

# The British Lepidoptera Collection

The Natural History Collections of  
The University of Edinburgh

Report on the **Re-cataloguing Lepidoptera**  
Project

Autumn 2017 - Spring 2018

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Frontispiece: Newly repinned and redisplayed British Hesperidae and Pieridae from the University of Edinburgh Natural History Collections

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# Introduction

A central problem facing academic or research institutions maintaining small natural history collections is the varied, taxonomically idiosyncratic, and often labour-intensive methods required for their curation and upkeep. Collections of natural history specimens represent a serious investment of time, effort and financial resources that continue to be useful for a range of biological questions, often in conjunction with cutting-edge genomic and phylogenetic techniques. Curators have a responsibility to see to their maintenance and appropriate expansion, otherwise they are certain to be slowly damaged and destroyed.

The thousands of specimens of Lepidoptera represented in the University Natural History Collections were scattered through over seventy storage boxes and drawers. Many were partially arranged according to taxonomy, but others were poorly organised: housed together with insects of different families and orders, from distinct collections received by the museum at various times (e.g. Figs. 1-3).

Such an arrangement is unsatisfactory from several perspectives.

- Material in the collection cannot be viewed by the public or utilised for educational purposes.
- The material cannot be employed for any serious scientific purpose, because its taxonomic, geographical, and numerical scope are entirely unknown.
- The disorganisation and lack of a standardised method of storage make efficient and adequate maintenance of the collection impossible to curatorial staff.
- Many specimens had not been formally catalogued and accessioned.

Many elements of the collection showed signs of significant damage due to attack by dermestid beetles, booklice (Psocoptera) and other pests of dried organic material, or through inappropriate storage and handling (e.g. Figs. 4-5).

The aim of this project was to remedy this situation for the Lepidoptera, as a pilot for the full Insecta collection at the Natural History Collections. We planned to examine all the Insecta, extracting and systematically organising the Lepidoptera. Special emphasis would be placed on specimens collected in the British Isles, which form the bulk of the material.

The ultimate goal was to achieve a fully recorded, scientifically usable collection of this group, arranged according to a modern taxonomic checklist in standardised storage units. In addition to improving the research potential of the collection, we explored the possibility of creating a new exhibit for public display using some of the specimens, illustrating the geographical distribution of butterflies and variation in faunal diversity throughout the British Isles.

# Methodology

Jamie Weir, a graduate in Evolutionary Biology with a strong amateur background in entomology, especially Lepidoptera, was recruited as a paid intern for the project (see [https://www.researchgate.net/profile/Jamie\\_Weir2](https://www.researchgate.net/profile/Jamie_Weir2) for a summary of JW's academic career and entomology and other publications).

The University recently obtained a collection of several hundred butterflies from the Malay archipelago (the "*Imrie collection*"). In order to allow for these and the original collection to be properly stored and protected, it was decided to purchase a new entomological cabinet. Cabinets are the preferable mode of storage for entomological material (particularly Lepidoptera) because they facilitate easy viewing of the specimens, by researchers and visitors, through glass-topped drawers, without exposing them to dust, damage, and the potential ingress of pests. A cabinet was purchased from Watkins & Doncaster (Hawkhurst, Kent) so that it matched the three cabinets already installed in the Aubrey Manning Gallery (Ashworth Laboratories, University of Edinburgh) and so that there would be a degree of interchangeability of drawers. This purchase will permit major reorganisation of the collection in the future without lengthy hand removal of specimens from each drawer.

Collection boxes were first frozen at  $-80^{\circ}\text{C}$  for at least 24 hours inside sealed polythene bags to kill any remaining pests.

