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Preliminary Notes on Tachinidae Reared from Lepidoptera in the Ecuadorian Andes

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Preliminary notes on Tachinidae reared from Lepidoptera in the Ecuadorian Andes (by J.O. Stireman)

Introduction

Current estimates of the species richness of Tachinidae among geographical provinces suggest that the Neotropical Region harbors the largest number of species and represents a geographic epicenter of tachinid diversification (O'Hara 2006). The Neotropics boasts an impressive fauna consisting of 2864 described species belonging to 822 genera at the time of the Neotropical catalog (Guimarães 1971), making it almost twice as species rich as any other geographic realm (O'Hara 2006; Stireman *et al*. 2006). This diversity is most apparent at middle elevations (1000–2000m) along the mountain chains of tropical Central and South America, where tachinids are an abundant and conspicuous component of the diurnal insect fauna. Despite this large number of described species, it is generally thought that only a fraction of Neotropical Tachinidae have been described, and for most of those that have been described, nothing is known about their life history, host associations, or behavior (Guimarães 1977). Here, I provide a preliminary list of the genera and numbers of species that have been reared from a research program focused on rearing Lepidoptera in the Ecuadorian Andes. I also provide host–family affiliations for most taxa as well as notes concerning the species reared, their characteristics, and/or their host associations. A more complete analysis of species diversity patterns and host associations will be published in a forthcoming special issue of the Journal of Research on the Lepidoptera.

Methods

The tachinid taxa discussed here were reared as part of a collaborative project with the goal of surveying and inventorying larval Lepidoptera and their parasitoids in an Ecuadorian cloud forest. This project, led by ecologist Lee Dyer (Tulane University), involves sampling of caterpillars from cloud forest plants, rearing the caterpillars on their food-plants, and collecting and preserving adults of Lepidoptera and their parasitoids.

The survey project is centered on Yanayacu Biological Station (YBS), located at 2200m in the Quijos Valley, Napo Province, in the eastern Ecuadorian Andes. Much of the 2000 hectares encompassed by the YBS is relatively level cloud forest, some of the only remaining habitat of this type in the Andes. Caterpillars were systematically sampled in 10m plots by visually scanning vegetation and collecting all individuals seen along with host plant material. Additional specimens were collected opportunistically as they were encountered along trails and streams. Caterpillars were reared individually in clear plastic bags hung in an open-walled rearing shed at ambient temperature and humidity. Every two days, bags were cleaned and foliage was replaced. All pupae were checked regularly to collect any adult Lepidoptera or parasitoids that emerged. Throughout this process life history data were recorded (e.g., host, host plant, collection date, pupation date, eclosion date).

Preliminary Results

Two hundred sixteen adults representing approximately 100 species of Tachinidae have been reared from caterpillars since the project was initiated. The exact number of species is difficult to ascertain because many "species" are represented by only one or a few individuals (often of one sex) making it difficult to determine where intraspecific morphological variation ends and interspecific variation begins. This is particularly difficult in several large genera in which there appear to be many undescribed species (e.g., *Siphona*, *Erythromelana*, *Calolydella*, *Leschenaultia*; Table 1). By examining morphospecies from both a "lumper" perspective (clustering individuals in which clear diagnosable traits cannot be found to separate them) and a "splitter" perspective (in which taxa are split based on more specific and perhaps more variable traits), it appears that we have reared as few as 87 distinct species, and as many as 103 species in 176 rearing events. An appreciable number of additional tachinid parasitism events have been recorded in which the adult tachinids have failed to eclose from puparia that emerged from hosts (or pupated within the host remains). Fewer than 10% of the reared species have been assigned a specific name at this point, and I would estimate that perhaps half have not been described in the literature. Probably 90–95% have never been reared before. This figure may be revised downward as we gain a better understanding of the overlap in taxa between this Ecuadorian site and other major Lepidoptera rearing efforts in Costa Rica by D.H. Janzen and W. Hallwachs (2006) and by Lee Dyer and Grant Gentry (Gentry and Dyer 2002). However, species accumulation curves (not shown) suggest that this represents a small fraction of the diversity of the total tachinid community. An online guide to the reared species of tachinids with close-up photos from a variety of angles as well as taxonomic notes and host life history information has been initiated. Pages for 37 species have been completed thus far (see http://www.wright.edu/~john.stireman/ [and click on the "Ecuador tachinids" link] or see the Ecuador pages on L.A. Dyer's www.caterpillars.org website).

