**Figure 1**. Field expedition by the Entomology Department of the University of California, Berkeley, to Fort Seward, CA, in 1936. (From the Archives of the Essig Museum.)

# One man's journey into the Tachinidae (Diptera)

by Paul A. Rude

*Essig Museum of Entomology, University of California (Berkeley), Berkeley, California 94720-4780, USA. E-mails: paul.rude@berkeley.edu, paulrudenia@gmail.com*

When I took on the task of sorting the tachinids in the Essig Museum, I knew it would be challenging. I didn't realize it would become a way of life.

The Essig Museum of Entomology on the campus of the University of California at Berkeley (UCB) has a research collection with over 5,000,000 pinned specimens. It is named in honor of Edward Oliver Essig 1884–1964, known largely for his work on aphids and other agricultural pests, but also author of general works including *Insects of Western North America* (Essig 1926). Essig was a UC professor from 1916 into the 1950s. Under his guidance, the California Insect Survey (CIS) was initiated in 1940 and became the basis for the current collection. The collection is strongest in holdings from western United States but also includes substantial material from Mexico, Central America, and the islands of the central Pacific. Field trips by staff and students to various locations, particularly within California, helped to build the collection (Fig. 1).

I had been associated with the museum off and on since the early1960s, when I processed specimens in a work/study position. My passion for insects started early. Growing up in what was then a relatively undeveloped area of San Diego County (California), I spent a lot of time outdoors and became fascinated by butterflies, which I caught by hand (today I cannot get near them with a net). Encouraged by my family, I learned how to spread the victims and keep them in a box. But since we did not travel much, I quickly ran out of butterfly species. I inherited an insect cabinet from a distant relative and started filling it with all manner of specimens from katydids to beetles to dragonflies. It had not escaped my attention that there was an endless panoply of wasps, bees, and flies visiting the flowers of California buckwheat (*Eriogonum fasciculatum*), one of the common chaparral plants of our hillside. As my drawers started getting crowded, these insects came to dominate my collecting activities.

As a teenager, I was introduced to Charles Harbison, curator of entomology at the San Diego Natural History Museum. With endless patience, "Harby" showed me how to use a microscope and introduced me to the concept of identifying specimens with a key. I was totally engrossed trying to take obscure acalypterates through Curran's (1934) key.

By the time I graduated high school, my cabinet contained equal portions of Diptera and Hymenoptera. I donated most of these to the San Diego museum and went off to UCB with the idea of becoming a professional entomologist. I had not thought about getting a job until a voice on the rooming-house phone asked if I was Paul Rude, did I know how to stick pins through bugs, and, if so, would I like to work in the museum? This was Jerry A. Powell, then Assistant Entomologist at the Essig Museum, now Professor Emeritus and a top specialist in Microlepidoptera. Like me, he had grown up in San Diego and had been a mentee of Charles Harbison. When I left for UCB, Harbison had called Jerry to tell him that a likely suspect was on the way.

**Figure 2**. Peter Oboyski (left) and Paul Rude (right) examine drawers of unidentified Tachinidae in the Essig Museum of Entomology, UCB.

It is a long story involving some of the notorious Berkeley hijinks of the 1960s, but I deviated from my original goal and ended up with an undergraduate degree in Communications. I spent a year in the Graduate School of Journalism and did a bit of work in radio. In 1971, I embarked on a year-long bus trip from Tijuana, Mexico, to Cochabamba, Bolivia, fulfilling an undeniable urge to see what lay beyond the Mexican hills that had been visible from my window as a child. Back in the United States, I worked a couple years in construction in Southern California and drove a taxi in San Francisco, among other jobs. But the lure of entomology drew me back to UCB, where I worked as a lab tech and field assistant for Jerry Powell and John T. Doyen, a professor and specialist in tenebrionid beetles. I was privileged to participate in many collecting trips in California and adjacent states, as well as in Baja California (Mexico).

