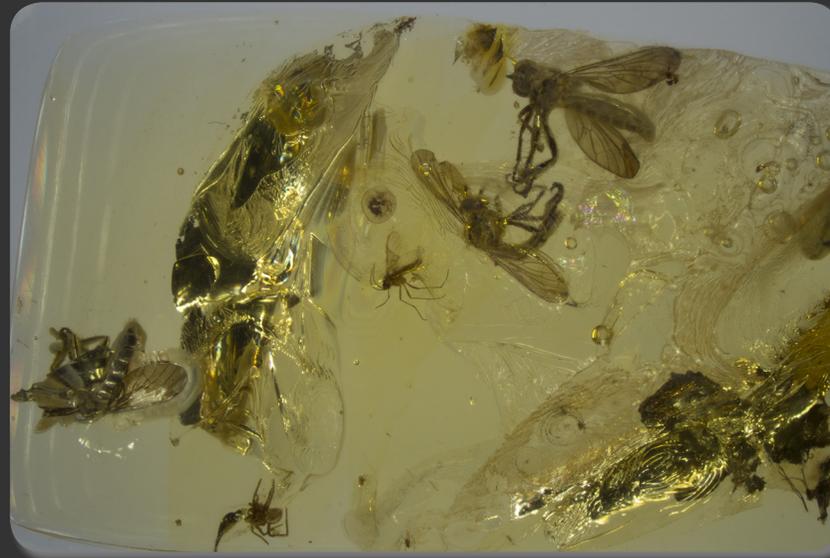


Review and phylogenetic placement of Assassin Flies (Asilidae) in Tertiary: Eocene ambers



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@TDikow #asiloidflies

PDF doi: [10.6084/m9.figshare.1466885](https://doi.org/10.6084/m9.figshare.1466885)

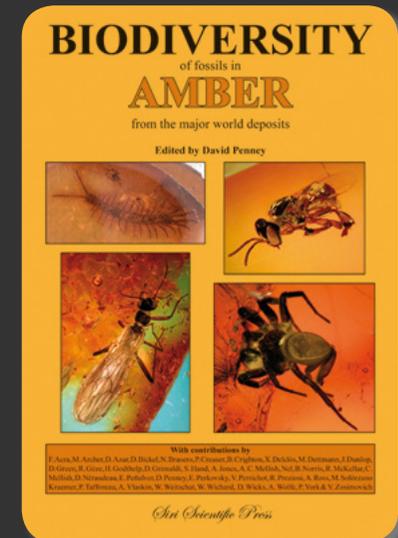


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- ◇ well-known amber from the Bay of Gdansk (Poland) in the south-eastern Baltic Sea
- ◇ 45 – 50 Million years old (myo)
- ◇ very rich in insect inclusions particularly Diptera (midges, flies and relatives)
 - › Hoffeins & Hoffeins 2003. *Studia dipterologica* 10(2): 381 – 392
- ◇ Bitterfeld and Rovno amber
 - › Penney 2010. *Biodiversity of fossils in Amber from the major world deposits*. Siri Scientific Press



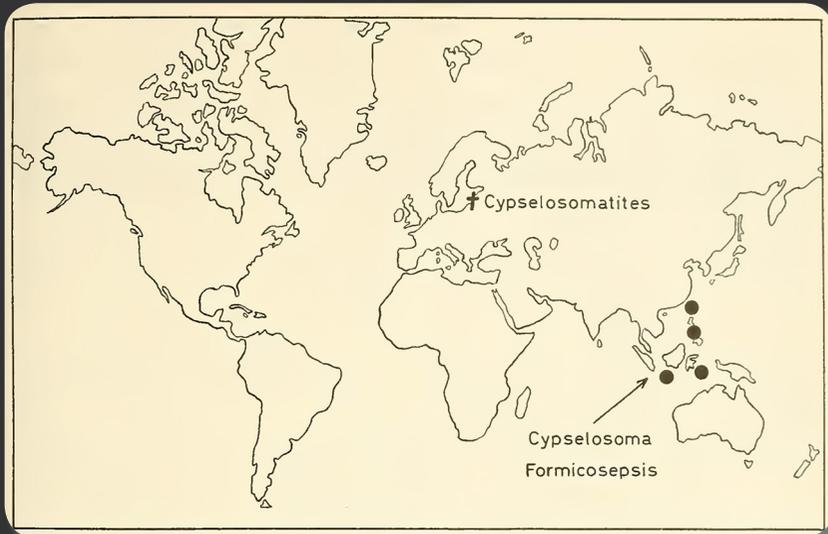
[SimpleMappr link](#)



