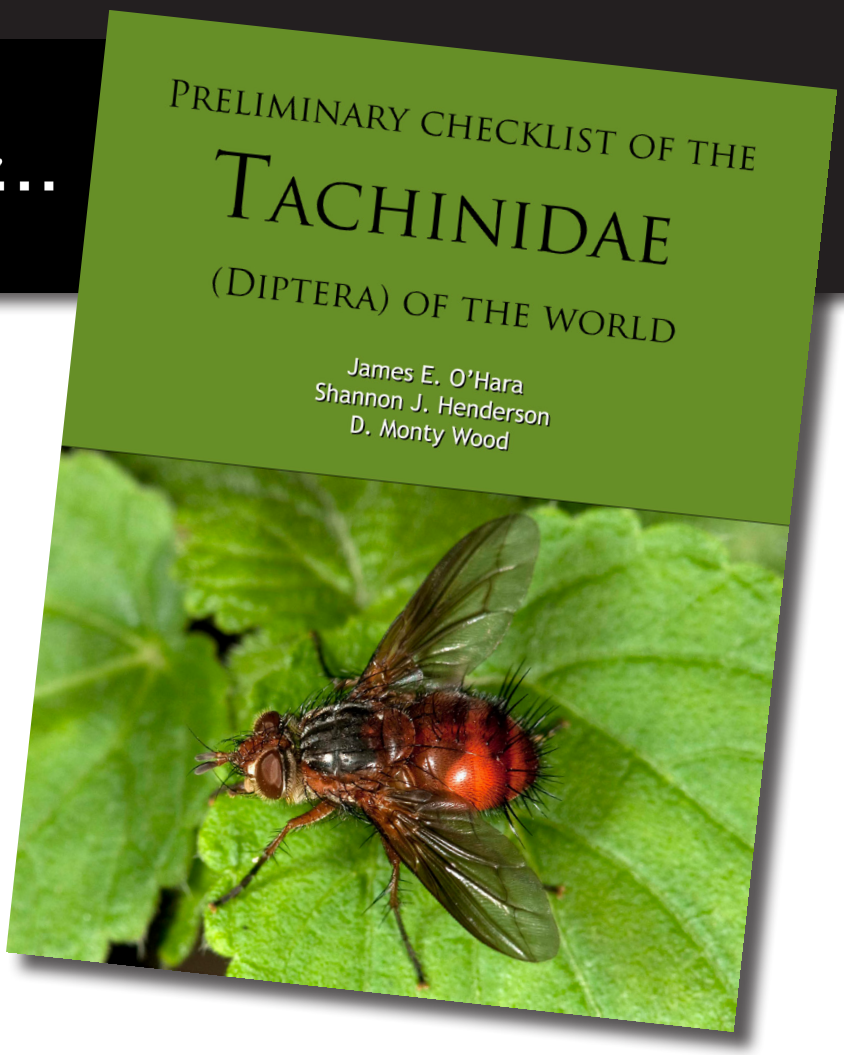
Introducing the...



by
James E. O'Hara
Shannon J. Henderson
D. Monty Wood

Canadian National Collection of Insects
Agriculture and Agri-Food Canada
960 Carling Avenue, Ottawa
Ontario, K1A 0C6, Canada
E-mails: james.ohara@canada.ca
shannon.henderson@canada.ca

Cover photo by S.A. Marshall

[As narrated by senior author]

Link to the homepage of the *Preliminary Checklist of the Tachinidae of the World*:
http://www.nadsdiptera.org/Tach/WorldTachs/Checklist/Worldchecklist.html

Historical background

A long time ago before entomology became my passion and profession, I was an undergraduate student at Carleton University in Ottawa looking for a summer job to pay my tuition in September. I was a biology student with an interest in insects and was taking what courses I could on them but had no clear idea where this might lead. Then one fateful day in the spring of 1977 I was told by a lab instructor that the Canadian National Collection of Insects (CNC) was looking for a summer student to assist with the preparation of a manual on flies. I was interviewed (the sole candidate), hired on the spot, and started work in the Diptera Unit the first week of May. My job was to attach name labels to mylar plates of flies drawn by Ralph Idema for volumes 1 and 2 of the upcoming *Manual of Nearctic Diptera* (McAlpine *et al*. 1981, 1987). This brought me into close proximity with all the coordinators of the *Manual* (see Cumming *et al*. 2011 for more on them) and my thoughts of becoming an insect systematist began to take shape. Before my first summer was over (I returned for a second), Monty Wood had offered me a part-time job throughout the school year to assist him with his research on Tachinidae.

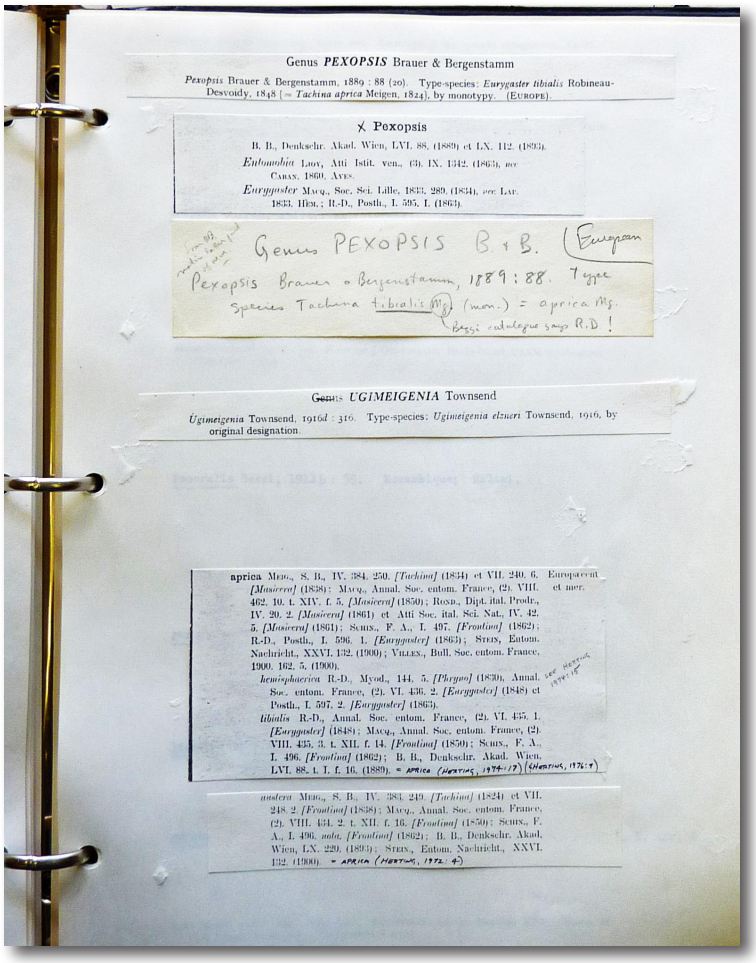


Figure 1. Monty's early cataloguing efforts consisted of binders with information about names photocopied from various catalogues and glued on pages. This binder dates from 1978.

I was soon smitten by Tachinidae but was also too naive to be afraid of them – Monty, after all, seemed to know most of them by heart and had a visual memory of where they were in the massive collection. Monty had a plan to reclassify the world Tachinidae and with that in mind he had me photocopy pages from the various regional catalogues and glue names together on pages as the first step towards reordering the family (Fig. 1). His own thoughts on classification were in close agreement with the work of the Europeans (principally Louis Mesnil and Benno Herting) but the earlier rearrangement of Nearctic tachinids by Sabrosky & Arnaud (1965) had only moved slightly in that direction and the Neotropical tachinids, as catalogued by Guimarães (1971), were still mired in the legacy of the notorious "splitter", C.H.T. Townsend. I did not understand much of this at the time but the allure of systematics was definitely taking a hold on me and I could see how solving taxonomic puzzles was more than just working on bugs. Besides, travelling to remote places in search of exotic treasures (new species) held a certain appeal to me.

So that was the start of the world Tachinidae project. Strips of paper with names arranged on sheets of paper in binders. Art Borkent continued with this task after I left but the time was not right for this plan to progress at a steady pace. Computers and databases were in the future and the demands of the *Manual of Nearctic Diptera* (MND), a huge revision of the Blondeliini (Wood 1985), and a phylogenetic study of the Nematocera (Wood & Borkent 1989) intervened for the next decade or so. Progress was made mostly in the form of notes in existing catalogues and in the memory banks of Monty's mind, constantly moving forward as types were examined in the world's collections, as specimens were acquired from hither and yon, and as character systems were deciphered to yield their secrets.

I had just one school year left after my first stint as a summer student in the Diptera Unit in 1977. By early 1978 I had to make a decision about what to do after graduation in the spring (with a B.Sc.), and after (hopefully) a second summer in the Diptera Unit. My interest in insect systematics had continued to grow but the influence of Dr. Henry Howden at Carleton University had me thinking about beetles and not flies as a career choice. Everyone recommended the esteemed Dr. George Ball at the University of Alberta in frigid Edmonton as the supervisor to strive for. I wrote him in January 1978 enquiring about the possibility of becoming a Master's student under his direction and suggested working on carabid beetles, his specialty. He promptly wrote back with an encouraging letter and asked me to submit a formal proposal to the Department of Entomology. By the time that proposal was submitted in late March my allegiance to beetles had waned and I outlined instead a taxonomic revision of *Siphona*

Meigen, the Tachinidae having won out as a result of Monty's enthusiasm for the family. I was accepted and off I went to Edmonton in late August 1978. While there I completed a Master's (1981) on *Siphona* and a Ph.D. (1987) on the Siphonini.

