

# **FLYTREE: Cooperative Research in Phylogenetics and Bioinformatics Toward a Dipteran Tree of Life**

**Brian Wiegmann, North  
Carolina State University,  
USA**

**Rudolf Meier, National  
University of SINGAPORE**

**David K. Yeates, CSIRO,  
Entomology, AUSTRALIA**

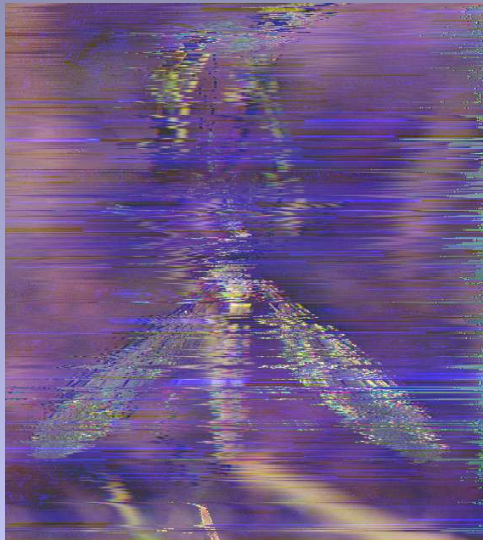
**Markus Friedrich, Wayne St.  
University, Detroit**

**Greg Courtney, Iowa State  
University**



**F. Christian Thompson, USDA, ARS,  
Systematic Entomology Lab, Washington DC, USA**

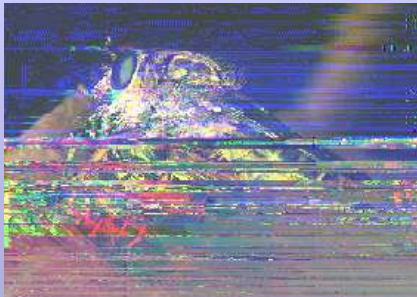
**Gail Kampmeier, Illinois Natural History Survey, Illinois, US**



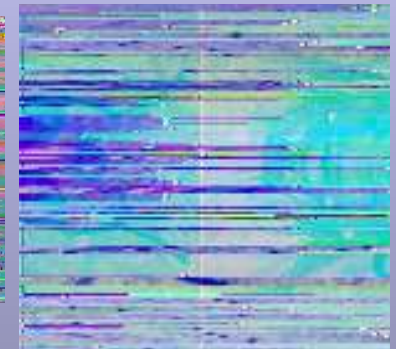
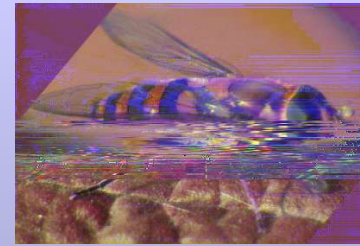
# DIPTERA



## Lower Diptera

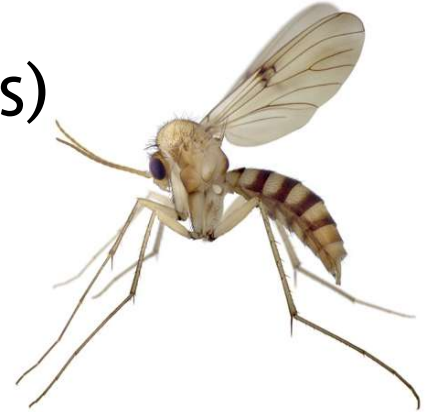


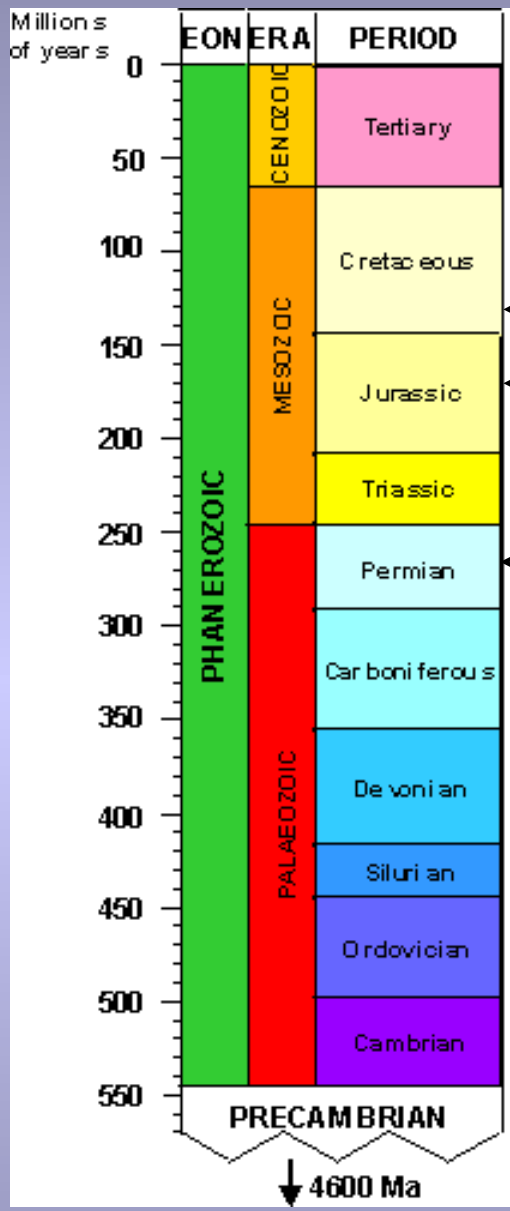
## Brachycera



# FLIES (DIPTERA): A Major Clade of Life

- ~125,000 species described (12% of animals)
- total species richness at least 2-3 times >>
- morphologically exuberant lineage
- origins in the late Paleozoic