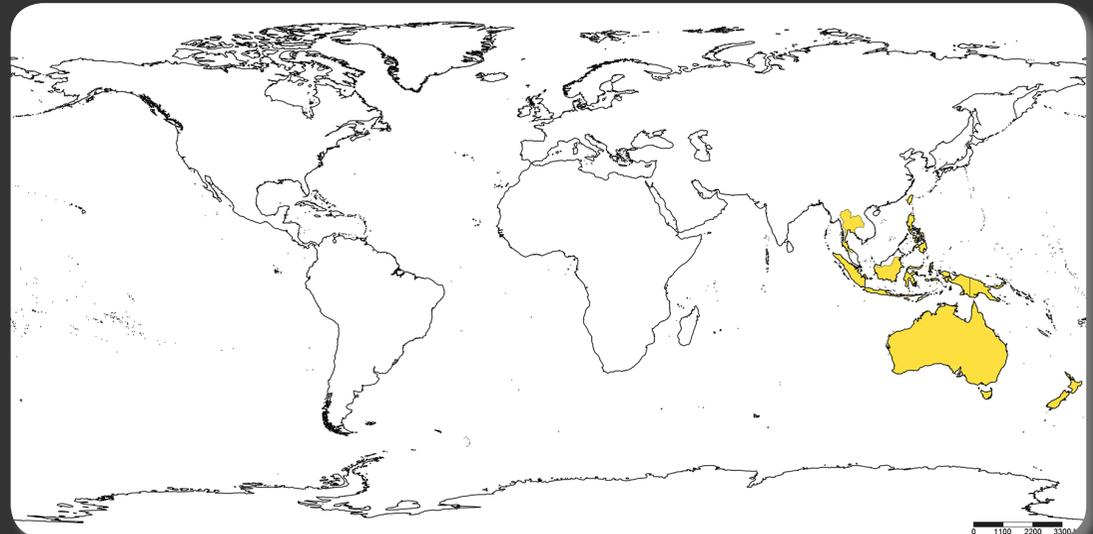
- ◇ Hennig studied Diptera inclusions extensively
 - › Acalypttratae, Acroceridae, Bombyliidae, Lower Brachycera, Therevidae
 - › recorded several acalypttrate families believed to be Southern Hemisphere endemics
- ◇ Cypselosomatidae (acalypttrate flies, Neriioidea)
 - › Hennig 1965 [BHL link](#)
 - › 1965 – 3 extant + 1 extinct species
 - › 2015 – 13 extant + 1 extinct species



Photo by Joanna Hamilton



distribution after Hennig 1965



current known distribution

- ◇ adult flies and larvae predatory
- ◇ size = 5 – 60 mm
- ◇ > 7,500 species in 541 genera
- ◇ speciose world-wide
 - › arid & semi-arid environments
 - › tropical environments
- ◇ perching sites to look for flying prey
 - › primarily on ground, rocks, leaves, small vegetation, or twig tips
 - › some species on living tree trunks
 - › Leptogastrinae capture resting prey
- ◇ morphological phylogeny
 - › Dikow 2009 [open-access link](#)



Scleropogon duncani



Ceraturgus fasciatus © M. Thomas

- ◇ 58 fossil species in 32 genera [catalog URL](#)
- ◇ oldest definitive assassin fly – †*Araripogon axelrodi*
 - › Cretaceous Crato Formation of Brazil, ≈ 112 myo
 - › Grimaldi 1990 [open-access link](#)
- ◇ rare in any amber due to life history
 - › strong flies that might pull their legs out of sticky tree resin

◇ known diversity in amber

| amber | age | # pieces | # sp. | # sp. nov. | |
|-----------|-----------|----------|-------|------------|---|
| Burmese | 100 myo | 2 | 1 | | Dikow & Grimaldi 2014 open-access link |
| Raritan | 92 myo | 1 | 1 | | Dikow & Grimaldi 2014 |
| Baltic | 45–50 myo | 28 | 4 | 6 | |
| Dominican | 20–25 myo | 18 | 2 | 4 | Dikow & Fisher in prep. |



†*Araripogon axelrodi* ♀



†*Burmapogon bruckschi* ♂ – Morphbank #832135

- ◇ Loew 1850 [BHL link](#)
 - › †*Asilus angustifrons* + †*Asilus trichurus* (species names *nomina nuda*)
 - › †*Holopogon pilipes*

- ◇ Meunier 1899 [BHL link](#), 1908 [BHL link](#)
 - › †*Asilus trichurus* Meunier, 1899
 - › †*Asilus (Lophonotus) klebsi* Meunier, 1908

- ◇ Hennig 1967 [BHL link](#)
 - › unable to locate any of the above type specimens

- ◇ Schumann 1984
 - › Bitterfeld amber
 - › †*Protolewinella keilbachi*

- ◇ Geller-Grimm 1998
 - › recorded †*Protolewinella keilbachi* from Baltic amber