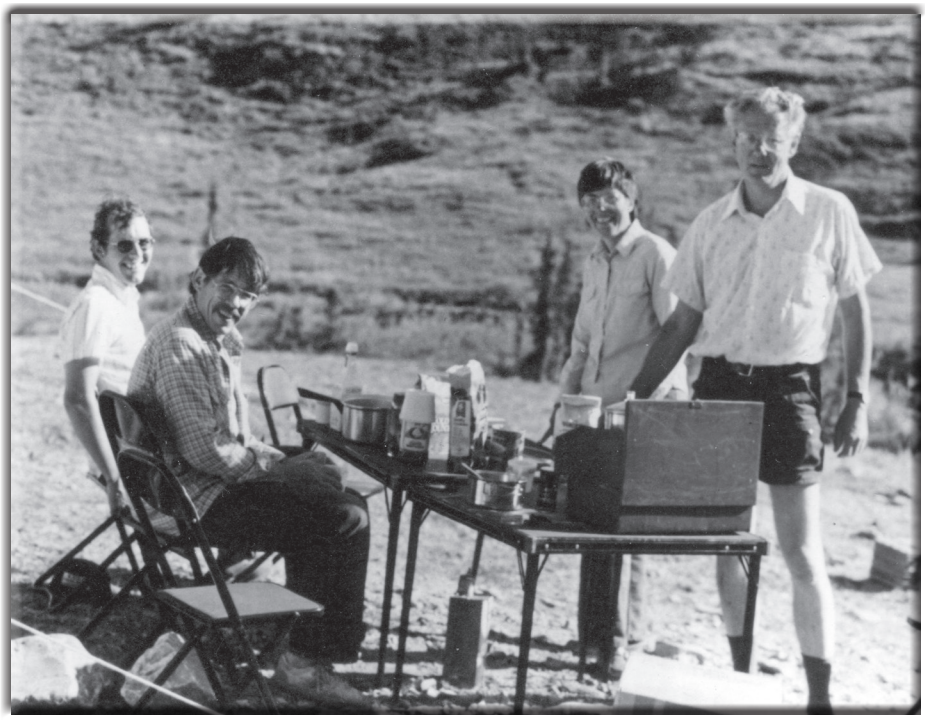


Figure 2. Expedition to the Firth River, Yukon Territory (Canada), 1984. Left to right: Don Lafontaine, Milt Campbell, and Grace and Monty Wood.

Things were happening back in Ottawa while I was pursing my graduate studies out west. Monty was busy with research and publications but was also itching to spend a greater amount of time in the field. As the 1980s were coming to a close he had been to the North five or six times (Fig. 2) and had been excited to discover tachinid faunal connections between the northeastern part of the Palaearctic Region and northwestern North America (see Lafontaine & Wood 1988). Monty had had an interest in Neotropical tachinids since his university days and was beginning to get more involved with this fauna. This region not only has the largest tachinid fauna in terms of described species (3032 according to O'Hara, Henderson & Wood 2019) but a staggering number of undescribed species also exist in collections and presumably many more species await discovery in nature. Monty had plans to extensively collect in the most diverse areas he could reach in order to broaden his knowledge of the fauna. He also wanted more visits to the world's collections to match up the types and names of Macquart, Wiedemann, van der Wulp and others who had described Neotropical species, and more frequent trips to the USNM [National Museum of Natural History] in Washington to study their 900 or so Townsend types. However, this master plan did not sit well with Monty's management. He was expected to concentrate on taxonomic problems of more direct relevance to Canada instead of reordering the whole family. For a time Monty took trips to the Neotropics at his own expense but in 1986, after 22 years with Agriculture & Agri-Food Canada and the CNC, he chose early retirement in order to pursue his own research path. He has continued his association with the CNC as an Honorary Research Associate from that day forth. It did not take long for Monty to adapt to his new-found freedom. He renewed his efforts to better understand Neotropical tachinids and began wintering in Costa Rica as a way to better learn its little-known fauna while also escaping Ottawa winters.

I completed my Ph.D. studies in 1987 and in 1989 moved back to Ottawa to accept a research position in the same Diptera Unit where I had worked as a summer student in 1977 and 1978. One of my first tasks was to reorganize the Tachinidae collection, then comprising perhaps 20 cabinets (now about 50). The collection was essentially arranged according to the classification of Sabrosky & Arnaud (1965) and this was hindering my ability to become familiar with it. Monty had made extensive changes to North American genera in his Blondeliini conspectus and MND Tachinidae chapter (Wood 1985, 1987). This was not a problem for Monty because he had memorized where the

genera were physically located and could think of a genus in one classification and find it in the collection under another. Monty consented to a rearrangement of the collection with some trepidation and afterwards was initially lost when using it even though it and his classification now matched.

As time went on I realized that a new catalogue to the Tachinidae of America north of Mexico was needed. Our collection was organized to match the generic changes published since Sabrosky & Arnaud (1965) but I wanted to look up information about names without a lot of searching, bearing in mind that the Internet was still in its infancy. I proposed to Monty a joint project that eventually resulted in the publication of our *Catalogue of the Tachinidae (Diptera) of America North of Mexico* (O'Hara & Wood 2004).

Our early catalogues

Our North American catalogue was my first exposure to a relational taxonomic database. As we explained in our introduction (O'Hara & Wood 2004: 2):

> "We used the software program *Platypus*® Version 1.1 (CSIRO, Australia) to input catalogue data and programmed a custom output from the underlying Microsoft Access® 97 database to obtain the desired format. Final changes and the index were made in Corel WordPerfect® 8."

Platypus was a nice, intuitive program with easy navigation and pop-up screens for information entry (Fig. 3). It unfortunately died an early death before it could be refined and broadly marketed. In fact, we were using it before the planned output options were developed and when it was abruptly discontinued (for budgetary reasons, if I remember correctly) we had to find a clever co-worker (Jennifer Read) who could program an output for us.

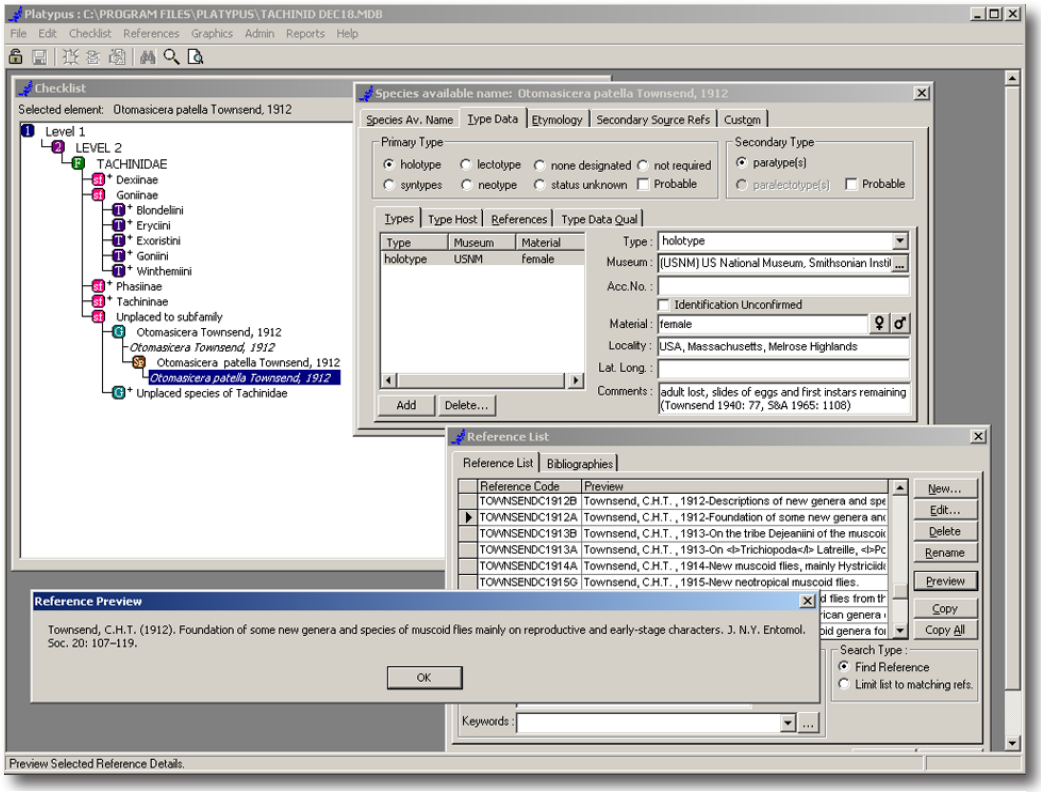


Figure 3. Screenshot of *Platypus*® (CSIRO, Australia), a relational database for managing taxonomic, geographic, and bibliographic information.

It was Monty, not me, who was planning to continue down the cataloguing path towards a world catalogue after our North American one was finished. He was still examining little-known tachinid taxa and accumulating notes about them. Technology had progressed significantly since his early efforts at cataloguing in the 1970s. He asked his friend and colleague, Manuel Zumbado (then with Instituto Nacional de Biodiversidad, Costa Rica), to build him a simple FileMaker® Pro database in which he could record names, type information, notes, and their original and present (or planned) placements. Monty, with the help of his wife Grace, went through most of the existing catalogues to enter information from them along with notes he had written about the types he had examined.

