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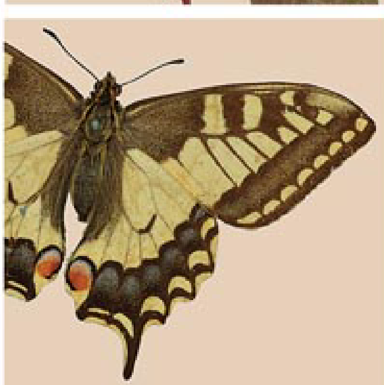
PATRON: HER MAJESTY THE QUEEN

The Linnaean Collections



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The Linnaean Collections

edited by

B. Gardiner and M. Morris

WILEY-BLACKWELL
9600 Garsington Road, Oxford OX4 2DQ

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Introduction

In its creation the Linnaean methodology owes as much to Artedi as to Linneaus himself. So how did this come about? It was in the spring of 1729 when Linnaeus first met Artedi in Uppsala and they remained together for just over seven years. It was during this period that they not only became the closest of friends but also developed what was to become their *modus operandi*.

Artedi was especially interested in natural history, mineralogy and chemistry; Linnaeus on the other hand was far more interested in botany. Thus it was at this point that they decided to split up the natural world between them. Artedi took the fishes, amphibia and reptiles, Linnaeus the plants, insects and birds and, while both agreed to work on the mammals, Linneaus obligingly gave over one plant family – the Umbelliforae – to Artedi "as he wanted to work out a new method of classifying them".

Before they left Uppsala Artedi and Linnaeus made a pact "if one should die the other would regard it as a sacred duty to give the world what observations might be left behind by him who had gone". Sadly, eight years later, on the 27th September 1735 Artedi, returning from a convivial evening with his employer, Albert Seba, stumbled into an unfenced canal and was drowned.

True to his word, Linnaeus began editing *Ichthyologia*, Artedi's manuscript, for publication. In the first chapter, which Linnaeus left untouched, we find the fully developed form of the Linnean method, which the two friends had evolved in collaboration during those seven years in Uppsala. In a letter of 1737, to Haller, Linnaeus writes: "in printing the posthumus works of my late friend Peter Artedi, in which if I mistake not, you will see more perfection than can be expected in botany for a hundred years to come. He has established natural classes, natural genera, complete characters, a universal index of synonyms, incomparable descriptions and exceptional specific definitions". In publishing *Ichthyologia* and in this letter to Haller Linnaeus has shown us what an important part Artedi played in the birth of systematics and the methodology he himself used in the *Systema*.*

Finally, proof that they both worked on mammals can be deduced from Broberg (1983) who summarised an unpublished manuscript of Artedi (written in the early 1730s) *Idea Institutionium Trichozoologiae* in which Artedi included man with the apes as subsequently did Linnaeus in the *Systema*.

As noted above, Artedi died in 1735 leaving Linnaeus alone to classify the natural world. Linnaeus started with the plants. First he published *Philosophia botanica*, refered to as "The masterpiece of the most compleat naturalist the world has ever seen"

*In recognition of Artedi's contribution to the Linnean methodology Linneaus named a member of the Umbelliforae *Artedi* in his memory.

(*Gentleman's Magazine* 1754). However, by 1750 Linnaeus had collected some 14 of his students to whom he referred as his apostles, and who subsequently went overseas to collect and bring back for him foreign plants. As Stern pointed out "Linnaeus' sexual system enabled specimens to be allocated quickly to groups and provided with names. The Linnaean method of botanical recording thus made botanical exploration worthwhile, for this became a means of contributing on a large scale to the world's knowledge. "Therein", continued Stern, "lies the clue to the zeal for travel that animated so many of Linnaeus' students/apostles".

To give you some idea of the extent of the 14 apostles' travels they are summarised below:

Anders Berlin (1746-73) went over much of North Africa, while Peter Forskål (1736-68) traveled to Arabia. Fredrik Hasselquist (1722-52) visited both Egypt and Palestine, while Pehr Löfling (1729-56) went to Spain, the Canary Islands, Colombia and Venezuela. Christopher Tärnström (1703-1837), on the other hand, collected in China. Adam Afzelius (1750-1837) confined himself mainly to North Africa while Pehr Kalm (1715-79) ranged all over North America, including Canada. Johan Gerrard König (1728-85) visited Tranquebar, whereas Lars Martin (1723-85) collected exclusively from Spitzbergen. Pehr Osbeck (1723-1805), like Tärnström, collected from China, but unlike Tärnström he also included the Far East. Daniel Rolander (1725-93) visited Surinam, whereas Daniel Carl Solander (1736-82) went with Cook and Banks on Cook's first voyage round the world. Finally, Anders Sparrman (1748-1820) joined Cook's second voyage of some 6,000 nautical miles, in the course of which he went to China, South Africa and Senegal.

BRIAN GARDINER FLS
Editor of *The Linnean*

Reference

Blunt, W. 1971, with the assistance of William T. Stearn. *The Compleat Naturalist, A Life of Linnaeus*, London, Collins.

A concise history of the Linnean Society's Linnaean Herbarium,

with some notes on the dating of the specimens it contains

Charlie Jarvis FLS

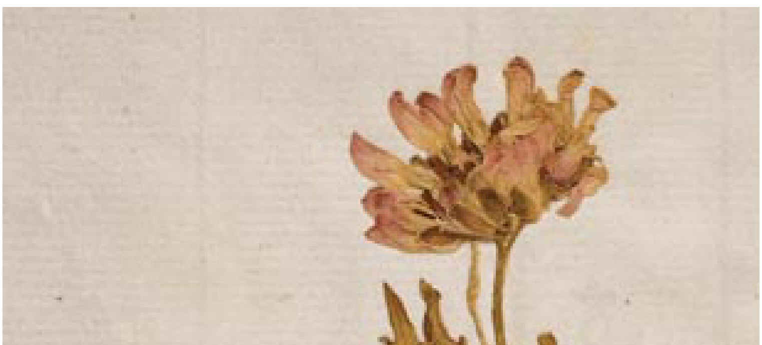
Department of Botany, Natural History Museum, Cromwell Road, London SW7 5BD

Linnaeus' herbarium specimens have been the subject of increasingly close scrutiny in recent years, chiefly as a result of the activities, both directly and indirectly, of the Linnaean Plant Name Typification Project (Cannon *et al.* 1983; Jarvis 1992; Jarvis & Cafferty 2003). In May 2007, this Project reached a major landmark with the publication of "Order out of Chaos – Linnaean plant names and their types". In this work, Linnaean (and Linnaean-linked) collections are discussed in detail, along with the collectors who supplied specimens and other sources of information, as well as an exhaustive A–Z of Linnaean binomials and their types, and much supplementary information. This article draws on the much more detailed account in my book (Jarvis 2007), to which the interested reader is referred.

The strongroom of the Linnean Society of London holds what is undoubtedly the single most important Linnaean collection of plant specimens, as well as the largest. Linnaeus started to assemble a herbarium in 1727, when he was 20, after seeing the collection of Kilian Stobaeus in Lund, and it grew steadily in size, not only through specimens he had collected himself, but also through acquisitions from friends, and later students and correspondents. The great Linnaean scholar William Stearn (1957:

Part of Linnaeus' herbarium and library in the strongroom at the Linnean Society.

105–108) identified five periods in its development between 1727 and the present. The first covers the period from its inception until 1752 when Linnaeus completed his manuscript of *Species Plantarum*. Starting with the plants he had collected himself around Stenbrohult, Lund and Uppsala, Linnaeus augmented these with his own Lapland specimens in 1732 (though they were soon to be given to Johannes Burman), and with duplicates from George Clifford's garden and from John Clayton's Virginian collection (given to him by Johan Gronovius) during Linnaeus' stay in the Netherlands in 1735–1738. Plants from Mexico (from Houstoun), the South of France (Magnol and Boissier de Sauvages), Russia (Amman, Gerber), Siberia (Gmelin), Kamchatka (Steller), China (Osbeck) and eastern North America (Kalm) followed, and this was the herbarium, supplemented by that of Burser which he could consult in Uppsala, that supplied Linnaeus with much of the specimen-based information that he used in producing *Species Plantarum*.



