspring, and closed-cell cleptos dig into another spider wasp's nest, find completed cells, kill the host wasp's egg, and lay their own egg, thus, stealing the spider for themselves.



Closed-cell cleptoparasites have specialized morphology for finding and digging out a host wasp's nest. The antennal segments are reduced in length, but have many more observable sensory setae than a typical spider wasp. Additionally, they have enlarged fore legs (Fig 2 & 3) and a well-developed tibial comb for digging.

Materials and Methods

Molecular Methods

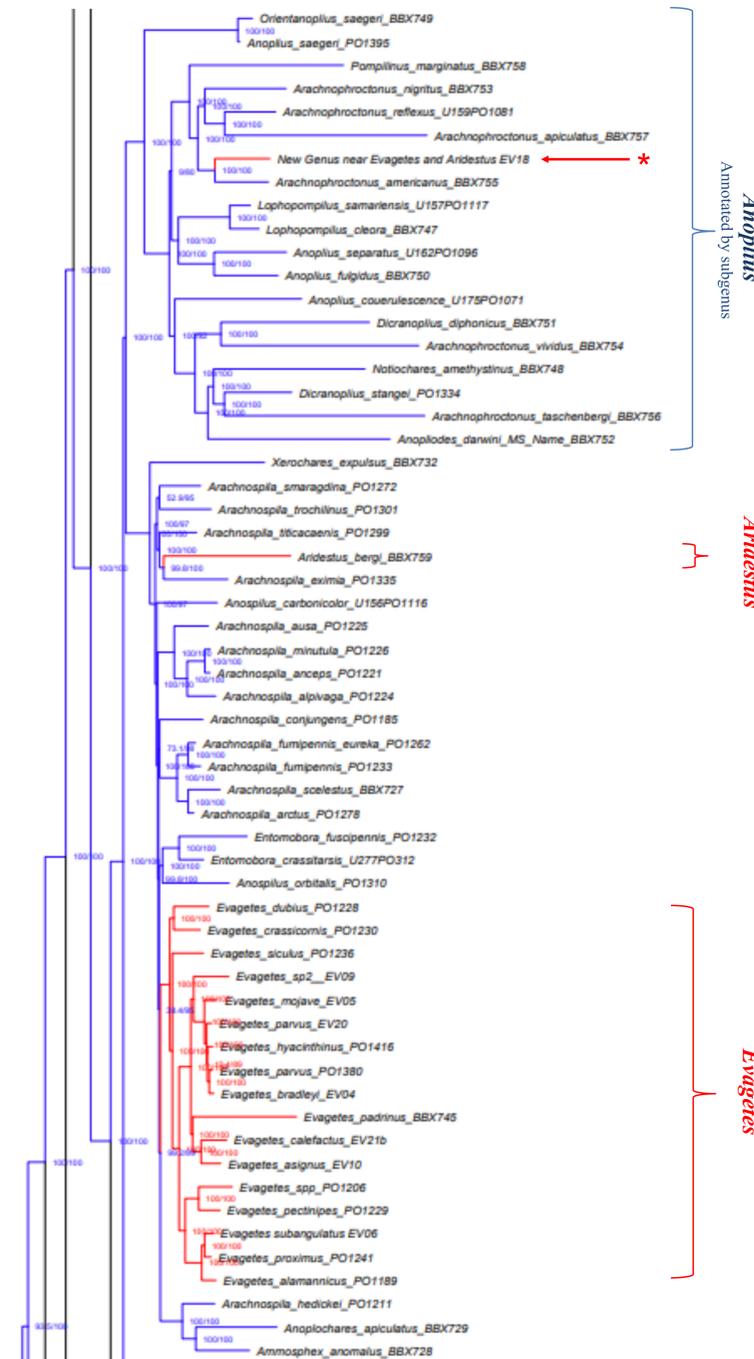
- DNA was extracted from pinned specimens using a Roche High Pure extraction kit.
- DNA was prepared using a Q800R2 Sonicator to break DNA strands into fragments ~ 600 base pairs in length. The optimal size for library preparation.
- DNA fragments were repaired and cleaned by using speedbeads, and magnetic stands (Fig 4). Libraries were also indexed using and iTru adaptor system and the thermocycler.
- DNA was pooled, enriched, and submitted as one lane to an Illumina sequencer.



Phylogenetic Analyses and Methods

- The UCE dataset included 1,308 UCE loci with 266,451 informative sites and a total length of 462,185 bp.
- The phylogenetic tree was created using Maximum Likelihood (ML) calculations via the program IQTree. The tree was visualized and colored using FigTree.

Results



Maximum likelihood phylogenetic tree created using IQTree is shown here. Each node shows two support values, SH-like procedure approximate likelihood-ratio test (SH-aLRT) support % / ultrafast bootstrap (UFboot) support %. The cleptoparasitic genera are marked in red, other genera are marked in blue. The cleptoparasitic species, in question, examined for this study is marked with a red arrow and red asterisk (*).

Discussion

1) Is this new species part of the genera of known to be closed-cell cleptoparasites (*Aridestus* or *Evagetes*), or does it belong to another group?

This new species unexpectedly was determined to be a new species of the genus *Anoplius*. The convergent morphology for a closed-cell cleptoparasite confused us and lead us to believe that this species was either a member of *Aridestus* or *Evagetes*. After this analysis, the specimens were studied again and it was found that they had a well-developed pulvillar pad with many (20-30) long setae, which is only seen in *Anoplius* species.

2) Do the closed-cell cleptoparasites form a monophyletic group (i.e. did cleptoparasites evolve only once in Pompilinae), and, if not, how many times has this behavior evolved within the Subfamily Pompilinae?

In this analysis, *Aridestus* and *Evagetes* were found to be not closely related and, they in turn, are not closely related to the new species. As such, closed-cell cleptoparasitism has evolved three times in Pompilinae.

Conclusion

- This specimen will need to be named. It will be placed in its own subgenus, and because it is a new species will be given a new specific epithet. We intend to name it *Anoplius (Aridestagetes) shimizui*.
- Future work will include looking for other specimens of closed-cell cleptoparasites within *Anoplius*.

Citations

- Evans, H. E. 1966. Studies on Neotropical Pompilidae (Hymenoptera) II. Genus *Aridestus* Banks, *Psyche: A Journal of Entomology*, vol. 73, Article ID 054507, <https://doi.org/10.1155/1966/54507>
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- Evans, H. E., Lin, C. S., and C. M. Yoshimoto. 1953. A Biological Study of *Anoplius apiculatus autumnalis* (Banks) and Its Parasite, *Evagetes* Mohave (Banks) (Hymenoptera, Pompilidae). *Journal of the New York Entomological Society*, 61(2), 61-78. <http://www.jstor.org/stable/25005489>

Acknowledgements

We would like to thank Dr. Bonnie Blaimer for her help in gathering sequence data, and Dr. Michael Branstetter for his UCE protocols and training in using the PHYLUCE software package. We acknowledge and thank Alex Wild for his photo of a pompilid with a spider (upper right corner). This research could not have been done without funding from NSF and the UAES.