Table 1. A preliminary list of the genera thus far reared from caterpillars from the Yanayacu Biological Station and surrounding areas. The number of rearing events (N), the number of species (Spp.; given as a range in cases of uncertainty), the host families from which they have been reared, and notes about particular taxa. Many identifications remain tentative pending more detailed examination and comparison with identified material.

Taxon	N	Spp.	Host Family	Notes
DEXIINAE	**23**	**10-13**		
CAMPYLOCHETINI				
Camplyocheta	12	3-5	Geometridae	One sp. is near *C. heteroneura* (Brauer & Berg.), most reared from hosts on *Diplazium costale.*
THELAIRINI				
Polygaster	2	1	Geometridae	
URAMYIINI				
Thelairaporia	6	3-4	Arctiidae (3), Limacodidae, Noctuidae	1 or 2 spp. appear to belong to the "*brasiliensis"* group (Guimarães). Distinction between this genus and *Uramya* appears blurred.
Uramya	2	2	Megalopygidae	
UNPLACED				
Argyromima	1	1	Nymphalidae (*Pedaliodes* sp.)	Possibly *A. mirabilis* Tnsd.
EXORISTINAE	**99**	**50-58**		
BLONDELIINI				
Anoxynops	1	1	Saturniidae	No prosternal setae.
Calolydella	13	4-6	Nymphalidae (5), Notodontidae (3), Arctiidae, Geometridae	One sp. is *C. geminata* Tnsd. and two others are quite close resulting in uncertainty in the number of species. *Actinote* is a common host genus.
Eribella	4	1?	Geometridae (3), Pyralidae	The pyralid record (on a different host plant) may represent a distinct species.
Erythromelana	16	7-9	Geometridae (14), Pyralidae, Megalopygidae	A diverse assemblage of species, probably all undescribed, including 2 that may belong to a separate genus.
Eucelatoria	7	7	Geometridae (2), Arctiidae, Pieridae, Noctuidae, Nymphalidae	Some quite large species, several small and similar in appearance (esp. males). One species may be *Vibrissina*.
Italispedia	3	1	Notodontidae	2 host species.
Leptostylum	2	2	Saturniidae	Different hosts. 7 reared from 1 *Gamelia* caterpillar.
Lixophaga	5	3	Nymphalidae, Pyralidae,	One species appears to be the same as an unnamed species from Costa Rica (D.M. Wood, pers. comm.).
Ptilodegeeria	1	1	Tenthredinidae (Hym.)	Unidentified species.
Leptomacquartia	1	1	Noctuidae	Probably *L. planifrons* Tnsd.
ERYCIINI				
Carcelia	10	4	Arctiidae	Includes species nr. *C. flavirostris-orellana*, and *C.* (*Chaetosisyrops*) *montanus* (Tnsd.).
Drino	1	1	Noctuidae	
Lespesia	7	2	Nymphalidae, Saturniidae	Robust species, largely black in coloration.
GONIINI				
Argyrochaetona	1	1	Pyralidae	
Chrysoexorista	2	1	Pyralidae	Very small in size for this genus.
Gaediopsis	1	1	Pyralidae	*G. punoenisis* Vim. & Souk. (?)