A specimen (842.3) believed to have been collected in Kamchatka by Georg Steller, the lectotype of *Arabis grandiflora* L. (= *Parrya nudicaulis* (L.) Regel).

Specimen of the genus that Linnaeus named *Hassequistia* to commemorate his apostle Fredrik Hasselquist. This specimen (348.2 LINN) is the lectotype of *H. aegyptiaca* L.

The second period runs from 1753 until Linnaeus' death in 1778 and was characterised by the steady addition of more material, often sent by former students such as Forsskål (plants mainly from Egypt, Arabia), Hasselquist (Middle East), Löfling (Spain and Portugal), Rolander (Surinam), Sparrman (South Africa) and Thunberg (South Africa, Japan), but also from correspondents like Allamand (Surinam), Allioni (Italy), Alströmer (Spain), Arduino (Italy and Brazil), Brander (Algeria), the Burmans (South Africa), Dahlberg (Surinam), Gérard (South of France), Gouan (South of France), Hudson (England), Jacquin (various), Kähler (Mediterranean), König (South Africa, India), Mútis (Colombia), David van Royen (various), Schreber (South Africa), Scopoli (Italy), Séguier (South of France), Swartz (Caribbean), Tulbagh (South Africa), Turra (Italy) and Vandelli (Portugal). Linnaeus had bought Patrick Browne's Jamaican herbarium in 1758. However, as well as acquisition, the discarding of specimens was also a feature in this period. Linnaeus' son, in a letter to his father's great friend Abraham Bäck in 1779, wrote "my late father weeded out his herbarium while he was able to work and seems to have burned all the duplicates, why, no one knows" (Stearn 1957: 108). Linnaeus had moved his collections, in haste, out of Uppsala at the time of the city's 1766 fire and subsequently housed them in a small, unheated museum that he had built in the grounds of his country estate at Hammarby. More of the supposed "duplicates" (specimens merely believed to be conspecific, rather than of the same provenance and/or gathering) were given away to Swedish friends and colleagues such as Alströmer, Bäck, Bergius, Montin, Retzius, Solander and Wahlbom. Such specimens comprise most of the Linnaean herbarium at the Swedish Museum of Natural History in Stockholm, and others are at the University of Uppsala.

The third period runs from Linnaeus' death in 1778 to that of his son in November 1783. Linnaeus had bequeathed his collections to his wife, Sara Lisa, explicitly prohibiting his son from having access to them. They therefore remained locked away at Hammarby while Sara Lisa tried to sell them but when this failed, she reluctantly allowed her son to remove them to Uppsala where he spent much time trying to restore the damage caused to them by the damp, verminous conditions they had endured. However, he apparently discarded the most badly damaged sheets.

The fourth period runs from Linnaeus filius' sudden death in late 1783 until that of J.E. Smith in 1828. Sara Lisa again attempted to sell the collection, which was offered to Sir Joseph Banks in the light of his earlier interest in buying the collection after Linnaeus' death. Banks was apparently not in a position to do so but recommended to the young James Edward Smith, with whom he was breakfasting when the letter from Sweden arrived, that he should secure the collection himself. Not without some difficulty, Smith eventually persuaded his father to provide the money for the purchase and, in October 1784, the entire collection arrived in England. After study and comparison by Smith, Dryander and Banks with Banks' herbarium (then at his home in Chelsea), Smith disposed of a number of supposed duplicates from the Linnaean plant collection. These included 85 to Banks (enumerated by Savage 1937: 10), which are now kept as a separate collection at BM (and which includes the lectotype of *Arabis capensis* L.), as well as smaller gifts to Davall (see de Beer, 1947), Hosack (taken to New York but now believed lost, see Robbins 1960) and Roscoe (now at LIV, listed by Stearn 1957: 111). Stearn reviews the subsequent history of the collection, through the founding of the Linnean Society of London in 1788 (of which Smith was the first President), the sale by Smith of the mineral collection in 1796, and the transfer of the library and collections to Smith's home in Norwich where they remained, comparatively inaccessible, until after his death in 1828.

The fifth and final period follows Smith's death. Despite his claim in his first Presidential address to the Linnean Society that, as far as the Linnaean collections were concerned, Smith considered himself "a trustee of the public", holding them "only for the purpose of making them useful to the world and natural history in general, and particularly to this society", he did not bequeath them to the Society in his will. Instead the Society was forced to borrow money (only managing to pay off the debt in 1861) to purchase them from the executor of Smith's estate.

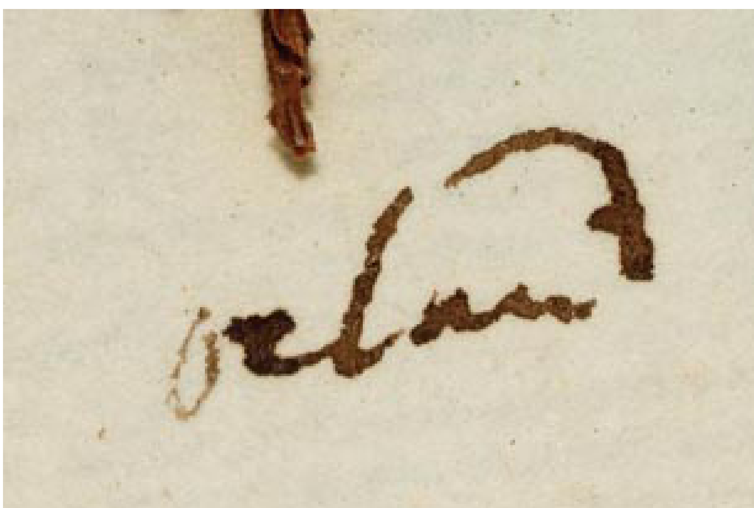
Cataloguing the Linnaean Herbarium

After their acquisition by the Society, the plant collections were quite frequently consulted (see Jackson (1922: 27–30) for a list of publications in which various specimens featured), and the first attempt at a published index to the botanical collection was that of the same author, Benjamin Daydon Jackson (1912), the Society's Librarian. Useful though this was, it has been supplanted by the much more detailed catalogue prepared by Spencer Savage (1945), his successor, which provided transcriptions of the annotations for each sheet and also introduced, for the first time, a numbering

The type sheet (1273.125) of *Lichen prunastri* L. (= *Evernia prunastri* (L.) Ach.).

system for the collection as a whole. Jackson also interpreted annotations in a series of lists at LINN as indicating whether a particular specimen was present in the herbarium in 1753, 1755 and 1767. Savage (1945: xi) opined, however, that this interpretation was “mere presumption”, and Jackson’s “dating” is frequently at odds with information drawn, for example, from Linnaeus’ correspondence, and cannot be relied upon (see Gage & Stearn 1988: 179). Unfortunately, some later authors have been misled by Jackson’s hypothesis into making inappropriate or disruptive type choices.

In 1939, the collections were evacuated from London first to Woburn Abbey, then the Tring Zoological Museum before returning to Burlington House in 1946. During this period, the sheets were numbered by Savage to facilitate their being systematically microfilmed, and his 1945 Catalogue was prepared to accompany the images. However, copies of the microfilm were distributed only to the University of Uppsala and the Arnold Arboretum, Massachusetts and were never widely available.



“oeland” [= Öland], written by Linnaeus on his sheet of *Cistus oelandicus* L. (689.40), indicating its provenence.

The Linnaean herbarium (LINN) remains substantially as it was when the Society acquired it in 1829, although there have been what Stearn refers to as “fragmentary” losses since then. Small samples removed from selected specimens can now be found in the collections of the Smithsonian Institution, Washington (US), the Field Museum, Chicago (F), the Gray herbarium at Harvard University (GH), the Universidad de Buenos Aires (BAA) and the Instituto de Botánica Darwinion, San Isidro (SI).

