ABSTRACT

BAYLESS, KEITH MOHR. Evolutionary Studies in Tabanomorpha (Diptera) with New Classifications of Xylophagidae and Tabaninae. (Under the direction of Dr. Brian M. Wiegmann).

Characterized by a great morphological and ecological diversity, Tabanomorpha deserves of the focus it has garnered in fly phylogenetics. Not only fraught with phylogenetic controversies, this infraorder contains more hematophagous species than any other insect lineage. Phylogenetic studies have challenged the composition of Tabanomorpha, and several of its families have not been corroborated as natural groups. Classifications of Tabanomorpha are based on a wealth of adult morphological characters, but phylogenies have revealed many homoplasies and a scarcity of strong, well-defined homologous characters that and clearly establish family-level composition. The families associated with Tabanomorpha are either large and sprawling, or small and highly specialized in morphology or ecology. In chapter one of this thesis, I seek to contextualize the relationships of groups with disparate diversity and ecology within a densely sampled phylogenetic analysis Tabanomorpha. The results provide a backdrop for detailed studies in subsequent chapters on the varied and unusual Xylophagidae and the ubiquitous but relatively homogeneous Tabaninae.

Xylophagidae is a family with a history of competing classification schemes, and detailed phylogenetic analysis including all major groups has never been performed. The aberrant *Rachicerus*, a diverse genus, some species of which have antennae with more annulations than any other higher fly, is included for the first time. *Rachicerus*, along with *Heterostomus*, *Exeretonevra*, and several coenomyiine genera share a history of controversial taxonomy that has placed xylophagid taxa in up to five separate families. Though adult morphology is varied, in recent years, Xylophagidae has been partly characterized by the highly distinctive larval habitus observed in many of its members. Chapter two of this study includes a comprehensive taxonomic sampling from all the higher-level taxa, as well as all the genera presently included in the family to shed light into the evolution of this morphologically complex group.

Multi-locus data collected for all taxa, and inclusion of *Rachicerus* in a molecular-based phylogenetic context for the first time, support an inclusive concept of Xylophagidae, which was recovered with high nodal support from analysis of the concatenated data set in using various reconstruction methods. A sister group relationship between *Xylophagus* and *Rachicerus*, and *Exeretonevra* and *Heterostomus*, were strongly supported. The placement of Australian *Exeretonevra* and South American *Heterostomus* with regard to Holarctic *Xylophagus* and *Rachicerus* is sensitive to gene sampling, alignment and phylogenetic reconstruction methods. This study confirms that both antennal structure and larval habitus, ostensibly highly derived and complex character sets, may be subject to convergence or loss within Xylophagidae.

Chapter three of this study focuses on Tabaninae, the most diverse lineage of horse flies. Phylogenies using molecular and morphological data challenge previous hypotheses about the evolution of this group. Significant findings include the non-monophyly of the three previous tribes in favor of nine strongly supported genus groups, which I describe as tribes or subtribes. Most of these newly identified lineages are corroborated by morphological or biogeographical evidence. The second most diverse genus, *Haematopota*, is recovered inside the most diverse genus, *Tabanus*. These results offer an opportunity to forge manageable classifications that are more likely to reflect the evolutionary histories of Xylophagidae and Tabaninae. I here resurrect and redescribe two tribes in Xylophaginae, Xylophagini and Heterostomini. In Tabaninae, Agelaniini new tribe is described, Chasmiini, Stenotabanini, Dasyrhamphini, Selasomatini, Bolbodimyiina, Dicladocerina, and Psalidiina resurrected and reinterpreted, Diachlorini is given a more restrictive meaning and Tabanini is expanded as Haematopotini is sunk into Tabanini. Species of *Dasybasis* Macquart from the Neotropical realm are found to belong to a different tribe than the type species from Australia, so two genus level names are resurrected to accommodate species formerly placed in *Dasybasis* from South America.

Evolutionary Studies in Tabanomorpha (Diptera) with New Classifications of Xylophagidae and Tabaninae

by
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BIOGRAPHY

Keith Bayless was born in New York City and grew up in Northern New Jersey. Both of his parents' careers were in education. His sister is a competitive synchronized ice skater. He became interested in entomology at age 11 after taking a class for middle schoolers offered at the American Museum of Natural History, taught in part by Caroline Chaboo and David Grimaldi. Along with a summer spent taking college classes on conservation biology, he worked in Dr. Carolyn Bentivegna's laboratory at Seton Hall University on chironomid ecology and population genetics in polluted marshes. His focus on flies grew due to this research experience and collecting *Aulacigaster* in his suburban backyard

Matriculating into the entomology program at Cornell University, Keith soon added another major in Biology with a concentration on Genetics and Development. He spent a semester working in Rick Harrison's lab, and went on his first collecting trip, accompanying Andrew Short to Costa Rica. He started his own research as an undergraduate under Cole Gilbert cataloging flightless flies, and was accepted as an REU student under Torsten Dikow and David Grimaldi at the AMNH. He coauthored a revision of a robber fly genus during this internship, published in 2009.

Fortunate to be accepted to NCSU as a student on a NSF PEET grant on Tabanidae, he has participated in many research avenues. He has presented research on fly taxonomy and phylogenetics at more than ten scientific conferences in the US and two internationally.

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CHAPTER 1

A review of the phylogenetic history of Tabanomorpha (Insecta: Diptera: Brachycera)

INTRODUCTION

The 5537 species (Pape & Thompson, 2010; Morita *et al*., 2010) that comprise Tabanomorpha (currently accomodated in families: Athericidae Stuckenberg 1973; Austroleptidae Nagatomi 1982; Bolbomyiidae Rohdendorf & Rasnitsyn 1980; Oreoleptidae Zloty, Sinclair & Pritchard 2005; Pelecorhynchidae Mackerras & Fuller 1942; Rhagionidae Samouelle 1819; Tabanidae Samouelle 1819; Vermileonidae Nagatomi 1975; Xylophagidae Stephens 1829) represent a diverse lineages of almost exclusively predatory flies (Wiegmann *et al*., 2000). These robust insects represent a crucial point in the evolutionary history of flies, considered sister to most of Brachycera, Orthorrhapha, or Stratiomyomorpha. A great level of variation in antennal, wing, genitalic, and larval morphology is found within the group (Woodley, 1989), moreso than in the much more diverse Schizophora. The vast majority of species diversity, however is classified in the morphologically homogeneous Tabanidae (Pape & Thompson, 2010; Morita *et al*., 2010; Pechuman & Teskey, 1981). While the larvae of most species in Tabanomorpha are predatory, their habitat and behavior is rich, ranging from desert sand to open water, some constructing pit traps to catch prey and others roaming throughout the substrate. Adult behavior is poorly known, with most families considered to visit flowers.

Table 1. Examples of morphological and biological diversity in Tabanomorpha. Monogeneric families not shown. (Sources: Burger, 2009; Kerr, 2010; James, 1981; Nagatomi, 1997; Pechuman & Teskey, 1981; Richter, 1997; Teskey, 1981a; Teskey, 1981b; Webb, 1981; Woodley, 2009.)

Family	Antennal forms	Flagellomere #	Wing veins	Size mm	Species	Larvae	Hematophagous?
Acroceridae	setiform, aristate	1 to 3	2 to 10	2.5 to 21	392	spider parasitoids	no
Athericidae	aristate	2	8 to 11	6 to 8	124	predators in streams	some
Nemestrinidae	stylate	1 to 3	7 to 9	4 to 16	277	Parasitoids	no

Table 1 continued

Family	Antennal forms	Flagellomere #	Wing veins	Size mm	Species	Larvae	Hem
Pelecorhynchidae	stylate	5 to 8	11	4 to 18	58	semi-aquatic predators	no
Rhagionidae	aristate to stylate	2 to 8	9 to 11	4 to 12	737	soil or aquatic predators	some
Tabanidae	stylate	2 to 8	10 to 11	6 to 30	4455	semi-aquatic predators	yes
Vermileonidae	aristate to stylate	2 to 8	8 to 10	7 to 12	60	predators in pits	no
Xylophagidae	aristate to stylate	8 to 36	8 to 11	2 to 25	136	soil and wood predators	no

Some genera of Athericidae and Rhagionidae, and almost all Tabanidae, are hematophagous. Less species-rich lineages in the infraorder, such as Vermileonidae (Devetak 2008) and Xylophagidae (Woodley, 2011), tend to have specialized larval habitats and a great deal of morphological variation, whereas nearly all of the species in largest family, Tabanidae, exhibit very similar morphology and ecology, as almost all adults are hematophagous and most known larvae are semiaquatic predators (Teskey, 1990) Table 1 summarizes antennal and wing morphology as examples of morphological variation, and the biology of Tabanomorpha. A lack of correlation between morphological variation and species diversity can be discerned from the table. Vermileonidae and Xylophagidae are sometimes placed in their own infraorders, (e.g. Griffiths, 1994; Woodley, 1989). Tabanomorpha is usually divided into two superfamilies, Tabanoidea including Tabanidae, Athericidae, Pelecorhynchidae, and Oreoleptidae, and Rhagionoidea containing the other families. Some challenging issues in the systematics of Tabanomorpha include (1) the monophyly of Tabanoidea; (2) the monophyly of Rhagionidae; and (3) the placement of Xylophagidae and Vermileonidae with regard to the infra-order and its included families. Whether *Bolbomyia* Loew and *Austroleptis* Hardy are more closely related to Rhagionidae or to Tabanoidea is explored herein, also for the first time, information from nuclear protein

coding genes will be used to examine the relationships of rhagionoids. I herein use phylogenetic analyses of Xylophagidae, a species-poor ancient lineage, and Tabaninae, the most diverse group of Tabanomorpha, as examples of diversification and morphological divergence in predatory Diptera.

MATERIALS AND METHODS

Data collection

All available data for Tabanomorpha species terminals as of October 2011 was assembled from GENBANK (USA NCBI). Also included is data Wiegmann *et al*., (2011) and Morita *et al*. (in prep) primarily for Xylophagidae, Rhagionidae, and Tabanidae. The genes are 16S, 18S, and 28S mitochondrial and nuclear ribosomal DNA, nuclear protein coding genes carbamoyl phosphate synthetase domain of CAD (CAD=CPS) (Moulton & Wiegman, 2007), period (PER), alanyl-tRNA synthetase 1 and 2 (AATS1+2), phosphogluconate dehydrogenase (PGD), triosephosphate isomerase (TPI), glucose-6-phosphate dehydrogenase (G6PD), phosphoenolpyruvate carboxykinase (PEPCK), C1-THF synthase homolog (PUG), seven in absentia (SIA), sans fille (SNF) (Wiegmann et al. 2011) and mitochondrial protein coding genes cytochrome oxidase I (COI) and NADH dehydrogenase (ND1). Table 2 lists the lengths of the gene fragments used.

Table 2. Tabanomorpha data set gene size and percentage coverage

Ribosomal gene	28S	16S	18S
Total basepairs	4274	1237	2015
Taxa covered	328	25	7
Percentage	92.7	7.1	0.02
Mito. NPC gene	COI+ND1		
Total basepairs	1527		
Taxa covered	294		
Percentage	83.05		

Nuclear NPC gene	AATS1+2	PGD	CAD	TPI	G6PD	PEPCK	PUG	SIA	SNF	PER
Total basepairs	606	807	3412	492	747	465	646	441	347	615
Taxa covered	239	227	273	25	4	4	4	5	4	6
Percentage	67.5	63.84	76.8	7.1	0.01	0.01	0.01	0.01	0.01	0.01

Data for the athericid genus *Suragina* Walker and the bombyliid genus *Lepidophora* Westwood are presented for the first time in this study. Primers used to obtain new data are the same as in Chapters 2 and 3 (Table 4, Table 6). Major groups of Stratiomyomorpha were also represented, from Brammer & von Dohlen (2007), Rozkosny *et al*. (in prep) and Wiegmann *et al*. (2011). Representatives of Hilarimorphidae, Acroceridae, and Nemestrinidae were also included as their placement relative to Tabanomorpha and other orthorrhaphous Brachycera was uncertain in several previous molecular studies (Trautwein *et al*., 2010; Wiegmann *et al*., 2011). Sampled members of Bombyliidae are definitive outgroups as placement of these outside Tabanomorpha is not contentious.

Available taxa were then pruned to meet the following criteria so that there would be enough data to insure some overlap:

1) Taxon samples were not included in the dataset if the only data available was the barcoding region of COI. This region has been shown to often fail to be informative by itself in higher level fly phylogenies (Skevington *et al*., 2007; Meier *et al*., 2008), and there are hundreds of COI sequences of possible Tabanomorpha on GenBank and DBOL that are determined only to the order Diptera so their inclusion would make the dataset more comprehensive but not more informative.

2) If a taxon had only data for 28S rDNA, it was included. This is the gene locus with the most complete taxon coverage, and the sequenced region is very large. Previous studies have shown that 28S is informative for Tabanomorpha (Wiegmann *et al*., 2000; Kerr, 2011)

3) In the absence of 28S data, a taxon was included only if it had data for at least 2 genes. This minimizes clade formation artifacts based on noise or missing data as phylogenies based on single genes are not expected to corroborate the phylogeny with concatenated data, particularly if that gene has poor coverage (e.g. Cho *et al*., 2012).

Alignment and Phylogenetic Analyses

Sequences were aligned with MAFFT E-INS-i algorithm (Katoh *et al*., 2002) on the CIPRES Science Gateway (Miller *et al.*, 2010). Unalignable regions were identified and masked using the least stringent parameters on GBlocks (Castresana, 2000) as removing regions of ambiguous alignment has been shown to improve the clarity of phylogenetic

signal (Talavera & Castresana, 2007). Nuclear protein coding genes were partitioned in a gene by codon matrix; other genes were placed in single partitions by gene. Maximum likelihood analyses were performed 50 concurrent times on Cipres XSEDE / Teragrid with RAxML 7.2.8, and 1000 bootstraps pseudoreplicates using RAxML rapid bootstrapping algorithm were performed on the data set (Stamatakis, 2006; Miller *et al*., 2010). Consense (Felsenstein, 1989) on CIPRES (Miller *et al*., 2010) was used to determine the bootstrap consensus as it allows bootstrap values lower than 50 to be mapped. Bayesian inference using MrBayes 3.1.2 (Ronquist & Huelsenbeck, 2003; Altekar *et al.*, 2004) on CIPRES Teragrid (Miller *et al.*, 2010) was attempted, but samples from the MCMC chains did not converge on stationary distribution, therefore are not presented.

RESULTS

Taxon Sampling and Assembled Dataset

The final analyzed data set contains data for 358 taxa with up to 15 genes (Appendices 1 & 2) There are 18165 total characters in the aligned and masked data set. 75.64% of the dataset is contains gap positions. Very few taxa, for instance *Hermetia illucens* (Linnaeus) (Stratiomyidae) and *Haematopota pluvialis* (Linnaeus) (Tabanidae) have data for all genes. Most of the data is taken from a few large studies using relatively few genes. More than half the genes are represented by data from Wiegmann et al. 2011 only. 28S has the best coverage, however the coverage is not complete as several studies e.g. Roskosny *et al.*, (in prep), did not use this gene. A mitochondrial region including COI has the next best coverage, and then the nuclear protein coding genes CAD, AATS, and PGD (Table 2).

Phylogenetic relationships

The analyses reveal many insights into Tabanomorpha phylogeny in spite of uneven and low gene coverage (Figures 1, 2). This data set allows us to make several statements about the outgroups. Acroceridae, on remarkably long branches, are not supported as close relatives of Tabanomorpha. The internal relationships of Stratiomyidae and other sampled Stratiomyiomorpha are not resolved, as they are not monophyletic with respect to Bombyliidae and Acroceridae. Tabanomorpha exclusive of Xylophagidae is recovered with a bootstrap score of 65. A sister group relationship between Xylophagidae and Nemestrinidae

is corroborated but not strongly supported. Within the Tabanomorpha, Rhagionidae sensu Kerr (2010) is not resolved, though the monophyly of the subfamilies of Rhagionidae sensu Kerr is supported. The placement of Austroleptidae and Bolbomyiidae do not concur with Kerr (2010), who placed them outside of Rhagionidae. Vermileonidae is placed inside Rhagionidae, sister to Rhagioninae with a bootstrap of 53. *Austroleptis* Hardy is sister to Vermileonidae and Rhagioninae with a bootstrap support of 68. *Bolbomyia* Loew is sister to the other subfamilies of Rhagionidae and Tabanoidea with a bootstrap support of 49. The relationships between Spaniinae, *Bolbomyia*, and Tabanoidea are poorly supported.

A Tabanoidea contrary to Stuckenberg (2001) but concurrent with Kerr (2010), with Pelecorhynchidae outside of Rhagionidae, is resolved with high support. Whether Pelecorhynchidae and Oreoleptidae successive sister groups to the rest of Tabanoidea in Wiegmann *et al*. (2011), but here Pelecorhynchidae and Oreoleptidae are supported as sister group with a bootstrap support of 76, and this lineage is sister to Athericidae and Tabanidae with a bootstrap support of 79. Within Pelecorhynchidae, *Pseudoerinna* Shiraki and *Glutops* Burgess are supported as sister group with a bootstrap support of 67, and *Pelecorhynchus* Macquart is moderately supported as sister to the rest with a bootstrap support of 98. The monophyly of Athericidae and Dasyommatinae are supported with a bootstrap of 100, and Athericinae is supported with 91. *Suragina* is placed within *Atherix* s.l. with a bootstrap support of 91.

While Tabanidae is more extensively sampled in the present dataset than in Morita et al. in prep and in Chapter 3, the relationships are congruent overall. Pangoniinae and Philolichini are recovered with bootstrap scores of 95 and 99 respectively, Scionini is not recovered, however, as *Goniops* Aldrich is outside Scionini, and the monophyly of Pangoniini including Mycteromyiini has a bootstrap score of 60. The internal relationships between Philolichini and Scionini species are poorly supported. Chrysopsinae is not supported, as its subordinate tribes Chrysopsini and Rhinomyzini, and several genus groups of a non-monophyletic Bouvieromyiini, are a succession of relationships leading to Tabaninae. None of these chrysopsine taxa are highly supported as sister group to Tabaninae, but *Pseudotabanus* Ricardo, *Coracella* Philip and Rhinomyzini are all more closely related to

that subfamily than to *Chrysops* Meigen. In the Tabaninae, sampling is increased with respect to Ch 3, and the results are identical except for several unsampled species of *Tabanus* falling outside the Tabanini due to unequal gene coverage.

DISCUSSION

The phylogenetic hypotheses recovered from this extensive taxon sampling illuminates many details of Tabanomorpha phylogeny (Figures 1, 2). This study constitutes the largest ever assembled for all ingroup families to date. For Vermileonidae and Athericidae, this is the first study comprehensive enough to address questions within the family. Discussion of the families of Tabanomorpha follows.

Sampling of genes and taxa representing Stratiomyomorpha was limited, and so the phylogenetic resolution of the group is poor. This may be due to the fact that there has not been a comprehensive sample of the group using the same genes. About half of the taxa were sequenced for Brammer and Von Dohlen (2008), while others were sequenced for Rozkosny *et al*. (in prep), or for Wiegmann et al. (2011). Only the derived stratiomyid *Hermetia* Latreille has all the genes sequenced, so the ability to recover expected relationships within Stratiomyomorpha and Stratiomyidae is likely limited due to missing data.

Xylophagidae, sometimes placed in its own infraorder, has unique larval habitats and a great deal of variation in wing venation and antennal morphology (Palmer and Yeates, 2000). The antennae of Xylophagidae vary from multiannulate antennae with 20 or more flagellomeres in species of *Rachicerus* to a nearly aristate condition in Dialysis (James, 1981; Woodley, 2009). This diversity is clear from the fact that the nine genera in Xylophagidae have previously been placed in up to 5 families (e.g. Nagatomi, 1975, Webb, 1984). However, the diversity of the family is limited for Diptera, and its 133 species (Woodley, 2011) constitute a depauperate lineage of Tabanomorpha. The phylogeny of this group is explored for the first time in Chapter 2.

Vermileonidae are delicate flies whose larvae construct pits in a similar fashion to ant lions (Neuroptera: Myrmeleontidae; Nagatomi, 1977; Devetak, 2008). Previously placed in Rhagionidae (e.g. James & Turner, 1981), the group was removed by Griffiths (1994) and placed in its own infraorder. It is also variable in the antennal conformation, and Stuckenberg

(1999) posited it as an analogue to antennal evolution in the rest of brachyceran flies. While this is the largest sample of Vermileonidae ever included in a molecular phylogenetic analysis, internal relationships of the family have never been investigated, and I herein test the placement of Vermileonidae. The placement of Vermileonidae inside Rhagionidae is a notable finding. Not enough members of Rhagionidae were included in Wiegmann *et al*. (2011) to test this, and Kerr 2010 recovered Vermileonidae as sister to Tabanomorpha or Tabanoidea. *Leptynoma* Westwood is resolved inside *Vermileo*. This is the group of Tabanomorpha that would be best served by additional taxon sampling.

Nemestrinidae and Acroceridae are two families of parasitic flies that were placed in a separate superfamily but are now included in Tabanomorpha (Pape & Thompson, 2010). These two families both have unusual, though not identical, wing venation, parasitic larvae preceded by a planidial stage, and many species with long probosides for pollination (Winterton *et al*., 2007; Richter, 1997; Teskey, 1981). However, a sister group relationship was not corroborated by Wiegmann *et al*. (2011). Nemestrinids are most diverse in arid regions, and the larvae, where known, are grasshopper parasitoids. Their unusual wing venation may improve flight stability and the fly with the longest proboscis belongs to this group (Manning & Goldblatt, 1997). The relationships of the subfamilies or genera of Nemestrinidae have never been rigorously tested as current data are insufficient. I here resolve Nemestrininae as sister to the rest of the family. *Neorhynchocephalus* Lichtwardt and an undescribed taxon from Chile are recovered inside *Hirmoneura* Meigen, which would render two subfamilies according to Bernardi (1973) non-monophyletic. Acroceridae, spider parasitoids, vary greatly in size, wing venation complexity, antennal conformation and proboscis length species (Winterton et al., 2007). Though the name small-headed flies is applied to the entire group, the relative sizes of tagmata shows great variation. Winterton et al. (2007) used nucleotide data to explore Acroceridae phylogeny, although the placement of the family is not resolved.

The rest of the families are unambiguously considered part of Tabanomorpha. The first three families, Austroleptidae, Bolbomyiidae, and Rhagionidae, are considered Rhagionoidea, which may not be a natural group, and the subsequent four, Pelecorhychidae,

Oreoleptidae, Athericidae, and Tabanidae, are Tabanoidea, which is supported as monophyletic.

While the groups that comprise Rhagionidae have shifted greatly over time and between authors, Kerr (2010) advanced Rhagionidae taxonomy by presenting a classification based on a phylogeny using morphological and 28S ribosomal data. He classified *Bolbomyia* and *Austroleptis* as separate monotypic families, and did not include the groups of Tabanoidea that Stuckenberg considered part of Rhagionidae. Bolbomyiidae is Holarctic and Austroleptidae is from Australia and Southern South America but their topology relative to the cosmopolitan Rhagionidae is not resolved. Stuckenberg (2001) and Woodley (2011) considered that *Austroleptis* might be more closely related to Xylophagidae, but such a placement is not supported by this analysis. Rhagionidae, the common, conspicuous, predatory snipe flies show great variation in wing venation, and many unplaced lower brachyceran fossils are placed in this family. Some species are known to be hematophagous. Stuckenberg (2001) considered some constituents of Rhagionidae as a separate family, but Kerr found no support for this. Stuckenberg (2001) and Woodley (2011) considered that *Austroleptis* might be more closely related to Xylophagidae, but such a placement is not supported by this analysis. *Ptiolina* Zetterstedt is recovered as monophyletic but the placement of the two sampled species is poorly supported.

Pelecorhynchidae is a tabanoid family consisting of 3 morphologically and geographically disparate genera (Teskey, 1981), so odd that family group names are associated with all three genera. *Pelecorhynchus*, from Australia, is recovered as sister to the Nearctic *Glutops* and Nearctic and Asian *Pseudoerinna*. Pelecorhynchidae was included in Rhagionidae sensu Stuckenberg (2001) but this result has not been corroborated in phylogenetic studies using molecular data (Kerr 2010; Wiegmann *et al.*, 2011)

Oreoleptidae was described in 2005 based on larvae collected in the Rocky Mountains and adults reared from them (Zloty *et al*., 2005). The larval form and habitat are reminiscent of Athericidae but a sister group relationship between Athericidae and Oreoleptidae was not recovered. Its placement in subsequent studies has varied, often placed sister to Pelecorhynchidae or to the rest of Tabanoidea. New data from additional genes will

be needed to confirm the first branching lineage of Tabanoidea as the current taxon sampling at the genus level is thorough.

Athericidae are predators in mountain streams as larvae. Their larvae have a streamlined body with long pseudopods for gripping algae covered rocks. Most genera are geographically restricted, except for the type genus, Atherix, which occurs worldwide (Webb, 1981). The adults vary significantly in antennal and wing morphology, and several genera seek vertebrate blood as adults (Stuckenberg, 2000). Athericidae was formerly a subfamily of Rhagionidae (Stuckenberg, 1973) but has been strongly supported as the sister group to Tabanidae. The two families are morphologically dissimilar but thare some putative synapomorphies such as venom ducts in the larval mandibles (Sinclair, 1992). The two subfamilies have been included in molecular phylogenetic studies, and the placement of the family is repeatedly supported as sister to Tabanidae. Dasyommatinae and Athericinae are both recovered. *Suragina* is placed within *Atherix* Meigen in the broad sense, suggesting a more restricted concept of *Atherix* might emerge from a more detailed phylogenetic revision of the group.

With 4,455 described species, Tabanidae, horse and deer flies, are the largest family of Tabanomorpha by a great margin. With four and half thousand species, Tabanidae are the largest family of bloodsucking insects. Like many biting flies, they can transmit diseases, such as the filarial disease loa loa, and in rare cases, trypanosomiasis, anthrax, and tularemia (Teskey, 1990; Desquesnes & Dia, 2004). Males and females of these large, fast flies are also valuable pollinators in some ecosystems (Johnson & Morita 2006; Morita 2011). The predominant larval habitat is freshwater semi-aquatic environments where they are predators. Tabanidae larvae feed by injecting venom into diverse prey, sometimes even as large as frogs (Jackman *et al*., 1983). There are also a variety of exceptional horse flies such as sand dune denizens (Philip, 1941) and flies that only hunt anacondas (Ferreira *et al*., 2002). It is unclear whether these few species with aberrant biology are relictual or belong to major lineages of horse flies. Compared to other families in Tabanomorpha, Tabanidae species have very similar wing venation, genitalia, and antennal morphology.

Horse fly diversity is currently encompassed in three subfamilies and between 9 and 11 tribes (Mackerras, 1954). Studies of the internal relationships of the group have been sparse. Several studies based on morphological characters only focused on limited character sets such as mouthparts or were phenetic in nature (e.g. Fang *et al*., 1999, Trojan *et al*., 1997). Pangoniines are large, pilose, and colorful flies, cosmopolitan and most diverse in semiarid Mediterranean climates. Almost all horse flies with long tongues are found in this subfamily, many of which are pollinators, but the function of these long proboscides is unconfirmed in many species. In all species that have been addressed this proboscis is used to extract nectar from specific types of elongate flowers. This pollination syndrome can coevolve even to the population level (Morita, 2006). Several subgroups of these pollinators have been intensely studied (Morita, 2006; Lessard & Yeates, 2011). Here, Pangoniinae are recovered as a monophyletic group and are placed as the sister to all other horse flies with strong support.

Chrysopsinae, the deer flies, are tenacious biters, and have the most complex eye patterns in Tabanidae. There are many relictual genera of uncertain affinity and the bulk of species are placed in *Chrysops* and *Silvius* Meigen. Chrysopsinae is a progression of relationships and clearly has a complex evolutionary history in comparison to its taxonomy. *Chrysops viduatus* Fabricius is sister to the rest of *Chrysops* likely because that species has 16s, which is not sampled in any other *Chrysops*. Deer fly larvae, while common, have an unknown diet, but may feed on soil microorganisms (Burger *et al*., 1981).

Tabaninae is the most diverse group of horse flies, and includes 1350 species classified in *Tabanus* Linnaeus, the medium to large green-eyed horse flies, and 555 species in *Haematopota* Meigen, the klegs. *Tabanus* is cosmopolitan and the diversity of *Haematopota*, the most recent large diversification in Tabanomorpha, is centered in the old world tropics. The third tribe, Diachlorini, is a paraphyletic grade. A more detailed discussion of Tabaninae evolution in the context of my current phylogenetic results is found in Chapter 3. Missing data for many genes in some key taxa may be responsible for some unexpected placements in Tabaninae. The results of the current higher-level analysis are identical to those presented in Chapter 3, except for the placement of *Tabanus bromius* L.

and *T. maculicornis* Zetterstedt. These taxa have data for 12S and 16S, genes unsampled in any other *Tabanus* species.

Despite size-related computational obstacles and unequal gene coverage (see Cho *et al.*, 2012), the evolutionary history of Tabanomorpha revealed by this phylogeny illuminates several trends worth further investigation. Tabanidae, the most diverse lineage and the least morphologically variable, is also the most recent derived family of Tabanomorpha. This family constitutes the most successful lineage of bloodsucking insects in terms of species diversity (Downes, 1971). Within Tabanidae, there is little morphological or ecological specialization. For instance, male genitalia are monotonous, almost all adults are generalist hematophages, and most larvae are predators without restricted diets. Adults will cease feeding at the first hint of wind or clouds (Teskey 1990). The major evolutionary transition to hematophagy likely occurred on the long-branch subtending the first divergence of modern day Tabanidae. There are at least two other lineages in Tabanomorpha that suck vertebrate blood. One, the rhagionid group including *Symphoromyia* Frauenfeld, is likely an independent origin of this ecological strategy. It is much more likely than bloodfeeding being unrecorded or lost in all the taxa separating *Symphoromyia* and Athericidae + Tabanidae. Within Athericidae, biological records are relatively scarce. Dasyommatinae does not contain any known hematophages, and within Athericinae, *Suragina* is hematophagous. The phylogenetically enigmatic athericid *Suraginella* Stuckenberg is also a suspected hematophage (Stuckenberg, 2000). Samples of *Suraginella* were not available for this study. More data are needed on the biology and phylogeny of Athericidae to determine the number of times adult bloodsucking evolved. Within Tabanomorpha, hematophagy likely evolved at least 3 times (Figure 3); once in Tabanidae, at least once in Athericidae (*Dasyomma*, *Suragina*, *Suraginella*) and at least once in spaniine Rhagionidae (*Spaniopsis* White, *Symphoromyia*)

Although Tabanomorpha in the broad sense contains several remarkable groups such as the highly modified larvae habits of Xylophagidae, Vermileonidae, Athericidae, and Nemestrinidae, the most diverse groups have not diversified in terms of morphology and ecology. There is also an apparent lack of correlation between species diversity,

morphological evolution, and rates of molecular evolution. The longest branches on the tree belong to Tabanidae, although this may be a node density artifact. Particularly morphologically unusual groups, including Xylophagidae. Oreoleptidae, and Vermileonidae, are on relatively short branches and species-poor. The groups on the longest branches, Athericidae and Acroceridae, are much less diverse than Rhagionidae exclusive of Rhagioninae and Tabaninae, the most diverse groups. The evolutionary history of Tabanomorpha contains an array of remarkable but relict groups in a progression of relationships and one diverse but homogenous clade with generalized morphology. The drivers of the diversification of Tabanidae deserve investigation, particularly considering that hematophagous Athericidae and Rhagionidae were not as successful.

This study is a great step forward toward a complete view of a diverse lineage of predatory flies. Any future more extensive phylogenetic studies of Tabanomorpha will likely rely on phylogenomics. This is another example of insights that can be gained from extremely large matrices that are incomplete or even biased. This analysis shows many genus level groups whose taxonomy does not accurately reflect the evolutionary history and thus should have revisionary studies prioritized, such as *Hirmoneura* (Nemestrinidae), *Vermileo* (Vermileonidae) and *Atherix* (Athericidae). The dichotomy between morphological specialization and species diversity is further explored in the subsequent chapters in this thesis concerning Tabanidae and Xylophagidae.

Figure 1. Maximum likelihood phylogram of Tabanomorpha based on the full concatenated gene dataset calculated in RAxML. Overall topology, including all sampled species, is shown with family, subfamily, or tribe membership as indicated; Boostrap values from 1000 replicate RAxML searches are shown for major nodes.

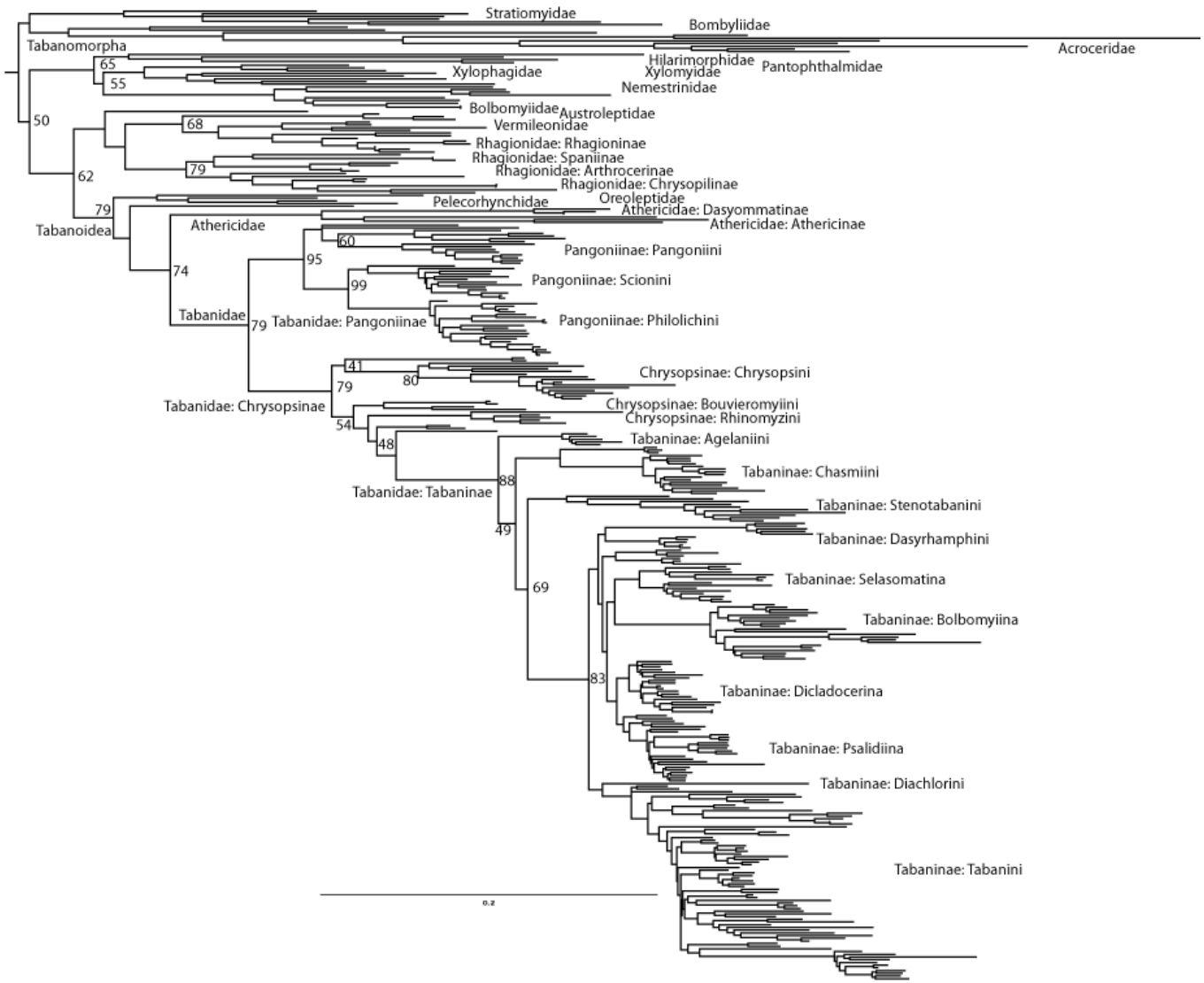
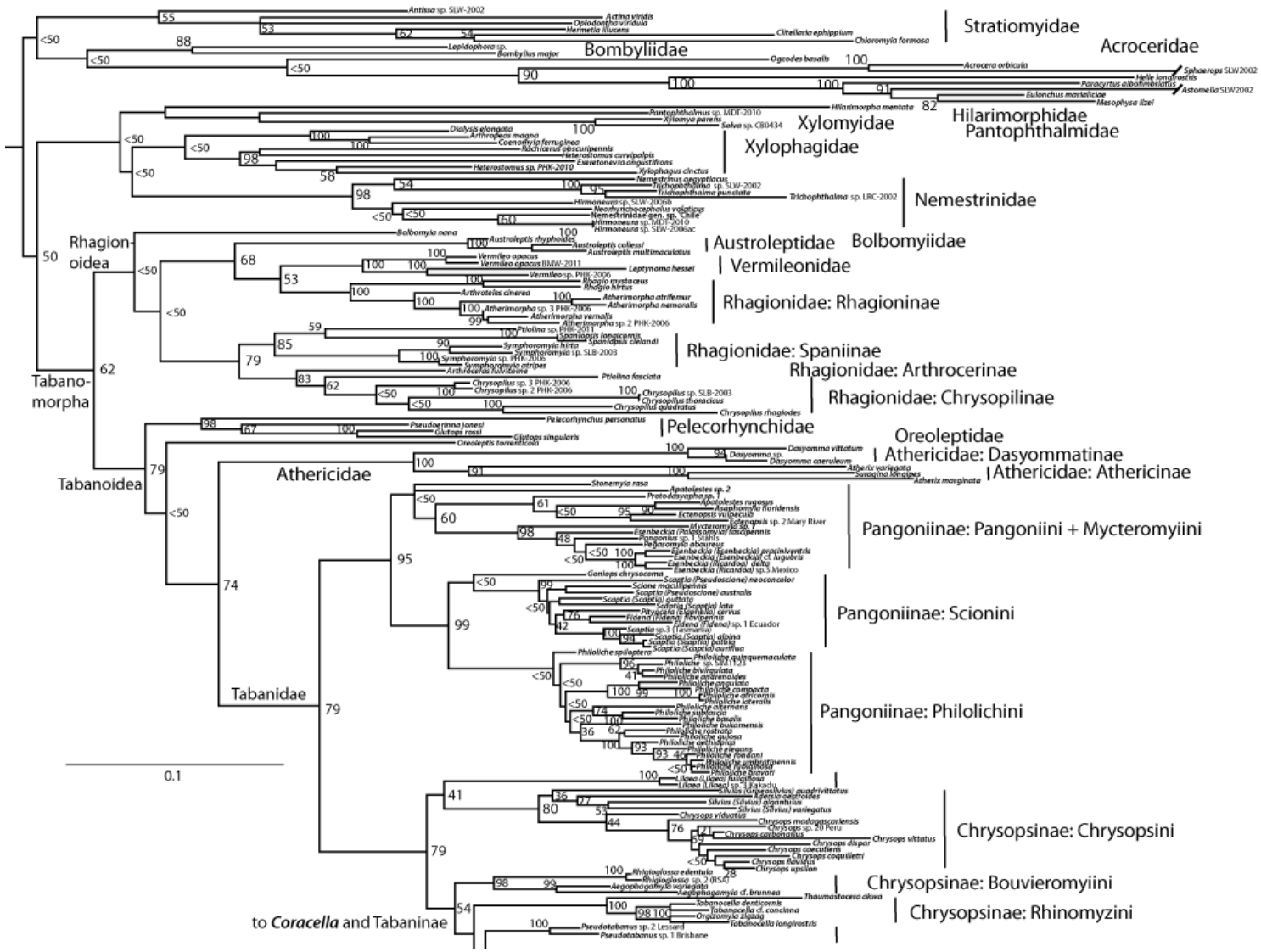

Stratiomyidae
Bombyliidae
Tabanomorpha
Acroceridae
Hilarimorphidae
Pantophthalmidae
Xylomyidae
Xylophagidae
Nemestrinidae
Bolbomyiidae
Austroleptidae
Vermileonidae
Rhagionidae: Rhagioninae
Rhagionidae: Spaniinae
Rhagionidae: Arthrocerinae
Rhagionidae: Chrysopilinae
Oreoleptidae
Pelecorhynchidae
Athericidae: Dasyommatinae
Athericidae: Athericinae
Tabanoidea
Athericidae
Pangoniinae: Pangoniini
Pangoniinae: Scionini
Tabanidae
Tabanidae: Pangoniinae
Pangoniinae: Philolichini
Chrysopsinae: Chrysopsini
Tabanidae: Chrysopsinae
Chrysopsinae: Bouvieromyiini
Chrysopsinae: Rhinomyzini
Tabaninae: Agelaniini
Tabaninae: Chasmiini
Tabanidae: Tabaninae
Tabaninae: Stenotabanini
Tabaninae: Dasyrhamphini
Tabaninae: Selasomatina
Tabaninae: Bolbomyiina
Tabaninae: Dicladocerina
Tabaninae: Psalidiina
Tabaninae: Diachlorini
Tabaninae: Tabanini
0.2

Figure 2. Maximum likelihood topology of Figure 1, indicating clade membership for non-Tabaninae taxa. All species, taxa, and support values are shown.


Stratiomyidae
Acroceridae
Bombyliidae
Hilarimorphidae
Pantophthalmidae
Xylomyidae
Xylophagidae
Nemestrinidae
Bolbomyiidae
Austroleptidae
Vermileonidae
Rhagionidae: Rhagioninae
Rhagionidae: Spaniinae
Rhagionidae: Arthrocerinae
Rhagionidae: Chrysopilinae
Pelecorhynchidae
Oreoleptidae
Athericidae: Dasyommatinae
Athericidae: Athericinae
Pangoniinae: Pangoniini + Mycteromyiini
Pangoniinae: Scionini
Pangoniinae: Philolichini
Chrysopsinae: Chrysopsini
Chrysopsinae: Bouvieromyiini
Chrysopsinae: Rhinomyzini
Rhagion-
oidea
Tabano-
morpha
Tabanoidea
Athericidae
Tabanidae
to Coracella and Tabaninae
0.1

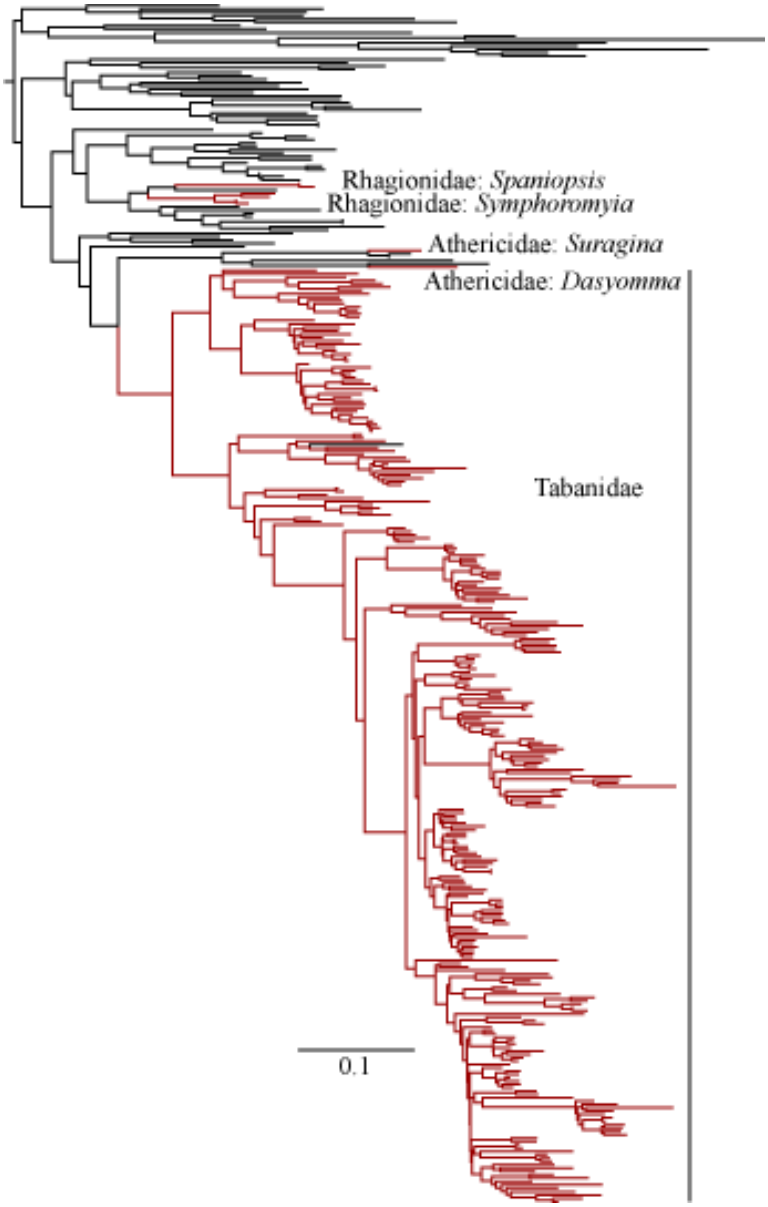


Figure 3. Maximum likelihood topology of Figure 1 showing distribution of hematophagous adults. Two genera of known bloodsuckers were sampled in each of Athericidae and Rhagionidae.