In the mid-1970s, I filled some of the gaps in my scientific education at the local junior college, then re-applied to UCB's Department of Entomology. I took a Masters in 1980, then worked several years at UC Davis producing integrated pest management manuals for California crops including cotton, tomatoes, and potatoes. After leaving UCD, I ended up spending most of my career as a general contractor. But when I retired at the end of 2014, I was eager to return to my original avocation. I offered my services as a volunteer to Peter Oboyski, Collections Manager



**Figures 3–6.** Four drawers of Tachinidae in the Essig Museum of Entomology, UCB. **3–4.** I started with 17 drawers like these of unsorted Tachinidae. **5**. Sorted Dexiinae, showing some miscellaneous tribes and genera. **6**. Sorted Leskiini.

for the Essig Museum (Fig. 2). He asked which groups I was interested in, and the word "Diptera" barely escaped my lips when Pete said "follow me". There had been no dipterist in the museum since the retirement of Frank Cole, author of *Flies of Western North America* (Cole 1969), in the 1970s. Since then, about 95 drawers of unsorted flies had accumulated: I clearly had my work cut out for me. In early 2015, I started spending two or three days a week re-acquainting myself with postorbital setae, vibrissae, and incomplete subcostas.

It took about a year and a half – with time off for a Berkeley-to-Savannah (Georgia) road trip and a couple visits to Baja – to get the flies sorted to family. Then it was time to try sorting some families to genus. I started with a few acalypterates, more or less at random, including Drosophilidae, Lauxaniidae, Sciomyzidae and Milichiidae. Having gained a bit of confidence, I ventured to look into the 17 drawers containing something like 12,000 unsorted tachinids (Figs. 3, 4). A daunting prospect indeed.

The tachinids were organized according to the *Catalog of the Diptera of America north of Mexico* (Sabrosky & Arnaud 1965). No doubt there is a rule that curation, like ontology, must recapitulate phylogeny, but with the number of tachinid tribes, this makes it tough to find anything unless you are already an expert. In order to place new specimens in the collection, or to find existing ones, I had to look up the genus in the catalog index, browse through the pages to find which tribe it was assigned to, then page forward or backward to see where that tribe was placed, after which I would try to find the appropriate drawer in the collection. All of this could easily take 15 minutes. At four flies per hour and with my retirement schedule of 20 hours a week for 30 weeks per year, that is 2,400 flies per year. I should be finished in about five years …. not counting time spent actually looking at specimens.

After consulting Martin Hauser, a dipterist at the California Department of Food and Agriculture in

Sacramento, I simplified things a bit. The tachs are still organized by subfamily (Fig. 5), but only the larger tribes have separate headings. "Large" can mean that the tribe has numerous genera, or that it includes one or more genera with a large number of specimens from our area. Genera of smaller tribes are filed under Miscellaneous Genera for the subfamily. For example, the Winthemiini get a heading because we have a drawer full of *Winthemia*, and the Leskiini are separated within Tachininae because we have specimens in quite a few genera (Fig. 6). On the other hand, Eutheriini, Palpostomatini, and Uramyini, which contain only one or a few genera, are filed as Misc Dexiinae. An Excel index shows where each genus is kept; a printout lives on a clipboard in the tach row.

The first pass through the tachinids took over a year. It would have taken more than a lifetime, but I concentrated first on picking out relatively recognizable taxa such as *Peleteria* and *Cylindromyia*. The objective was to make the collection more accessible, not to identify every specimen. But I gradually developed search images for other genera such as *Winthemia*, *Thelaira*, and *Leschenaultia*. I now have a pretty fair *gestalt* for 50 or 60 genera. It did not help that there are relatively few large sets of specimens; in most cases, I would have just one specimen at a time. This makes it difficult to decide on a certain character, as there is no way to check another specimen.

