Gall Things Considered: Taxonomy of Gall Wasp Parasitoids in Genus *Ormyrus*

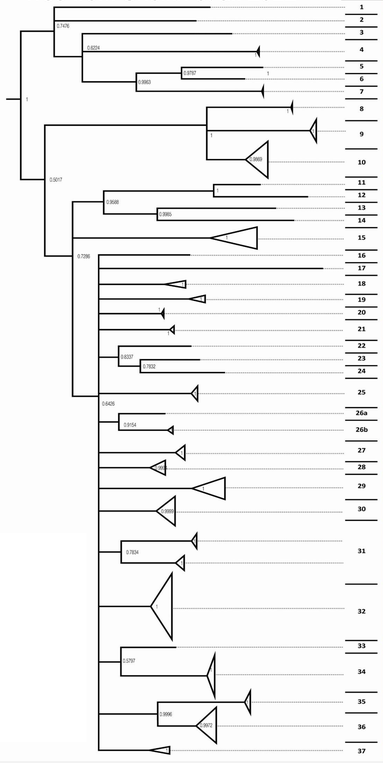
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Introduction

- Robust species hypotheses are essential to understanding the ecology and evolution of highly diverse taxa like parasitic wasps[1]
- *Ormyrus* (Chalcidoidea: Ormyridae), a species-rich genus of gall parasitoids, was recently revealed to contain many cryptic species based on DNA barcoding[2,3] (Fig. 1)
- *Ormyrus* species delimitation is necessary to untangle their diverse host associations[2]
- Some cryptic *Ormyrus* species have been delimited using an integrative taxonomic approach combining morphological, molecular, and ecological data[4]; more species await delimitation