CHAPTER 2

The evolutionary relationships of the genera of Xylophagidae

INTRODUCTION

The suborder Brachycera, commonly known as short horned flies, contains the majority of fly species diversity. Characterized by a suite of convincing morphological synapomorphies, the monophyly of this group has not been questioned by studies using adults and immature morphological features (e.g. Woodley, 1989; Yeates, 2002; Sinclair *et al*., 2007), as well as studies using nucleotide data (Wiegmann *et al*., 2000; Bertone *et al*., 2008; Wiegmann *et al*., 2011). 'Brachycera' is named from the Latin for 'short horned' referring to the reduced length of the antennal flagellum. Most brachyceran flies have eight or fewer annulations of the flagellum, however some species in the enigmatic genus xylophagid genus *Rachicerus* Walker have up to 26 highly modified annulated subsegments. Although there is no consensus as to the placement of *Rachicerus*, as some authors have placed it in a separate nominal family, most recent works consider *Rachicerus* as a member of Xylophagidae. Phylogenetic study of the family is needed to resolve the placement of this unique fly and to interpret its antennal variation to confirm the suspected independent re-acquisition of the multi-annulated flagellum found in lower Diptera.

Xylophagidae, either the sole family in the Xylophagomorpha, or included in Tabanomorpha, contains 136 described species of flies (Woodley, 2011) with unusual larval morphology (Woodley, 2009) and a rich fossil record (e.g. Mostovski 1999, Poinar 1993, Jarzembowski & Mostovski 2000). Members of the family are a distinctive component of most wet temperate forests, and many species found in the tropics await formal description (Woodley, 2009). Xylophagid larvae are predators in soil and rotting logs (Webb 1984). No species in this family are known from the Afrotropics, and the described diversity is centered in Asia (Woodley, 2011). Xylophagus and Rachicerus larvae live under bark but coenomyiine larvae are readily found in soil (Palmer and Yeates 2000, Woodley, 2011). A character unique to Xylophagidae, according to Woodley (1989), is the sclerotized dorsal plate surrounding the spiracles and ending in a pair of hook-like processes. Woodley (1989) listed two other larval characters as supporting the monophyly of a Xylophagomorpha

including *Exeretonevra*, *Heterostomus*, and Panthophthalmidae as *incertae sedis*. Xylophagidae adult morphology is highly varied, for instance antennal morphology; *Dialysis* Walker has stylate to nearly aristate antennae (James 1981) while some species of *Rachicerus* have more antennal annulations than any other brachyceran fly. Woodley (2009) differentiates Xylophagidae adults from other Brachycera by the presence of pulvilliform empodia and wing venation.

Woodley (1989), Wiegmann *et al*., (2000), Sinclair *et al*., (2007) Wiegmann *et al*., (2011), and other studies have investigated the phylogenetic relationships of xylophagids with regard to other flies in the context of comprehensive studies, and while this question is not fully resolved, xylophagids are most likely the sister group of most Brachycera or of other 'orthorrhaphous' infraorders. Of recent authors, Nagatomi has consistently separated the genera into separate families: Rachiceridae, Coenomyiidae, Heterostomidae, and Exeretonevridae (e.g. Nagatomi 1982, 1996). Santos (2010) also delineates these families and questions the monophyly of Xylophagomorpha. Jentzch and Arnold (2006), and Roskozny *et al*., (2008) continue to consider Coenomyiidae as a separate family. Mostovski and Martínez-Delclòs (2000) associate Heterostomus with the otherwise extinct family Rhagionemestriidae. For reviews of Xylophagidae classification and for more detail on morphological phylogenetic hypotheses see Woodley (2011) and Palmer and Yeates (2000).

Phylogenetic hypotheses of the subfamilies and genera within this presumably ancient family have never been rigorously tested. Through this study I aim to further our understanding of these flies by analyzing the largest dataset of Xylophagidae ever assembled, and including *Rachicerus* in a phylogenetic context for the first time. Sensitivity analyses were used to test the levels of uncertainty at several nodes. Removing the third codon position in protein coding genes is a practice that has been shown to reduce data conflict in higher level phylogenetic studies, for instance in flies (Wiegmann *et al*., 2011) and Lepidoptera (Cho *et al*., 2011), and molluscs (Jorger *et al*., 2010). Within family phylogenies, however, removing third positions may oblate signal. I observed the changes in support with third positions included and excluded, and partition schemes for each gene, gene types (mitochondrial vs. nuclear), or codon position. Optimal alignment procedures also

differ for phylogenies investigating deep splits and those investigating smaller taxa. I observed the differences in support using MAFFT (Katoh *et al*., 2002) or secondary structure for alignment and Gblocks (Castresana, 2002) for data masking.

MATERIALS AND METHODS

Taxon sampling

I sampled 7 ingroup species from all but 2 genera of Xylophagidae: *Odontosabula* Matsumura, which consists of five species found in Japan, China, and Eastern Russia, and *Anacanthaspis* Röder, with two species from the Eastern Palaearctic (Woodley, 2011). *Rachicerus pilosus* (Frey) known only from Myanmar, is sometimes placed in another genus, *Gymnorhachicerus* Frey, and was also not included in the current study, however Woodley's (2011) most recent classification has maintained this species in *Rachicerus*. Nucleotide sequence data were generated (or retrieved from GENBANK) for five nuclear loci, one ribosomal (28S) and four protein coding (CAD (CPS), AATS, TPI, and PGD). Taxa included and their gene coverage is summarized in Table 3.

The ingroups included in this study are representatives of three of the five genera of Coenomyiinae. *Arthropeas* Loew is a genus of large bodied flies, with 4 species, 2 in Nearctic region and 2 in Russia. *Coenomyia ferruginea* (Scopoli), a large, distinctive fly with coloration ranging from yellow to brown, is the only *Coenomyia* Latreille.species found in the Nearctic and Paleartic region; 3 other *Coenomyia* species are known from Asia. The most diverse group in the subfamily is the Holarctic genus *Dialysis* Walker, with 17 species mostly found in the US and temperate Asia. Many species of *Dialysis* have long, narrow stylate antennal flagellomeres that closely resemble aristate antennae.

The other four genera are the focus of most of the uncertainty. All four are either placed in separate families, unplaced in Xylophagidae, placed in Xylophagidae in monogeneric subfamilies Rachicerinae and Heterostominae (e.g. Jarzembowski & Mostovski 2000, Nagatomi 1977) or in a Xylophaginae *s.l.* (Woodley 2011).

Table 3. Ingroup and Outgroup taxa used in Xylophagidae analysis, with locality and gene coverage data.

Family group	ID	Locality	28s	CAD	AATS	PGD	TPI
Xylomyidae	*Xylomya parens*	USA: NC: Swain Co: Cherokee GSMNP Ravensford site: B. K. Cassel	AY456143 AY456153	FLYTREE	FLYTREE	FLYTREE	FLYTREE
Vermileonidae	*Vermileo opacus*	USA: CA	HM770493 AF238553 AF238529 AF238507 AF238510 AF238532 AF238556		FLYTREE		FLYTREE
Rhagionidae	*Rhagio hirtus*	USA: IL	DQ415535	FLYTREE	FLYTREE	FLYTREE	FLYTREE
Nemestrinidae	*Trichophthalma* cf. *punctata*		FLYTREE	FLYTREE	FLYTREE	FLYTREE	FLYTREE
Hilarimorphidae	*Hilarimorpha mentata*	UT: Wayne Co; Capitol Reef Natl Pk; Sulphur Crk; 31.v.1992-2.vi.1992; J.F. MacDonald	FLYTREE	FLYTREE	FLYTREE		FLYTREE
Xylophagidae	*Xylophagus cinctus*		HM770496	FLYTREE	FLYTREE	FLYTREE	FLYTREE
Xylophagidae	*Exeretonevra angustifrons*	AUS: NSW:South Black Ra., Tallaganda Natl Pk;14.3km fr. Hoskins town 3-21 Feb 2004; ANIC 2133; 35˚24'52"S 149˚32'09"E; C.Lambkin, N.Starick	HM770494	FJ040628	FLYTREE	FJ040733	FJ040682
Xylophagidae	*Arthropeas magna*	Canada: Saskatchewan	AF238503 AF238525 AF238549		NEW	NEW	NEW
Xylophagidae	*Coenomyia ferruginea*	USA: TN	AF238504 AF238526 AF238550		NEW	NEW	NEW
Xylophagidae	*Dialysis elongata*	NC: Avery Co.; 2km S Crossnore, Hwy 221; 3.viii.1996; L. Yang	AF238505 AF238527 AF238551	AF539869	NEW	NEW	NEW
Xylophagidae	*Heterostomus curvipalpis*	MEI-97-61: Chile M. E. Irwin	HM770495 HM183028	AY280682	NEW	NEW	NEW

Table 3 continued

Family group	ID	Locality	28s	CAD	AATS	PGD	TPI
Xylophagidae	*Rachicerus obscuripennis*	USA: NC: Wake Co: Raleigh; Schenck Forest MT streambed 7-17.vi.2009 K. M. Bayless	NEW	NEW	NEW	NEW	NEW

The Holarctic genus *Xylophagus* includes about 25 spp. and is most diverse in Russian Far East, and some authors ascribe subgenera (James, 1981). The sampled taxon *Xylophagus cinctus* (DeGeer) corresponds to *X. abdominalis* (Loew) included in Wiegmann 2000, which is now considered a junior synonym (Webb 1979).

Exeretonevra contains 4 described spp. from Australia, and its placement was debated before Palmer and Yeates (2000) presented strong evidence for a relationship with Xylophagidae based on larval morphology. *Heterostomus curvipalpis* Bigot, from Chile, is the only described species in the genus. The larvae are known and the description of its morphology is forthcoming (Sinclair, pers. comm.). *Rachicerus* includes 70 spp., holarctic and neotropical, and is most diverse in tropical Asia; additional undescribed species are known from the Neotropical region. *Rachicerus*, *Exeretonevra* and *Heterostomus* have each been sometimes considered at times as sister to large clades of Brachycera (Nagatomi 1977, 1982).

Several non-xylophagid outgroups were chosen from the phylogenetic datasets presented in Chapter 1. Five outgroups were included: *Xylomya parens* (Williston) (Stratiomyomorpha: Xylomyidae), *Vermileo opacus* (Coquillett) (Tabanomorpha: Vermileonidae), *Rhagio hirtus* Loew (Tabanomorpha: Rhagionidae), *Trichophthalma* sp. (Tabanomorpha?: Nemestrinidae), and *Hilarimorpha mentata* Webb (???: Hilarimorphidae). Nemestrinidae is included as it was placed as sister to Xylophagidae in Wiegmann *et al.*, (2011), and Hilarimorphidae due to its variable placement in multiple studies (Trautwein *et al.*, 2011, Wiegmann *et al.*, 2011). Two tabanomorphs were included, one from Vermileonidae was also sampled, as this family is sometimes placed in its own infraorder, Vermileonomorpha (Griffiths 1994, Nagatomi 1997).

Molecular methods

DNA was extracted from whole flies using the DNEasy kit according to manufacturer's instructions (Qiagen Inc., Valencia, CA). Extraction procedures for terminal taxa included in previous studies, primers and PCR conditions used to amplify sampled genes are specified in Wiegmann *et al.* (2000), Wiegmann *et al.* (2011), and Trautwein *et al.* (2011). Published primers and established PCR conditions were used to amplify 28S, CAD, AATS, PGD, and TPI (Table 4).

Table 4. Primers used for new data acquisition in Xylophagidae

Gene name	Primer code	Reference	Sequence 5'-3'
TPI	111Fb	Bertone *et al*., 2008	GGNAAYTGGAARATGAAYGG
TPI	277R	Bertone *et al*., 2009	CCDATNGCCCANACNGGYTC
AATS	39F	Wiegmann *et al*., 2011	TGTAAAACGACGGCCAGTGCNGGNATGAAYCARTTYAARCC
AATS	244R	Wiegmann *et al*., 2011	CAGGAAACAGCTATGACCATNCCRCARTCNATRTGYTT
PGD	2F	Regier *et al*., 2008	ATHGARTAYGGNGAYATGCA
PGD	4R	Regier *et al*., 2009	CCNGTCCARTTNGTRTG

PCR products were run on an agarose gel, and gel extractions performed by QiaQuick (Qiagen Inc., Valencia, CA). Sequencing was performed using BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, CA).

Sequencing electropherograms were visually inspected and edited in Sequencher 4.8 (GeneCodes Inc., Ann Arbor, MI). and later organized in Se-Al v2.0a11 (Rambaut, 2002). Translation-based alignment was unambiguous for nuclear protein coding genes except for PGD, which contains an easily identified intronic region that was subseuently removed from phylogenetic datasets. 28S alignments were performed based on secondary structure

alignments inferred from Wiegmann *et al.* (2011), or using the l-ins-i algorithm in MAFFT on its home server (Katoh *et al*., 2002) on CIPRES Teragrid / XSEDE (Miller *et al*., 2010). To obtain a secondary structure alignment (Kjer 1995), sequences were aligned using reference sequences aligned by secondary structure for Wiegmann *et al*. (2011). To identify positions of questionable alignment in 28S, masking was done using the least stringent parameters in G-Blocks (Castresana, 2002), and the resulting alignment was used in several analyses.

Phylogenetic analyses

Phylogenetic analyses were performed using maximum likelihood (implemented in RAxML-HPC2 7.3.0) and Bayesian analysis (implemented in MrBayes 3.1.2 Ronquist & Huelsenbeck 2003); clade suport was assessed with non-parametric bootstraps. Consense (Felsenstein, 1989) on CIPRES (Miller *et al*., 2010) was used to determine the bootstrap consensus as it allows bootstrap values lower than 50 to be mapped. Random seeds necessary for RAxML were obtained from http://www.random.org (Randomness and Integrity Services Limited, Dublin, Ireland). Bayesian tree search was carried out in MrBayes 3.1.2 (Ronquist & Huelsenbeck, 2003, Altekar *et al.*, 2004) on CIPRES XSEDE (Miller *et al.*, 2010). In the Bayesian analyses, data sets were partitioned by gene, 4 chains on 2 runs for 3 million generations, sampled every 1000 generations with a burnin of 300. Commands used in MrBayes are as follows: partition FIVE=5: 28s, CAD, AATS, PGD, TPI; set partition=FIVE lset applyto=(1,2,3,4,5) nst=6 rates=invgamma; prset applyto=(all) ratepr=variable; unlink pinv=(all) revmat=(all) statefreq=(all) shape=(all); mcmc ngen=3000000 nruns=2 nchains=4 samplefreq=1000 sump printtofile=yes burnin=300; sumt burnin=300. The average standard deviation of split frequencies was 0.002256.

The following sensitivity analyses were performed, and summarized in Table 2; 1) All genes: partitioned by gene, third codon position included; partitioned by codon, third codon position included; partitioned by gene by codon, third codon position included; partitioned by gene, third codon position excluded; partitioned by gene by codon, third codon position excluded; partitioned by codon, third codon position excluded; 2) 28S only: uncut (alignment inferred from MAFFT l-ins); Gblocks; 3) nuclear protein coding (NPC) genes

only: partitioned by gene, third codon position included; partitioned by codon, third codon position included; NPC genes only partition by gene, thirds excluded; NPC genes only partition by codon, thirds excluded.

RESULTS

Alignments and data sets

The fully aligned dataset includes 12 taxa and 8359 characters. 3324 basepairs of 28s were included, four regions of CAD totalling 3324 bp, 595 bp of AATS, 713 bp of PGD, and 479 bp of TPI. Gene coverage is nearly complete except for several regions of CAD for *Arthropeas* and *Coenomyia*. The data set includes 1317 parsimony-informative sites. When removing unalignable data, either by eye or by a masking program, branch length estimations may less accurate due to relative changes in sequence length before and after data exclusion. If the length of the loop regions of 28s differs between taxa, then when removing data, branch lengths based on those nucleotide changes may be affected disproportionately (Jorger *et al.*, 2011). Sensitivity analyses of masked and unaltered datasets provide a means of observing the extent of this bias. The General Time Reversible model including gamma and a proportion of invariant sites was used as a model for Bayesian inference and for RAxML, GTRCAT model was used for the bootstrapping phase, and GTRGAMMA for the final tree inference (Stamatakis, 2006, Miller *et al*., 2010).

Phylogenetic relationships

Xylophagidae is strongly supported as monophyletic in all analyses using the full concatenated gene data set. Coenomyiinae is also supported, as is a clade consisting of the other four genera (Figures 3-5). Among the sampled species outside of Xylophagidae, evidence to support a specfic sister group for Xylophagidae is low and inconsistent. Depending on partitioning scheme and included partitions, either Tabanomorpha (including Vermileonidae), Nemestrinidae, or a clade encompassing Tabanomorpha and Nemestrinidae is sister to Xylophagidae. A close relationship with *Hilarimorpha* or Stratiomyomorpha is not observed. Xylophagidae is recovered in single gene analyses when of TPI or 28S rDNA, but not when analyzing CAD, AATS, and PGD alone. Analyses including the nuclear protein coding genes alone (e.g. excluding 28S) do not recover Xylophagidae, but does recover

Xylophaginae and Coenomyiinae. No analysis supports *Rachicerus*, *Heterostomus*, or *Exeretonevra* outside Xylophaginae. Support for the monophyly of Coenomyiinae is consistently robust, and all topologies placed *Dialysis* as sister to a clade comprising *Arthropeas* and *Coenomyia*; the same topology was recovered by Wiegmann *et al.* (2000) based only on 28S.

Support for the monophyly of a clade comprising non-coenomyiine genera is moderate to high and consistent. The relationships between these non-coenomyiine ingroup taxa, however, are less consistent. *Rachicerus* and *Xylophagus* are resolved as sister groups, but their support varies under different reconstruction methods. In the Bayesian inference, *Heterostomus* and *Exeretonevra* are placed as sister clades, but in the Maximum Likelihood sensitivity analyses, this relationship is recovered with low support. In the sensitivity analyses, depending on the parameters, *Heterostomus* and *Exeretonevra* are sister groups, or *Exeretonevra* is sister to *Xylophagus*, or a group comprised of *Xylophagus* and *Rachicerus* is sister to either *Exeretonevra* or *Heterostomus* the sister to *Exeretonevra* + *Xylophagus* + *Rachicerus*, or *Exeretonevra* is sister to the rest. These relationships and support values vary depending on the alignment, masking, partitioning, genes included, and whether variable regions in 28S and 3rd positions in the nuclear protein coding genes are included. *Heterostomus* is sister to *Exeretonevra* with low bootstrap support unless third positions are included and the data set is partioned by codon, or if the nuclear protein coding genes are analyzed singly or together. *Rachicerus* and *Xylophagus* are resolved as sisters, with low bootstrap support unless third positions are removed and the dataset is partitioned by codon or gene by codon, or if AATS is analyzed alone or if 28S is excluded. The incidence and support for these topologies is enumerated in Table 5.

Table 5. Xylophagidae sensitivity analyses. 2nd in alignment refers to secondary structure; gbc is gene by codon partition; npc refers to nuclear protein coding genes. Values are bootstrap supports from RAxML rapid bootstrapping analyses.

Included Alignment	all MAFFT	all MAFFT	all MAFFT	all MAFFT	all MAFFT	all MAFFT	all 2nd	all 2nd
Masking	gblocks	gblocks	gblocks	gblocks	gblocks	gblocks	none	eye
Partition	gene	gbc	codon	gene	gbc	codon	gene	gene
3rds	in	in	in	out	out	out	in	in
Length in bp	8359	8359	8359	6791	6791	6791	9187	8903
Xylophagidae monophyly	72.5	83	79.7	93.3	93.3	87.7	65.1	61.8
Coenomyiinae monophyly	100	100	99.8	99.9	98.7	99.2	100	99.9
Arthropeas + *Coenomyia*	100	100	100	100	100	100	100	100
Xylophaginae monophyly	96	96.9	99.5	95.5	93.8	97.6	86.4	81.2
Heterostomus sister to other Xylophaginae								
Exeretonevra sister to other Xylophaginae			99.5					
Rachicerus sister to other Xylophaginae					93.8	97.6		
Heterostomus + *Exeretonevra*	40.7	34.5		54.1	53	58.5	50	41.6
Rachicerus + *Xylophagus*	43.3	50	53.1	40.3			54.2	56.7
Xylophagus + *Exeretonevra*								
Heterostomus sister to *Xylophagus* + *Exeretonevra*								

Table 5 continued

included alignment	npc	npc	npc	npc	npc	28S MAFFT	28S MAFFT	TPI	AATS	PGD	CAD
masking						none	gblocks				
partition	none	gene	gbc	codon	gene	gene	gene	none	none	none	none
3rds	in	in	in	in	out			in	in	in	in
length in bp	5031	5031	5031	5031	3354	4130	3437	480	594	714	3243
Xylophagidae monophyly						89.8	94.7	62			
Coenomyiinae monophyly	74.3	87.5	85.1	82.3	53.9	90.4	75.1	99.3	56.7	88	
Arthropeas + *Coenomyia*	96.6	98.8	96.7	99	89.6	98.9	100	99	33.6	68.6	
Xylophaginae monophyly	69.5	67.2	71.6	72.4	33.1	44.6	40.8	83.3		67.3	
Heterostomus sister to other Xylophaginae			71.6								
Exeretonevra sister to other Xylophaginae											
Rachicerus sister to other Xylophaginae	69.5	67.5		72.4							
Heterostomus + *Exeretonevra*						68.9	52.3	38.9			
Rachicerus + *Xylophagus*						27.2	32.9	54.3		43.9	
Xylophagus + *Exeretonevra*	32	24.1	28.8	36.5					43.5		
Heterostomus sister to *Xylophagus* + *Exeretonevra*	38.9	30.5		23.3							

DISCUSSION

The dataset used in the present study provides a new, well-supported phylogenetic phylogenetic hypothesis for the Xylophagidae. The composition of the group and relationships among its major genera have been difficult to discern using more traditional methods. Sequence data provide key new evidence to evaluate unique and controversial morphological features in the group. For example, the recessed clypeus in adult Coenomyiinae corroborates their monophyly. Coenomyiinae species also have less sclerotized larvae with wider heads than *Xylophagus* and *Rachicerus* (James, 1981), though they can be distinctly recognized as xylophagids. Woodley (2011) suggests that *Odontosabula* is closely related to *Coenomyia* and *Anacanthaspis* is related to *Arthropeas*. *Dialysis*, the most species-rich genus within Coenomyiinae, and the only genus with an aristate-like flagellum, shares fewer characters with *Odontosabula* and *Anacanthaspis*, but as these taxa are not included in the present study so their affinities. Palmer and Yeates (2000) placed *Exeretonevra* in Coenomyiinae, however I here resolve *Exeretonevra* closer to the non-coenomyiine genera.

Since the other genera of Xylophagidae form a monophyletic unit sister to Coenomyiinae, the classification of higher categories of Xylophagidae is a matter of further taxonomic revision. Although, the adult morphology family includes significant variation, each genus is easily diagnosable. Five families could be a justified classification. However the arguments for including them all in the same family are more compelling. All Xylophagidae, apart from *Heterostomus*, have highly distinctive larvae, clearly differentiated from any other Brachycera in morphology and ecology. *Heterostomus* larvae are known but their description is unpublished, and the adults are bizarre, however wing venation characters can describe Xylophagidae including *Heterostomus* (Woodley, 2009) A monophyletic single family -Xylophagidae is more informative, as the infraorder level is less commonly used, so 5 families in a monophyletic Xylophagomorpha is accessible to fewer researchers. Nemestrinidae, a group with divergent larval habitus and ecology, may be the sister group to Xylophagidae, this might dilute the meaning of a Xylophagomorpha and distort the more obvious natural division between the two clades. Or, if instead I find Xylophagidae is better

placed within Tabanomorpha, having 5 separate families would significantly change the concept of that group. Either way, it is more useful to retain the nine genera conscribed at the family level within a widely recognized taxonomic unit. Separating Coenomyiidae, Rachiceridae, Exeretonevridae, and/ or Heterostomidae is not warranted.

DNA data for two distinct samples of *Heterostomus curvipalpis* exist on GENBANK, one from Trautwein *et al*. (2010) and one from Kerr (2010). The sequences show a large amount of divergence in 28S, however they are both supported in Xylophagidae if one or both sequences are included. Though this may be indicative that one of these samples contains contamination, the placement of these strongly suggests that there is large variation within the putative species. More samples of *Heterostomus* are needed to resolve this, and may result in the discovery of undescribed species.

Similar arguments can be used for having 4 subfamilies other than Coenomyiinae. The fact that the non-coenomyiine genera are distinguishable is already clear from their description as 4 genera. There is no need to ignore the fact that these four genera are highly distinctive, so as our Bayesian inference resolves *Rachicerus* and *Xylophagus* as sister groups, this is the most useful classification, considering the history, morphology, and phylogeny of Xylophagidae.

New Xylophagidae Classification

Coenomyiinae
- *Anacanthaspis* Röder, 1889
- *Arthropeas* Loew, 1850
- *Coenomyia* Latreille, 1797
- *Dialysis* Walker, 1850
- *Odontosabula* Matsumura, 1905

Xylophaginae
- Heterostomini Nagatomi, 1977 (n.stat)
- Exeretonevrini Daniels, 1989 junior synonym
  - *Exeretonevra* Macquart, 1846
  - *Heterostomus* Bigot, 1857

- Xylophagini (rev. stat)
- Rachicerini Curran, 1934 junior synonym
  - *Xylophagus* Meigen 1803
  - *Rachicerus* Walker, 1854

This classification is useful and imparts the following discoveries of our phylogeny; Xylophagidae, Coenomyiinae, and the other genera are supported as monophyletic; Coenomyiinae is strongly supported, and sister to the rest; genera other than Coenomyiinae form a clade; a sister group relationship between Rachicerus and Xylophagus is supported; *Exeretonevra* and *Heterostomus* are supported as closely related to Xylophagini. Woodley (2011) notes four potential synapomorphies uniting Xylophagus and Rachicerus.

The lack of resolution I found for the Xylophaginae taxa sampled from different regions reduces how much I can say about macroevolution and biogeography of Xylophagidae. Since Coenomyiinae, entirely Holarctic, is sister to the rest, Xylophagidae either dispersed to the Northern Hemisphere twice or the southern hemisphere once. Within Xylophaginae, support for a southern hemisphere assemblage and northern hemisphere assemblage is relatively low. A southern hemisphere origin is still plausible. Data from Neotropical *Rachicerus* would be informative as they may represent the remnants of Xylophagids moving north, or a secondary dispersal by derived *Rachicerus*. While additional sampling would be helpful, more data for *Heterostomus* will reduce the uncertainty due to the previously mentioned problems with the templates from Kerr (2010) and Trautwein *et al*. (2010).

The sister group to Xylophagidae is not resolved by this study, however no new hypotheses are present in the analyses. Wiegmann et al. (2011) recovered a sister group relationship with Nemestrinidae as does Chapter 1. More traditional classifications and the phylogenetic hypothesis of Wiegmann et al. 2000 instead recover Xylophagids sister to Vermileonidae and the other Tabanomorpha. As might be expected for old lineages such as these, removing third position sites reduces support within the Xylophagidae, but increases support for its placement in regard to other brachyceran families.

Our phylogenetic hypothesis reveals two biological noteworthy examples of morphological reversal that underscore the importance of understanding the evolution of Xylophagidae. Larval Coenomyiinae have a conical, highly sclerotized head and a flattened dorsal spiracular plate posteriorly. Larval Xylophagini have a more elongate head and sclerotized thoracic plates (James, 1981). This syndrome is thought to afford the voracious

larvae protection from the environment and their prey as they patrol narrow spaces in rotten logs and the soil (Palmer & Yeates, 2000). *Exeretonevra* has simplified larvae compared to either of these, as does the unpublished larvae of *Heterostomus*. Our phylogenetic hypothesis that *Exeretonevra* and *Heterostomus* are sister to Xylophagini show that this larval syndrome was either lost or evolved independently. This may corroborate two transitions between wood and soil dwelling as was hypothesized by Palmer and Yeates (2000).

Our phylogeny and classification confirm that *Rachicerus*, the only brachyceran fly with more than 8 antennal flagellomeres, is not a transitional lineage placed between the lower Diptera and Brachycera. Instead, it is strongly supported as sister to *Xylophagus* within a well-supported Xylophagidae. Even if Xylophagidae is sister to all Brachycera, which is unlikely, *Rachicerus* is still separated from stem Brachycera by four nodes. While the placement of Xylophagidae is not resolved, four nodes is likely an underestimate given the age of the group and our limited sampling. The exact placement of *Rachicerus* is dependent on partitioning and alignment, however there is no conflict as to its placement within Xylophagidae. Mapping flagellomere number on the phylogeny by parsimony implies a clear reversal of flagellomere loss in these flies.

This could be an intriguing counterexample to Dollo's (1893) principle of the irreversibility of organic evolution for complex traits. There are two biologically reasonable scenarios for the reversal in antennal morphology of *Rachicerus*: that the flagellomere number of other flies was reduced independently, or that the flagellomere of *Rachicerus* is a reversal

1) The reduction of antennal flagellomeres in the other xylophagid genera, and their potential sister groups -Nemestrinidae and other Tabanomorpha- occurred independently. Under this explanation, a reduced flagellomere became a synapomorphy for Brachyceran flies on a branch closer to Cyclorrhapha, in other words, more than 8 flagellomeres is in the groundplan of all Brachycera and is lost independently in Xylophagidae and all remaining lower Brachyceran taxa. This is corroborated by the diversity of antennal morphology in Xylophagidae, and lower Brachycera in general. Many fossil Brachycera species have been

described, but no others have been described with more than 8 flagellomeres, thus leaving no paleontological evidence for this case.

2) *Rachicerus* antennae represent a true reversal. In this scenario, one would infer that the gene regulatory cascade silenced or lost in the brachyceran stem was not entirely lost when the first *Rachicerus* evolved, or was somehow re-activated. There are examples in modern genetics to support this, for instance the same gene (*pax6/eyeless)* regulates eye development in molluscs, *Drosophila*, and vertebrates, although their most recent common ancestor was probably eyeless (Tomarev *et al*., 1997; Xu *et al*., 1997). Another example is the same genes (*nkx2-5*) regulating the development of the heart in many organisms (Olsen, 2006). A possible reversal to a 'non-brachyceran' state from a maximum of 8 annulations to 20-36 in *Rachicerus* is astounding. Further genetic studies to understand the regulation of the development of xylophagid antennae are necessary to confirm whether this is a reversal. It is possible that the multi-annulation of Rachicerus antennae is derived in a novel way from other flies. This is less likely because only non-brachyceran flies and *Rachicerus* have this multiannulate antennal form. Even if *Rachicerus* and non-brachyceran fly antennae are not homologous, morphologically or genetically, this antennal form would represent a fascinating evolutionary novelty deserving further investigation.

Conclusion

Our study reveals a set of new, sequence-based, phylogenetic hypotheses for Xylophagidae. The stark differences in topology and bootstrap values observed depending on partitioning, alignment, and masking affect the topology demonstrates how choice among genes, included partitions, and alignment methods can affect recovery of relationships among taxa, especially if divergences are quite old. Uncertainty of the utility and information content of hypervariable regions suggests that the use of a single alignment method, masking, and partitioning paradigm based on a priori assumptions about the focal taxon may lead to overconfidence in a single result.

Although the key node for biogeographic turnover is not supported, and identification of the sister group to Xylophagidae was inconclusive, our understanding of the phylogeny of Xylophagidae is greatly increased. Within Xylophagidae, our study confirms an informative

classification. Unexpectedly, our study suggests that the unmistakeable larval habitus of Xylophagidae has a complex evolutionary history. This study substantiates the antennal condition of *Rachicerus* as a remarkable novelty in the morphological evolution of flies. Further behavioral and genetic studies on these multiannulate antennae will doubtless be fruitful.

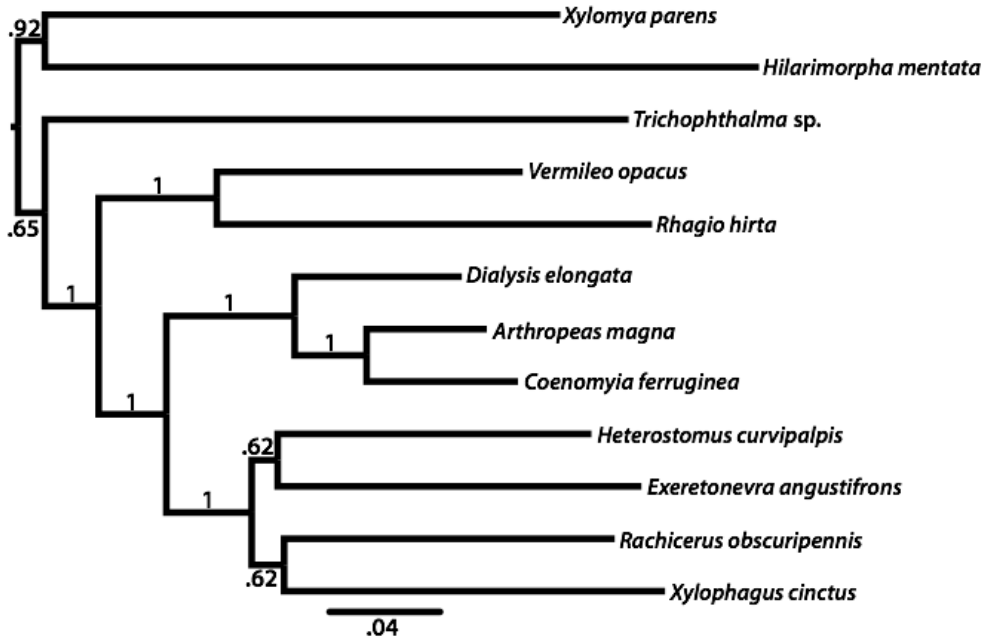
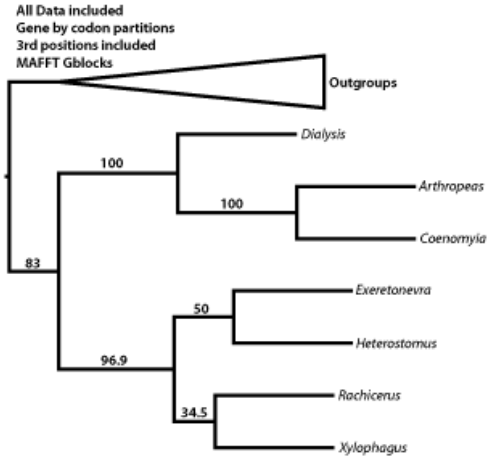
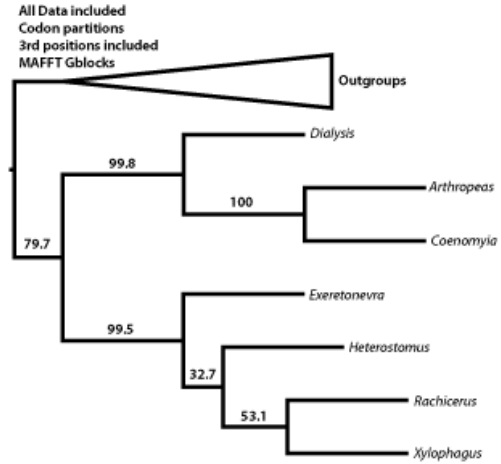
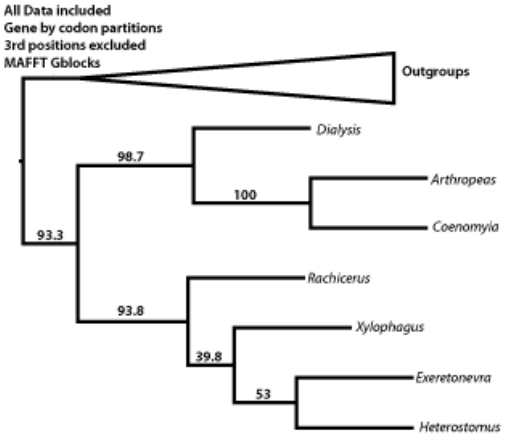


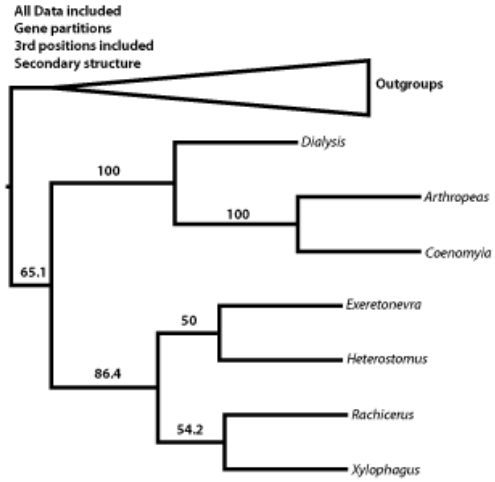
Figure 4. Bayesian topology for Xylophagidae based on the full concatenated data set. All posterior probabilities shown next to respective nodes.

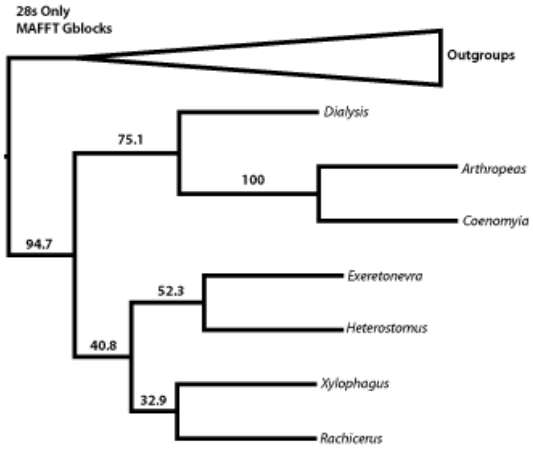
Figure 5. Examples of alternate topologies of Xylophagidae based on sensitivity analyses in Maximum Likelihood (RAxML). The data included, partitioning, and alignment protocol changes not only the support value but the topology recovered.

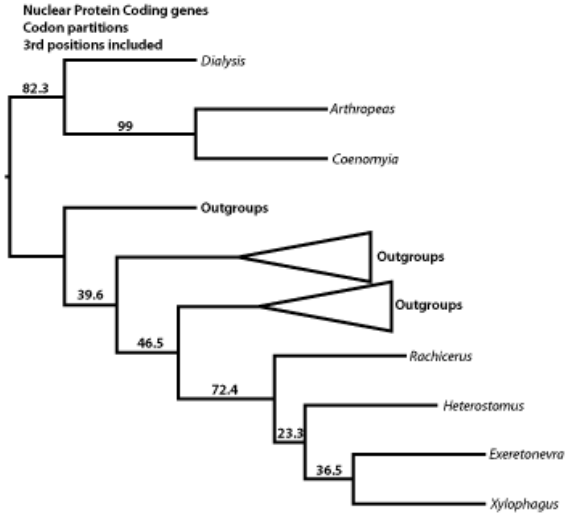

All Data included
Gene by codon partitions
3rd positions included
MAFFT Gblocks
Outgroups
Dialysis
Arthropeas
Coenomyia
Exeretonevra
Heterostomus
Rachicerus
Xylophagus
100
100
83
50
96.9
34.5


All Data included
Codon partitions
3rd positions included
MAFFT Gblocks
Outgroups
Dialysis
Arthropeas
Coenomyia
Exeretonevra
Heterostomus
Rachicerus
Xylophagus
99.8
100
79.7
99.5
32.7
53.1


All Data included
Gene by codon partitions
3rd positions excluded
MAFFT Gblocks
Outgroups
Dialysis
Arthropeas
Coenomyia
Rachicerus
Xylophagus
Exeretonevra
Heterostomus
98.7
100
93.3
93.8
39.8
53


All Data included
Gene partitions
3rd positions included
Secondary structure
Outgroups
Dialysis
Arthropeas
Coenomyia
Exeretonevra
Heterostomus
Rachicerus
Xylophagus
100
100
65.1
50
86.4
54.2


28s Only
MAFFT Gblocks
Outgroups
Dialysis
Arthropeas
Coenomyia
Exeretonevra
Heterostomus
Xylophagus
Rachicerus
75.1
100
94.7
52.3
40.8
32.9


Nuclear Protein Coding genes
Codon partitions
3rd positions included
Dialysis
Arthropeas
Coenomyia
Outgroups
Outgroups
Outgroups
Rachicerus
Heterostomus
Exeretonevra
Xylophagus
82.3
99
39.6
46.5
72.4
23.3
36.5

CHAPTER 3

Thorough taxon sampling of the Diachlorini yields a new phylogeny based classification of Tabaninae

INTRODUCTION

The four and half thousand species of horse flies comprise Tabanidae, the largest lineage of bloodsucking insects. Like many biting flies, they can transmit diseases to humans, such as the filarial disease loa loa, and in rare cases anthrax (Rao & Mohiyudeen, 1958; Kraneveld & Djaenoedin, 1940), tularemia (Farlow *et al*., 2005; Klock *et al*., 1973), and trypanosomiasis (Desquesnes & Dia, 2004). Their populations can be dense enough to cause losses in tourism, and physical damage to livestock (Perich *et al*., 1986, Davis & Saunders, 1981, Kingston, 1983). The painful bite of a horse fly (Stoffolano & Yin 1983) can be frustrating as they are among the fastest and most agile of all flying insects - some aerial maneuvers developed with fighter jets were truly invented by horse flies first (Wilkerson & Butler, 1984).

Both sexes visit flowers as adults, and this behavior is much less studied than hematophagy. Horse flies can be dominant pollinators in semiarid regions (Johnson & Morita, 2006) The likely key role of horse flies as pollinators in tropical forests where their populations are dense deserves serious investigation. The venomous predatory larvae are found in a variety of semiaquatic environs (Teskey, 1990). The most diverse subfamily is Tabaninae, which includes the conventional horse flies in the very species rich genus *Tabanus.* Most adults have a broad host range, although most of the few horse flies with specialized adult hosts are tabanines (e.g. Limeira-de-Oliveira *et al*., 2002; Ferreira *et al*., 2002). Similarly, several genera of Tabaninae have restricted larval habits, though most are typical voracious predators in muddy substrates as far as is known.

Tabaninae is defined by several clear anatomical characters of unclear function, for instance the loss of the tibial spurs on the metathoracic leg (Mackerras. 1954), and is strongly supported in previous molecular phylogenies (Wiegmann *et al*., 2000; Morita *et al*., in prep). Why this lineage has diversified more successfully than other horse fly and most other bloodsucking insect lineages is not apparent. There are a few Tabaninae with aberrant

morphologies and ecological strategies, but the relationships of these taxa have not been addressed. This study seeks to characterize the diversity of horse flies and assess whether ecological diversity foster radiations, or whether oddballs belong to relictual lineages by assembling a thorough sample of Tabaninae.

I have taken a major step towards understanding the drivers of this remarkable diversification by identifying natural groups and forging a more useful classification. The focus of this study is the cosmopolitan Diachlorini, the most genus-rich tribe. Tabanini, including the huge genera *Tabanus* and *Hybomitra*, and Haematopotini are more thoroughly sampled than ever before, and future studies will address its complex evolutionary history. The nearly 70 genera of Diachlorini include many unusual groups, such as some *Stenotabanus* (*Cretotabanus*) *cretatus* and *Phaeotabanus* species that hunt anacondas (Ferreira *et al*., 2002); sand dune denizens like *Stenotabanus* (*Aegialomyia*) (Fairchild, 1980). *Stibasoma* larvae are predators in the water inside bromeliads (Burger, 2009). The larvae of wasp-mimicking *Acanthocera* are only found in sap filled rotting holes in certain trees (Burger, 2002). *Lepiselaga crassipes* lives in open water apparently feeding on water lettuce (*Pistia*) (Fairchild, 1969). *Leucotabanus ambiguus* larvae are only found in the nests of certain termite species (Burger, 1974). *Bolbodimyia* larvae are found in moss mats in hygropetric habitats (Burger, 1974), and some South American *Dasybasis* are found in fast flowing mountain streams (Coscaron & Philip, 1967). *Chlorotabanus*, *Cryptotylus*, and *Stibasoma* (*Rhabdotylus*) all feed nocturnally as adults. The longest-tongued horse flies outside of Pangoniinae are diachlorines in the genus *Dasychela*. The diversity of Diachlorini is centered in South America and Australasia, and the biology of most species is unknown.