At first I relied only on the tachinid key in the *Manual of Nearctic Diptera* (MND) (Wood 1987). As with all large keys, it has a considerable learning curve. You have to learn how to weigh such terms as "usually", how to extrapolate between conflicting figures, when to be suspicious of a result, and when to try both branches of a couplet. I took notes on quirks in the key, such as typos and conflicting couplets; these are summarized below in the Appendix. I would have given up soon after I began without the photos in the online *TachImage Gallery* (O'Hara & Henderson 2018). There were innumerable cases in which a quick check of the photos showed that an initial determination was far off the mark, and that I needed to start over. In other cases, it was warmly gratifying to find a portrait that looked just like my specimen! In those cases, I added a little + sign to the determination label.

I later ventured into MCAD, the *Manual of Central American Diptera* (Wood & Zumbado 2010). The MCAD key has its quirks too, but in some ways it is easier to follow. For one thing, it starts with readily visible supra-alar bristles, rather than prosternal setae that can be hard to see between the front coxae. I used it not only for Neotropical specimens, but also as a double-check for Nearctic specimens, often with good results. The big gap in coverage is Mexico, which apparently has quite a few genera or parts of genera that are not covered in either key. Let us hope that an enterprising systematist in Mexico City will one day work to fill this void.

At first, I passed over specimens from outside the United States. But as I became more confident, I started placing a few Mexican and Central American specimens too. To confirm determinations, I compared my results with identified specimens in the Essig collection, and also with specimens in the California Academy of Sciences in San Francisco and the California Department of Food and Agriculture in Sacramento.

Like all large keys, many of the couplets in both MND and MCAD refer to the same characters, so users answer the same redundant questions several times in taking a specimen through the keys. In an attempt to make the process more accessible, I have developed a searchable character matrix in Excel with the help of an online programmer (Fig. 7). The matrix is along the lines of the *MOSCHweb* key to Palaearctic Tachinidae (see Cerretti *et al*. 2012). Our much simpler system is limited for now to California genera, and is intended for less experienced users. Rather than trying to take users to a single genus, our objective is to narrow a search down to a handful of genera, each with a description and either a photo or a link to a photo source such as the *TachImage Gallery*. Users can then choose the best match. We are incorporating close-up photos of key characters. This is very much a work in progress. If you would like more information or would like to help, please contact me.

