

## SHORT COMMUNICATION

## Leaf masquerade in an orb web spider

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**Abstract.** Leaf masquerade—an animal resembling leaves that are inedible for predators or innocuous for prey—is well known in insects but less so in arachnids. We report a case of a striking morphological and behavioral adaptation that can be labeled as leaf masquerade in an undescribed spider species (*Poltys* C.L. Koch, 1843, Araneidae) from southwest China. The female abdomen has anatomical analogues of a leaf pedicel and venation, and its color is both green and brown, thus resembling both live and dry leaves. The spider camouflages itself with pulled dead leaves among live ones. This novel natural history in a spider adds an arachnid model to the growing literature on animal masquerade.

**Keywords:** Passive defenses, anachoresis, crypsis, *Poltys*, Araneidae

Masquerade, the resemblance to uninteresting objects, is a fascinating product of natural selection that deceives predators or helps gain access to prey (Skelhorn et al. 2010). Better known in insects, plants, birds, and fish (Nel et al. 2008), masquerade in arachnids involves only a handful of spider genera with phenotypes that resemble flowers, dead twigs, plant detritus, buds, bark, or bird droppings (Foelix 2011; Liu et al. 2014; Pekar 2014). However, genuine leaf masquerade has not been known in arachnids. Here, we provide anecdotal evidence for such masquerade in a spider from southwest China and Southeast Asia belonging to a taxonomically and biologically unstudied species group within the genus *Poltys* C. L. Koch, 1843 (Araneidae). We show that females easily blend into live and dead leaf surroundings through color, morphological, and behavioral adaptation. The former involve shades of green and brown on the same animal, and, morphologically, the abdomen resembles a pedicel and leaf venation. Behavioral adaptation most likely involves the spider pulling and anchoring dead leaves amongst live ones, for the ultimate visual deception (Fig. 1).

We observed a *Poltys* species in Xishuangbanna, Yunnan, China, in January 2011. A female, deposited at National Museum of Natural History, Smithsonian Institution, Washington DC, USA (NMNH; accession number 2076621), was found in a rainforest near Mengla (21.54069444°N, 101.4907778°E, at 962 m) with no web, but rather with hung dead leaves on a twig, and her abdomen resembled a dead leaf ventrally and a live green leaf dorsally with an apical, pedicel-like abdominal projection (Fig. 1). During two weeks of searching only a single additional (juvenile) was found in its orb web in Baka forest (21.713675°N, 100.783023°E, at 695 m) (Fig. 2), and only one additional sample from Vietnam was discovered in museums (a female RMNH.ARA.12114, made available by J. Miller). This suggests that this form of *Poltys* is rare in tropical rain forests of southwest China and Southeast Asia.

*Poltys* research contains no reference to leaf masquerade, however, old descriptions depict this very shape of abdomen (Günther 1862; Ausserer 1871; Simon 1895; Hogg 1919; Grassé 1949). These shaped females are only known in three species, *P. mouhoti* (Günther, 1862) from Vietnam, *P. idae* (Ausserer, 1871) from Borneo, and *P. longitergus* Hogg, 1919 from Sumatra. To facilitate future identification of our samples, we provide their DNA barcodes (Appendix 1); the barcode from the Vietnam sample is

available on BOLD (as an unidentified araneid: SVN03312). The two DNA barcodes from Yunnan are nearly identical (K2P distance between these sequences is only 0.2%), so these samples are clearly conspecific (Čandek & Kuntner 2014). However, K2P distances ranged 5.7–5.9% between the samples from Yunnan and Vietnam, falling into the lower range of interspecific mean distances reported for araneids ( $8.8 \pm 4.2\%$ ; Čandek & Kuntner 2014). If the Vietnam population is about 6% different from the Yunnan one, then we find it likely that other Southeast Asian populations (see below) are also genetically distinct. We find it likely that the Vietnam sample belongs to *P. mouhoti* and that our samples from Yunnan belong to an undescribed species. More material and taxonomic studies are needed to confirm this.