There is a paucity of studies examining the phylogenetic history of Tabaninae relative to its diversity and importance. Trojan *et al*. (1997) used distance methods and a morphological data set of nine characters to investigate the relationships of the five tribes sensu Trojan (1994a)- Diachlorini Heptatomini, Haematopotini, Lepidoselagini, and Tabanini. These tribes were described based on some characters shown to be variable in the same species (Burger, 1991), such as the width of the clypeus. Lepidoselagini consisted mainly of species in Diachlorini s.l. with wider clypeus from temperate climates. Trojan *et al*.

(1997) suggested *Heptatoma* sister to the rest of Tabaninae, but the rest of the results were inconclusive, as almost every topology possible including those five taxa was presented. Fang et al (1999) presented a cladistic analysis of horse flies based on mouthpart characters. El-Hassan *et al*. (2010) presented a morphological phylogeny using only Egyptian exemplars. The utility of molecular barcoding using cytochrome oxidase I in Tabanidae phylogenetics was explored by Cywinska *et al*. (2010). Fang *et al*. (1999), El-Hassan *et al*. (2010), and Cywinska *et al*. (2010) do not have conclusive results but concur as to the lack of support for the monophyly of *Tabanus*. Birus *et al*., (in prep) used mitochondrial ribosomal genes to show that European species of Diachlorini are a separate lineage from European *Tabanus*.

The classification of Tabaninae, though turbulent prior to the later half of the twentieth century, has been remarkably stable since Mackerras (1954). Diachlorini was described by Lutz (1909, 1911). Tabaninae and Diachlorini were given more expansive meanings by Enderlein (1922) and Kröber (1931a, 1932). Enderlein (1922) also split *Tabanus* into several subfamilies, e.g. Bellardiinae. Mackerras (1954, 1971) and Fairchild (1969a, 1969b, 1971) worked to sort out the discrepancies and instituted the current 3- tribe system, with a narrow Haematopotini and expansive Tabanini and Diachlorini, which Fairchild and Mackerras conceded may not be natural groups. Mackerras said on the subject that Tabanini 'merges with Diachlorini in the neotropical region.' Though the phylogenies and classifications vary, several generalizations can be made. Olsufjev (1964), Terteryan (1980) Philip (1941), and Trojan (1994a) proposed new tribes based on various subdivisions, however none of these received wide recognition. The Bayesian inference and maximum likelihood phylogenies presented by Morita *et al*. (in prep), using mitochondrial, nuclear ribosomal, and nuclear protein coding genes, showed Diachlorini to be a grade, a progression of relationships including two other diverse and morphologically distinct tribes, Tabanini and Haematopotini, which were not resolved in respect to one another. I anticipate the non-monophyly of *Tabanus* and Diachlorini.

During the course of a USA National Science Foundation PEET (Partnerships for Enhancing Expertise in Taxonomy) grant to reinvigorate study of the family, the rigorous test

of the phylogeny of Tabanidae using molecular characters was completed (Morita *et al*., in press) Here I delve into Tabaninae with a more extensive taxon sample, two new genes, and morphological data. The 49 character morphological data set represents the largest sampling of morphological characters ever assembled to investigate Tabanidae phylogeny. Prior to Morita *et al*., (in prep), there were no rigorous phylogenetic hypotheses of worldwide Tabanidae using repeatable methods. There have been several attempts to classify Diachlorini.

Our intensive sampling using data from mitochondrial cytochrome oxidase 1, ribosomal 28S, and three nuclear protein coding genes, PGD, AATS, and CAD (CPS) and 49 external adult morphological characters will allow for a full test of Mackerras's (1954) classification. Ten diachlorine genus groups form natural groups, and at least five of these must be raised to a suprageneric level to inform a more robust classification of Tabaninae. I discuss the morphological homoplasy and potential biogeographic signal that underlies the three poorly resolved areas of the topology that may indicate ancient rapid radiations.

MATERIALS AND METHODS

Morphological characters were assembled primarily from anatomical and phenotypic concepts considered previously considered as useful characters for classification, identification, or phylogeny (e.g. Fang *et al*. 1999, Terterian 1972, 1980, Trojan *et al.* 1997, Coscaron & Papavero 1994, Burger 1981). Explicit language is used to refine terminology commonly used by horse fly specialists to define several characters. For instance, basal flagellomere complex instead of basal plate of antennal flagellum (e.g. Coscaron & Papavero 1994) as this structure is likely derived from many elements (Stuckenberg 1999) and 'plate' is misleading; macrotrichiae on the basicosta instead of setae as there are two distinct sizes of setae present. All terms can be understood through Burger (2009) and McAlpine (1981). Morphological character states were scored from specimens collected dry, in ethanol, or in propylene glycol using a Nikon SMZ1000 stereomicroscope (Nikon Corp. Tokyo, Japan). Photomicrographs taken for this study were by a LEICA Z16APO, stacked with Automontage Pro. The morphological and molecular data set included 217 species, genomic data for most of which was extracted using the basic protocol and components of QiaGEN

DNeasy Blood & Tissue Kit (QiaGen Valencia, CA).

Modified extraction protocol for ancient DNA

DNA data were extracted for some specimens available only as pinned material, or alcohol specimens of old or questionable provenance. The extraction procedure differed for these, and was adapted from Evangelista (2012). For some specimens available only as pinned material, modifications were made in the extraction protocol. These modifications served to thoroughly clean the samples in order to remove potentially contaminating surface pollutants, and to enhance DNA yield on the genomic template, as DNA in pinned material is known to degrade over time (Lindahl, 1993). With this procedure, 28S rDNA and PGD data were obtained from 40 year old specimens, specimens that were kept in the open in room temperature ethanol for more than ten years, and specimens that had already been used in failed full body extractions with the typical Qiagen extraction. The goals of the procedure are to minimize contamination while insuring that the DNA is adequately hydrated. The novel procedure for horse flies is explained here:

1. Thoroughly sterilize tools and working space using 10% bleach solution, 95% ethanol, flame sterilization, and/or ultraviolet radiation cross-linking.
2. Prior to extraction, remove one leg if the specimen is pinned, the right metathoracic leg in this study, and pull some muscle tissue out of the thorax or the whole specimen if it is in ethanol and wash with pure water and ethanol. Focus on removing moth scales or fungal debris with forceps, brushes, and water and alcohol rinses.
3. Incubate the specimens in 70% ethanol for 24 hours to one week, with vial and ethanol replaced at each 8-12h. After removed from ethanol, rinse the samples with pure water, transfer them to Qiagen AE buffer, then to new water, then new AE several times, and soak them in AE for 24h.

During extraction procedure:

4. Remove a leg from the whole specimen in alcohol. Homogenize the leg and muscle tissue as well as possible, though with sclerotized horse fly legs they may never be entirely homogenized. Then put the whole fly into the extraction if possible.
5. Incubate in Proteinase K + ATL Buffer for 48 hours. Grind the leg tissue again and hand

mix the tube in 8-12 hours intervals. After 24 hours, add another 5µl of proteinase K.
6. During the rest of the steps, do not mix extracts by vortexing. Instead, gently shake the vial and carefully mix the extract with a pipette tip.
7. Before eluting the DNA out of the spin column (step 13), heat AE buffer up to 50ºC. Refrigerate AW wash before use Pipet 30µl Buffer AE directly onto the membrane and let it incubate for 2-5min. Repeat the elution with 100µl and place this elution in a separate vial. Following the extraction procedure, specimens were soaked into 95% ethanol during 24h to prevent further tissue digestion by the DNA extraction agents. All genomic extracts are currently stored at -80°C in TE buffer in the North Carolina State University Insect Genome Bank.

Nine gene fragments were amplified from five genes; the barcoding region (Hebert *et al*., 2003) of mitochondrial Cytochrome Oxidase I (COI); three amplicons of nuclear ribosomal 28S, d-i, f-k, and q-z (Wiegmann, 2000); one amplicon of alanyl-tRNA synthetase 1 (AATS); one amplicon of phosphogluconate dehydrogenase (PGD) (Regier *et al*., 2008); and three amplicons of carbamoylphosphate synthase domain of the rudimentary locus (CAD=CPS), called CAD1, CAD3, CAD5 (Moulton & Wiegmann, 2007). Primers used were new or from Wiegmann *et al*. (2000), Bertone *et al.* (2008), Regier *et al*. (2008), Wiegmann *et al.* (2011) and Morita *et al*. (in prep). New primers used in this study can be found in table 6.

Table 6. New primers developed for this study for use in Diachlorini.

Gene	Primer	5’-3’ sequence
28s	d1 dia	TGATTGGGAAGCAATAAAATGG
28s	f1 dia	GAGGTGTAGCATAAGTGGGA
28s	f2 dia	GTGTTCAGTACATACAGAGAC
28s	q1 dia	GGTCGTATCCGTGCTGGATTGTAATG
28s	i1 dia	TTCCCCAAGTCCGTGCCAGTTCT
28s	k1 dia	CCGCCCCAGTCAAACTCCCCACC
28s	k2 dia	GGTTCCTCTCGTACTACGCA
CAD1	65F TAB	CCTGAATCWATGACTGAYCG
CAD1	75F TAB	MGRTCRCAAATHYTDGTRYTRAC
CAD1	384R TAB	DCCTTCRTTDGSNTKRTCRTTNABRTTHG
CAD1	392R TAB	TCYTKRTGKATTATRCCTTC
m13 CAD	592F DIA	GCTGGARTHTTTRAAAAGTATAA

Table 6 continued

m13 CAD	603F DIA	CTTGGRACWCCAATHAAAWCAAT
m13 CAD	800R DIA	ACSACACARTAATCSARRCTVGGTTC
m13 CAD	809R DIA	AAYTTRGCYAARTCCCAACGDGGDATTT
CAD	1062F TAB	GATATGTGCGATCGTYTYTAYTTTGARG
CAD	1069F DIA	GAGGAAATYTCNTTTGARGTDGTYATGG
CAD	1074F STE	GGAAATHTCDTTTGARGTKGTYATGGA
CAD	1077F TAB	GTKATGGAYATTTATSAGMTGG
CAD	1265R DIA	ATCAAGGAGRGCNGCAATATC
CAD	1271R TAB	AAADGGTCCAGTCACATC
CAD	1278R TAB	RTTNTTYTTGGCGATGAAGTGCAT
m13 PGD	2+20FDIA	TGGCTGYYGARTTYGATAAATGGAA
m13 PGD	4-31RDIA	CCCCACTTAACYGCRTGACTAACAAC
PGD	4-82R DIA	CTTCGRATRATACARCCTCC

For more sequencing details, see Materials and Methods of Chapter 2. Introns in PGD were removed, as they could not be aligned for many taxa. Otherwise, alignment of protein coding genes was trivial. 28S was aligned in MAFFT e-ins-i algorithm (Katoh *et al*., 2002; 2005), and unalignable regions were identified using the least stringent parameters on GBlocks (Castresana, 2000) and removed in the analyzed dataset.

Bayesian inference using MrBayes 3.1.2 (Ronquist & Huelsenbeck, 2003, Altekar *et al*., 2004) on CIPRES Teragrid (Miller *et al*., 2010), partitioned by gene. The commands were as follows: partition six=6: CO1, AATS, PGD, CAD, 28S, MORPH; set partition=six; lset applyto=(1,2,3,4,5) nst=6 rates=invgamma; prset applyto=(all) ratepr=variable; unlink pinv=(all) revmat=(all) statefreq=(all) shape=(all); mcmc ngen=18000000 nruns=2 nchains=6 samplefreq=1000. Maximum likelihood analyses were performed on Cipres Teragrid RaxML 7.2.8, 1000 bootstraps using RaxML rapid bootstrapping algorithm were also performed on the data set (Stamatakis, 2006, Miller *et al*., 2010).

MORPHOLOGICAL CHARACTERS

1. ABDOMEN POLLINOSITY: (0) pollinose; (1) bare and glabrous (e.g. figure 6f).
2. ABDOMINAL SHAPE: (0) lateral margins approximately straight, posterior apex rounded; (1) narrow anteriorly and widened posteriorly, wasp-like (figure 8a); (2) lateral margins approximately straight, posterior apex acutely pointed.

3. ABDOMINAL COLOR AND TRANSLUCENCE: (0) dark brown, gray not translucent; (1) pale, greenish, translucent.
4. FACE INFLATION: (0) flat; (1) inflated.
5. FRONTOCLYPEUS POLLINOSITY: (0) pollinose; (1) pollinosity absent medially; (2) entirely bare & shining.
6. OCELLI PRESENCE: (0) absent; (1) present.
7. OCELLAR TUBERCLE PRESENCE: (0) absent; (1) present.
8. SUBCALLUS INFLATION: (0) flat; (1) inflated (figure 8c).
9. SUBCALLUS PRUINOSITY: (0) pruinose; (1) partly bare medially to entirely bare(figure 8c).
10. BASAL FLAGELLOMERE COMPLEX: (0) absent; (1) present.
11. NUMBER OF ANTENNAL ANNULATIONS: (0) 8; (1) 5 total, 4 smaller annulations distal to basal flagellomere complex; (2) 4 total 3 smaller annulations distal to basal flagellomere complex; (3) 3 total 2 smaller annulations distal to basal flagellomere complex.
12. DORSAL PROJECTION OF BASAL FLAGELLOMERE COMPLEX PRESENCE: (0) absent; (1) present (Figures 7b, 7f).
13. LENGTH OF DORSAL PROJECTION ON BASAL FLAGELLOMERE COMPLEX (relative to rest of flagellum): (0) shorter than basal flagellomere complex; (1) as long or longer than basal flagellomere complex, shorter than rest of flagellum; (2) longer than rest of flagellum.
14. PEDICEL SHAPE: (0) cylindrical; (1) wider distally; (2) enlarged medially, globose.
15. PEDICEL DORSAL PROJECTION: (0) absent; (1) present.
16. SCAPE POLLINOSITY: (0) pollinose; (1) bare.
17. SCAPE SHAPE: (0) cylindrical; (1) wider distally; (2) enlarged medially (globose); (3) with dorsal projection.
18. FRONTAL CALLUS: (0) absent; (1) present.
19. FRONTAL CALLUS EXTENT (in respect to eye margin): (0) separated; (1) touching.

20. FRONTAL CALLUS MORPHOLOGY: (0) basal callus absent, medial callus present; (1) basal callus present, medial callus present; (2) basal callus present, medial callus absent.
21. FRONTAL CALLUS EXTENT (in respect to subcallus): (0) separated; (1) touching.
22. PROBOSCIS FUNCTIONAL SIZE: (0) normal sized, functional; (1) very small, nonfunctional.
23. PROBOSCIS LENGTH (with respect to head height): (0) proboscis shorter than head height; (1) proboscis as long as or longer then head height; (2) proboscis more than twice head height.
24. EYES COLOR IN LIVING FEMALE: (0) single color; (1) two colors; (2) three colors; (3.) one to four lateral bands; (4) multiple bands and spots.
25. EYE SETULOSITY LENGTH IN FEMALE: (0) bare or microscopic; (1) setulosity present.
26. LABELLA SCLEROTIZATION: (0) membranous and pollinose; (1) sclerotized.
27. LABELLA SCLEROTIZATION EXTENT: (0) partly sclerotized, partly membranous and pollinose; (1) entirely sclerotized.
28. SECOND PALPOMERE SHAPE IN FEMALE: (0) slender; (1) broad basally.
29. SECOND PALPOMERE POLLINOSITY IN FEMALE: (0) pollinose; (1) bare.
30. MESONOTUM VESTITURE TYPE AND EXTENT: (0) pollinose; (1) partly bare; (2) with sparse green setulosity; (3) long dense setulosity.
31. MESONOTUM PATTERN: (0) one color; (1) longitudinal stripes present; (2) transverse bands present; (3) spots present.
32. BARE AREAS ON PROEPISTERNUM: (0) absent; (1) present.
33. SCUTELLUM COLOR WITH RESPECT TO MESONOTUM: (0) lighter than mesonotum; (1) same color as mesonotum; (2) darker than mesonotum.
34. MESOTHORACIC TIBIAL SPURS: (0) absent; (1) present.
35. METATHORACIC TIBIAL SPURS: (0) absent; (1) present.
36. PROTHORACIC TIBIA: (0) one color; (1) bicolored.
37. METATHORACIC TIBIA: (0) one color; (1) bicolored.
38. PROTIBIA SHAPE: (0) slender, approximately parallel-sided; (1) enlarged medially.

39. MESOTIBIA SHAPE: (0) slender, approximately parallel-sided; (1) enlarged medially.
40. METATIBIA SHAPE: (0) slender, approximately parallel-sided; (1) enlarged medially.
41. BASICOSTA VESTITURE: (0) macrotrichiae absent, basicosta with microtrichiae only (figure 8e); (1) macrotrichiae present, basicosta with macrotrichiae and microtrichiae (figure 8d).
42. BASICOSTA MACROTRICHIAE DENSITY: (0) less dense than costal macrotrichiae (figure 8d); (1) as dense as costal macrotrichiae; (2) denser than costal macrotrichiae.
43. R_4 VEIN SHAPE: (0) straight proximally; (1) medially sinuate; (2) abruptly bends anteriorly proximally (figure 8b).
44. R_5 CELL SHAPE: (0) open; (1) closed.
45. M_3 VEIN SHAPE: (0) straight; (1) bends anteriorly.
46. WING PIGMENTATION: (0) absent; (1) present.
47. WING PIGMENTATION EXTENT: (0) hyaline to tinted; (1) crossveins pigmented only (figure 6j); (2) bands, stripes, small black areas apart from crossveins (figure 6e); (3) predominantly black; large pigmented areas spanning several wing cells (figure 7i).
48. WING ORIENTATION AT REST: (0) flat, horizontal; (1) raised medially, roof-like.
49. APPENDIX ON R_4 PRESENCE: (0) absent; (1) present (figure 6e).

RESULTS

Analyses using single genes yielded highly variable results even though phylogenetic hypothesis from the concatenated data set is robust. 681 basepairs (bp) of mitochondrial COI (97% complete) was sequenced, along with, 1930 bp of nuclear ribosomal 28S (99% complete), 540 bp AATS(79% complete); 801 bp PGD (90% complete), and 2370 bp of CAD (73% complete). The dataset is 86.25% complete. Topologies resulting from maximum likelihood and Bayesian analyses are extremely similar. Our Bayesian analyses also included morphological data, and the most important differences between the results of Bayesian and those of ML is the placement of *Lepiselaga* and several *Tabanus* group lineages such as *Euancala*. Parsimony analyses resolved the same major lineages, however some of the relationships between these lineages conflict with the other approaches. As Bayesian inference included more data and the models could take branch lengths and biases in

nucleotide frequency and mutation rates into account, the results will focus on the Bayesian results (figures 9-11)

Goniops chrysocoma was used as outgroup. This species was the only included member of Scionini, and was a preferable outgroup because Pangoniini and Chrysopsinae have been recovered as non-monophyletic in previous analyses (Morita *et al.* in prep) A monophyletic Pangoniinae is recovered, and Pangoniini including the sampled species is supported. Chrysopsinae is not resolved, and the topology is very similar to Morita *et al.* (in prep). Along with the high support that *Coracella*, a bouvieromyiine from Chile, is the sister to Tabaninae there is high support that African Rhinomyzini are closely related to Tabaninae. Australian *Pseudotabanus* is placed as sister to *Coracella* and Tabaninae with a posterior probability of 0.54.

Within Tabaninae, the first four nodes are highly supported; the posterior probability for the monophyly and placement of each those groups is 1. The sister to the rest of Tabaninae is a group of genera including *Agelanius*, *Nubiloides*, and *Scaptiodes*. *Nubiloides* is recovered inside *Agelanius* although posterior probabilities between species of these two genera are 0.82 and lower.

The next branching lineage includes taxa from the Old World Southern Hemisphere. There is a deep and well-supported divergence between African *Limata* and the rest of the taxa in the clade, all of which are Australasian. *Dasybasis*, *Cydistomyia*, and *Chasmia*, all of the Australasian genera with more than one species sampled, are not monophyletic with respect to one another and *Lissimas* with high supports, 0.97 posterior probabilities or higher. South American *Dasybasis* are not closely related to Australasian *Dasybasis*.

The sister lineage to the rest of Tabaninae includes the diverse genus *Stenotabanus* (101 spp. Morita *et al*., 2010) and the monotypic *Himantostylus intermedius*. The *Stenotabanus* subgenera *Cretotabanus* and *Aegialomyia* are successive sister groups to the rest of *Stenotabanus*. *Stenotabanus* (*Stenotabanus*) is includes the subgenera *Stenochlorops* and *Brachytabanus* with low support

The next lineage is on a long branch, but the next bifurcation is highly supported. This taxon includes the Palaearctic *Dasyrhamphis* and *Philipomyia*. This Palaearctic group is

sister to an area of the topology of Tabaninae with very short branch lengths and lower support values, which includes a split between several Neotropical lineages and a lineage consisting of *Diachlorus*, *Lepiselaga*, Tabanini, and Haematopotini. These five Neotropical lineages are well supported as monophyletic, and support for the relationships between them is moderate, and conflicts in the sensitivity analyses. *Dicladocera*, *Philipotabanus*, and several smaller genera are strongly supported as sister to a clade comprised of *Catachlorops*, *Dichelacera*, *Acanthocera*, *Dasychela*, and *Querbetia*. *Philipotabanus* is not recovered as monophyletic, although its subgenera are recovered. *Dicladocera* forms at least two separate clades, one of which contains the monotypic *Eristalotabanus* and *Spilotabanus*, and one of which contains *Philipotabanus* and *Hemichrysops*. *Catachlorops* is also not recovered, although most of its subgenera are supported. *Catachlorops* (*Catachlorops*) is sister to the rest of this clade. Sister to all exclusive of subgenus *Catachlorops* is a group including *Catachlorops* (*Amphichlorops*) and two species of *Catachlorops* (*Psalidia*). Another species of *Psalidia* is more closely related to *Catachlorops* (*Rhamphidommia*), *Catachlorops* (*Psarochlorops*), and *Dasychela*. *Dasychela* is well supported as monophyletic but is placed inside *Catachlorops* (*Psarochlorops*) with a posterior probability of 1. *Dasychela* subgenus *Triceratomyia* is placed inside *Dasychela* (*Dasychela*). The groups containing *Dicladocera* and *Catachlorops* are moderately well supported as sister to a clade containing another two suprageneric lineages, one containing *Bolbodimyia* and one containing *Leucotabanus*. Each of these groups is well supported, although their sister group relationship is poorly supported with a posterior probability of 0.74. One lineage of Nearctic *Leucotabanus* and one of Neotropical *Leucotabanus* are in a unresolved polytomy with *Pseudacanthocera*, which is sister to another lineage of Neotropical *Leucotabanus*. *Leucotabanus* is sister to group including *Selasoma*, *Stypommisa*, and an unplaced undescribed species. *Stypommisa* is not monophyletic because one species, *S. maruccii*, is placed closer to *Bolbodimyia* in another genus group.

The lineage including *Bolbodimyia* has two major divisions. One includes moss-mat inhabiting *Bolbodimyia*, sister to *Holcopsis*, and both sister to bromeliad inhabiting *Stibasoma*. The other lineage includes *Myiotabanus* and *Eutabanus* sister to *Chlorotabanus*,

Cryptotylus, and *Phaeotabanus*. The sister group relationship between calyptrate-mimicking *Myiotabanus* and *Eutabanus* is strongly supported, but the relative position of this clade and *Chlorotabanus* is not supported. The branch lengths for *Chlorotabanus* are remarkably long. These four lineages, the *Bolbodimyia* lineage, the *Leucotabanus* lineage, the *Dicladocera* lineage, and the *Catachlorops* lineage, are sister to the Neotropical species described in *Dasybasis*. Within *Dasybasis* there is a strong division, and each branch contains three sampled species.

Diachlorus is sister to a major lineage containing *Tabanus*, but whether *Lepiselaga* is sister to *Diachlorus*, or the rest of this lineage exclusive of *Diachlorus*, is not supported. Sampled species of *Diachlorus* are the tip of a long branch. Sister to Tabanini and Haematopotini is *Haematopotina*, a small genus from the southern cone of South America. The next clearly defined groups within Tabanus are both Neotropical, except for *T. lineola* and *sackeni* which are Nearctic. One includes *Poeciloderas*, *Phorcotabanus*, species related to *Tabanus lineola*, and several large bodied *Tabanus*. The other lineage, which is sometimes resolved as sister to all other *Tabanus* group, includes species with ornate scutellum which were previously ascribed to the genus *Bellardia*. Another lineage of Nearctic species including *Hamatabanus* and *Anacimas* is sometimes resolved as sister to all non-Neotropical *Tabanus* group. The relationships among most other *Tabanus* group species are not resolved. *Therioplectes* and *Ancala* are recovered but their relationship with other *Tabanus* group is unclear. *Haematopota* may be related to *Euancala* or *Hybomitra*. *Atylotus* is not recovered, and *Agkistrocerus* is recovered deep inside a lineage of *Tabanus* species, including *T. sudeticus*, which is likely the sampled species that is most closely related to the type species of *Tabanus*, *T. bovinus*.

The topology of the maximum likelihood analysis is very similar to that of the Bayesian inference and differs mainly in that the bootstrap values are different and usually lower on any node with a posterior probability less than 1, and the placement of *Lepiselaga*, *Euancala*, and Neotropical *Dasybasis* vary slightly. All the genus groups are recovered in parsimony analyses, except *Chlorotabanus* is placed near *Diachlorus*. The relationships between the genus groups differ in parsimony, for instance the group including *Stenotabanus* is more

closely related to the old world group including *Cydistomyia*.

DISCUSSION

The phylogenetic results recovered from the Bayesian inference (figures 9-11) present a compelling hypothesis for the evolutionary relationships of Tabaninae. These robust findings contrast with the traditional classification of Diachlorini, Tabanini, and Haematopotini; none of these groups are monophyletic. The alternate classification presented by Trojan (1994a) is also not recovered as his concepts of Diachlorini and Lepidoselagini are interdigitated and Tabanini includes Heptatomini and Haematopotini. Phylogenetic analyses resolve the diversity of Tabaninae falling within nine lineages, five of which I describe as tribes and four as subtribes. One family group name is described as new; all others are resurrected or reinterpreted. This new classification is strongly corroborated by morphological and biogeographic evidence. Diagnoses and discussions of the newly interpreted tribes and subtribes follow.

Descriptions of taxa

Agelaniini **new tribe**

Genera included: *Agelanius*, *Nubiloides*, *Scaptiodes*

Diagnosis

Medium sized gray or black horse flies with dense macrotrichiae on the eyes, ocelli present, often with wide frons usually four times wider than tall, rarely with macrotrichiae on the basicosta, and with dorsal projection on basal flagellomere complex present only in *Nubiloides.*

Remarks

As in Morita *et al*. (in prep), *Agelanius*, a small nondescript Neotropical genus of gray horse flies (Figure 7a), is sister to all other Tabaninae. Additional sampling strengthened this position. This lineage is well supported, and in a pivotal location on the phylogeny, so horse fly taxonomy would be best serve by the description of a new tribe, Agelaniini, to contain three genera. The characteristic that *Nubiloides*, *Agelanius*, and *Scaptiodes* seem to share most certainly is their biogeography; all are found in Argentina and Chile, and further North

along the Andes Mountains. *Nubiloides* has a long projection on its antennal flagellomere, and was proposed by Burger to be more closely related to *Dicladocera*. A morphological character that unites these groups is the dense microtrichia among the ommatidia. These three genera are markedly dissimilar and a non-monophyletic *Agelanius* was unanticipated and is unlikely to be maintained with further sampling.

Chasmiini Enderlein 1922 **rev. stat**.

Genera included: *Atelozella*, *Atelozomyia*, *Bartolomeudiasella*, *Chalybosoma*, *Chasmia*, *Cydistomorpha*, *Cydistomyia*, *Dasybasis*, *Japenoides*, *Limata*, *Lissimas*, *Lissimodes*, *Neavella*, *Neobolbodimyia*, *Philipota*, *Protodasyommia*, *Udenocera*, *Udenoceroides*

Diagnosis

Small to large horse flies, with no macrotrichiae on the basicosta, ocelli almost always present, and rarely with dorsal projection on basal flagellomere complex present only in some *Cydistomyia* spp.

Remarks

Chasmiini is an Enderlein name reinstated to encompass former diachlorine genera found in the Old World Southern Hemisphere, mainly Southern Africa and Australia, but also found in Madagascar, Sri Lanka and India, New Zealand, Papua New Guinea, New Caledonia, and several smaller Pacific Ocean and Indian Ocean islands. These are the most common and diverse group of horse flies in the Australasian region (Mackerras 1954) (Figures 6a, 7b). The increased sampling yields a topology concordant with that of Morita *et al*. (in prep), but this result was not anticipated by the morphology or previous classifications. Chasmiini will now be the third most diverse tribe of Tabanidae at the genus level. Since all sampled Southern Hemisphere old world ‘diachlorines’ were placed herein with strong support, all remaining genera in that region without nucleotide data available will be placed in Chasmiini. There are no known morphological synapomorphies for this group. Further sampling may reveal that this concept of Chasmiini is too broad.

This group includes a preponderance of morphologically unusual, geographically

restricted small or monotypic genera. The biology for most of these is unknown, but deserves investigation. *Neavella* is a coastal dune endemic in southeastern Africa and Madagascar (Oldroyd, 1954). *Chalybosoma* adults are one of the few iridescent horse flies. *Cydistomyia longirostris* was collected while attacking crocodiles in the Philippines (Philip, 1959a, 1959b) Within Chasmiini, a deep division between African and Australasian taxa is evident. One scenario could be that this lineage originated in Africa, and dispersed to the Australasian region as India was moving from Africa to Asia. The Malagasy fauna of Chasmiini contains only *Neavella* and *Limata*, also found on mainland Africa. *Cydistomyia* subgenus *Tabanotelum* is restricted to Seychelles and Indian Ocean Islands. Sri Lankan *Udenocera* and *Lissimodes*, *Philipota* from India, and several more genera endemic to Papua New Guinea would also need to be sampled to test the hypothesis of the divergences of Chasmiini following the movement of the Indian tectonic plate. In the Australasian taxa, which are better sampled, genus level classification is highly discordant with the resolved topology. Trojan attempted to address the difficulty of diagnosing *Dasybasis*, *Cydisomyia*, and *Chasmia*, although some of his genera are more problematic New Caledonian Chasmia are sister to Australian *Cydistomyia*, Papuan *Cydistomyia* and Papuan *Chasmia* are related. Trojan reinstated *Chasmiella* and placed in it some New Caledonian and some Papuan *Chasmia*. Burger synonymized the two. Based on these results, *Chasmiella* sensu Trojan is not useful, so breaking up *Chasmia* will hinge upon further sampling, including the newly discovered Australian *Chasmia*, and revisionary work. Australian and Tasmanian *Dasybasis* are recovered together, even though each of these three species falls in a different genus according to Trojan. His conception of a divided Australian *Dasybasis* should not be maintained, except for the separation of New Zealand species into *Protodasyommia*. Table 7 has the specific taxonomic changes necessary to keep Dasybasis a useful taxon. This New Zealand group is sister to Papuan *Cydistomyia*, *Chasmia*, and *Lissimas*. Further studies should focus on sampling African *Cydistomyia* to observe true extent of the non-monophyly of *Cydistomyia*.

Table 7. New Classification of Australian *Dasybasis*. New Zealand taxon *Protodasyommia* raised to genus level and Neotropical taxa removed.

Dasybasis Macquart 1847
type species *appendiculata* Macquart
acutipalpis (Macquart, 1838)
albohirtipes (Ferguson, 1921)
angusticallus (Ricardo, 1917)
anomala Mackerras & Rageau, 1958
appendiculata Macquart, 1847
banksiensis (Ferguson & Hill, 1922)
caesia (Walker, 1848)
circumdata (Walker, 1848)
cirra (Ricardo, 1917)
clavicallosa (Ricardo, 1917)
constans (Walker, 1848)
diemanensis (Ferguson, 1921)
dixoni (Ferguson, 1921)
dubiosa (Ricardo, 1915)
edentula (Macquart, 1846)
eidsvoldensis (Taylor, 1919)
evenhuisi Burger, 1995
exulans (Erichson, 1842)
froggatti (Ricardo, 1915)
gemella (Walker, 1848)
gentilis (Erichson, 1842)
germanica (Ricardo, 1915)
gracilipalpis Burger, 1995
gregaria (Erichson, 1842)
griseoannulata (Taylor, 1917)
hebes (Walker, 1848)
hobartiensis (White, 1915)
imperfecta (Walker, 1848)
indefinita (Taylor, 1918)
innotata (Ferguson & Henry, 1920)
kewensis (Ferguson & Henry, 1920)
lydiae Trojan, 1991
macrophthalma (Schiner, 1868)
mellicallosa Mackerras & Rageau, 1958
microdonta (Mackerras, 1947)
milsoni (Taylor, 1917)
milsoni (Ricardo, 1917)
moretonensis (Ferguson & Hill, 1922)
nemopunctata (Ricardo, 1914)
nemotuberculata (Ricardo, 1914)
neobasalis (Taylor, 1918)
neocirrus (Taylor, 1918)
neogermanica (Ricardo, 1915)
neolatifrons (Ferguson & Hill, 1922)
neopalpalis (Ferguson & Hill, 1920)
ochreoflava (Ferguson & Hill, 1920)
oculata (Ricardo, 1915)
padix (Taylor, 1917)
parva (Taylor, 1913)
ponandouensis Burger, 1995
postica (Wiedemann, 1828)
postponens (Walker, 1848)
pseudocallosa (Ferguson & Hill, 1922)
rainbowi (Taylor, 1918)
regisgeorgii (Macquart, 1838)
rubicallosa (Ricardo, 1914)
rufifrons (Macquart, 1855)
setipalpis Burger, 1995
spatiosa (Ricardo, 1915)
standfasti Mackerras, 1964
tasmaniensis (White, 1915)
tillierorum Trojan, 1991
trilinealis (Ferguson & Henry, 1920)
tryphera (Taylor, 1917)
vespiformis (Ferguson & Henry, 1920)
vetusta (Walker, 1848)

Table 7 continued
Protodasyommia Enderlein, 1925
type species *loewi* Enderlein
bratrankii (Nowicki, 1875) **n. comb.**
chazeaui Trojan, 1991 **n. comb.**
danielae Trojan, 1991 **n. comb.**
difficilis (Krober, 1931) **n. comb.**
grenieri (Mackerras & Rageau, 1958) **n. comb.**
loewi Enderlein, 1925 **n. comb.**
nigripes (Krober, 1931) **n. comb.**
opla (Walker, 1850) **n. comb.**
rageaui (Mackerras, 1962) **n. comb.**
sarpa (Walker, 1850) **n. comb.**
thereviformis (Mackerras, 1957) **n. comb.**
transversa (Walker, 1854) **n. comb.**
truncata (Walker, 1850) **n. comb.**
viridis (Hudson, 1892) **n. comb.**

Stenotabanini Krober 1929 **rev. stat.**

Genera included: *Himantostylus*, *Oopelma*, *Roquezia*, *Stenotabanus*

Diagnosis

Small to medium horse flies with eye without macrotrichiae, often banded green and purple in life, without macrotrichiae on the basicosta, dorsal projection on basal flagellomere complex absent, with frons much higher than wide except in subgenus *Brachytabanus.*

Remarks

These results demonstrate that Stenotabanini is a distinct lineage. This concept of Stenotabanini is narrower than Krober's. Fairchild considered *Stenotabanus* distinct from other Neotropical 'diachlorines', except for *Diachlorus*, and instated a *Stenotabanus-Diachlorus* genus group. Prior to Morita *et al*., in prep, *Stenotabanus* as a lineage entirely separate from any other Neotropical 'diachlorines' was not hypothesized. However, there are several monotypic genera which have been considered closely related to *Stenotabanus*, including *Oopelma* and *Roquezia*. *Oopelma* is a small fly extremely rarely collected from the Amazon, and *Roquezia* is known only from the type specimen collected in Colombia. *Stenotabanus* (*Cretotabanus*) adults (Figures 6i, 7j) specialize on large reptiles in the

Amazon, anaconda and caiman (Ferreira et al 2002). *S*. (*Aegialomyia*) are restricted to coastal dunes throughout the Caribbean and Central America, except for the dubiously placed *S. bruesi*, found in deserts in Ecuador and Peru (Chainey 1999). *S*. (*Stenotabanus*) includes *S*. (*Brachytabanus*) and *S*. (*Stenochlorops*) in this analysis. The data for these two smaller genera was gathered through the ancient DNA protocol, so this may be a result of missing data. Chainey et al. (1999) performed a thorough study of South American *Stenotabanus*, and *Stenotabanus* north of South America would benefit greatly from a taxonomic revision at the species level, particularly Caribbean species of *S. (Aegialomyia).*

Dasyrhamphini Olsufjev 1964 **rev. stat.**

Genera included: *Dasyrhamphis*, *Nanorrhynchus*, *Philipomyia*

Diagnosis

Horse flies lacking macrotrichiae on the basicosta, dorsal projection on basal flagellomere complex usually present, ocelli absent.

Remarks

Olsufjev recognized *Dasyrhamphis* as distinct from other Diachlorini, however his classification was not recognized. Our results validate Olsufjev's hypothesis and Dasyrhamphini is reinstated. Although *Dasyrhamphis* and *Philipomyia* have divergent appearances, species of both are large, robust flies sharing acute or long dorsal projection on the antennal basal flagellomere complex and both lacking ocellar tubercles and macrotrichiae on the basicosta (Figures 6d, 7d). Both genera are similarly distributed in Europe, North Africa, and the Middle East. *Nanorrhynchus*, an enigmatic monotypic genus without functional mouthparts, found in one desert in Kazakhstan (Andreeva, 1999), is placed here based on biogeography. Olsufjev (1966) suggested that *Nanorrhynchus* is related to *Stenotabanus* (*Aegialomyia*), however *Nanorrhynchus* does not have the purple and green eye color pattern typical of *Stenotabanus*, and no *Stenotabanus* lack functional mouthparts, so their similar appearance is likely due to convergences from a shared psammophilous biology. Birus et al (in press) used a molecular phylogeny based on mitochondrial data to show that *Philipomyia* and *Dasyrhamphis* are distinct from Tabanini.

Selasomatini Lutz 1913 **rev. stat.**

Taxa included: Bolbodimyiina, Dicladocerina, Psalidiina, Selasomatina, *Acellomyia, Anaerythrops, Archiplatius* (including former *Dasybasis*), *Erioneura*, *Pseudoselasoma* (including former *Dasybasis*), *Teskeyellus*

Diagnosis

Variable group of horse flies with macrotrichiae on basicosta present or not, but rarely as dense as on costa, vestiges of ocelli present or not, and dorsal projection on basal complex of antennal present or absent.

Remarks

The next tribe with a reinstated name, Selasomatini, is the second largest tribe in the family in terms of genera. This group was described as Selasomini, however Sabrosky (1999) pointed out that this was conjugated incorrectly. The taxa included here are Neotropical, with one or two species of *Leucotabanus*, *Chlorotabanus*, *Diachlorus*, and *Bolbodimyia* extending into the Nearctic realm. In all analyses, this group was comprised of five well-supported lineages. One, often resolved as sister to the rest, is the Neotropical *Dasybasis*.

Trojan (1994b) resurrected *Pseudoselasoma* and *Archiplatius* to accommodate the Neotropical species placed in *Dasybasis*. This facet of his classification was not subsequenty recognized (Fairchild & Burger 1994, Gonzalez 1999). The status quo cannot be sustained, as species in the same genus being placed in different tribes is not tenable. I reinstate *Pseudoselasoma* and *Archiplatius* sensu Trojan (1994b) (Table 8). A new genus group name is not described and instead these genera are placed as *incertae sedis* because there is low support for their placement and under some analysis regimes (Table 9), *Pseudoselasoma* and *Archiplatius* are placed as sister to Bolbodimyiina. This group strongly merits further revisionary studies such as Gonzalez (1999), and yet more genus level changes may be necessary.

Table 8. New Classification of Neotropical species formerly associated with *Dasybasis*. One Neotropical species moved to *Archiplatius* and 68 species are moved to *Pseudoselasoma*.

Archiplatius Enderlein 1922 **rev. stat.**
Type species *Tabanus trifarius* Macquart (orig. des.) syn. *chilensis* Macquart
chilensis (Macquart, 1838) **n. comb.**

Pseudoselasoma Brethes, 1910 **rev. stat.**
Type species *Pseudoselasoma opacum* Brethes
adornatum (Krober, 1934) **n. comb.**
albohirtum (Walker, 1836) **n. comb.**
albosignatum (Krober, 1930) **n. comb.**
albotibiale (Krober, 1931) **n. comb.**
alticolum (Enderlein, 1925) **n. comb.**
andicolum (Philippi, 1865) **n. comb.**
antilope (Brethes, 1910) **n. comb.**
arauca (Coscaron & Philip, 1967) **n. comb.**
aricum (Coscaron & Philip, 1967) **n. comb.**
barbatum (Coscaron & Philip, 1967) **n. comb.**
bejaranoi (Coscaron & Philip, 1967) **n. comb.**
belenensis (Coscaron & Philip, 1967) **n. comb.**
boliviame (Coscaron & Philip, 1967) **n. comb.**
bonariensis (Macquart, 1838) **n. comb.**
brethesi (Coscaron & Philip, 1967) **n. comb.**
bruchii (Brethes, 1910) **n. comb.**
bulbiscapens (Coscaron & Philip, 1967) **n. comb.**
bulbulum (Coscaron & Philip, 1967) **n. comb.**
canipilis (Krober, 1934) **n. comb.**
caprii (Coscaron & Philip, 1967) **n. comb.**
chillan (Coscaron, 1972) **n. comb.**
chubutensis (Coscaron, 1962) **n. comb.**
colla (Coscaron, 1969) **n. comb.**
coquimbo (Coscaron, 1972) **n. comb.**
cumelafquen (Coscaron, 1962) **n. comb.**
delpontei (Coscaron & Philip, 1967) **n. comb.**
diaguita (Coscaron, 1991) **n. comb.**
erynnis (Brethes, 1910: 481) **n. comb.**
elquiensis (Gonzalez), 2000 **n. comb.**
excelsior (Fairchild, 1956) **n. comb.**
fairchildi (Coscaron & Philip, 1967) **n. comb.**
fornesi (Coscaron, 1974) **n. comb.**
frequens (Krober, 1934) **n. comb.**
fumifrons (Coscaron & Philip, 1967) **n. comb.**

Table 8 continued
geminatum (Coscaron & Philip, 1967) **n. comb.**
hepperi (Coscaron & Philip, 1967) **n. comb.**
hirsutum (Coscaron & Philip, 1967) **n. comb.**
inatum (Coscaron & Philip, 1967) **n. comb.**
kroeberi (Coscaron & Philip, 1967) **n. comb.**
limbativenum (Krober, 1931) **n. comb.**
maletecta (Bigot, 1892) **n. comb.**
mendozana (Enderlein, 1925) **n. comb.**
minor (Macquart, 1850) **n. comb.**
missionum (Macquart, 1838) **n. comb.**
montium (Surcouf, 1919) **n. comb.**
neogrisescens (Krober, 1934) **n. comb.**
nigrum (Enderlein, 1925) **n. comb.**
nigrifemur (Krober, 1934) **n. comb.**
nigrifrons (Philippi, 1865) **n. comb.**
opacum Brethes, 1910 **n. comb.**
ornatissimum (Brethes, 1910) **n. comb.**
pallipes (Krober, 1931) **n. comb.**
penai (Coscaron & Philip, 1967) **n. comb.**
pereirai (Coscaron & Philip, 1967) **n. comb.**
persignatum (Krober, 1934) **n. comb.**
piliferum (Krober, 1934) **n. comb.**
poroma (Coscaron & Philip, 1967) **n. comb.**
pruinivitta (Krober, 1934) **n. comb.**
punensis (Hine, 1920) **n. comb.**
schineri (Krober, 1931) **n. comb.**
schnusei (Krober, 1931) **n. comb.**
senile (Philippi, 1865) **n. comb.**
shannoni (Krober, 1930) **n. comb.**
subtritum (Coscaron & Philip, 1967) **n. comb.**
testaceomaculata (Macquart, 1838) **n. comb.**
trigonophora (Macquart, 1838) **n. comb.**
tritus (Walker, 1837) **n. comb.**
vasta (Coscaron & Philip, 1967) **n. comb.**

Three other rare monotypic Neotropical genera formerly placed in Diachlorini are placed here with *Pseudoselasoma* and *Archiplatius* as Selasomatini incertae sedis. The morphology of *Anaerythrops*, *Erioneura*, and *Teskeyellus* are not sufficient for them to be assigned to a subtribe. The relationships between the other lineages of Selasomatinae are stable, though not well supported in the current study, and each of these lineages is easier to diagnose along. Each of these groups has at least one genus with a family group name. Therefore, four subtribes of Selasomatini are erected.

