



Parasites on the spot: the rediscovery of a presumably extinct Apodanthaceae in São Paulo state, Brazil

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Abstract: Apodanthaceae are achlorophyllous herbs holoparasitic on the stems and roots of species of Fabaceae or Salicaceae (*Casearia* and *Xylosma*). The family consists of two genera, *Apodanthes* Poit. and *Pilostyles* Guill. Although one species of each genus occurs in several states of Brazil, we report a new record of *Pilostyles blanchetti* (Gardner) R.Br. in the state of São Paulo, the first in 50 years. Comments on the distribution of species, hypothetical pollinators, and color images are presented.

Key words: Atlantic Rainforest; Fabaceae; Holoparasite; Salicaceae

Apodanthaceae is composed of achlorophyllous herbaceous holoparasites on the stems and roots of members of Fabaceae and Salicaceae (*Casearia* and *Xylosma*). BELLOT & RENNER (2014) recognized two genera within Apodanthaceae: *Apodanthes* Poit. and *Pilostyles* Guill. The ten species of the family (nine of them in *Pilostyles*) are distributed throughout the Americas, Africa, Asia and Australia. The species currently circumscribed in Apodanthaceae have traditionally been included as a tribe (Apodanthae) in Rafflesiaceae (besides Rafflesiaceae, Cytineae, and Mitrastemonaceae); however, recent analyses suggest the recognition of four different families, each one corresponding to the tribes cited above (Rafflesiaceae *sensu stricto*, Cytinaceae, Mitrastemonaceae, and Apodanthaceae; APG IV 2016), none of them closely related to each other. As a consequence, holoparasitism should be interpreted as convergent in these families. Apodanthaceae is now positioned within the Cucurbitales (NICKRENT et al. 2004; FILIPOWICZ & RENNER 2010; APG IV 2016). Only two species occur in Brazil, *Apodanthes caseariae* Poit., and *Pilostyles blanchetti* (Gardner) R.Br. (Groppo 2016).

Apodanthaceae includes plants with unique characteristics, including a vegetative body reduced to a haustorial system, whose parenchymatic and tracheary elements invade the host stem (GROPPO et al. 2007). The main plant body remains hidden within the host tissue,

except when flowering. This feature makes it difficult to find the species in the field, and therefore Apodanthaceae is likely underrepresented in herbaria.

While collecting plants in the municipality of Buri (São Paulo, Brazil), we found a species of Apodanthaceae parasitizing trees of *Bauhinia forficata* Link (Fabaceae). Host branches were covered with emerging flowers from the parasite, which was identified as *Pilostyles blanchetii*. Images of the species, as well as comments on taxonomy, biology and geographic distribution are presented.

Specimens were collected from of *Bauhinia* trees growing on a forest border located on private property owned by the family of the first author in the municipality of Buri, in the southwestern region of the state of São Paulo (23°45'36.8" S, 048°38'55.3" W and 674 m above sea level; Figure 1). Collections were deposited at ESA (Herbarium, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, Brazil).

Material examined: Brazil, São Paulo, Buri: Gissi, D.S. 02 (ESA114052); Gissi, D.S. 49 (ESA126572).

The plants were identified using the keys and descriptions of VATTIMO (1971), and BELLOT & RENNER (2014). *Pilostyles* differs from *Apodanthes* for parasitizing Fabaceae and for its pistillate flowers less than 5 mm long, while *Apodanthes* parasites Salicaceae, with the inner whorl of petals easily deciduous and pistillate flowers more than 5 mm long. VATTIMO (1971) referred 15 species of *Pilostyles* in Brazil, distinguished by the host and small details of the flowers; however, BELLOT & RENNER (2014) recognized a single species of the genus in this country, *P. blanchetii*. This species can be distinguished from other Neotropical *Pilostyles* by presenting anthers in two whorls, tepals purple to brown sometimes with clearer margins and the middle ones mostly diamond-shaped (BELLOT & RENNER 2014). The host species was identified as *Bauhinia forficata* Link ssp. *pruinosa* (Vogel) Fortunato & Wunderlin (Fabaceae) using the keys and descriptions of VAZ & TOZZI (2005).

The site where the specimen was collected is located in the municipality of Buri, southwestern São Paulo state

