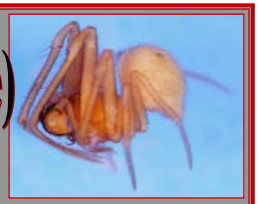
Phylogenetic Revision of Mysmenid Spiders and their Webs (Araneae, Araneoidea, Mysmenidae)



Lara Lopardo and Gustavo Hormiga Department of Biological Sciences, The George Washington University, 2023 G St. NW, Washington, D.C. 20052, USA.

INTRODUCTION

The family Mysmenidae is a conflictive and poorly studied family of tiny spiders created by Simon in 1922 and distributed worldwide, comprising a total of 91 described species in 22 genera (12 of them monotypic). The controversial diagnosis, as well as the monophyly of Mysmenidae is not very clear, and it is still under debate.

Mysmenids are the least studied family-level group among the orb-weaving spiders, mainly because of their small size and cryptic habits. It is also not very well represented at museum collections, and therefore not accessible to arachnologists.

NATURAL HISTORY

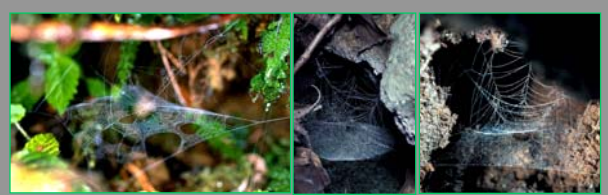
Very little is known about the biology and natural history of mysmenids. Mysmenids mainly occur in leaf litter and other cryptic places in very humid habitats.

Kleptoparasitism.
Eleven species in four mysmenid genera have been reported to be **kleptoparasites** on the webs of other spiders. Anapidae and Symphytognathidae, two families closely related to each other and to Mysmenidae, also have one known kleptoparasitic species each (Ramírez & Platnick, 1999; Platnick & Shadab, 1978). The best-studied cases of kleptoparasitism in Mysmenidae are some species in the Neotropical genus ***Mysmenopsis*** (Eberhard et al., 1993). As no cladistic analysis was performed in the family, it is not known whether mysmenid kleptoparasitism was originated once within the family, or independent origins caused convergent behavior in this tiny spiders.

Web Architecture.
Mysmenid **web architecture** is known for a few species of *Maymena*, *Mysmena*, and *Microdipoena guttata* (Eberhard, 1982, 1987; Coddington, 1986). Kleptoparasitic species are not known to build webs of their own and some have lost the ability to spin sticky silk characteristic of orbweaving spiders (Griswold et al., 1998).

Mysmena species build highly derived three-dimensional orb webs, with a proliferation of out-of-plane radii that result in a characteristic spherically shaped web (Forster 1959). Sticky spiral construction is very irregular, resulting in a layer of sticky silk spanning just the perimeter of the web. Radii near the center of the web are bare of sticky spiral attachments, so that if the outer sticky layer is perforated, the spherically symmetric radial lines are revealed.

The web of *Microdipoena guttata* is similar to that of *Mysmena* species.

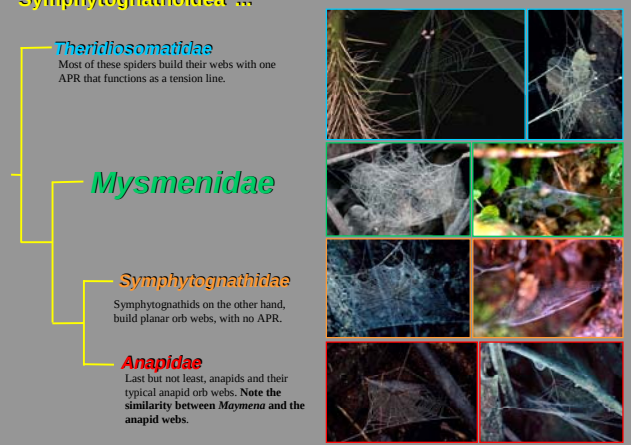


In contrast, *Maymena* webs are mainly planar with one to several out-of-plane radii that attach to substrate above the web. Anapids make similar webs, not only in structure but also in the behavior used to construct the webs (Coddington 1986, Eberhard 1987,Griswold *et al* .1998).