In spite of the rarity of leaf masquerading *Poltys* spp., these spiders, judging from online photo repositories, can be found all over Southeast and East Asia (Taiwan; Vietnam; Malaysia; Borneo; Hong Kong), but have so far not been recorded in mainland China. While Chinese *Poltys* records exist from Hainan, species that occur there (*P. ellipticus* Han, Zhang & Zhu, 2010, *P. hainanensis* Han, Zhang & Zhu, 2010, and *P. pygmaeus* Han, Zhang & Zhu, 2010) do not mimic leaves (Han et al. 2010; World Spider Catalog 2016). We have examined other *Poltys* species from Yunnan (Gregorič et al. 2015a; unpublished data), but again, these are not leaf mimics.

Our juvenile was found at night in its aerial orb web with a tight mesh architecture, as is typical of *Poltys* (Fig. 2; compare with fig. 3 in Blackledge et al. 2011). The female, on the other hand, was found in early evening hiding among leaves on a tree and without a functional web. These spiders probably hide in camouflage during the day and only build webs at night, as is typical in *Caerostris* Thorell, 1868 and other *Poltys* (Smith 2006; Kuntner & Agnarsson 2010; Gregorič et al. 2015b). The observed female must have actively lifted dead leaves from the forest floor to attach them to a twig about 2.5 meters high up on a tree prior to positioning herself on a thread of silk amidst live and dead leaves (Fig. 1A–D). Lifting dead leaves is not uncommon in araneoid spiders; several species decorate their webs with lifted and folded leaves that function as retreats (Kuntner et al. 2008; Gregorič et al. 2015a). However, the speculated attaching of leaves to vegetation to match the spider body form is a novel behavior in orb web spiders. Such a manipulated scene blends the motionless spider perfectly with its surroundings to protect it from visual predators and/or gain access to prey by being mistaken for innocuous objects.