Taxon	N	Spp.	Host Family	Notes
GONIINI (cont.)				
Hyphantrophaga	3	2		
Leschenaultia	7	5-6	Arctiidae (4), Apatelodidae, Noctuidae	One species is nr. *L. leucophrys* Wied., a few forms differ primarily in size and may represent a single species.
Mystacella	5	1-2	Pyralidae	May be a single species.
New genus	3	1	Nymphalidae	This is a new genus in the process of being described by N. Woodley (M. Wood, pers. comm.). I am uncertain if it is a goniine.
Patelloa	5	2-4	Arctiidae (2), Noctuidae, Geometridae	*P. andina*, (Tnsd.) and *P. xanthura-similis* (or nr.). Variation in size and color may be intraspecific.
WINTHEMIINI				
Winthemia	1	1	Nymphalidae	Similar to *W. floridensis* Guimarães.
TACHININAE	**54**	**27-32**		
ERNESTIINI				
Fasslomyia	2	1	Arctiidae, Apatelodidae	sp. nr. *F. fantastica* Tnsd.
GRAPHOGASTERINI				
Phytomyptera	2	2	Pyralidae	
LESKIINI				
Leskia	1	1	unknown	*L. leskiopalpus* group.
Micronychiops	1	1	unknown	I am uncertain of the current tribal placement of this genus.
NEMORAEINI				
Xanthophyto	2	1-2	Geometridae	Probably 2 species.
POLIDEINI				
Chlorohystricia	1	1	unknown	*C. cussirilis* Reinhard.
Chrysotachina	2	1	Hesperiidae	Sp. nr. *C. peruviana* (Tnsd.)
Hystricia	10	4	Arctiidae (5), Apatelodidae, Saturniidae	Including *H. laxa* Curran, *H.* nr. *micans* Wulp, and *H.* nr. *browni* Curran.
Unknown genus 1	1	1	Pyralidae	*Exoristoides*?
Unknown genus 2	1	1	Noctuidae	Similar to *Spilochaetosoma.*
SIPHONINI				
Actia	4	2-4	Pyralidae	All specimens are morphologically distinct but possible sexual variation.
Siphona	14	7-10	Pyralidae (7), Geometridae (5), Notodontidae	4 morphologically distinct forms reared from one host on one host plant probably represent only 1 or 2 species. Subgenera include *Actinocrocuta, Siphonopsis*, *Siphona, Pseudosiphona*.
TACHININI				
Rhachoepalpus	1	1	unknown	*R. immaculatus* (Macq.).
Trichophora	1	1	unknown	
TELOTHYRINI				
Telothyria	1	1	Pyralidae	Possibly *Eutelothyria*.
TOTAL	**176**	**87-103**		
SARCOPHAGIDAE				
BOETTCHERIINI				
Boettcheria	2	1	Saturniidae	(Larval parasitoids.)

The overall parasitism frequency of the caterpillars is approximately 27% (based on >18,000 individual caterpillar rearings), and a little over one quarter of this is due to Tachinidae. Many more tachinids likely died in hosts that succumbed to pathogens or other sources of mortality (e.g., less than 50% of collected Lepidoptera resulted in an adult insect, whether it be moth or parasitoid).

As can be seen in Table 1, some subfamilies and tribes are extremely well represented, and others poorly so. In part this is due to the focus on lepidopteran hosts, so such groups as Phasiinae and Dexiini that primarily attack non-lepidopteran hosts would not be expected to be well represented. However, frequencies of reared taxa are generally consistent with the observed frequencies of taxa hand netted in the same area. For example, I have not collected a single member of Phasiinae along roadside and trailside collecting spots that yielded impressive numbers of species in other subfamilies. Dexiini are also rare in my collections, despite frequent hand collecting from flowers (e.g., Asteraceae) where many dexiine genera (and Phasiinae) often take nectar and/or pollen in other regions. Voriini were also markedly absent in hand collecting and absent from reared taxa despite their general habit of using Lepidoptera as hosts (e.g., Geometridae).

Over half of all species reared (and half of all incidents of tachinid parasitism) belong to the subfamily Exoristinae. In general, Blondeliini were extremely well represented by a diverse assemblage of closely related species and genera (e.g., *Calolydella, Eucelatoria, Lixophaga, Erythromelana*), suggesting that the region is likely a cradle for their diversification. This tribe accounts for over 30% of both caterpillars parasitized by tachinids and of all tachinid species reared. Goniini and Eryciini are also responsible for a fairly large number of parasitism events, although certain taxa well represented in D.H. Janzen and W. Hallwach's (2006) caterpillar rearing database, such as *Drino, Lespesia*, and *Belvosia* are noticeable rare or absent (and the eryciine species that were reared belong to only a handful of genera). *Leschenaultia* and other morphologically similar Goniini (e.g., *Gaediopsis*) were particularly conspicuous in the Yanayacu fauna both in terms of reared and hand collected specimens.

The subfamily Tachininae is fairly well represented, but in this case there seems to be a disconnect between the set of taxa that has been reared and what I have observed and collected by hand. From observations and hand-netting there appears to be an inordinate diversity of Tachinini, especially the "big fuzzy" taxa such as *Epalpus* and allied genera (e.g., *Lindigepalpus, Parepalpus, Eulasiopalpus*), yet very few Tachinini have been reared. This may be due to bias in the caterpillar hosts that were reared (e.g., perhaps few large caterpillar species were reared that were capable of hosting these bulky tachinids), or, perhaps more likely, a bias in the noticeability of these large and active tachinids (i.e., their abundance is overestimated due to their conspicuousness). In contrast, Siphonini are common and diverse in both the reared and my netted collections.

Figure 1. An unusual tachinid, *Telothyria* sp. (Telothyriini), reared from an unidentified pyralid feeding on *Hoffmannia* sp. (Rubiaceae).