Selasomatina Lutz 1913 ***status novum***

Genera included: *Leptapha, Leucotabanus, Pseudacanthocera, Selasoma, Stypommisa*

Diagnosis

Flies variable in shape and coloration, with macrotrichiae on the basicosta, with ocelli almost always present, and dorsal projection on basal flagellomere complex rarely present.

Remarks

The nominal subtribe includes species with visible ocelli, basicosta with macrotrichiae, and very few species with bifurcated antennal flagellomeres. *Pseudacanthocera* is placed as sister to the Nearctic *Leucotabanus*. I do not synonymize *Pseudacanthocera* as raising the Nearctic *Leucotabanus* to genus level may prove more useful with further sampling. Larvae of *Leucotabanus ambiguus*, a Nearctic species of *Leucotabanus*, have been found only in trmite nests (Burger, 1974) and *Pseudacanthocera* are unusual among horse flies in their intense sexually dimorphic color patterns. *Selasoma* is extremely morphological unusual and may be an orchid bee mimic (Burger, 2009). This mimicry may have led *Selasoma* to have strong morphological convergence with *Lepiselaga*, but they are easily distinguished by size and because *Lepiselaga* lacks macrotrichia on the basicosta. *Selasoma* larvae are recorded as having a similar life history to Lepiselaga, living in open water on *Pistia stratiotes* L. leaves (Burger, 2009). *Selasoma* is very closely related to *Stypommisa*, a diverse heterogenous genus (Figures 6j, 7k) that would benefit greatly from revisionary work. Undescribed genus A comprises two species known from 3 specimens from the Ecuadorean highlands and paramo. Description of that genus is underway with R. Cardenas, contingent on the discovery

of additional specimens. *Leptapha* was not sampled for molecular data, however it is very morphologically similar to *Leucotabanus*, differing in the lack of sexual dimorphism, a glabrous frons, and elongate antennal flagellomeres (Coscaron & Papavero 1993). *Stenotabanus* species have been commonly moved to and from *Stypommisa*. Chainey (1999) relied heavily on defining Stenotabanus by a purple-on-green or green-on-purple eye pattern, and moved all South American taxa without this character to *Stypommisa*. For instance, preserved specimens of *Stypommisa unigrum* and *Stenotabanus* sp. 10 Guatemala are both heavily patterned and nearly identical except for the presence of macrotrichiae on the basicosta. All sampled true *Stypommisa* have at least some macrotrichiae on the basicosta, but some species classified as *Stypommisa* do not. These species are unlikely to be classified well in *Stypommisa* as all other species in the subtribe have macrotrichiae present on the basicosta.

Bolbodimyiina Philip 1941 ***status novum***

Genera included: *Bolbodimyia, Chlorotabanus*, *Cryptotylus*, *Eutabanus, Holcopsis*, *Myiotabanus, Pachyschelomyia*, *Phaeotabanus, Stibasoma*

Diagnosis

Often ornately colored and glabrous flies, without macrotrichiae on the basicosta, without vestiges of ocelli, and without dorsal projection on basal flagellomere complex, except for short bifurcations in *Cryptotylus*, *Stibasoma*, and some *Phaeotabanus*, rarely extending past first free antennal flagellomere.

Remarks

Bolbodimyiina, a subtribe with many species with strikingly unusual morphology and coloration, has moderate support as sister to Selasomatina. These flies have reduced or absent ocelli, no macrotrichae on the basicosta, and few species with bifurcated antennal flagellomere. Only species of *Cryptotylus*, *Stibasoma*, and some *Phaeotabanus* have bifurcated antennal flagellomeres. This subtribe includes *Chlorotabanus*, and Philip 1941 described tribes with both *Bolbodimyia* and *Chlorotabanus* as type genera. Bolbodimyiina is used herein as it has page precedence- it is mentioned earlier on page 5 of Philip 1941 than

Chlorotabanini, and because *Chlorotabanus* is phylogenetically volatile due to divergent 28S sequences. Morita et al (in prep) recovered *Chlorotabanus* as sister to the *Tabanus* group. This increased sampling suggests that was a long-branch artifact due to the aberrant 28S of *Chlorotabanus*. Challenges in determining species limits within Chlorotabanus (Krolow & Henriques 2010) may be related to this divergence. I sampled three additional species of *Chlorotabanus* herein, and they all had apparently higher rates of molecular evolution in 28S than any other known horse fly. Although the placement of *Chlorotabanus* within Bolbodimyiina is not well supported, in the Bayesian inference, nocturnal *Chlorotabanus* is sister to nocturnal *Cryptotylus* and *Phaeotabanus*. Some *Cryptotylus* live in open water on Pistia similar to *Selasoma* and *Lepiselaga* (Burger, 2009). Some species of *Phaeotabanus* are specialists on reptiles similar to *Cretotabanus* (Ferreira *et al*., 2002). *Myiotabanus* and *Eutabanus* (Figures 6g, 7g), horse flies that may mimic calyptrates (Krolow *et al*., 2012), are sister to that lineage. The other lineage of Bolbodimyiina includes *Holcopsis*, *Bolbodimyia*, and *Stibasoma*. Another species of calyptrate mimicking fly currently placed in *Stypommisa*, *S. marucci*, is sister to *Stibasoma*. The morphology of this species should be reappraised and may warrant the description of its own genus. The larvae of *Bolbodimyia* are found in moss mats (Burger, 1974), and the larvae of *Stibasoma* (*Stibasoma*) have been reared from bromeliads. *S*. (*Rhabdotylus*) adults are nocturnal. *Pachyschelomyia* from Northern Argentina was not sampled, however it is very morphologically similar to *Phaeotabanus* (Coscaron & Papavero 1993) and is therefore included in this subtribe. One species each of *Chlorotabanus* and *Bolbodimyia* range into the Southern U.S. (Pechuman & Teskey 1981), and the rest of the species are found in the Neotropical region.

Dicladocerina Enderlein 1927 ***status novum***

Genera included: *Dicladocera*, *Eristalotabanus*, *Hemichrysops*, *Philipotabanus*, *Spilotabanus*

Diagnosis

Often setose flies with vestiges of ocelli, macrotrichia present on the basicosta but rarely as dense as those on costa, most species with a dorsal projection on basal flagellomere

complex, except for *Spilotabanus*, *Hemichrysops*, and *Philipotabanus* (*Philipotabanus*), most species with macrotrichiae on the eyes.

Remarks

The non-monophyly of *Dicladocera*, strongly supported in this phylogeny, cannot be taxonomically resolved until the type species, *Dicladocera bellicosa*, or a closely related species, is sampled. If *D. bellicosa* is related to *D. argentomacula*, the *Dicladocera* sister to the monotypic but morphologically unusual (Coscaron & Papavero, 1993) genera *Eristalotabanus* (Figures 6f, 7f) and *Spilotabanus* will be described as a different genus. It is more likely that *D. bellicosa* is related to *D. macula*, and *Eristalotabanus* and *Spilotabanus* will be sunk to subgenus level at least, and *Dicladocera* related to *D. argentomacula* and *D. clara* will be described as a separate genus. Undescribed genus X refers to two male specimens known from the highlands of Peru that are similar to *Spilotabanus* except for different wing patterns and the presence of a bifurcated basal complex of the antennal flagellomere, not known in *Spilotabanus*. It may be appropriate to raise the subgenera of *Philipotabanus*- *Mimotabanus*, *Melasmatabanus*, and *Philipotabanus*- to genus level. However this may not be necessary, and instead *Hemichrysops* should be subsumed within *Philipotabanus*, since it is recovered with moderate support inside *Philipotabanus* (*Philipotabanus*).

Psalidiina Enderlein 1922 ***status novum***

Genera included: *Acanthocera*, *Catachlorops*, *Dasychela*, *Dichelacera*, *Querbetia*

Diagnosis

Often brightly colored flies with long dorsal projections on basal flagellomere complex, except for some species of *Acanthocera* (*Mimodynerus*), with frontal callus much higher than wide, without macrotrichiae on the basicosta, and without macrotrichiae on the eyes except for *Dasychela.*

Remarks

Although there have been non-monophyletic genera in all the new subtribes of Selasomatini, the situation in Psalidiina Enderlein, 1922 is most severe. *Psalidia* is currently

a subgenus, so family group names based on it are still valid, and it has page precedence (p. 344) over Dichelocerina Enderlein, 1922 (p. 346, also a misspelling based on *Dichelacera*) and Acanthocerini Enderlein, 1922 (p. 349). Although the International Code of Zoological Nomenclature does not require choosing valid names via page precedence, it is a useful objective metric for choosing between equally valid names. The fact that *Psalidia* is a subgenus will also not be a concern for long because the other subgenera of *Catachlorops* do not form a group with the nominal subgenus *Catachlorops* (*Catachlorops*). This lineage is sister to the rest of Psalidiina. The lineage sister to all Psalidiina other than *Catachlorops* (*Catachlorops*) is comprised of *Catachlorops* (*Amphichlorops*) and two species of *Catachlorops* (*Psalidia*). The rest of Psalidiina is in two clades. One is a progression of relationships into *Dasychela*, including another species of *Catachlorops* (*Psalidia*), *Catachlorops* (*Rhamphidommia*), and *Dasychela* placed inside *Catachlorops* (*Psarochlorops*). *Psarochlorops* and *Dasychela* are very similar except for coloration and proboscis length (Figures 6c, 7c). The affinities of some species in this lineage are unclear (e.g. Henriques & Krolow 2008) and it should be revised pending further investigation into *Catachlorops*.

The other split in Psalidiina includes *Dichelacera*, *Acanthocera*, and *Querbetia*. This clade is strongly supported, however the relationships between these taxa is not resolved with robust support. Subgenera *Nothocanthocera* has been placed in either *Dichelacera* (Fairchild & Burger, 1994) or *Acanthocera* (Henriques & Rafael 1993) and deserves its own genus, as it is recovered outside either genus, though its placement relative to *Querbetia*, *Dichelacera*, and *Acanthocera* is poorly supported. *Querbetia* and *Idiochelacera* have similar taxonomic histories and should also be considered as separate genera. The branches between *Querbetia*, *Idiochelacera*, *Dichelacera* (*Dichelacera*), *Nothocanthocera*, and *Acanthocera* (*Acanthocera*) are very short and poorly supported, and these groups have longer branches than other Psalidiina. The nominal, and most speciose, subgenera of *Dichelacera* and *Acanthocera* are resolved decisively. The inclusion of subgenera *Orthostyloceras* and *Desmatochelacera* in *Dichelacera*, and *Polisitimima* and *Mimodynerus* in *Acanthocera* deserves scrutiny.

Diachlorini Lutz 1909 ***sensu novo***

Genera included: *Diachlorus*, *Lepiselaga*

Diagnosis

Dark and often glabrous flies that may mimic stinging Hymenoptera, without vestiges of ocelli or macrotrichiae on the eyes or basicosta and dorsal projection on basal flagellomere complex absent.

Remarks

Diachlorus is a morphologically remarkable fly (Wilkerson & Fairchild, 1982) and potentially a hymenopteran mimic (Figures 6e, 7e). This notability led to it being described first and associated with the first family level name, however it is robustly supported as not closely related to other former 'diachlorines' save *Lepiselaga*. The taxonomic history is as confused as the phylogenetic history. Diachlorini was described anonymously by Lutz (1909), who credited himself for the description two years later (Lutz, 1911). Diachlorini has page precedence over Lepidoselagini, the second oldest family group name in Tabaninae outside of Tabanini. Lepidoselagini is also not preferred as it is a misspelling, based on *Lepiselaga*. Furthermore, the placement of *Lepiselaga* is not well resolved but this is the most manageable possible position according to the available data. Both *Diachlorus* and *Lepiselaga* (Figure 7i) are black, glabrous, and have no macrotrichiae on the basicosta or evidence of ocelli. When the molecular data is analyzed alone in maximum likelihood, *Lepiselaga* is the sister to Tabanini s.l. with moderate support.

Tabanini ***sensu novo*** (including Haematopotini)

Genera included: *Agkistrocerus*, *Anacimas*, *Ancala*, *Atylotus*, *Euancala*, *Haematopota*, *Haematopotina*, *Heptatoma*, *Hippocentrodes*, *Hippocentrum*, *Hybomitra*, *Isshikia*, *Microtabanus*, *Olsufjevotabanus*, *Parancala*, *Phorcotabanus*, *Poeciloderas*, *Stigmatophthalmus*, *Tabanus*, *Therioplectes*, *Whitneyomyia*

Diagnosis

Often drab except for *Euancala* and *Haematopota*, often with banded or brightly patterned eyes in life, with dense macrotrichiae on the basicosta except in *Haematopotina*

and some specimens of *Anacimas* and *Microtabanus*, vestiges of ocelli absent except in *Hybomitra* and some Neotropical *Tabanus*, dorsal projection on basal flagellomere complex present or absent.

Remarks

Tabanini is the only cosmopolitan tribe in Tabaninae, and the most species rich, though not the largest in terms of genera. The paraphyly of *Tabanus* spans the entire tribe other than *Haematopotina*. *Haematopotina*, *Anacimas*, *Microtabanus* are transferred from Diachlorini *sensu lato*. The placement of *Haematopotina* is unanticipated, as previously the genus has been considered close to the genera associated with *Dasybasis*, such as *Agelanius* and *Acellomyia*. *Dasybasis* s.l. appears in four different places in the phylogeny, suggesting that the southern cone of South America fostered important events in the evolutionary history of Tabaninae. Only 28S was sequenced from *Haematopotina*, but the extraction was performed twice and sequenced with different primers to confirm the sequence. *Haematopotina* contains the only species in Tabaninae always lacking macrotrichiae on the basicosta. *Haematopota* and related genera (Figure 7h) are resolved several nodes inside *Tabanus* with high support. Maintaining a family group associated with *Haematopota* would necessitate raising up to fifteen other tribes or subtribes. The genera formerly constituting the tribe Haematopotini are now included in Tabanini, so *Haematopota*, *Heptatoma*, *Hippocentrum*, and *Hippocentrodes* are transferred into this tribe. *Heptatoma pellucens* is not related to the other former Haematopotini. *Haematopota*, sometimes including *Hippocentrum*, is resolved on a very long branch. *Hippocentrodes* from Nepal and Northern India is not sampled, but is probably related to *Haematopota*.

The resolved topology of *Tabanus* and related groups shows some signal with regards to large-scale biogeography. Morphological trends within this array of dizzying diversity, however, are not yet apparent. Sister to the rest is *Haematopotina* from southern South America, and the next two nodes, one including *Poeciloderas* and *Phorcotabanus*, and the other including species in the '*Tabanus oculus*' group, are Neotropical, except for the *Tabanus lineola* group whose range includes the Nearctic region. These Neotropical lineages include many unusual species, for instance *Phorcotabanus cinereus* (Wiedemann, 1821),

adults of which prefer to attack waterfowl such as anatid ducks (Limeira-de-Oliveira *et al*., 2002) Sister to the remaining Tabanini is a Nearctic group including *Hamatabanus* (Figure 6h) and *Anacimas*. Branch lengths are very short in the succeeding group excluding Neotropical and most Nearctic Tabanini. Approximately fourteen lineages are recovered and supported, but the bootstrap values and posterior probabilities for the nodes between them are low. Several correspond to established genera- *Hybomitra*, *Haematopota*, *Ancala*, *Therioplectes*, *Euancala*, *Heptatoma*. The affinities of several species of *Tabanus*, such as *T. pumilis*, are unclear. There are several well supported lineages of multiple *Tabanus* species, one including Holarctic *Tabanus* and *Agkistrocerus*, and another including *Atylotus*. The only non-*Tabanus* genus in Tabanini not recovered as monophyletic is *Atylotus*. *Tabanus pumilis*, *Therioplectes*, and *Heptatoma* are recovered outside this lineage depending on the alignment, partitioning, and analysis paradigm.

The unsampled genera placed herein are very likely part of the poorly resolved Tabanus s.l. or core Tabanini, except *Stigmatophthalmus altivagus*. This species from Rio de Janeiro, Brazil, was placed in Tabanini by Coscaron & Papavero (1994) and in Diachlorini by Fairchild and Burger (1994). Due to the dense macrotrichiae on the basicosta and the absence of ocelli, it is more likely referable to Tabanini, however it may be part of the grade including *Haematopotina*. This is corroborated by the lack of Neotropical Tabanini from the sampled Core Tabanini. The other unsampled genera placed in Tabanini- *Isshikia*, *Olsufjevotabanus*, *Parancala*, and *Whitneyomyia*, are found outside the Neotropical region, so biogeography is less informative. Trojan (1976) considered Indonesian *Parancala* close to Afrotropical *Ancala* and *Euancala*, however there is no evidence that the latter two genera are related so the affinities of *Parancala* remain unclear. *Isshikia*, from East Asia, has remarkably long projections on the basal flagellomere complex, but this is also present in *Agkistrocerus*, among others, so this does not provide strong evidence for the resolution of *Isshikia* outside core Tabanini. *Olsufjevotabanus rarus* was described based on its remarkable long white setosity, which may not prove a useful generic character. The larvae of *Whitneyomyia* are very similar to Nearctic *Tabanus* (Pechuman & Teskey 1981). Nearctic *Tabanus* fall into several separate lineages, so the larval morphology does not allow us to

infer more about the phylogenetic position of *Whitneyomyia*. These genera likely represent unsampled lineages within the core Tabanini, within *Tabanus* s.l. Providing further resolution of the radiation of Tabanini remains the most daunting challenge to horse fly researchers.

Conclusion

This well-resolved phylogeny of Tabaninae I recover differs from previous classifications and phylogenies in several intriguing and illuminating aspects. The topology is robust enough to inform a new classification at the tribal level, discussed herein. Discovering that *Coracella* may be the sister group to all Tabaninae is an important step in deciphering the subfamily's origins. Tabaninae is on a long branch, and the branches between *Coracella*, Rhinomyzini, and *Pseudotabanus* are all much shorter. Adding another species of *Tabanocella* increased confidence in the placement of Rhinomyzini in comparison to Morita et al in prep. Further sampling of Asian Rhinomyzini and other Bouvieromyiini such as *Merycomyia* and *Gressittia* is needed to impart more confidence in the sister group to Tabaninae. The other outgroups were all sampled in Morita et al in prep except for the pangoniines *Pangonius*, *Protodasyapha*, and another species of *Ectenopsis*, and another species of the chrysopsine Lilaea. More Pangoniini were added because that tribe was not recovered in all analyses, Scionini and Philolichini were resolved together with high support in Morita et al in prep so potential affinities with Tabaninae are slim. Since the monophyly of Pangoniini could not be assumed, *Goniops* was designated as the outgroup. This sampling, including fewer species but genera of Pangoniini unsampled in Morita *et al.* (in prep) recovers a strongly supported Pangoniini. Athericid or other non-Tabanidae outgroups were not included because they have highly divergent 28S sequences in relation to that of Tabaninae, and excluding them increased alignable regions in the matrix. The exclusion of Scionini and Philolichini also made 28S alignment more manageable.

Agelaniini and Chasmiini are the potential Gondwanan elements. The clear declaration of this is contingent on further scrutiny of the fossil record and more divergence time analyses. Agelaniini, Chasmiini, Stenotabanini, and Dasyrhamphini form the nominal ACSD grade, which is a progression of relationships sister to 'core Tabaninae.' Within Tabanini, the well supported clade exclusive of *Poeciloderas*, *Phorcotabanus*, and *Tabanus* from the

Neotropical realm, in other words cosmopolitan *Tabanus* and relatives, is considered ‘core Tabanini.’

There are 3 areas of uncertainty in the phylogeny - 1) Monophyly of the South American radiation, i.e. Selasomatini; placement of *Pseudoselasoma* (=South American *Dasybasis*) 2) Placement of *Lepiselaga*; sister group to *Diachlorus* or to Tabanini s.l. 3) Diversification of ‘core’ Tabanini, cosmopolitan *Tabanus*, i.e. Tabanini other than the Neotropical lineages, and Nearctic *Hamatabanus* and *Anacimas*. The amount of conflict and uncertainty is implied by how the support values and topologies at these nodes changes based on the partitioning scheme or taxon sampling (Table 9). Adding the other 3 species of *Lepiselaga* and additional species of *Diachlorus* may alleviate uncertainty as for the position of these enigmatic and phylogenetical crucial genera. Both of these genera are extremely morphologically distinct, and the sampled *Diachlorus* species are very closely related, on long branches (Figures 8, 9). The morphological novelty of these two genera suggests that their evolutionary history is much older than their crown groups, which may obfuscate potential clarity gained from additional sampling.

Table 9. Sensitivity analyses for Tabaninae. Reduced taxon set removes all taxa with <60% data. Values are bootstrap supports from RAxML rapid bootstrapping analyses.

Alignment	MaFFT+ Gblocks	MaFFT+ Gblocks	MaFFT+ Gblocks	MaFFT+ Gblocks
Partitioning	gene	codon	gene by codon	gene by codon
Taxon sample	full	full	full	reduced
Coracella sister to Tabaninae		50	55.2	53.2
Monophyly of Tabaninae	88	100	100	100
Agelaniini sister to rest of Tabaninae	88	100	100	100
Monophyly of Agelaniini	100	100	100	100
Chasmiini sister to non-Agelaniini Tabaninae	49	98	99.2	98.7
Monophyly of Chasmiini	96	100	99.7	100

Table 9 continued

Alignment	MaFFT+ Gblocks	MaFFT+ Gblocks	MaFFT+ Gblocks	MaFFT+ Gblocks
Partitioning	gene	codon	gene by codon	gene by codon
Taxon sample	full	full	full	reduced
Stenotabanini sister to Dasyrhamphini + "Core Tabaninae"	69	89	86.3	85.8
Monophyly of Stenotabanini	98	100	100	100
Dasyrhamphini sister to "Core Tabaninae"	83	100	99.7	100
Monophyly of Dasyrhamphini	100	100	100	100
"Core Tabaninae"	32	43	39.1	43.7
Monophyly of Selasomatini	36	53	49.1	53.9
Monophyly of Selasomatini other than unplaced spp.		33		39.3
Selasomatina+ Bolbomyiina		38		42.2
Monophyly of Selasomatina	100	100	100	100
Monophyly of Bolbodimyiina	99	100	100	100
Dicladocerina + Psalidiina	98	100	100	100
Monophyly of Dicladocerina	100	98	99.6	100
Monophyly of Psalidiina	98	97	99.2	100
Diachlorini+ Tabanini	31	43	34	44.9
Lepiselaga sister to Tabanini	47	57	56.3	47.7
Haematopotina sister to rest of Tabanini	57	100	99.6	
Monophyly of Tabanini excluding Haematopotina	46	72	76.2	100
Monophyly of Neotropical Tabanini	47	34		47.7
Hamatabanus group + "Core Tabanini"	43	92	43.5	87

Table 9 continued

Alignment	MaFFT+ Gblocks	MaFFT+ Gblocks	MaFFT+ Gblocks	MaFFT+ Gblocks
Partitioning	gene	codon	gene by codon	gene by codon
Taxon sample	full	full	full	reduced
Monophyly of "Core Tabanini"	22	51	30.4	44.5
Tabanus promesogaeus + *Haematopota*		37	36.6	37.8
Euancala sister to *Atylotus* group		14	12.9	

The two radiations within the family are distinct in several aspects. The Selasomatini are geographically limited, but their members show a great deal of ecological diversity. Tabanini is cosmopolitan and more diverse, but there are fewer species with exceptional biologies. The sister group to both of these lineages is informative. The Dasyrhamphini are geographically separated from the Selatomatini, and the larval biology of *Lepiselaga* is very different from any known Tabanini. This suggests that Selasomatini radiated ecologically due to a broad gap in a limited geographic area, e.g. South America 60 mya, while the Tabanini found a narrow ecological niche that it could exploit worldwide. As Selasomatini is highly supported as sister group to *Diachlorus*, *Lepiselaga*, and Tabanini, an extension of this is that ancient selasomatine flies were able to diversify into many niches, one of which was novel, allowing Tabanini to colonize the globe. It is clear that the driving forces of the diversification of hematophagous flies is variable, even in sister group lineages.

Haematopota is the most speciose recent lineage of horse flies, its relationships to other Tabanini deserves further investigation. This genus is found worldwide except for Australia and South America, and only 5 of its 555 describes species are found in the Nearctic. The genus may include *Hippocentrum*, and these lineages are clearly closely related. The bayesian inference supports a relationship of *Haematopota* and *Hippocentrum* with Afrotropical *Euancala*. Though this relationship is unanticipated, both genera are ornately patterned horse flies. *Haematopota* is speciose in tropical Africa, however the sister group to

other currently sampled *Haematopota* varies. In Bayesian inference, Afrotropical *Hippocentrum* is sister to *Haematopota*, which would corroborate a sister group relationship of this lineage with *Euancala*. Using other analysis paradigms and partitioning schemes, the sampled Nearctic species is sometimes resolved as sister to other *Haematopota*. When morphology is excluded, the diverse genus Holarctic genus is resolved as closely related to *Haematopota* with low support *Hybomitra*. Both genera have four eye bands. Though *Hybomitra* has a distribution similar to that of *Haematopota*, it is most diverse at high latitudes, in colder climates, and *Haematopota* is most diverse in the tropics. This suggests a possible sign of ancient competitive exclusion.

This study gives us insight into an enigma of insect phylogenetics; why are tabanine horse flies more diverse than any other group of hematophages? The two radiations recovered in the subfamily, one in core Tabaninae and Selasomatini, and in the core Tabanini, account for much of this diversity. The two areas of the phylogeny have lowest support values and shortest branches (Table 9, Figure 10). The factors possibly influencing these diversifications include larval habitat subdivision, exploiting niches in new biogeographic areas, a canalized evolutionary strategy, or the result of ecological diversification leading to a successful novel life history. Are these radiations the result of adaptive radiations to new areas, or the result of key innovations?

The success of the Tabaninae evolutionary strategy may be a result of an intrinsic propensity that allows the group to speciate more rapidly. The apparently unspecialized body plan may be canalized compared to other Tabanomorpha. The lack of morphological diversity and adult specialization is restricted within strict boundaries. This is similar to how anomuran hermit crabs are diverse in body forms but much less diverse than brachyuran true crabs which are much more diverse than other decapod lineages although they have a comparatively homogenous body plan. The morphological diversity of other more species poor Tabanomorpha lineages may also be an intrinsic attribute and not the result of selection forces. This pattern appears even within Tabaninae. Many of the largest tabanine genera are unspecialized, for instance *Stenotabanus*, *Cydistomyia*, *Dasybasis*, *Hybomitra*, and *Tabanus*. These genera cannot be differentiated without the inspection of subtle characters.

Haematopota, however, is very species diverse and has elevated rates of molecular evolution, morphological change, and speciation present. Others are morphologically and molecular divergent but not speciose, like *Chlorotabanus*. It is not clear how the exploitation of the same or very similar niches would lead to speciation.

A restricted adult morphology may make the clade appear less diversified than it is. Adult behavior may be one facet of specialization. From what is known, adult males in some species swarm over specific landmarks for short periods of time (Wilkerson and Fairchild 1985). Subdividing adult sexual behaviors may explain the diversity of the group, though mating behavior is known for a small fraction of species, primarily holarctic *Tabanus* and *Hybomitra*. Similarly, relatively little is known about the larval habitats of Agelaniini, Chasmiini, and Dasyrhamphini, the non- core Tabaninae from South America. Diversification of larval morphology is a driver of diversification in other lineages such as anurans (Roelants et al 2011). Species of *Stenotabanus* (*Aegialomyia*) and *Stenotabanus* (*Brachytabanus*) are found in coastal dunes, a variable and ephemeral biome exploited only by a few specialized taxa. Similarly, there are many noteworthy life histories among Selasomatini larvae. *Acanthocera* (*Polistimima*) larvae are found in sap filled tree holes, Stibasoma larvae live inside bromeliads, *Bolbodimyia* nigra is in moss mats on slanted surfaces, and *Leucotabanus ambiguus* is found in termite nests, for example. These anecdotal taxa have diverse biologies, but the larval biology of most species, and a few tribes, is unknown. This gap in our knowledge may be due to the paucity of collectors working on tropical insect ecology, or because those unknown taxa have yet greater levels of biological diversity. The possible subdivision of larval habitat may account for the diversity of the group where adults are indiscriminate feeders.

The radiation of Selasomatini and core Tabanini likely had different driving factors. As Selasomatini is restricted to South America, the group may have diversified to fill many niches in this region. This specialization might usually be a dead end, leading to some bizarre but species poor lineages such as *Cryptotylus*. However, in some groups, experimentation may lead to explosive radiations. Particular focus is warranted on the genera *Haematopotina*, *Lepiselaga* and *Diachlorus* as they are sister to the extremely diverse and rapidly diversified

Tabanini. About 30 species of widespread and bizarre bee-mimicking *Lepiselaga* and *Diachlorus* are sister to more than 2000 species. *Lepiselaga* larvae live in open water and may consume plant material. *Haematopotina*, strikingly convergent with more recently derived *Haematopota*, and geographically restricted, is the next sister to the 2000 species of Tabanini. *Phorcotabanus*, a genus in one of the first lineages within Tabanini, is the only horse fly known to only feed on waterfowl as adults. These lineages may represent remnants of a spate of morphological and ecological diversification in ancient South America. This may have lead to one particular larval and adult habitus that proved so successful that the lineage rapidly colonized the globe and became the modern core Tabanini. The typical Tabanidae larval biology of predation in damp soil may have instead have been a particularly successful evolutionary novelty in line with others in the core Tabaninae.

Table 10. Summary of Proposed Classification Changes within Tabaninae

Agelaniini **new tribe**
- *Agelanius* Rondani
- *Nubiloides* Coscaron & Philip
- *Scaptiodes* Enderlein

Chasmiini Enderlein 1922 **rev. stat**.
- *Atelozella* Bequaert
- *Atelozomyia* Dias
- *Bartolomeudiasella* Dias
- *Chalybosoma* Oldroyd
- *Chasmia* Enderlein
- *Cydistomyia* Taylor
- *Cydistomorpha* Trojan
- *Dasybasis* Macquart
- *Limata* Oldroyd
- *Lissimas* Enderlein
- *Lissimodes* Mackerras
- *Japenoides* Oldroyd
- *Neavella* Oldroyd
- *Neobolbodimyia* Ricardo
- *Philipota* Kapoor
- *Protodasyommia* Enderlein
- *Udenocera* Ricardo
- *Udenoceroides* Trojan

Table 10 continued

Stenotabanini Krober 1929 **rev. stat.**
- *Himantostylus* Lutz
- *Oopelma* Enderlein
- *Roquezia* Wilkerson
- *Stenotabanus* Lutz

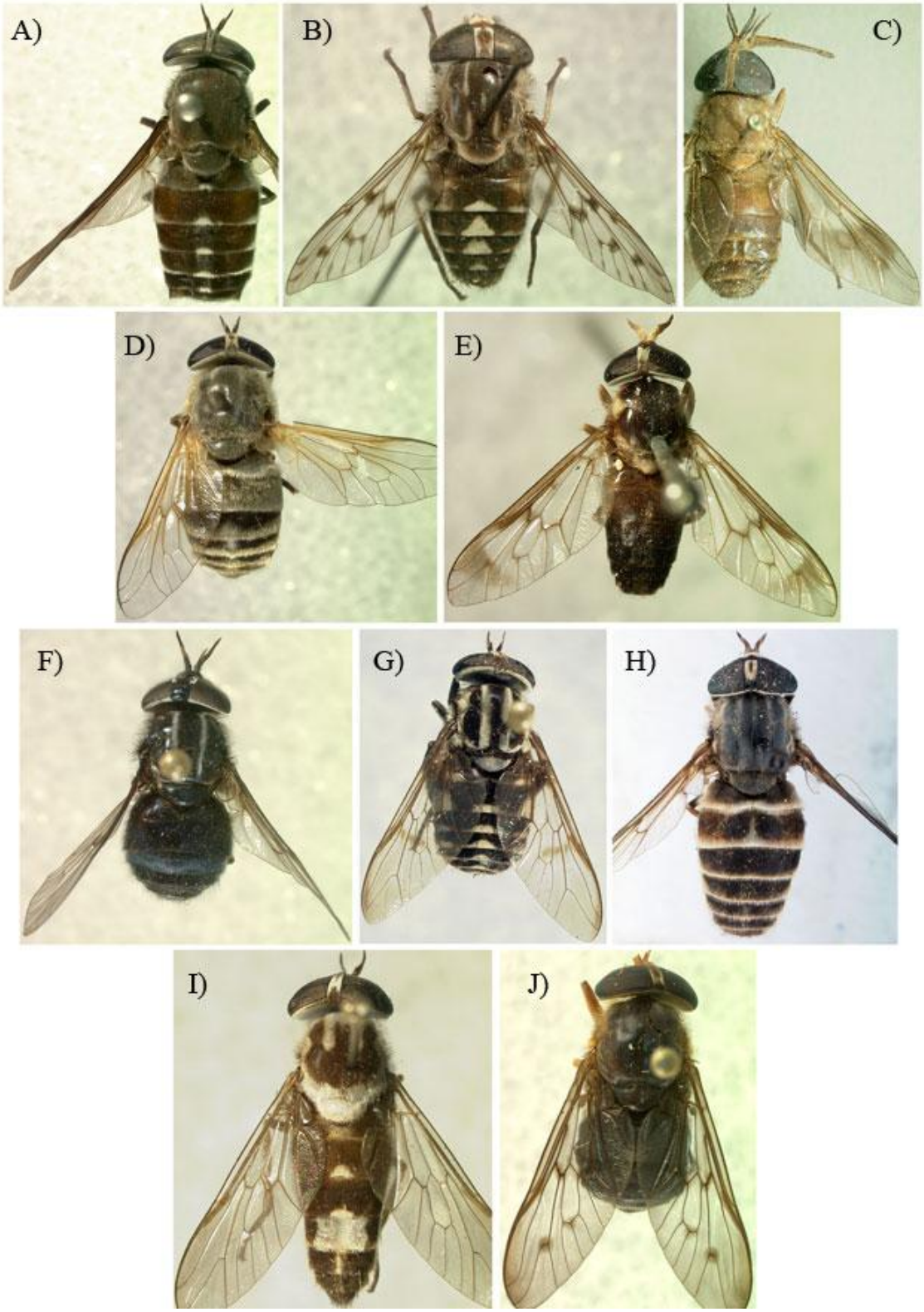
Dasyrhamphini Olsufjev 1964 **rev. stat.**
- *Dasyrhamphis* Enderlein
- *Nanorrhynchus* Olsufjev
- *Philipomyia* Olsufjev

Selasomatini Lutz 1913 **rev. stat.**
- Selasomatini *incertae sedis*
  - *Acellomyia* Gonzalez
  - *Anaerythrops* Barretto
  - *Archiplatius* Enderlein (including former *Dasybasis*)
  - *Erioneura* Barretto
  - *Pseudoselasoma* Brethes (including former *Dasybasis*)
  - *Teskeyellus* Philip & Fairchild
- Bolbodimyiina Philip 1941 **status novum**
  - *Bolbodimyia* Bigot
  - *Chlorotabanus* Lutz
  - *Cryptotylus* Lutz
  - *Eutabanus* Krober
  - *Holcopsis* Enderlein
  - *Myiotabanus* Lutz
  - *Phaeotabanus* Lutz
  - *Pachyschelomyia* Barretto
  - *Stibasoma* Schiner
- Selasomatina Lutz 1913 **status novum**
  - *Leptapha* Enderlein
  - *Leucotabanus* Lutz
  - *Pseudacanthocera* Lutz
  - *Selasoma* Macquart
  - *Stypommisa* Enderlein
- Dicladocerina Enderlein 1927 **status novum**
  - *Dicladocera* Lutz
  - *Eristalotabanus* Krober
  - *Hemichrysops* Krober
  - *Philipotabanus* Fairchild
  - *Spilotabanus* Fairchild
- Psalidiina Enderlein 1922 **status novum**
  - *Acanthocera* Macquart

Table 10 continued

Catachlorops Lutz
Dasychela Enderlein
Dichelacera Macquart
Querbetia Fairchild
Diachlorini Lutz 1909 ***sensu novo***
Diachlorus Osten Sacken
Lepiselaga Macquart
Tabanini Samouelle 1819 ***sensu novo*** (including Haematopotini)
Agkistrocerus Philip
Anacimas Enderlein
Ancala Enderlein
Atylotus Osten Sacken
Euancala Enderlein
Haematopota Meigen
Haematopotina Coscaron & Philip
Hamatabanus Philip
Heptatoma Meigen
Hippocentrodes Philip
Hippocentrum Austen
Hybomitra Enderlein
Isshikia Shiraki
Microtabanus Fairchild
Olsufjevotabanus
Parancala Trojan
Phorcotabanus Fairchild
Poeciloderas Lutz
Stigmatophthalmus Lutz
Tabanus Linnaeus
Therioplectes Zeller
Whitneyomyia Bequaert

Figure 6. Examples of the diversity of the major lineages of Tabaninae, dorsal view. A) Chasmiini- *Cydistomyia doddi* Taylor B) Selasomatini *incertae sedis*- *Pseudoselasoma schineri* (Kröber) C) Psaliidiina- *Dasychela macintyrei* Bequaert D) Dasyrhamphini- *Dasyrhamphis insecutor* (Austen) E) Diachlorini- *Diachlorus neivai* Lutz F) Dicladocerina- *Eristalotabanus violaceus* Kröber G) Bolbodimyiina- *Eutabanus pictus* Kröber H) Tabanini- *Hamatabanus annularis* (Hine) I) Stenotabanini- *Stenotabanus* (*Cretotabanus*) *cretatus* Fairchild J) Selasomatina- *Stypommisa ramosi* Gorayeb & Fairchild.


A)
B)
C)
D)
E)
F)
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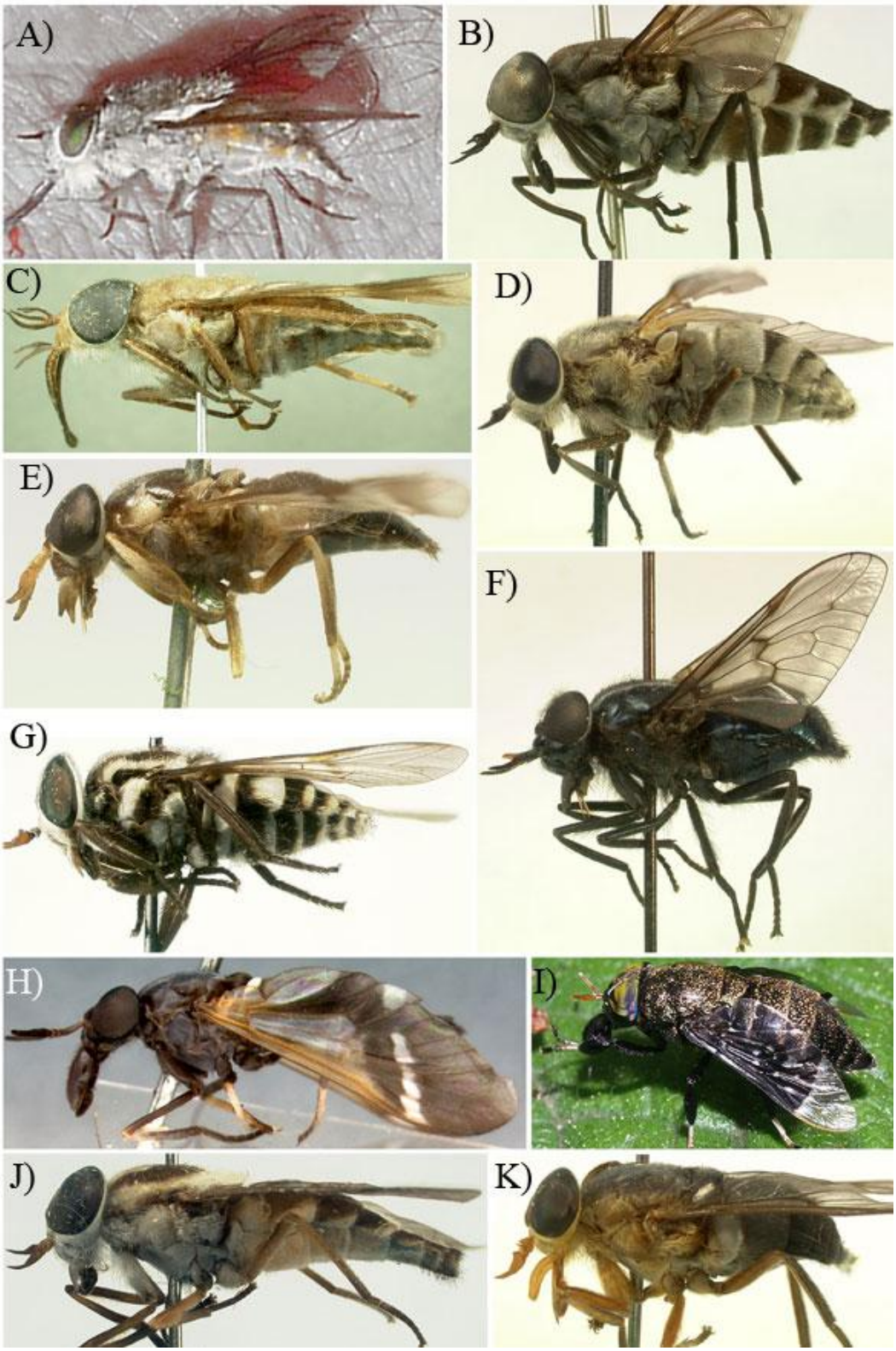
J)

Figure 7. Examples of the diversity of the major lineages of Tabaninae, lateral view. A) Agelaniini- Agelanius sp. (photo credit estamakabro flickr.com) B) Chasmiini- *Cydistomyia doddi* Taylor C) Psaliidiina- *Dasychela macintyrei* Bequaert D) Dasyrhamphini- *Dasyrhamphis insecutor* (Austen) E) Diachlorini- *Diachlorus neivai* Lutz F) Dicladocerina- *Eristalotabanus violaceus* Kröber G) Bolbodimyiina- *Eutabanus pictus* Kröber H) Tabanini- *Hippocentrum versicolor* Austen I) Diachlorini- *Lepiselaga crassipes* (Fabricius) (photo credit Bernhard Jacobi) J) Stenotabanini- *Stenotabanus* (*Cretotabanus*) *cretatus* Fairchild K) Selasomatina- *Stypommisa ramosi* Gorayeb & Fairchild.


