Figure 1. The Natural History Museum in London, England, UK.

For the love of bristles – adventures with tachinids at the *Natural History Museum, London*

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The Natural History Museum in London (Fig. 1) holds a globally important insect collection, one of the largest in the world and including many type specimens. Most of our collection is held in the controlled environment of the protective Cocoon – a large structure inside the Darwin Centre 2 building, which from outside looks like... a cocoon (Fig. 2). The specimens are housed in wooden drawers, many with cardboard unit trays lined with plastazote – we are painstakingly moving everything from the cork slats to make the collection safe, secure and more accessible. The drawers are housed in sealed metal cabinets and organized by family (Fig. 6), with the British and Irish collection kept separate from the World Collection.

> *"The Natural History Museum in London holds a globally important insect collection, one of the largest in the world"*

The Diptera account for approximately 2.5 million specimens, dry-pinned, slide mounted, preserved in ethanol and frozen in liquid nitrogen. It includes almost 18,000 primary types, among them roughly 1700 tachinids, although these numbers change as the type status of some specimens is reviewed and the types of newly described species are added. We also collect new material and receive donations from private donors. Not all of our specimens are identified to species and there is scope for scientific discovery.

Within the Diptera Collection at the NHM one can find tachinid specimens in the Walker Collection (Evenhuis 2018), as well as the type specimens of such well-known dipterists as J.M.F. Bigot (1818–1893), P.J.M. Macquart (1778–1855), J.R. Malloch (1875–1963), F. Walker (1809–1874), J. Villeneuve (1868–1944), E.E. Austen (1867–1938),

C.H. Curran (1894–1972), N.I. Baranov (1887–1981), L.P. Mesnil (1904–1986), C.H.T. Townsend (1863–1944), F.I. van Emden (1898–1958), M. Bezzi (1868–1927), R.W. Crosskey (1930–2017), and F.M. van der Wulp (1818–1899) – just to name a few.

The Historic Collections, which are kept separately from the main collection, include Sir Joseph Banks' (1743–1820) Insect Collection with specimens from Captain Cook's *Endeavour* voyage, collected by Banks and his colleagues, as well as those supplied by his worldwide network of collectors. It counts 55 drawers, with flies occupying 1⅓ drawers. This collection was studied by J.C. Fabricius and includes many primary types of various insects. The collection of Sir Hans Sloane (1660–1753) is also very interesting. It includes the insect collection of James Petiver (1665–1718), with some specimens preserved between two sheets of mica in two folios, as well as pinned specimens in small boxes with glass screens. It also includes the world's oldest complete insect collection: Leonard Plukenet's (1641–1706) bound volume of pressed insects. Whether you are a taxonomist or natural historian, the NHM's Insects Collection is a highly valuable source of information.

Figure 2. The Cocoon (view from lower ground floor).

I (Figs. 3, 4) began my adventure with flies at the NHM over ten years ago when I visited the Angela Marmont Centre for UK Nature (AMC) to try and identify specimens collected during my MSc project on decomposition of surface remains (wild boar carcasses) in a pine forest in Poland. I had only just finished my MSc in Forensic Archaeological Science and my knowledge of Diptera taxonomy was minimal, but I was enthusiastic, interested, and was willing to put the time and work into learning entomology. At about the same time the Diptera Section was looking for volunteers to sort Malaise trap samples, and I was lucky enough to be invited to participate in that project. At the time I was doing non-entomological jobs to support myself, but every free moment was spent at the NHM, either sorting samples or at the AMC learning stacked imaging (Fig. 5) from Chris Raper and Florin Feneru. This skill turned out to be very useful in my future endeavours.

Figures 3–4. The author, Olga Sivell. **3.** In the NHM Diptera Collection with a drawer of shiny metallic-coloured rutiliine tachinids from Australia. **4.** Collecting insects for Darwin Tree of Life Project during Covid-19 Pandemic.