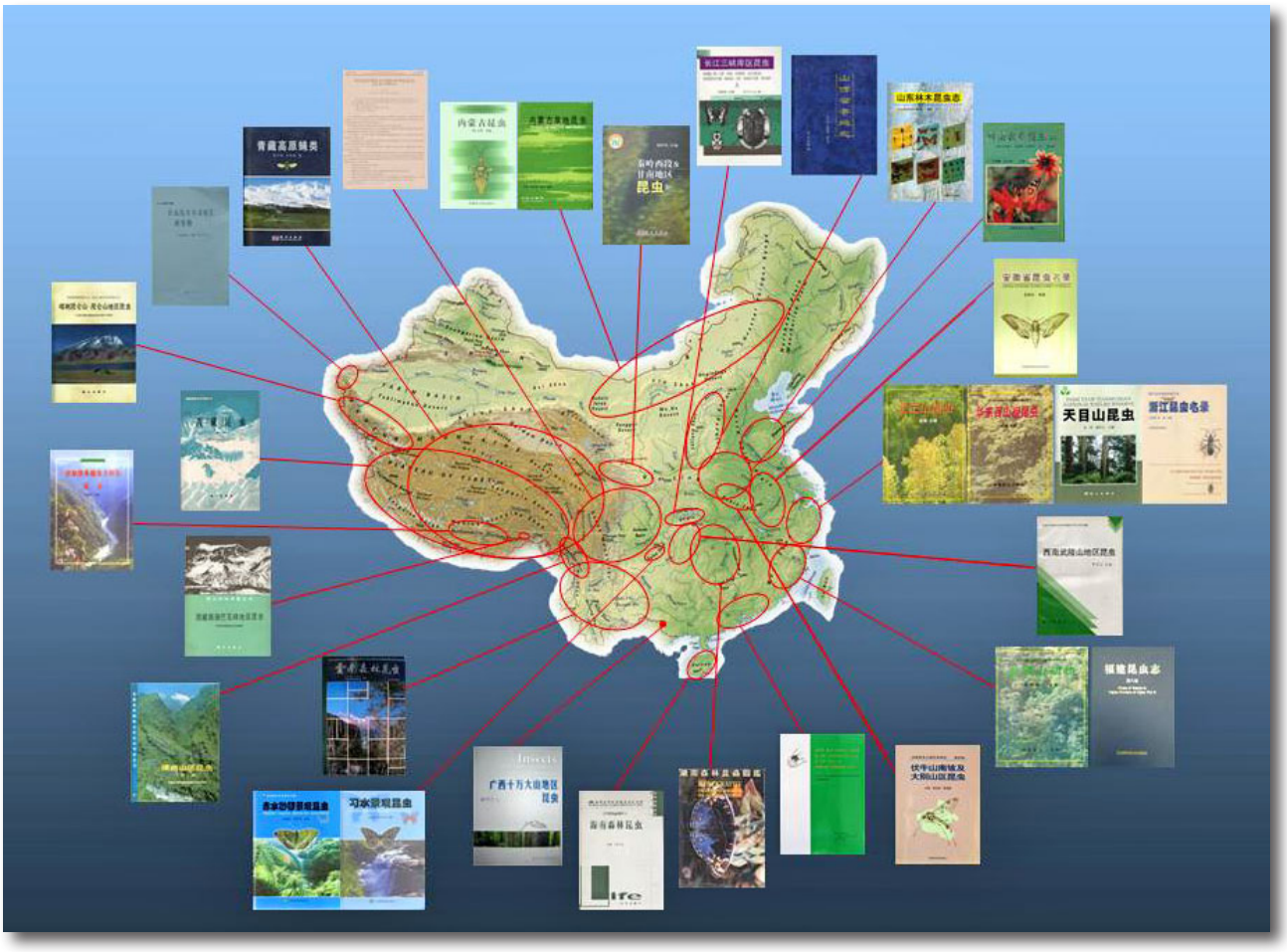


Figure 4. Map of China with book covers of 31 of the 40 faunal surveys published between the 1980s and 2008 that recorded tachinids within their areas of coverage (outlined in red ovals). (From O'Hara, Shima & Zhang 2008.)

While Monty was proceeding with his cataloguing efforts, I found myself being drawn more and more into the world of names. This was self-serving at first because I wanted to keep up with what was going on in the world of Tachinidae and organizing literature and keeping track of names was part of this. I soon realized that with my website and newsletter I could make some of the information I was gathering for myself available to a broader audience. I developed that idea into the *World Genera of the Tachinidae (Diptera) and Their Regional Occurrence* and posted the first version of this PDF document on our website in 2005. This resource has since progressed through to the current (tenth) version and is now coauthored with my technician Shannon Henderson (O'Hara & Henderson 2018).

I soon took on a new cataloguing project on the tachinids of China with my colleagues Hiroshi Shima (Kyushu University, Japan; since retired but still active) and Chuntian Zhang (Shenyang Normal University, China). China was, and continues

to be, of interest to my employer because it is potentially the source of both invasive insect species and their biological control agents. I was dutifully trying to keep up with the literature on Chinese tachinids but was falling behind. The Chinese were surveying insects all over the country (Fig. 4) and describing new species at a feverish rate. An authoritative review of Chinese tachinids had been published in *Flies of China* by the renowned Chinese tachinid expert Chien-ming Chao in 1998 (Chao *et al*. 1998) (see biography by Zhang & Hao 2008) but this resource was quickly becoming outdated. The number of known tachinid species in China jumped from 754 in 1998 (Chao *et al*. 1998) to almost 1100 ten years later (O'Hara 2008). Chao had kindly kept me supplied with his own papers over the years and Monty had been collecting literature from everywhere in the years before my arrival in Ottawa so I had a good start on Chinese literature. I gathered together the research papers, bought all the books on faunal surveys (Fig. 4), and received otherwise unobtainable works from Chuntian.

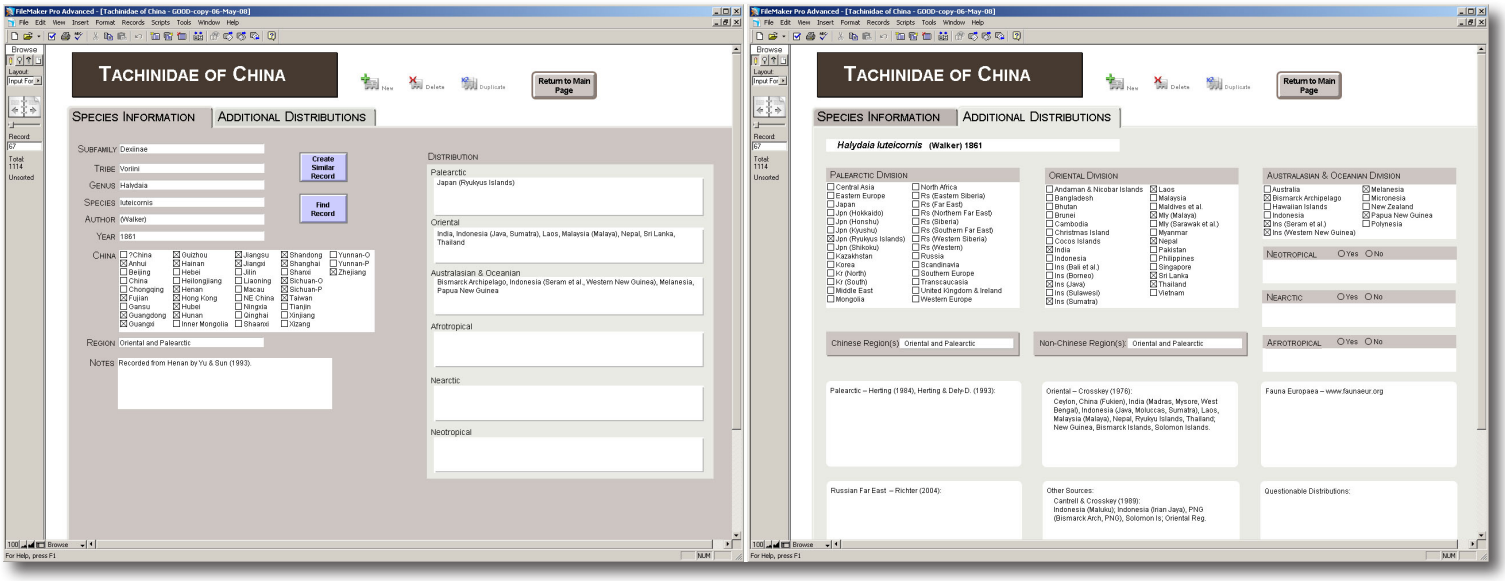


Figure 5. Distribution of *Halydaia luteicornis* (Walker) within (left) and outside (right) China as recorded in the FileMaker® Pro distributional database developed by Shannon.

The cataloguing of the Tachinidae of China was done largely in a Word document because we had no relational database to use for it. We did, however, benefit from a relatively simple distributional database that Shannon, just recently hired, developed for us using FileMaker® Pro (Fig. 5). This allowed us not only to input distributional data but to examine biogeographical aspects of the distributions as well. For example, the highest numbers of tachinid species in China, and highest numbers of endemic species (per province), were recorded from Sichuan and Yunnan (Fig. 6). We came to the following conclusions about the Tachinidae of China in a presentation given at the XXIII International Congress of Entomology in Durban, South Africa in 2008 (O'Hara, Shima & Zhang 2008):

1. 1114 species were recorded from China.
2. 404 species (36%) were recorded as endemic to China.
3. There is a gradual transition in the tachinid fauna from north to south in China, although overall there is a greater affinity with the Palaearctic than the Oriental Region.
4. Chinese endemics are concentrated in the south.
5. The Hengduan Mountains biodiversity 'hotspot' [essentially consisting of extreme eastern Xizang, western half of Sichuan, and northwestern tip of Yunnan] is exceptionally rich in Tachinidae as evidenced by the high number of species and endemics recorded from Sichuan and Yunnan.
6. Sichuan and Yunnan together had a known fauna of 539 tachinid species, representing 48% of all species known from China. Of this number, 190 species were endemic to Sichuan + Yunnan.