A)
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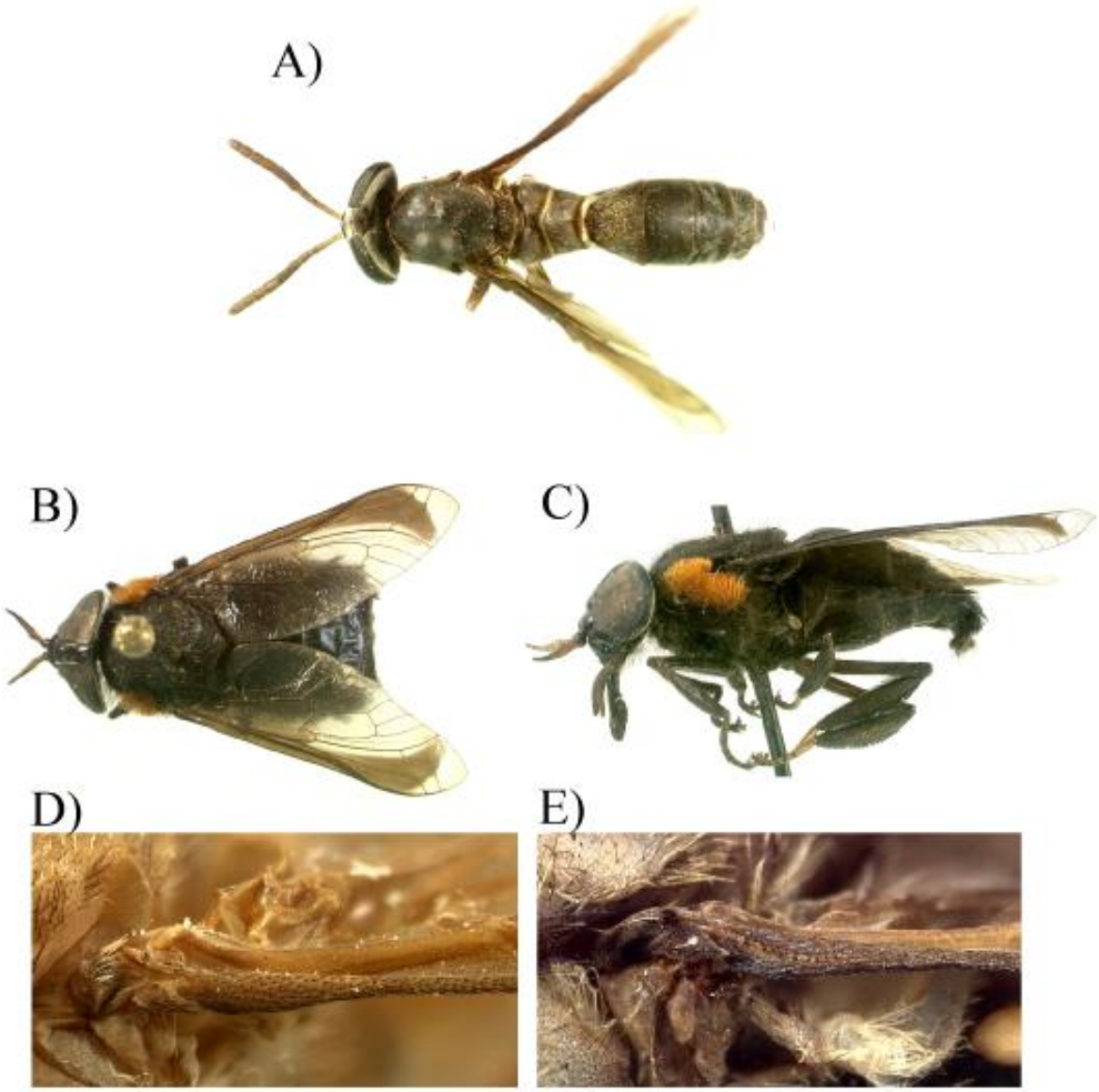


Figure 8. Examples of morphological character states. A) *Acanthocera (Mimodynerus) anacantha* Lutz & Neiva dorsal view B) *Bolbodimyia dampfi* Philip dorsal view C) *Bolbodimyia dampfi* Philip lateral view D) *Leptapha fumata* (Wiedemann) wing base anterior view, showing basicosta with macrotrichiae present E) *Roquezia signifera* Wilkerson wing base anterior view, showing basicosta with macrotrichiae absent.

Figure 9. Bayesian inference phylogeny of Tabaninae, overvew and outgroups through Stenotabanini. Unless otherwise indicated, all nodes with posterior probability of 1.

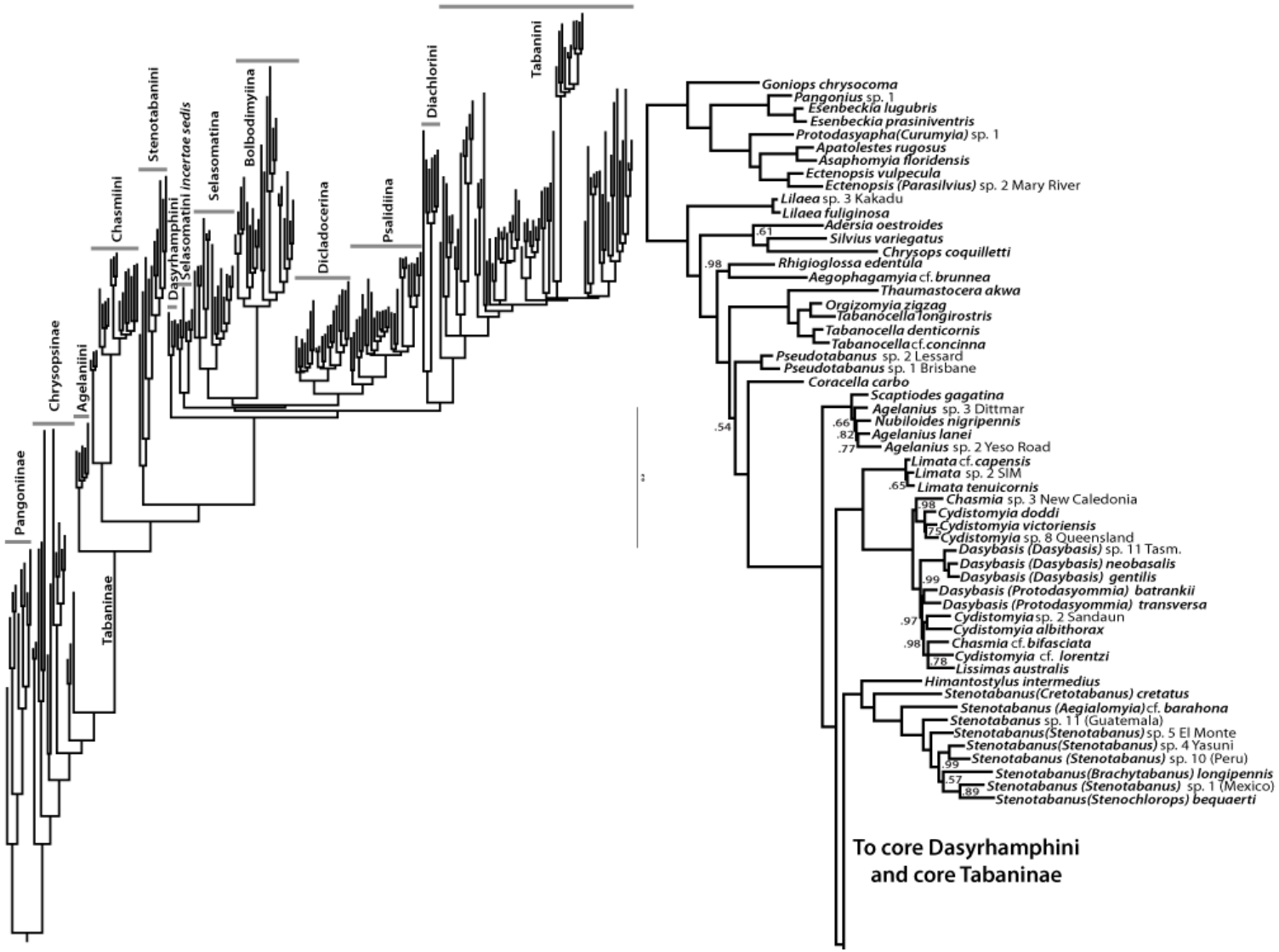
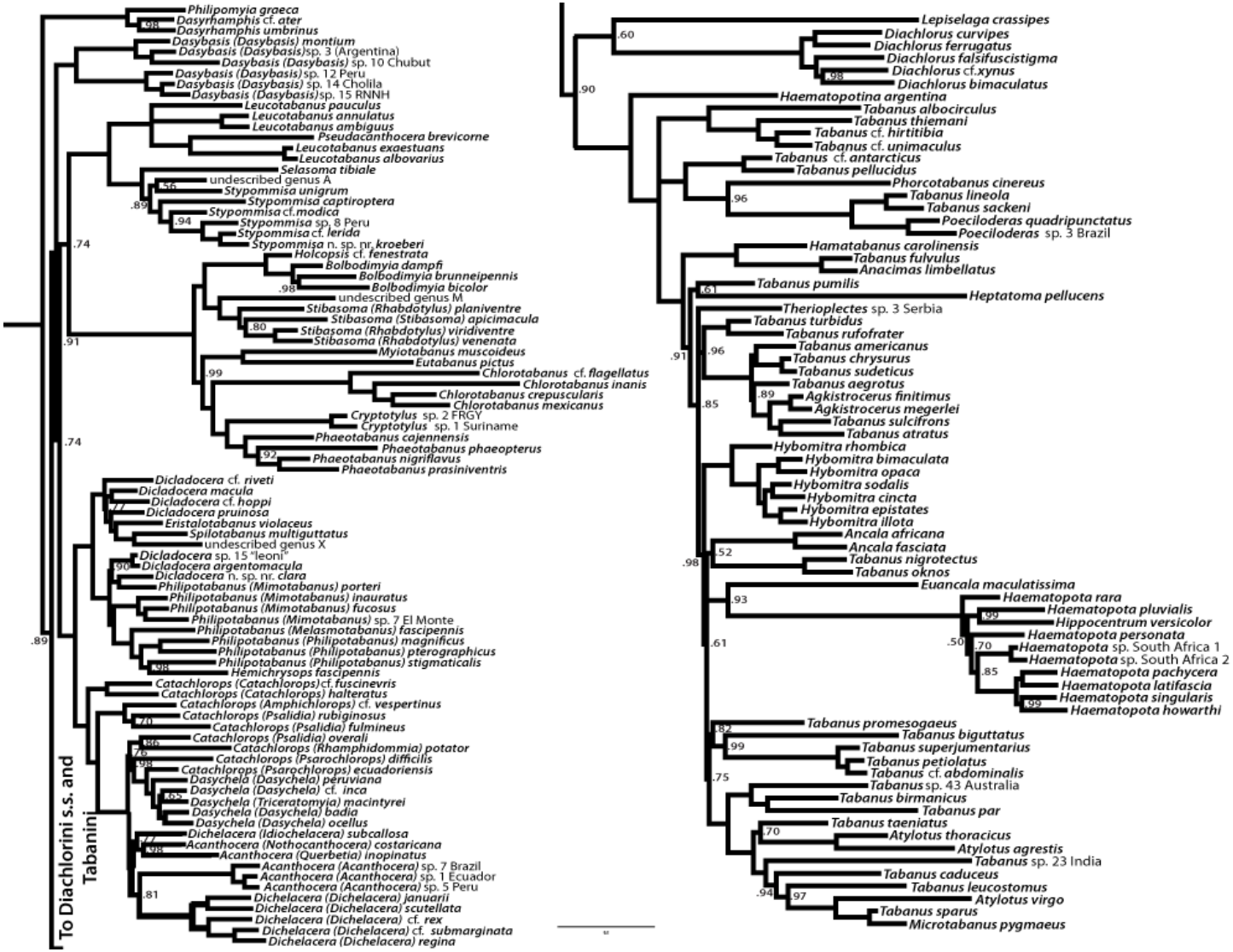

Pangoniinae
Chrysopsinae
Agelaiini
Chasmiini
Stenotabanini
Dasyrhamphini
Selasomatini incertae sedis
Selasomatina
Bolbodimyiina
Dicladocerina
Psalidiina
Diachlorini
Tabanini
Tabaninae
Goniops chrysocoma
Pangonius sp. 1
Esenbeckia lugubris
Esenbeckia prasiniventris
Protodasyapha(Curumyia) sp. 1
Apatolestes rugosus
Asaphomyia floridensis
Ectenopsis vulpecula
Ectenopsis (Parasilvius) sp. 2 Mary River
Lilaea sp. 3 Kakadu
Lilaea fuliginosa
Adersia oestroides
Silvius variegatus
Chrysops coquilletti
Rhigioglossa edentula
Aegophagamyia cf. brunnea
Thaumastocera akwa
Orgizomyia zigzag
Tabanocella longirostris
Tabanocella denticornis
Tabanocella cf. concinna
Pseudotabanus sp. 2 Lessard
Pseudotabanus sp. 1 Brisbane
Coracella carbo
Scaptiodes gagatina
Agelanius sp. 3 Dittmar
Nubiloides nigripennis
Agelanius lanei
Agelanius sp. 2 Yeso Road
Limata cf. capensis
Limata sp. 2 SIM
Limata tenuicornis
Chasmia sp. 3 New Caledonia
Cydistomyia doddi
Cydistomyia victoriensis
Cydistomyia sp. 8 Queensland
Dasybasis (Dasybasis) sp. 11 Tasm.
Dasybasis (Dasybasis) neobasalis
Dasybasis (Dasybasis) gentilis
Dasybasis (Protodasyommia) batrankii
Dasybasis (Protodasyommia) transversa
Cydistomyia sp. 2 Sandaun
Cydistomyia albithorax
Chasmia cf. bifasciata
Cydistomyia cf. lorentzi
Lissimas australis
Himantostylus intermedius
Stenotabanus(Cretotabanus) cretatus
Stenotabanus (Aegialomyia) cf. barahona
Stenotabanus sp. 11 (Guatemala)
Stenotabanus(Stenotabanus) sp. 5 El Monte
Stenotabanus(Stenotabanus) sp. 4 Yasuni
Stenotabanus (Stenotabanus) sp. 10 (Peru)
Stenotabanus(Brachytabanus) longipennis
Stenotabanus (Stenotabanus) sp. 1 (Mexico)
Stenotabanus(Stenochlorops) bequaerti
.61
.98
.54
.66
.82
.77
.65
.98
.75
.99
.97
.98
.78
.99
.57
.89
To core Dasyrhamphini
and core Tabaninae

Figure 10. Bayesian inference phylogeny of Tabaninae, showing Dasyrhamphini, Selasomatini, Diachlorini, and Tabanini. Unless otherwise indicated, all nodes with posterior probability of 1.


Philipomyia graeca
Dasyrhamphis cf. ater
Dasyrhamphis umbrinus
Dasybasis (Dasybasis) montium
Dasybasis (Dasybasis)sp. 3 (Argentina)
Dasybasis (Dasybasis) sp. 10 Chubut
Dasybasis (Dasybasis)sp. 12 Peru
Dasybasis (Dasybasis) sp. 14 Cholila
Dasybasis (Dasybasis)sp. 15 RNNH
Leucotabanus pauculus
Leucotabanus annulatus
Leucotabanus ambiguus
Pseudacanthocera brevicorne
Leucotabanus exaestuans
Leucotabanus albovarius
Selasoma tibiale
undescribed genus A
Stypommisa unigrum
Stypommisa captiroptera
Stypommisa cf. modica
Stypommisa sp. 8 Peru
Stypommisa cf. lerida
Stypommisa n. sp. nr. kroeberi
Holcopsis cf. fenestrata
Bolbodimyia dampfi
Bolbodimyia brunneipennis
Bolbodimyia bicolor
undescribed genus M
Stibasoma (Rhabdotylus) planiventre
Stibasoma (Stibasoma) apicimacula
Stibasoma (Rhabdotylus) viridiventre
Stibasoma (Rhabdotylus) venenata
Myiotabanus muscoideus
Eutabanus pictus
Chlorotabanus cf. flagellatus
Chlorotabanus inanis
Chlorotabanus crepuscularis
Chlorotabanus mexicanus
Cryptotylus sp. 2 FRGY
Cryptotylus sp. 1 Suriname
Phaeotabanus cajennensis
Phaeotabanus phaeopterus
Phaeotabanus nigriflavus
Phaeotabanus prasiniventris
Dicladocera cf. riveti
Dicladocera macula
Dicladocera cf. hoppi
Dicladocera pruinosa
Eristalotabanus violaceus
Spilotabanus multiguttatus
undescribed genus X
Dicladocera sp. 15 "leoni"
Dicladocera argentomacula
Dicladocera n. sp. nr. clara
Philipotabanus (Mimotabanus) porteri
Philipotabanus (Mimotabanus) inauratus
Philipotabanus (Mimotabanus) fucosus
Philipotabanus (Mimotabanus) sp. 7 El Monte
Philipotabanus (Melasmotabanus) fascipennis
Philipotabanus (Philipotabanus) magnificus
Philipotabanus (Philipotabanus) pterographicus
Philipotabanus (Philipotabanus) stigmaticalis
Hemichrysops fascipennis
Catachlorops (Catachlorops)cf. fuscinevris
Catachlorops (Catachlorops) halteratus
Catachlorops (Amphichlorops) cf. vespertinus
Catachlorops (Psalidia) rubiginosus
Catachlorops (Psalidia) fulmineus
Catachlorops (Psalidia) overali
Catachlorops (Rhamphidommia) potator
Catachlorops (Psarochlorops) difficilis
Catachlorops (Psarochlorops) ecuadoriensis
Dasychela (Dasychela) peruviana
Dasychela (Dasychela) cf. inca
Dasychela (Triceratomyia) macintyrei
Dasychela (Dasychela) badia
Dasychela (Dasychela) ocellus
Dichelacera (Idiochelacera) subcallosa
Acanthocera (Nothocanthocera) costaricana
Acanthocera (Querbetia) inopinatus
Acanthocera (Acanthocera) sp. 7 Brazil
Acanthocera (Acanthocera) sp. 1 Ecuador
Acanthocera (Acanthocera) sp. 5 Peru
Dichelacera (Dichelacera) januarii
Dichelacera (Dichelacera) scutellata
Dichelacera (Dichelacera) cf. rex
Dichelacera (Dichelacera) cf. submarginata
Dichelacera (Dichelacera) regina
To Diachlorini s.s. and Tabanini
Lepiselaga crassipes
Diachlorus curvipes
Diachlorus ferrugatus
Diachlorus falsifuscistigma
Diachlorus cf.xynus
Diachlorus bimaculatus
Haematopotina argentina
Tabanus albocirculus
Tabanus thiemani
Tabanus cf. hirtitibia
Tabanus cf. unimaculus
Tabanus cf. antarcticus
Tabanus pellucidus
Phorcotabanus cinereus
Tabanus lineola
Tabanus sackeni
Poeciloderas quadripunctatus
Poeciloderas sp. 3 Brazil
Hamatabanus carolinensis
Tabanus fulvulus
Anacimas limbellatus
Tabanus pumilis
Heptatoma pellucens
Therioplectes sp. 3 Serbia
Tabanus turbidus
Tabanus rufofrater
Tabanus americanus
Tabanus chrysurus
Tabanus sudeticus
Tabanus aegrotus
Agkistrocerus finitimus
Agkistrocerus megerlei
Tabanus sulcifrons
Tabanus atratus
Hybomitra rhombica
Hybomitra bimaculata
Hybomitra opaca
Hybomitra sodalis
Hybomitra cincta
Hybomitra epistates
Hybomitra illota
Ancala africana
Ancala fasciata
Tabanus nigrotectus
Tabanus oknos
Euancala maculatissima
Haematopota rara
Haematopota pluvialis
Hippocentrum versicolor
Haematopota personata
Haematopota sp. South Africa 1
Haematopota sp. South Africa 2
Haematopota pachycera
Haematopota latifascia
Haematopota singularis
Haematopota howarthi
Tabanus promesogaeus
Tabanus biguttatus
Tabanus superjumentarius
Tabanus petiolatus
Tabanus cf. abdominalis
Tabanus sp. 43 Australia
Tabanus birmanicus
Tabanus par
Tabanus taeniatus
Atylotus thoracicus
Atylotus agrestis
Tabanus sp. 23 India
Tabanus caduceus
Tabanus leucostomus
Atylotus virgo
Tabanus sparus
Microtabanus pygmaeus

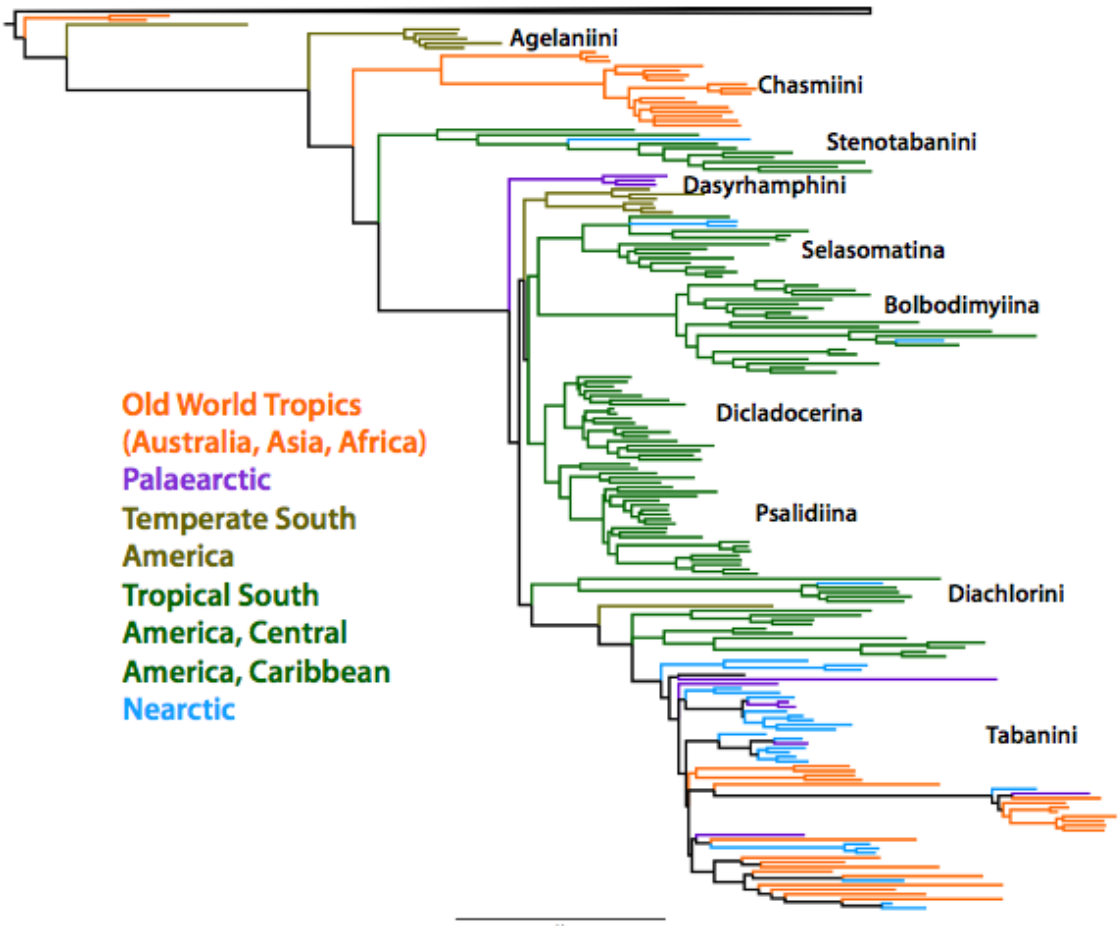


Figure 11. Bayesian inference phylogeny of Tabaninae, branches colored according to the biogeographical origin of each sampled species. Orange is for the Australia, South Asia, and Africa (Old World tropics), purple is the Palaearctic, brown is temperate South America, green is the Neotropics north of temperate South America (tropical South America, Central America, the Caribbean) and blue is the Nearctic.

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APPENDICES

Appendix A

Tabanomorpha Taxon Sample

Outgroups

Family	Taxon	Taxon code for analysis
Acroceridae	*Acrocera orbicula*	Acrocorb
Acroceridae	*Astomella* sp. SLW-2002	Astomel
Acroceridae	*Eulonchus marialiciae*	Eulonmar
Acroceridae	*Helle longirostris*	Hellelo
Acroceridae	*Mesophysa ilzei*	Mesophil
Acroceridae	*Ogcodes basalis*	Ogba21
Acroceridae	*Paracyrtus albofimbriatus*	Paracyal
Acroceridae	*Sphaerops* sp. SLW-2002	Sphaerops
Bombyliidae	*Bombylius major*	Boma19
Bombyliidae	*Lepidophora* sp.	Lepidoph
Hilarimorphidae	*Hilarimorpha mentata*	Hila
Pantophthalmidae	*Pantophthalmus* sp. MDT-2010	Pantomdt
Stratiomyidae	*Actina viridis*	Actinavi
Stratiomyidae	*Antissa* sp. SLW-2002	Antisslw
Stratiomyidae	*Chloromyia formosa* CB0502	Chloromf
Stratiomyidae	*Clitellaria ephippium*	Cliteph
Stratiomyidae	*Hermetia illucens*	heil24
Stratiomyidae	*Oplodontha viridula*	Oplodovi2
Xylomyidae	*Solva* sp. CB0434	Solvacb
Xylomyidae	*Xylomya parens*	Xymy

Tabanomorpha and related taxa alphabetized by family and then by species

Family	Taxon	code
Athericidae: Athericinae	*Atherix marginata*	Athmarg
Athericidae: Athericinae	*Atherix variegata*	Athvar
Athericidae: Dasyommatinae	*Dasyomma caeruleum*	Dasyommca
Athericidae: Dasyommatinae	*Dasyomma* sp.	Dasyomma
Athericidae: Dasyommatinae	*Dasyomma vittatum*	Dasyommvi
Athericidae: Athericinae	*Suragina longipes*	Suragina
Austroleptidae	*Austroleptis collessi*	Austrolco
Austroleptidae	*Austroleptis multimaculatus*	Austrolmu
Austroleptidae	*Austroleptis rhyphoides*	Austrolrh
Bolbomyiidae	*Bolbomyia nana*	Bolbomyna

Family	Taxon	code
Nemestrinidae: Hirmoneurinae	*Hirmoneura* sp. MDT-2010	Hirmmdt
Nemestrinidae: Hirmoneurinae	*Hirmoneura* sp. SLW-2006ac+MDT-2010	Hirmms
Nemestrinidae: Hirmoneurinae	*Hirmoneura* sp. SLW-2006c	Hirmslwb
Nemestrinidae	Nemestrinidae gen. sp. 'Chile'	Nemchile
Nemestrinidae: Nemestrininae	*Nemestrinus aegyptiacus*	Nemesaeg
Nemestrinidae: Trichopsideinae	*Neorhynchocephalus volaticus*	Neorhynvo
Nemestrinidae: Nemestrininae	*Trichophthalma punctata*	Tpu
Nemestrinidae: Nemestrininae	*Trichophthalma* sp. LRC-2002	Trichlrc
Nemestrinidae: Nemestrininae	*Trichophthalma* sp. SLW-2002	Trichslw
Oreoleptidae	*Oreoleptis torrenticola*	Oreotor
Pelecorhynchidae	*Glutops rossi*	Glutros
Pelecorhynchidae	*Glutops singularis*	Glutsin
Pelecorhynchidae	*Pelecorhynchus personatus*	Peleper
Pelecorhynchidae	*Pseudoerinna jonesi*	Pseujon
Rhagionidae: Arthrocerinae	*Arthroceras fulvicorne*	Arthrocfu
Rhagionidae: Rhagioninae	*Arthroteles cinerea*	Arthrotci
Rhagionidae: Rhagioninae	*Atherimorpha atrifemur*	Atherimat
Rhagionidae: Rhagioninae	*Atherimorpha nemoralis*	Atherimne
Rhagionidae: Rhagioninae	*Atherimorpha* sp. 2 PHK	Atherim2
Rhagionidae: Rhagioninae	*Atherimorpha* sp. 3 PHK	Atherim3
Rhagionidae: Rhagioninae	*Atherimorpha vernalis*	Atherimve
Rhagionidae: Chrysopilinae	*Chrysopilus quadratus*	Chryquad
Rhagionidae: Chrysopilinae	*Chrysopilus rhagiodes*	Chryrhag
Rhagionidae: Chrysopilinae	*Chrysopilus* sp. 2 PHK-2006	Chry2phk
Rhagionidae: Chrysopilinae	*Chrysopilus* sp. 3 PHK-2006	Chry3phk
Rhagionidae: Chrysopilinae	*Chrysopilus* sp. SLB-2003	Chrysoslb
Rhagionidae: Chrysopilinae	*Chrysopilus thoracicus*	Chrythor
Rhagionidae: Spaniinae	*Ptiolina fasciata*	Ptiofas
Rhagionidae: Spaniinae	*Ptiolina* sp. PHK-2011	Ptiophk
Rhagionidae: Rhagioninae	*Rhagio hirtus*	Rhaghir
Rhagionidae: Rhagioninae	*Rhagio mystaceus*	Rhagmys2
Rhagionidae: Spaniinae	*Spaniopsis clelandi*	Spaniocle
Rhagionidae: Spaniinae	*Spaniopsis longicornis*	Spaniolon
Rhagionidae: Spaniinae	*Symphoromyia atripes*	Symphat
Rhagionidae: Spaniinae	*Symphoromyia hirta*	Symphir
Rhagionidae: Spaniinae	*Symphoromyia hirta*	Symphir2

Family	Taxon	code
Rhagionidae: Spaniinae	*Symphoromyia hirta*	Symphir3
Rhagionidae: Spaniinae	*Symphoromyia* sp. PHK-2006	Symphphk
Rhagionidae: Spaniinae	*Symphoromyia* sp. SLB-2003	Symphslb
Tabanidae: Tabaninae	*Acanthocera (Acanthocera)* sp. 5 (Peru)	Acantho5p
Tabanidae: Tabaninae	*Acanthocera* (*Acanthocera*) sp. 7 Brazil	Acantho7b
Tabanidae: Tabaninae	*Acanthocera (Acanthocera)* sp.1 (EC)	Acantho1e
Tabanidae: Tabaninae	*Acanthocera (Nothocanthocera) costaricana*	Nothcos
Tabanidae: Tabaninae	*Acanthocera (Querbetia) inopinatus*	Querbin
Tabanidae	*Adersia oestroides*	Aderso
Tabanidae: Chrysopsinae	*Aegophagamyia (Triclida)* cf. *brunnea*	Aegoph1
Tabanidae: Chrysopsinae	*Aegophagamyia (Triclida) variegata*	Aegophva
Tabanidae: Tabaninae	*Agelanius lanei*	Agelanla
Tabanidae: Tabaninae	*Agelanius* sp. 2 Yeso Road males	Agelan2y
Tabanidae: Tabaninae	*Agelanius* sp. 3 Dittmar	Agelan3d
Tabanidae: Tabaninae	*Agkistrocerus finitimus*	Agfin
Tabanidae: Tabaninae	*Agkistrocerus megerlei*	Agmeg
Tabanidae: Tabaninae	*Anacimas limbellatus*	Anacil
Tabanidae: Tabaninae	*Ancala africana*	Ancaafr
Tabanidae: Tabaninae	*Ancala fasciata*	Ancafas
Tabanidae: Pangoniinae	*Apatolestes (Apatolestes) rugosus*	Apatrug
Tabanidae: Pangoniinae	*Apatolestes sp.2*	apatol2
Tabanidae: Pangoniinae	*Asaphomyia floridensis*	Asaphfl
Tabanidae: Tabaninae	*Atylotus agrestis*	Atyloagr
Tabanidae: Tabaninae	*Atylotus thoracicus*	Atylotho
Tabanidae: Tabaninae	*Atylotus virgo*?	Atylovi
Tabanidae: Tabaninae	*Bolbodimyia bicolor*	Bolbobic
Tabanidae: Tabaninae	*Bolbodimyia brunneipennis*	Bolbobr
Tabanidae: Tabaninae	*Bolbodimyia dampfi*	Bolboda
Tabanidae: Tabaninae	*Catachlorops (Amphichlorops)* cf. *vespertinus*	Cataamp5
Tabanidae: Tabaninae	*Catachlorops (Catachlorops)* cf. *fuscinevris*	Cata4f
Tabanidae: Tabaninae	*Catachlorops (Catachlorops) halteratus*	Catahalt
Tabanidae: Tabaninae	*Catachlorops (Psalidia) fulmineus*	Cataful
Tabanidae: Tabaninae	*Catachlorops (Psalidia) overali*	Cataover
Tabanidae: Tabaninae	*Catachlorops (Psalidia) rubiginosus*	Catarubi
Tabanidae: Tabaninae	*Catachlorops (Psarochlorops) difficilis*	Catadif
Tabanidae: Tabaninae	*Catachlorops (Psarochlorops) ecuadoriensis*	Cataecu
Tabanidae: Tabaninae	*Catachlorops (Rhamphidommia) mucosus*	Catarmuc
Tabanidae: Tabaninae	*Chasmia bifasciata*	Chasmia1b

Family	Taxon	code
Tabanidae: Tabaninae	*Chasmia* sp. 3 New Caledonia	Chasmia3n
Tabanidae: Tabaninae	*Chlorotabanus crepuscularis*	Chlorcre
Tabanidae: Tabaninae	*Chlorotabanus flagellatus*	Chloro4f
Tabanidae: Tabaninae	*Chlorotabanus inanis*	Chlorin
Tabanidae: Tabaninae	*Chlorotabanus mexicanus*	Chlormex
Tabanidae: Chrysopsinae	*Chrysops caecutiens*	Chryscae
Tabanidae: Chrysopsinae	*Chrysops carbonarius*	Chryscarb
Tabanidae: Chrysopsinae	*Chrysops coquilletti*	Chryscoq
Tabanidae: Chrysopsinae	*Chrysops dispar*	Chrysdisp
Tabanidae: Chrysopsinae	*Chrysops flavidus*	Chrysflav
Tabanidae: Chrysopsinae	*Chrysops madagascariensis*	Chrysmad
Tabanidae: Chrysopsinae	*Chrysops niger*	Chrysnige
Tabanidae: Chrysopsinae	*Chrysops* sp. 20 Peru	Chrys20p
Tabanidae: Chrysopsinae	*Chrysops upsilon*	Chrysupsi
Tabanidae: Chrysopsinae	*Chrysops viduatus*	Chrysvidu
Tabanidae: Chrysopsinae	*Chrysops vittatus*	Chrysvit
Tabanidae: Chrysopsinae	*Coracella carbo*	Coracel1
Tabanidae: Tabaninae	*Cryptotylus* sp. 1 Suriname	Crypto1s
Tabanidae: Tabaninae	*Cryptotylus* sp. 2 FRGY	Crypto2f
Tabanidae: Tabaninae	*Cydistomyia (Cydistomyia) albithorax*	Cydialbi
Tabanidae: Tabaninae	*Cydistomyia (Cydistomyia) doddi*	Cydistdo
Tabanidae: Tabaninae	*Cydistomyia (Cydistomyia) lorentzi*	Cydi4w
Tabanidae: Tabaninae	*Cydistomyia (Cydistomyia)* sp. 2 Sandaun	Cydi2s
Tabanidae: Tabaninae	*Cydistomyia (Cydistomyia)* sp. 8 QLD	Cydist8q
Tabanidae: Tabaninae	*Cydistomyia (Cydistomyia) victoriensis*	Cydist8q
Tabanidae: Tabaninae	*Cydistomyia duplonotata*	Cydistdup
Tabanidae: Tabaninae	*Dasybasis (Dasybasis) gentilis*	Dasybgen
Tabanidae: Tabaninae	*Dasybasis (Dasybasis) montium*	Dasybmon
Tabanidae: Tabaninae	*Dasybasis (Dasybasis) neobasalis*	Dasybneo
Tabanidae: Tabaninae	*Dasybasis (Dasybasis)* sp. 10 Chubut	Dasyb10c
Tabanidae: Tabaninae	*Dasybasis (Dasybasis)* sp. 11 Tasmania	Dasyb11t
Tabanidae: Tabaninae	*Dasybasis (Dasybasis)* sp. 12 Peru	Dasyb12p
Tabanidae: Tabaninae	*Dasybasis (Dasybasis)* sp. 14 Cholila	Dasyb14c
Tabanidae: Tabaninae	*Dasybasis (Dasybasis)* sp. 3 Argentina	Dasybda3a
Tabanidae: Tabaninae	*Dasybasis (Protodasyommia) batrankii*	Dasybbat
Tabanidae: Tabaninae	*Dasybasis (Protodasyommia) transversa*	Dasybtra
Tabanidae: Tabaninae	*Dasybasis* sp. 15 (RNNH)	Dasyb15r
Tabanidae: Tabaninae	*Dasychela (Dasychela) badia*	Dasycbad
Tabanidae: Tabaninae	*Dasychela (Dasychela)* cf. *inca*	Dasyc6h

Family	Taxon	code
Tabanidae: Tabaninae	*Dasychela (Dasychela) ocellus*	Dasycoce
Tabanidae: Tabaninae	*Dasychela (Dasychela) peruviana*	Dasycper
Tabanidae: Tabaninae	*Dasychela (Triceratomyia) macintyrei*	Dasycmac
Tabanidae: Tabaninae	*Dasyrhamphis anthracinus*	Dasyrant2
Tabanidae: Tabaninae	*Dasyrhamphis* cf. *ater*	Dasyrant
Tabanidae: Tabaninae	*Dasyrhamphis umbrinus*	Dasyrumb
Tabanidae: Tabaninae	*Diachlorus bimaculatus*	Diabim
Tabanidae: Tabaninae	*Diachlorus* cf. *xynus*	Diaxy
Tabanidae: Tabaninae	*Diachlorus curvipes*	Diacurv
Tabanidae: Tabaninae	*Diachlorus falsifuscistigma*	Diafals
Tabanidae: Tabaninae	*Diachlorus ferrugatus*	Diaferr
Tabanidae: Tabaninae	*Dichelacera (Dichelacera) rex*	Dich8r
Tabanidae: Tabaninae	*Dichelacera (Dichelacera) submarginata*	Dich7s
Tabanidae: Tabaninae	*Dichelacera (Dichelacera) januarii*	Dichjan
Tabanidae: Tabaninae	*Dichelacera (Dichelacera) regina*	Dichreg
Tabanidae: Tabaninae	*Dichelacera (Dichelacera) scutellata*	Dichscut
Tabanidae: Tabaninae	*Dichelacera (Idiochelacera) subcallosa*	Dichidio
Tabanidae: Tabaninae	*Dicladocera* sp. 15 leoni	Dicl15l
Tabanidae: Tabaninae	*Dicladocera argentomacula*	Diclarg
Tabanidae: Tabaninae	*Dicladocera* cf. *riveti*	Dicl14v
Tabanidae: Tabaninae	*Dicladocera hoppi*	Dicl12h
Tabanidae: Tabaninae	*Dicladocera macula*	Diclmac
Tabanidae: Tabaninae	*Dicladocera* n. sp. nr *clara*	Diclcla
Tabanidae: Tabaninae	*Dicladocera pruinosa*	Diclpru
Tabanidae: Pangoniinae	*Ectenopsis (Ectenopsis) vulpecula*	Ectenvu
Tabanidae: Pangoniinae	*Ectenopsis (Parasilvius)* sp. 2 Mary River	Ectenp2
Tabanidae: Tabaninae	*Eristalotabanus violaceus*	Eristvi
Tabanidae: Pangoniinae	*Esenbeckia (Esenbeckia) cf. lugubris*	Esenlug
Tabanidae: Pangoniinae	*Esenbeckia (Esenbeckia) prasiniventris*	Esenpra
Tabanidae: Pangoniinae	*Esenbeckia (Palassomyia) fascipennis*	Esenfas
Tabanidae: Pangoniinae	*Esenbeckia (Ricardoa) delta*	Esendel
Tabanidae: Pangoniinae	*Esenbeckia* (*Ricardoa*) sp.3 Mexico	Esenric3m
Tabanidae: Tabaninae	*Euancala maculatissima*	Euanmac
Tabanidae: Tabaninae	*Eutabanus pictus*	Eutab
Tabanidae: Pangoniinae	*Fidena (Fidena) flavipennis*	Fidenafla
Tabanidae: Pangoniinae	*Fidena (Fidena)* sp. 1 Ecuador	Fidena1e
Tabanidae: Pangoniinae	*Goniops chrysocoma*	Goniops
Tabanidae: Tabaninae	*Haematopota howarthi*	Haemhow
Tabanidae: Tabaninae	*Haematopota latifascia*	Haemlat

Family	Taxon	code
Tabanidae: Tabaninae	*Haematopota pachycera*	Haempac
Tabanidae: Tabaninae	*Haematopota personata*	Haemper
Tabanidae: Tabaninae	*Haematopota pluvialis*	Haemplu
Tabanidae: Tabaninae	*Haematopota rara*	Haemrar
Tabanidae: Tabaninae	*Haematopota singularis*	Haemsing
Tabanidae: Tabaninae	*Haematopota* sp. South Africa 1	Haemrsa
Tabanidae: Tabaninae	*Haematopota* sp. South Africa 2	Haemsim
Tabanidae: Tabaninae	*Haematopotina argentina*	Haemnar
Tabanidae: Tabaninae	*Hamatabanus carolinensis*	Hamacar
Tabanidae: Tabaninae	*Hemichrysops fascipennis*	Hemifas
Tabanidae: Tabaninae	*Heptatoma pellucens*	Hepta
Tabanidae: Tabaninae	*Himantostylus intermedius*	Himantin
Tabanidae: Tabaninae	*Hippocentrum versicolor*	Hippmver
Tabanidae: Tabaninae	*Holcopsis fenestrata*	Holcofen
Tabanidae: Tabaninae	*Hybomitra bimaculata*	Hybobim
Tabanidae: Tabaninae	*Hybomitra cincta*	Hybocin
Tabanidae: Tabaninae	*Hybomitra epistates*	Hyboepi
Tabanidae: Tabaninae	*Hybomitra illota*	Hyboill
Tabanidae: Tabaninae	*Hybomitra opaca*	Hyborho
Tabanidae: Tabaninae	*Hybomitra rhombica*	Hyborho
Tabanidae: Tabaninae	*Hybomitra sodalis*	Hybosod
Tabanidae: Tabaninae	*Lepiselaga (Lepiselaga) crassipes*	Lepicra2
Tabanidae: Tabaninae	*Leucotabanus albovarius*	Leucalbo
Tabanidae: Tabaninae	*Leucotabanus ambiguus*	Leucambi
Tabanidae: Tabaninae	*Leucotabanus annulatus*	Leucann
Tabanidae: Tabaninae	*Leucotabanus exaestuans*	Leucex
Tabanidae: Tabaninae	*Leucotabanus pauculus*	Leucpau
Tabanidae: Chrysopsinae	*Lilaea (Lilaea) fuliginosa*	Lilaful
Tabanidae: Chrysopsinae	*Lilaea (Lilaea)* sp. 3 Kakadu	Lila3k
Tabanidae: Tabaninae	*Limata* cf. *capensis*	Limata2m
Tabanidae: Tabaninae	*Limata* sp. 1 SIM	Limata1s
Tabanidae: Tabaninae	*Limata tenuicornis*	Limatate
Tabanidae: Tabaninae	*Lissimas australis*	Lissaus
Tabanidae: Tabaninae	*Microtabanus pygmaeus*	Micropy
Tabanidae: Pangoniinae	*Mycteromyia* sp. 1	Myct1
Tabanidae: Tabaninae	*Myiotabanus muscoideus*	Myiomus
Tabanidae: Tabaninae	*Nubiloides nigripennis*	Nubini
Tabanidae: Chrysopsinae	*Orgizomyia zigzag*	Orgizig
Tabanidae: Pangoniinae	*Pangonius* sp. 1 Ståhls	Pango1

Family	Taxon	code
Tabanidae: Pangoniinae	*Pegasomyia abaureus*	Pegasab
Tabanidae: Tabaninae	*Phaeotabanus cajennensis*	Phaeoca
Tabanidae: Tabaninae	*Phaeotabanus nigriflavus*	Phaeoni
Tabanidae: Tabaninae	*Phaeotabanus phaeopterus*	Phaeoph1b
Tabanidae: Tabaninae	*Phaeotabanus prasiniventris*	Phaeopra
Tabanidae: Tabaninae	*Philipomyia aprica*	Philmapr
Tabanidae: Tabaninae	*Philipomyia graeca*	Philmgra
Tabanidae: Tabaninae	*Philipotabanus (Melasmatabanus) fascipennis*	Philtfas
Family	Taxon	code
Tabanidae: Tabaninae	*Philipotabanus (Mimotabanus) fucosus*	Philtfuc
Tabanidae: Tabaninae	*Philipotabanus (Mimotabanus) inauratus*	Philtmin
Tabanidae: Tabaninae	*Philipotabanus (Mimotabanus) porteri*	Philtpor
Tabanidae: Tabaninae	*Philipotabanus (Mimotabanus)* sp. 7 El Monte	Dicl7el
Tabanidae: Tabaninae	*Philipotabanus (Philipotabanus) magnificus*	Philtmag
Tabanidae: Tabaninae	*Philipotabanus (Philipotabanus) pterographicus*	Philtpter
Tabanidae: Tabaninae	*Philipotabanus (Philipotabanus) stigmaticalis*	Philtstig
Tabanidae: Pangoniinae	*Philoliche (Buplex) basalis*	Philbas
Tabanidae: Pangoniinae	*Philoliche (Philoliche) aethiopica*	Philaet
Tabanidae: Pangoniinae	*Philoliche (Philoliche) rostrata*	Philros
Tabanidae: Pangoniinae	*Philoliche (Returneria) alternans*	Philalt
Tabanidae: Pangoniinae	*Philoliche andrenoides*	Philandr
Tabanidae: Pangoniinae	*Philoliche angulata*	Philangu
Tabanidae: Pangoniinae	*Philoliche atricornis*	Philatri
Tabanidae: Pangoniinae	*Philoliche bivirgulata*	Philbivi
Tabanidae: Pangoniinae	*Philoliche bukamensis*	Philbuka
Tabanidae: Pangoniinae	*Philoliche compacta*	Philcomp
Tabanidae: Pangoniinae	*Philoliche elegans*	Phileleg
Tabanidae: Pangoniinae	*Philoliche gravoti*	Philgrav
Tabanidae: Pangoniinae	*Philoliche gulosa*	Philgulo
Tabanidae: Pangoniinae	*Philoliche lateralis*	Phillate
Tabanidae: Pangoniinae	*Philoliche quinquemaculata*	Philquin
Tabanidae: Pangoniinae	*Philoliche rondani*	Philrond
Tabanidae: Pangoniinae	*Philoliche rubiginosa*	Philrubi
Tabanidae: Pangoniinae	*Philoliche* sp. SIM1123	Phil1123
Tabanidae: Pangoniinae	*Philoliche spiloptera*	Philspil
Tabanidae: Pangoniinae	*Philoliche subfascia*	Philsubf