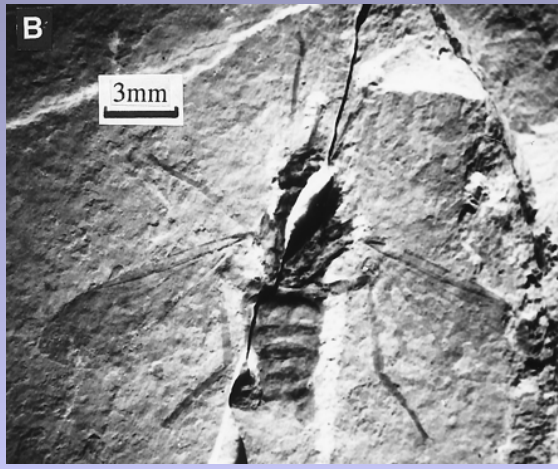




← **Earliest Angiosperms**

← **Earliest Brachycera**

← **Earliest Diptera**



# Dipteran Genomes

10 Additional dipteran genomes  
in progress:



- *Drosophila pseudobscura*
- *Glossina morsitans*
- *Aedes aegypti*
- 8 species of *Drosophila*



*Anopheles gambiae*

# FLYTREE - NSF AToL Diptera

- **Cooperative Research in Phylogenetics and Bioinformatics of True Flies (Diptera:Insecta) (8 laboratories, 15-20 collaborating dipterists; 5 years)**
- **Large project to bring together major contributors to modern synthesis of fly phylogeny**
- **Multi-level approach with three main “tiers”**
  - **Tier 1: 42-taxon framework phylogeny covering the entire order. 30 kb of DNA, morphology, full mitochondrial genomes.**
  - **Tier 2: “Supermatrix” representing data collection for all fly families= >250 taxa, multiple genes, morphology**
  - **Tier 3: “Supertree” analyses of Dipteran relationships based on individual analyses of specific phylogenetic groups from within the project and from published analyses.**
  - **“Phylogenetic database to distribute biological information on Diptera: taxonomy, genetics, development, morphology, behavior, etc.**

# FLYTREE PIs & Key Collaborators



# Additional Collaborators





# Tier 1

- 42-taxon framework phylogeny
- Exemplar taxa are “model organisms” that represent all *major* lineages
- 30kb+ of nuclear genomic DNA sequence
- Comprehensive comparative morphology scored across the order
- Full mitochondrial genomes for all 42 species

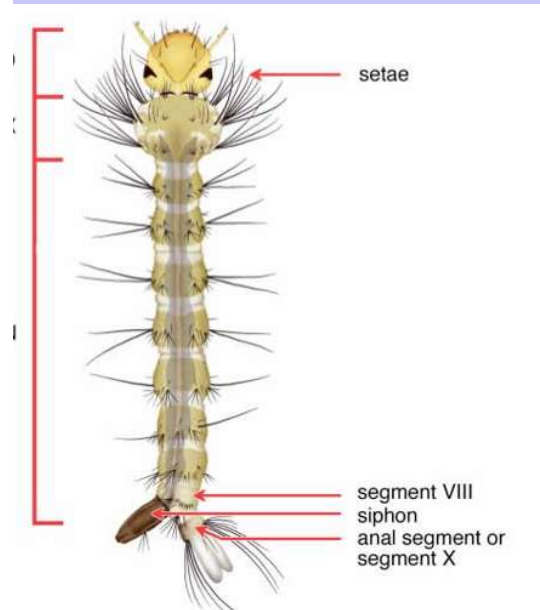
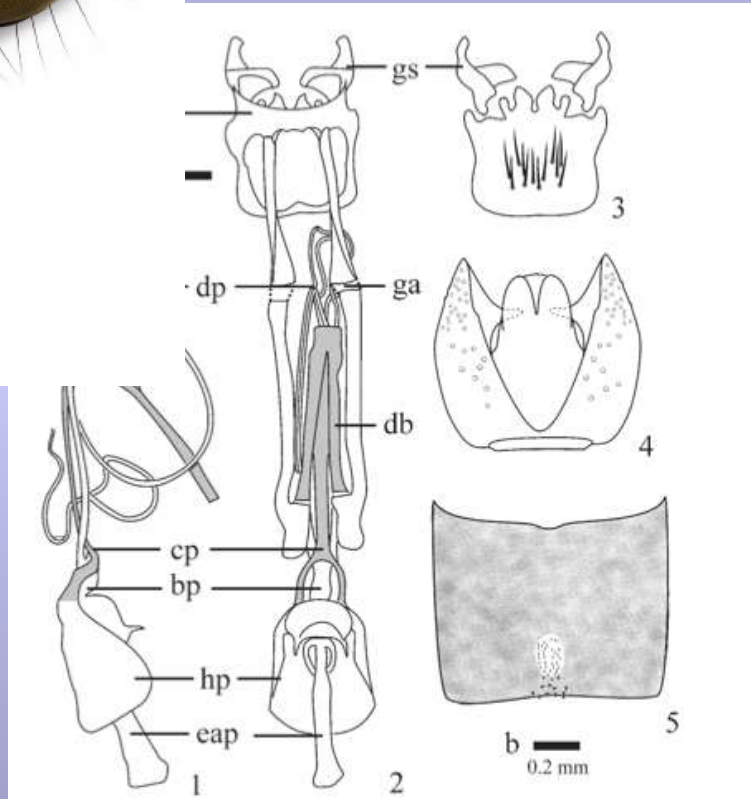
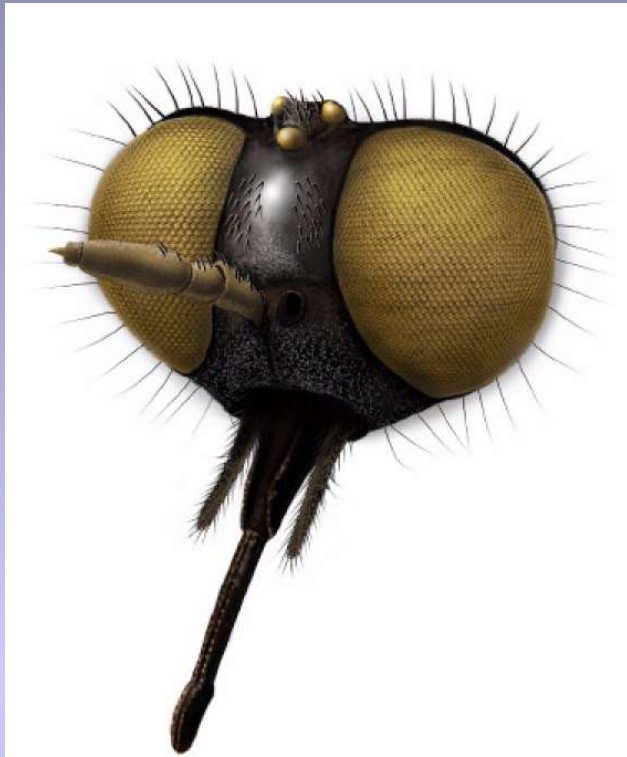