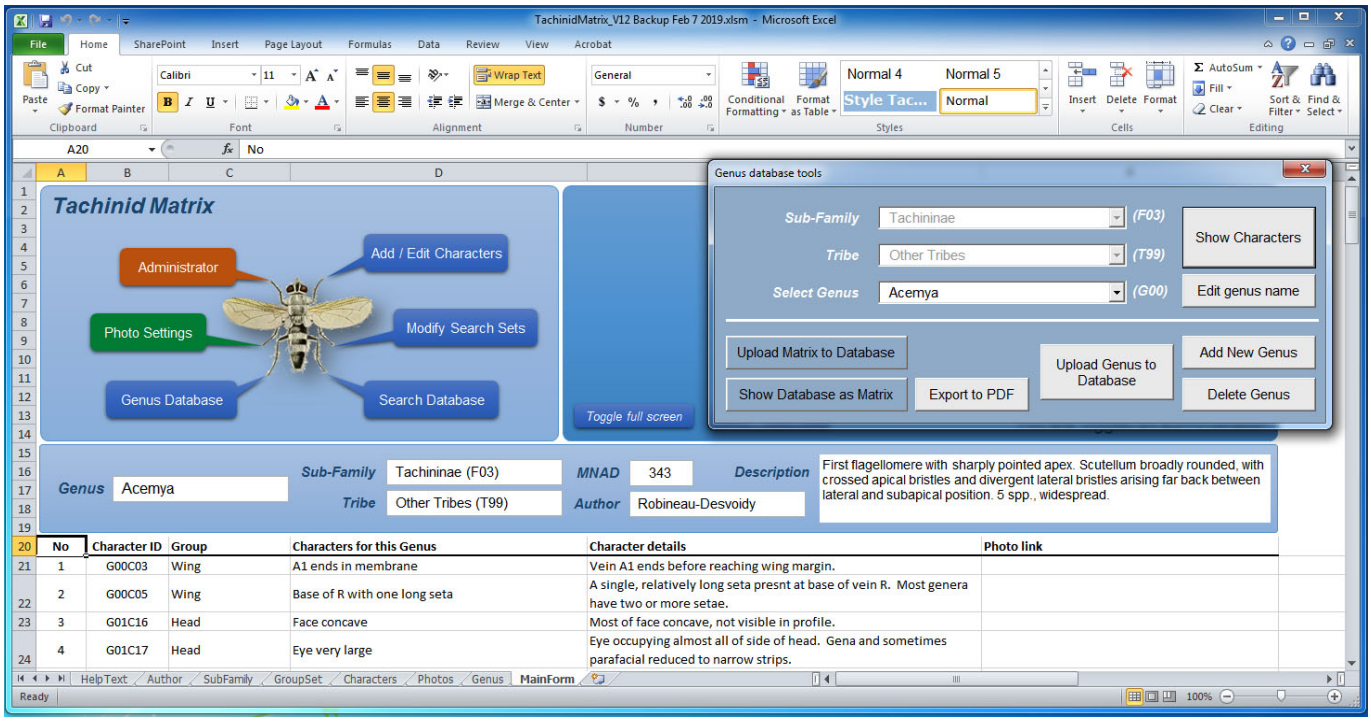



**Figure 7**. *Tachinid Matrix*, an Excel-based searchable character matrix developed by the author to assist with the identification of California tachinids.

By the most recent tally, the Essig collection includes 274 tachinid genera, 172 of them represented in California. There are a few genera noted in MND as not occurring in the West, including *Masiphya*, *Prooppia*, *Chaetoglossa*, and *Chaetonodexodes*. There are numerous species with reliable host records, especially from Jerry Powell's rearings of Microlepidoptera. We still have one or two drawers of undetermined specimens from California, one from other states, two from Mexico, and two or three from other areas, mostly Costa Rica. I'll be trying to whittle those down in coming months. In my spare time, I will also be reorganizing the collection according to the latest catalogue by O'Hara & Wood (2004).

Among the confounding features of the tachinid sort was the fleeting nature of the characters. Specimens that clearly had a bare prosternum when I first checked grew setae over the following few weeks, confounding my original determination. Others grew anipimeral bristles, lost scutellar bristles, or re-oriented their ocellar bristles. The most disturbing were those that evolved into sarcophagids while I wasn't looking. I have searched the web for a character-stabilizing product to prevent such alterations, thus far with no results.

Continued tach exposure can produce psychological effects. A few months into the effort, I dreamed that I was sorting a tray with 115 tachs, all dark grey, all about the same size. I started picking out flies that looked similar enough to be congeneric, starting with about a dozen. The vision quickly went south: all of these turned out to be different genera. Then it got worse. The next group, this time only five specimens, all looked identical in dorsal view – same wing pattern, same pattern of pruinescence, and the same snarky expression. But no two of these were congeneric either; in fact the five specimens represented five tribes in two suborders. Then I realized that I wasn't dreaming at all – I was wide awake at my scope in the middle of the day! With time, more pronounced symptoms developed: I woke at midnight with the feeling that my acrostical setae were shrinking and my postpronotum swelling. Fighting off the sweats, I re-read Franz Kafka's (1915) *Metamorphosis* and took heart that it is fiction, but if the visions continue I will either seek professional help or switch to a more manageable group, perhaps Lonchopteridae or Braulidae.

In spite of the many discouraging moments, the project has rewarded me with a renewed sense of wonder at the astounding diversity of the insect world. It did not take long to become compulsive in my need to see the next bizarre tachinid face. Late at night, after hours over the scope and clearly in need of rest, I could not resist looking at "just one more". Often, this turned out to be 20 or 30 more, but then I went to bed satisfied.