Family	Taxon	code
Tabanidae: Pangoniinae	*Philoliche umbratipennis*	Philumbr
Tabanidae: Tabaninae	*Phorcotabanus cinereus*	Phorcin
Tabanidae: Pangoniinae	*Pityocera (Elaphella) cervus*	Pitycerv
Tabanidae: Tabaninae	*Poeciloderas quadripunctatus*	Poeciloq
Tabanidae: Tabaninae	*Poeciloderas sp. 3 (Brazil)*	Poecilo3b
Tabanidae: Pangoniinae	*Protodasyapha (Curumyia*) sp. 1	Protocu1
Tabanidae: Tabaninae	*Pseudacanthocera brevicorne*	Pseudac1
Tabanidae: Chrysopsinae	*Pseudotabanus* sp. 1 Brisbane	Pseudot1b
Tabanidae: Chrysopsinae	*Pseudotabanus* sp. 2 Lessard	Pseudot2l
Tabanidae: Chrysopsinae	*Rhigioglossa (Rhigioglossa) edentula*	Rhigioed
Tabanidae: Chrysopsinae	*Rhigioglossa (Rhigioglossa)* sp.2 (RSA)	Rhigio2
Tabanidae: Pangoniinae	*Scaptia* (*Pseudoscione*) *australis*	Scaptaus
Tabanidae: Pangoniinae	*Scaptia (Pseudoscione) neoconcolor*	Scapt4a
Tabanidae: Pangoniinae	*Scaptia (Scaptia) alpina*	Scaptalp
Tabanidae: Pangoniinae	*Scaptia (Scaptia) auriflua*	Scaptaur
Tabanidae: Pangoniinae	*Scaptia (Scaptia) guttata*	Scaptgut
Tabanidae: Pangoniinae	*Scaptia* (*Scaptia*) *lata*	Scaptlat
Tabanidae: Pangoniinae	*Scaptia (Scaptia) patula*	Scaptpat
Tabanidae: Pangoniinae	*Scaptia sp. Ballard et al*	Scaptball
Tabanidae: Pangoniinae	*Scaptia* sp.3 (Tasmania)	Scapt3t
Tabanidae: Tabaninae	*Scaptiodes gagatina*	Scaptga
Tabanidae: Pangoniinae	*Scione maculipennis*	Sciomac
Tabanidae: Tabaninae	*Selasoma tibiale*	Selati
Tabanidae: Chrysopsinae	*Silvius (Griseosilvius) quadrivittatus*	Silvquad
Tabanidae: Chrysopsinae	*Silvius (Silvius) gigantulus*	Silvgig
Tabanidae: Chrysopsinae	*Silvius (Silvius) variegatus*	Silvvar
Tabanidae: Tabaninae	*Spilotabanus multiguttatus*	Spilomul
Tabanidae: Tabaninae	*Stenotabanus (Aegialomyia)* cf. *barahona*	Stenotae6
Tabanidae: Tabaninae	*Stenotabanus (Brachytabanus)* longipennis	Stenotb13
Tabanidae: Tabaninae	*Stenotabanus (Cretotabanus) cretatus*	Stenotcre
Tabanidae: Tabaninae	*Stenotabanus (Stenochlorops) bequaerti*	Stenotscb
Tabanidae: Tabaninae	*Stenotabanus (Stenotabanus)* sp. 1 Mexico	Stenot1m
Tabanidae: Tabaninae	*Stenotabanus (Stenotabanus)* sp. 10 Hermosa	Stenot10h
Tabanidae: Tabaninae	*Stenotabanus (Stenotabanus)* sp. 11 Guatemala	Stenot11g
Tabanidae: Tabaninae	*Stenotabanus (Stenotabanus)* sp. 4 Ecuador	Stenot4e
Tabanidae: Tabaninae	*Stenotabanus (Stenotabanus)* sp. 5 Elmonte	Stenot5el
Tabanidae: Tabaninae	*Stibasoma (Rhabdotylus)* cf. *viridiventre*	Stibarven
Tabanidae: Tabaninae	*Stibasoma (Rhabdotylus) planiventre*	Stibarpla

Family	Taxon	code
Tabanidae: Tabaninae	*Stibasoma (Rhabdotylus) venenata*	Stibar4
Tabanidae: Tabaninae	*Stibasoma (Stibasoma) apicimacula*	Stibast1
Tabanidae: Pangoniinae	*Stonemyia rasa*	Stonras
Tabanidae: Tabaninae	*Stypommisa captiroptera*	Stypom2f
Tabanidae: Tabaninae	*Stypommisa* cf. *modica*	Stypom10m
Tabanidae: Tabaninae	*Stypommisa lerida*	Stypomle
Tabanidae: Tabaninae	*Stypommisa* n. sp. nr. *kroeberi*	Stypom4k
Tabanidae: Tabaninae	*Stypommisa* sp. 8 Peru	Stypom8p
Tabanidae: Tabaninae	*Stypommisa unigrum*	Stypomunp
Tabanidae: Chrysopsinae	*Tabanocella (Tabanocella)* cf. *concinna*	Tabanoclo
Tabanidae: Chrysopsinae	*Tabanocella (Tabanocella) denticornis*	Tabanocde
Tabanidae: Chrysopsinae	*Tabanocella (Tabanocella) longirostris*	Tabanocde
Tabanidae: Tabaninae	*Tabanus abdominalis*	Tabanabd
Tabanidae: Tabaninae	*Tabanus aegrotus*	Tabanaeg
Tabanidae: Tabaninae	*Tabanus albocirculus*	Tabanalbo
Tabanidae: Tabaninae	*Tabanus americanus*	Tabanamer
Tabanidae: Tabaninae	*Tabanus atratus*	Tabanatr
Tabanidae: Tabaninae	*Tabanus biguttatus*	Tabanbig
Tabanidae: Tabaninae	*Tabanus birmanicus*	Tabanbir
Tabanidae: Tabaninae	*Tabanus bromius*	Tabanbrom
Tabanidae: Tabaninae	*Tabanus caduceus*	Tabancad
Tabanidae: Tabaninae	*Tabanus* cf. *antarcticus*	Tabananta
Tabanidae: Tabaninae	*Tabanus* cf. *hirtitibia*	Tabanhirt
Tabanidae: Tabaninae	*Tabanus* cf. *unimaculus*	Taban20b
Tabanidae: Tabaninae	*Tabanus chrysurus*	Tabanchry
Tabanidae: Tabaninae	*Tabanus fulvulus*	Tabanfulv
Tabanidae: Tabaninae	*Tabanus leucostomus*	Tabanleu
Tabanidae: Tabaninae	*Tabanus lineola*	Tabanlcx
Tabanidae: Tabaninae	*Tabanus maculicornis*	Tabanmacu
Tabanidae: Tabaninae	*Tabanus nigrotectus*	Tabannigt
Tabanidae: Tabaninae	*Tabanus oknos*	Tabanok
Tabanidae: Tabaninae	*Tabanus par*	Tabanpar
Tabanidae: Tabaninae	*Tabanus pellucidus*	Tabanp15f
Tabanidae: Tabaninae	*Tabanus petiolatus*	Tabanpet
Tabanidae: Tabaninae	*Tabanus promesogaeus*	Tabanprom
Tabanidae: Tabaninae	*Tabanus pumilis*	Tabanpum
Tabanidae: Tabaninae	*Tabanus rufofrater*	Tabanruf
Tabanidae: Tabaninae	*Tabanus sackeni*	Tabansack
Tabanidae: Tabaninae	*Tabanus* sp. 23 India	Taban23i

Family	Taxon	code
Tabanidae: Tabaninae	*Tabanus* sp. 43 Australia	Taban43aus
Tabanidae: Tabaninae	*Tabanus sparus*	Tabanspar
Tabanidae: Tabaninae	*Tabanus subsimilis*	Tabansubs
Tabanidae: Tabaninae	*Tabanus sudeticus*	Tabansude
Tabanidae: Tabaninae	*Tabanus sulcifrons*	Tabansulc
Tabanidae: Tabaninae	*Tabanus superjumentarius*	Tabansup
Tabanidae: Tabaninae	*Tabanus taeniatus*	Tabantaen
Tabanidae: Tabaninae	*Tabanus thiemanus*	Tabanthie
Tabanidae: Tabaninae	*Tabanus turbidus*	Tabanturb
Tabanidae: Chrysopsinae	*Thaumastocera akwa*	Thaumak
Tabanidae: Tabaninae	*Therioplectes* sp. 3 Serbia	Therio3
Tabanidae: Tabaninae	undescribed genus A	Ngenand
Tabanidae: Tabaninae	undescribed genus M	Stypommar
Tabanidae: Tabaninae	Undescribed genus X	Xgen
Vermileonidae	*Leptynoma hessei*	Leptynoh
Vermileonidae	*Vermileo opacus*	Verm
Vermileonidae	*Vermileo opacus BMW-2011*	Vermopa
Vermileonidae	*Vermileo* sp. PHK-2006	Vermphk
Xylophagidae: Coenomyiinae	*Arthropeas magna*	Art
Xylophagidae: Coenomyiinae	*Coenomyia ferruginea*	Coe
Xylophagidae: Coenomyiinae	*Dialysis elongata*	Dyl
Xylophagidae: Xylophaginae	*Exeretonevra angustifrons*	Exan22
Xylophagidae: Xylophaginae	*Heterostomus curvipalpis*	Htsta
Xylophagidae: Xylophaginae	*Heterostomus* sp. PHK-2011	Htstphk
Xylophagidae: Xylophaginae	*Rachicerus obscuripennis*	Rach1
Xylophagidae: Xylophaginae	*Xylophagus cinctus*	Xya

Appendix B

Tabanomorpha Gene Coverage. Genbank codes included where possible.

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Acantho1e	yes			yes	yes	yes		yes						
Acantho5p	yes			yes	yes	yes		yes						
Acantho7b	yes			yes	yes	yes		yes						
Acrocorb	DQ631983	AY140863		AY144414	AF539893		yes							
Actinavi				AY144382	HM183060	yes		yes	yes					
Aderso	yes			yes	yes	yes		yes						
Aegoph1	yes			yes	yes	yes		yes						
Aegophva	yes			yes		yes								
Agelan2y	yes			yes	yes	yes		yes						
Agelan3d	yes			yes	yes	yes		yes						
Agelanla	yes			yes	yes	yes		yes						
Agfin	yes			yes	yes	yes		yes						
Agmeg	yes			yes	yes	yes		yes						
Anacil	yes			yes	yes			yes						
Ancaafr	yes			yes	yes	yes		yes						
Ancafas	yes			yes	yes	yes		yes						
Antisslw	DQ631992	AY140891			AF539870									
Apatol2				yes										
Apatrug	yes			yes	yes	yes		yes						
Art				yes		yes		yes	yes					
Arthrocfu				DQ415517										
Arthrotci				HM770491										
					yes									
Asaphfl	yes			yes	DQ983561	yes		yes						
				AY144441										
				AY144440										
Astomel	DQ631978	AY140859		AY144439	AF539901									
Atherim3				DQ415522										
Atherimat				DQ415518										

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Atherimne				DQ415519										
Atherimve				DQ415520										
Athmarg	yes			yes		yes								
				AF238565										
				AF238541										
Athvar	yes			AF238517	yes	yes			yes					
Atyloagr	yes			yes	yes	yes		yes						
Atylotho	yes			yes	yes	yes		yes						
Atylovi	yes			yes	yes	yes		yes						
Austrolco				DQ415523										
Austrolmu				DQ415524										
Austrolrh				DQ415525										
Bolbobic	yes			yes	yes			yes						
Bolbobr	yes			yes	yes			yes						
Bolboda	yes			yes	yes	yes		yes						
Bolbomyna	yes			DQ415526	yes	yes		yes	yes					
Boma19			yes	yes	yes	yes	yes	yes	yes			yes	yes	yes
Cata4f	yes			yes	yes	yes		yes						
Cataamp5	yes			yes										
Catadif	yes			yes	yes	yes		yes						
Cataecu	yes			yes	yes	yes		yes						
Cataful	yes			yes	yes	yes		yes						
Catahalt	yes			yes	yes	yes		yes						
Cataover	yes			yes	yes	yes		yes						
Catarmuc				yes				yes						
Chasmia1b	yes			yes	yes	yes		yes						
Chasmia3n	yes			yes		yes		yes						
Chlorcre	yes			yes	yes	yes		yes						
Chlorin	yes			yes	yes			yes						

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Chlormex	yes			yes	yes	yes		yes						
Chloro4f	yes			yes	yes	yes		yes						
Chloromf		GU947385		DQ168802										
Chry2phk				DQ415530										
Chry3phk				DQ415531										
				AF238511										
				AF238533										
				AF238557										
Chryquad	yes			DQ415527	yes	yes		yes	yes					
Chryrhag				DQ415528										
Chrys20p	yes			yes										
Chryscae	yes			yes		yes								
				AY123353										
				AF238562										
				AF238538										
Chryscarb		AY123341		AF238514										
Chryscoq	yes			yes	yes	yes		yes						
Chrysdisp	yes			yes		yes								
Chrysflav	yes			yes		yes								
Chrysmad	yes			yes	yes	yes								
Chrysnige			AF073889											
Chrysoslb	AY165706													
Chrysupsi	yes			yes										
Chrysvit				DQ415542	yes	yes			U82706					
				AF238536										
				AF238560										
Chrythor	yes			DQ415529	yes	yes								
Cliteph		GU947399		DQ168777										

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Coe				yes		yes		yes	yes					
Coracel1	yes			yes		yes		yes						
Crypto1s	yes			yes	yes	yes		yes						
Crypto2f	yes			yes	yes	yes		yes						
Cydi2s	yes			yes	yes	yes		yes						
Cydi4w	yes			yes	yes	yes		yes						
Cydialbi	yes			yes	yes	yes		yes						
Cydist8q	yes			yes	yes	yes		yes						
Cydist8q	yes			yes	yes	yes		yes						
Cydistdo	yes			yes	yes	yes		yes						
Cydistdup														
Dasyb10c	yes			yes				yes						
Dasyb11t	yes			yes	yes	yes		yes						
Dasyb12p	yes			yes	yes	yes		yes						
Dasyb14c	yes			yes	yes	yes		yes						
Dasyb15r				yes				yes						
Dasybbat	yes			yes	yes	yes		yes						
Dasybda3a	yes			yes	yes	yes		yes						
Dasybgen	yes			yes	yes			yes						
Dasybmon	yes			yes	yes	yes		yes						
Dasybneo	yes			yes	yes	yes		yes						
Dasybtra	yes			yes	yes	yes		yes						
Dasycbad	yes			yes	yes	yes		yes						
Dasycmac	yes			yes	yes			yes						
Dasycoce	yes			yes	yes	yes		yes						
Dasycper	yes			yes	yes	yes		yes						
Dasyomma	yes			yes	yes	yes								
Dasyommc a				DQ415532										

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Dasyommvi				DQ415533										
Dasyrant	HM132120	HM132113		yes	yes	yes		yes						
Dasyrant2	HM132121	HM132114												
Dasyrumb	yes			yes	yes	yes		yes						
Diabim	yes			yes	yes	yes		yes						
Diacurv	yes			yes	yes	yes		yes						
Diafals	yes			yes	yes	yes		yes						
Diaferr	yes			yes	yes	yes		yes						
Diaxy	yes			yes	yes	yes		yes						
Dich7s	yes			yes	yes	yes		yes						
Dich8r	yes			yes	yes	yes		yes						
Dichidio	yes			yes	yes	yes		yes						
Dichjan	yes			yes	yes	yes		yes						
Dichreg	yes			yes	yes	yes		yes						
Dichscut	yes			yes	yes	yes		yes						
Dicl12h	yes			yes		yes		yes						
Dicl14v	yes			yes	yes	yes		yes						
Dicl15l	yes			yes	yes	yes		yes						
Dicl7el	yes			yes	yes	yes		yes						
Diclarg	yes			yes	yes	yes		yes						
Diclcla	yes			yes	yes	yes		yes						
Diclpru	yes			yes	yes	yes		yes						
Dyl	yes	AY140888		yes	yes	yes		yes	yes					
Ectenp2	yes			yes		yes		yes						
Ectenvu	yes			yes	yes	yes		yes						
Eristvi	yes			yes	yes	yes		yes						
Esendel	yes			yes	yes	yes								

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
				AF238563										
				AF238539										
Esenfas	yes			AF238515	yes	yes								
Esenlug	yes			yes	yes	yes		yes						
Esenpra	yes			yes	yes	yes		yes						
Esenric3m	yes			yes	yes	yes								
Euanmac	yes			yes	yes	yes		yes						
Eulonmar	DQ631979	AY140853		AY144397	AF539887									
Eutab	yes			yes	yes	yes		yes						
									FJ04					
Exan22			yes	yes	yes	yes	yes	yes	0682	yes	yes	yes	yes	yes
Fidena1e	yes			yes	yes									
Fidenafla	yes			yes	yes	yes								
				AF238570										
				AF238546										
Glutros	AY165651			AF238521										
Glutsin	yes			yes	yes	yes		yes	yes					
Goniops	yes			yes	yes	yes		yes						
Haemhow	yes			yes	yes	yes		yes						
Haemlat	yes			yes	yes	yes		yes						
Haemnar	yes			yes	yes			yes						
Haemper	yes			yes	yes	yes		yes						
Haemplu	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	
Haemrar	yes			yes	yes	yes		yes						
				AF238567										
				AF238543										
Haemrsa	yes			AF238518	yes	yes								
Haemsim	yes			yes	yes	yes								
Haemsing	yes			yes	yes	yes		yes						

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Hamacar	yes			yes	yes	yes		yes						
heil24			yes	yes	yes	yes	yes	yes	yes	yes	yes		yes	yes
				AY144430										
				AY144431										
				AY144432										
Hellelo	DQ631973	AY140869		AY144433	AF539884									
Hemifas	yes			yes	yes	yes		yes						
Hepta	yes			yes	yes	yes		yes						
Hila				yes	yes	yes			yes					
Himantin	yes			yes	yes	yes		yes						
Hippmver	yes			yes	yes	yes		yes						
Hirmmdt				HM183030										
Hirmms	DQ631988	DQ537936		DQ537937	DQ537938									
Hirmslwb														
Holcofen	yes			yes	yes	yes		yes						
Htsta				yes	yes	yes		yes	yes					
Htstphk				HM770495										
Hybobim	yes			yes	yes	yes		yes						
Hybocin	yes			yes	yes	yes		yes						
Hyboill	yes			yes	yes	yes		yes						
Hyborho	yes			yes	yes	yes		yes						
Hyborho	yes			yes	yes	yes		yes						
Hybosod	yes			yes	yes	yes		yes						
Lepicra2	yes			yes	yes	yes		yes						
Lepidoph	yes			yes	yes	yes		yes						
				AF238552										
				AF238528										
Leptynoh				AF238506	HM183066									
Leucalbo	yes			yes	yes	yes		yes						

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Leucambi	yes			yes	yes			yes						
Leucann	yes			yes	yes			yes						
Leucex	yes			yes	yes	yes		yes						
Leucpau	yes			yes	yes	yes		yes						
Lila3k	yes			yes	yes	yes		yes						
Lilaful	yes			yes	yes	yes		yes						
Limata1s	yes			yes	yes	yes		yes						
Limata2m	yes			yes	yes			yes						
Limatate	yes			yes	yes	yes		yes						
Lissaus				yes										
Mesophil				HM204928	HM183064									
Micropy				yes										
				AF238564										
				AF238540										
Myct1	yes			AF238516	yes	yes								
Myiomus	yes			yes	yes	yes		yes						
Nemchile		AY140850		AY144410	AF539899									
				AY456145										
Neorhynvo				AY456155										
Ngenand	yes			yes	yes	yes		yes						
Nothcos	yes			yes	yes	yes		yes						
code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Nubini	yes			yes	yes	yes		yes						
Ogba21			yes	yes	yes	yes	yes	yes	yes	yes		yes	yes	yes
Oplodovi2		GU947377		EF417074										
Oreotor				yes	yes	yes		yes	yes					
Orgizig	yes			yes	yes	yes		yes						
Pango1	yes			yes	yes			yes						
Pantomdt				HM183029	HM183062	yes		yes	yes					

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Paracyal	DQ631985	AY140868		AY144388	AF539892									
Pegasab	yes			yes	yes									
				AF238569										
				AF238545										
Peleper	yes			AF238520	HM183067	yes								
Phaeoca	yes			yes				yes						
Phaeoni	yes			yes	yes	yes		yes						
Phaeoph1b	yes			yes										
Phaeopra	yes			yes	yes	yes		yes						
Phil1123					DQ983547									
Philaet	yes			yes	yes	yes								
Philalt	yes			yes	yes	yes								
Philandr	DQ983506				DQ983544									
Philangu	DQ983507				DQ983545									
Philatri	DQ983504				DQ983542									
Philbas	yes			yes	yes	yes								
Philbuka	DQ983503				DQ983540									
Philcomp	DQ983502				DQ983539									
Phileleg	DQ983514				DQ983554									
Philgrav	DQ983510				DQ983549									
Philgulo	DQ983516				DQ983556									
Phillate	DQ983505				DQ983543									
Philmapr	HM132116	HM132109												
Philmgra	HM132117	HM132110		yes										
Philquin	DQ983509													
Philrond	DQ983528				DQ983569									
Philros	yes			yes	yes	yes								

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Philrubi	DQ983526				DQ983566									
Philspil					DQ983541									
Philsubf	DQ983501				DQ983538									
Philtfas	yes			yes	yes	yes		yes						
Philtfuc	yes			yes	yes	yes		yes						
Philtmag	yes			yes	yes	yes		yes						
Philtmin	yes			yes	yes	yes		yes						
Philtpor	yes			yes	yes	yes		yes						
Philtpter	yes			yes	yes	yes		yes						
Philtstig	yes			yes	yes			yes						
Philumbr	DQ983527				DQ983567									
Phorcin	yes			yes		yes		yes						
Pitycerv	yes			yes	yes	yes								
Poecilo3b	yes			yes	yes	yes		yes						
Poeciloq	yes			yes	yes	yes		yes						
Protocu1	yes			yes		yes		yes						
Pseudot1b	yes			yes	yes	yes		yes						
Pseudot2l	yes			yes	yes	yes		yes						
Pseujon	yes			yes	yes									
				AF238508										
				AF238530										
				AF238554										
Ptiofas	yes			DQ415534	yes	yes								
Ptiophk				HM770492										
Querbin	yes			yes	yes	yes		yes						
Rach1	yes			yes	yes	yes		yes	yes					
				AF238510										
				AF238532										
Rhaghir				AF238556	yes	yes		yes	yes					

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
				DQ415535										
				AF238509										
				AF238531										
Rhagmys2	GU013655			AF238555										
Rhigio2	yes			yes	yes									
Rhigioed	yes			yes	yesDQ983564	yes		yes						
Scapt3t	yes			yes		yes								
Scapt4a	yes			yes	yes	yes								
Scaptalp	yes			yes										
Scaptaur	yes			yes										
Scaptaus	yes			yes										
Scaptball														
Scaptga	yes			yes	yes	yes		yes						
Scaptgut	yes			yes	yes	yes								
Scaptpat	yes			yes	yes	yes								
Sciomac	yes			yes	yes	yes								
Selati	yes			yes	yes	yes		yes						
Silvgig	yes			yes	yes	yes								
Silvquad	yes			yes										
Silvvar	yes			yes	yes	yes		yes						
Solvacb				DQ168797	HM183062									
Spaniocle				DQ415537										
Spaniolon				DQ415538										
				AY144403										
Sphaerops	DQ631987	AY140877		AY144404	AF539875									
Spilomul	yes			yes	yes	yes								
Stenot10h	yes			yes	yes	yes		yes						
Stenot11g	yes			yes	yes	yes		yes						

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Stenot1m	yes			yes	yes	yes								
Stenot4e	yes			yes										
Stenot5el	yes			yes	yes	yes		yes						
Stenotae6	yes			yes	yes	yes		yes						
Stenotb13				yes				yes						
Stenotcre	yes			yes	yes	yes		yes						
Stenotscb				yes				yes						
Stibar4	yes			yes	yes			yes						
Stibarpla	yes			yes	yes	yes		yes						
Stibarven	yes			yes	yes			yes						
Stibast1	yes			yes				yes						
Stonras	yes			yes	yes	yes								
Stypom10m	yes			yes		yes								
Stypom4k	yes			yes	yes	yes		yes						
Stypom8p	yes			yes	yes	yes		yes						
Stypomle	yes			yes	yes	yes		yes						
Stypommar	yes			yes	yes			yes						
Stypomunp	yes			yes	yes	yes		yes						
Suragina	yes			yes	yes	yes		yes						
				AF238535										
Symphat	yes			AF238559		yes								
Symphir	yes			DQ415539		yes								
				AF238512										
				AF238534										
Symphir2				AF238558										
Symphir3				DQ415539										
Symphphk				DQ415540										
Symphslb	AY165652													
Taban20b	yes			yes	yes	yes		yes						

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Taban23i	yes			yes	yes	yes		yes						
Taban43aus	yes			yes	yes	yes		yes						
Tabanabd	yes			yes	yes			yes						
Tabanaeg	yes			yes	yes	yes		yes						
Tabanalbo	yes			yes	yes	yes		yes						
Tabanamer	yes			yes	yes	yes		yes						
Tabananta	yes			yes	yes	yes		yes						
Tabanatr	yes			AF238568 AF238544 AF238519	yes	yes		yes	yes					
Tabanbig	yes			yes	yes	yes		yes						
Tabanbrom	HM132118	HM132111												
Tabancad	yes			yes	yes	yes		yes						
Tabanchry	yes			yes	yes	yes		yes						
Tabanfulv	yes			yes	yes	yes		yes						
Tabanhirt	yes			yes				yes						
Tabanlcx	yes			yes	yes	yes		yes						
Tabanleu	yes			yes	yes	yes		yes						
Tabanmacu	HM132119	HM132112												
Tabannigt	yes			yes	yes			yes						
Tabanocde	yes			yes	yes	yes								
Tabanocde	yes			yes	yes	yes		yes						
Tabanoclo	yes			yes	yes	yes		yes						
Tabanok	yes			yes	yes	yes		yes						
Tabanp15f	yes			yes	yes	yes		yes						
Tabanpar	yes			yes	yes	yes		yes						
Tabanpet	yes			yes	yes	yes		yes						

code	CO1ND1	16S	18S	28s	CAD	AATS1	AATS2	PGD	TPI	G6PD	PEPCK	PUG	SIA	SNF
Tabanprom	yes			yes	yes	yes		yes						
Tabanpum	yes			yes	yes	yes		yes						
				AF238561										
				AF238537										
Tabanruf	DQ631993	AY140887		AF238513	yes	yes		yes						
Tabansack	yes			yes	yes	yes		yes						
Tabanspar	yes			yes	yes	yes		yes						
Tabansubs				DQ415541										
Tabansude	yes			yes	yes	yes		yes						
Tabansulc	yes			yes	yes	yes		yes						
Tabansup	yes			yes	yes	yes		yes						
Tabanthie	yes			yes	yes	yes		yes						
Tabanturb	yes			yes	yes	yes		yes						
Thaumak	yes			yes	yes	yes		yes						
Therio3	yes			yes	yes	yes		yes						
Tpu	yes		yes	yes	yes	yes		yes	yes					
Trichlrc		AF456854		wrong										
Trichslw	DQ631994	AY140849		AY144383	AF539868									
				HM770493										
				AF238553										
				AF238529										
Verm				AF238507	yes	yes		yes	yes					
Vermopa				yes										
Vermphk				DQ415543										
Xgen	yes			yes	yes	yes		yes						
Xya				yes	yes	yes		yes	yes					
				AY456143										
Xymy				AY456153	yes	yes		yes	yes					

Appendix C

Tabaninae taxa provenance

Outgroups

Family group	ID	Locality verbatim
Chrysopsinae	*Adersia oestroides*	Kenya: Coast Province Msambweni, on beach 4*28.41'S. 39*29.44'E 3.I.2000, sweep net R. Copeland
Chrysopsinae	*Aegophagamyia (Triclida)* cf. *brunnea*	Madagascar: Antsiranana Province, Sakarany, 7km N. Jaffreville hand netted in tropical deciduous forest; M.E.Irwin, F.D. Parker, R.Harin'Hala 2-7.I.2007; 360m; 12*20;S 49*15;E
Pangoniinae	*Apatolestes (Apatolestes) rugosus*	USA: CA: Mendocino Co.; Hopland REC, Lookout Point hilltop; 898m; 39*01'36.0"N 123*03'35.6"W; 30.v.2009; J. F. Gibson & O. Lonsdale
Pangoniinae	*Asaphomyia floridensis*	USA: FL: M. Deyrup
Chrysopsinae	*Chrysops coquilletti*	USA: CA: E. Sarnat
Chrysopsinae	*Coracella carbo*	Chile: Quillota Province; Palma de Ocoa; Parque Nacional Campanas malaise in hillside draw; 215 m; 2/10-I-2000 M.E. Irwin, E. I. Schlinger 32.9324*S 71.0781*W
Pangoniinae	*Ectenopsis (Ectenopsis) vulpecula*	Australia: Old Bribie Island; S27.053' W153.180' 17.x.2007 SL Winterton; Heathland
Pangoniinae	*Ectenopsis (Parasilvius)* sp. 2 Mary River	Australia: Northern Territory Mary River- roadhouse camp; South edge of Kakadu NP 13*36'47.1" 132*13'41.3"E 27.ix.2002 Whiting, Ogden, Svenson
Pangoniinae	*Esenbeckia (Esenbeckia) prasiniventris*	Costa Rica: Caribe: Rio francesca Malaise trap; 11-17.vi.2007 ARDeans
Pangoniinae	*Esenbeckia lugubris*	Bolivia: Santa Cruz Co.; San Jose; MVL; 17*44.903'S 061*04.202'W 13.I.2004 Svenson, Cameron, Bybee
Pangoniinae	*Goniops chrysocoma*	USA: Maryland: Little Orleans: 2007
Chrysopsinae	*Lilaea (Lilaea) fuliginosa*	AUS: NSW; Tallaganda Natl Pk; 7.8 km E Hoskinstown; Malaise trap 9-24 Jan 2006 1142m S. Fayed, C. Manchester, S. Alasya, ANIC Bulk sample No 2824 35*24'53"S 149*32'07"E GPS
Chrysopsinae	*Lilaea (Lilaea)* sp. 3	Australia: Northern Territory Kakadu National Park- Gabiru 12*50'37.2"S 132*51'26.9"E 28.ix.2002 Whiting, Ogden, Svenson
Chrysopsinae	*Orgizomyia zigzag*	Madagascar: Antsiranana Province, Sakarany, 7km N. Jaffreville hand netted in tropical deciduous forest; M.E.Irwin, F.D. Parker, R.Harin'Hala 2-7.I.2007; 360m; 12*20;S 49*15;E
Pangoniinae	*Pangonius* sp. 1	Greece; Samos Island, nr Neochori, 17.v.2010 :37*42.612N 26*45.936E 213m; G. Ståhls & E. Rattel
Pangoniinae	*Protodasyapha (Curumyia)* sp. 1	Argentina: Chubut Prov. Cholila, Steven Bussey's property; malaise in steep gorge; 23-31.xii.2005, ML Irwin, 560m 42*27.02S, 71*27.00'W
Chrysopsinae	*Pseudotabanus* sp. 1 Brisbane	Australia: SE Queensland; Brisbane Forest pk, Scrub Rd; S27.427 E152.841 13.xii.2007-17.I.2008; Malaise over shallow creek in rainforest; S.L. Winterton & J.S. Bartlett
Chrysopsinae	*Pseudotabanus* sp. 2 Lessard	Australia: B. D. Lessard
Chrysopsinae	*Rhigioglossa (Rhigioglossa) edentula*	South Africa: WCP: S. I. Morita
Chrysopsinae	*Silvius (Silvius) variegatus*	Spain: Valencia: El Honda Reserve; 3m 38*12'13"N 00*45'24"W 29.v.2008 J. & R. Skevington

Family group	ID	Locality verbatim
Chrysopsinae	*Tabanocella (Tabanocella)* cf. *concinna*	Zambia: Copperbelt Province; Kitwe District; Kumasamba Lodge Near Kafue River, Abt. 5 km S Kitwe; 12*54'20"S 28*14'22.3"E 18-30.iv.2006 G. Svenson
Chrysopsinae	*Tabanocella (Tabanocella) longirostris*	Madagascar: Majunga Prov. 20km NW Port-Berger, Ambovomamy Belambo, hand-netted in secondary growth on white sand; 9.I.2007; M.E.Irwin, F.D. Parker, R.Harin'Hala; 36m; 15*27.07'S 47*36.80'E
Chrysopsinae	*Thaumastocera akwa*	Nigeria; IITA Forest MT iii.06

Ingroup Tabaninae Locality

Family group	ID	Locality verbatim
Psalidiini	*Acanthocera (Acanthocera)* sp. 5 Peru	Peru: Rio Tambopata Explorers Inn- Rio Tower 12*50.208S 069*17.603W; 10.xii.2003 Svenson
Psalidiini	*Acanthocera* (*Acanthocera)* sp. 7 Brazil	Brazil: Amazonas: Manaus; Malaise Igarape; ZF2 23-26.ix.2010 Cordeiro, Guedes, Guisales, Haseyama
Psalidiini	*Acanthocera (Acanthocera)* sp.1 Ecuador	Ecuador: Yasuni: T. Erwin
Psalidiini	*Acanthocera (Nothocanthocera) costaricana*	Costa Rica: Prov. Limon. Veragua Rainforest, Campamento. 400-440m. 24-27 mar 2009. R. Villalobos, Tp. Luz Mercurio. I._N_212220_625230 #96172
Psalidiini	*Acanthocera (Querbetia) inopinatus*	Peru: Huanuco vic. Tingo Maria 1-5 June 1999 W. Hanson, S. Keller
Agelaniini	*Agelanius lanei*	Chile: PNAA: Chaicra Trap 3 I.2007 Admin B. Brown
Agelaniini	*Agelanius* sp. 2 Yeso Road	Chile: Yeso Road; Valle del Rio Volcan; 18.xi.2008; 33*47'33"S 70*12'07"W 1325m J. Skevington
Agelaniini	*Agelanius* sp. 3 Dittmar	Argentina; Pv. De Neuquen R. P. 43; 3 km S de Aguas Calientes 1751m NN; 36*40'46"S 70*36'23.8:W 23.I.2003 Dittmar, de la Cruz
Tabanini	*Agkistrocerus finitimus*	USA: FL: Franklin Co.: nr. Sumatra: Apalachicola National Forest: Wright Lake campground; CO2 baited Malaise Trap 1.iv.2010 K. M. Bayless & A. T. Burke
Tabanini	*Agkistrocerus megerlei*	USA: FL: Franklin Co.: nr. Sumatra: Apalachicola National Forest: Wright Lake; Human bait sweep near dome swamp on blue trail 1.iv.2010 K. M. Bayless & A. T. Burke
Tabanini	*Anacimas limbellatus*	USA: FL: Wakulla Co.: Ochlochonee R. St. Pk. 17.iv.1979; L.L. Pechuman CUIC
Tabanini	*Ancala africana*	South Africa: S. I. Morita
Tabanini	*Ancala fasciata*	Nigeria; IITA Forest MT iii.07
Tabanini	*Atylotus agrestis*	India: Rajasthan, Jodhpur distr. 10 km SW Jodhpur Machia Safari Park, malaise in dry wash 11-15.viii.2008 M. E. Irwin, D. R. Priydarsanan 300m; 26*18.60'N 72*58.71'E
Tabanini	*Atylotus thoracicus*	USA: CT: Middlesex Co. East Haddam, near north end of Lake Haward 41.53206*N -72.33458*W 3 july 2010 leg. Chris T. Maier
Tabanini	*Atylotus virgo*	India: Rajasthan, Jodhpur distr. 10 km SW Jodhpur Machia Safari Park, malaise in dry wash 11-15.viii.2008 M. E. Irwin, D. R. Priydarsanan 300m; 26*18.60'N 72*58.71'E

Family group	ID	Locality verbatim
Bolbodimyiini	*Bolbodimyia bicolor*	Ecuador: Pichincha: Los Cedros: Cerca del Rio 00*18'19"N 78*46'28"W 1150m R. Cardenas
Bolbodimyiini	*Bolbodimyia brunneipennis*	French Guiana: Regina; Kaw Mtns, Point Road 40 (PR40) (Rainforest #1 Plantation #3) ca. 300m, 3-27.iii.2006, MT leg. Keijo Sarv, sample ID FR-GY/2006/108-(Tabanidae) sorted by Marc Pollet
Bolbodimyiini	*Bolbodimyia dampfi*	Guatemala: Menas CF 18.iv.2008 Bolbod. # 2 MT-W B. Sutton
Psalidiini	*Catachlorops (Catachlorops)* cf. *fuscinevris*	Brazil: Parana, Guaratuba, Comunidade Castelhanos, 25*48'43.8"-48*55'20.5" 318m 12.I.2010, M.N. Mendonca
Psalidiini	*Catachlorops (Catachlorops) halteratus*	Brazil: Amazonas Manaus, Reserva Ducke xi.2009 Malaise Trap M.N. Mendonca leg.
Psalidiini	*Catachlorops (Psalidia) fulmineus*	Costa Rica: San Gerardo: Potrero Argentina Malaise A.R. Deans 15-21.viii.2007
Psalidiini	*Catachlorops (Psalidia) overali*	Brazil: Amazonas Cuicras 2*20'S 60*W xi.2009 Malaise Trap M.N. Mendonca leg
Psalidiini	*Catachlorops (Psalidia) rubiginosus*	Brazil: Amazonas Cuicras 2*20'S 60*W xi.2009 Malaise Trap M.N. Mendonca leg
Psalidiini	*Catachlorops (Psarochlorops) difficilis*	French Guiana: Roura, Kaw Road, Km 37, Relais Patawa, N 4* 32' 42" / W52* 09' 09" Coll: Jean A. Cerda Nov 2008 Mal. Trap
Psalidiini	*Catachlorops (Psarochlorops) ecuadoriensis*	Ecuador: Cascada san Rafael; 2.xi.2006 R. Cardenas
Psalidiini	*Catachlorops (Rhamphidommia) potator*	Brazil: Nova Teutonia; 27*11'B. 52*23' L Fritz Plaumann 300-500m x.1973 FMNH Z-15,289
Chasmiini	*Chasmia* cf. *bifasciata*	Papua New Guinea: Chimbu Province; Wara Sera Research Station Crater Mountain Research Area 8-13.vii.2001 Bradler, Jarvis, Svenson
Chasmiini	*Chasmia* sp. 3 New Caledonia	New Caledonia, Province Nord 20.397*S 164.528*E Mt. Mandjelia. 5 km WSW Puebo 780m, 3-6m, 2-2m Malaise Traps in alpine forest, 13-27.xi.2000 E. I. Schlinger, L. J. Boutin
Bolbodimyiini	*Chlorotabanus* cf. *flagellatus*	Bolivia: Cochabamba Villa Tunari Animal Rehab Center 9.I.2004; Svenson, Cameron, Bybee
Bolbodimyiini	*Chlorotabanus crepuscularis*	USA: Florida: Leon Co: Apalachicola National Forest FS Road 390: bottomland "mosquito hell" Malaise trap 30*21.696'N 84*40.399'W 5-13.vi.2005 Ronquist lab
Bolbodimyiini	*Chlorotabanus inanis*	French Guiana: Regina; Kaw Mtns, Point Road 40 (PR40) (Rainforest near edge) ca. 300m, 2-20.xi.2006, MT leg. Keijo Sarv, sample ID FR-GY/2006/110-(Tabanidae) sorted by Marc Pollet
Bolbodimyiini	*Chlorotabanus mexicanus*	Costa Rica: Heredia Ur. Puerto Viejo, La Selva Biol. Sta. 179'; 10*25'N 84*00'W; 23.ii-2.iii.2004 K.B. Miller
Bolbodimyiini	*Cryptotylus* sp. 1 Suriname	Suriname: Para District Zanderij, near Guesthouse; ; N05*27.5' W055*13.0' 7-9.ii.2010 . P. Skelley, W. Warner, C. Gillett
Bolbodimyiini	*Cryptotylus* sp. 2 FRGY	French Guiana: FG10L23 G. Zhang

Family group	ID	Locality verbatim
Chasmiini	*Cydistomyia (Cydistomyia) albithorax*	Papua New Guinea: Chimbu Province; Wara Sera Research Station Crater Mountain Research Area 8-13.vii.2001 Bradler, Jarvis, Svenson
Chasmiini	*Cydistomyia (Cydistomyia)* cf. *lorentzi*	Papua New Guinea: Chimbu Province; Wara Sera Research Station Crater Mountain Research Area 6-10.x.2001 A.S. & M.F.Whiting
Chasmiini	*Cydistomyia (Cydistomyia) doddi*	Australia: Qld: Wooroonooran NP; Misty Mountains; 15.i.2010; 17.6258*S145.7441*E +/-6; 524m; Qld 549 K. A. Meiklejohn B. D. Lessard
Chasmiini	*Cydistomyia (Cydistomyia)* sp. 2 Sandaun	Papua New Guinea: Sandaun Province; Menakmofib village; 04*49.786'S 141*38.126'E 21-24.ix.2000 M. T.; A.S. & M.F.Whiting
Chasmiini	*Cydistomyia (Cydistomyia) victoriensis*	AUS: NSW Kosciusko National Park; Island bend; Camping area caught on jeans; 9Jan2008, D. Carnovale, V. Hatten, C. Manchester, D. Yeates. 1276m S36*19'27 E148*28'21 GPS
Chasmiini	*Dasybasis (Dasybasis) gentilis*	AUS: NSW; Tallaganda Natl Pk; 7.8 km E Hoskinstown; Malaise trap 6-21 Dec 2005 1152m S. Fayed, C. Manchester, J. LaSalle, ANIC Bulk sample No 2805 35*24'48"S 149*32'12"E GPS
Selasomatini	*Dasybasis (Dasybasis) montium*	Ecuador: Pichincha: Yanacocha; paramo; sweep off cows; 00°06.613'S; 3514m 78°35.072'W; 3.viii.2009; KMB09123; D.E.Ramirez, K.M.Bayless, R.Cardenas
Chasmiini	*Dasybasis (Dasybasis) neobasalis*	AUS: NSW Kosciusko National Park; Thredbo water treatment plant, hand caught on blue jeans 23jan2008 11:10 AM, D. Carnovale, D. Yeates, C. Manchester. 1354m S38*29'44 E148*19'15 GPS
Selasomatini	*Dasybasis (Dasybasis)* sp. 10 Chubut	Argentina: Chubut Prov: 24 km SE entrance to Alerces Nat Park malaise near stream in Nothofagus forest, 90m: 23-31.xii.2005: ME Irwin 42*59.36S 71*33.94W
Chasmiini	*Dasybasis (Dasybasis)* sp. 11 Tasmania	Australia: TAS 508 Strathgordon 42.76713, 146.04443; Lessard, Mieklejohn & Gunter; 28 Jan 2010 Beat & sweep
Selasomatini	*Dasybasis (Dasybasis)* sp. 12 Peru	Peru: Between Cusco & Peema on bus; 20-08-10 B. Lessard
Selasomatini	*Dasybasis (Dasybasis)* sp. 14 Cholila	Argentina: Chubut Prov. Cholila, Steven Bussey's property; malaise in steep gorge; 23-31.xii.2005, ML Irwin, 560m 42*27.02S, 71*27.00'W
Selasomatini	*Dasybasis (Dasybasis)* sp. 3 Argentina	Argentina: Chubut Prov: 2 km SE of Entrance to Alerces Nat Park malaise nr. Stream: Nothofagus forst. 23-31.xii.2005:509m ME Irwin 42*58.36S 71*33.99W
Chasmiini	*Dasybasis (Protodasyommia) batrankii*	New Zealand: North Island:Woshi Malaise 9-14.ii.2006 B. Brown &H. Oliver
Chasmiini	*Dasybasis (Protodasyommia) transversa*	New Zealand: North Island:Mt. Mochau Sandy B Malaise ?2006 B. Brown ?
Selasomatini	*Dasybasis* sp. 15 (Rio Negro Nahuel Huapi)	Argentina, Rio Negro Prov. Nahuel Huapi National Park, Rincon Chico, malaise nr. Stream, in Patagonian steppe, 24-31.xii.2005, M.E.Irwin, 825m 40*59.25'S 71*05.81'W
Psalidiini	*Dasychela (Dasychela) badia*	Costa Rica: Prov. Alajuela: Penas Blancas: San Ramon; 450m 31Mar2010 Col. W. Porras Tp. Malaise; N843705/102300
Psalidiini	*Dasychela (Dasychela)* cf. *inca*	Peru: Dept. Junin: Pampa Hermosa Lodge; 2-4.xi.2009 1220m Heppner, Carrera, Huamani