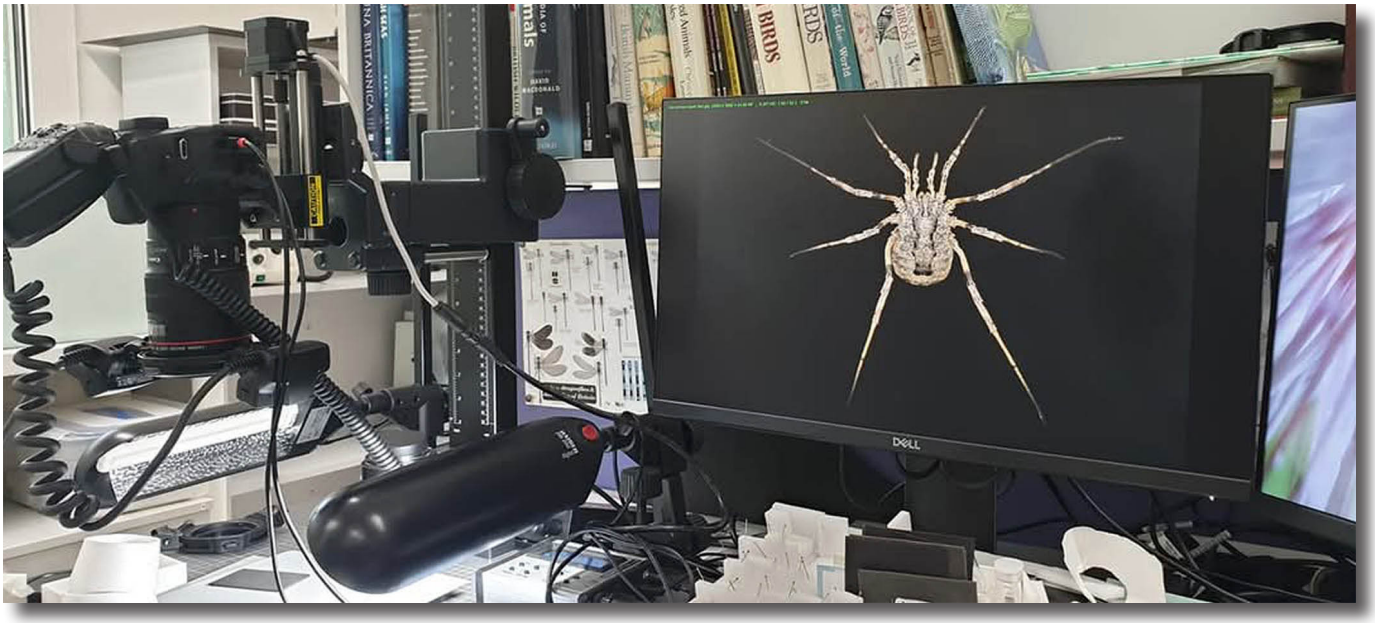

Figure 5. Image stacking equipment at the Angela Marmont Centre (AMC) for UK Nature.

I quickly became focused on Calliphoridae (blow flies). I always had a fascination for forensics, death and decay, and the biology of these flies coupled with their undeniable charm captivated me so much that I made them the subject of my doctoral research. I produced a key to the British species of Calliphoridae and Polleniidae, which was subsequently published by the Royal Entomological Society (RES) in their *Handbooks for Identification of British Insects* series (Sivell 2021). Most photographs included in that book were taken at the AMC. I was also hired to produce photographs for two other RES Handbooks: on Banchinae (Hymenoptera) (Brock 2017) and on Ichneumonidae (Hymenoptera) (Broad et al. 2018).