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# Comparative Morphology

- Scored for all life stages across the entire order

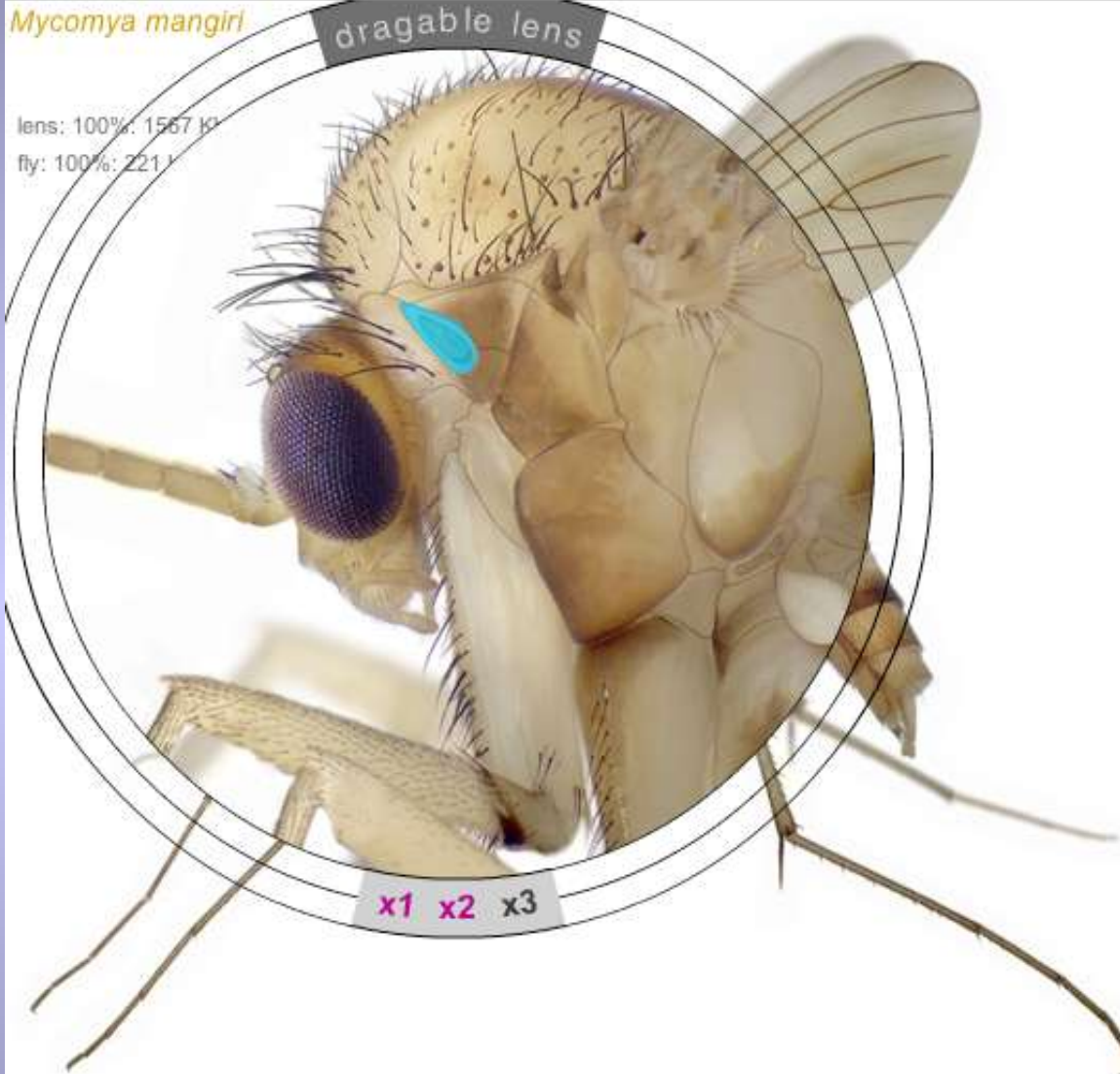


*Mycomya mangiri*

dragable lens

lens: 100%: 1567 KJ

fly: 100%: 221 KJ



x1 x2 x3

thorax

- acrostichal bristles →
- anepimeron**
- anepisternum**
- anepisternal bristles →
- i** anterior spiracle
- dorsocentral bristles →
- halter**
- katepisternum**
- katepisternal bristles →
- laterotergite**
- meron**
- notopleural bristles**
- pleural suture**
- posterior spiracle**
- postpronotal bristles →
- postpronotum**
- presutural bristle →
- scutellar bristles**
- scutellum**
- scutoscutellar suture →
- scutum**
- transverse suture →