One slightly puzzling feature of Linnaeus’ herbarium is the comparatively small amount of Swedish material that it contains (see Lindberg 1958, Gage & Stearn 1988: 178). That it lacks all but a few of the collections that Linnaeus made in Lapland in 1732 is no surprise, as these were given to Johannes Burman and are still extant in the Institut de France in Paris (see, for example, the type of *Nymphaea lutea* L., reproduced in Jarvis 2007: 171). However, Linnaeus collected extensively in other parts of Sweden too, yet there seem to be surprisingly few of these specimens in LINN. An exception can be found among the lichen collections, where many specimens were annotated by Linnaeus with the corresponding account number from *Flora Suecica* (1745). This work utilised a single number sequence through the entire volume, with the members of *Lichen* numbered from 936 to 991 (e.g. “959” appears on sheet 1273.125 LINN, corresponding with the entry for the species subsequently named *Lichen prunastri* L.). A detailed study of Linnaeus’ lichen names and their associated specimens and illustrations has been provided by Jørgensen *et al*. (1994).

A Patrick Browne collection from Jamaica, the lectotype of *Croton glabellus* L. (= *Phyllanthus glabellus* (L.) Fawc. & Rendle).

Elsewhere in the collection, there are occasional specimens that carry geographical information written by Linnaeus that confirms their origin as Swedish. From their annotations, some may well have been collected by Linnaeus himself, e.g. *Alisma ranunculoides* L. (473.6: "Gotland"), *Agrostis pumila* L. (84.28: "Hammarby"), *Astragalus alpinus* L. (926.41: "Lapp."), *Veronica hybrida* L. (26.14: "in insula Maelari", "Fläsklösan"), *Cistus oelandicus* L. (689.40: "Oel." [Öland]), *Carex arenaria* L. (1100.9: "Scania") and *Pulmonaria angustifolia* L. (184.1: "Scara Wgothia"). However, others (e.g. "Jemtia" [Jämtland] (*Satyrium nigrum* L., 1055.4) refer to places that Linnaeus never visited, so these specimens must have been collected by others. Stearn (*in litt.* 16 Mar 1966) wrote: ". . . most of the Swedish specimens known once to have been in Linnaeus's possession are missing from the Linnaean herbarium, as Swedes long ago noted, but unfortunately nothing is known of their fate; they may have been taken out for a special purpose and then destroyed as a whole either accidentally or deliberately, as Linnaeus burned a large number of specimens in his old age".

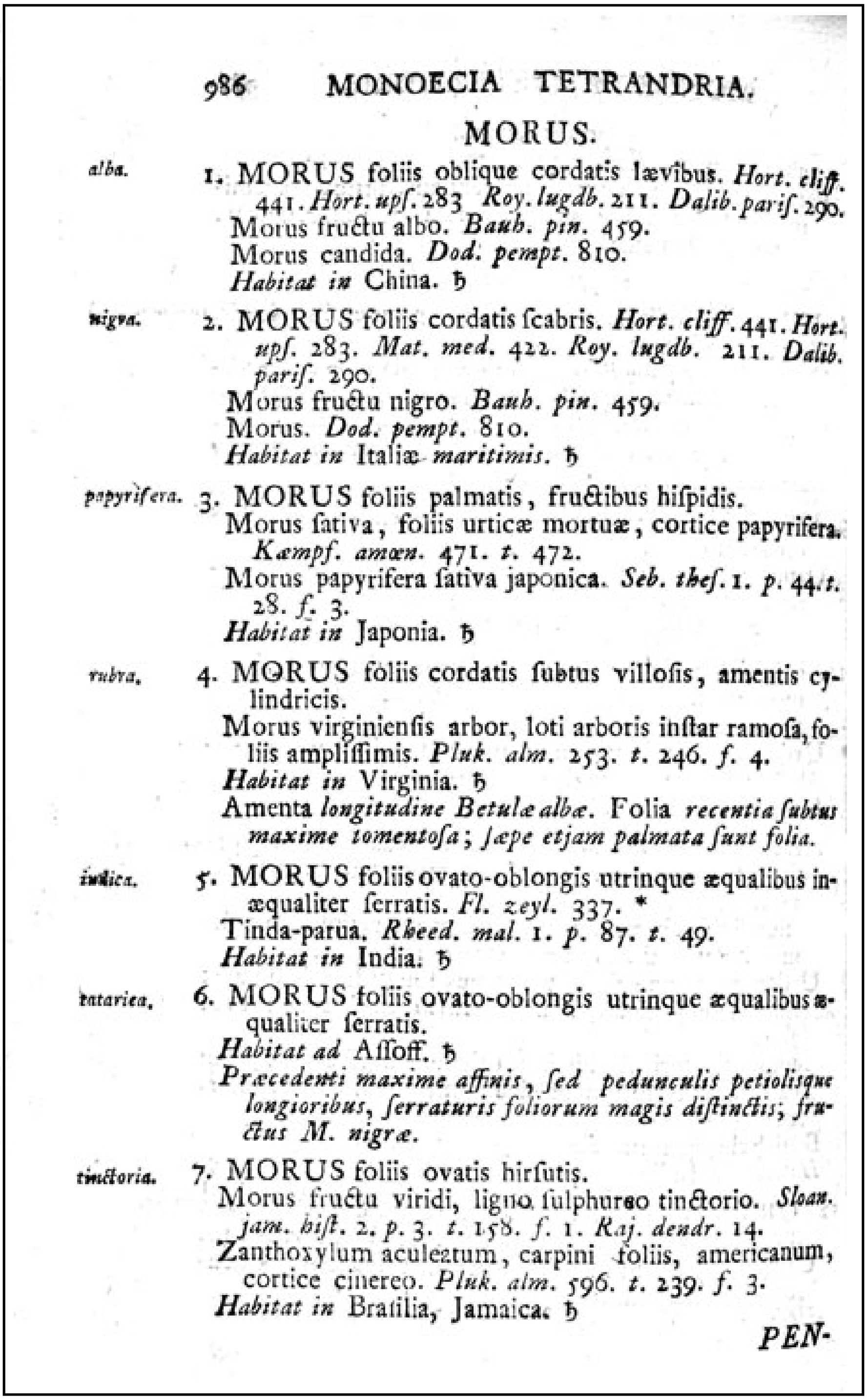
Dating of Specimens in the Linnaean Herbarium

For the purposes of establishing type specimens for Linnaean names, it is clearly important to know if a given specimen was in Linnaeus' possession by the time he named its corresponding species, or whether it was a later acquisition. Most of the collections that Linnaeus studied which did not end up in his own herbarium (e.g. those of Clayton, Clifford and Hermann, now at the Natural History Museum in London) he studied long before he published the associated binomials. Consequently, provided they have appropriate bibliographical or other links (e.g. annotations by Linnaeus), there is little uncertainty about the status of these specimens as original material.

However, it would clearly be wrong for a specimen collected after Linnaeus had described the species to which it belonged to be accepted as original material for that name. The dating of collections in Linnaeus' own herbarium is not straightforward, and has been the subject of differing interpretations in the past. There are few problems in ascertaining the approximate dates of acquisition where specimens are clearly linked with their collectors (e.g. Allioni, Brander or Browne), as these can often be correlated with other sources of information (e.g. dated letters received by Linnaeus). However, the comparative brevity of annotation on the majority of the specimens, and the frequent absence of collector information in the original publication of the name often makes it difficult to ascertain the provenance of a given specimen with any degree of confidence.