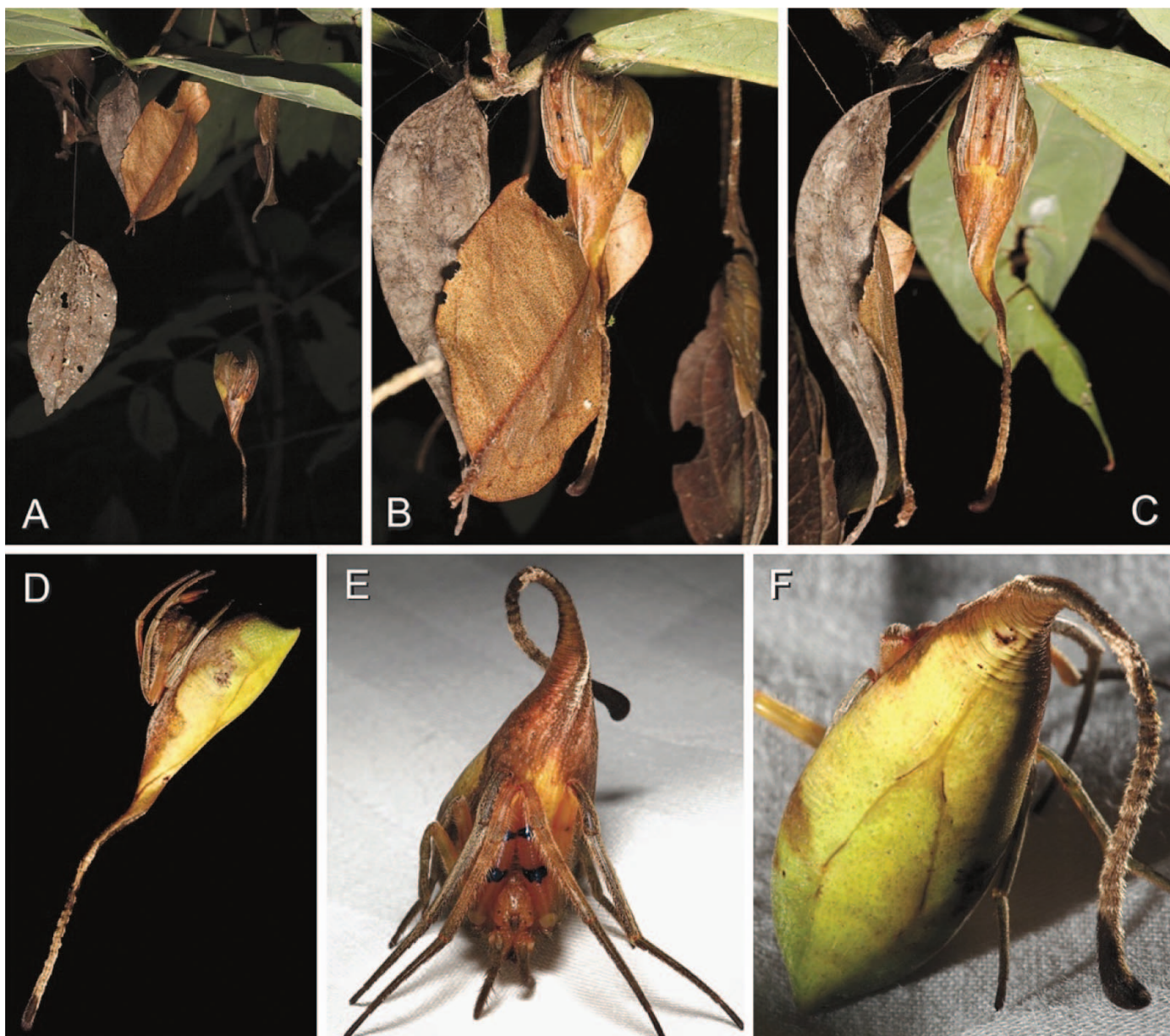


Figure 1.—The ultimate leaf masquerade in an orb web spider, an undescribed species of *Polys* (Araneidae) from Yunnan. A–C, A female had hung dead leaves from a twig that also included live leaves to masquerade itself from visual predators (A). Upon slight disturbance, she withdrew higher onto the twig (B, C) where it remained motionless; D, lateral view of female pose in nature, note her abdomen resembling a dead leaf ventrally and a live, green leaf dorsally, both parts extending into a long and straight, apical abdominal hairy pedicel; E, female placed on a flat surface, showing her flexible abdominal pedicel, now curved; F, same, dorsal close up, note “leaf venation” and long hairy pedicel.

Distinguishing true masquerade (avoiding predation by being misidentified) from various types of crypsis (blending in with background not to be detected at all) is difficult with many cases falling in between well-defined extremes (Cuthill et al. 2005; Ruxton et al. 2005; Stevens & Merilaita 2009). Some grasshoppers and katydids (Orthoptera), stick and leaf insects (Phasmatodea), praying mantises (Mantodea), and moths and butterflies (Lepidoptera) are textbook examples of plant masquerade (Wedmann 2010). However, reviews on the topics of spider disguise and deceptive coloration do not account for leaf masquerade on a par with our reported example (Thery & Casas 2009; Foelix 2011; Nelson & Jackson 2011), and only anecdotal evidence exists for *Romphaea* L. Koch, 1872 and

*Arachnura* Vinson 1863 to resemble dead leaves (Marson 1945; Whitehouse 1987).

True masquerade is rare in spiders being described in only about 100 of the 45,945 known species of spiders (Pekar 2014; World Spider Catalog 2016). In spiders, masquerade is mostly confined to the family Araneidae, with spider resemblance to twigs, debris, fruits, or bird droppings (Liu et al. 2014; Pekar 2014), and as we report here, leaves. Thomisid genera resemble flowers and plant detritus, *Deinopis* MacLeay 1839 (Deinopidae), *Tetragnatha* Latreille 1804 (Tetragnathidae) and *Miagrammopes* O. Pickard-Cambridge 1870 (Uloboridae) resemble dead twigs, *Portia* Karsch, 1878 (Salticidae), *Cyclosa* Menge, 1866 (Araneidae) and *Neospintharus* Exline, 1950 (Theridi-



Figure 2.—Juvenile *Poltys*, conspecific with female in Fig. 1, on a vertical orb web (web width 10.5 cm, height 12 cm, distance from top spiral to hub 6 cm). This typical *Poltys* web contained primary (and no secondary) radii and a dense mesh of sticky spiral.

idae) mimic plant detritus, whereas *Caerostris* and some other *Poltys* (Araneidae) mimic plant buds or bark (Grasshoff 1984; Smith 2006; Gregorič et al. 2015b). Among orb web spiders, masquerade typically occurs in nocturnal species and at intermediate phylogenetic levels within families (Pekar 2014).