antenna  
head  
thorax  
wing  
leg  
abdomen

Lower Diptera

Lower Brachycera

Acalyprate

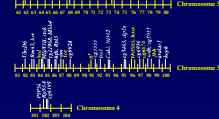
Calyprate

terms

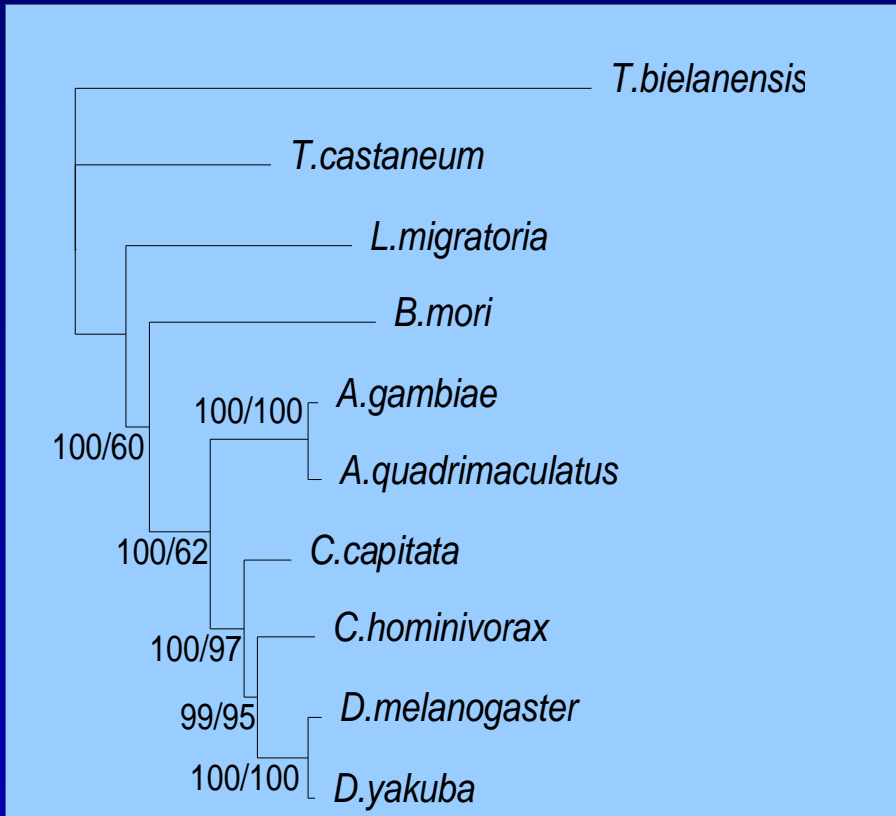
?

# Molecular datasets

-full mitochondrial genomes and  
multiple nuclear genes



*D. melanogaster*, nuclear genome  
O'Grady and DeSalle, pers. comm.



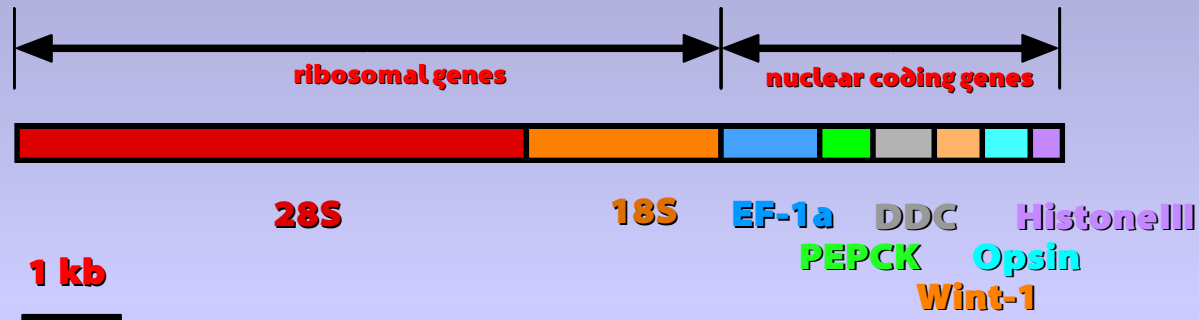
QP JJT-dΓ aa (3586 sites) / QP HKY-dΓ 12+16S (1634 sites)

Mitochondrial

Nuclear

# Molecular Systematist's Standard Arsenal of Markers

## Current molecular phylogenetic arsenal



## Two "new" phylogenetic markers



# Tier 2

- 250-taxon “supermatrix” representing all fly families
- 15-20 kb of nuclear DNA
- Comprehensive comparative morphology
- Analyses under multiple conditions requiring intensive computational resources
- Comparison and combination of data partitions

# Tier 3

- Supertree analysis of recent and newly obtained estimates of phylogenetic relationships within dipteran clades
- Meta analysis of published hypotheses
- Detailed studies of key dipteran clades
- Comprehensive summary of evidence on phylogeny for a large fraction of dipteran diversity
- 1,500 species