Many authors in the first half of the 20th century followed Jackson (1912), who interpreted marginal marks made by Linnaeus in copies of his works published between 1753 and 1767 as confirmation of the presence or absence of material in the Linnaean herbarium at the time of each "enumeration". However, it is worth quoting Stearn (*in litt.*, 20 May 1983, in a discussion of the relevance of sheet 1071.10 (LINN), material apparently linked with *Aristolochia longa* L.):

> "This, according to Jackson, was in Linnaeus's possession prior to 1753. Linnaean scholars have long known that no reliance whatever can be placed on such a statement by Jackson, which was based on the fact that Linnaeus underlined many specific numbers in his interleaved copy of the *Species*



986 MONOECIA TETRANDRIA.

MORUS.

alba. 1. MORUS foliis oblique cordatis lævibus. *Hort. cliff.* 441. *Hort. upf.* 283 *Roy. lugdb.* 211. *Dalib. parif.* 290.
Morus fructu albo. *Bauh. pin.* 459.
Morus candida. *Dod. pempt.* 810.
Habitat in China. ♄

nigra. 2. MORUS foliis cordatis fcabris. *Hort. cliff.* 441. *Hort. upf.* 283. *Mat. med.* 422. *Roy. lugdb.* 211. *Dalib. parif.* 290.
Morus fructu nigro. *Bauh. pin.* 459.
Morus. *Dod. pempt.* 810.
Habitat in Italiæ *maritimis.* ♄

papyrifera. 3. MORUS foliis palmatis, fructibus hifpidis.
Morus fativa, foliis urticæ mortuæ, cortice papyrifera. *Kæmpf. amœn.* 471. *t.* 472.
Morus papyrifera fativa japonica. *Seb. thef.* 1. *p.* 44. *t.* 28. *f.* 3.
Habitat in Japonia. ♄

rubra. 4. MORUS foliis cordatis fubtus villofis, amentis cylindricis.
Morus virginienfis arbor, loti arboris inftar ramofa, foliis ampliffimis. *Pluk. alm.* 253. *t.* 246. *f.* 4.
Habitat in Virginia. ♄
Amenta *longitudine Betulæ albæ.* Folia *recentia fubtus maxime tomentofa; fæpe etjam palmata funt folia.*

indica. 5. MORUS foliis ovato-oblongis utrinque æqualibus inæqualiter ferratis. *Fl. zeyl.* 337. *
Tinda-parua. *Rheed. mal.* 1. *p.* 87. *t.* 49.
Habitat in India. ♄

tatarica. 6. MORUS foliis ovato-oblongis utrinque æqualibus æqualiter ferratis.
Habitat ad Affoff. ♄
Præcedenti maxime affinis, fed pedunculis petiolisque longioribus, ferraturis foliorum magis diftinctis; fructus M. nigræ.

tinctoria. 7. MORUS foliis ovatis hirfutis.
Morus fructu viridi, ligno fulphureo tinctorio. *Sloan. jam. hift.* 2. *p.* 3. *t.* 158. *f.* 1. *Raj. dendr.* 14.
Zanthoxylum aculeatum, carpini foliis, americanum, cortice cinereo. *Pluk. alm.* 596. *t.* 239. *f.* 3.
Habitat in Brafilia, Jamaica. ♄

PEN-

The account of the genus *Morus* in Linnaeus' *Species Plantarum* (1753: 986).

The type specimen of *Morus tatarica* L., annotated with the corresponding *Species Plantarum* number (i.e. "6") and almost certainly collected by Traugott Gerber.

Plantarum (1753). No one really knows why he did this. Linnaeus nowhere stated the intent of this underscoring but Jackson guessed that it referred to the presence of a specimen in his herbarium, for which there is no proof and much difficulty. Even if this were so, it would not necessarily be evidence that the specimen now in the Linnaean Herbarium is the very same specimen Linnaeus had under his eyes when drafting before 1753 the text of the *Species Plantarum*. Modern botanists tend to overlook the fact that Linnaeus lived in the 18th not the 20th century and that a good illustration often provided him with more useful relevant information than a poor specimen. However,

> as Spencer Savage, a great Linnaean scholar long in charge of the Linnaean Herbarium, at one time Jackson's assistant, later his successor, stated in 1945, "it is mere presumption to suppose that the markings had the intention of registering the presence of specimens in the Herbarium"".

There are numerous examples where Jackson's theory is contradicted by independent evidence. For example, he lists material of *Phyteuma orbicularis* L. as present in the first (1753) enumeration. However, the only material associated with this name (sheet 223.7) carries a numbered (39) label written by Linnaeus' correspondent, Giovanni Scopoli, which corresponds with a specimen listed in a letter, dated 1762, which was sent to Linnaeus by the Italian. Clearly, this specimen could not have been in Linnaeus' possession in 1753.

Refuting Jackson's theory, Stearn instead emphasised the importance of the numbers that Linnaeus often wrote on his herbarium sheets. These typically appear towards the bottom of the sheet, centrally and just below the specimen(s) in question, and are often placed near to the specific epithet, where present. Such numbers almost always link these specimens with the corresponding account in the first edition of *Species Plantarum* (1753).

In the case of *Morus*, for example, species number 1 (*Morus alba*) is represented in LINN by sheet 1112.1 which bears both "1" and "alba" near the base, and by 1112.2, which carries just "1". Similarly, for the second species, *Morus nigra*, there is sheet 1112.3 "2 nigra", and for the fourth, *Morus rubra*, 1112.6 "rubra 4" and "K"[alm] indicating the provenance of this North American collection. *Morus tatarica* is the sixth species, represented by sheet 1112.9 "tatarica 6". However, *Morus zanthoxylum*, which was not published until 1759 and is represented by sheet 1112.10, carries no number but only "Xanthoxylon" (deleted), and "tinctoria" in Linnaeus' hand.

The numbers that Linnaeus gave to his species in 1753 were retained in his next worldwide treatment in *Systema Naturae*, ed. 10, vol. 2 in 1759, with species that he was describing as new (or had already described since 1753) intercalated between the existing species and allocated letters rather than numbers. In the 1759 treatment of *Myrtus*, for example, there are six new species, lettered A to E, scattered among the seven species recognised in 1753. The letters often appear on associated herbarium specimens in LINN, as is the case with *Myrtus biflora* ("A" – 637.6), *Myrtus dioica* ("B" – 637.11), *Myrtus chytraculia* ("C" – 637.12) and *Myrtus zuzygium* ("D" – 637.13). By his next global treatment in the second edition of *Species Plantarum* (1762), Linnaeus decided to renumber the species.

Here, *Myrtus biflora* appears as number three, *Myrtus dioica* as six, *Myrtus chytraculia* as seven and *Myrtus zuzygium* as eight. This process was repeated in his last comprehensive treatment of the plants in *Systema Naturae*, ed. 12, vol. 2 (1767) with the now 12 recognised species again being partially renumbered.

Significantly, it is only the species numbers from the first edition of *Species Plantarum* (or the letters from *Systema Naturae*, ed. 10, vol. 2) that appear on sheets in this way, and Stearn, from long study of the herbarium specimens and protologues over many years, reached the conclusion that the presence of such a number provided extremely strong evidence that the collection in question was in Linnaeus' possession by 1753.

Stearn (*in litt*., 20 Mar 1969) wrote:

> "The fact, however, that Linnaeus possessed a specimen of a given taxon in 1753 does not necessarily mean that this same specimen exists in the Linnaean Herbarium today, since Linnaeus sometimes replaced an earlier gathering by a later one conspecific with it in his opinion though not necessarily so, according to ours. Fortunately such substitution, as far as the first edition (1753) of the *Species Plantarum* is concerned, becomes evident through absence of a species number associated with that edition. Conversely, the presence of such a number usually establishes authenticity. Neither Jackson nor Savage appreciated the historical relevance of the numbers on the sheets of the Linnaean herbarium, possibly because working taxonomists and matters of typification of names were not so critically considered in their day. Linnaeus had not hit upon the consistent use of *nomina trivialia* (specific epithets) when he began to prepare the first draft of the *Species Plantarum* and before the introduction of binomial nomenclature for species the only convenient way to designate them concisely was by use of numerals. There is good reason to believe that Linnaeus originally numbered his herbarium sheets using *Species Plantarum* entry numbers, later added specific epithets, then used a number and a specific epithet together on a sheet, then abandoned numbers (since the renumbering of entries in his later works would have necessitated the total renumbering of his herbarium to obviate confusion), and used simply a specific epithet alone. After 1753 Linnaeus gave *Species Plantarum* (1753) entry numbers to the specimens he received from Louis Gérard in 1753, but not, it would appear, to much of any later material. Hence a number on a sheet is fairly good evidence that Linnaeus possessed it in 1753 and examined it for the *Species Plantarum*".