Our discovery adds an arachnid model, *Poltys*, to the growing literature on animal passive defenses. We hope it will facilitate new research into masquerade and deceptive mimicry in arachnids, where leaf masquerade has not been known. One serious hindrance to this, however, is the apparent rarity of this enigmatic *Poltys*, confined to rainforests of southwest China, Southeast Asia, and East Asia where its cryptic habits and nocturnal lifestyle help evade not only predators, but also researchers.

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#### APPENDIX 1

DNA barcodes of the studied specimens.

*Polys* sp. female from Yunnan, China (Genbank accession code KX231812):

GACATTATATTTAATGTTTGGGGCATGGGCTTCTATAGTA  
GGGACAGCAATAAGAGTTTTAATTCGAATTGAATTAGGT  
CAACCTGGGAGATTTATTGGGGATGATCAGTTATATAAT  
GTTATTGTAACGGCACATGCTTTTGTTATAATTTTTTTAT  
AGTGATACCTATTTTAATTGGGGGGTTTGAAATTGGTT  
AGTTCCATTAATGTTAGGAGCTCCGGATATAGCTTTTCT  
CGAATAAATAATTTAAGATTTTGTTGCTTCTCCATCTTT  
ATTTCTTTTATTAATTTCTTCTATAGTAGAAGTAGGAGTG  
GGAGCAGGGTGGACAGTTTATCCTCCTTTAGCAAGATTA  
GAGGGGCATGCTGGAAGATCTATAGATTTTGCAATTTTT  
CTCTTCATTTAGCAGGGCTTCATCAATTATAGGGGCAAT  
TAATTTTATTTCAACTATTATTAATATACGATTTTATGGGA

TATCTATGGAGAAAGTTTCATTGTTTGTGTTGATCAGTTTT  
AATTACTGCTGTATTATTATTATTATCTTTACCTGTATTGG  
CAGGAGCTATTACCATATTATTAACAGATCGAAATTTTAA  
TACTTCATTTTTTGATCCTTCAGGGGGAGGGGATCCAATT  
TTATTTCAA

*Polys* sp. juvenile from Yunnan, China (Genbank accession code KX231813):

GACATTATATTTAATGTTTGGGGCATGGGCTTCTATAGTA  
GGGACAGCAATAAGAGTTTTAATTCGAATTGAATTAGGT  
CAACCTGGGAGATTTATTGGGGATGATCAGTTATATAAT  
GTTATTGTAACGGCACATGCTTTTGTTATAATTTTTTTAT  
AGTGATACCTATTTTAATTGGGGGGTTTGAAATTGGTT  
AGTTCCATTAATGTTAGGAGCTCCGGATATAGCTTTTCT  
CGAATAAATAATTTAAGATTTTGTTGCTTCTCCATCTTT  
ATTTCTTTTATTAATTTCTTCTATAGTAGAAGTAGGAGTG  
GGAGCAGGGTGGACAGTTTATCCTCCTTTAGCAAGATTA  
GAGGGGCATGCTGGAAGATCTATAGATTTTGCAATTTTT  
TCTCTTCATTTAGCAGGGCTTCATCAATTATAGGGGCAA  
TTAATTTTATTTCAACTATTATTAATATACGATTTTATGGG  
ATATCTATGGAGAAAGTTTCATTGTTTGTGTTGATCAGTTT  
TAATTAAGTCTGTATTATTATTATTATCTTTACCTGTATTG  
GCA

—————TTCTTTTTTTGATCCTTCAGGGGGAG  
GGGATCCAATTTTATTTCAA