PHYLOGENETIC ANALYSES and TAXONOMIC POSITION of MYSMENIDAE

No modern phylogenetic research has ever been done in this araneoid group. The family level of mysmenidae was first recognized in 1977, and one year later an explicit and precise diagnosis was provided, although for New world species only. Also, the generic limits within Mysmenidae vary from tenuous to almost nonexistent. Phylogenetically mysmenids belong to the so-called Symphytognathoidea group, a clade within Araneoidea, tiny orbweaving spiders that build highly modified orb webs, usually tri-dimensional.

"Symphytognathoidea"...



Only two recent higher level cladistic analyses have included **mysmenid representatives**:

In an analysis of the orbweaving families **Griswold et al. (1998)** included two mysmenid genera (*Mysmena* and *Maymena*) and hypothesized three synapomorphies for the monophyly of the family. Because no comprehensive study of the family has ever been attempted it is not known whether all mysmenids exhibit these synapomorphies.

The second phylogenetic analysis was done by **Schütt (2003)**, who studied the composition of Symphytognathidae sensu Forster (1959), and included three mysmenids representatives (*Trogloneta*, *Microdipoena* and *Cepheia*). Schütt delimited Mysmenidae, and elevated Synaphrinae to family, assuming its monophyly based only in one genus (*Cepheia*) in the analysis. Independently, Marusik & Lehtinen elevated Synaphridae as a new family of spiders, based on morphological data and without any phylogenetic analysis.

GOALS

The goals of this project are
- to produce a robust and stable phylogenetic hypothesis to:
  - test the monophyly of Mysmenidae and
  - provide a good diagnosis for the family,
- test the monophyly of *Maymena*
- provide the comparative basis for the study of web architecture and kleptoparasitism.

First, we will reconstruct the higher level phylogenetic structure of mysmenids, using morphological, behavioral and molecular characters. This analysis will also test the position and monophyly of Schütt's and Marusik and Lehtinen "Synaphridae."

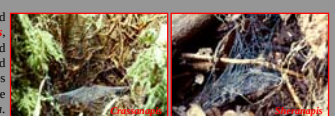
PRELIMINARY RESULTS

Interestingly, in the phylogeny of symphytognathoids, web architecture seems to be **homoplastic**, mainly between **Mysmenids and Anapids**, and between **Symphytognathids and Anapids**. Even though mysmenids, anapids and symphytognathids share some morphological features with members of their own families, their markedly similar webs among each other could suggest alternative associations with these other families.

In order to **explore this conflicting information** between morphological and behavioral characters we included, in Griswold et al. (1998), and Schütt (2003):

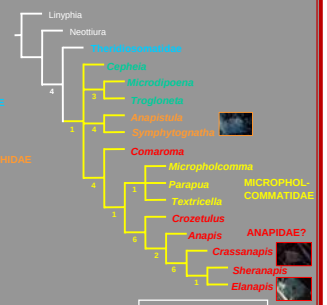
Elanapis, the only known anapid genus that builds webs similar to those of symphytognathids.

Crassanapis and *Sheranapis*, two other anapid genera that build typical anapid webs similar to the mysmenid *Maymena*.



1. Araneoidea
Griswold, Coddington, Hormiga & Scharff – 1998
31 taxa, 94 characters (91 inform.)

2. Symphytognathidae *s.l.*
(Anapidae + Micropholcommatidae + Mysmenidae + Symphytognathidae s.s.)
Schütt – 2003
14 taxa, 120 characters (80 inform.)



In Griswold *et al*. study, when including the three anapid genera, the analysis results in a **similar tree**, Anapidae is monophyletic, and the family relationships within symphytognathoidea are preserved. However, anapid generic relationships are not well defined. The basal position of *Elanapis* within Anapidae in some resolutions of the trees points out the **conflict in the optimization of web evolution**, and consequently in the homology of orb webs with out-of-plane radii and those planar bidimensionals.