JW examined every box, drawer and display case containing insects in the University's collections and sorted those containing any Lepidoptera from those which did not. Each of these storage units were photographed in their present state and recorded in a database. The database assigns each original storage unit a unique number, and describes the type of storage unit, its general contents (insect order, e.g. Lepidoptera, Coleoptera, mixed, etc.), a detailed description of the contents (notable localities, British *versus* foreign, principal families represented, nature of any descriptive labels, life history stages, inferences as to age and collectors, interesting specimens, estimates of the proportion of specimens which have collection data, etc.), a photograph of the contents, and details of any larger collection to which this unit belonged (e.g. Department of Forestry and Natural Resources, etc.). This records the arrangement of the specimens in the collection at this moment in time, before re-organisation.

All specimens were removed from each storage unit and assigned a unique individual reference number (these numbers formed a consecutive sequence applicable to specimens of Lepidoptera only, e.g. Lep.0123). The reference numbers of specimens occurring in each storage unit were recorded, such that it would be possible to say which original unit each individual originated from after they had been re-organised. Where specimens had suffered slight damage (e.g.

detached abdomen or wing) this was repaired if possible, using a minimum quantity of appropriate adhesive (Watkins & Doncaster insect body cement). Among the uncatalogued specimens, those few damaged to such an extent that they were judged by JW to be of no serious scientific use were discarded.

Specimens were roughly arranged into British and foreign material, with those collected in the British Isles being subsequently classified into families. British specimens were then identified to species, primarily using Howarth (1973. Colour Identification Guide to British Butterflies. Viking) and Skinner (2009. Colour Identification Guide to the Moths of the British Isles. Apollo Books). Typically, batches of phenotypically similar or congeneric specimens were identified together, to allow for comparison and the appreciation of more subtle interspecific distinctions - this is common entomological practice when identifying large quantities of material. When identified to species, specimens were arranged in cabinet drawers according to the most recent taxonomic checklist of British Lepidoptera (Agassiz *et al.*, 2015. Checklist of the Lepidoptera of the British Isles. Royal Entomological Society).

The Lepidoptera were organised into two separate collections:

1. species occurring in the British Isles (including foreign examples of those species)
2. remaining species occurring only outside of the British Isles.

It was decided by JW to include specimens not caught in the British isles in the collection of British species essentially to avoid duplication - i.e. having two series of individuals belonging to the same species, separated only on the basis of locality, when this can be easily determined by reference to the data labels. Furthermore, many specimens lacked collection data and therefore ascribing British origin to them would in any case be supposition.

# Results

In total, 74 store boxes, cabinet drawers and display boxes were photographed, recorded and the specimens contained therein removed and reorganised (Figs. 6-8). The University of Edinburgh Natural History Collections contain 2863 specimens of Lepidoptera, excluding those in the Imrie collection, which have yet to be properly documented. This includes examples of imagines (e.g. Figs. 13-14), pupae, cocoons (Fig. 9), larval spinnings (Fig. 10), larvae (Figs. 11-12), eggs, characteristic damage to larval host-plants, parasitoids, and hyperparasitoids. All specimens are preserved dry using standard methods (e.g. imagines are pin mounted, eggs and cocoons often direct pinned in situ or mounted on card, etc.). Notably, the collection contains many specimens of larvae preserved dry by "blowing", where air is passed into the hollowed skin of a specimen while it is held in a warm oven. The process involves a great deal of skill, and these specimens are in almost all instances very well preserved and delicate - as such they should be treated with particular care (Figs. 11-12). Some illustrate larvae on preserved, natural food-plants. Details of the taxonomic composition of the British portion of the collection can be found in Table 1.

All specimens were moved at least once, from their original storage units to a new temporary location, and, in the case of the British material, moved again into their final systematic order in new cabinet drawers. Cabinet drawers were organised as a continuous series of specimens running in vertical rows reading from top to bottom then left to right, following convention. Labels detailing higher taxonomic levels (family to genus) precede specimens belonging to that group, with the specific epithet appearing after all specimens of that species (Figs. 13-14). Specimens belonging to species not occurring in the British Isles were stored together for future taxonomic arrangement. Similarly, British species belonging to those families commonly referred to as "microlepidoptera" were collected into a single store box - identifying these species can be a protracted exercise, often involving genitalia dissection, and as such they were grouped together to be worked on at a future date. The collection contains several dozen specimens of British microlepidoptera.

