What does morphology say about Phasiinae systematics?

Deepening the knowledge on Phasiinae systematics and morphology

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Figure 1. Author collecting tachinids at Estação Biológica de Boracéia in São Paulo state. (Photo taken on October 2016 by Pedro Dias.)

The subfamily Phasiinae is the smallest of the four subfamilies of Tachinidae considering the number of species, but it also presents an astonishing morphological variation (Blaschke *et al*. 2018). The subfamily was historically grouped mainly by its habit of parasitizing Heteroptera. Now it is accepted that there are a few exceptions in Phasiinae, as well as a few other Tachinidae that parasitize Heteroptera (Blaschke *et al*. 2018). Many phasiine hosts are pests of different agricultural crops, and Phasiinae play an important role in biological control.

For some time, the only putative synapomorphy for Phasiinae was the presence of an elongated medial plate of the hypandrium in males, in which the pregonites are attached posteriorly (Tschorsnig 1985). Recently, another possible putative synapomorphy was proposed – the lack of differentiation between the basiphallus and distiphallus (Shima 2015).

The first phylogenetic reconstruction focused on Tachinidae based on morphological characters considered Phasiinae monophyletic, but the subfamily was grouped with homoplasies and with a taxonomic sampling that included mostly Nearctic and Palaearctic species (Cerretti *et al*. 2014). A focused and extensive Phasiinae phylogeny using molecular data was just published and it corroborates the subfamily monophyly, with very interesting results, and represents a great contribution to the subfamily knowledge (Blaschke *et al.* 2018).

At the present time, there are 13 tribes of Phasiinae: Catharosiini, Cylindromyiini, Euscopoliopterygini, Gymnosomatini (Fig. 2), Hermyini, Imitomyiini, Leucostomatini, Parerigonini, Phasiini, Strongygastrini, Tarassini (Fig. 3), Xystini and Zitini (Blaschke *et al.* 2018). This last publication reinstated the tribe Xystini, erected the new tribe Zitini, and changed the composition of some of the other tribes. Two of the tribes, Tarassini and Euscopoliopterygini, are rare and could not be sampled for this last phylogeny hypothesis. It is possible that both of them can be included in other phasiine tribes, and this is one of the questions I will address in my Ph.D. project.

Despite the smallest number of species within Tachinidae, the subfamily Phasiinae is a morphologically diverse group, with the highest diversity of forms in the male terminalia among the four tachinid subfamilies (Dupuis 1963, Tschorsnig 1985). Some structures of phasiine male terminalia do not have appropriate terminology, even though some detailed studies have been made (Rubtzov 1951, Verbeke 1962, Tschornsig 1985, Cantrell 1988).