A few years after my humble beginnings as an insect goop sorter I found myself at the NHM again, working on a genome sequencing project called Darwin Tree of Life (DToL), a large collaboration led by the Sanger Wellcome Institute, with the ambitious goal to sequence genomes of all eukaryotic species from the British Isles (darwintreeoflife.org). Together with my colleagues we managed to collect a number of tachinid species, despite the added difficulty of live identification, a requirement of the project which aimed for the best possible DNA preservation by freezing specimens in liquid nitrogen. For those interested in tachinid genomics, DToL genomes are an amazing, free resource. There are currently 41 species in the pipeline (https://tolqc.cog.sanger.ac.uk), including 17 already published genomes: *Cistogaster globosa* (Fab.) (Falk & Lennon et al. 2023), *Dexiosoma caninum* (Fab.) (Sivell, Mitchell & Raper et al. 2024b), *Epicampocera succincta* (Meigen) (Falk & Raper et al. 2023b), *Germaria angustata* (Zett.) (Sivell, Mitchell & Raper et al. 2024a), *Gymnocheta viridis* (Fallén) (Barclay et al. 2024), *Gymnosoma rotundatum* (L.) (Smith et al. 2022), *Linnaemya tessellans* (R.-D.) (Falk & Smith et al. 2024), *Linnaemya vulpina* (Fallén) (Sivell, Mitchell & Raper et al. 2024c), *Lypha dubia* (Fallén) (Falk & Akinmusola et al. 2024), *Nowickia ferox* (Panzer) (Falk & Raper et al. 2023a), *Panzeria rudis* (Fallén) (Falk & Smith et al. 2023b), *Phania funesta* (Meigen) (Nash & Falk et al. 2024), *Phasia obesa* (Fab.) (Falk, Mitchell & Smith et al. 2024), *Tachina grossa* (Natural History Museum Genome Acquisition Lab et al. 2024), *Tachina fera* (L.) (University of Oxford, Wytham Woods Genome Acquisition Lab et al. 2022), *Tachina lurida* (Fab.) (Falk & Smith et al. 2023a) and *Thelaira solivaga* (Harris) (Falk & Smith et al. 2023c).

Figure 6. Diptera Collection inside the Cocoon.

After DToL I worked on the UK Barcode of Life Project (UKBOL, ukbol.org), processing insects and other arthropods for barcoding. The aim of the project is to provide high-quality sequences for British species, in particular those under-represented on BOLD (Barcode Of Life Data System) (Ratnasingham et al. 2024). The specimens are identified by experts, photographed, and the vouchers preserved in the NHM collection. At the NHM the project is led by Ben Price (Senior Curator in Charge of Small Orders) and comprises a network of UK government agencies, biodiversity institutions and individual scientists (Price et al. 2020, Price et al. 2022, Price et al. 2023, Price et al. 2024).

Since then, I had the privilege to work on rehousing and digitisation of the historical insect collection of Sir Joseph Banks (Figs. 7–10). This has been a great challenge as the extremely fragile specimens were housed in old wooden drawers lined with cork and paper. Most have been organised by curators long ago, with the last four drawers housing "overspill" from the Coleoptera drawers. This historic collection is an example of how entomological collections were organised in the past, not only to provide taxonomic information (e.g., by selecting a male and female of each species and pinning one dorsally and one ventrally) but to be also, and perhaps most of all, visually pleasing. A decision was made to preserve that aspect of the collection as far as possible, hence the specimens with all associated labels were being moved to the same position in a new, plastazote and paper lined drawer. All specimens were being photographed with their associated labels, in dorsal and lateral view, using stacked images (Ryder et al. 2024). The work on this project is ongoing, and we are planning to publish a full catalogue once the work is complete.