The University of Edinburgh Natural History Collections now possesses four entomological cabinets in the Aubrey Manning Gallery, including the most recent purchase, two being used for the storage and display of Lepidoptera and one each for Diptera and Coleoptera.

# Notes and Highlights

## Collections represented

The Lepidoptera in the University's Natural History Collections are the result of several distinct donations and accessions. A large proportion of the British material in the collection are labelled "**Mitchell Collection**" or "**Mitchell Col.**", possessing no other associated data. These labels are printed and JW estimates they date from the late nineteenth/early twentieth century, though it is possible the specimens date from earlier and have been assigned these labels after they were acquired by the University, or a previous collector. It is perhaps unlikely that the collector in question ("Mitchell") would have labelled his own specimens in this fashion. Although the practice continues to an extent, collecting and preparing specimens without adequate labelling was far more common in the early nineteenth century, declining thereafter. However, one specimen labelled "Mitchell Col." also bears another labelled dating its collection to 1923 - it has evidently been purchased or received through exchange, and would suggest the Mitchell collection was accumulated and donated to the University no earlier than this date.

Other specimens were formerly part of the **University's Department of Forestry and Natural Resources collection** of economically important or injurious insects (primarily Coleoptera, but also Lepidoptera, Diptera and Hymenoptera). Before amalgamation of the Lepidoptera into a single collection, these specimens were contained in deep, heavy duty drawers which showed examples of the entire life cycle of the particular species in question, including imagines, pupa, cocoons, larvae of various instars, ova and typical damage caused to the host-plant, often with explanatory notes (e.g. Figs. 15-16). Based on labels contained within the drawers, they were arranged for display in the late 1970s and early 1980s by Alan J. Hayes, formerly a lecturer in that department.

## Collectors represented

A variety of collectors and entomologists are represented in the University's collections, as would be expected where it had resulted through several distinct accessions. Perhaps a majority originated with the "**Mitchell collection**", though this individual is not known to JW, nor can MB find any reference to him in the museum records. These specimens have almost no other associated collection data. However, a large proportion of the moths bear quite detailed labels and are attributed to a collector "**D.R.G.**". These specimens were in almost every case collected in 1958 and 1959, either in Edinburgh or some of the well-worked northern localities, such as Rannoch (Figs. 17-18). A very small proportion of the material collected by "**D.R.G.**" comes from other areas of Britain (e.g. Cheltenham).

Together, the Mitchell and D.R.G. collections comprise the great majority of all British Lepidoptera in the University's collection.

There are a number of specimens attributed to named collectors to whom one can find reference in the entomological literature, for example Leonard Tatchell (Fig. 19), S.G.C. Russell, S.W.P. Pooles (Fig. 20), W.G. Clutten (Figs. 21-22), A. Druitt (Fig. 23), Thomas H. Court, and others. Of particular note is a "silver y" *Autographa gamma* collected by H. A. Leeds at Monks Wood in Huntingdon (Fig. 24) - this can only be Henry Attfield Leeds, a celebrated collector in his time who specialised in the study of variation in butterflies. Together with P.M. Bright, he authored *A Monograph of the British Aberrations of the Chalk-hill Blue Butterfly*, and several important papers on the Satyridae. Monks Wood was one of his favoured collecting localities, strongly supporting the veracity of the label.

Almost all of the foreign material, mainly representing exotic species occurring in South America, Africa, Indochina and the Malay archipelago, was purchased from various biological supply houses in the late 1980s (principally "Worldwide Butterflies"). Hence they are not attributed to particular collectors, though the supplier is always indicated on the labels. These specimens possess inadequate collection data in most instances, often only species and country of origin being indicated, and are thus of limited scientific utility.