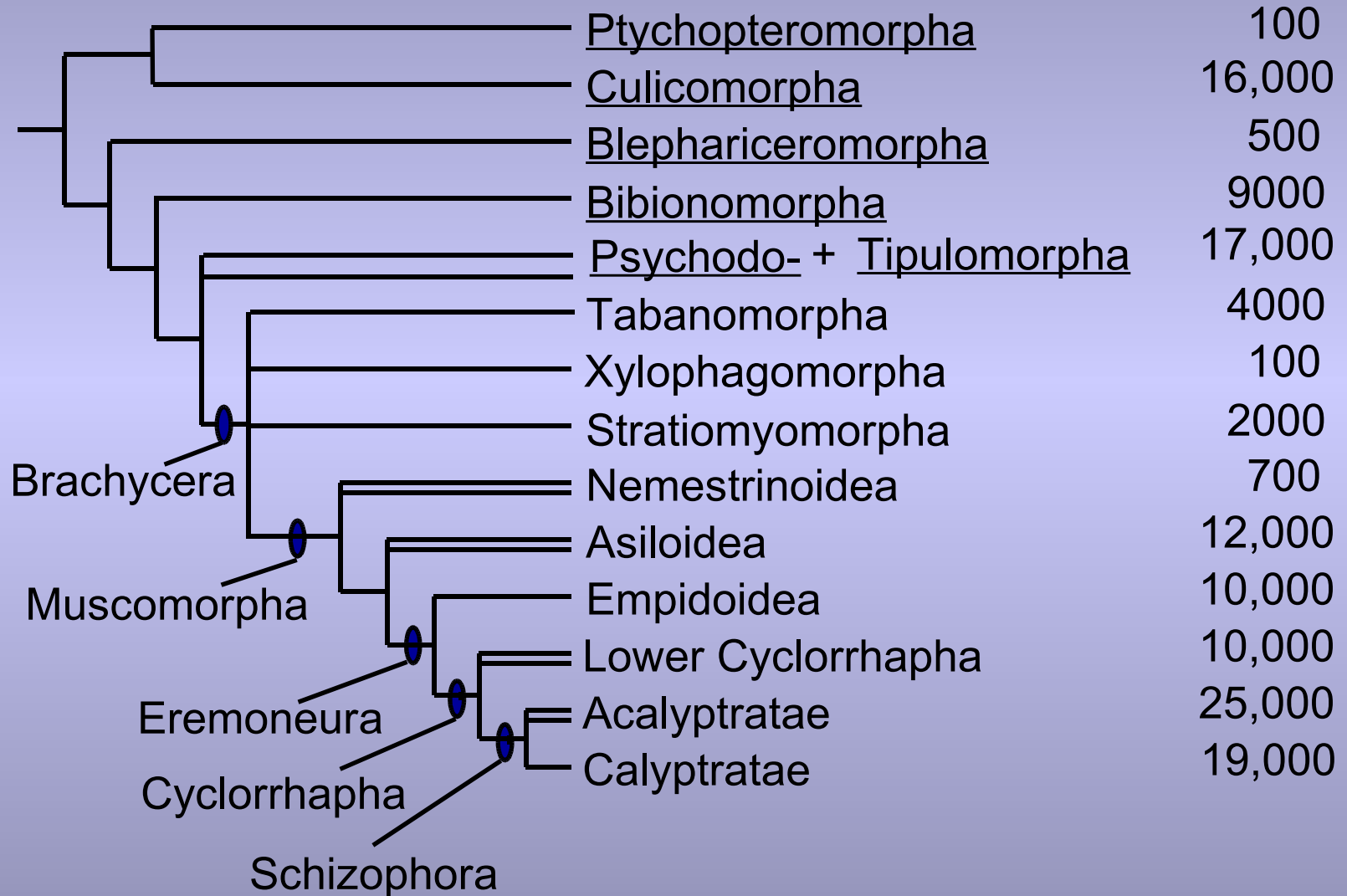


# Some Recent and Ongoing Phylogenetic Studies of Dipteran Lineages that contribute to tier 3

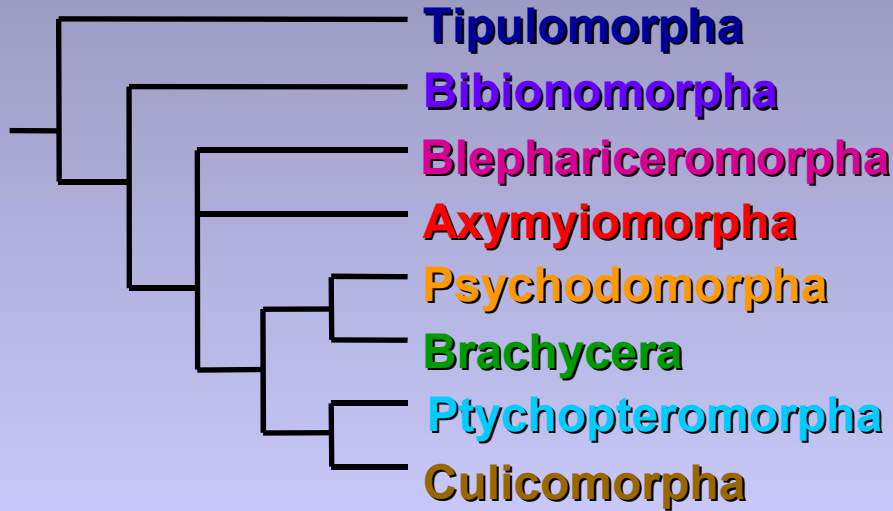
- Lower Diptera ('Nematocera')
- Lower Brachycera
- Culicoidea
- Therevidae
- Acroceridae
- Asilidae
- Bombyliidae
- Empidoidea
- Eremoneura
- Calyptratae
- Sciomyzoidea
- Tephritoidea
- Oestroidea
- Hippoboscoidea
- Sepsidae
- Coelopidae
- Muscidae
- Sarcophagidae
- Pipunculidae
- Rhagionidae
- Tabanomorpha
- Syrphidae
- Deuterophlebiidae