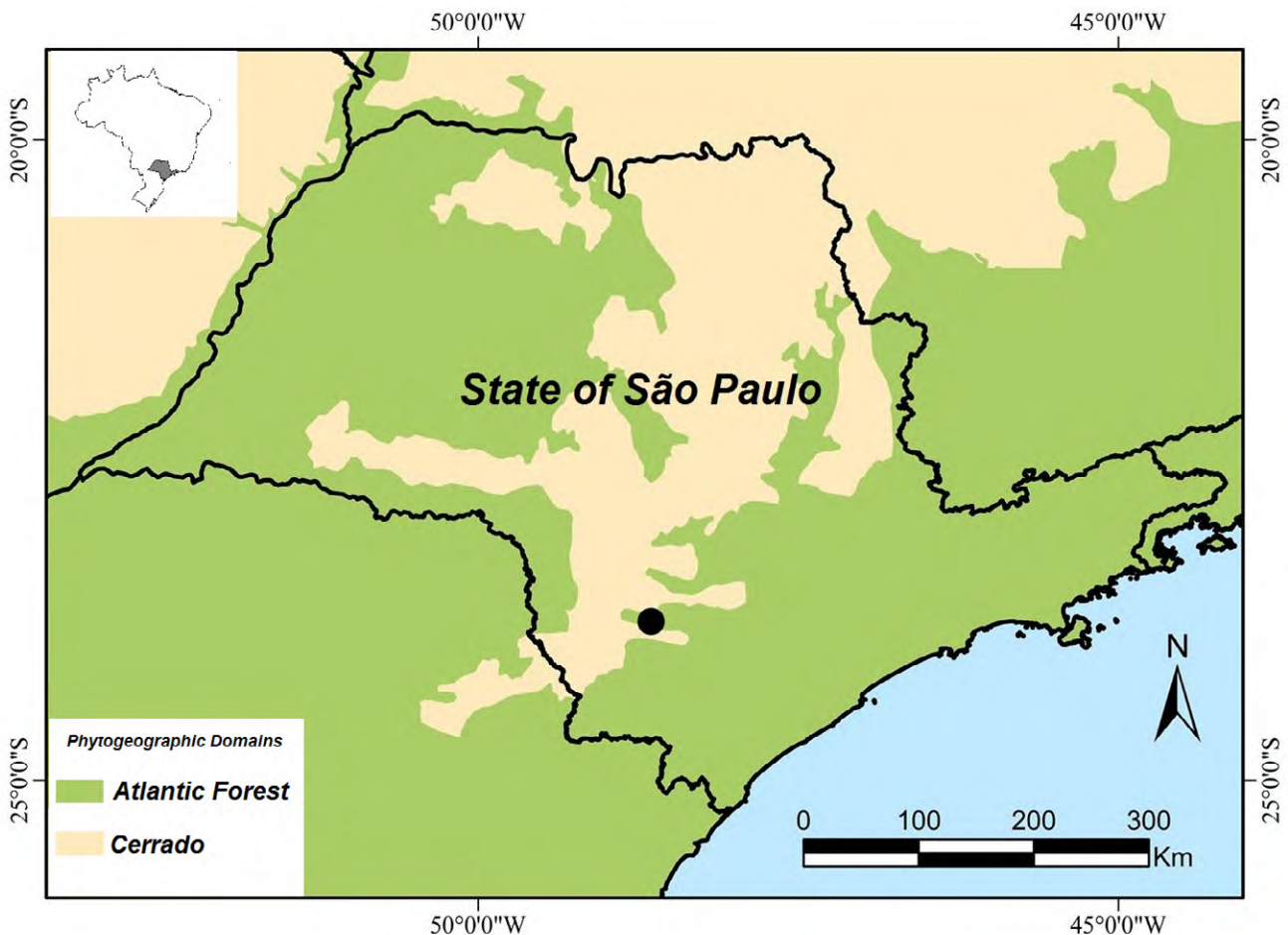


Figure 1. Geographic distribution of *Pilostyles blanchetti* in the state of São Paulo, Brazil.

and within in the transition of Cerrado and Atlantic Forest phylogeographical domains, both Brazilian hotspots (MYERS et al. 2000). The property is a farm with intense agricultural land use with some small forest remnants along streams. Nearby in other forest fragments in the same property, additional individuals of infected *B. forficata* were found on saplings to fully grown trees. Personal field observations indicate that the parasites bloom every year during the summer (December to February).

Gissi 02 was collected in 20 February 2011 and bears only fruits or late pistillate flowers. A new record was made in 1 January 2014 (Gissi 49), with staminate flowers (Figure 2). *Pilostyles blanchetii* occurs in several Brazilian states (Groppo 2016), including Minas Gerais and Paraná, both bordering São Paulo. It occurs in other countries in south America, including Colombia, Venezuela, Guyana, Argentina and Uruguay, as well as in Central America and the Caribbean, including Jamaica, the Cayman Islands, Costa Rica, and Panama (BELLOT & RENNER 2014).

Until the discovery of this population in Buri, the only known record of Apodanthaceae in São Paulo dates from 1961 (Araraquara, 28 January 1961, M. Kuhlman *s.n.*, IPA 12303), and since then, there are no literature or herbarium records of the family in the state. The species could be considered presumably extirpated in the state of São Paulo according to the criteria used for the list of endangered

species in the state (SOUZA et al. 2007), because it has not been collected or observed in the wild for over 50 years. Therefore, this new record sheds light to the conservation of this species, which now can be considered Endangered (EN) in the state due to a restricted distribution not within the limits of a conservation area; it should be included in the official list of endangered species (SMA 2016). This record also shows the importance of search effort, even in areas that are thought to be satisfactorily collected, or even over-collected, such as this state.

The absence of regular collections of *Pilostyles* (or any other species of Apodanthaceae) from São Paulo can be a result of an insufficient sampling, given the invisibility of these parasites when not in flower. It is possible that *P. blanchetii* is more common in São Paulo than what herbarium records suggest. On the other hand, collections of *P. blanchetti* are scarce from localities from southernmost latitudes, with some exceptions from Paraná and Santa Catarina states. Perhaps a latitudinal gradient (colder climates in the south) plays a role in the distribution of the species.