### ***Missives from the Museum: Notable specimens and species***

JW maintained a lively and informative public blog, "**Missives from the Museum**" (at <https://missivesfromthemuseum.wordpress.com/>), during his internship, describing the work he was doing and giving details of some of his discoveries. The collection contains many individual specimens and species which should be considered of particular interest. These include some very old specimens, collected in the late nineteenth century, and others from the early part of the last century (e.g. Figs 19-26). The large number of moths collected from Edinburgh in the late 1950s represent a valuable resource for the study of industrial melanism in species other than *Biston betularia*, a topic which has received comparatively little attention from entomologists.

There are many specimens of species now rare, vagrant or extinct in Britain in the collection, including a series of *Danaus plexippus* (Fig. 27), *Maculinea arion*, *Gonepteryx cleopatra*, and *Lycaena dispar* (Fig. 28), amongst others. While the specimens of *M. arion* in the collection originated from Poland, it is not possible to eliminate the possibility that the specimens of *D. plexippus*, *G. cleopatra* and *L. dispar* were collected in Britain. These specimens lack any collection data, and occur only rarely in this country. Detailed examination and comparison of their colouration might yield clues as to their origin.

There are also long series of specimens for some species, e.g. *Coenonympha tullia*, which might facilitate phenotypic and genomic studies of geographical variation. In addition, the collection contains a specimen of *Thysania agrippina*, a Neotropical noctuid species which has the largest wingspan of any Lepidopteran in the world (Fig. 29). There may be other such notable species among the tropical material, but this has yet to be worked through properly.

## On-going Work

Currently, the British moths in the collection have been completely identified and are now being systematically arranged in new cabinet drawers, according to the most recent checklist. It is anticipated that this will be completed in the coming weeks. This material will then be arranged, along with the drawers containing the already organised British butterflies, into an extensive reference and research collection of British Lepidoptera. In addition, the preserved specimens of life-history stages other than the imago (i.e. larvae, pupae, cocoons) and parasitoids of these species will be arranged in drawers separately and cross-referenced to the appropriate species.

Work is also underway to complete a planned exhibit of **Wings on the map: British butterflies** for public display in the museum cabinets of the Ashworth Laboratories. Our concept is of a physical map, to which we attach specimens of British species, placed in accordance with their current known ranges. We will also attempt to show rarity and abundance by having multiple specimens of abundant taxa. The solid structure of the map has been manufactured, using birch plywood with a routed outline of the British Isles. Next, representative specimens of a range of species will be selected from the collection and housed in labelled, sealed plastic boxes, to protect them from pest damage. These boxes will be fixed to the map, representing the distribution of the respective species across the country. A second Lepidoptera display is in the design stage. The intention of this display is to show the **Phylogenetic relationships of British butterflies**, similarly using actual specimens to illustrate each species, but this time placed on a large-scale phylogenetic tree of Lepidoptera, and including representative non-British specimens from the NHC to illustrate "missing" families.

The **Imrie Collection** of butterflies, mainly from Malaya, is the subject of an ongoing undergraduate honours project. In this project, a final year student is reviewing and repinning the ~400 specimens of tropical butterflies. Many of these specimens came from collections made in Malaya in the 1960's, and we have found that many others derive from Papua New Guinea collections of the same approximate date. The student is repinning these, exploring their taxonomy, providing new and enhanced descriptions, and, for a select few, performing DNA barcoding using the universal barcode marker gene cytochrome oxidase subunit 1. The DNA sequence data will allow her to place the specimens in the NHC in the full context of the



global understanding of lepidopteran (and especially Malaysian lepidopteran) diversity.

## Suggestions for Future Work

Depending on how completely the present work progresses in its organisation of the Lepidoptera, it may be that specimens of foreign species can only be organised to family level, as the literature involved in their identification and/or verification of previously ascribed specific identification is so much more extensive, and the process more protracted. It would therefore be a worthwhile object of future resources to fully arrange systematically the remaining insects belonging to this order in the University's collection.