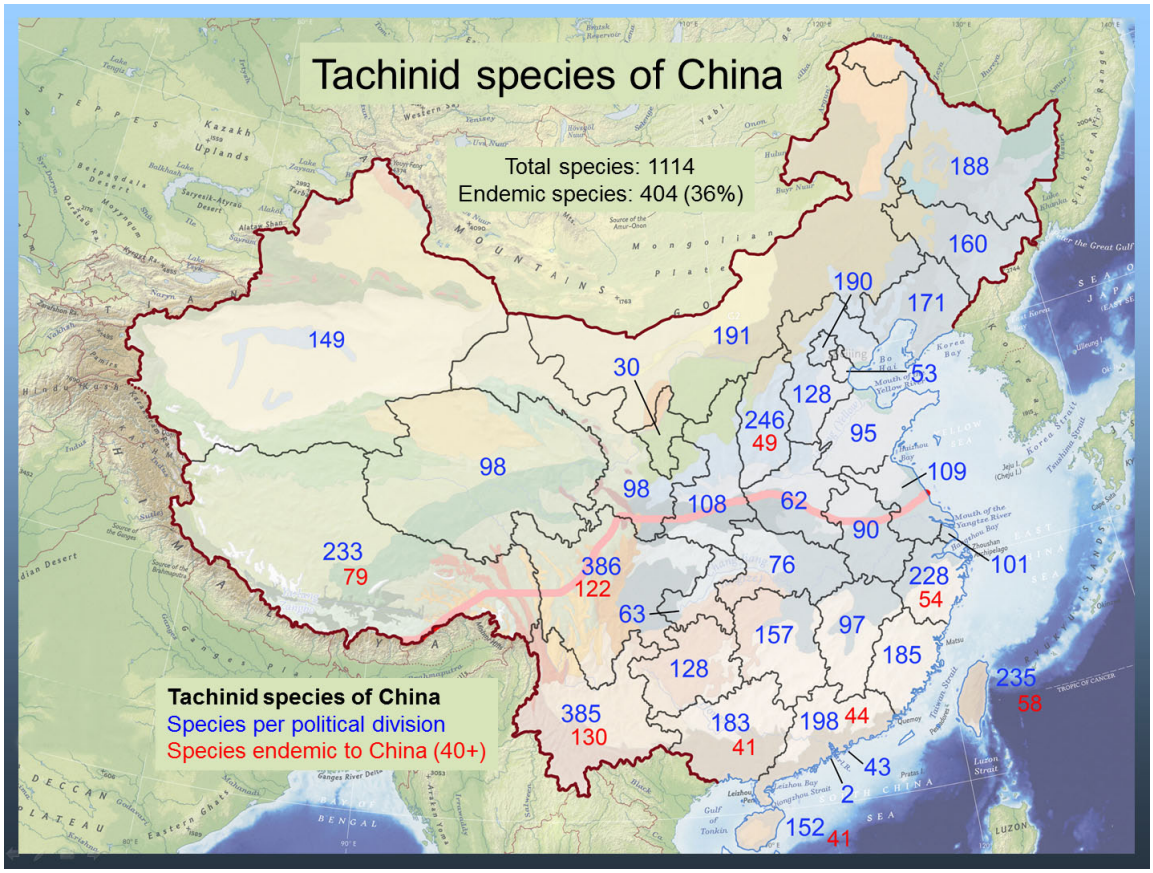


Figure 6. Number of tachinid species per province in China; total number in blue and number of species endemic to China (not province) in red. (From O'Hara, Shima & Zhang 2008.)

We were also able to more broadly compare the tachinid fauna of China with that of the rest of the world and in particular the Palaearctic Region (Fig. 7). Our conclusions based on these comparisons were summarized as follows (O'Hara, Shima & Zhang 2008):

1. The most species were shared with Japan, Europe, and Russian Far East.
2. A relatively high number of species were shared with Caucasus.
3. In the Palaearctic Region, biologically rich areas shared the most species with China.
4. In the Oriental Region, relatively few species were shared with China as a whole.

The cataloguing of the Chinese Tachinidae came to a close with the publication of *Annotated Catalogue of the Tachinidae (Insecta: Diptera) of China* (O'Hara, Shima & Zhang 2009). I had hoped for us to publish a separate paper on the biogeography of Chinese Tachinidae but due to other distractions on my part this never came to pass.

I gained more experience with the subtleties of nomenclature and the desirable attributes of a taxonomic catalogue while working on the Tachinidae of China. This resulted in an expanded section at the beginning of our catalogue on such matters as name-bearing types, avoidance of assumption of holotype, lectotypifications, type localities, and geographic divisions (information basically akin to the small print you never read that comes with the instructions for small household appliances). I could already recognize some slight imperfections in the North American catalogue of O'Hara & Wood (2004) that few readers would notice but were irritating to me.

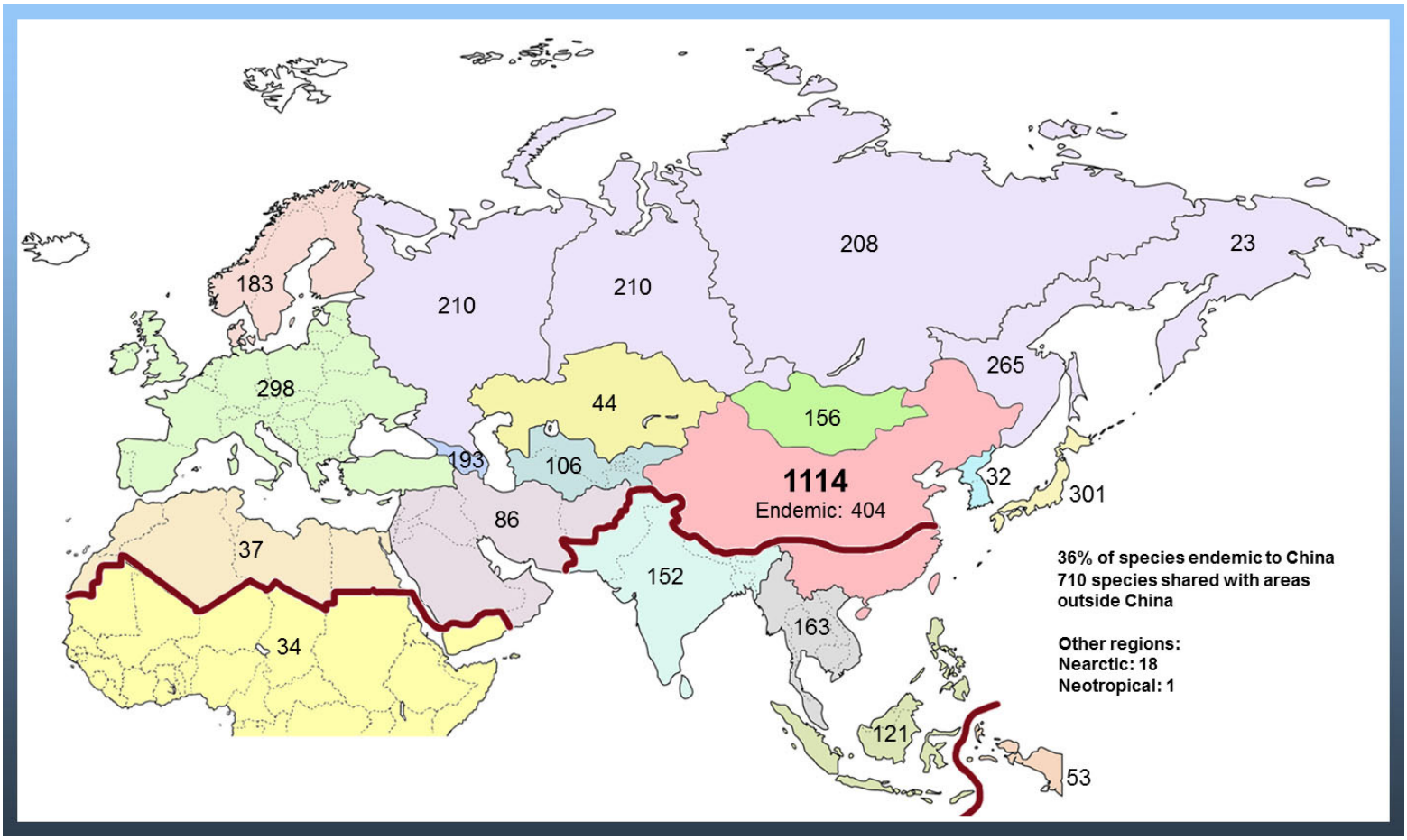


Figure 7. Number of tachinid species shared beween China and other parts of the world, with an emphasis on the Palaearctic Region. (From O'Hara, Shima & Zhang 2008.)

It was during the cataloguing of Chinese Tachinidae that I began to entertain thoughts of a grander plan to catalogue the Tachinidae of the world. I did not particularly want to go down this path for several reasons: 1) it would be a long-term project that would likely curtail significant revisionary work for many years; 2) it would require careful up-front planning and a sophisticated relational database; and 3) Monty was already working towards this goal. (I suppose I could add a fourth reason, unfounded optimism, because later in my announcement of the project I wrote "An optimistic guess might put the length of this project at five years, but it could take seven or eight", O'Hara 2008: 7.)

I must have let my mind wander in unguarded moments towards thoughts of a world catalogue. Would it not be useful to have all the world's tachinid names and distributions in one place in a single classification scheme? We already had nearly all the literature. Shannon had shown an aptitude for database development. Monty's database was more taxonomically than nomenclaturally oriented and did not include distributions. A few discussions and e-mails later and a plan was born. It was initially conceived to be an international collaboration involving myself, Monty Wood, Vera Richter, Hiroshi Shima, and Shannon Henderson [Shannon Mahony at the time] (O'Hara 2008). The team has since dwindled to just the three of us in Ottawa for the simple reason that most of the work is literature-based and primarily concerns names, dates, types, distributions, and the interpretation of various nomenclatural quandaries. The other aspect of the work—revising the classification to adapt to the community's and our (mostly Monty's) perceptions of tachinid relationships—is, at the database level, merely a matter of changing names and species groupings.

The plan for a world Tachinidae catalogue centred around finding or creating a relational database that would suit our needs. This was back in 2007. Computer technology was well advanced by then and I suspected there was a taxonomic database out there that we could use and would have a longer life expectancy than *Platypus*. Most taxonomic databases were strong on specimen data and weak on nomenclatural data (e.g., *Mandala*, https://www.gbif.org/tool/81360/mandala). The list of possibilities was quickly narrowed down to none; we would have to create our own.