Future Directions

Considerably more caterpillar sampling and rearing is needed before we can achieve a more complete picture of the richness of the community of caterpillar-attacking tachinids in this region and its composition. Although we have already reared many species, it is clear that we have sampled only a small fraction of tachinid species in this hyperdiverse community. Thus, we plan to continue our caterpillar rearing project as long as we can maintain funding. We plan to accompany this rearing with hand netting (in progress), pan trapping, and Malaise trapping in order to collect tachinids that attack hosts other than Lepidoptera for further taxonomic, ecological, and molecular study.

It is hoped that much of the material reared from this project will contribute to future taxonomic revisions and species descriptions. Many of the taxa listed here need to be examined in more depth to differentiate species and to determine identifications for those that have been named. One benefit of the rearing approach to collecting specimens employed in our study is that the host associations may provide ecological clues as to species limits and/or relationships. Another benefit is that for gregarious species, sexes can be associated preventing unnecessary and faulty descriptions of different sexes as distinct species. Ecological data can also help in this regard. DNA sequence data can also aid in delineating taxa and samples (mid-legs) are now being gathered for mtDNA sequencing of the reared tachinids. Altogether, it is clear that the great diversity of Tachinidae in the Ecuadorian Andes and their myriad associations with hosts will continue to provide new taxonomic specimens, new ecological data, and new hypotheses for many years to come.

Acknowledgements

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Artificial neural networks for insect identification (by J. Vaňhara[1*], N. Murárikóvá[2], I. Malenovský[3] and J. Havel[4])

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In contrast to wide applications in other sciences, e.g. chemistry, the use of artificial neural networks (ANN) in zoological taxonomy has been rather rare; e.g., in chemotaxonomic identification of limpets (Hernández-Borges *et al.* 2004), bioacoustic identification of Orthoptera (Chesmore 2004), or optically sensed aphids (Moore and Miller 2002), even despite the visionary review by Weeks *et al.* (1997) and the case spider study by Do *et al.* (1999) pointed out their great potential. Perhaps the first real dipterological application was used for the sandfly family Psychodidae (Marcondes and Borges 2000).

The ANN approach in model species from Diptera (Tachinidae) were tested and applied. We have examined possibilities of a supervised ANN methodology based on morphometric data for semi-automated insect identification (Havel and Vaňhara 2006, Vaňhara *et al.* 2006, Vaňhara *et al.* in press). We then tested the insect orders Thysanoptera (Fedor *et al.* in press) and Hemiptera (Psylloidea) (unpublished).

At first, appropriate diagnostic characters (variables) have to be selected and recorded for individual species of all specimens which are correctly identified by a taxonomist (expert). This is necessary to create a training database. Secondly, an ANN model is designed to find a relation between the characters (=*input*) and species (=*output*) (Fig. 1).

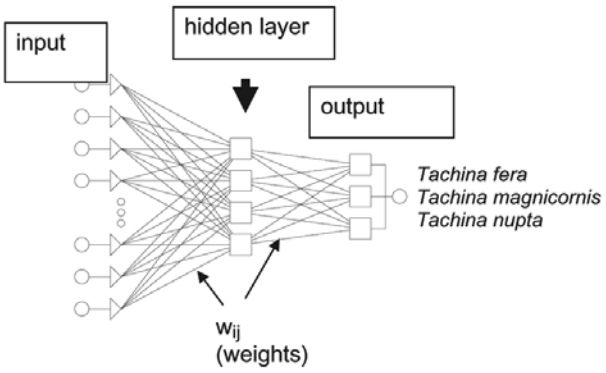

Figure 1. Optimal Artificial Neural Network architecture for classification of 3 species of *Tachina*.

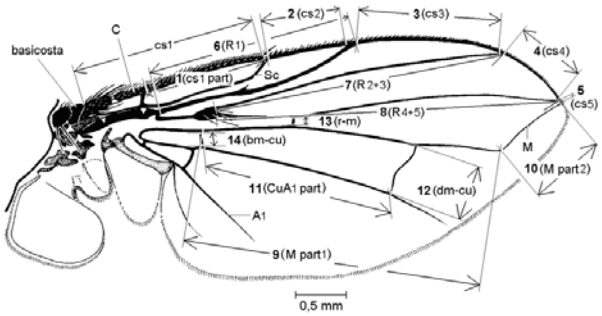

Figure 2. Measured wing characters in Tachinidae.

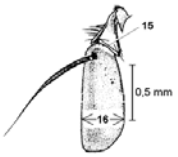

Figure 3. Measured antennal characters in Tachinidae.