Tree from Sheikh et al. 2022



Clade number	ASAP	bPTP	Morphological ID (Hanson key)	Gall host(s)	Gall description	Tree section
1			*Ormyrus nr turio*	*Callirhytis flavipes*	elongated midrib swelling	*Quercus*
2			*Ormyrus thymus*	*Basisettia pallida*	stem swelling	*Virentes*
3				*Disholcaspis pedunculoides*	pointed growth	*Quercus*
4			*Ormyrus venustus*	*Acraspis erinacei* *Amphibolips quercusostensackenii*	spiny ellipsoid, oak apple w/ radiating fibers	*Quercus* *Lobatae*
5				*Andricus quercuspetiolicola*	firm integral swelling	*Quercus*
6			Unidentified	*Atrusca sp.*	radiating fibers gall	*Quercus*
7			*Ormyrus nr venustus*	*Xanthoteras eburneum*	smooth midrib cluster	*Quercus*
8			*Ormyrus reticulatus*	*Disholcaspis quercusglobulus* *Andricus quercuspetiolicola*	woody bullet gall firm integral swelling	*Quercus*
9			*Ormyrus labotus*	*Andricus quercuspetiolicola* *Acraspis villosa* *Andricus quercusstrobilanus*	hairy ellipsoid, terminal cluster of angular galls	*Quercus*
10			Unknown sp. 1	*Andricus quercusfoliatus* *Callirhytis quercusclavigera*	elongated bud scale with bracts, stem swelling	*Virentes* *Lobatae*
11			*Ormyrus distinctus*	*Antron douglasii*	glaucous with thorns	*Quercus*
12				*Andricus bakkeri*	cup-like with pinched top	*Quercus*
13				*Disholcaspis simulata*	bullet gall, loose larval cell	*Quercus*
14			Unidentified	*Disholcaspis quercusvirens*	honeydew secreting cluster	*Virentes*
15			*Ormyrus dryorhizaxeni*	*Andricus quercusfoliatus* *Belonocnema treatae*	round & elongated bud scale w/ bracts, woody sphere	*Virentes*
16			Unidentified	*Neuroterus saltatrius*	saucer-shaped	*Quercus*
17			*Ormyrus nr distinctus*	*nr Andricus costatus*	ribbed gall in acorn cap	*Quercus*
18			*Ormyrus labotus*	*Andricus pattoni* *Bassettia pallida*	woolly midrib gall, stem swelling	*Quercus* *Virentes*
19				*Andricus dimorphus*	midrib cluster	*Quercus*
20				*Callirhytis pigra*	midrib swelling	*Lobatae*
21			Unknown sp. 2	unknown leaf gall *Dryocosmus sp.*	disc-like, blister-like gall	*Lobatae*
22			*Ormyrus labotus*	*Callirhytis pigra*	midrib swelling	*Lobatae*
23			Unidentified	*Andricus robustus*	midrib cluster	*Quercus*
24				raised vein gall	raised vein on leaf top	*Lobatae*
25				*Phylloteras poculum* *Phylloteras volutellae* *Andricus chinquapin*	glaucous spangle galls, extended vein	*Quercus*
26a				*Andricus quercuspetiolicola*	firm integral swelling	*Quercus*
26b				*Unknown* *Dryocosmus floridensis*	growths on stem, rosette of bracts	*Lobatae*
27				*Andricus quercuslanigera* *Disholcaspis quercusvirens*	woolly midrib cluster, honeydew secreting cluster	*Virentes*
28				*Belonocnema kinseyi*	woody spherical gall	*Virentes*
29				*Belonocnema treatae* *Belonocnema fossaria* *Andricus quercusfoliatus*	woody sphere, elongated bud scale w/ bracts	*Virentes*
30				*Callirhytis seminator* *Andricus quercuspetiolicola*	fuzzy globular gall, firm integral swelling	*Quercus*
31			*Ormyrus labotus*	*Dryocosmus cinereae* *Dryocosmus quercuspalustris* *Amphibolips quercusostensackenii*	integral and globular with free rolling cell, oak apple w/ radiating fibers	*Lobatae*
32				*Dryocosmus quercusnotha* *Amphibolips quercusostensackenii* *Dryocosmus cinereae*	integral with free rolling cell, oak apple w/ radiating fibers	*Lobatae*
33				*Callirhytis quercusgemmaria* *Andricus quercusfrondosus* *Andricus nigricens* *Callirhytis quercusaperator* *Melikaiella ostensackeni* *Callirhytis quercusclavigera*	small ribbed in clusters, small sphere with bracts, midrib cluster, woolly fuzz, parenchyma thickening, woody stem swelling	*Quercus* *Lobatae*
34				*Callirhytis quercuscornigera*	woody horned gall	*Lobatae*
35				*Philonix nigra* *Callirhytis quercusfutilis* *Acraspis erinacei* *Andricus quercusflocci*	globular with felt, blister w/ radiating fibers, spiny ellipsoid, woolly midrib cluster	*Quercus*
36				*Acraspis pezomachoides* *Acraspis erinacei*	textured or hairy ellipsoids	*Quercus*
37				*Acraspis villosa* *Acraspis prinoides* *Acraspis macrocarpae*	hairy or textured ellipsoids	*Quercus*
			Ormyrus rosae	*Diplolepis* (genus of gall inducers on roses and blueberries)		

Fig 1. Phylogenetic tree based on *Ormyrus* DNA barcodes[3]