# *Diptera Phylogeny- Current Synthesis*

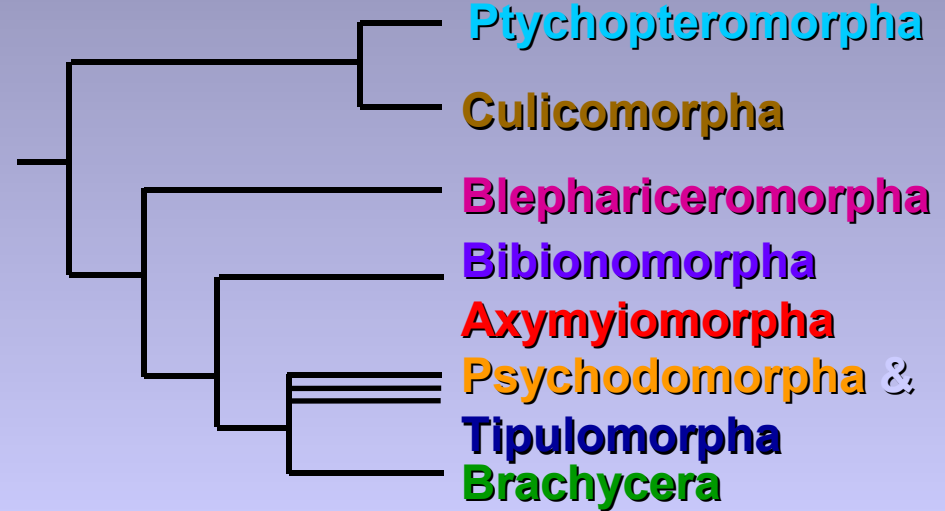
Estimated # spp.