Our field observations revealed the flowering phenology of *Pilostyles* follows the seasonal cycle of host plant senescence and growth. *Bauhinia forficata* loses its leaves during the dry season and starts producing new branches when the rainy season comes (around December); at that



Figure 2. Staminate flowers of *Pilostyles blanchetti* on the stems of the host *Bauhinia forficata*. Photo by Danilo Soares Gissi.



Figure 3. Beetles visiting the flowers of *Pilostyles*, perhaps nourishing of the nectar produced on the nectaries. Photo by Danilo Soares Gissi.

point, the parasite's flowers emerge. We observed ants and beetles visiting the flowers (Figure 3). BELLOT & RENNER (2013) stated the small sessile flowers offer nectar in minute quantities from a shallow nectary cushion at their bases. This nectar may be collected by the ants and beetles, which may be the effective pollinators. However, further studies are necessary to test this hypothesis.

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LITERATURE CITED

- APG IV. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 1–20 doi: [10.1111/boj.12385](https://doi.org/10.1111/boj.12385)
- BELLOT, S. & S.S. RENNER. 2013. Pollination and mating systems of Apodanthaceae and the distribution of reproductive traits in parasitic angiosperms. *American Journal of Botany* 100: 1083–1094. doi: [10.3732/ajb.1200627](https://doi.org/10.3732/ajb.1200627)
- BELLOT, S. & S.S. RENNER. 2014. The systematic of the worldwide endoparasite family Apodanthaceae (Cucurbitales), with a key, a map, and color photos of most species. *Phytokeys* 36: 41–57. doi: [10.3897/phytokeys.36.7385](https://doi.org/10.3897/phytokeys.36.7385)
- FILIPOWICZ, N. & S.S. RENNER. 2010. The worldwide holoparasitic Apodanthaceae confidently placed in the Cucurbitales by nuclear and mitochondrial gene trees. *BMC Evolutionary Biology* 10: 219. doi: [10.1186/1471-2148-10-219](https://doi.org/10.1186/1471-2148-10-219)
- GROPPA, M., M.M. AMARAL & G.T. CECCANTINI. 2007. Flora da Serra do Cipó, Minas Gerais: Apodanthaceae. *Boletim de Botânica da Universidade de São Paulo* 25: 87–92. doi: [10.11606/issn.2316-9052.v25i1p87-94](https://doi.org/10.11606/issn.2316-9052.v25i1p87-94)
- GROPPA, M. 2016. Apodanthaceae in Flora do Brasil 2020 em construção. Jardim Botânico do Rio de Janeiro. Accessed at <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB49>, 18 January 2016.
- MYERS, N., R.A. MITTERMEIER, C.G. MITTERMEIER, G.A. FONSECA & J. KENT. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858. doi: [10.1038/35002501](https://doi.org/10.1038/35002501)
- NICKRENT, D.L., A. BLARER, Y.-L. QIU, R. VIDAL-RUSSELL & F.E. ANDERSON. 2004. Phylogenetic inference in Rafflesiales: The influence of rate heterogeneity and horizontal gene transfer. *BMC Evolutionary Biology* 4: 40. doi: [10.1186/1471-2148-4-40](https://doi.org/10.1186/1471-2148-4-40)
- SMA (SECRETARIA DO ESTADO DO MEIO AMBIENTE DE SÃO PAULO). 2016. Lista oficial das espécies da flora do Estado de São Paulo ameaçadas de extinção. Resolução nº 57, de 5 de Junho de 2016. Accessed at http://www.ambiente.sp.gov.br/wp-content/uploads/2016/06/pg_0073.pdf, 12 November 2016.
- SOUZA, V. C., M.C.H. MAMEDE, I. CORDEIRO, J. PRADO, F. BARROS, M.G.L.W. WANDERLEY, P.Y. KAGEYAMA, G. CECCANTINI & J.G. RANDO. 2007. Critérios utilizados na elaboração da Lista de Espécies da Flora Ameaçadas de Extinção no estado de São Paulo; pp. 15–20, in: M.C.H. Mamede, V.C. Souza, J. Prado, F. Barros, M.G.L. Wanderley and J.G. Rando (org.). Livro Vermelho das espécies vegetais ameaçadas do estado de São Paulo. Vol. 1. 1 ed. São Paulo: Instituto de Botânica.
- VAZ, A.M.S.F. & A.M.G.A. TOZZI. 2005. Sinopse de *Bauhinia* sect. *Pauletia* (Cav.) DC. (Leguminosae: Caesalpinioideae: Cercideae) no Brasil. *Brazilian Journal of Botany* 28(3): 477–491. doi: [10.1590/S0100-84042005000300006](https://doi.org/10.1590/S0100-84042005000300006)
- VATTIMO, I. 1971. Contribuição ao conhecimento da tribo Apodanthaceae R. Br. parte 1 — conspecto das espécies (Rafflesiaceae). *Rodriguésia* 26(38): 37–62.

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