- ◇ to date, 4 species from Baltic – includes 1 species also known from Bitterfeld amber

- ◇ 27 amber pieces with assassin-fly inclusions
 - › 25 Baltic + 2 Rovno amber
- ◇ primarily from Coll. Hoffeins (Hamburg, Germany) and AMNH
 - › amber beautifully enhanced through cutting and embedding in “modern” resin
- ◇ photography
 - › Zeiss SteREO Discovery.V12, PlanApo S 0.63x or 1x lens (5x to 10x magnification)
 - › mixed LED lighting: Bright Field, Dark Field, and Transillumination
 - › Olympus micro Four-Thirds mirrorless E-PL 5, RAW image
 - › manual “slicing” – rendered with HeliconFocus
- ◇ morphological matrix [TreeBase PURL](#) from Dikow 2009 [open-access link](#)
 - › TNT 1.1 (February 2014) Goloboff *et al.* 2008 [doi link](#)
 - › exhaustive search of tree space (MacPro 3.5 GHz 6-core Intel Xeon E5, 64 GB RAM)
 - › Bremer support Bremer 1988 [doi link](#)
 - › character analysis Mesquite (3.01) and WinClada/Asado (1.08)

- ◇ Laphriinae: Atomosiini
- ◇ previously known from Baltic and Bitterfeld ambers
 - › newly recorded from Rovno amber (K-4739, Schmalhausen Institute of Zoology, Kiev)
- ◇ most abundantly preserved assassin fly (10 pieces with 13 enclosed specimens)



†*Protolewinella keilbachi* ♀ coll. Hoffeins 938-3 left



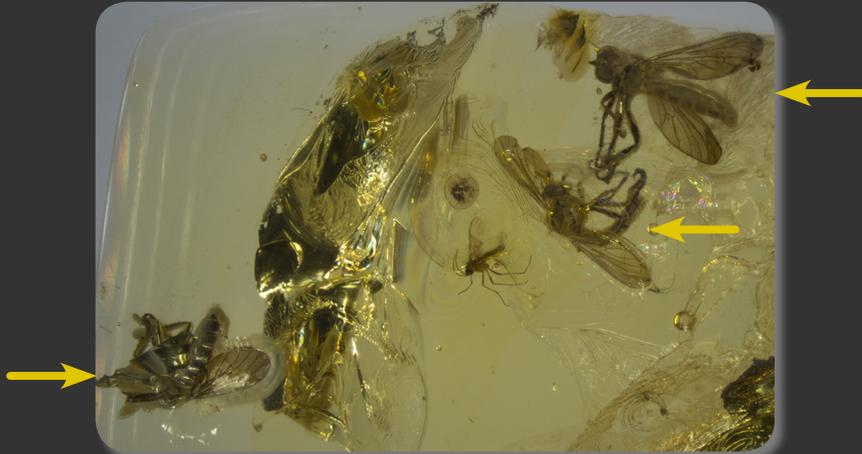
†*Protolewinella keilbachi* ♀ coll. Hoffeins 938-3 right

◇ Atomosiini

- › tree trunks or vegetation as perching sites
- › relatively small and “weak” assassin flies



Atomosia puella © M. Thomas



3x †*Protolewinella keilbachi* coll. Hoffeins 1038-2 dorsal

◇ another unique Atomosiini species?

- › 3 specimens morphologically similar to †*Protolewinella keilbachi*
- › antennal stylus longer, abdominal tergites less microrugose



†Atomosiini ? gen. nov. sp. nov. ♀ coll. Hoffeins 1392-1 dorsal



†Atomosiini ? gen. nov. sp. nov. ♀ coll. Hoffeins 1392-1 ventral



†Atomosiini ? gen. nov. sp. nov. ♀ coll. Hoffeins 1392-1 left



†Atomosiini ? gen. nov. sp. nov. ♀ coll. Hoffeins 1392-1 right

◇ †Asilinae gen. nov. A sp. nov.