# LOWER DIPTERA (Nematocera)

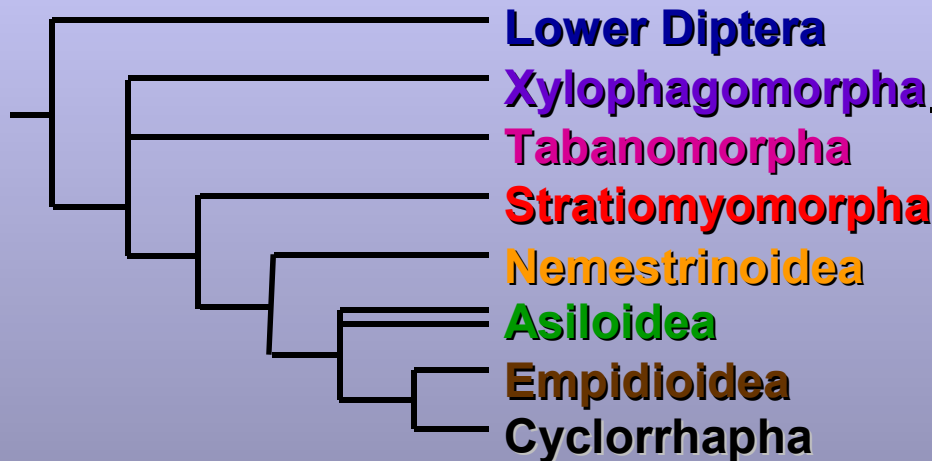


Wood & Borkent 1989  
Sinclair 1992

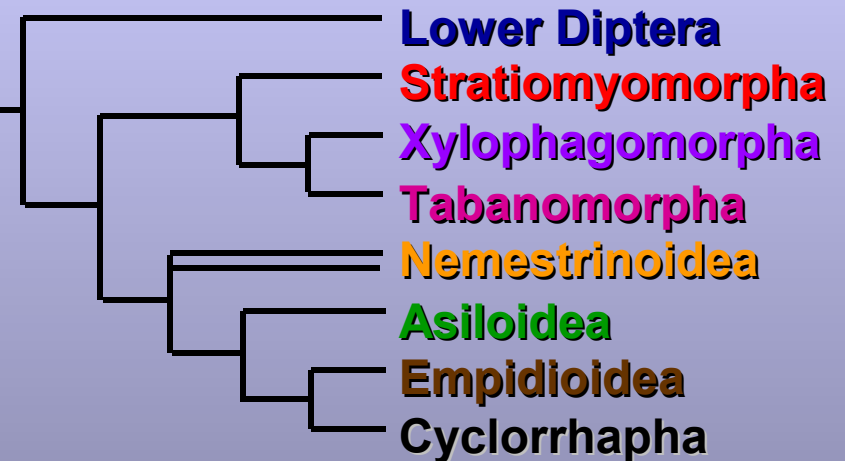


Oosterbroek & Courtney 1995

# LOWER BRACHYCERA (Orthorrhapha)

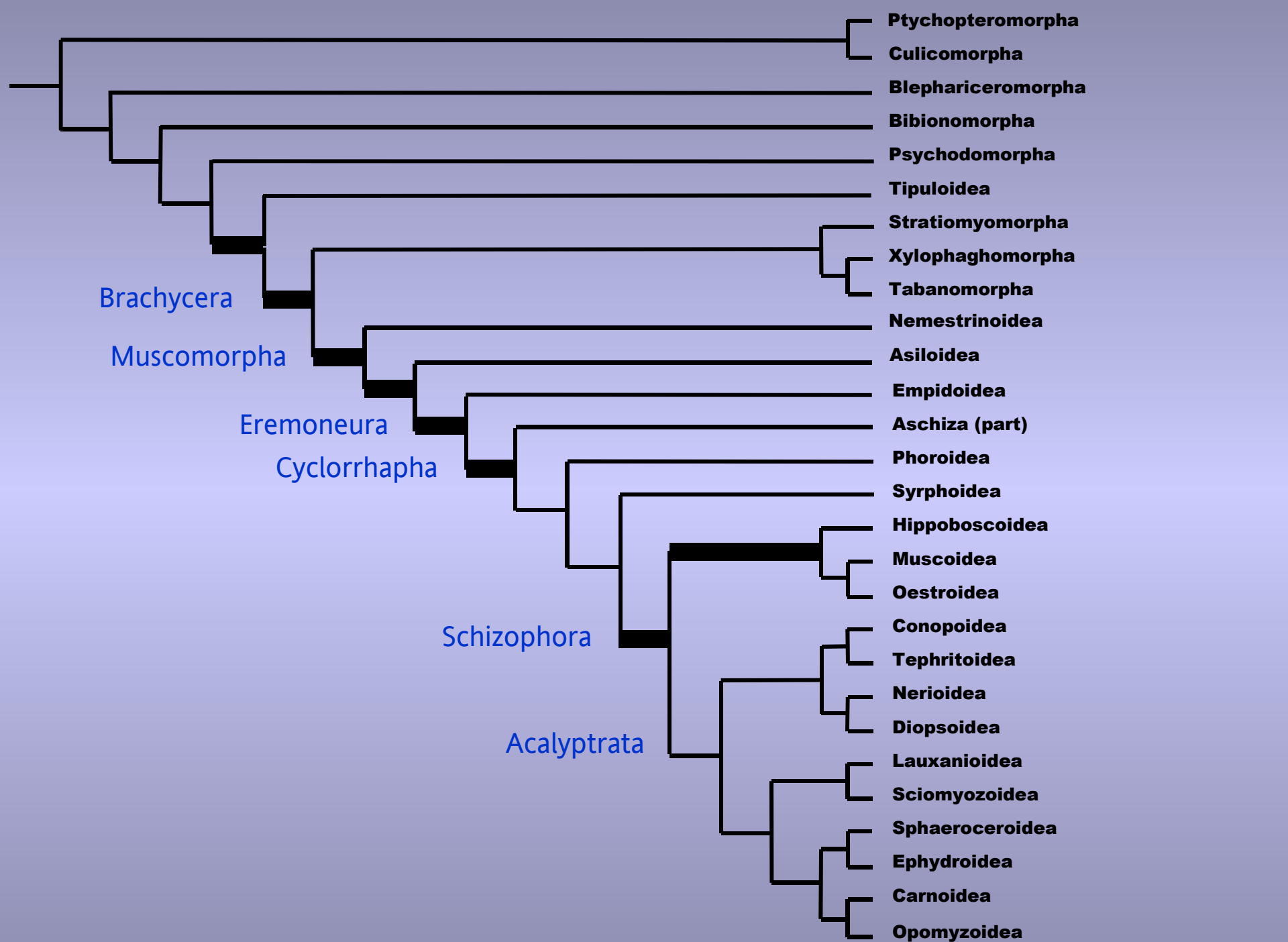


Sinclair *et al* 1993



Yeates 2002





# Bioinformatics of Diptera

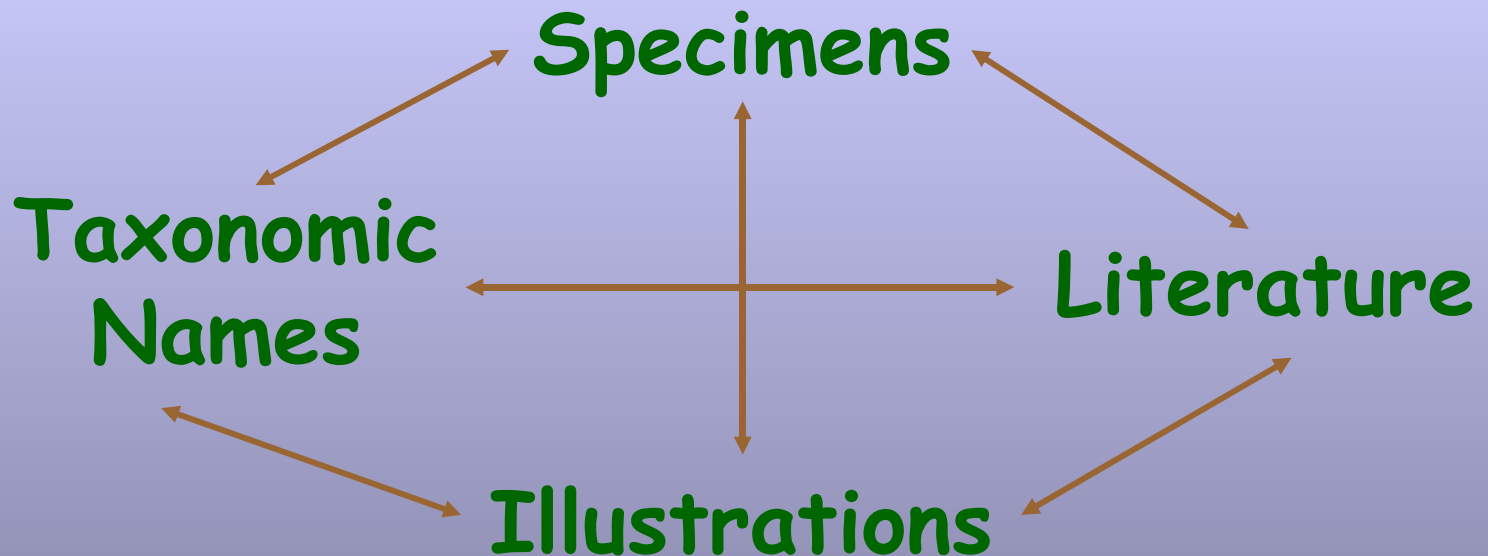
- Develop tools for dissemination of biodiversity information on flies
  - FLYTREE website ([www.inhs.uiuc.edu/cee/FLYTREE](http://www.inhs.uiuc.edu/cee/FLYTREE))
  - Biosystematic Database of World Diptera (BDWD)
  - MANDALA [Phylogenetic/Taxonomic data archive and delivery
  - Diptera Web ([www.diptera.org](http://www.diptera.org))
  - Morphological Glossary, Interactive keys, TOL.org, image databases, species pages

# FLYTREE -- builds on previous and current collaborative projects

- PEET - Therevidae - **DEB 95-21925 & 99-77958**  
collecting/specimen database/ monography/  
phylogenetics
- BSI projects -- Fiji, Thailand, Madagascar
- Phylogenomics/Biocomplexity - Drosophilidae  
(DeSalle and O'Grady) and Deep Arthropod  
(Cunningham and Regier)
- Lab cultures/evo-devo/med-vet/ipm

# What is Mandala?

- Cross-platform database system supporting data acquisition & management for systematics & biodiversity studies