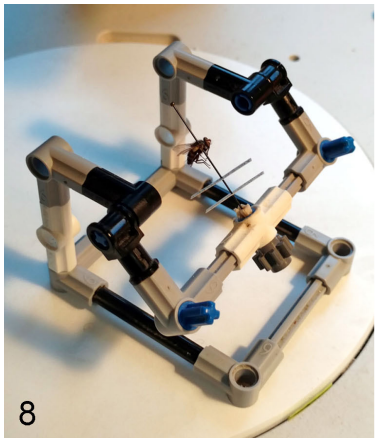
## Acknowledgements

I would not have survived this adventure without the generous support of Pete Oboyski and Martin Hauser here in California and, via the internet, Jim O'Hara of the Canadian National Collection of Insects in Ottawa, and John Stireman of Wright State University in Dayton, Ohio. Jim and John have been especially generous in identifying specimens from photos I sent them by email. Sincere thanks to all.

## Accessories

For others studying tachs or other insects, I can recommend these accessories:

1. A plastic stage, assembled from inexpensive LEGO® parts available on the Internet, enables the viewing of specimens from nearly any angle without excessive handling (Fig. 8). See article by Dupont *et al*. (2015).
2. A small LED flashlight such as Streamlight's Strion LED HL® can project an intense beam into obscure recesses where even the flexible arm of a microscope light source doesn't quite reach, revealing setae otherwise invisible. These are also great for collecting at light, snooping under logs, etc. See https://www.streamlight.com/en/products/detail/index/strion-led-hl.
3. Since I work largely at home, carrying specimens back and forth, I hit upon this system for packing specimens securely into Schmidt boxes (Figs. 9, 10). For specimens in unit trays, all it takes is a strip of foam or similar material to fill any extra space between the trays and the sides of the box. Several boxes fit snugly in the insulated shopping bags sold in many grocery stores.






**Figures 8–10**. **8**. LEGO® stage for viewing specimens at all angles. **9**. Schmidt box for carrying specimens between museum and home. **10**. Insulated shopping bag for carrying multiple Schmidt boxes snugly and safely.

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## Appendix

### Conflicts and typos in Wood's (1987) key to Tachinidae of America north of Mexico

**Couplet 37**, choice 2: "*Hind coxa bare on posteroapical margin*" → 38. This can lead to the opposite condition farther in key:

Couplet 38, choice 2: "*Apical scutellar bristles crossed …*" → 39

Couplet 39, choice 2: "*Facial ridge bare ...*" → 48

Couplet 48, choice 2: "*Katepisternum with 2 or 3 bristles ...*" → 50

Couplet 50, choice 2: "*Vibrissa arising at level of lower facial margin ...*" → 51

Couplet 51, choice 2: "*M ending in wing margin …*" → 52

Couplet 52, choice 2: "*Palpus pale brown or yellowish …*" → 54

Couplet 54, choice 2: "*Anterodorsal setae of hind tibia uneven in length …*" → 55

Couplet 55, choice 1: "*Hind with one or more setae on posteroapical margin …*" → *Hubneria* Robineau-Desvoidy
Hence, it is not possible to identify *Hubneria* using this key.

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**Couplet 48**, choice 1: "*... Katepisternum with four bristles arranged in a trapezoidal pattern (as in Fig. 177).*" I am not clear what "trapezoidal" has to do with it. The pattern I see in most specimens and in Fig. 177 is closer to a triangle. In any case, the choice is primarily between 4 bristles and either 2 or 3. The term is not needed for the rare exception noted in Choice 2.

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**Couplet 54**, choice 1: "*... Abdominal tergites 2 and 3 each lacking median discal bristles*"
Choice 2: "*... Abdominal tergites 2 and 3 each with scattered median discal bristles*"
I have to wonder if these are typos. Is it actually tergites 3 and 4?