The current project has dealt only with Lepidoptera, a single order of Insecta represented in the NHC. Based on a cursory examination of the remaining material, and considering research on tropical diseases conducted at Edinburgh in the middle of the last century, JW would suggest the Diptera (flies) are the group in most need of proper curation and systematic organisation. The number of specimens of Diptera in the collection perhaps exceed the Lepidoptera. Many (e.g. *Anopheles* mosquitoes) are economically and medically important, and are represented in large series from a range of geographical regions almost invariably with extensive collection data, potentially facilitating in-depth studies of phenotypic or genetic variation. Modern genomic techniques might allow research into evolution of the parasites for which these species act as vectors. The Diptera possessed by the University may be of significant entomological and general scientific importance, and having them studied by an appropriate specialist is of pressing concern.

Represented in the British lepidoptera collection are several individuals that form complexes of cryptic species, such as *Noctua janthe* and *N. janthina*, *Acronicta psi* and *A. tridens*, and *Oligia* spp.. Species in these groups are not reliably distinguished on morphological grounds, and resort is often made to examination of microscope mounts of the genitalia. These would be a worthwhile object of future research, separating the species by genitalia or DNA barcoding.

With regard to future maintenance of the collection, JW recommends a regular regime of freezing (at -80°C) of all Lepidoptera drawers (ideally every 6 months or as frequently as is practical). This will be easier given the now standardised storage units, and is another reason why the remainder of the Insecta should be reorganised in a similar fashion as soon as possible. JW also recommends that consideration be given to fumigants commonly used in place of the harmful p-DCB, e.g essential oils such as citronella or lavender. These do not offer an alternative to regular freezing, nor will they deal with a pre-existing infestation, but do act as an extra layer of deterrence, and are harmless to humans. JW also intends

to produce a guide describing proper practice for non-specialists working in the collection and handling specimens.

**Table: Families of Lepidoptera represented in the Natural History Collections of The University of Edinburgh (excluding families of “Microlepidoptera”)**

<i>Group / Taxonomic Family</i>	<i>Number of species</i>
<b>Butterflies</b>	<b>70</b>
Papilionidae	1
Hesperiidae	8
Pieridae	11
Danaidae	1
Satyridae	12
Nymphalidae	18
Rionidae	1
Lycaenidae	18
<b>Larger Moths (excl. “micromoths”)</b>	<b>249</b>
Arctiidae	12
Cossidae	1
Endromidae	1
Erebidae	4
Drepanidae	6
Geometridae	75
Hepialidae	5
Lasiocampidae	11
Lymantriidae	6
Noctuidae	102
Nolidae	1
Notodontidae	9
Saturniidae	1
Sesiidae	5
Sphingidae	5
Zygaenidae	5
<b>TOTAL</b>	<b>319</b>

# Museums and Galleries Fund Grant Statement

The re-cataloguing and repinning of the Lepidoptera was funded through a University of Edinburgh Museums and Galleries Fund award, and support from the School of Biological Sciences of the University of Edinburgh. We thank Jacky MacBeath, David Gray and Anne Payne for their support.

<b>Item</b>	<b>Value</b>
<b>EXPENDITURE</b> (to date; 01/03/2018)	
<b>Hardware</b>	
Purchase of Watkins and Doncaster 20 drawer insect cabinet (including carriage)	£3051.60
Purchase of entomological supplies from Watkins and Doncaster (insect pins, insect glue, plastazote)	£104.52
Purchase of labelling card and laser cartridges	£138.00
Purchase of ziplock polythene bags for specimen freezing	£62.15
<b>Hardware TOTAL</b>	<b>£3356.27</b>
<b>Staff</b>	
<b>Stipend for Jamie Weir, intern</b>	<b>£1727.60</b>
<b>EXPENDITURE TOTAL</b>	<b>£4083.87</b>
<b>INCOME</b>	
CCUC grant	£1000.00
SBS Support	£2200.00
From NHC account (accrued income)	£104.52
From M. Blaxter G40273 account*	£1979.35
<b>INCOME TOTAL</b>	<b>£4083.87</b>
From M. Blaxter G40273 account*	£1979.35
<b>Balance</b>	<b>£0.00</b>

\* Please note that these funds are from Prof. M. Blaxter's non-grant income, and were not specifically acquired for this purpose. Some of these funds may be claimed from the NHC account if 2018 expenditure is lower than expected.