In Schütt's study of Symphytognathidae *s.l*, adding the three anapid genera does not improve the tree, and the **webs of *Elanapis* and Symphytognathidae are convergent**.

DISCUSSION

In every analyzed datamatrix, *Elanapis* belongs to Anapidae, and the homology among the web architectures of *Elanapis* and symphytognathids, and of *Maymena* and the rest of anapids are **ambiguous**. Although *Elanapis* and *Maymena* share some morphological features with their families, the high similarity between *Elanapis* - Symphytognathidae and *Maymena* - Anapidae webs could suggest that their web building behaviors could also be similar, therefore supporting an association based on web architecture and building behaviors

Few characters related to orb webs were originally included in the two analized matrices, and this favors the support towards a morphology-based relationship rather than behavioral. This convergence of web architecture (and probably web building behaviors) questions the membership of some symphytognathoids within their families, as well as the phylogenetic content of orb webs structural details, at least in this big group of small spiders.

Last, the two datamatrices analyzed in this project contain sets of very different characters, as well as different spider representatives, and the three of them suggest different associations between the few families they have in common. Therefore, combining the matrices and performing a **simultaneous analysis** is the proper solution when proposing general conclusions, and it is **our next step** in this project.

FUTURE WORK

A robust phylogenetic hypothesis of mysmenid relationships will be necessary to understand the evolution of web architecture and kleptoparasitism within this family and its close relatives, and we are working towards it.

We will also make all the information we collect available to everyone, by

Interactive identification keys. (LucID) species-level keys for Maymena; and world genera of Mysmenidae.

On-line Digital Image Banks. Databases of taxonomic images of the world genera of Mysmenidae to assist with identification.

On-line database of images of web architecture.

Specimen databases. specimen label data will be collected/archived using Biota and made available on our website.

ACKNOWLEDGMENTS

We would like to thank the following people and institutions: Martín J. Ramírez, Norm Platnick, Cristina Scioscia, Cristian Grismado, The George Washington University, National Museum of Natural History, American Museum of Natural History, and Museo Argentino de Ciencias Naturales. We thank Martín J. Ramírez, Jonathan Coddington and Fernando Alvarez-Padilla for additional photographs of orbicularian webs.

REFERENCES

Coddington, J. A. 1986. The monophyletic origin of the orb web. *In* W. Shear (editor), Spiders: Webs, Behavior and Evolution: 319–363. Stanford: Stanford University Press.
Eberhard, W.G. 1982. Behavioural characters for the higher classification of orb-weaving spiders. Evolution 36: 1067-1095.
Eberhard, W. G. 1987. Web-building behavior of anapid, symphytognathid, and mysmenid spiders. Journal of Arachnology 14: 339–358.
Eberhard, W. G., N. I. Platnick & R. T. Schuh. 1993. Natural history and systematics of arthropod symbionts (Araneae; Hemiptera; Diptera) inhabiting webs of the spider Tengella radiata (Araneae, Tengellidae). Amer. Mus. Novit. 3065: 1-17.
Forster, R. R. 1959. The spiders of the family Symphytognathidae. Trans. R. Soc. N.Z. 86: 269-329.
Griswold, C. E., J. A. Coddington, G. Hormiga and N. Scharff, 1998. Phylogeny of the orb-web building spiders (Araneae, Orbiculariae: Deinopoidea, Araneoidea). Zoological Journal of the Linnean Society 123: 1–99.
Platnick, N. I. & M. U. Shadab. 1978. A review of the spider genus Mysmenopsis (Araneae, Mysmenidae). Am. Mus. Novit. 2661: 1-22.
Ramírez, M. J., and N. I. Platnick. 1999. On *Sofanopis antillanca* (Arane-ae, Anapidae) as a kleptoparasite of austro-chiline spiders (Araneae, Austrochilidae). Journal of Arachnology 27: 547–549.
Schütt, K. 2003. Phylogeny of Symphytognathidae s.l. (Araneae, Araneoidea). Zool. Scripta 32: 129-151. 129-151.