By this time I knew exactly what I wanted a cataloguing database to do. I did not know if it was possible, but my criteria were well established. We would be dealing with not just the 1500 valid names of genera and 8500 valid names of species of Tachinidae (O'Hara & Henderson 2018) but all the non-valid names as well, roughly doubling the total number of names. There were then all the other types of names to work into the mix: justified and unjustified emendations, names suppressed by the *Code* (ICZN 1999), available names of unrecognized species (*nomina dubia*), unavailable names (e.g., misspellings, manuscript names), *nomina oblita* and *nomina protecta*; to name all but the most obscure. All the various sorts of name-bearing types would need to be accommodated with standards applied for lectotypifications (see lengthy discussion in O'Hara, Shima & Zhang 2009: 10–11). For distributions, the world would have to be subdivided geographically in a sensible manner and synchronized with some major divisions already in use in regional catalogues (e.g., the divisions of Russia and the former Soviet Union as used in the Palaearctic catalogue of Herting & Dely-Draskovits 1993: 7–8). The boundary between the Nearctic and Neotropical regions would be arbitrarily set at the border between Mexico and the United States because the distributions of Mexican Tachinidae are too poorly known to adopt a boundary inside Mexico as advocated by Griffiths (1980). A boundary between the Palaearctic and Oriental regions in China would have to be set based on our experience with Chinese Tachinidae because there was no agreement on the boundary in the literature (indeed, the "boundary" is in reality a transition zone but something more definite was needed for cataloguing purposes). Place names (for type localities and geographic divisions) would have to follow as much as possible a standard reference to avoid arbitrary and even multiple spellings.

Catalogue of World Tachinidae database

Shannon felt that FileMaker Pro would provide a suitable platform for the sort of database I was thinking of. She went off to Toronto for advanced training while I thought about the user screens we might want and how they might be linked together to mirror a taxonomic hierarchy and lead off to screens on types and distributions at the most appropriate point. Perhaps the most fundamental decisions were to keep all literature in EndNote (where we had it already) and all taxonomic and nomenclatural information in FileMaker, and to separate names into the primary categories of subfamily, tribe, valid genus, available genus, valid species, and available species and to have these major options available on the homepage (Fig. 8).

We discussed how all the information listed in the last paragraph of the previous section might be incorporated into the database. I was only interested in how all these linkages would appear to the user, for instance how to get from an available species name to type data, or where emendations would be entered. The programming side was up to Shannon. I knew that the programming of the database would take months and likely involve the solving of complex problems beyond Shannon's formal training. No one at our Centre had advanced expertise in FileMaker

and Shannon would eventually solve the more perplexing obstacles by seeking the assistance of geek-level FileMaker Pro online forums.

Magically (or so it seemed to me) the database began to take shape. As the need for the distributional component approached I sat down with atlases and taxonomic catalogues for a couple of weeks and divided up the world, using *The Times Comprehensive Atlas of the World* (Times Books 2007). We also started lists of "standards" pertaining to how strings of information might be ordered to always appear in the same way. For example, here are three examples of data associated with two valid (uppercase bold italics) and one invalid (uppercase italics) generic names:

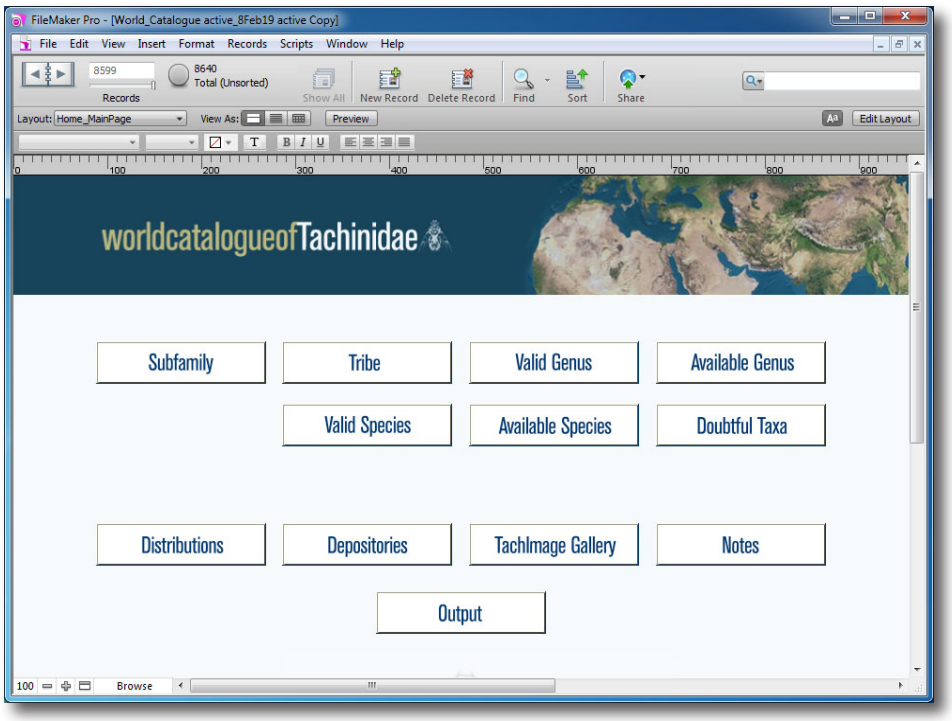
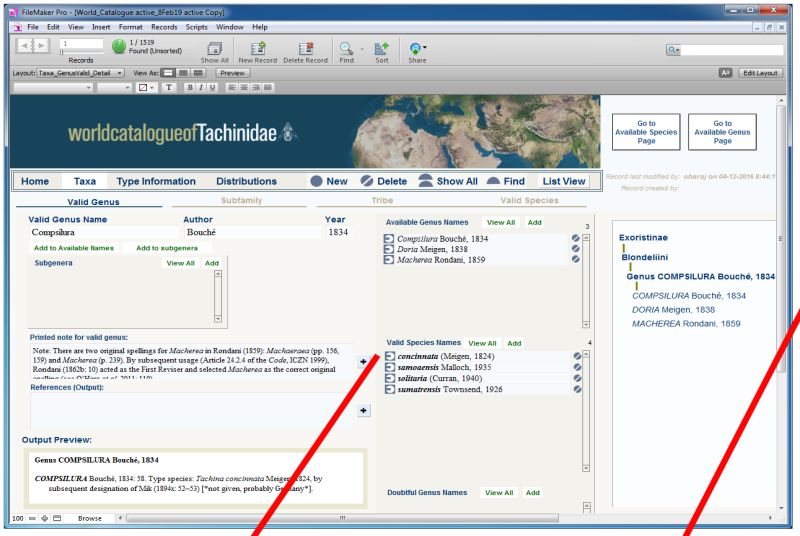


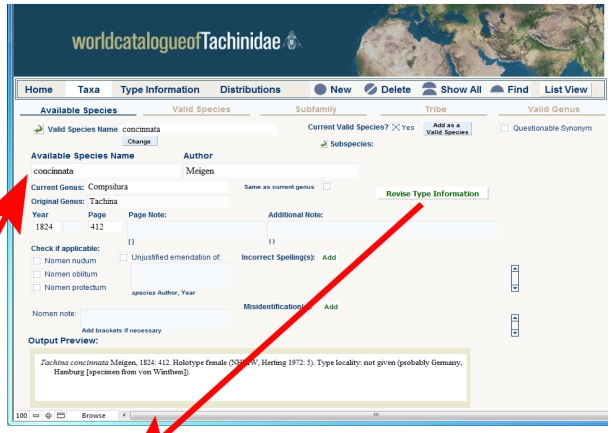
Figure 8. Home page for *Catalogue of World Tachinidae* database.

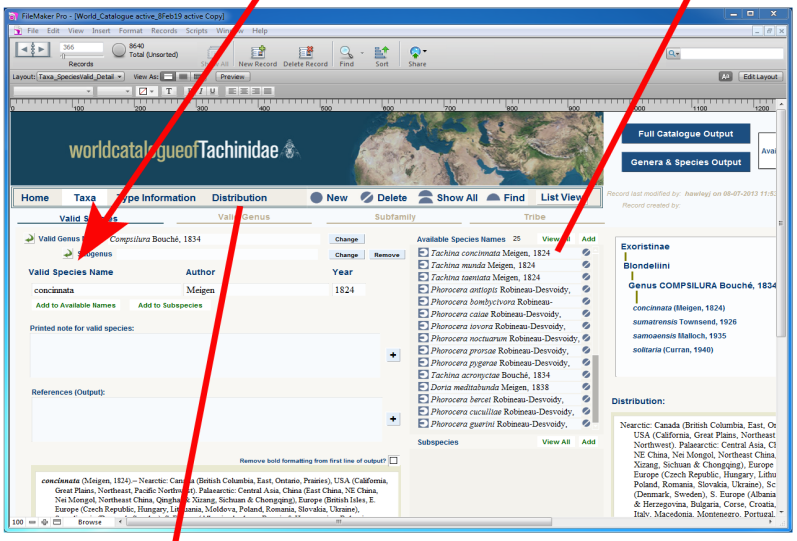
> ***PROSOPEA*** Rondani, 1861d: 36 (as subgenus of *Frontina* Meigen, 1838, as "*Prosopèa*"). Type species: *Frontina* (*Prosopea*) *instabilis* Rondani, 1861 (as "*P. Instabilis* Mihi") (= *Frontina nigricans* Egger, 1861), by original designation.
>
> ***BRACHYMERA*** Brauer & Bergenstamm, 1889: 116 [also 1890: 48]. Type species: *Pachystylum letochai* Mik, 1874 (as "*Letochae* Mik", an improper correction from Mik's original spelling of "*Letochai*", an epithet based on the surname *Letocha* [see Article 32.5.2.1 of ICZN 1999]), by monotypy.
>
> *SCHAUMIA* Robineau-Desvoidy, 1863b: 43. Type species: *Tachina inclusa* Hartig, 1838, by fixation of O'Hara *et al*. (2009: 46) under Article 70.3.2 of ICZN (1999), misidentified as *Tachina bimaculata* Hartig, 1838 in the fixation by monotypy of Robineau-Desvoidy (1863b, as "*Tachina bi-maculata*").