# Brief History of Mandala

- Begun in 1995 for the revid NSF PEET\* project
- Currently uses FileMaker® Pro 5/6
  - Relational
  - Works on Macintosh & Windows OS
- Extensible, adaptable, & evolving
- Fully operational demo available by request

# Serve Species Webpages of Target Taxa from Mandala

## Thereva bakeri Cole 1923:15



### Taxonomy

[Type](#)

[Description](#)

[Phylogeny](#)

[More images](#)

### Biology

[Distribution](#)

[Phenology](#)

[Ecology](#)

[Immature](#)

[Bioassociation](#)

[More links](#)

Story here



### Biogeographic Regions

- Afrotropical
- Australasian
- Nearctic
- Neotropical
- Oceanian
- Oriental
- Palearctic

### Synonyms

hauseri Hauser 1980:12 (Ocoa)

[link to classification](#)

# Existing Mandala Features for FLYTREE

- Mandala links GenBank entries to Specimens & Taxa
  - Record the GenBank accession number
  - Choose the genetic marker from the editable popup list
  - URL links the database record to the Genbank website for your sequence when you click on the globe button.

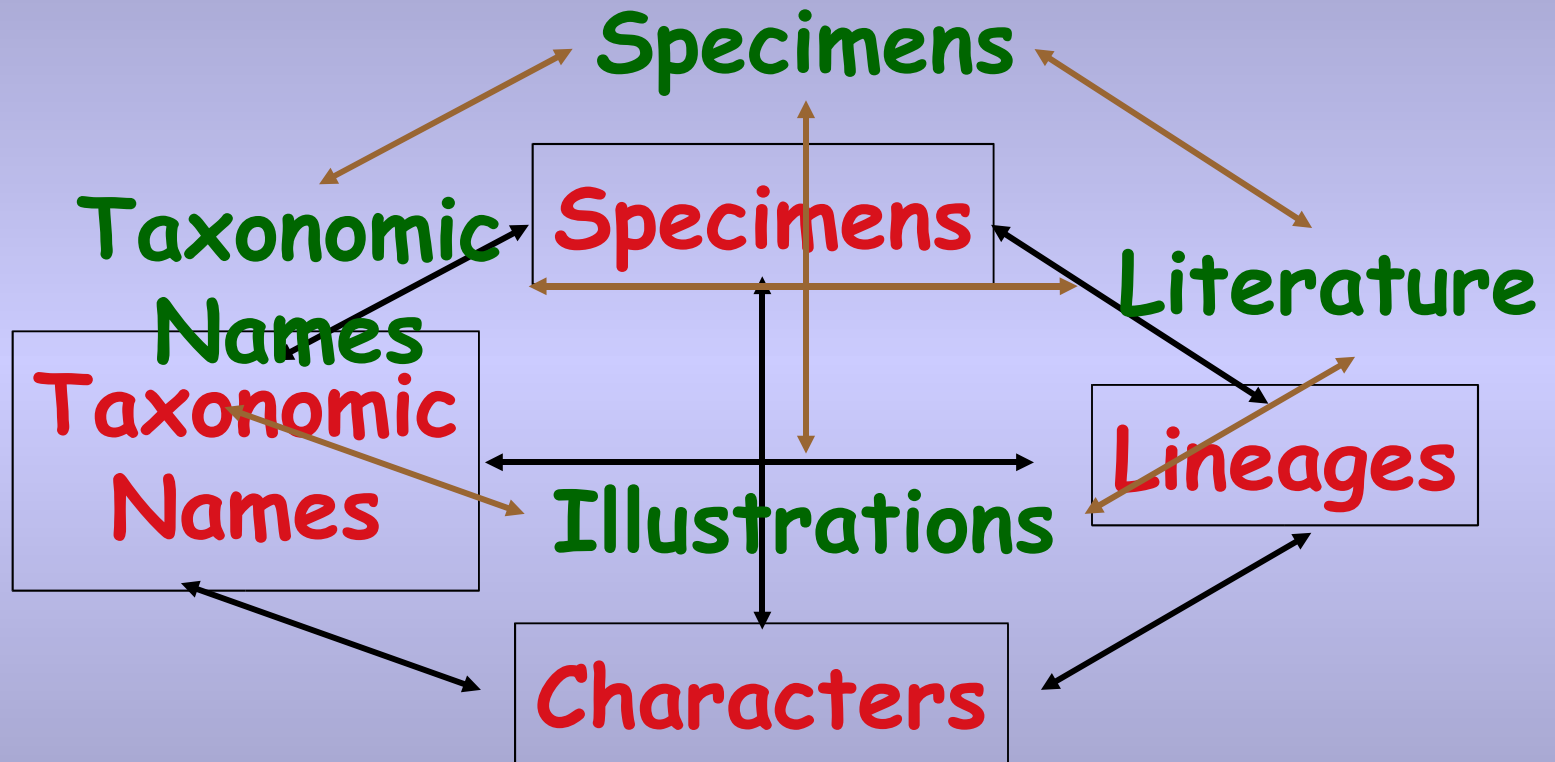
# Plans for Extending Mandala

- Registration system for FLYTREE workers around the world to document work on taxa and genetic markers
- Track specimens used in studies
- Document taxonomic names
- Organize & serve illustrations to web
- Upgrade to FileMaker 7 with increased security & web features

# Expansion of Phylogenetic Infrastructure in Classification- based Web Products

- Biosystematic Database of World Diptera
- Maddison's Tree of Life Website (Tol.org)
- Interactive Key to World Diptera
- FLYBASE
- FLYTREE Website

# MANDALA -- FLYTREE





# FLY-TREE Assembling the Tree of Life - Diptera

- FLYTREE**
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**With nearly 150,000 described species, flies (the insect order Diptera), are among the most diverse groups of living organisms on the planet... (more)**