# Figures



Figure 1. Original storage unit no.3, containing assorted disorganised and damaged microlepidoptera.



Figure 2. Original storage unit no.22, containing disorganised noctuid moths from various collections and localities.



Figure 3. Original storage unit no.33, containing damaged and disorganised geometrid moths.



Figure 4. Original storage unit no.13, showing damage resulting from an infestation of dermestid beetles. The body and wings of some specimens are irreparably damaged or entirely destroyed.



Figure 5. Original storage unit no.68, a cabinet drawer containing tropical Lepidoptera. A large quantity of frass is visible beneath the large specimen in the top right, indicative of damage resulting from an infestation of dermestid beetles or other pests of dried organic material.





Figure 6. Store boxes containing specimens of Lepidoptera before reorganisation of the collection.



Figure 7. Drawers containing specimens of Lepidoptera arranged in the Ashworth laboratories, University of Edinburgh. Each drawer contained specimens before the reorganisation of the collection.





Figure 8. An example storebox filled with noctuid moths before identification to species and systematic reorganisation in new cabinet drawers.

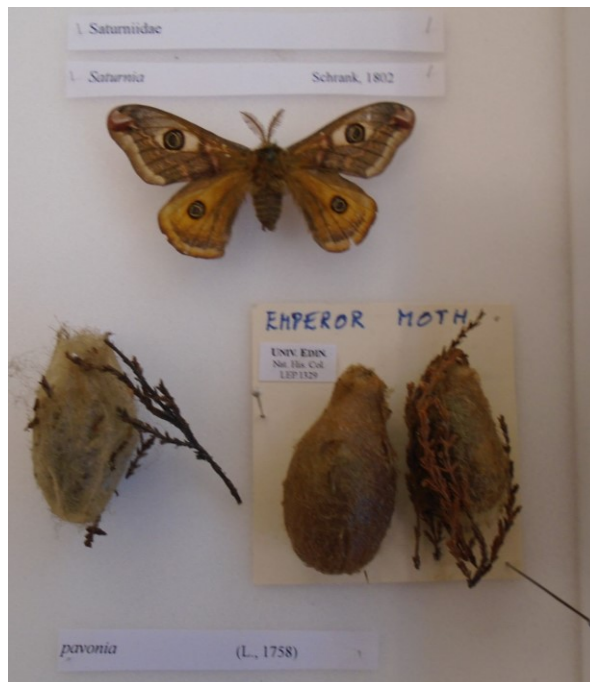


Figure 9. Pupae and cocoons of the emperor moth *Saturnia pavonia*.



Figure 10. Larval spinnings of the brown-tail moth *Euproctis chrysorrhoea*. Larvae use silk to spin together a protective nest of leaves on their host-plant.



Figure 11. Skins of Lepidopteran larvae preserved dry via "blowing".



Figure 12. Preserved larvae of the scalloped hazel *Odontopera bidentata*, a geometrid moth.





Figure 13: Drawer of re-organised British Satyridae. Specimens are arranged by species in columns or "series" reading from top to bottom, left to right. The generic name appears at the head of the columns and specific epithet follows the series of that species. The taxonomic sequence follows Agassiz *et al.* (2015).



Figure 14. Drawer of re-organised British Lycaenidae (the "Blues"). Specimens are arranged by species in columns or "series" reading from top to bottom, left to right. The generic name appears at the head of the columns and specific epithet follows the series of that species. The taxonomic sequence follows Agassiz *et al.* (2015).