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**Couplet 61**, choice 1: "*M ending in $R_{4+5}$ some distance from wing margin ...*" → leads to *Erynnia* in couplet 65. But *E. condecens* as shown in *TachImage* has M and R meeting right at the margin.
Choice 2: "*M ending in wing margin separately from $R_{4+5}$ ...*" → 67, but this leads to the opposite condition:
Couplet 67, choice 2: "*Anterodorsal bristles on hind tibia irregular ...*" → 70
Couplet 70, choice 1: "*Parafacial with setae ...*" → 71
Couplet 71, choice 1: "*Facial ridge with row of stout erect bristles ...*" → 72
Couplet 72, Choice 1: "*M ending in $R_{4+5}$ before reaching wing margin ...*" → *Cloacina* Reinhard

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**Couplet 84**, choice 1: "*Postpronotum with middle basal bristle displaced anteriorly, forming a triangle with outer and inner basal bristle ...*" → 85
Choice 2: "*Postpronotum with middle basal bristle more or less in line...*" → 86
Couplet 85, choice 2 leads to *Allophorocera* Hendel but specimens in the Essig collection determined by Monty Wood as *Allophorocera arator* (Aldrich) have the postpronotal bristles in a nearly straight line, not in a triangle.

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**Couplet 96**, choice 2: "*...if three pairs [of scutellar bristles] present, then the lateral bristles are shorter than the apical bristles ...*" → 100, 101, 102, 105, 106, 116, 118, 119, 123, 132, 135, 136, 138 → 147
Couplet 147, choice 2: "*Lateral scutellar bristle absent.*" I find this misleading. If "*lateral bristles absent*" is a possibility, then it should be mentioned in couplet 96. The reference to Fig. 184 is also misleading, as the figure shows *Eucelatoria* with laterals present but apicals absent; i.e., the laterals are infinitely longer than the apicals.
I find couplet 147 especially confusing. There are species with three sets of scutellar bristles in which the apicals are apparently absent. Another interpretation might be that the apicals are strong but the subapicals are absent, but certainly the apicals are not crossed. At least some *Cryptomeigenia* follow this pattern.

**Couplet 109**, choice 2 → *Chetogena*. This does not work for *C. parvipalpus*, which lacks eye hair. The species then ends up in couplet 113, *Gueriniopsis*. Apparently *C. parvipalpus* is the only species with this feature. I checked the dozen or so species in the Essig Museum and the Cal. Academy; all except *C. parvipalpus* have the eye haired. Judging by what I see in collections, *C. parvipalpus* is by far the most common *Chetogena* in the western U.S. I suggest a revision along these lines:

Couplet 109, choice 2: should be "*Chetogena*, in part."

Insert new couplet 112A after 112:

Couplet 112A, choice 1: Lower facial margin protruding; wing creased after bend of M, appearing as a stub or continuation of M → *Chetogena* in part.

Couplet 112A, choice 2: Facial margin not protruding (? not sure if this is accurate for *Gueriniopsis*); wing not creased → 113.

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**Couplet 114**, choice 1: "*Frontal bristles descending to level of middle of facial ridge*" → *Exorista*.

To my eye, both Fig. 36 and the photo of *E. mella* in *TachImage* show the frontals extending only to the upper third of the ridge. It would be more accurate to say the frontals extend to the halfway point of the third flagellomere.

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**Couplet 116**, choice 2: "*Apical scutellar bristles much shorter than sublateral or lateral scutellar bristles.*" The "sublateral" must be a typo for "subapical."

Also, as in Couplet 96, the choice should probably be "Lateral scutellar bristles **either absent** or much shorter than the apical bristles."

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**Couplet 118**, choice 1: "*Subapical scutellar bristles divergent.*"

Choice 2: "*Subapical scutellar bristles convergent.*"

I have seen quite a few that are parallel.

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**Couplet 120**, choice 2: "*Eye apparently bare, with hairs sparse and inconspicuous, if present ...*"

Wording is confusing. I would say "Eye bare or nearly bare. If hairs are present, they are sparse and inconspicuous."