- › 1 female specimen
- › similarities to *Astochia*, *Neoitamus*, some *Promachus*



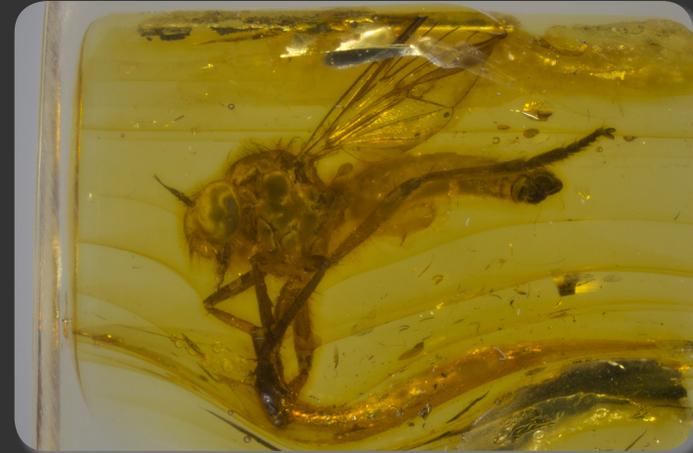
†Asilinae gen. nov. A sp. nov. ♀
coll. Hoffeins 1453-1 right



†Asilinae gen. nov. A sp. nov. ♀
coll. Hoffeins 1453-1 left

◇ †Asilinae gen. nov. B sp. nov.

- › 6 specimens (4 males, 2 females)
- › similarities to *Neomochtherus*



†Asilinae gen. nov. B sp. nov. ♂ coll. Hoffeins 938-1 left



†Asilinae gen. nov. B sp. nov. ♂ coll. Hoffeins 938-1 right

- ◇ †Leptogastrinae gen. nov. sp. nov.
 - › 1 male specimen
 - › similarities to *Leptogaster*

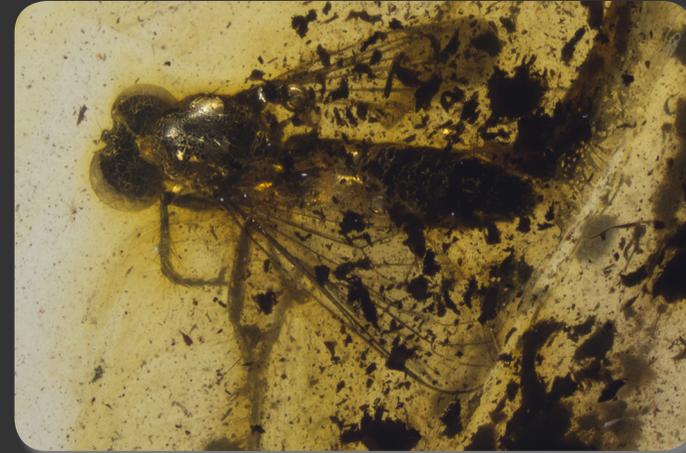


†Leptogastrinae gen. nov. sp. nov. ♂ coll. Hoffeins 1570 dorsal



†Leptogastrinae gen. nov. sp. nov. ♂ coll. Hoffeins 1570 ventral

- ◇ †"Stenopogoninae" gen. nov. sp. nov.
 - › 1 male and 1 female specimens



†"Stenopogoninae" gen. nov. sp. nov. ♀ coll. Hoffeins 632-2 dorsal



†"Stenopogoninae" gen. nov. sp. nov. ♀ coll. Hoffeins 632-2 ventral

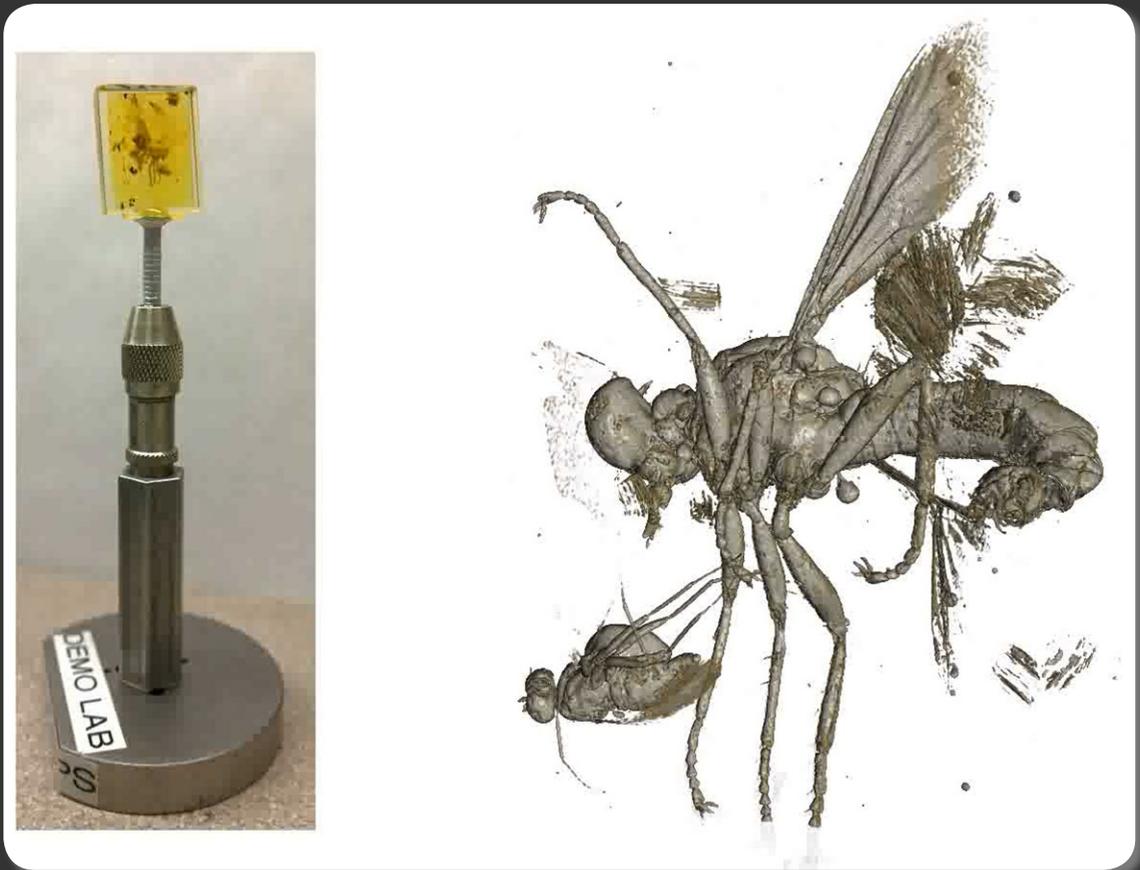
- ◇ †Laphriinae gen. nov. sp. nov.
 - › 1 male specimen
 - › specimen covered by milky “fog”