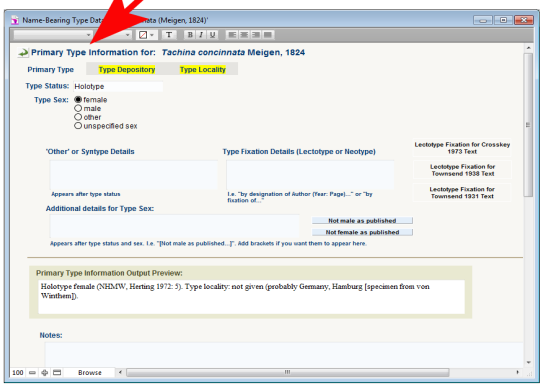
The database was completed about ten years ago and except for minor tweaks is still the same now as it was then. Fig. 8 shows the homepage and Fig. 9 has a walk-through of the main screens of data associated with the species *Compsilura concinnata* (Meigen), a well-known tachinid of Old World origin that was introduced into the Nearctic Region for biological control purposes.

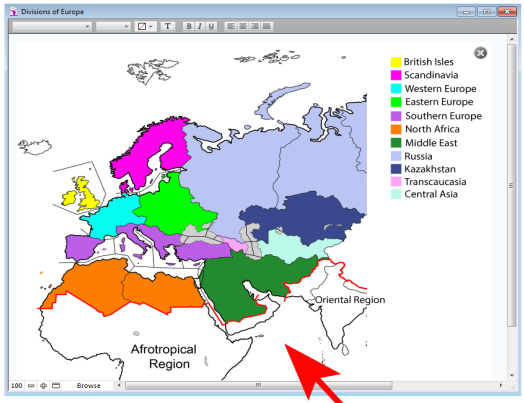
To see data on *C. concinnata* in the database (Fig. 9), the user can start on the *Compsilura* valid genus screen (upper left) or the *C. concinnata* valid species screen (middle left). If starting on the former, then the user has the option of accessing screens on the three available generic names (one of which is also the valid name and the others are synonyms) or selecting a species from the full list of valid species names. Selecting "*concinnata*" opens the valid species screen for this species. Here, summaries are visible of the full output for the species and also (separately) its distribution. A list of the 25 available names associated with the valid name (one name also being the valid name and the others are synonyms) is included to the right of the valid name data. A click on "*Tachina concinnata*" opens the

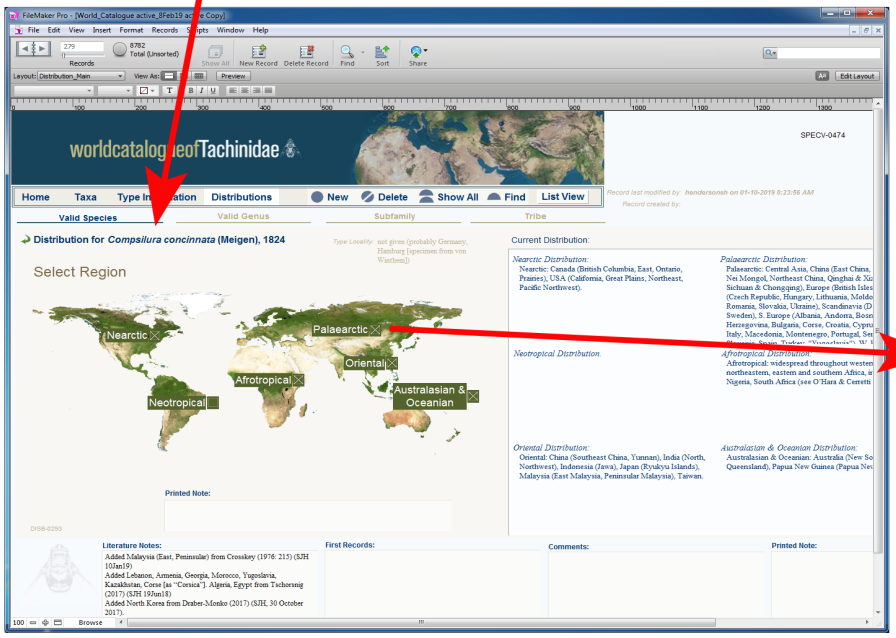

worldcatalogueofTachinidae
Home
Taxa
Type Information
Distributions
New
Delete
Show All
Find
List View
Valid Genus
Subfamily
Tribe
Valid Species
Valid Genus Name
Author
Year
Compsilura
Bouché
1834
Exoristinae
Blondeliini
Genus COMPSILURA Bouché, 1834
COMPSILURA Bouché, 1834
DORIA Meigen, 1838
MACHEREA Rondani, 1859
concinnata (Meigen, 1824)
samoaensis Malloch, 1935
solitaria (Curran, 1940)
sumatrensis Townsend, 1926
Output Preview:


worldcatalogueofTachinidae
Home
Taxa
Type Information
Distributions
New
Delete
Show All
Find
List View
Available Species
Valid Species
Subfamily
Tribe
Valid Genus
Valid Species Name
concinnata
Available Species Name
Author
Meigen
Current Genus: Compsilura
Original Genus: Tachina
Year
Page
1824
412
Revise Type Information
Output Preview:


worldcatalogueofTachinidae
Full Catalogue Output
Genera & Species Output
Home
Taxa
Distribution
New
Delete
Show All
Find
List View
Valid Species Name
concinnata
Meigen
1824
Exoristinae
Blondeliini
Genus COMPSILURA Bouché, 1834
concinnata (Meigen, 1824)
sumatrensis Townsend, 1926
samoaensis Malloch, 1935
solitaria (Curran, 1940)
Distribution:


Primary Type Information for: Tachina concinnata Meigen, 1824
Primary Type
Type Depository
Type Locality
Type Status: Holotype
Type Sex:
female
male
other
unspecified sex
Primary Type Information Output Preview:
Holotype female (NHMW, Herting 1972: 5). Type locality: not given (probably Germany, Hamburg [specimen from von Winthem]).
Notes:


Divisions of Europe
British Isles
Scandinavia
Western Europe
Eastern Europe
Southern Europe
North Africa
Middle East
Russia
Kazakhstan
Transcaucasia
Central Asia
Oriental Region
Afrotropical Region


worldcatalogueofTachinidae
Home
Taxa
Distributions
New
Delete
Show All
Find
List View
Valid Species
Valid Genus
Subfamily
Tribe
Distribution for Compsilura concinnata (Meigen), 1824
Select Region
Nearctic
Palaearctic
Oriental
Afrotropical
Neotropical
Australasian & Oceanian
Current Distribution:
Printed Note:
Literature Notes:
First Records:
Comments:

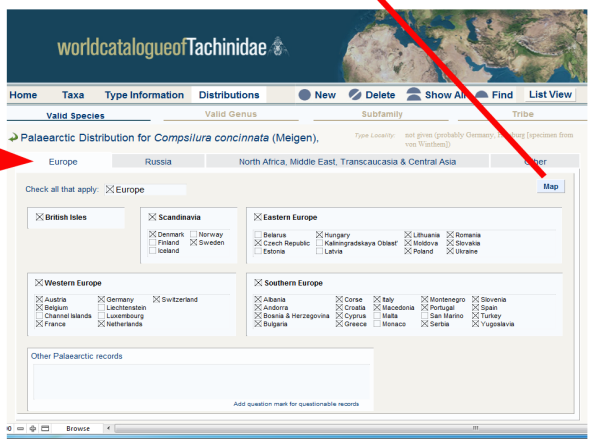

worldcatalogueofTachinidae
Home
Taxa
Type Information
Distributions
New
Delete
Show All
Find
List View
Valid Species
Valid Genus
Subfamily
Tribe
Palaearctic Distribution for Compsilura concinnata (Meigen),
Europe
Russia
North Africa, Middle East, Transcaucasia & Central Asia
Check all that apply:
British Isles
Scandinavia
Eastern Europe
Western Europe
Southern Europe
Other Palaearctic records

Figure 9. [Caption for figure on previous page.] Shown here are the main entry screens for *Compsilura concinnata* (Meigen) in the *Catalogue of World Tachinidae* database. In the upper left is the valid genus screen for *Compsilura* Bouché (the available genus screen is not shown). A click on "*concinnata*" in the species list opens the screen in the middle left, the valid species screen for *C. concinnata* (Meigen). A click on "*Tachina concinnata*" opens the screen in the upper right (right side of screen cropped), the available species screen for *Tachina concinnata* Meigen. A click on "Revise Type Information" opens the screen in the middle right, one of the Type Information screens (the one for Primary Type; there are other screens for Type Depository and Type Locality). Back on the valid species screen in the middle left, a click on "Distribution" opens the screen in the lower left, the main Distribution screen. This screen is the portal to additional distribution screens for each region. A click on "Palaearctic" opens the screen in the lower right (right side of screen cropped), the one for Europe (other tabs to the right of "Europe" open screens for other parts of the Palaearctic). A click on "Map" opens a reference map showing the divisions of the western Palaearctic.

available name screen (top right) and provides details about the name, author, date, page, and other names that might be associated with it (e.g., misidentifications, unjustified emendations, incorrect spellings). Clicking on "Revise Type Information" (right middle) opens the first screen of data associated with the name-bearing type. Other screens deal with "Type Depository" and "Type Locality". All the type data is summarized in the preview window at the bottom of the screen. Distributions are associated only with valid species names, so back on the *C. concinnata* valid species screen (middle left) a click on "Distribution" opens the main screen for this species' distribution (lower left). Each region is accessed separately to reach additional input screens. A complete summary of the distribution is given on the right side of the main screen. Clicking on "Palaearctic" opens the first screen associated with that region (lower right). The first screen is the one for Europe and countries with records for *C. concinnata* can be checked off here before toggling to screens with the other parts of the Palaearctic Region. Clicking "Map" opens a screen (middle right) showing a reference map to the major divisions of the western Palaearctic.