Years of study of Linnaean protologues and collections have not convinced me that Stearn's hypothesis is seriously flawed. As he notes, Gérard's specimens (received by Linnaeus after the publication of *Species Plantarum*), where they represented species already known to Linnaeus, were annotated with the relevant *Species Plantarum* number. For example, *Gérard 13* (sheet 982.8) is annotated "*linosyris* 4" [= *Chrysocoma*] by Linnaeus, and something similar occurred with at least some of the specimens acquired in 1758 from Patrick Browne. However, where we know the provenance and date of acquisition of collections, there is, generally, a very strong correlation (for 1753 names) on the one hand between presence in the herbarium pre-1753 and a number written on the sheet, and on the other, acquisition post-1753 and the absence of any such number.

For the Linnaean Plant Name Typification Project, in dealing with over 9,000 names, it has been necessary to adopt a consistent approach to the interpretation of what is, and what is not, original material. Based on Stearn's hypothesis, for those names published in 1753, material in LINN (and the collections derived from that herbarium) that lacks a *Species Plantarum* number written on the sheet by Linnaeus is not, in general, accepted as being original material for the name in question. However, if, in individual cases, additional data (e.g. dated specimen lists, geographical information, precise agreement with a description etc.) suggest strongly that an unnumbered sheet was available to Linnaeus, and that he believed it to be identifiable with the name in question, then such sheets have been admitted as original material.

Consulting the Linnaean Herbarium in the 21st century

Until the late 1950s, the only way of consulting and studying the Linnaean herbarium was by contacting the Linnean Society and arranging access to the collections either in person or with the direct assistance of Society staff or officers such as Benjamin Jackson, Spencer Savage, Theodore O'Grady, William Stearn and their successors. In 1959, a microfiche edition of the Linnaean herbarium was prepared, and subsequently marketed by Inter Documentation Centre (IDC); copies were quite widely distributed in larger herbaria and botanical libraries. However, the microfiche provides only low resolution images, making close study of plant characteristics difficult. With the advent of the possibility of providing web-based online herbaria, new opportunities have developed. In 2003, the Linnaean Plant Name Typification Project's website (*http://www.nhm.ac.uk/researchcuration/projects/linnaean-typification/*) made available good quality digital images of several hundred specimens from LINN, representing the type material for Linnaeus' generic names. Recognising the utility of this kind of approach, the Linnean Society embarked on the Computer Access to the Records of the Linnean Society (CARLS) Project, one of the first products of which will be the production of high-quality digital images of all the specimens in the Linnaean herbarium (due for completion in 2007). Lower resolution images of these will be freely viewable via the Linnean Society's website (*www.linnean.org*). In the future, botanists and Linnaean scholars worldwide will not have to travel further than their desks in order to examine Linnaeus' specimens in detail.

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Clifford's Banana: How Natural History was made in a Garden

Mark Griffiths FLS

26 Albert Street, Oxford OX2 6AY

Some future literary historian, describing publishing trends around the turn of the century, may well refer to the cod-and-clock or apple-and-nutmeg school of popular non-fiction. This perfectly respectable genre of science writing takes some commodity (cod, quinine, nutmeg), or an invention (Harrison's clocks), or an epiphanic event (a falling apple, a voyage of discovery) and tells us how it changed the world.

So far, the school has overlooked one such Eureka! episode which could indeed be said to have changed the world, or at least the way in which we see the natural world. This omission is mystifying: the tale has all the right ingredients – a reclusive billionaire, a questing young genius, set-backs and set-tos, props of breathtaking rarity and beauty, and, finally, a breakthrough for which the biosphere is all the better. It is the story of a garden long since vanished but where, in just a few years, the foundations were laid for ways of studying, naming and classifying nature that remain cardinal to this day. In terms of the history of biology, this episode might be judged to be of an importance comparable to that of Darwin's time on HMS *Beagle*. In this respect, Clifford's Banana is the tale of an epoch-making voyage of discovery. That it took place within the high walls of a garden makes it all the more remarkable.

When Carl Linnaeus arrived in Amsterdam on June 13, 1735, he was twenty-eight years old and a medical student in search of a doctorate. In his native Sweden, he had already made something of a name for himself as a botanist, mineralogist, lecturer and as the explorer of Lapland. He brought with him in draft several of his most influential works. He left behind his eighteen year-old fiancée, Sara Lisa Moraea, the Fair Lily of Falun, to whom he would return three years later, and who, by all accounts, would make the remainder of his seventy years fairly comfortless.

His journey to the Netherlands had been eventful. In Hamburg, he had encountered face-to-faces the notorious seven-headed hydra, a monstrous stuffed beast that had been taken as an unlikely spoil of war from a church in 1648 after the Battle of Prague. At the time, few doubted that this hydra was genuine. Naturalists had described and illustrated it – most notably Albert Seba in 1734, alongside an equally implausible but perfectly real flying lizard. The King of Denmark had offered its then owner, the Burgomaster of Hamburg, a king's ransom for it. Young Linnaeus was intrigued, and disappointed. What he found was a grisly amalgam of snakeskin and ferrets' heads. Having proudly advertised his debunking of the hydra, Linnaeus found himself leaving Hamburg in a hurry, the city's angry Burgomaster clutching a heap of devalued carrion. In slaying this dragon, Linnaeus made a suitable start to his true mission – to put out of its misery an age of bestiaries, non-empirical herbals and unnatural natural history. At that time, the University of Harderwijk in Gelderland offered a doctoral degree that would have alleviated the budgetary problems of our present Minister for Health at a stroke. This degree was Linnaeus' ostensible motive in traveling to the Netherlands. Harderwijk's attitude to doctoral training, attendance and costs was not unlike that of the State of Nevada in relation to marriage and divorce. On June 17, 1735, Linnaeus arrived at the University. On the eighteenth, he passed an exam entitling him to become a medical candidate. On the nineteenth he presented a thesis (24 pages on wisselkoortsen – 'recurring illnesses' or fevers), and was given leave to print it. Between the twentieth and twenty-second of June, the thesis was printed and examined. On the twenty-third, he graduated. *Doctor* Linnaeus could now return to the proper business of botany.

By the summer of 1735, he had already won over several of the Netherlands' botanical luminaries. The great Leiden botanist and physician, Herman Boerhaave was an enthusiastic supporter and asked Linnaeus to undertake a plant-collecting trip to the Cape and America. But not even the carrot on the stick, the promise of a chair in botany at Leiden on his return, could persuade Linnaeus to overcome his fear of extremes of temperature, danger and discomfort – a fear borne out time and again throughout his life by the deaths overseas of friends and disciples. Another botanical-medical man, Johan Gronovius was so taken with Linnaeus' fledgling *Systema Naturae* that he offered to publish it, and did so in December that year. In Amsterdam, Linnaeus' near-contemporary Johan Burman, Professor of Botany and Director of the Botanic Garden, invited him to stay at the garden and to work alongside him on the *Thesaurus Zeylanicus*.