†Laphriinae gen. nov. sp. nov. ♂ coll. Hoffeins 1305-1 dorsal



†Laphriinae gen. nov. sp. nov. ♂ coll. Hoffeins 1305-1 ventral

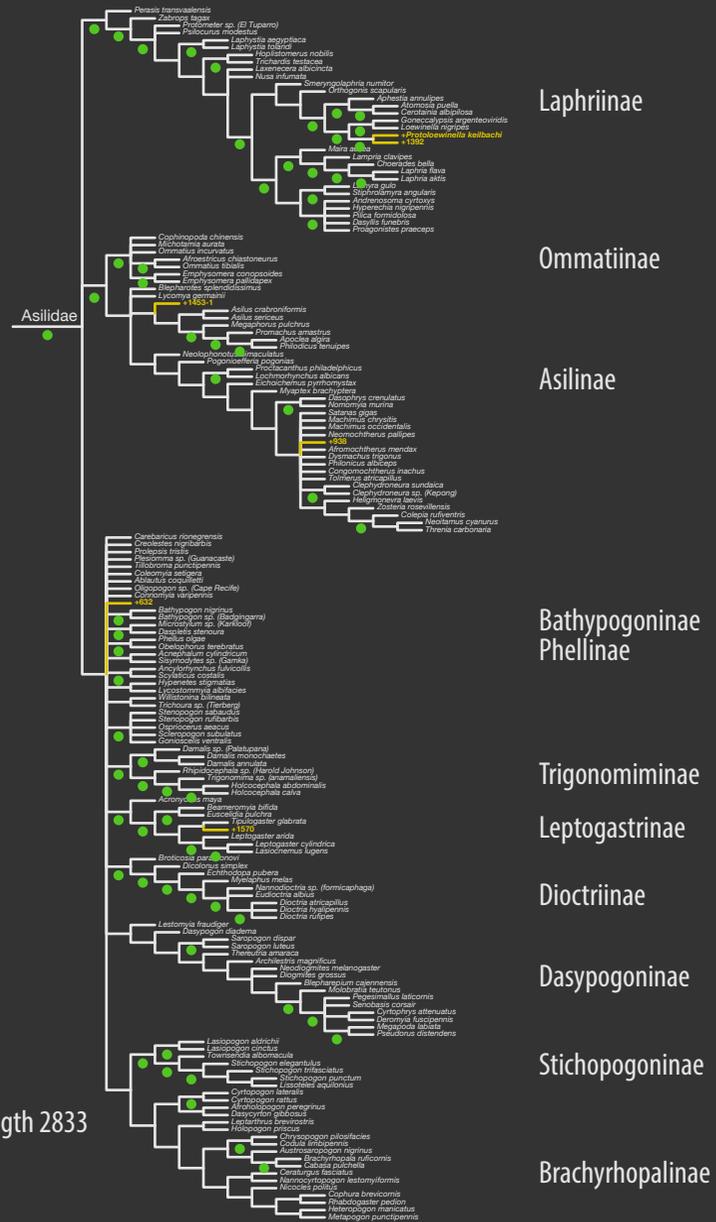


- ◇ †Laphriinae gen. nov. sp. nov.
 - › Zeiss Xradia micro-CT scan



15mm FOV

| included fossil taxa | % missing characters (of 220 characters) |
|-------------------------|---|
| †Asilinae A | 43 |
| †Asilinae B | 28 |
| † <i>Protolewinella</i> | 36 |
| †Atomosiini | 36 |
| †Leptogastrinae | 48 |
| †“Stenopogoninae” | 30 |