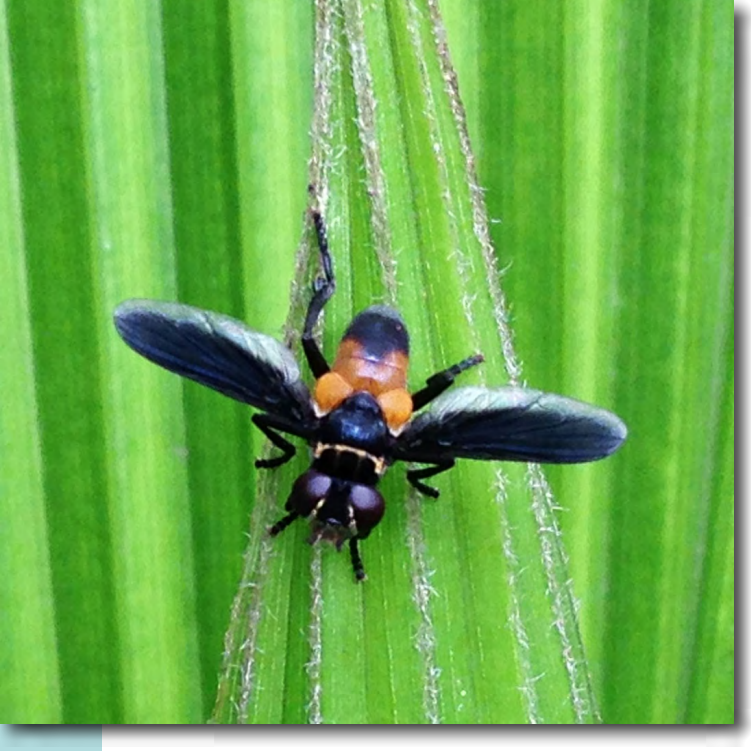

Figure 2. A female of *Eutrichopoda* sp., photographed in the city of São Paulo, Brazil.

Considering the historical bias towards male terminalia studies in insect taxonomy (Ah-King *et al.* 2014, Simmons 2014), the female terminalia characterization in Tachinidae is even scarcer, with Herting's (1957) publication on Calyptratae flies and some relevant studies with Phasiinae (Dupuis 1963, Cantrell 1988). Nevertheless, females of Phasiinae have a wide range of adaptations and modifications in their morphology to inject eggs into, or attach them on to, their hosts. These different forms could have evolved due to their phasiine habit of parasitizing adults and nymphs of Heteroptera which are heavily sclerotized (in contrast to most Tachinidae which parasitize larvae with soft bodies) (Verbeke 1962, Blaschke *et al.* 2018). The diversity of female terminalia was also used by Dupuis (1963) to classify phasiine tribes but lacked a comprehensive study of its terminalia (male and female), as well as homology hypotheses.

Phasiinae systematics has undergone great improvement in its knowledge and understanding, but there is always more that can be added. My Ph.D. project is being done at the "Insects Systematics and Biogeography Laboratory" at the University of São Paulo (Brazil) under the supervision of Dr. Silvio Shigueo Nihei. My project aims to produce a cladistic analysis of the Phasiinae based on morphological data. I have been studying Tachinidae, mainly Phasiinae, since my graduation and I am focused on the Neotropical fauna, in which I have a great interest (Figs. 1, 4).

In my Ph.D. project I intend to include all tribes in the analysis, and at the moment the only tribe that I still do not have any specimens of is the new tribe, Zitini. I am trying to sample the greatest number of Phasiinae genera possible, but I am still missing some monotypic genera. Of the approximately 100 genera of Phasiinae, I have sampled more than half. I will expand my examination of the Phasiinae by studying the collections of the Smithsonian National Museum of Natural History (Washington, D.C., United States) and the Canada National Collection of Insects (Ottawa, Canada) in the first semester of 2018. Visiting these collections will allow me to include more terminal taxa in the analysis. Most of my characters are from male and female terminalia and one of the expected outcomes of my Ph.D. research will be a comprehensive study of Phasiinae terminalia, focusing in females. Some taxonomic revisions are also being prepared.

My preliminary analyses, based on low sampling (few genera for each tribe), results in a topology for the Phasiinae that is similar in many aspects to the recent one of Blaschke *et al.* (2018), with some small differences. But probably some changes will occur once more taxa are added to the analysis. Most of the proposed changes in the tribal composition are also being recovered. I expect to recognize synapomorphies for most or all of the tribes and for the subfamily itself, as well as discuss and try to interpret some important Phasiinae characteristics. I also intend to present some preliminary results at the 9th International Congress of Dipterology (Windhoek, Namibia).

Figure 3. Lateral view of a male of the rare *Tarassus shannoni* Aldrich. Scale bar = 1mm.

I would appreciate some extra Phasiinae material on loan, if available. Most of my missing genera are from the Afrotropical, Oriental and Australasian regions, but more material from rare Palaearctic genera would be great contributions (mainly in the Leucostomatini and Catharosiini). Since I am including many terminalia characters, I need specimens from both sexes and they need to be dissected.

Figure 4. Author in the Brazilian Atlantic Forest, Estação Biológica de Boracéia, São Paulo state. (Photo by Fernando Martins.)

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