We have been populating the database with information about names, types, distributions and so forth for about ten years. Summer students helped initially but now most of the data entry is by Shannon and some by me and this gives us more control over the accuracy and consistency of the information going into the database. Virtually all the data from the catalogues on America north of Mexico (O'Hara & Wood 2004), China (O'Hara, Shima & Zhang 2009) and the Afrotropical Region (O'Hara & Cerretti 2016) has been entered, information has been entered but not completely verified for the Oriental Region (Crosskey 1976) and for Australasian and Oceanian Regions (Cantrell & Crosskey 1989), more work is needed (especially on name-bearing types) for the Neotropical Region (Guimarães 1971), and for the Palaearctic Region (Herting & Dely-Draskovits 1993) there is an especially large amount of work to do particularly on synonyms at the species level and name-bearing types.

Each year in January, Shannon performs a search for literature on Tachinidae using all the resources available to us through the library services of Agriculture and Agri-Food Canada. We also receive literature from colleagues, for which we are most grateful. All the new literature is compiled and listed each year in *The Tachinid Times*. The new literature is checked for new taxa, taxonomic changes, nomenclatural acts and distributions, and this information is entered into our database to keep it current. A spin-off from this activity is the irregular publication of *World Genera of the Tachinidae (Diptera) and Their Regional Occurrence* (O'Hara & Henderson 2018).

Checklist of World Tachinidae

Outputs from the *Catalogue of World Tachinidae* database can be programmed as desired. Shannon has created a few but our most popular is a full catalogue along the lines of O'Hara, Shima & Zhang (2009) and O'Hara & Cerretti (2016). Data for special purposes, such as numbers of genera or species by region, is exported into Excel for easy handling.

Exporting to text files is not as user friendly as exporting to Excel; in fact, there is no provision for an output to Microsoft Word. The best that can be achieved is a decent output to a PDF that then needs massaging in Word. We have reached a point where we have confidence that our data on the valid names of genera, and on the valid names and distributions of species, of Tachinidae is ready for circulation. We realize that in a project of this magnitude we surely have made mistakes and have overlooked relevant sources but we hope these are few. To mitigate this problem we have decided to call our checklist "preliminary" and to publish it electronically on our *Tachinidae Resources* website rather than in a peer-reviewed journal. This way we can correct and update it on an irregular basis in the same fashion as our world genera document.

The layout of the checklist is simple. It is a listing of species arranged by genus, tribe and subfamily. Each species is identified by a name (in bold italics), author and date (with these last two in parentheses if the species is no longer in its original genus). Following this is the distribution. Distributions are cited in an order and manner described in a lengthy section at the beginning of the checklist under Materials and Methods. Maps to regions and in some cases subregions are provided for easy reference. Cited below the distribution in the checklist is the original combination of the species name (in italics) followed by author and date. Each tribe starts on a new page and the page header throughout the checklist displays the proper subfamily and tribe. There is no index for two reasons: 1) it is time-consuming to compile, and 2) it is not as valuable as it used to be given that the text is searchable and the checklist is not meant to be printed.

The classification in the checklist is generally that in common use as determined by the authors (but let us know of inadvertent errors) but has some rearrangements here and there among Neotropical Tachinidae for the more obvious misplacements in the past. The bulk of the taxonomic changes we anticipate making in the future will be based on years of study by Monty Wood and will appear in the Chilean and New World catalogues (see below).

Where are all the species?

Six years ago I published an article entitled, *Where in the world are all the tachinid genera?* (O'Hara 2013). Genera were dealt with again by O'Hara & Henderson (2018) so here I will only briefly comment on the distribution of species of Tachinidae.

The number of described species of Tachinidae is constantly changing as new species are described and the names of others are being moved into synonymy. In our database we are also in the process of moving *nomina dubia* out of our lists of valid species. These are names of unrecognized species; usually names for which the name-bearing type is lost or has not been examined and matched to a species. These names are technically valid but

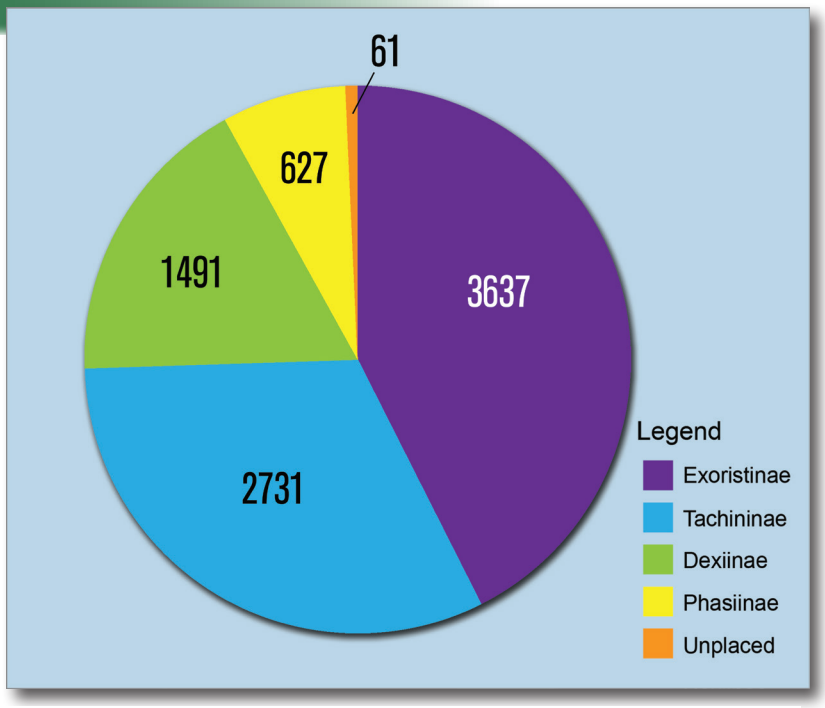


Figure 10. Number of species of Tachinidae per subfamily. Total = 8547.

because they are unrecognized we like to group them at the end of a genus in our catalogues and we do not count them among the valid species of a genus. According to these criteria the number of tachinid species listed in our checklist (version 1.0) is 8547. The number of species per subfamily is shown in Fig. 10. From largest to smallest the subfamilies are Exoristinae, Tachininae, Dexiinae and Phasiinae. Interestingly, the greatest morphological diversity is in the Phasiinae and Tachininae, and the subfamily with the most tribes is Tachininae with 24. Some rearrangements may be necessary within the family as a result of the recent molecular phylogeny of Stireman *et al*. (2019), most significantly regarding the tachinine tribes Macquartiini + Myiophasiini that were reconstructed as a basal clade sister to the rest of the Tachinidae.

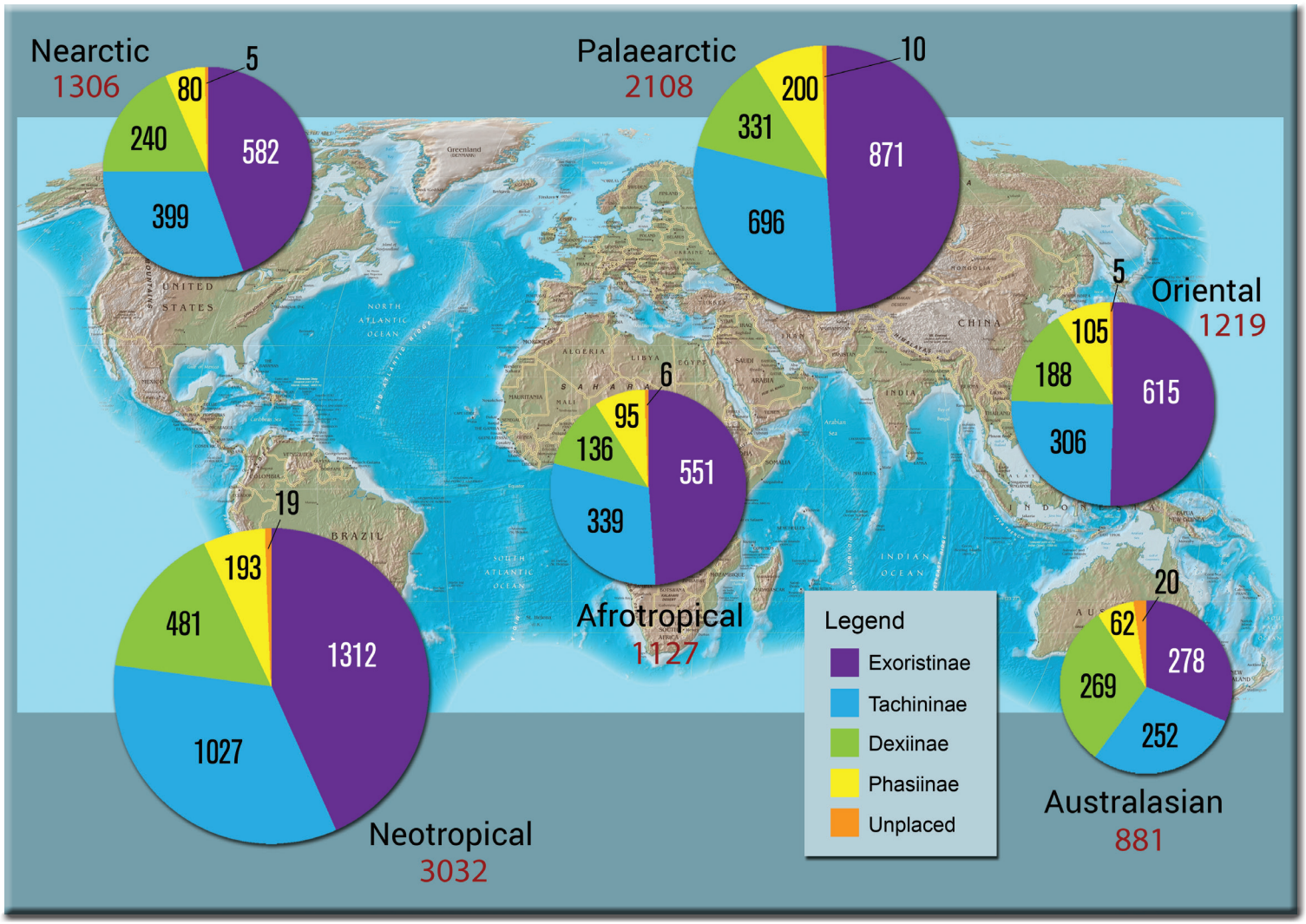


Figure 11. The number of described species of Tachinidae by biogeographic region and subfamily is shown in proportionally-sized pie charts. The total number of species per region is shown in red and the total number of species in the world is 8547.