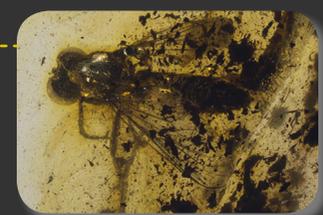
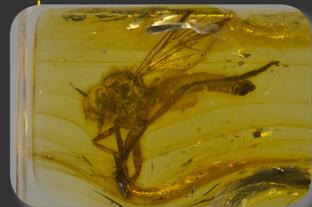
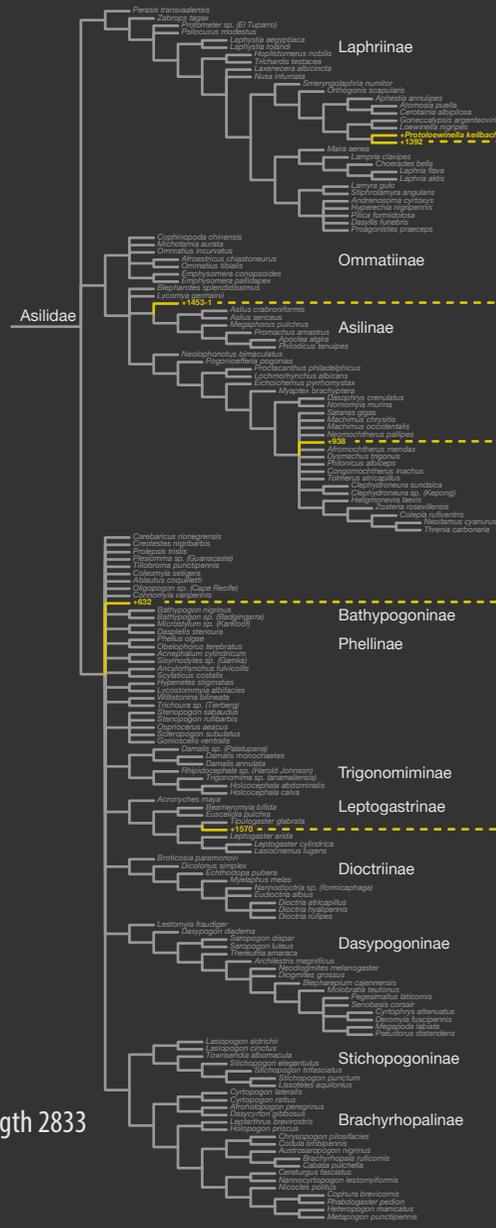
strict consensus topology of 348 most parsimonious trees of length 2833