Family group	ID	Locality verbatim
Psalidiini	*Dasychela (Dasychela) ocellus*	Ecuador: Pichincha: Los Cedros: malaise trap Ei:T2 6-7am 28.viii.2007 R. Cardenas
Psalidiini	*Dasychela (Dasychela) peruviana*	Peru: Cock-of-the-Rock Lodge; Malaise trap; 13*03'21"S, 71*32'46"W; 18-20.x.2006; ~1380m J. Skevington
Psalidiini	*Dasychela (Triceratomyia) macintyrei*	Ecuador: Yasuni: T. Erwin
Dasyrhamphini	*Dasyrhamphis* cf. *ater*	Greece: Lesvos Island: Agiassos 30.v.2009 leg G. Ståhls
Dasyrhamphini	*Dasyrhamphis umbrinus*	Greece: Lesvos Island: nr. Mystegna 319.v.2009 leg G. Ståhls
Diachlorini	*Diachlorus bimaculatus*	Peru: Rio Tambopata Explorers Inn 12*50.208'S 069*17.603'W; 2-13.viii.2005 Whiting et al. Canopy Light Trap
Diachlorini	*Diachlorus* cf. *xynus*	Peru: Rio Tambopata Explorers Inn 12*50.208'S 069*17.603'W; 2-13.viii.2005 Whiting et al. Canopy Light Trap
Diachlorini	*Diachlorus falsifuscistigma*	Brasil: Amazonas Cuicras 2*20'S 60*W xi.2009 Malaise Trap M.N. Mendonca leg
Diachlorini	*Diachlorus ferrugatus*	USA: Florida: Leon Co: Apalachicola National Forest FS Road 390: bottomland "mosquito hell" Malaise trap 30*21.696'N 84*40.399'W 15-20.v.2005 A. R. Deans & D. Murray
Psalidiini	*Dichelacera (Dichelacera)* cf. *rex*	Ecuador: Alinahui: 5.iii.2006 R. Cardenas
Psalidiini	*Dichelacera (Dichelacera)* cf. *submarginata*	Ecuador: Canande; 24.ii.2007; R. Cardenas
Psalidiini	*Dichelacera (Dichelacera) januarii*	Brazil: Parana, Guaratuba, Comunidade Castelhanos, 25*48'43.8"-48*55'20.5" 318m 12.I.2010, M.N. Mendonca
Psalidiini	*Dichelacera (Dichelacera) regina*	Costa Rica: Caribe: Rio francesca Malaise trap; 11-17.vi.2007 ARDeans
Psalidiini	*Dichelacera (Dichelacera) scutellata*	Bolivia: Santa Cruz Co.; San Ignacio, MVL; 12.I.2004 Svenson, Cameron, Bybee
Psalidiini	*Dichelacera (Idiochelacera) subcallosa*	Costa Rica: Prov. Cartago, Jimenez, Pejibaye, Selva, Alb. El Copal. 1000m 14-17 jun 2007 . A. Garcia, M. Zumbado. Tp. Malaise. L_N_196750_563695 #92403
Dicladocerini	*Dicladocera* sp. 15 "leoni"	Ecuador: Pichincha: Nambillo: Mindo: bosque primario nr. tarabita: 00*04.597'S 78*45.883'W 1330m; 29.vii.2009 D.E.Ramirez
Dicladocerini	*Dicladocera argentomacula*	Ecuador: Pichincha: Nambillo: Mindo: bosque primario nr. tarabita: 00*04.597'S 78*45.883'W 1330m; 29.vii.2009 D.E.Ramirez
Dicladocerini	*Dicladocera* cf. *hoppi*	Peru: Dept. Cusco; Kosnipata Vy. San Pedro; 16-19.xi.2009 1368m J.B. Heppner, C. Carrera, E. Huamani
Dicladocerini	*Dicladocera* cf. *riveti*	Venezuela: Lara; Yacambu National Park, 5.ix.2008; 9*42'14"N 69*34'22"W J. Skevington; 1695m
Dicladocerini	*Dicladocera macula*	Ecuador: Pichincha: Yanacocha; paramo; parking lot sweep off cars; 00°06.693’S 78°35.082’W;3539m;3.viii.2009; KMB09122; D.E.Ramirez, K.M.Bayless, R.Cardenas
Dicladocerini	*Dicladocera* n. sp. nr. *clara*	Ecuador: Pichincha: Nambillo: Mindo: El Monte Lodge: MT#3 27.vii.2009 D.E.Ramirez, K.M.Bayless, R.Cardenas

Family group	ID	Locality verbatim
Dicladocerini	*Dicladocera pruinosa*	Ecuador: Pichincha: Bellavista cloud forest;swept off malaise trap;30.vii.2009; 00°00.650’S 78°41.278’W 2293m D.E.Ramirez, K.M.Bayless, R.Cardenas
Dicladocerini	*Eristalotabanus violaceus*	Ecuador: Pichincha: Yanacocha; paramo; parking lot sweep off cars; 00°06.693’S 78°35.082’W;3539m;3.viii.2009; KMB09122; D.E.Ramirez, K.M.Bayless, R.Cardenas
Tabanini	*Euancala maculatissima*	Kenya: Nyanza Prov. Ungoye Field St., 1147m 0*36.91'S 34*05.52'E Malaise Trap, 18-25.xii.2004 R. S. Copeland
Bolbodimyiini	*Eutabanus pictus*	Bolivia: Beni, 40 km E San Borja, Estacion Biologica Beni, Palm camp at Rio Curiraba 6-15.x.1987. R. J. McGinley
Tabanini	*Haematopota howarthi*	Thailand: Loei; Phu Kradueng NP Dry dipterocarp forest E-lerd Loei forest unit 2; MT; 16*56.651N 101* 48.903E 273m 11-18.ix.2006 Sutin Glong-lasae; leg.7949
Tabanini	*Haematopota latifascia*	Thailand: Chiang Mai; Doi Inthanon NP Campground Pond; 18*32.40N 98*37.80E; 1200m Malaise trap 15-22.iv.2007; Y. Areeluck T1843
Tabanini	*Haematopota pachycera*	Thailand: Phetchabun; Nam Nao NP Helicopter landing ground, 16*43.156'N 101*35.118'E 890m; malaise trap 17-24.vii.2006 Noopean Hongyothi, Leng Janteab leg. T275
Tabanini	*Haematopota personata*	Thailand: Chiang Mai; Doi Inthanon NP Campground Pond; 18*32.40N 98*37.80E; 1200m Malaise trap 8-15.iv.2007; Y. Areeluck T1831
Tabanini	*Haematopota rara*	USA: Maryland: Calvert Co. American Chestnut land trust, Warriors Rest, Sanctuary 38*31'54.04" N 26*32'31.62"W 9-22.vi.07 SEL Hym unit MT Residue "Monster MT"
Tabanini	*Haematopota singularis*	Thailand: Phetchabun; Khao Kho NP office 16*39.550'N 101*08.123'E Malaise trap 26.vii-02.viii.2006 Somchai Chatchuman, Sa-ink Singtong leg. 165
Tabanini	*Haematopota* sp. South Africa 1	South Africa: D. M. Webb 1997
Tabanini	*Haematopota* sp. South Africa 2	South Africa: West Cape Province: S. I. Morita
Tabanini	*Haematopotina argentina*	Argentina: Chubut Prov: 24 km W of Sarmiento, 310m, malaise in small dry wash: 21-31.xii.2005:509m ME Irwin 42*32.17S 69*17.62W
Tabanini	*Hamatabanus carolinensis*	USA: N. Carolina; Granville Co. Picture Creek Area 35.165*N 78.739*W (+/- 500m) 28.v-11.vi.2009; Malaise Trap R. L. Blinn & I. Miko
Dicladocerini	*Hemichrysops fascipennis*	Costa Rica: Prov. Alajuela, Guatoso, P.N. V. Tenorio. Est. Pilou. 700-800m. 21-23 mar 2009. J. A. Azofeifa,M. Zumbado, A. Garcia. Tp. Luz mercurio. L_N_298212_427913 #97194
Tabanini	*Heptatoma pellucens*	Finland; Paljahkla; 11.7.2010 G. Ståhls
Stenotabanini	*Himantostylus intermedius*	Peru: Dept. M. de Dios Hac. Amazonas, Atalaya 10-18 Nov 2007 495m J. B. Heppner
Tabanini	*Hippocentrum versicolor*	Ghana: Volta Region Kyabobo Park, campsite Koue Village, 15.vi.2005 08*29'37.4"N 000*35'36.2"E K.B. Miller
Bolbodimyiini	*Holcopsis fenestrata*	Guatemala: Menas: B. Sutton
Tabanini	*Hybomitra bimaculata*	Hungary: Bács-Kiskun: Fülöpháza; 16.vi.2005 M. Foldvari
Tabanini	*Hybomitra cincta*	USA:WV:Hardy Co. Malaise trap 28.vi-13.vii.2007 Dave Smith
Tabanini	*Hybomitra epistates*	USA: IL: Don Webb
Tabanini	*Hybomitra illota*	USA: Minnesota: Anoka/Isanti Cos. East Bethel, Cedar Creek reserve; 24-26.vi.2008 I.S. Winkler

Family group	ID	Locality verbatim
Tabanini	*Hybomitra opaca*	Canada: MB: Churchill; Twin Lakes, Malaise 2; 58.3746° N, 93.4752° W; 1.viii.2007; J.Skevington
Tabanini	*Hybomitra rhombica*	USA: CA: S. I. Morita
Tabanini	*Hybomitra sodalis*	USA:WV:Hardy Co. Malaise trap 28.vi-13.vii.2007 Dave Smith
Diachlorini	*Lepiselaga (Lepiselaga) crassipes*	Peru: Madre de Dios 4-16.v.2009 J.T. Smit
Selasomatini	*Leucotabanus albovarius*	Ecuador: Alinahui: 5.iii.2006 R. Cardenas
Selasomatini	*Leucotabanus ambiguus*	USA: AZ: Huachuca Mtns Miller Canyon 5000' 4.vii.2009 Charles W. Melton
Selasomatini	*Leucotabanus annulatus*	USA: NC: Duplin Co: nr. Pink Hill; Cabin Lake County Park: behind lake opposite park entrance MT site B: 20-26.viii.2009; B. Cassel
Selasomatini	*Leucotabanus exaestuans*	Argentina: Misiones:Reserva de Vida Silvestre Urugua-I 25*8.471'S 5406.986'W 400m 26-29.xii.2003 L. Gonzales G. Kung
Selasomatini	*Leucotabanus pauculus*	Brasil, Amazonas Cuicras 2*20'S 60*W xi.2009 Malaise Trap M.N. Mendonca leg
Chasmiini	*Limata* cf. *capensis*	South Africa: W Cape: 7 km E Ladismith; MT in sandy wash 1-23.x.04 520m ME Irwin, M Hauser, FD Parker 33*31'00"S 21*19'51"E
Chasmiini	*Limata* sp. 1 SIM	South Africa: East Cape Province: S. I. Morita
Chasmiini	*Limata tenuicornis*	South Africa: Western Cape, vegetated dunes+margin S Papendorp, 31*43'01"S 018*12'22"E 9m 29.ix.2009 T. Dikow & J. Londt
Chasmiini	*Lissimas australis*	Australia: Qld.; 2km N Kuranda; at blacklight; 23.xii.1978; W. D. Sumlin USNM
Tabanini	*Microtabanus pygmaeus*	USA: NC
Agelaniini	*Nubiloides nigripennis*	Chile: Malleco Pino Hachado, 1480m 38*39'S 70*58'W 8-9.I.1994 C. & O. Flint, Jr.
Bolbodimyiini	*Phaeotabanus cajennensis*	Suriname: Sipaliwini CSNR, Raleighvallen Camp Boinski 4.72'N 56.21'W 50m 16-23.viii.2007, G. Kung, A. Kreuter MT # 6
Bolbodimyiini	*Phaeotabanus nigriflavus*	Brasil: Amazonas Cuicras 2*20'S 60*W xi.2009 Malaise Trap M.N. Mendonca leg
Bolbodimyiini	*Phaeotabanus phaeopterus*	Brasil: Amazonas Manaus, Reserva Ducke xi.2009 Malaise Trap M.N. Mendonca leg.
Bolbodimyiini	*Phaeotabanus prasiniventris*	Guyane: Roura, Kaw Road, PK 37 (km 37), Relais Patawa, N 4* 32' 42" / W52* 9' 9" Coll: Jean A. Cerda July 2008 (Malaise trap)
Dasyrhamphini	*Philipomyia graeca*	Greece: Lesvos Island: nr. Brisa (?) 31.v.2009 leg G. Ståhls
Dicladocerini	*Philipotabanu (Mimotabanus)* sp. 7 El Monte	Ecuador: Pichincha: Nambillo: Mindo: El Monte Lodge: hand netted near cabana; 28.vii.2009: K.M. Bayless, D.E.Ramirez, R. Cardenas
Dicladocerini	*Philipotabanus (Melasmatabanus) fascipennis*	Ecuador: Pichincha: Nambillo: Mindo: bosque primario nr. tarabita: 00*04.597'S 78*45.883'W 1330m; 29.vii.2009 D.E.Ramirez

Family group	ID	Locality verbatim
Dicladocerini	*Philipotabanus (Mimotabanus) fucosus*	Peru: Dept. Cusco; Kosnipata Vy. San Pedro; 16-19.xi.2009 1368m J.B. Heppner, C. Carrera, E. Huamani
Dicladocerini	*Philipotabanus (Mimotabanus) inauratus*	Costa Rica: Prov. Alajuela. Guatuso, Sitio Catarata Rio Buenavista, 700-800m 23 mar 2007. J. A. Azofeifa. Tp. Luz. L_N_298474 #91074
Dicladocerini	*Philipotabanus (Mimotabanus) porteri*	Ecuador: Esmeraldas Kumanii Lodge 69m 78*54'59.4"W 00*45'21.9"N 15APR2006 R. Cardenas; EX: Malaise Trap, Dry Ice & Human Bait, open area Trampa: T2 Hora: 14-17:00 QCAZ35818
Dicladocerini	*Philipotabanus (Philipotabanus) magnificus*	Ecuador: Canande; 23.ii.2007; R. Cardenas
Dicladocerini	*Philipotabanus (Philipotabanus) pterographicus*	Costa Rica: San Gerardo La Argentina Malaise A.R. Deans 16-22.vi.2007
Dicladocerini	*Philipotabanus (Philipotabanus) stigmaticalis*	French Guiana: Regina; Kaw Mtns, Point Road 40 (PR40) (Rainforest #1 Plantation #3) ca. 300m, 3-27.iii.2006, MT leg. Keijo Sarv, sample ID FR-GY/2006/108-(Tabanidae) sorted by Marc Pollet
Tabanini	*Phorcotabanus cinereus*	Ecuador: Prov. Napo vic. Puerto Misahuali, 1650-1900ft, 6-19-xi-1998 J. E. Eger, coll.1*2'4.2"S lat, 77-39'49.2"W lon Mercury vapor & ultraviolet lights
Tabanini	*Poeciloderas quadripunctatus*	Ecuador: Alinahui: 8.iii.2006 R. Cardenas
Tabanini	*Poeciloderas* sp. 3 (Brazil)	Brazil: Parana, Guaratuba, Comunidade Castelhanos, 25*48'43.8"-48*55'20.5" 318m 12.I.2010, M.N. Mendonca
Selasomatini	*Pseudacanthocera brevicorne*	Bolivia: Santa Cruz Co.; San Jose; MVL; 17*44.903'S 061*04.202'W 13.I.2004 Svenson, Cameron, Bybee
Agelaniini	*Scaptiodes gagatina*	Chile: Reg. 9 Araucania Prov. Malleco: PN Tolhuaca Lago Malleco 850m Nothofagus forest/lake margin; J. Heppner, A. Angulo, J. Brambila, B. Sutton 2006?
Dicladocerini	*Spilotabanus multiguttatus*	Ecuador: Pichincha: Yanacocha; paramo; sweep off cows; 00°06.613'S; 3514m 78°35.072'W; 3.viii.2009; KMB09123; D.E.Ramirez, K.M.Bayless, R.Cardenas
Stenotabanini	*Stenotabanus (Aegialomyia)* cf. *barahona*	Bahamas: Great Inagua; Matthew Town night collecting; 9-vii-2007; coll. T. Smith
Stenotabanini	*Stenotabanus (Brachytabanus) longipennis*	Brazil
Stenotabanini	*Stenotabanus (Cretotabanus) cretatus?*	Brasil: Amazonas: Manaus RFA Ducke 16-20.ix.10 M.T. Cordeiro, Guedes, Guisales, Haseyama
Stenotabanini	*Stenotabanus (Stenochlorops) bequaerti*	Brazil
Stenotabanini	*Stenotabanus (Stenotabanus)* sp. 1 Mexico	Mexico: Sonora: Rancho el Cajon 40 km E of Alamos; Malaise on sand, bench of Rio Cuchujaqui; Taxodium riparian tropical deciduous forest 1-11.x.2006 M.E.Irwin 420m 27*03.00'N 108*43.91'W

Family group	ID	Locality verbatim
Stenotabanini	*Stenotabanus (Stenotabanus)* sp. 10 Peru	Peru: Dept. Junin: Pampa Hermosa Lodge; 2-4.xi.2009 1220m Heppner, Carrera, Huamani
Stenotabanini	*Stenotabanus (Stenotabanus)* sp. 11 Guatemala	Guatemala: Cerro Mono 4/19/08: B. Sutton
Stenotabanini	*Stenotabanus (Stenotabanus)* sp. 4 Yasuni	Ecuador: Yasuni: T. Erwin
Stenotabanini	*Stenotabanus (Stenotabanus)* sp. 5 El Monte	Ecuador: Pichincha: Nambillo: Mindo: El Monte Lodge: sweeping while checking traps 9-11am; 00*04.331'S 78*45.624'W 1390m; 29.vii.2009 K.M.Bayless, D.E.Ramirez, R.Cardenas KMB09110
Bolbodimyiini	*Stibasoma (Rhabdotylus) planiventre*	Brazil: Parana, Guaratuba, Comunidade Castelhanos, 25*48'43.8"-48*55'20.5" 318m 12.I.2010, M.N. Mendonca
Bolbodimyiini	*Stibasoma (Rhabdotylus) venenata*	Ecuador: Tandayapa Lodge Trails, 12.iii,2008 00*00'08"N 78*40'37"W J. & A. Skevington 1740m
Bolbodimyiini	*Stibasoma (Rhabdotylus) viridiventre*	Venezuela: Aragua: Henri Pittier National Park, Scrubby Yard near Choroni; 12.ix.2008; 10*28'31"N 67*36'19"W J. Skevington; 205m
Bolbodimyiini	*Stibasoma (Stibasoma) apicimacula*	Ecuador: Rio Salanche, 16.iii.2008; 425m 00*08'42"N, 79*08'29"W J. & A. Skevington
Selasomatini	*Stypommisa captiroptera*	French Guiana: Regina; Kaw Mtns, Point Road 40 (PR40) (Rainforest near edge) ca. 300m, 2-20.xi.2006, MT leg. Keijo Sarv, sample ID FR-GY/2006/110-(Tabanidae) sorted by Marc Pollet
Selasomatini	*Stypommisa* cf. *lerida*	Ecuador: Pichincha: Bellavista cloud forest;swept off malaise trap;30.vii.2009; 00°00.650'S 78°41.278'W 2293m D.E.Ramirez, K.M.Bayless, R.Cardenas
Selasomatini	*Stypommisa* cf. *modica*	Brazil: Rondonia 62 km SE Ariquemes 22-31 Oct 1997 W. J. Hanson
Selasomatini	*Stypommisa* n. sp. nr. *kroeberi*	Ecuador: Pichincha: Los Cedros: malaise trap E2:T2 16:40pm 21.viii.2005 R. Cardenas
Selasomatini	*Stypommisa* sp. 8 Peru	Peru: Dept. Junin: Pampa Hermosa Lodge; 2-4.xi.2009 1220m Heppner, Carrera, Huamani
Selasomatini	*Stypommisa unigrum*	Guatemala: Dept. Zacapa: Sierra de las Minas, San Lorenzo Rd. El Naranjo, 1610m, nr. 15.07329, -89.68481; 29.v-1.vi.2009; Sutton, Steck, Monson S.; oak forest
Tabanini	*Tabanus albocirculus*	Costa Rica: San Gerardo: Potrero Argentina Malaise A.R. Deans & D. Janzen 28.vi-4.vii.2007
Tabanini	*Tabanus americanus*	USA: Florida: Leon Co: Apalachicola National Forest FS Road 390: bottomland "mosquito hell" Malaise trap 30*21.696'N 84*40.399'W 5-13.vi.2005 Ronquist lab
Tabanini	*Tabanus atratus*	USA: NC: Raleigh: B.M. Wiegmann
Tabanini	*Tabanus biguttatus*	South Africa: KwaZulu Natal: S. I. Morita
Tabanini	*Tabanus birmanicus*	Thailand: Sakhon Nakhon; Phu phan NP; Behind forest protection unit at Huay Wien Prai; 17*06.810'N104*00.318'E 318m; Malaise trap 4-10.ii.2007; Winlon Kongnara leg. T1684
Tabanini	*Tabanus caduceus*	Thailand: Chiang Mai; Doi Inthanon NPSummit marsh; 18*35.361'N 98*29.157'E; 2500m Malaise trap 22-29.iv.2007; Y. Areeluck T1846
Tabanini	*Tabanus* cf. *abdominalis*	USA: NC: Wake Co: Raleigh; Schenck Forest MT 4-14.vi.2008

Family group	ID	Locality verbatim
		I. Winkler
Tabanini	*Tabanus* cf. *antarcticus*	Brazil: Parana, Guaratuba, Comunidade Castelhanos, 25*48'43.8"-48*55'20.5" 318m 12.I.2010, M.N. Mendonca
Tabanini	*Tabanus* cf. *hirtitibia*	Ecuador: Yasuni: T. Erwin
Tabanini	*Tabanus* cf. *unimaculus*	Ecuador: Pichincha: Bellavista cloud forest; swept off malaise trap;1.viii.2009; 00°00.650'S 78°41.278'W 2293m K.M.Bayless, R.Cardenas, D.E.Ramirez
Tabanini	*Tabanus chrysurus*	Japan: Tokyo prefecture; Tamagawa River, Ome area; 26.vii.2009 Coll. W.K. Reeves
Tabanini	*Tabanus fulvulus*	USA: NC: Durham Co.: Durham: House off Chicopee trail; came to llight at night; 4.vii.2009 K.M. Bayless
Tabanini	*Tabanus leucostomus*	South Africa: W Cape: 7 km E Ladismith; MT in sandy wash 1-23.x.04 520m ME Irwin, M Hauser, FD Parker 33*31'00"S 21*19'51"E
Tabanini	*Tabanus lineola*	USA: NC: Duplin Co: nr. Pink Hill; Cabin Lake County Park: behind lake opposite park entrance MT site B: 30.vii-8.viii.2009; B.K. Cassel
Tabanini	*Tabanus nigrotectus*	Thailand: Khonkaen; Nam Pong NP; office 24A*12.11'N 183A*p.324E Malaise traps 19-26.vii.2006 Khumphone Jaidee leg. T109
Tabanini	*Tabanus oknos*	Thailand: Khonkaen; Phu Pha Man NP Teak plantation, 16*44.837'N 102*0.160'E 265m 6-13.vi.2006, Malaise trap Vinai Boonma
Tabanini	*Tabanus par*	D. R. Congo: Nsheshe forest: Malaise Forest/grassland border 6-14.vii.2008 S. Heydon Mfinda/Nseka
Tabanini	*Tabanus pellucidus*	French Guiana: Regina; Kaw Mtns, Point Road 40 (PR40) (Rainforest #1 Plantation #3) ca. 300m, 3-27.iii.2006, MT leg. Keijo Sarv, sample ID FR-GY/2006/108-(Tabanidae) sorted by Marc Pollet
Tabanini	*Tabanus petiolatus*	USA: NC: Duplin Co: nr. Pink Hill; Cabin Lake County Park: behind lake opposite park entrance MT: 14.vii.2009; K.M.Bayless & B. Cassel
Tabanini	*Tabanus promesogaeus*	Greece: Kerkini; Midway Site; M.T. N41*18'49.8 E023*16'35.6 16-22.vi.2008 T. Zeegers
Tabanini	*Tabanus pumilis*	USA: NC: Durham Co: Hill Demonstration Forest: MT mixed forest 500m from 36.201ºN 78.887ºW A. R. Deans 3.vi.2009
Tabanini	*Tabanus rufofrater*	USA: GA: Effingham; B. M. Wiegmann
Tabanini	*Tabanus sackeni*	Canada:ON: Burnt Lands Provincial Park Reserve near Almonte; 45.248998*N 76*145996*W Malaise Trap; 4-11.vi.2009; M. M. Locke
Tabanini	*Tabanus* sp. 23 India	India: Rajasthan, Jodhpur distr. 10 km SW Jodhpur Machia Safari Park, malaise in dry wash 11-15.viii.2008 M. E. Irwin, D. R. Priydarsanan 300m; 26*18.60'N 72*58.71'E
Tabanini	*Tabanus* sp. 43 Australia	Australia: Qld: Lolworth NP, site 1; Malaise, open forest QM14727; 14.xii.2006-12.ii.2007; 19°49.7'S;146°05.4'E; 277m; S. Wright
Tabanini	*Tabanus sparus*	USA:WV:Hardy Co. Malaise trap 28.vi-13.vii.2007 Dave Smith
Tabanini	*Tabanus sudeticus*	Greece: Kerkini; Ramna Site; M.T. N41*17'42.5 E023*11'33.1 25.v-1.vi.2008 T. Zeegers
Tabanini	*Tabanus sulcifrons*	USA:WV:Hardy Co. Malaise trap 28.vi-13.vii.2007 Dave Smith
Tabanini	*Tabanus taeniatus*	South Africa: Western Cape Province Cederburg State Forest; Driehoek turn off, Dic Vlei 32*25.946'S 019*08.827'E 7.ii.2009 Song, Mugleston, Bazelet

Family group	ID	Locality verbatim
Tabanini	*Tabanus thiemanus*	Ecuador: Pichincha: Nambillo: Mindo: El Monte Lodge: sweeping while checking traps 9-11am; 00*04.331'S 78*45.624'W 1390m; 29.vii.2009 K.M.Bayless, D.E.Ramirez, R.Cardenas KMB09110
Tabanini	*Tabanus turbidus*	USA: NC: Wake Co: Raleigh; Schenck Forest MT streambed 29.v-7.vi.2009 K. M. Bayless
Tabanini	*Therioplectes* sp. 3 Serbia	Serbia: Hilltop W of Nova Varos 43.456954*N 19.784583*E 1058m 15.vi.2009; J. Skevington
Selasomatini	undescribed genus A	Ecuador: Pichincha: Yanacocha; paramo; sweep from 'Inca trail'; 00°06.962'S; 78°35.088'W;3.viii.2009; 3562m KMB09124; K.M.Bayless, R.Cardenas, D.E.Ramirez
Bolbodimyiini	undescribed genus M	French Guiana: Amazone Nature Lodge, 30 km SE Roura on Kaw Rd 18-23-iv-2007 J. E. Eger
Dicladocerini	undescribed genus X	Peru: Dept. Cusco; Kosnipata Vy. San Pedro; 16-19.xi.2009 1368m J.B. Heppner, C. Carrera, E. Huamani

Appendix D

Tabaninae gene coverage

ID	Locality	CO1	AATS	CAD	PGD	28S
Acanthocera (Acanthocera) sp. 5 Peru	Peru	NEW	NEW	NEW	NEW	NEW
Acanthocera (*Acanthocera)* sp. 7 Brazil	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Acanthocera (Acanthocera) sp.1 Ecuador	Ecuador	NEW	NEW	NEW	NEW	NEW
Acanthocera (Nothocanthocera) costaricana	Costa Rica	NEW	NEW	NEW	NEW	NEW
Acanthocera (Querbetia) inopinatus	Peru	NEW	NEW	NEW	NEW	NEW
Adersia oestroides	Kenya	NEW	NEW	NEW	NEW	NEW
Aegophagamyia (Triclida) cf. *brunnea*	Madagascar	NEW	NEW	NEW	NEW	NEW
Agelanius lanei	Chile	NEW	NEW	NEW	NEW	NEW
Agelanius sp. 2 Yeso Road	Chile	NEW	NEW	NEW	NEW	NEW
Agelanius sp. 3 Dittmar	Argentina	NEW	NEW	NEW	NEW	NEW
Agkistrocerus finitimus	USA: FL	NEW	NEW	NEW	NEW	NEW
Agkistrocerus megerlei	USA: FL	NEW	NEW	NEW	NEW	NEW
Anacimas limbellatus	USA: FL	NEW		NEW	NEW	NEW
Ancala africana	South Africa	NEW	NEW	NEW	NEW	NEW
Ancala fasciata	Nigeria	NEW	NEW	NEW	NEW	NEW
Apatolestes (Apatolestes) rugosus	USA: CA	NEW	NEW	NEW	NEW	NEW
Asaphomyia floridensis	USA: FL	NEW	NEW	NEW	NEW	NEW
Atylotus agrestis	India	NEW	NEW	NEW	NEW	NEW
Atylotus thoracicus	USA: CT	NEW	NEW	NEW	NEW	NEW
Atylotus virgo	India	NEW	NEW	NEW	NEW	NEW
Bolbodimyia bicolor	Ecuador	NEW		NEW	NEW	NEW
Bolbodimyia brunneipennis	French Guiana	NEW		NEW	NEW	NEW
Bolbodimyia dampfi	Guatemala	NEW	NEW	NEW	NEW	NEW
Catachlorops (Amphichlorops) cf. *vespertinus*	Peru	NEW				NEW
Catachlorops (Catachlorops) cf. *fuscinevris*	Brazil: PR	NEW	NEW	NEW	NEW	NEW
Catachlorops (Catachlorops) halteratus	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Catachlorops (Psalidia) fulmineus	Costa Rica	NEW	NEW	NEW	NEW	NEW
Catachlorops (Psalidia) overali	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Catachlorops (Psalidia) rubiginosus	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Catachlorops (Psarochlorops) difficilis	French Guiana	NEW	NEW	NEW	NEW	NEW
Catachlorops (Psarochlorops) ecuadoriensis	Ecuador	NEW	NEW	NEW	NEW	NEW
Catachlorops (Rhamphidommia) potator	Brazil: SC				NEW	NEW
Chasmia cf. *bifasciata*	Papua New Guinea	NEW	NEW	NEW	NEW	NEW
Chasmia sp. 3 New Caledonia	New Caledonia	NEW	NEW		NEW	NEW
Chlorotabanus cf. *flagellatus*	Bolivia	NEW	NEW	NEW	NEW	NEW
Chlorotabanus crepuscularis	USA: FL	NEW	NEW	NEW	NEW	NEW
Chlorotabanus inanis	French Guiana	NEW		NEW	NEW	NEW

ID	Locality	CO1	AATS	CAD	PGD	28S
Chlorotabanus mexicanus	Costa Rica	NEW	NEW	NEW	NEW	NEW
Chrysops coquilletti	USA: CA	NEW	NEW	NEW	NEW	NEW
Coracella carbo	Chile	NEW	NEW		NEW	NEW
Cryptotylus sp. 2 FRGY	French Guiana	NEW	NEW	NEW	NEW	NEW
Cydistomyia (Cydistomyia) albithorax	Papua New Guinea	NEW	NEW	NEW	NEW	NEW
Cydistomyia (Cydistomyia) cf. *lorentzi*	Papua New Guinea	NEW	NEW	NEW	NEW	NEW
Cydistomyia (Cydistomyia) doddi	Australia: QLD	NEW	NEW	NEW	NEW	NEW
Cydistomyia (Cydistomyia) sp. 2 Sandaun	Papua New Guinea	NEW	NEW	NEW	NEW	NEW
Cydistomyia (Cydistomyia) sp. 8 Queensland	Australia: QLD	NEW	NEW	NEW	NEW	NEW
Cydistomyia (Cydistomyia) victoriensis	Australia: NSW	NEW	NEW	NEW	NEW	NEW
Dasybasis (Dasybasis) gentilis	Australia: NSW	NEW		NEW	NEW	NEW
Dasybasis (Dasybasis) montium	Ecuador	NEW	NEW	NEW	NEW	NEW
Dasybasis (Dasybasis) neobasalis	Australia: NSW	NEW	NEW	NEW	NEW	NEW
Dasybasis (Dasybasis) sp. 10 Chubut	Argentina	NEW			NEW	NEW
Dasybasis (Dasybasis) sp. 11 Tasmania	Australia: TAS	NEW	NEW	NEW	NEW	NEW
Dasybasis (Dasybasis) sp. 12 Peru	Peru	NEW	NEW	NEW	NEW	NEW
Dasybasis (Dasybasis) sp. 14 Cholila	Argentina	NEW	NEW	NEW	NEW	NEW
Dasybasis (Dasybasis) sp. 3 Argentina	Argentina	NEW	NEW	NEW	NEW	NEW
Dasybasis (Protodasyommia) batrankii	New Zealand	NEW	NEW	NEW	NEW	NEW
Dasybasis (Protodasyommia) transversa	New Zealand	NEW	NEW	NEW	NEW	NEW
Dasybasis sp. 15 (Rio Negro Nahuel Huapi)	Argentina				NEW	NEW
Dasychela (Dasychela) badia	Costa Rica	NEW	NEW	NEW	NEW	NEW
Dasychela (Dasychela) cf. *inca*	Peru	NEW	NEW	NEW	NEW	NEW
Dasychela (Dasychela) ocellus	Ecuador	NEW	NEW	NEW	NEW	NEW
Dasychela (Dasychela) peruviana	Peru	NEW	NEW	NEW	NEW	NEW
Dasychela (Triceratomyia) macintyrei	Ecuador	NEW		NEW	NEW	NEW
Dasyrhamphis cf. *ater*	Greece	NEW	NEW	NEW	NEW	NEW
Dasyrhamphis umbrinus	Greece	NEW	NEW	NEW	NEW	NEW
Diachlorus bimaculatus	Peru	NEW	NEW	NEW	NEW	NEW
Diachlorus cf. *xynus*	Peru	NEW	NEW	NEW	NEW	NEW
Diachlorus curvipes	French Guiana	NEW	NEW	NEW	NEW	NEW
Diachlorus falsifuscistigma	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Diachlorus ferrugatus	USA: FL	NEW	NEW	NEW	NEW	NEW
Dichelacera (Dichelacera) cf. *rex*	Ecuador	NEW	NEW	NEW	NEW	NEW
Dichelacera (Dichelacera) cf. *submarginata*	Ecuador	NEW	NEW	NEW	NEW	NEW
Dichelacera (Dichelacera) januarii	Brazil: PR	NEW	NEW	NEW	NEW	NEW
Dichelacera (Dichelacera) regina	Costa Rica	NEW	NEW	NEW	NEW	NEW
Dichelacera (Dichelacera) scutellata	Bolivia	NEW	NEW	NEW	NEW	NEW

ID	Locality	CO1	AATS	CAD	PGD	28S
Dichelacera (Idiochelacera) subcallosa	Costa Rica	NEW	NEW	NEW	NEW	NEW
Dicladocera sp. 15 "leoni"	Ecuador	NEW	NEW	NEW	NEW	NEW
Dicladocera argentomacula	Ecuador	NEW	NEW	NEW	NEW	NEW
Dicladocera n. sp. nr. *clara*	Ecuador	NEW	NEW	NEW	NEW	NEW
Dicladocera cf. *hoppi*	Peru	NEW	NEW		NEW	NEW
Dicladocera cf. *riveti*	Venezuela	NEW	NEW	NEW	NEW	NEW
Dicladocera macula	Ecuador	NEW	NEW	NEW	NEW	NEW
Dicladocera pruinosa	Ecuador	NEW	NEW	NEW	NEW	NEW
Ectenopsis (Ectenopsis) vulpecula	Australia: QLD	NEW	NEW	NEW	NEW	NEW
Eristalotabanus violaceus	Ecuador	NEW	NEW	NEW	NEW	NEW
Esenbeckia prasiniventris	Costa Rica	NEW	NEW	NEW	NEW	NEW
Esenbeckia lugubris	Bolivia	NEW	NEW	NEW	NEW	NEW
Euancala maculatissima	Kenya	NEW	NEW	NEW	NEW	NEW
Eutabanus pictus	Bolivia	NEW	NEW	NEW	NEW	NEW
Goniops chrysocoma	USA: MD	NEW	NEW	NEW	NEW	NEW
Haematopota howarthi	Thailand	NEW	NEW	NEW	NEW	NEW
Haematopota latifascia	Thailand	NEW	NEW	NEW	NEW	NEW
Haematopota pachycera	Thailand	NEW	NEW	NEW	NEW	NEW
Haematopota personata	Thailand	NEW	NEW	NEW	NEW	NEW
Haematopota pluvialis	Germany	NEW	NEW	NEW	NEW	NEW
Haematopota rara	USA: MD	NEW	NEW	NEW	NEW	NEW
Haematopota singularis	Thailand	NEW	NEW	NEW	NEW	NEW
Haematopota sp. South Africa 1	South Africa	NEW	NEW	NEW		AF238567 AF238543 AF238518
Haematopota sp. South Africa 2	South Africa	NEW	NEW	NEW		NEW
Haematopotina argentina	Argentina	NEW		NEW	NEW	NEW
Hamatabanus carolinensis	USA: NC	NEW	NEW	NEW	NEW	NEW
Hemichrysops fascipennis	Costa Rica	NEW	NEW	NEW	NEW	NEW
Heptatoma pellucens	Finland	NEW	NEW	NEW	NEW	NEW
Himantostylus intermedius	Peru	NEW	NEW	NEW	NEW	NEW
Hippocentrum versicolor	Ghana	NEW	NEW	NEW	NEW	NEW
Holcopsis fenestrata	Guatemala	NEW	NEW	NEW	NEW	NEW
Hybomitra bimaculata	Hungary	NEW	NEW	NEW	NEW	NEW
Hybomitra cincta	USA: WV	NEW	NEW	NEW	NEW	NEW
Hybomitra epistates	USA: IL	NEW			NEW	AF238566 AF238542
Hybomitra illota	USA: MN	NEW	NEW	NEW	NEW	NEW
Hybomitra opaca	Canada: MB	NEW	NEW	NEW	NEW	NEW
Hybomitra rhombica	USA: CA	NEW	NEW	NEW	NEW	NEW
Hybomitra sodalis	USA: WV	NEW	NEW	NEW	NEW	NEW
Lepiselaga (Lepiselaga) crassipes	Peru	NEW	NEW	NEW	NEW	NEW
Leucotabanus albovarius	Ecuador	NEW	NEW	NEW	NEW	NEW

ID	Locality	CO1	AATS	CAD	PGD	28S
Leucotabanus ambiguus	USA: AZ	NEW		NEW	NEW	NEW
Leucotabanus annulatus	USA: NC	NEW		NEW	NEW	NEW
Leucotabanus exaestuans	Argentina	NEW	NEW	NEW	NEW	NEW
Leucotabanus pauculus	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Lilaea (Lilaea) fuliginosa	Australia: NSW	NEW	NEW	NEW	NEW	NEW
Lilaea (Lilaea) sp. 3	Australia: NT	NEW	NEW	NEW	NEW	NEW
Limata cf. *capensis*	South Africa	NEW		NEW	NEW	NEW
Limata sp. 1 SIM	South Africa	NEW	NEW	NEW	NEW	NEW
Limata tenuicornis	South Africa	NEW	NEW	NEW	NEW	NEW
Lissimas australis	Australia: QLD					NEW
Microtabanus pygmaeus	USA: NC					NEW
Myiotabanus muscoideus	Guatemala	NEW	NEW	NEW	NEW	NEW
Nubiloides nigripennis	Chile	NEW	NEW	NEW	NEW	NEW
Pangonius sp. 1	Greece	NEW		NEW	NEW	NEW
Phaeotabanus cajennensis	Suriname	NEW			NEW	NEW
Phaeotabanus nigriflavus	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Phaeotabanus phaeopterus	Brazil: AM	NEW				NEW
Phaeotabanus prasiniventris	French Guiana	NEW	NEW	NEW	NEW	NEW
Philipomyia graeca	Greece	NEW				NEW
Philipotabanus (Mimotabanus) sp. 7 El Monte	Ecuador	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Melasmatabanus) fascipennis	Ecuador	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Mimotabanus) fucosus	Peru	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Mimotabanus) inauratus	Costa Rica	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Mimotabanus) porteri	Ecuador	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Philipotabanus) magnificus	Ecuador	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Philipotabanus) pterographicus	Costa Rica	NEW	NEW	NEW	NEW	NEW
Philipotabanus (Philipotabanus) stigmaticalis	French Guiana	NEW		NEW	NEW	NEW
Phorcotabanus cinereus	Ecuador	NEW	NEW		NEW	NEW
Poeciloderas quadripunctatus	Ecuador	NEW	NEW	NEW	NEW	NEW
Poeciloderas sp. 3 (Brazil)	Brazil: PR	NEW	NEW	NEW	NEW	NEW
Protodasyapha (Curumyia) sp. 1	Argentina	NEW	NEW		NEW	NEW
Pseudacanthocera brevicorne	Bolivia	NEW	NEW	NEW	NEW	NEW
Pseudotabanus sp. 1 Brisbane	Australia: QLD	NEW	NEW	NEW	NEW	NEW
Pseudotabanus sp. 2 Lessard	Australia	NEW	NEW	NEW	NEW	NEW
Rhigioglossa (Rhigioglossa) edentula	South Africa	NEW	NEW	NEW	NEW	NEW
Scaptiodes gagatina	Chile	NEW	NEW	NEW	NEW	NEW
Selasoma tibiale	Bolivia	NEW	NEW	NEW	NEW	NEW
Silvius (Silvius) variegatus	Spain	NEW	NEW	NEW	NEW	NEW
Spilotabanus multiguttatus	Ecuador	NEW	NEW	NEW		NEW
Stenotabanus (Aegialomyia) cf. *barahona*	Bahamas	NEW	NEW	NEW	NEW	NEW
Stenotabanus (Brachytabanus) longipennis	Costa Rica				NEW	NEW