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**Couplet 126**, choice 2 → *Eulasiona*

To get here you need to choose "*Eye covered with conspicuous dense hairs*" at couplet 123, choice 1, but *E. genalis* in *TachImage* has the eye bare. Same for a specimen in front of me.

**Couplet 132**, choice 1: "*Subvibrissal ridge with a row of four or more well-developed bristles; this ridge longer than row of supravibrissal setae on facial ridge.*"

Choice 2: "*Subvibrissal ridge with at most three large bristles arranged in a row shorter than the row of setae above vibrissa.*"

But a row with only 3 bristles can be longer than the row above the vibrissa. A row with four strong setae can be shorter.

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**Couplet 156**, choice 2: "*Postpronotum with at least three bristles, arranged in a triangle ...*" → 159, 160, 162 → 163, but this leads to the opposite condition:

Couplet 163, Choice 2: "*Postpronotum usually with three bristles, but if with four, then the three basal bristles arranged in a straight line ...*"

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**Couplet 166**, choice 1: "*Scutum with three pairs of presutural acrostichal bristles ...*"

Choice 2: "*Scutum with only two pairs of presutural acrostichal bristles ...*"

Any chance this is a typo? Should presutural be postsutural? Cf. couplet 336.

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**Couplet 218**, choice 2: "*... Last section of* $CuA_1$ *.... between half as long .... and twice as long ... as preceding section*" → 119, 222, 223, 224 → *Kirbya* Robineau-Desvoidy

But *Kirbya aldrichi*, as shown in *TachImage*, is not even close.

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**Couplet 262**, choice 1: "*Bristles on lower part of parafacial reclinate ... extending ventrally nearly to lower margin of parafacial (Fig. 104) ...*" → *Dichocera* Williston

But Fig. 204 seems to show them extending only about 2/3 of the way down. *Dichocera dichoceroides* in *TachImage* looks similar.

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**Couplet 279**, choice 1: "*M ending in* $R_{4+5}$ *well before wing margin ...*" → 280, 281, 282, 283 → 284.

Couplet 279, choice 2: "*... (Fig. 214)*" → *Oestrophasia* Brauer & Bergenstamm

But in Fig. 214 and the *TachImage* photo for *O. clausa* the veins meet at the wing margin.

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**Couplet 288**, choice 1 → *Vanderwulpia* Townsend

This works only for *V. sequens* Townsend, in which the prosternum is bare. The other species, *V. atrophopodoides* Townsend, has two pairs of strong setae on the prosternum.

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**Couplet 291**, choice 2: "*Ocellar bristles procinate or absent ...*" → 292, 293, 294, 299, 303, 304 → 305, but this has a conflicting description:

Couplet 305, choice 1: "*Ocellar setae of female, and of both sexes of* arctica *(Sack), lateroclinate*" → *Trafoia* Brauer & Bergenstamm

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**Couplet 301**, choice 1: "*Frontal bristles extending ventrally, nearly to lower margin of parafacial (Fig. 104) ...*" → *Dichocera* Williston

But Fig. 104 shows frontals reaching only the lower margin of the eye.

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**Couplet 314**, choice 2: "*M with a distinct angular bend ...*" → 315, 316, → 317, but with no angular bend in M:

Couplet 317, choice 1: "*M not reaching wing margin, ending about where bend should be.*"

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**Couplet 317**, choice 1: "*M not reaching wing margin, ending about where bend should be ...*" → 318

Couplet 318, choices 1 and 2 → *Bezzimyia* Townsend and *Besseria* Robineau-Desvoidy.

But the photo for *Besseria brevipennis* in *TachImage* clearly shows a normal bend in M.

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**Couplet 336**, choice 1: "*Scutum with only one pair of presutural acrostical bristles, the posteriormost, which is situated anterior to scutellum.*"

Must be a typo, since setae next to scutellum would be postsutural. Cf. couplet 166.