● Bremer ≥ 5

> relationships among higher-level taxa less-resolved

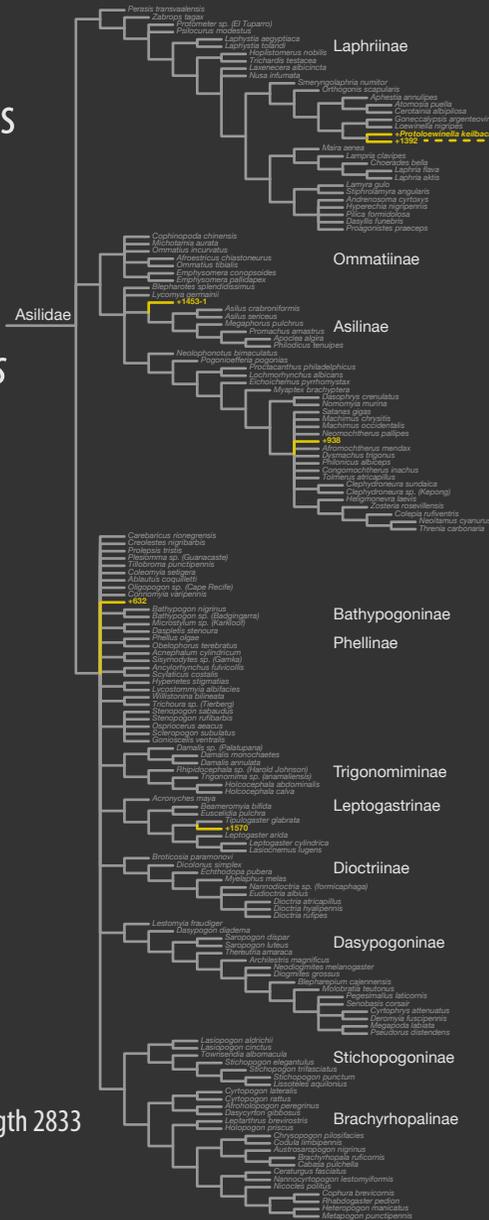
> 3 subfamily taxa non-monophyletic

- > Stenopogoninae
- > Tillobromatinae
- > Willistoninae



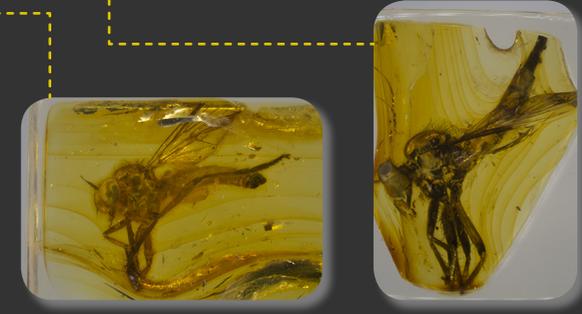
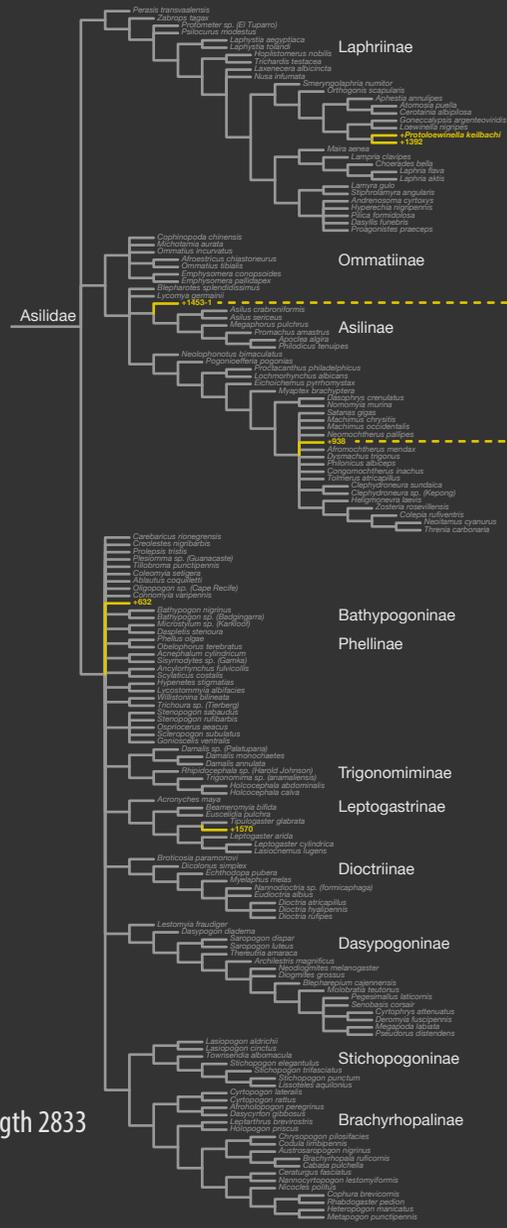
strict consensus topology of 348 most parsimonious trees of length 2833

- › all Atomosiini specimens represent single species
 - › †*Protolewinella keilbachi*
- › 13 amber pieces with 16 flies preserved
- › sister-group *Loewinella nigripes* + *Goneccalypsis argenteoviridis*



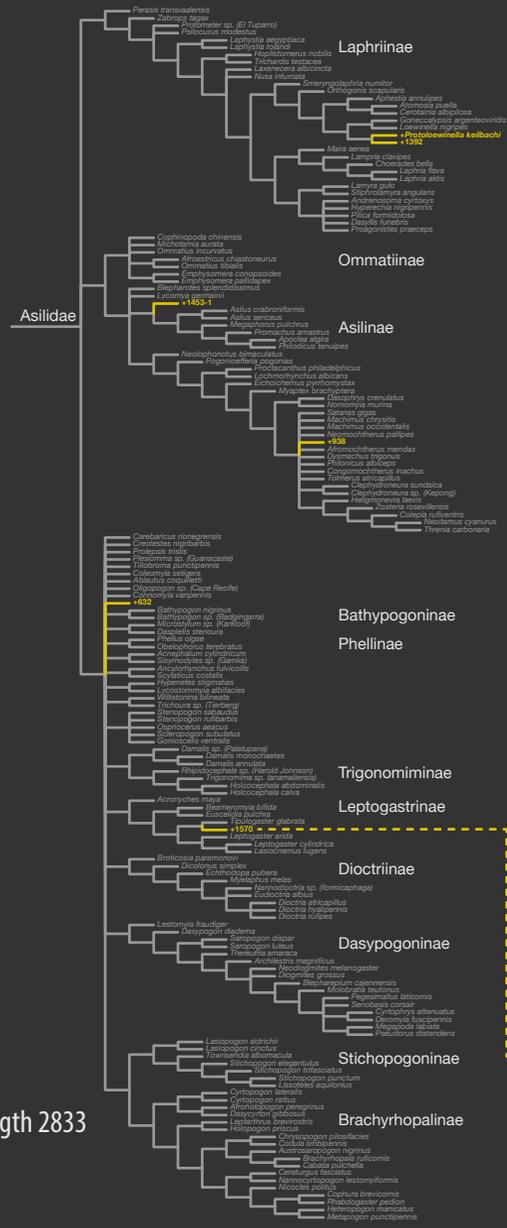
strict consensus topology of 348 most parsimonious trees of length 2833