Following the retirement of Nigel Wyatt, I was extremely lucky to become the new NHM curator for Calyptrate flies, Sciomyzoidea, Lauxanioidea and Platypezoidea. I am now living the dream. I constantly find myself in search of new exciting projects. Luckily, in the insect world, there is always so much to do! The tachinid community has been most welcoming and encouraging and I am devoting more and more time to study these intriguing creatures. I recently embarked on a journey of discovery, sticking my nose into the collection of the Linnean Society in London. I was checking Calliphoridae types when I was pulled towards a tachinid, one of the species I actually recognize. It was the common *Eriothrix rufomaculata* (De Geer), however it was labelled as *Musca albifrons*. No surprise, during Linnaeus' time most flies were in the genus *Musca*, but *albifrons*? I had not seen that name before. Before long, myself, James O'Hara and Chris Raper embarked on a mission to resolve the mystery of a name published a few years before the currently accepted *rufomaculata*. Do not be alarmed! No name changes will occur on this occasion. The manuscript to retain the name *rufomaculata* has only just been submitted for publication, so hopefully you will be able to read all about this case soon (Sivell, Raper & O'Hara, in prep.).

Figures 7-10. The historic Sir Joseph Banks' Insect Collection. **7.** Author holding a drawer of beetles from the Banks Collection. **8.** A specimen of *Musca grossa* Linnaeus identified by Fabricius. This widespread Palaearctic species was later designated as the type species of the genus *Tachina* Meigen, 1803. **9.** A drawer of Diptera before (left) and after (right) rehousing. **10.** Close-up of six curated tachinids in the lower right corner of the right drawer in Fig. 9.

Another small project I am working on is aiming at resolving the *Germaria angustata* species complex. While working on the publication of the whole genome of *G. angustata* from Britain I compared the barcodes of the specimens used in DToL with ones published on BOLD, including those from specimens collected from southwestern Yukon, Canada. British and Canadian barcodes cluster in different BINs and it appears they are separate species. James O'Hara kindly provided me with a loan of specimens from Canada and when compared with British specimens they display some clear morphological differences. A third population of *G. angustata* occurs in Central Asia: Russian South Siberia, Mongolia, China and Kyrgyzstan (Ziegler 2015, O'Hara et al. 2020, Environment and Climate Change Canada 2023). I suspect those may represent a third species in that complex and I am hoping to examine the specimens in the future.

At present I am passing my time preparing samples for genome skimming (including some primary types) for the Biodiversity Genomics Europe project. We have also other projects looking at molecular data and we are always exploring funding opportunities and potential for collaboration.

At the same time we are preparing our collections for the mass digitisation project: *The Distributed System of Scientific Collections UK* (DiSSCo UK), scheduled to commence next year. All of the specimens will be imaged individually and the data incorporated into our Collections Management System and Data Portal (data.nhm.ac.uk). This will vastly improve data sharing and reduce the need of physical loans and handling of fragile specimens.

Being a Diptera curator at the NHM is a very varied and busy job. However, as it is fuelled by passion and vast amounts of coffee and cake shared with amazing colleagues, it rarely feels overwhelming. There are many learning and research opportunities, potential collaborations and projects to be shared. I am truly looking forward to meeting all of you at some point of our entomological journeys of discovery, either online or in person. I will do my best to help with any queries regarding tachinids at the NHM collection that you may have. Hopefully, with time, I can also add a little bit to the knowledge of Tachinidae.

Projects and collections online

Diptera collection: https://www.nhm.ac.uk/our-science/services/collections/entomology/diptera.html
Historical collections: https://www.nhm.ac.uk/our-science/services/collections/entomology/historical.html
Darwin Tree of Life: https://www.darwintreeoflife.org/
Darwin Tree of Life at the NHM: https://www.nhm.ac.uk/our-science/research/projects/darwin-tree-of-life/
UK Barcode of Life: https://www.ukbol.org/about
Biodiversity Genomics Europe: https://biodiversitygenomics.eu/
The Distributed System of Scientific Collections UK (DiSSCo UK): https://dissco-uk.org/
Natural History Museum to lead new national programme to digitise the UK's natural science collections: https://www.nhm.ac.uk/press-office/press-releases/natural-history-museum-to-lead-new-national-programme-to-digitis.html

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