ID	Locality	CO1	AATS	CAD	PGD	28S
Stenotabanus (Cretotabanus) cretatus?	Brazil: AM	NEW	NEW	NEW	NEW	NEW
Stenotabanus (Stenochlorops) bequaerti	Brazil: AM				NEW	NEW
Stenotabanus (Stenotabanus) sp. 1 Mexico	Mexico	NEW	NEW	NEW		NEW
Stenotabanus (Stenotabanus) sp. 10 Peru	Peru	NEW	NEW	NEW	NEW	NEW
Stenotabanus (Stenotabanus) sp. 11 Guatemala	Guatemala	NEW	NEW	NEW	NEW	NEW
Stenotabanus (Stenotabanus) sp. 4 Yasuni	Ecuador	NEW		NEW		NEW
Stenotabanus (Stenotabanus) sp. 5 El Monte	Ecuador	NEW	NEW	NEW	NEW	NEW
Stibasoma (Rhabdotylus) planiventre	Brazil: PR	NEW	NEW	NEW	NEW	NEW
Stibasoma (Rhabdotylus) venenata	Ecuador	NEW		NEW	NEW	NEW
Stibasoma (Rhabdotylus) viridiventre	Venezuela	NEW		NEW	NEW	NEW
Stibasoma (Stibasoma) apicimacula	Ecuador	NEW			NEW	NEW
Stypommisa captiroptera	French Guiana	NEW		NEW	NEW	NEW
Stypommisa cf. *lerida*	Ecuador	NEW	NEW	NEW	NEW	NEW
Stypommisa cf. *modica*	Brazil: RO	NEW	NEW			NEW
Stypommisa n. sp. nr. *kroeberi*	Ecuador	NEW	NEW	NEW	NEW	NEW
Stypommisa sp. 8 Peru	Peru	NEW	NEW	NEW	NEW	NEW
Tabanocella (Tabanocella) cf. *concinna*	Zambia	NEW	NEW	NEW	NEW	NEW
Tabanocella (Tabanocella) denticornis	South Africa	NEW	NEW	NEW		NEW
Tabanocella (Tabanocella) longirostris	Madagascar	NEW	NEW	NEW	NEW	NEW
Tabanus aegrotus	USA: CA	NEW	NEW	NEW	NEW	NEW
Tabanus albocirculus	Costa Rica	NEW	NEW	NEW	NEW	NEW
Tabanus americanus	USA: FL	NEW	NEW	NEW	NEW	NEW
						AF238568
						AF238544
Tabanus atratus	USA: NC	NEW	NEW	NEW	NEW	AF238519
Tabanus biguttatus	South Africa	NEW	NEW	NEW	NEW	NEW
Tabanus birmanicus	Thailand	NEW	NEW	NEW	NEW	NEW
Tabanus caduceus	Thailand	NEW	NEW	NEW	NEW	NEW
Tabanus cf. *abdominalis*	USA: NC	NEW		NEW	NEW	NEW
Tabanus cf. *antarcticus*	Brazil: PR	NEW	NEW	NEW	NEW	NEW
Tabanus cf. *hirtitibia*	Ecuador	NEW			NEW	NEW
Tabanus cf. *unimaculus*	Ecuador	NEW	NEW	NEW	NEW	NEW
Tabanus chrysurus	Japan	NEW	NEW	NEW	NEW	NEW
Tabanus fulvulus	USA: NC	NEW	NEW	NEW	NEW	NEW
Tabanus leucostomus	South Africa	NEW		NEW	NEW	NEW
Tabanus lineola	USA: NC	NEW	NEW	NEW	NEW	NEW
Tabanus nigrotectus	Thailand	NEW		NEW	NEW	NEW
Tabanus oknos	Thailand	NEW	NEW	NEW	NEW	NEW
Tabanus par	D. R. Congo	NEW	NEW	NEW	NEW	NEW
Tabanus pellucidus	French Guiana	NEW	NEW	NEW	NEW	NEW
Tabanus petiolatus	USA: NC	NEW	NEW	NEW	NEW	NEW
Tabanus promesogaeus	Greece	NEW	NEW	NEW	NEW	NEW
Tabanus pumilis	USA: NC	NEW	NEW	NEW	NEW	NEW

ID	Locality	CO1	AATS	CAD	PGD	28S
						AF238561 AF238537
Tabanus rufofrater	USA: GA	NEW	NEW	NEW	NEW	AF238513
Tabanus sackeni	Canada: ON	NEW	NEW	NEW	NEW	NEW
Tabanus sp. 23 India	India	NEW	NEW	NEW	NEW	NEW
Tabanus sp. 43 Australia	Australia: QLD	NEW	NEW	NEW	NEW	NEW
Tabanus sparus	USA: WV	NEW	NEW	NEW	NEW	NEW
Tabanus sudeticus	Greece	NEW	NEW	NEW	NEW	NEW
Tabanus sulcifrons	USA: WV	NEW	NEW	NEW	NEW	NEW
Tabanus superjumentarius	USA: NC	NEW	NEW	NEW	NEW	NEW
Tabanus taeniatus	South Africa	NEW	NEW	NEW	NEW	NEW
Tabanus thiemanus	Ecuador	NEW	NEW	NEW	NEW	NEW
Tabanus turbidus	USA: NC	NEW	NEW	NEW	NEW	NEW
Thaumastocera akwa	Nigeria	NEW	NEW	NEW	NEW	NEW
Therioplectes sp. 3 Serbia	Serbia	NEW	NEW	NEW	NEW	NEW
undescribed genus A	Ecuador	NEW	NEW	NEW	NEW	NEW
undescribed genus M	French Guiana	NEW		NEW	NEW	NEW
undescribed genus X	Peru	NEW	NEW	NEW	NEW	NEW

Appendix E

Tabaninae Morphological data matrix characters 1-24

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Acanthocera (Acanthocera) sp. 5 Peru	1	1	0	1	2	0	1	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	2
Acanthocera (*Acanthocera)* sp. 7 Brazil	1	1	0	1	2	0	1	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	2
Acanthocera (Acanthocera) sp.1 Ecuador	1	1	0	1	2	0	1	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	2
Acanthocera (Nothocanthocera) costaricana	0	0	0	0	1	0	1	0	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	2
Acanthocera (Querbetia) inopinatus	0	0	0	0	1	0	1	0	1	1	1	1	0	1	1	1	2	1	1	0	1	0	0	2
Adersia oestroides	0	0	1	0	0	1	1	0	0	0	0	0	-	2	0	0	1	0	-	-	-	1	0	0
Aegophagamyia (Triclida) cf. *brunnea*	0	0	0	-	0	-	1	-	-	0	1	0	-	-	-	0	-	-	-	-	-	0	1	-
Agelanius lanei	0	0	0	0	0	1	1	0	0	1	1	0	-	1	1	0	1	1	0	1	1	0	0	0
Agelanius sp. 2 Yeso Road	0	0	0	0	0	1	1	0	0	1	1	0	-	1	1	0	1	1	0	1	1	0	0	0
Agelanius sp. 3 Dittmar	0	0	0	0	0	1	1	0	0	1	1	0	-	1	1	0	1	1	0	1	1	0	0	0
Agkistrocerus finitimus	0	0	0	-	0	0	1	-	-	1	1	1	0	1	1	0	1	1	-	-	-	0	0	-
Agkistrocerus megerlei	0	0	0	-	0	0	1	-	-	1	1	1	0	1	1	0	1	1	-	-	-	0	0	-
Anacimas limbellatus	0	0	0	-	0	0	1	-	-	1	1	0	-	-	-	0	-	0	-	-	-	0	0	-
Ancala africana	0	0	0	-	0	0	0	-	-	1	1	0	-	-	-	0	-	1	1	0	1	0	0	-
Ancala fasciata	0	0	1	-	0	0	0	-	-	1	1	0	-	-	-	0	-	1	1	0	1	0	0	-
Apatolestes (Apatolestes) rugosus	0	0	0	-	0	1	1	-	-	0	0	0	-	-	-	0	-	-	-	-	-	0	1	-
Asaphomyia floridensis	0	0	0	-	0	1	1	-	-	0	1	0	-	-	-	0	-	-	-	-	-	0	1	-
Atylotus agrestis	0	0	0	-	0	0	1	-	-	1	1	0	-	-	-	0	-	1	0	2	0	0	0	-
Atylotus thoracicus	0	0	0	-	0	0	1	-	-	1	1	0	-	-	-	0	-	1	0	2	0	0	0	-
Atylotus virgo	0	0	0	-	0	0	1	-	-	1	1	0	-	-	-	0	-	0	-	-	-	0	0	-
Bolbodimyia bicolor	0	0	0	1	2	0	1	1	1	1	1	0	-	1	0	1	2	1	1	1	1	0	0	3
Bolbodimyia brunneipennis	0	0	0	1	2	0	1	1	1	1	1	0	-	1	0	1	2	1	1	1	1	0	0	3
Bolbodimyia dampfi	0	0	0	1	2	0	0	1	1	1	1	0	-	1	0	1	2	1	1	1	1	0	0	3
Catachlorops (Amphichlorops) cf. *vespertinus*	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Catachlorops) cf. *fuscinevris*	1	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Catachlorops) halteratus	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Psalidia) fulmineus	1	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Psalidia) overali	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Psalidia) rubiginosus	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Psarochlorops) difficilis	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Catachlorops (Psarochlorops) ecuadoriensis	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Catachlorops (Rhamphidommia) potator	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	1	0	0	0
Chasmia cf. *bifasciata*	0	0	0	-	0	1	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Chasmia sp. 3 New Caledonia	0	0	0	-	0	1	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Chlorotabanus cf. *flagellatus*	0	0	1	0	1	1	1	0	0	1	1	0	-	1	1	0	1	0	-	-	-	0	0	0
Chlorotabanus crepuscularis	0	0	1	0	1	1	1	0	0	1	1	0	-	1	1	0	1	0	-	-	-	0	0	0
Chlorotabanus inanis	0	0	1	0	1	1	1	0	0	1	1	0	-	1	1	0	1	0	-	-	-	0	0	0
Chlorotabanus mexicanus	0	0	1	0	1	1	1	0	0	1	1	0	-	1	1	0	1	0	-	-	-	0	0	0
Chrysops coquilletti	0	0	0	1	1	1	1	1	1	1	1	0	-	0	0	0	2	1	0	2	0	0	0	3
Coracella carbo	0	0	0	0	2	1	1	0	1	0	1	0	-	1	0	0	1	1	0	1	0	0	1	2
Cryptotylus sp. 1 Suriname	0	0	1	0	0	0	1	0	0	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0
Cryptotylus sp. 2 FRGY	0	0	1	0	0	0	1	0	0	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0
Cydistomyia (Cydistomyia) albithorax	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Cydistomyia (Cydistomyia) cf. *lorentzi*	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Cydistomyia (Cydistomyia) doddi	0	0	0	-	0	-	1	-	-	1	1	1	1	-	-	0	-	1	-	-	-	0	0	-
Cydistomyia (Cydistomyia) sp. 2 Sandaun	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Cydistomyia (Cydistomyia) sp. 8 Queensland	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Cydistomyia (Cydistomyia) victoriensis	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Dasybasis (Dasybasis) gentilis	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Dasybasis (Dasybasis) montium	0	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	1	2	1	0	0	0
Dasybasis (Dasybasis) neobasalis	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Dasybasis (Dasybasis) sp. 10 Chubut	1	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	1	2	1	0	0	0
Dasybasis (Dasybasis) sp. 11 Tasmania	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Dasybasis (Dasybasis) sp. 12 Peru	0	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	1	2	1	0	0	0
Dasybasis (Dasybasis) sp. 14 Cholila	0	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	1	2	1	0	0	0
Dasybasis (Dasybasis) sp. 15 (RNNH)	0	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	1	2	1	0	0	0
Dasybasis (Dasybasis) sp. 3 Argentina	0	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	1	2	1	0	0	0
Dasybasis (Protodasyommia) batrankii	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Dasybasis (Protodasyommia) transversa	0	0	0	-	0	-	1	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	0	-
Dasychela (Dasychela) badia	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	0	0	1	0
Dasychela (Dasychela) cf. *inca*	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	0	0	1	0
Dasychela (Dasychela) ocellus	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	0	0	1	0
Dasychela (Dasychela) peruviana	0	0	0	0	0	1	1	0	0	1	1	1	2	1	1	0	1	1	0	1	0	0	1	0
Dasychela (Triceratomyia) macintyrei	0	0	0	0	0	1	1	0	0	1	1	1	2	1	0	0	1	1	0	1	0	0	2	0
Dasyrhamphis cf. *ater*	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1	0	0	0
Dasyrhamphis umbrinus	0	0	0	0	0	0	1	1	1	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Diachlorus bimaculatus	0	0	0	1	1	0	1	0	0	1	1	0	-	0	0	0	0	1	0	2	1	0	0	3
Diachlorus cf. *xynus*	0	1	0	1	1	0	1	0	1	1	1	0	-	0	0	0	0	1	0	2	1	0	0	3
Diachlorus curvipes	0	0	0	1	1	0	1	0	0	1	1	0	-	0	0	0	0	1	0	2	1	0	0	3
Diachlorus falsifuscistigma	0	0	0	1	1	0	1	0	0	1	1	0	-	0	0	0	0	1	0	2	1	0	0	3
Diachlorus ferrugatus	0	0	0	1	1	0	1	0	0	1	1	0	-	0	0	0	0	1	0	2	1	0	0	3
Dichelacera (Dichelacera) cf. *rex*	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0	2
Dichelacera (Dichelacera) cf. *submarginata*	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0	2
Dichelacera (Dichelacera) januarii	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0	2
Dichelacera (Dichelacera) regina	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0	2
Dichelacera (Dichelacera) scutellata	0	0	0	0	1	0	1	0	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	2
Dichelacera (Idiochelacera) subcallosa	0	0	0	0	1	0	1	0	1	1	1	1	0	1	1	0	1	1	1	0	1	0	0	2
Dicladocera sp. 15 "leoni"	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0
Dicladocera argentomacula	0	0	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0
Dicladocera cf. *hoppi*	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0
Dicladocera cf. *riveti*	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0
Dicladocera macula	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0
Dicladocera n. sp. nr. *clara*	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	0	1	1	0	1	1	0	0	0
Dicladocera pruinosa	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0
Ectenopsis (Ectenopsis) vulpecula	0	0	0	-	0	1	1	-	-	0	0	0	-	-	-	0	-	-	-	-	-	0	1	-
Ectenopsis (Parasilvius) sp. 2 Mary River	0	0	0	-	0	1	1	-	-	1	1	0	-	-	-	0	-	-	-	-	-	0	1	-
Eristalotabanus violaceus	1	0	0	1	2	0	1	1	1	1	1	1	1	1	1	0	1	1	1	2	1	0	0	-
Esenbeckia lugubris	0	0	0	0	0	1	1	0	0	0	0	0	-	1	0	0	1	1	0	0	-	0	2	0
Esenbeckia prasiniventris	0	0	1	0	0	1	1	0	0	0	0	0	-	1	0	0	1	1	0	0	-	0	2	0
Euancala maculatissima	0	0	1	-	0	0	0	-	-	1	1	0	-	-	-	0	-	1	-	-	-	0	-	-
Eutabanus pictus	0	0	0	0	0	0	1	0	1	1	1	0	-	1	0	0	1	1	0	2	1	0	0	2
Goniops chrysocoma	0	0	0	-	0	1	1	1	0	0	0	0	-	-	-	0	-	-	-	-	-	0	-	-
Haematopota howarthi	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota latifascia	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota pachycera	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota personata	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota pluvialis	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota rara	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota singularis	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota sp. South Africa 1	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopota sp. South Africa 2	0	0	0	-	1	0	0	-	-	1	2	0	-	1	0	1	2	1	-	-	-	0	0	3
Haematopotina argentina	0	0	0	1	0	0	1	0	0	1	1	0	-	1	0	0	1	1	1	2	1	0	0	0

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Hamatabanus carolinensis	0	0	0	-	0	0	0	-	-	1	0	1	1	1	1	0	1	1	-	-	-	0	0	3
Hemichrysops fascipennis	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	0	0	1	0
Heptatoma pellucens	0	0	0	-	-	0	-	-	-	1	1	0	-	1	0	1	1	1	-	-	-	0	0	2
Himantostylus intermedius	1	0	0	1	1	1	1	0	1	1	0	0	-	1	0	0	0	1	0	1	0	0	0	0
Hippocentrum versicolor	1	1	0	1	2	0	0	1	1	1	2	0	-	1	0	1	2	1	1	1	1	0	1	3
Holcopsis fenestrata	0	0	0	-	2	0	1	1	-	1	1	0	-	-	-	1	1	1	0	-	-	0	-	-
Hybomitra bimaculata	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Hybomitra cincta	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Hybomitra epistates	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Hybomitra illota	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Hybomitra opaca	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Hybomitra rhombica	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Hybomitra sodalis	0	0	0	0	0	0	1	0	1	1	1	0	-	-	-	0	-	1	0	1	1	0	0	0
Lepiselaga (Lepiselaga) crassipes	1	0	0	1	2	0	1	0	1	1	1	0	-	1	0	0	0	1	0	2	1	0	0	3
Leucotabanus albovarius	0	0	0	0	0	1	1	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Leucotabanus ambiguus	0	0	0	0	0	1	1	1	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Leucotabanus annulatus	0	0	0	0	0	1	1	1	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Leucotabanus exaestuans	0	0	0	0	0	1	1	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Leucotabanus pauculus	0	0	0	0	0	1	1	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Lilaea (Lilaea) fuliginosa	0	0	0	-	0	1	1	-	-	0	1	0	-	-	-	0	-	-	-	-	-	0	-	-
Lilaea (Lilaea) sp. 3	0	0	0	-	0	1	1	-	-	0	1	0	-	-	-	0	-	-	-	-	-	0	-	-
Limata cf. *capensis*	0	0	0	0	0	-	1	0	1	1	1	0	-	-	-	0	-	1	-	-	-	0	-	-
Limata sp. 1 SIM	0	0	0	0	0	-	1	0	1	1	1	0	-	-	-	0	-	1	-	-	-	0	-	-
Limata tenuicornis	0	0	0	0	0	-	1	0	1	1	1	0	-	-	-	0	-	1	-	-	-	0	-	-
Lissimas australis	-	-	-	-	-	-	1	0	1	1	1	0	-	-	-	0	-	1	-	-	-	0	-	-
Microtabanus pygmaeus	0	0	0	-	0	0	1	-	-	1	2	0	-	-	-	0	-	0	-	-	-	1	0	-
Myiotabanus muscoideus	0	2	0	0	0	0	1	0	1	1	1	0	-	1	0	0	1	1	0	2	1	0	0	2
Nubiloides nigripennis	0	0	0	0	0	1	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	0	0	0
Orgizomyia zigzag	1	0	0	1	0	1	1	0	0	1	2	1	0	1	0	0	0	-	-	-	-	0	-	-
Pangonius sp. 1	0	0	0	0	0	1	1	0	0	0	0	0	-	1	0	0	1	1	0	0	-	0	2	0
Phaeotabanus cajennensis	0	0	0	0	0	0	1	0	0	1	1	0	-	1	1	0	0	1	0	1	1	0	0	0
Phaeotabanus nigriflavus	0	0	0	0	0	0	1	0	1	1	1	0	-	1	1	0	0	1	0	1	1	0	0	0
Phaeotabanus phaeopterus	1	0	0	0	0	0	1	0	1	1	1	0	-	1	1	0	0	1	0	1	1	0	0	0
Phaeotabanus prasiniventris	0	0	0	0	0	0	1	0	1	1	1	0	-	1	1	0	0	1	0	1	1	0	0	0
Philipomyia graeca	0	0	0	0	0	0	1	0	0	1	1	1	0	-	-	0	-	1	0	0	0	0	0	0
Philipotabanus (Melasmatabanus) fascipennis	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	0	0	1	0

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Philipotabanus (Mimotabanus) fucosus	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Philipotabanus (Mimotabanus) inauratus	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Philipotabanus (Mimotabanus) porteri	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Philipotabanus (Mimotabanus) sp. 7 El Monte	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Philipotabanus (Philipotabanus) magnificus	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Philipotabanus (Philipotabanus) pterographicus	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Philipotabanus (Philipotabanus) stigmaticalis	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Phorcotabanus cinereus	0	0	0	0	0	0	0	1	0	1	2	0	-	1	1	0	3	1	1	2	1	0	0	2
Poeciloderas quadripunctatus	0	0	0	-	0	-	-	-	-	1	1	0	-	-	-	0	3	1	-	-	-	0	-	-
Poeciloderas sp. 3 (Brazil)	0	0	0	-	0	-	-	-	-	1	1	0	-	-	-	0	3	1	-	-	-	0	-	-
Protodasyapha (Curumyia) sp. 1	0	0	0	-	0	1	1	-	-	1	1	0	-	-	-	0	-	-	-	-	-	0	1	-
Pseudacanthocera brevicorne	0	0	0	0	1	1	1	0	1	1	1	0	-	1	1	0	1	1	1	1	1	0	0	0
Pseudotabanus sp. 1 Brisbane	0	0	0	-	0	1	1	-	-	0	1	0	-	-	-	0	-	-	-	-	-	0	-	-
Pseudotabanus sp. 2 Lessard	0	0	0	-	0	1	1	-	-	0	1	0	-	-	-	0	-	-	-	-	-	0	-	-
Rhigioglossa (Rhigioglossa) edentula	0	0	0	0	0	1	1	0	0	0	1	0	-	-	-	0	-	-	-	-	-	0	1	0
Scaptiodes gagatina	1	0	0	1	2	1	1	1	1	1	1	0	-	1	0	0	1	1	0	0	0	0	0	0
Selasoma tibiale	1	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
Silvius (Silvius) variegatus	0	0	0	0	0	1	1	0	0	0	1	0	-	0	0	0	0	1	0	2	0	0	0	3
Spilotabanus multiguttatus	0	0	0	0	0	1	1	0	0	1	1	0	-	1	0	0	1	1	1	1	1	0	0	0
Stenotabanus (Aegialomyia) cf. *barahona*	0	0	0	1	0	1	1	0	0	1	1	0	-	1	0	0	1	1	0	2	1	0	0	3
Stenotabanus (Brachytabanus) longipennis	0	0	0	0	0	1	1	0	0	1	2	0	-	1	0	0	1	1	1	1	1	0	0	3
Stenotabanus (Cretotabanus) cretatus?	0	0	0	1	0	1	1	0	0	1	1	0	-	1	0	0	1	1	0	2	1	0	0	3
Stenotabanus (Stenochlorops) bequaerti	1	0	0	1	0	2	1	0	0	1	1	0	-	1	0	0	1	1	0	2	1	0	0	3
Stenotabanus (Stenotabanus) sp. 1 Mexico	0	0	0	0	0	1	1	0	0	1	1	0	-	1	0	0	1	1	1	1	1	0	0	3
Stenotabanus (Stenotabanus) sp. 10 Peru	0	0	0	0	0	1	1	0	0	1	1	0	-	1	0	0	1	1	1	1	1	0	0	3
Stenotabanus (Stenotabanus) sp. 11 Guatemala	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	1
Stenotabanus (Stenotabanus) sp. 4 Yasuni	0	0	0	0	0	1	1	0	0	1	1	0	-	1	0	0	1	1	1	1	1	0	0	3
Stenotabanus (Stenotabanus) sp. 5 El Monte	0	0	0	0	0	1	1	0	0	1	1	0	-	1	0	0	1	1	1	1	1	0	0	3
Stibasoma (Rhabdotylus) planiventre	0	0	1	0	0	0	1	0	0	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0
Stibasoma (Rhabdotylus) venenata	0	0	1	0	0	0	1	0	0	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0
Stibasoma (Rhabdotylus) viridiventre	0	0	1	0	0	0	1	0	0	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0
Stibasoma (Stibasoma) apicimacula	0	0	0	0	0	0	1	0	1	1	1	1	2	1	1	0	1	1	1	1	1	0	0	0
Stypommisa captiroptera	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
Stypommisa cf. *lerida*	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
Stypommisa cf. *modica*	1	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
Stypommisa n. sp. nr. *kroeberi*	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Stypommisa sp. 8 Peru	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
Stypommisa unigrum	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
Tabanocella (Tabanocella) cf. *concinna*	0	0	0	1	0	1	1	1	0	1	1	1	0	1	1	0	0	1	0	1	0	0	0	-
Tabanocella (Tabanocella) denticornis	0	0	0	1	0	1	1	1	0	0	1	1	1	1	1	0	0	1	0	1	0	0	0	-
Tabanocella (Tabanocella) longirostris	0	0	0	1	0	1	1	1	0	0	1	1	0	1	1	0	0	1	0	1	0	0	1	-
Tabanus aegrotus	1	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus albocirculus	0	0	0	0	0	0	1	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus americanus	1	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus atratus	1	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus biguttatus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus birmanicus	1	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus caduceus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus cf. *abdominalis*	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus cf. *antarcticus*	0	0	0	0	0	1	1	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	1	0
Tabanus cf. *hirtitibia*	0	0	0	0	0	0	1	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus cf. *unimaculus*	0	0	0	0	0	0	1	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus chrysurus	0	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus fulvulus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	2
Tabanus leucostomus	0	0	0	0	0	0	0	1	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus lineola	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	1
Tabanus nigrotectus	1	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus oknos	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus par	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus pellucidus	0	0	0	0	0	0	1	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus petiolatus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus promesogaeus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	2
Tabanus pumilis	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	2
Tabanus rufofrater	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus sackeni	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	1
Tabanus sp. 23 India	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Tabanus sp. 43 Australia	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus sparus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	0
Tabanus sudeticus	0	0	0	0	0	0	0	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus sulcifrons	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus superjumentarius	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus taeniatus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	0	1	0	0	0	2

ID	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
Tabanus thiemanus	0	0	0	0	0	0	1	0	0	1	1	1	-	1	1	0	1	1	1	1	0	0	0	0
Tabanus turbidus	0	0	0	0	0	0	0	0	0	1	1	0	-	1	1	0	1	1	1	1	0	0	0	0
Thaumastocera akwa	0	0	0	0	0	1	1	1	1	0	2	1	2	1	0	0	1	1	0	1	1	0	0	0
Therioplectes sp. 3 Serbia	0	0	0	-	0	1	0	-	-	1	1	1	-	-	-	0	-	1	-	-	-	0	-	-
undescribed genus A	0	0	0	0	0	-	1	1	0	1	2	0	-	1	1	0	2	1	0	1	1	0	0	1
undescribed genus M	0	0	0	0	0	0	1	0	0	1	1	0	-	1	0	0	1	1	0	1	1	0	0	0
undescribed genus X	0	0	0	-	0	-	1	-	-	1	1	1	0	-	-	0	-	1	-	-	-	0	-	-

Tabaninae Morphological data matrix characters 25-49

ID	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Acanthocera (Acanthocera) sp. 5 Peru	0	1	0	0	0	0	0	1	1	1	0	1	1	0	0	0	0	-	0		0	1	2	0	0	1
Acanthocera (*Acanthocera)* sp. 7 Brazil	1	1	0	0	0	0	0	1	1	1	0	1	1	0	0	0	0	-	0		0	1	2	0	0	1
Acanthocera (Acanthocera) sp.1 Ecuador	1	1	0	0	0	0	0	1	1	1	0	1	1	0	0	0	0	-	0		0	1	2	0	0	1
Acanthocera (Nothocanthocera) costaricana	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0		0	1	2	0	0	0
Acanthocera (Querbetia) inopinatus	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0		0	1	2	0	0	0
Adersia oestroides	0	0	-	1	0	0	0	0	0	1	1	0	0	0	0	0	0	-	1		0	0	0	0	1	-
Aegophagamyia (Triclida) cf. *brunnea*	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	-	-	0	-		0
Agelanius lanei	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0		0	1	1	0	-	0
Agelanius sp. 2 Yeso Road	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0		0	1	1	0	-	0
Agelanius sp. 3 Dittmar	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0		0	1	1	0	-	0
Agkistrocerus finitimus	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	0		0	1	1	0	1	0
Agkistrocerus megerlei	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	0		0	1	1	0	1	0
Anacimas limbellatus	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	0	-	--		0	-	0	-	0
Ancala africana	-	-	-	-	-	-	-	-	-	1	0	-	-	1	0	0	1	1	-	--		-	-	0	-	0
Ancala fasciata	-	-	-	-	-	-	-	-	-	1	0	-	-	1	0	0	1	1	-	--		-	-	0	-	0
Apatolestes (Apatolestes) rugosus	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	--		-	-	0	-	-
Asaphomyia floridensis	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	--		-	-	0	-	-
Atylotus agrestis	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	--		-	-	0	-	0
Atylotus thoracicus	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	--		-	-	0	-	0
Atylotus virgo	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	--		-	-	0	-	0
Bolbodimyia bicolor	-	1	1	0	0	1	1	1	1	1	0	1	0	1	1	1	0	-	2		0	1	2	0	0	0
Bolbodimyia brunneipennis	-	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	0	-	2		0	1	2	0	0	0
Bolbodimyia dampfi	-	1	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	-	2		0	1	2	0	0	0
Catachlorops (Amphichlorops) cf. *vespertinus*	0	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	-		1	1	0	0	0
Catachlorops (Catachlorops) cf. *fuscinevris*	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0		0	1	1	0	0	0
Catachlorops (Catachlorops) halteratus	0	1	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	-	0		0	1	3	0	0	0

ID	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Catachlorops (Psalidia) fulmineus	0	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	-	1	2	0	0	0
Catachlorops (Psalidia) overali	0	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	-	1	2	0	0	0
Catachlorops (Psalidia) rubiginosus	0	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	-	1	2	0	0	0
Catachlorops (Psarochlorops) difficilis	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	0	1	1	0	0	0
Catachlorops (Psarochlorops) ecuadoriensis	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	0	1	1	0	0	0
Catachlorops (Rhamphidommia) potator	0	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0		1	2	0	0	0
Chasmia cf. *bifasciata*	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	1
Chasmia sp. 3 New Caledonia	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	1
Chlorotabanus cf. *flagellatus*	-	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	-	0	0	0	1	0	1	0
Chlorotabanus crepuscularis	-	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	1	0
Chlorotabanus inanis	-	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	-	0	0	1	1	0	1	0
Chlorotabanus mexicanus	-	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	1	0
Chrysops coquilletti	-	-	-	1	1	1	1	1	1	1	1	1	1	0	0	0	0	-	0	0	1	2	0	0	1
Coracella carbo	-	-	-	1	0	0	0	0	0	1	1	-	-	0	0	0	0	-	-	--	-	-	0	-	0
Cryptotylus sp. 1 Suriname	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	-	0	0	0	-	0	1	0
Cryptotylus sp. 2 FRGY	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	-	0	0	0	-	0	1	0
Cydistomyia (Cydistomyia) albithorax	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Cydistomyia (Cydistomyia) cf. *lorentzi*	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Cydistomyia (Cydistomyia) doddi	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Cydistomyia (Cydistomyia) sp. 2 Sandaun	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Cydistomyia (Cydistomyia) sp. 8 Queensland	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Cydistomyia (Cydistomyia) victoriensis	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Dasybasis (Dasybasis) gentilis	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Dasybasis (Dasybasis) montium	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Dasybasis (Dasybasis) neobasalis	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Dasybasis (Dasybasis) sp. 10 Chubut	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Dasybasis (Dasybasis) sp. 11 Tasmania	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Dasybasis (Dasybasis) sp. 12 Peru	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Dasybasis (Dasybasis) sp. 14 Cholila	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Dasybasis (Dasybasis) sp. 15 (RNNH)	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Dasybasis (Dasybasis) sp. 3 Argentina	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Dasybasis (Protodasyommia) batrankii	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Dasybasis (Protodasyommia) transversa	-	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	0	-	-	--	-	-	0	-	0
Dasychela (Dasychela) badia	1	0	-	1	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	2	0	0	0
Dasychela (Dasychela) cf. *inca*	0	0	-	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	1	2	0	0	0
Dasychela (Dasychela) ocellus	1	0	-	1	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	2	0	0	0
Dasychela (Dasychela) peruviana	1	0	-	1	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	2	0	0	0
Dasychela (Triceratomyia) macintyrei	0	0	-	1	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	1	2	0	0	0
Dasyrhamphis cf. *ater*	0	0	-	1	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	3	0	1	0
Dasyrhamphis umbrinus	0	0	-	1	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	3	0	1	0

ID	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Diachlorus bimaculatus	0	0	-	1	0	1	1	1	2	1	0	0	0	1	0	0	0	-	0	0	1	2	0	0	0
Diachlorus cf. *xynus*	0	0	-	1	1	1	1	1	1	1	0	0	0	1	0	0	0	-	0	0	1	2	0	0	0
Diachlorus curvipes	0	0	-	1	0	1	1	1	2	1	0	1	1	1	0	0	0	-	0	0	1	2	0	0	0
Diachlorus falsifuscistigma	0	0	-	1	0	1	1	1	2	1	0	1	1	1	0	0	0	-	0	0	1	2	0	0	0
Diachlorus ferrugatus	0	0	-	1	0	1	1	1	2	1	0	1	1	1	0	0	0	-	0	0	1	2	0	0	0
Dichelacera (Dichelacera) cf. *rex*	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0	0	1	2	0	0	0
Dichelacera (Dichelacera) cf. *submarginata*	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0	0	1	2	0	0	0
Dichelacera (Dichelacera) januarii	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0	0	1	2	0	0	0
Dichelacera (Dichelacera) regina	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0	0	1	2	0	0	0
Dichelacera (Dichelacera) scutellata	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0	0	1	2	0	0	0
Dichelacera (Idiochelacera) subcallosa	0	1	1	1	0	0	2	0	2	1	0	1	1	0	0	0	0	-	0	0	1	2	0	0	0
Dicladocera sp. 15 "leoni"	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0
Dicladocera argentomacula	1	0	-	0	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	1	2	0	0	0
Dicladocera cf. *hoppi*	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0
Dicladocera cf. *riveti*	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0
Dicladocera macula	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0
Dicladocera n. sp. nr. *clara*	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	1	1	0	0	0
Dicladocera pruinosa	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	2	0	0	0
Ectenopsis (Ectenopsis) vulpecula	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	0	0	0	-	0	1	-
Ectenopsis (Parasilvius) sp. 2 Mary River	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	0	0	0	-	0	1	-
Eristalotabanus violaceus	1	0	-	1	0	1	1	1	1	1	0	0	0	0	0	0	0	-	0	0	1	1	0	0	0
Esenbeckia lugubris	0	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	-	0		0	-	0	1	-
Esenbeckia prasiniventris	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	-	0		1	0	0	1	-
Euancala maculatissima	-	-	-	-	-	-	3	-	0	1	0	-	-	1	0	0	1	1	-	-	-	1	2	0	-	0
Eutabanus pictus	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	-	0	0	0	2	0	0	0
Goniops chrysocoma	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	0	0	1	3	0	-	-
Haematopota howarthi	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota latifascia	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota pachycera	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota personata	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota pluvialis	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota rara	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota singularis	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota sp. South Africa 1	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopota sp. South Africa 2	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	1	2	1	1	1
Haematopotina argentina	0	0	-	1	0	1	1	0	1	1	0	1	1	0	0	0	0	-	0	0	1	2	0	1	0
Hamatabanus carolinensis	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	-	0
Hemichrysops fascipennis	0	0	-	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	1	3	0	0	0
Heptatoma pellucens	-	-	-	-	-	-	-	-	-	-	1	0	1	0	0	0	0	1	1	-	-	0	2	1	0	0
Himantostylus intermedius	0	0	-	1	1	1	0	1	1	1	0	0	0	1	1	1	0	-	0	0	1	3	0	0	0

ID	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Hippocentrum versicolor	-	-	-	1	1	1	1	1	-	1	0	-	-	1	1	1	1	1	-	-	-	-	1	-	1
Holcopsis fenestrata	-	1	-	-	-	-	-	-	-	1	0	-	-	0	0	0	0	-	0	-	1	2	0	-	0
Hybomitra bimaculata	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Hybomitra cincta	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Hybomitra epistates	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Hybomitra illota	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Hybomitra opaca	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Hybomitra rhombica	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Hybomitra sodalis	1	0	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	0	1	0
Lepiselaga (Lepiselaga) crassipes	0	0	-	1	1	2	0	1	1	1	0	0	0	1	1	1	0	-	0	1	1	3	0	0	0
Leucotabanus albovarius	0	-	-	-	-	2	-	-	0	1	0	-	-	-	-	-	1	0	-	-	1	0	0	-	0
Leucotabanus ambiguus	0	-	-	-	-	-	-	-	0	1	0	-	-	-	-	-	1	0	-	-	1	0	0	-	0
Leucotabanus annulatus	0	-	-	-	-	-	-	-	0	1	0	-	-	-	-	-	1	0	-	-	1	0	0	-	0
Leucotabanus exaestuans	0	-	-	-	-	-	-	-	0	1	0	-	-	-	-	-	1	0	-	-	1	0	0	-	0
Leucotabanus pauculus	0	-	-	-	-	-	-	-	0	1	0	-	-	-	-	-	1	0	-	-	1	0	0	-	0
Lilaea (Lilaea) fuliginosa	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	-	-	0	-	0
Lilaea (Lilaea) sp. 3	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	-	-	0	-	0
Limata cf. *capensis*	1	-	-	-	1	-	-	-	-	1	0	-	-	-	-	-	0	-	-	-	-	-	0	1	0
Limata sp. 1 SIM	1	-	-	-	1	-	-	-	-	1	0	-	-	-	-	-	0	-	-	-	-	-	0	1	0
Limata tenuicornis	1	-	-	-	1	-	-	-	-	1	0	-	-	-	-	-	0	-	-	-	-	-	0	1	0
Lissimas australis	1	-	-	-	1	-	-	-	-	1	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Microtabanus pygmaeus	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	0	-	-	0	-	0	-	0
Myiotabanus muscoideus	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	-	0	0	0	-	0	0	0
Nubiloides nigripennis	1	0	-	0	0	0	0	0	1	1	0	0	0	0	0	0	0	-	0	0	1	1	0	-	0
Orgizomyia zigzag	-	-	-	0	0	0	1	0	1	1	1	-	-	-	-	-	0	-	-	-	-	-	0	-	0
Pangonius sp. 1	0	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	-	0		0	-	0	1	-
Phaeotabanus cajennensis	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	0	-	0	1	0
Phaeotabanus nigriflavus	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	3	0	1	0
Phaeotabanus phaeopterus	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	3	0	1	0
Phaeotabanus prasiniventris	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-	0	0	1	3	0	1	0
Philipomyia graeca	0	0	-	1	0	0	0	0	0	1	0	1	1	0	0	0	0	-	0	0	0	-	0	0	0
Philipotabanus (Melasmatabanus) fascipennis	0	0	-	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	1	3	0	0	0
Philipotabanus (Mimotabanus) fucosus	0	0	-	1	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	1	2	0	0	0
Philipotabanus (Mimotabanus) inauratus	0	0	-	1	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	1	2	0	0	0
Philipotabanus (Mimotabanus) porteri	0	0	-	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0
Philipotabanus (Mimotabanus) sp. 7 El Monte	0	0	-	1	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	1	2	0	0	0
Philipotabanus (Philipotabanus) magnificus	0	0	-	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	1	2	0	0	0
Philipotabanus (Philipotabanus) pterographicus	0	0	-	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	1	2	0	0	0
Philipotabanus (Philipotabanus) stigmaticalis	0	0	-	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	-	0	0	0
Phorcotabanus cinereus	0	0	-	1	1	0	1	0	1	1	0	1	1	0	0	0	1	1	0	0	0	-	0	0	0

ID	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Poeciloderas quadripunctatus	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	0	-	-	-	-	0	-	0
Poeciloderas sp. 3 (Brazil)	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	0	-	-	-	-	0	-	0
Protodasyapha (Curumyia) sp. 1	1	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	0	0	0	-	0	1	-
Pseudacanthocera brevicorne	0	0	-	1	1	0	1	0	0	1	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0
Pseudotabanus sp. 1 Brisbane	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	-	-	0	-	0
Pseudotabanus sp. 2 Lessard	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	-	-	0	-	0
Rhigioglossa (Rhigioglossa) edentula	-	-	-	-	-	0	0	0	1	1	1	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Scaptiodes gagatina	1	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0
Selasoma tibiale	0	0	0	1	0	0	0	0	1	1	0	0	0	1	1	1	1	0	0	0	1	3	0	1	0
Silvius (Silvius) variegatus	-	-	-	0	0	0	0	0	1	1	1	0	0	0	0	0	0	-	0	0	1	1	0	0	1
Spilotabanus multiguttatus	0	0	0	1	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0
Stenotabanus (Aegialomyia) cf. *barahona*	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	-	0	0	1	1	0	1	0
Stenotabanus (Brachytabanus) longipennis	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	-	0	0	0	0	0	0	0
Stenotabanus (Cretotabanus) cretatus?	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	-	0	0	1	1	0	1	0
Stenotabanus (Stenochlorops) bequaerti	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	-	0	0	1	1	0	1	0
Stenotabanus (Stenotabanus) sp. 1 Mexico	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	-	0	0	0	0	0	0	0
Stenotabanus (Stenotabanus) sp. 10 Peru	0	0	0	1	0	0	0	0	1	1	0	1	1	0	0	0	0	-	0	0	0	0	0	1	0
Stenotabanus (Stenotabanus) sp. 11 Guatemala	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	-	0	0	1	1	0	1	0
Stenotabanus (Stenotabanus) sp. 4 Yasuni	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	-	0	0	0	0	0	0	0
Stenotabanus (Stenotabanus) sp. 5 El Monte	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	-	0	0	0	0	0	0	0
Stibasoma (Rhabdotylus) planiventre	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	-	0	0	1	0	0	0	0
Stibasoma (Rhabdotylus) venenata	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	-	0	0	1	1	0	0	0
Stibasoma (Rhabdotylus) viridiventre	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	-	0	0	1	0	0	0	0
Stibasoma (Stibasoma) apicimacula	0	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	0	-	0	0	1	0	0	0	0
Stypommisa captiroptera	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0
Stypommisa cf. *lerida*	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0
Stypommisa cf. *modica*	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0
Stypommisa n. sp. nr. *kroeberi*	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0
Stypommisa sp. 8 Peru	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0
Stypommisa unigrum	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0
Tabanocella (Tabanocella) cf. *concinna*	-	-	-	0	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	1	2	0	-	0
Tabanocella (Tabanocella) denticornis	-	-	-	0	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	1	2	0	-	0
Tabanocella (Tabanocella) longirostris	-	-	-	0	-	-	-	-	-	1	1	-	-	-	-	-	0	-	-	-	1	2	0	-	0
Tabanus aegrotus	0	0	-	-	0	0	0	0	1	1	0	0	0	0	0	0	1	1	-	1	1	1	0	-	0
Tabanus albocirculus	0	0	-	-	0	0	1	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	0	-	0
Tabanus americanus	0	0	-	-	0	0	0	0	1	1	0	0	0	0	0	0	1	1	-	1	1	1	0	-	0
Tabanus atratus	0	0	-	-	0	0	0	0	1	1	0	0	0	0	0	0	1	1	-	1	1	3	0	-	0
Tabanus biguttatus	0	0	-	-	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	1	3	0	0	0
Tabanus birmanicus	0	0	-	-	0	0	0	0	1	1	0	1	0	0	0	0	1	1	-	1	1	1	0	-	0
Tabanus caduceus	0	0	-	-	0	0	1	0	2	1	0	-	-	0	0	0	1	1	-	-	-	-	0	-	0

ID	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4
	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Tabanus cf. *abdominalis*	0	0	-	-	0	0	1	0	-	1	0	1	1	0	0	0	1	1	-	1	-	1	1	0	-
Tabanus cf. *antarcticus*	0	0	-	-	0	0	1	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus cf. *hirtitibia*	0	0	-	-	0	0	1	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus cf. *unimaculus*	0	0	-	-	0	0	1	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus chrysurus	0	0	-	-	0	0	1	0	-	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus fulvulus	1	0	-	-	0	0	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus leucostomus	0	0	-	-	0	0	-	0	-	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus lineola	1	0	-	-	0	0	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus nigrotectus	0	0	-	-	0	0	0	0	1	1	0	0	0	0	0	0	1	1	-	1	-	1	1	0	-
Tabanus oknos	0	0	-	-	0	0	-	0	-	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus par	0	0	-	-	0	0	0	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus pellucidus	0	0	-	-	0	0	1	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus petiolatus	0	0	-	-	0	0	1	0	-	1	0	1	1	0	0	0	1	1	-	1	-	1	1	0	-
Tabanus promesogaeus	1	0	-	-	0	0	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus pumilis	0	0	-	1	0	0	1	0	1	1	0	-	-	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus rufofrater	0	0	-	-	0	0	1	0	-	1	0	1	1	0	0	0	1	1	-	1	-	1	1	0	-
Tabanus sackeni	1	0	-	-	0	0	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus sp. 23 India	0	0	-	-	0	0	1	0	-	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus sp. 43 Australia	0	0	-	-	0	0	0	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus sparus	1	0	-	-	0	0	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus sudeticus	0	0	-	-	0	0	1	0	-	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus sulcifrons	0	0	-	-	0	0	1	0	-	1	0	1	1	0	0	0	1	1	-	1	-	1	1	0	-
Tabanus superjumentarius	0	0	-	-	0	0	1	0	-	1	0	0	0	0	0	0	1	1	-	-	-	1	1	0	-
Tabanus taeniatus	1	0	-	-	0	0	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	-	0	0	0
Tabanus thiemanus	0	0	-	-	0	0	1	0	1	1	0	-	-	0	0	0	1	1	-	-	-	-	-	0	-
Tabanus turbidus	0	0	-	-	0	0	1	0	-	1	0	1	1	0	0	0	1	1	-	1	-	1	1	0	-
Thaumastocera akwa	0	0	-	1	0	0	1	0	1	0	1	0	0	1	0	0	0	1	-	-	-	1	3	0	-
Therioplectes sp. 3 Serbia	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	1	-	-	-	-	-	0	-
undescribed genus A	1	0	-	0	0	0	1	0	0	1	0	0	0	0	0	0	1	2	0	0	1	1	0	1	0
undescribed genus M	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0
undescribed genus X	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	-	1	0	-	-	1	1	0	-	0