- › Asilinae resolution improved
- › in 2009 hypothesis Asilinae is unresolved
- › †Asilinae A in clade with *Promachus*
 - › addition of extant *Astochia* needed
- › †Asilinae B in clade with *Neomochtherus*



strict consensus topology of 348 most parsimonious trees of length 2833

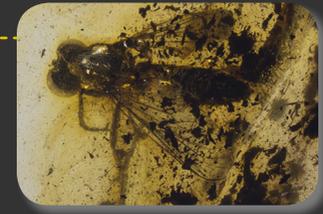
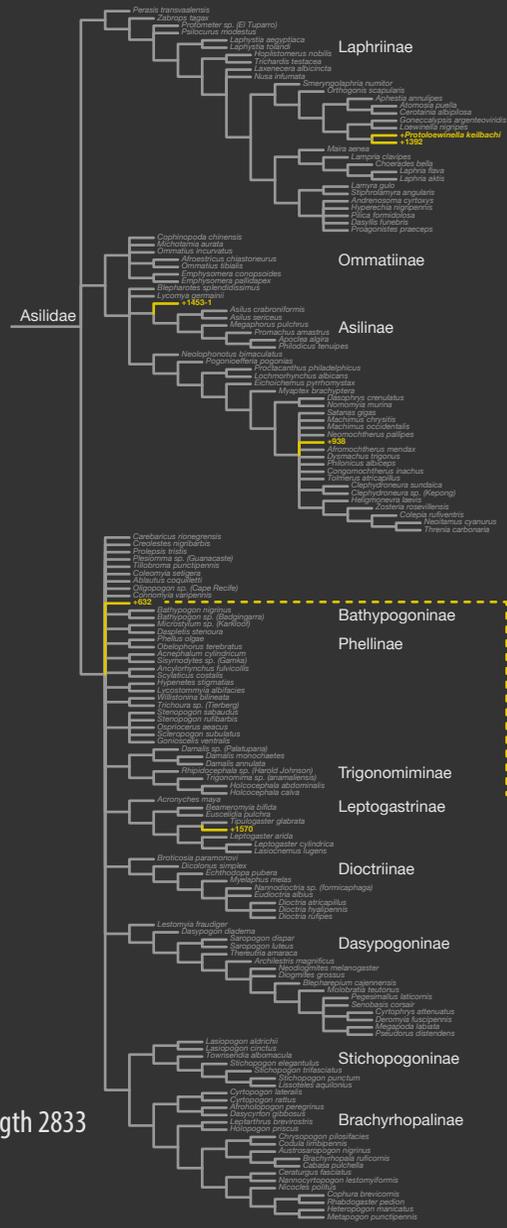
- > deeply placed within Leptogastrinae
- > sister-group to *Tipulogaster glabrata*



strict consensus topology of 348 most parsimonious trees of length 2833



- › not easily placed
- › Stenopogoninae non-monophyletic
- › female and male specimen available



strict consensus topology of 348 most parsimonious trees of length 2833

- ◇ 6 new species for a total of 10 assassin-fly species in Baltic amber
- ◇ 5 new genera
- ◇ 2 specimens await further micro-CT data analysis for placement
- ◇ Baltic, Bitterfeld, and Rovno amber preserved same fauna – †*Protolewinella keilbachi*
- ◇ phylogenetic study important to evaluate morphological variation
- ◇ phylogenetic placement successful except for 1 taxon

- ◇ Fritz Geller-Grimm
- ◇ Christel and Hans-Werner Hoffeins and David Grimaldi for specimens
- ◇ Masako Terada at Zeiss Xradia
- ◇ U.S. National Science Foundation REVSYS [DEB-0919333](#)



presentation PDF doi: [10.6084/m9.figshare.1466885](https://doi.org/10.6084/m9.figshare.1466885)



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