Burman's first encounter with Linnaeus had not gone well. One can imagine them, a year apart in age, the one fully established at twenty-one as Director of a garden that was the botanical depot of one of the world's great colonial powers, the other a pushy unknown Swede with a headful of disruptive ideas. Their second meeting was similarly gladiatorial. It involved a game in which horticulturally-minded botanists and botanically-minded horticulturists often delight – guess the plant. Following their first, unhappy encounter, Burman had deigned to receive Linnaeus once more, prompted by a letter of introduction from Boerhaave. This time he set Linnaeus a test, the identification of an unlabelled specimen of an exotic, large – and glossy-leaved evergreen which, as Burman and many another Dutch botanist had good reason to know, was cinnamon, *Cinnamomum zeylanicum*. Linnaeus diagnosed the specimen as a laurel, a member of the genus *Laurus*. To his delight, Burman thought he had the popinjay on the ropes. But then Linnaeus explained himself. In a dazzling exercise of his new system, he argued purely from morphological observation that *Cinnamomum* really ought to be merged with *Laurus* – as indeed, they were for some time thereafter. In a rare instance of the taxonomic uniting of two genera fostering unity between two taxonomists, Burman was convinced and embraced the Swedish upstart.

Cinnamomum zeylanicum, *Laurus zeylanica*, cinnamon. Fortunes had been made from it and other precious spice plants from the Dutch East Indies. One such fortune, one of the largest of all, belonged to a tall, fifty-year-old man, silver-haired, clad in black and with a countenance midway between severity and wistfulness. This was George Clifford the Younger (born 1685), a Dutch banker and merchant of English extraction and Director of the Dutch East India Company. In 1709, Clifford's father had bought an estate, De Hartekamp, near Bennebroek to the north of Heemstede and not far from Haarlem. A passionate plantsman and amateur of botany, the younger George was dealt his ideal opportunity when he inherited De Hartekamp on his father's death in 1727. Using his own connections with international trade and his close links with Boerhaave (his former physician) and, later, with Burman, he set out to create the world's finest private botanic garden. By 1735, it would appear that he had succeeded. The annual budget for this botanical Xanadu was 12,000 gulden. Clifford's garden, which both literally and metaphorically-speaking was something of a *hortus conclusus*, became the stuff of legend. Only the very favoured few had walked its mazes, mounds, parterres and lakesides; visited its menageries and glasshouses, its herbarium and library. Indeed such was the speculation surrounding this secret paradise, that Linnaeus himself confesses to having doubted that such a place could exist, suspecting it was mere garden of the mind, a modern myth like some latter-day Hesperides, or a garden of Tantalus, invented to taunt other botanists and plantsmen, none of whom had the stature even to peer over its walls.

In the dedication to *Hortus Cliffortianus* ('Clifford's Garden') Linnaeus asks his patron 'do you recall the day when you asked a foreigner walking in the Amsterdam Botanic Garden, about a suitable curator for a collection?' Clifford met Linnaeus, who had then been working at the garden for two months, in the summer of 1735. The merchant prince was much taken with the Swede's skill in classifying Asian plants using only his own, new system. An invitation to visit De Hartekamp followed, and on August 13, Linnaeus, accompanied by Burman, saw Clifford's garden for the first time. His first sight of De Hartekamp was a critical moment not only for Linnaeus but for all biology since. We have to imagine a young man, thoroughly versed in herbals, floras and desiccated specimens; someone whose own plant explorations had taken him not south but north, to places where the tallest and gaudiest plant on the landscape was *Andromeda poliifolia*; someone whose horticultural experience had gone no further than his father's small rectory garden at Stenbrohult, and for whom a glimpse of gorse was a special event. Most of the plants in Clifford's collection Linnaeus would never have seen before, and certainly not alive and growing together. Not even a spell in Sri Lanka itself could have impressed on him such an overwhelming sense of biodiversity. Prior to Linnaeus' arrival at De Hartekamp, it is as if the living world had presented itself to him in black and white. Suddenly it was in colour. Here is that moment in Linnaeus' own words:

> "My eyes were captivated by so many masterpieces of nature aided by art: shady walks, topiary, statuary, pools, artfully contrived hills and mazes. I was enthralled by your menageries, crowded with tigers, apes and monkeys, wild dogs, antelope, wild goats, peccaries and warthogs, and by the myriad flocks of birds whose calls and songs echo through your garden, among them parrots, pheasants, peacocks and doves. I was astonished when I entered your hothouses, crammed with such profusion, such variety of plants as to enchant a son of the cold north, uncomprehending of the strange, new world into which you had brought him. In the first house you tended the harvest of southern Europe, the plants of Spain, southern France, Italy, Sicily and the Greek Islands. In the second house, lay the treasures of Asia, among them Kaempferia, Poinciniana, Adenanthera, Costus, Garcinia, Phoenix, Coccus and Corypha. In the third house, the plants of Africa – bizarre, not to say freakish in form, among them many Mesembranths, Aloes, Stapeliads,

> Crassulas, Euphorbias and Proteas. And in the fourth house, The lovely natives of America, and all that the New World brings forth – crowds of cacti, Epidendrums, Passiflora, Hernandia, Dioscorea, Magnolia, Brunsfelsia, Maranta, Plumeria, Browallia, Hura, Cassia, Acacia, Papaya, Manihot and so forth. At play among these, I saw the world's greatest marvels, bananas, and the exquisite Hermannia, the silvered Protea and the priceless camphor tree. I had no greater desire than to see an account of such a garden made public, and no greater fear than that I might not be able to extend a helping hand…"

While it is questionable that Clifford would have wanted his garden made too public, there is no question that he needed a garden director – someone to oversee the development and well-being of the living collection, curate the library and herbarium and, above all, to compose a catalogue. Linnaeus was just the man, and he had something else that counted in his favour – that hard-won Harderwijk medical degree. Clifford was a hypochondriac, and hypochondriacs need physicians like exhibitionists need voyeurs. Human resources negotiations of a distinctly mercantile flavour began between Clifford and Burman. In the end, Linnaeus was bartered for a book, released from Burman's employ in exchange for Clifford's own copy of Sloane's *Natural History of Jamaica*. This trade must count as Sir Hans Sloane's single greatest, if unwitting, contribution to botany. Linnaeus arrived for work at De Hartekamp on August 18, 1735, at a salary of one thousand florins per year. Clifford was unusually generous for a wealthy man: the perks he provided included use of a carriage and lavish board and lodgings. In all, Linnaeus was treated as a son by this botanical Maecenas.