The distribution of species by subfamily and number is shown in proportionally-sized pie charts for each biogeographic region in Fig. 11. These numbers are based on described species and the true sizes of the faunas are not accurately reflected by the pie charts. The Neotropical fauna is vastly underestimated; its true size could be twice or several times larger than the already-large known fauna. The faunas of the Nearctic and Palaearctic regions are better known and the number of undescribed species in each might be closer to 20% of the described species, although in the latter region the fauna of the western part is well known and most of the new species will be found

in the eastern part (especially in the Palaearctic portion of China). The percentage of undescribed species in the Afrotropical Region is uncertain but is likely significantly higher than for the Nearctic and Palaearctic Regions. The tachinid faunas of the Oriental and Australasian regions are much more diverse than indicated by their described species. O'Hara *et al*. (2004) estimated that Australia might have a tachinid fauna of over 3000 species and this could put the Australasian fauna in contention for second place after the Neotropical fauna when the world's tachinid fauna is better known.

The proportional sizes of tachinid subfamilies are also shown in Fig. 11. These are also a reflection of the revisionary work that has been done in each region but the relative proportions are likely more meaningful among regions than are the numbers of described species. If we accept this premise, then the Exoristinae are dominant in all regions except the Australasian where, interestingly and uniquely, the known faunas of the Exoristinae, Tachininae and Dexiinae are virtually the same size. In the other regions there is the same trend as there is in the world (Fig. 10) with the size of subfamilies decreasing in the same order: Exoristinae, Tachininae, Dexiinae and Phasiinae.

The future

Our ultimate goal is to produce a catalogue of world Tachinidae to the same level of detail as in the China and Afrotropical catalogues (O'Hara, Shima & Zhang 2009, O'Hara & Cerretti 2016). I cannot say for sure that we will reach this goal because some aspects of cataloguing the Palaearctic fauna, such as interpreting every name-bearing type and type locality for every available species in whatever language the information is given, is a slow process. We may need to reassess what we can achieve in a reasonable amount of time.

In the short term we have a detailed catalogue of the Tachinidae of Chile in a well advanced state. This is being prepared in collaboration with our colleague Christian González of the Instituto de Entomología, Universidad Ciencias de la Educación, Santiago, Chile. The next catalogue after that is expected to encompass all of the New World Tachinidae, replacing the catalogues of Guimarães (1971) and O'Hara & Wood (2004). Maybe in a future version of the world checklist we can add additional information, perhaps including bibliographic citations to the available species names and citing the few thousand relevant references in a bibliography at the end of the checklist.

References

Cantrell, B.K. & Crosskey, R.W. (1989) Family Tachinidae. Pp. 733–784. *In*: Evenhuis, N.L. (ed.), *Catalog of the Diptera of the Australasian and Oceanian Regions*. Bishop Museum Special Publication 86. Bishop Museum Press, Honolulu and E.J. Brill, Leiden. 1155 pp.

Chao, C.-m. *et al*. (1998) Tachinidae. Pp. 1661–2206 + pls. 1–30. *In*: Xue, W.-q., Chao, C.-m. (Eds.), *Flies of China*. Volume 2. Liaoning Science and Technology Press, Shenyang. 17 pp. + 1366–2425 + 32 pls. [In Chinese with English summary.]

Crosskey, R.W. (1976) A taxonomic conspectus of the Tachinidae (Diptera) of the Oriental Region. *Bulletin of the British Museum (Natural History). Entomology Supplement*, 26, 357 pp.

Cumming, J.M., Sinclair, B.J., Brooks, S.E., O'Hara, J.E. & Skevington, J.H. (2011) The history of dipterology at the Canadian National Collection of Insects, with special reference to the *Manual of Nearctic Diptera*. *Canadian Entomologist*, 143, 539–577.

Griffiths, G.C.D. (1980) Preface. Pp. V–XIII. *In*: Griffiths, G.C.D., (ed.), *Flies of the Nearctic Region*. Volume 1. Handbook, Part 1. History of Nearctic dipterology. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

Guimarães, J.H. (1971) Family Tachinidae (Larvaevoridae). *A catalogue of the Diptera of the Americas south of the United States*, 104, 333 pp.

Herting, B. & Dely-Draskovits, Á. (1993) Family Tachinidae. Pp. 118–458. *In*: Soós, Á. & Papp, L. (eds.), *Catalogue of Palaearctic Diptera*. Volume 13. Anthomyiidae – Tachinidae. Hungarian Natural History Museum, Budapest. 624 pp.

International Commission on Zoological Nomenclature (1999) *International Code of Zoological Nomenclature*. Fourth edition adopted by the International Union of Biological Sciences. International Trust for Zoological Nomenclature, London. xxix + 306 pp.

Lafontaine, J.D. & Wood, D.M. (1988) A zoogeographic analysis of the Noctuidae (Lepidoptera) of Beringia, and some inferences about past Beringian habitats. Pp 109–123. *In*: Downes, J.A. & Kavanaugh, D.H. (eds.), Origins of the North American insect fauna. *Memoirs of the Entomological Society of Canada*, 144, 168 pp.

McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H.J., Vockeroth, J.R. & Wood, D.M. (coordinators) (1981) Manual of Nearctic Diptera. Volume 1. *Agriculture Canada Monograph*, 27, vi + 1–674.

McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H.J., Vockeroth, J.R. & Wood, D.M. (coordinators) (1987) Manual of Nearctic Diptera. Volume 2. *Agriculture Canada Monograph*, 28, vi + 675–1332.

O'Hara, J.E. (2008) Cataloguing the Tachinidae. *The Tachinid Times*, 21, 6–10.

O'Hara, J.E. (2013) Where in the world are all the tachinid genera? *The Tachinid Times*, 26, 10–16.

O'Hara, J.E. & Cerretti, P. (2016) Annotated catalogue of the Tachinidae (Insecta, Diptera) of the Afrotropical Region, with the description of seven new genera. *ZooKeys*, 575, 1–344.

O'Hara, J.E. & Henderson, S.J. (2018) *World genera of the Tachinidae (Diptera) and their regional occurrence*. Version 10.0. PDF document, 89 pp.
Available at: http://www.nadsdiptera.org/Tach/WorldTachs/Genera/Worldgenera.htm.

O'Hara, J.E., Henderson, S.J. & Wood, D.M. (2019) *Preliminary Checklist of the Tachinidae of the World*. Version 1.0. PDF document, 681 pages.
Available at: http://www.nadsdiptera.org/Tach/WorldTachs/Checklist/Worldchecklist.html.

O'Hara, J.E., Shima, H. & Zhang, C.-t. (2008) *Biogeography of the Tachinidae (Diptera) of China*. Presentation given at the XXIII International Congress of Entomology, Durban, South Africa, 6–12 July 2008.

O'Hara, J.E., Shima, H. & Zhang, C.-t. (2009) Annotated catalogue of the Tachinidae (Insecta: Diptera) of China. *Zootaxa*, 2190, 1–236.

O'Hara, J.E., Skevington, J.H. & Hansen, D.E. (2004) A reappraisal of tachinid diversity in Carnarvon N.P., Australia, and estimation of the size of the Australian Tachinidae fauna. *The Tachinid Times*, 17, 8–10.

O'Hara, J.E. & Wood, D.M. (2004) Catalogue of the Tachinidae (Diptera) of America north of Mexico. *Memoirs on Entomology, International*, 18, iv + 410 pp.

Sabrosky, C.W. & Arnaud, P.H., Jr. (1965) Family Tachinidae (Larvaevoridae). Pp. 961–1108. *In*: Stone, A., Sabrosky, C.W., Wirth, W.W., Foote, R.H. & Coulson, J.R. (eds.), A catalog of the Diptera of America north of Mexico. *United States Department of Agriculture. Agriculture Handbook*, 276, iv + 1696 pp.

Stireman, J.O. III, Cerretti, P., O'Hara, J.E., Blaschke, J.D. & Moulton, J.K. (2019) Molecular phylogeny and evolution of world Tachinidae (Diptera). *Molecular Phylogenetics and Evolution* (preprint, 19 pp.), https://doi.org/10.1016/j.ympev.2018.12.002

Times Books (2007) *The Times comprehensive atlas of the world*. 12th edition. Times Books, London. 67 + [2] pp. + 125 pls. + 223 (Glossary and Index) + [1 (Acknowledgements)] pp. [Each of the 125 plates spans 2 pages.]

Wood, D.M. (1985) A taxonomic conspectus of the Blondeliini of North and Central America and the West Indies (Diptera: Tachinidae). *Memoirs of the Entomological Society of Canada*, 132, 1–130.

Wood, D.M. (1987) Tachinidae. Pp. 1193–1269. *In*: McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H.J., Vockeroth, J.R. & Wood, D.M. (coordinators), Manual of Nearctic Diptera. Volume 2. *Agriculture Canada Monograph*, 28, vi + 675–1332.

Wood, D.M. & Borkent, A. (1989) Phylogeny and classification of the Nematocera. Pp. 1333–1370. *In*: McAlpine, J.F. & Wood, D.M. (coordinators), Manual of Nearctic Diptera. Volume 3. *Agriculture Canada Monograph*, 32, vi + 1333–1581.

Zhang, C.-t. & Hao, J. (2008) Chien-ming Chao, 1927–2007. *The Tachinid Times*, 21, 2–6.