Objective

Elucidate cryptic *Ormyrus* species within an integrative taxonomic framework

Methods

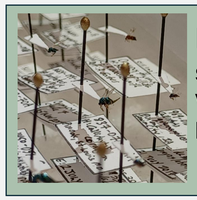


Fig 2. Prepare specimens
Vouchers from DNA barcoding studies

Collect morphological data (Fig 3.)
Light and scanning electron microscopy

Fig 4. Construct character matrix
Using TaxonWorks

	Code	Row objects	Head coloration	Antennal scape coloration	Mesosoma coloration	Metacoxa coloration	Metafemur coloration	Gaster coloration	Antennal flagellum	Antenna with	Fn1
29		Ormyrus battlecat	3	0	3	3	2	3	0	0	1
30		Ormyrus biollantus	0	2	0	7	1	7	0	0	2
31		Ormyrus eventhorizonae	2	3	2	2	2	2	0	0	2
32		Ormyrus ghidorai	2	3	2	2	5	9	0	0	2
33		Ormyrus godzillus	1	1	1	1	1	8	0	0	2
34		Ormyrus grogus	3	4	3	3	7	4	0	0	1
35		Ormyrus hades	1	1	1	1	3	8	0	0	0
36		Ormyrus hulkus	0	2	0	0	0	4	0	0	0
37		Ormyrus kenobii	1	1	1	1	1	11	0	0	2
38		Ormyrus kermitus	0	2	0	0	0	0	1	0	1
39		Ormyrus kolossus	1	1	1	1	1	1	0	0	1
40		Ormyrus kyogrus	0	4	1	1	1	18	0	0	1
41		Ormyrus loraxus	1	0	5	4	3	6	0	0	1
42		Ormyrus manhattani	1	5	1	1	1	10	0	0	2
43		Ormyrus midasi	3	6	3	3	0	4	0	0	1
44		Ormyrus planktoni	1	1	1	1	1	1	0	0	1
45		Ormyrus rayquazus	1	1	1	1	1	1	0	0	2
46		Ormyrus sarlaccus	0	2	0	0	0	0	0	0	0

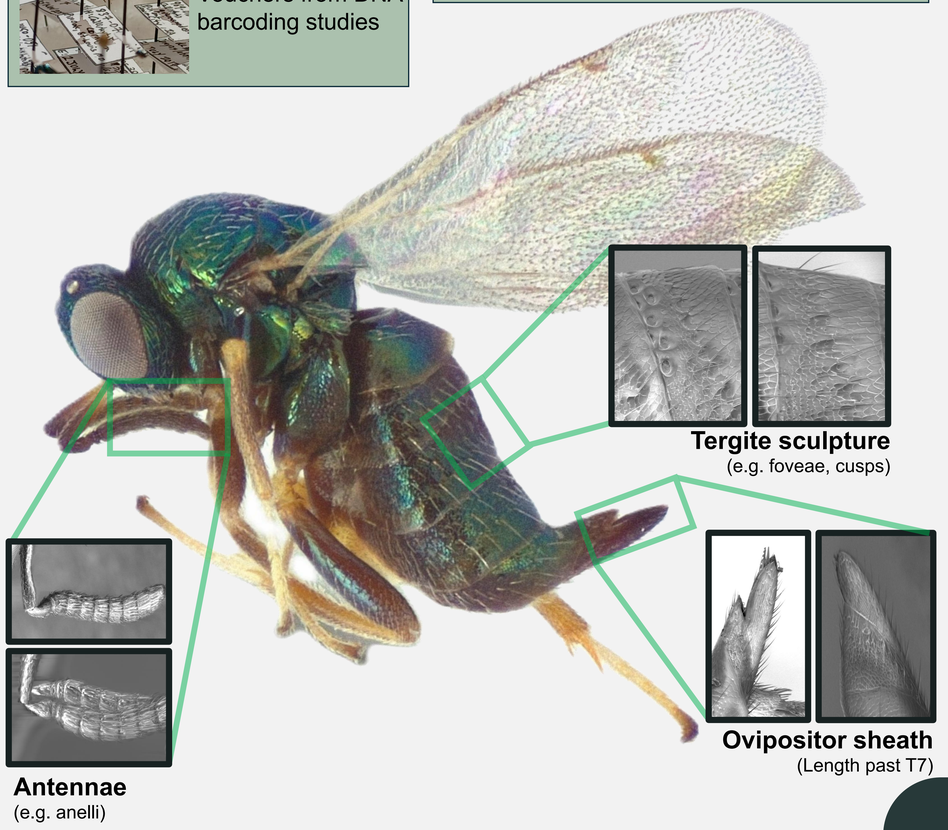


Fig 3. Example *Ormyrus* sp. and SEM images of delimiting characters

Results

- Integrative taxonomic work confirms species hypotheses from Sheikh et al. 2022 [3]
- Over 40 putative species identified
- Over 40 morphological characters delimiting species

Future Directions

- TaxonWorks character matrix will be used for future species descriptions, identification keys, and taxonomic revision
- Additional specimens, including museum material, are being incorporated into continuing taxonomic work

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References

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