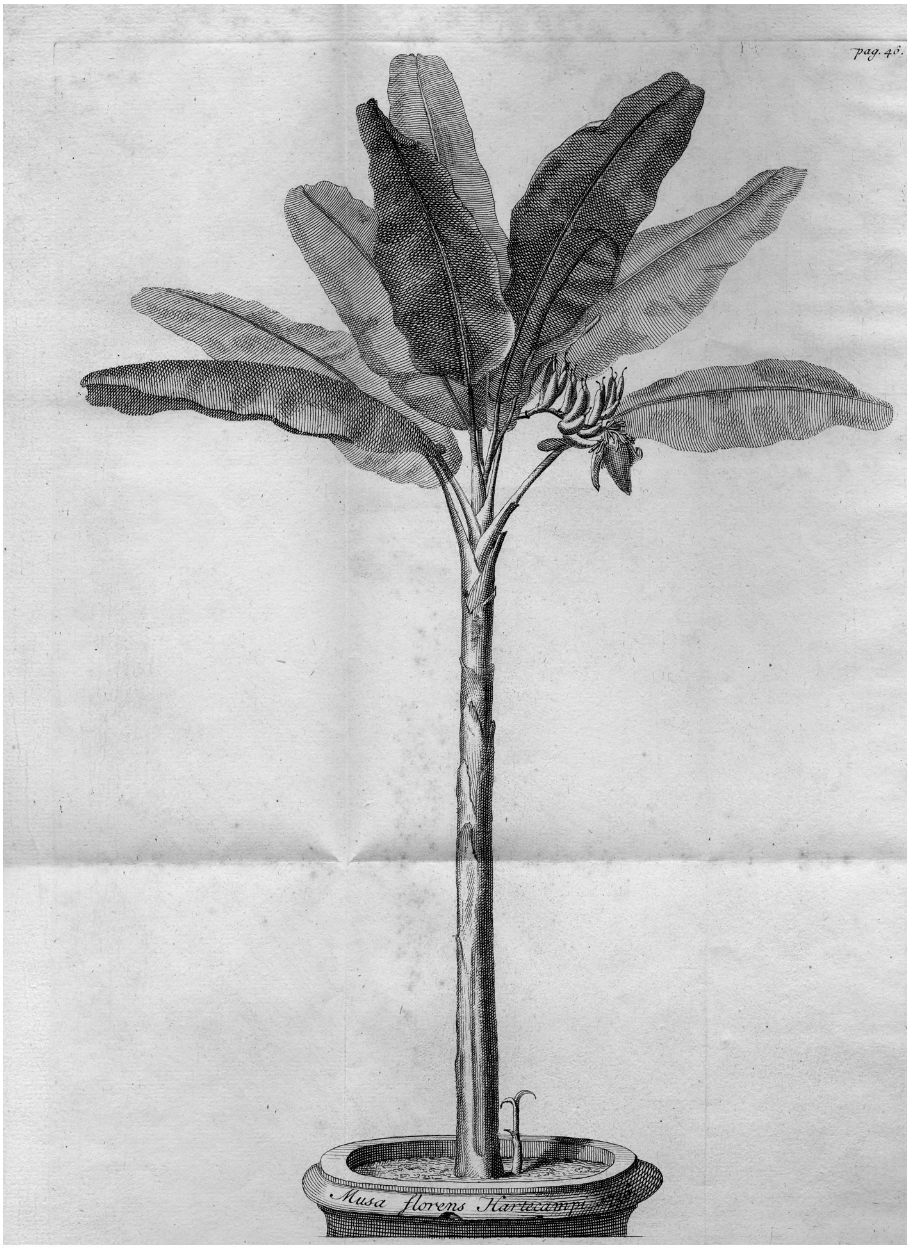
Pride of place in Clifford's earthly paradise went, appropriately enough, to the plant that Linnaeus and many others believed to be the tree of knowledge, the banana. Although grown in Europe, no plant of it had ever flowered or fruited by 1735. The fruits themselves existed only as travelers' tales, memories that exaggerated beyond measure their flavour and magical properties. The English herbalist John Gerard, who owned a preserved specimen, wrote in his *Herball* of 1597 that the banana

> "is called Musa by such as travel to Alepo.... The Jewes also suppose it to be that tree of whose fruit Adam did taste.... It is called in that part of Africa we call Ginny, Bananas: in English Adam's Apple….."

No plant, then, was more swathed in symbolism. One banana was worth all the tulips, all the spices in the world. This plant had possibly stood at the centre of Creation. One bite of its fruit had cast man out of the garden and forced him into occupations less congenial than horticulture and taxonomy. To a curate's son curating the new Eden, the temptation to flower and fruit such a fabulous plant was irresistible.

Then it happened – typical Linnaean luck. In annotations to his own copy of *Musa Cliffortiana*, the 1736 treatise he wrote on the banana, Linnaeus recalls in the graphological equivalent of a hushed, marveling tone:

> "It began to flower on January 24 1736 and stopped on March 24 1736, thus it was in flower for two months. The fruit began to mature and had done so by July 3. Thus the fruit took six months to ripen when in India it would have taken two."



Musa paradisiaca, the frontispiece of *Musa Cliffortiana*, as drawn by Martin Hoffman and engraved by Vander Laan.

So the first banana had flowered and set fruit in Europe and all upon the advent of Linnaeus, Clifford's new garden curator. Of course, a good deal of the credit for this achievement must go to Clifford's head-gardener Dietrich Nietzel. At the same time, it was Linnaeus who set out to induce its flowering by imitating what, he imagined, were its conditions in habitat – richly fertile soil, and a period of dry, cool conditions followed by high temperatures and plentiful water.

The banana's fruiting was news. It broke down the high walls of Clifford's garden and placed it firmly at the centre of the botanical and horticultural world. De Hartekamp became a place of pilgrimage. Verses were composed in honour of the great event by poetasters such as Snakenberg, and Fungius, who commended Linnaeus to 'Flora's flowery breast' for having given the Dutch the banana. Clifford's judgment in taking on the young Swede was judged consonant with a great lawgiver and a visionary speculator, whilst Linnaeus' skills were deemed nothing less than miraculous. One result of this gardening phenomenon was the publication in 1736 of *Musa Cliffortiana*, 'Clifford's Banana'. A slender volume with a small print-run, it was published privately by Clifford and presented to close friends and esteemed colleagues.

The keystone of Linnaeus' early reform of plant nomenclature was his regulation of the generic names of plants. Of the nine works that he managed to publish during his brief time in the Netherlands, none is technically more important than *Genera Plantarum* published in 1737. In this, Linnaeus lays down rules for the invention, choice and imposition of stable generic epithets that could be used by all. Here are two such rules –

> "No man in his right mind introduces primitive words as generic names, by which, as is well-understood, I mean words that have no clear derivation or meaning"

> "Generic names that are not derived from Greek or Latin should be rejected"

As we have already learnt from John Gerard, the name 'musa' for banana was believed to be of obscure Middle Eastern origin. In accepting it as the generic epithet for his plant prodigy, Linnaeus chose to break his own rules. It seems that he could not resist the name, largely because it appealed to his taste for complex word associations. In a deft stroke of special pleading, he overlooks *Musa*'s vernacular, Arabian roots and chooses instead to say that it commemorates Antonius Musa, who was physician to the Emperor Augustus. So, subtly, he identifies the banana with himself, physician to the great patron of the golden age of botany, George Clifford. Linnaeus was sensitive to such mythical, classical and poetical resonances. In the case of the banana, he was keenly aware that *musa* was also the poet's *muse*. For example, in the Dedication to *Hortus Cliffortianus* he puns away gleefully:

> "I settled in your shade, I played with Your Floras, Your Muses [Musae] applauded by flowering in both years that I was a guest in your garden."

In later years, when naming a genus of banana look-alikes, Linnaeus elaborated on this wordplay by calling them *Heliconia*, after Mount Helicon, mythical home of the muses.

Some dismissed *Musa Cliffortiana* as a vain-glorious and self-serving production – principally those who were not on the circulation list. 'Why ever devote a whole work to a single plant?' seems to have been the most common criticism, and a fact that also happens to be one of the work's most interesting qualities. 'Clifford's Banana' was effectively the first botanical monograph. It remains one of the most richly layered and exquisitely observed botanical studies ever made, transporting us from the realm of theological debate and jungle magic to the then cutting edge of biology. In it, Linnaeus examines the banana, *Musa paradisiaca*, from every aspect open to his inquiring eye. We learn of its many vernacular names, its history and ethnobotany in each of the places where it grows, its supposed culinary, medicinal and economic properties, its taxonomic history, its morphology and cultivation.

Musa Cliffortiana also provided Linnaeus with an opportunity to refine and to rehearse his *Methodus*, the taxonomic and nomenclatural principles that he had formulated early in his career and first presented in *Systema Naturae*. Offered this time in the form of a folded fly leaf, it outlines each of the categories of information a naturalist must supply in order to achieve an accurate classification and description of any natural object, be it animal, vegetable or mineral. Under *nomina* we find the selected name, the generic and specific epithet chosen by the naturalist himself, together with any synonyms, and vernacular names. This is followed under *theoria* by the class and order to which the plant – say – belongs. The next category requires those characteristics that distinguish the genus from others within its order and furnish it with its natural and unique identity, its *facies* in Linnaean parlance, or what we might term Gestalt. Next comes the species which needs a description, a note of its distinguishing characters (*differentia*) and an account of any varieties. *Attributa* covers such matters as place of origin, habit, habitat and any findings made ‘microscopically’ (that is, with a magnifying glass). *Usus* covers the plant’s various edible, economic and medicinal properties, and *litteraria* any bibliographic references, anecdotal material, superstitious nonsense and literary allusions. Today the *Methodus* may seem obvious, barely worth running through. In 1736, however, this painstaking, skeptical and systematic approach was an innovation, and an innovation that had been necessitated by the process of studying a cultivated plant at close quarters and winnowing reality from myth. It is a typically Linnaean innovation, fearlessly ambitious yet self-evidently simple in a way that makes one ask `why did nobody think of that before?’ It brings order to chaos, to the critical mess heaped up by centuries of commentary, discovery and hearsay, and it does so with a combination of learning, practicality and careful observation.