Figure 15. Drawer showing the life-cycle of the pine beauty *Panolis flammea*, including adults, ova, larvae, pupae, parasitoids and characteristic damage to host plants. From the collection of the Department of Forestry and Natural Resources, University of Edinburgh.



Figure 16. Drawer showing the life-cycle of *Cossus cossus*, including adults, larvae, pupae, cocoons, and characteristic damage to host plants. From the collection of the Department of Forestry and Natural Resources, University of Edinburgh.



Figure 17. Specimen of *Noctua janthe/jantheta* collected in Edinburgh on 3 August 1958 by "D.R.G."



Figure 18. Specimen of great brocade *Eurois occulta* collected near Loch Rannoch on the 19 July 1958 by "D.R.G."

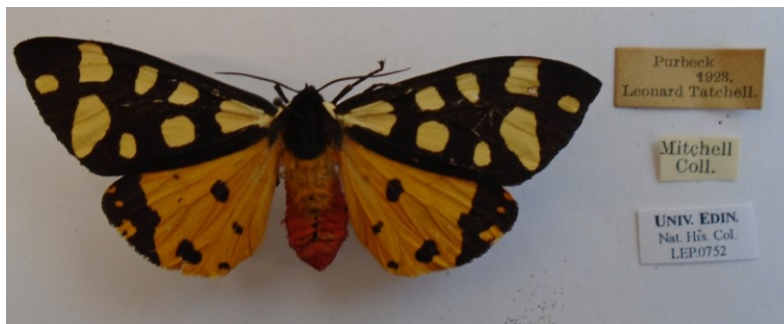


Figure 19. Specimen of the cream-spot tiger *Arctia villica* collected from the Isle of Purbeck by Leonard Tatchell in 1923.



Figure 20. Specimen of the black arches *Lymantria monacha*, collected from Castor Hanglands in Cambridgeshire, by S.W.P. Pooles.



Figure 21. Specimen of the cinnabar *Tyria jacobaeae*, collected from Manchester in 1899 by W.G. Clutton.



Figure 22. Specimen of the large yellow underwing *Noctua pronuba*, collected in Burnley in 1895 by W.G. Clutton.



Figure 23. Specimen of the clouded border *Lomaspilis marginata*, collected in Hampshire in 1891 by A. Druitt.





Figure 24. Specimen of the "silver y" *Autographa gamma*, collected from Monks Wood, Huntingdon, on the 16 July 1911 by H.A. Leeds. Leeds was a noted field entomologist of the early twentieth century and co-author, with P.M. Bright, of the *Monograph of the British Aberrations of the Chalk-hill Blue Butterfly*, a comprehensive treatment of phenotypic variation in that species.



Figure 25. Specimen of the early grey *Xylocampa areola*, collected from Tilgate, Sussex, in 1895.



Figure 26. Specimen of the brown-tail moth *Euproctis chrysorrhoea* from the Isle of Sheppy, collected by an anonymous individual in 1907.



Figure 27. Series of the monarch butterfly *Danaus plexippus* in the University of Edinburgh Natural History Collections. Several bear labels which indicate they were collected in North America, though it is possible that those labelled only "Mitchell Col." may be rare migrants to Britain.



Figure 28. Series of the large copper *Lycaena dispar* in the University of Edinburgh Natural History Collections. None of these specimens possess any collection data, so they may have originated in mainland European localities, may have been bred in Britain from European livestock, or they may have been collected from one of the several artificial colonies of this species established in the British Isles after its extinction.



Figure 29. The white witch moth *Thysania agrippina*. This species has the largest wingspan of any species of Lepidoptera in the world (measured as twice the distance from the centre of the thorax to the apex of the forewing). A member of the Noctuidae, it occurs throughout South America, though the specimen has no associated collection data.