Linnaeus’ love of close observation clearly found the perfect object in Clifford’s banana. *Musa Cliffortiana* as published is detailed in a way that no plant publication had been before, but clearly not detailed enough for the author. Some of Linnaeus’ marginalia heralding the flowering and fruiting of the banana were quoted above. In fact, his own copy of *Musa Cliffortiana* eventually became overwritten with his comments on such matters as the number of the banana’s male flowers, their position in the inflorescence, the size and nature of the bracts that envelop them and how their tepals wither, become black, but do not fall, while those of the females drop away with what remains developing as fruit. This minutely observed, diary-type annotation, based on revisiting the plant day-by-day and year-on-year, shows the tireless excitement of Linnaeus’ investigation. It derives from a kind of intimacy that is only possible in a garden.

Later among these marginalia we find Linnaeus recording the banana’s demise following flowering and fruiting. This time his language is far from scientific shorthand. It is a lament for the sad spectacle of his vegetable muse now deflowered and in decline. This plant, he notes, was formerly more blameless, graceful and shining than any other in the world – at least, that is, as a virgin – but now it has been brought low by shameless acts of lust. This aside is perfectly in character: a blend of shrewd objectivity and anthropomorphic whimsy laced with a lively interest in sex.

Throughout his career, Linnaeus was aware of the desirability of arriving at a more natural system of plant classification. He argued, however, that until we knew all plants, any attempt at a full natural classification would be flawed, full of gaps and those leaps which, as he famously said, Nature herself never makes. His great achievements, the solid, fundamental units of genus and species are, of course, natural and were in part the products of the type of feeling, intuitive response to plants made possible by his time at Clifford's Garden. But it is also the case that many of his artificial orders correspond to orders and families that we would recognize today as natural. In *Musa Cliffortiana*, for example, he describes the *Classis Palmarum* and, within it, four orders named simply 'A, B, C and D' that equate to aroids, palms, gingers and orchids. In the process, he names several new genera including the familiar *Chamaerops* and *Costus*. At moments such as these, Linnaeus anticipates a convincingly natural systematics and runs ahead of himself and his subject by about a century. It is doubtful that he could have done so had he not been able to stroll daily through Clifford's hothouses, surrounded by living bananas, palms, gingers and aroids. Nor could he have done so had he been unable to consult Clifford's library, which included such works as Rheede's *Hortus Malabaricus* (1678-1703), the most lavishly illustrated account of the exotics to be found in the Dutch East Indian territories.

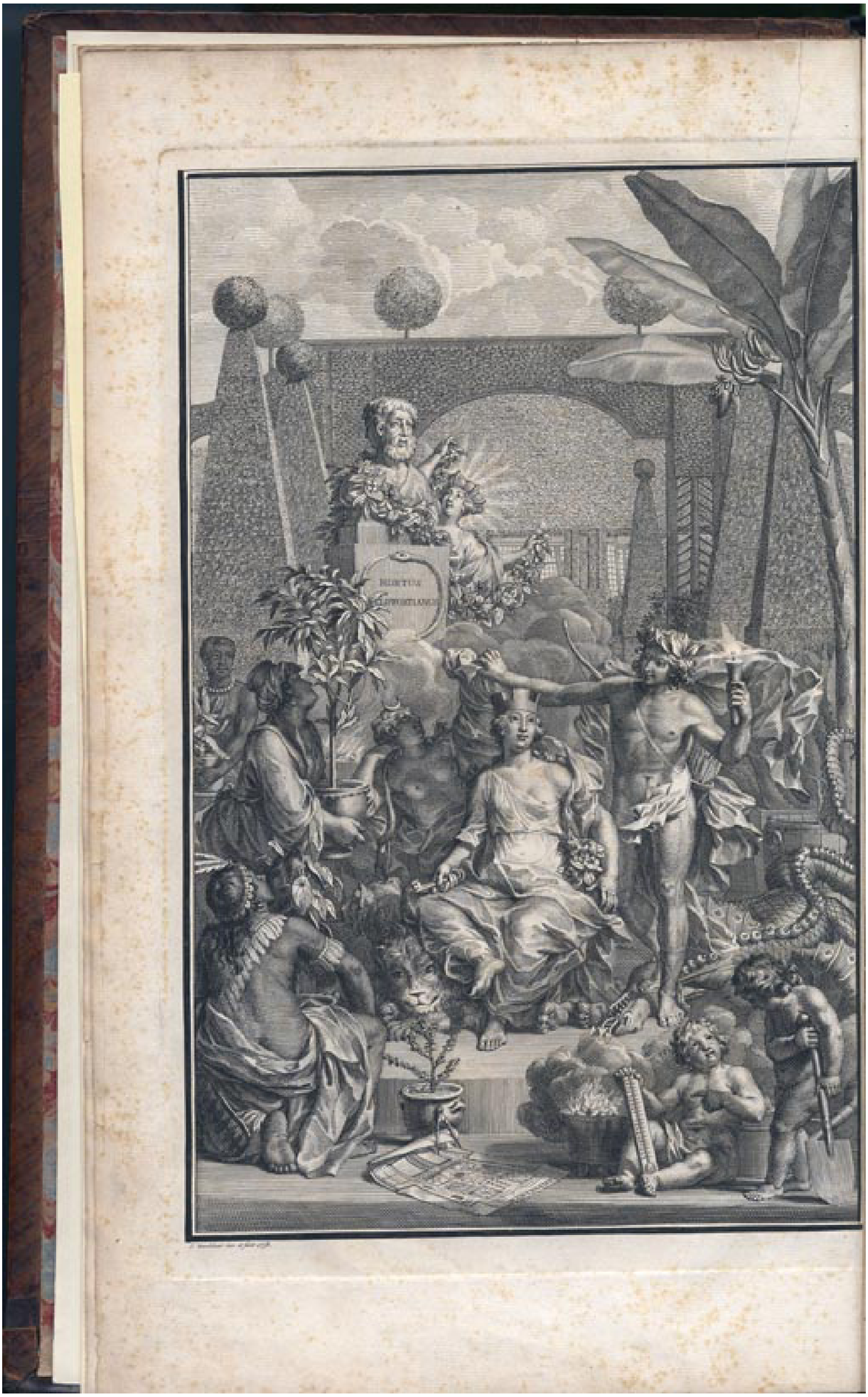
The artist Martin Hoffman, who in 1737 painted the famous portrait of Linnaeus in Lapland costume, prepared two plates for *Musa Cliffortiana* – a whole plant portrait of *Musa paradisiaca* to act as frontispiece to the work, and a massive illustration of its inflorescence, fruit and flower details to end the volume. These were engraved by Vander Laan and set a new standard for accuracy, if not exactly realism, in botanical illustration. Among Linnaeus' papers there is also a pen and ink wash drawing of the banana, made at more or less the same time as the plates. Some have attributed this drawing to Georg Dionysus Ehret who, as we shall see, came to play an important role in the tale of Clifford's garden. For all that the drawing is accurate and dramatic, however, its very boldness and the coarse quality of the line work suggest that it is probably not the work of Ehret, but one of Hoffman's preliminary sketches instead. The drawing's grandiose, static, and very linear style of representation appears to be rooted in the 17th century and the tradition of such works as the *Hortus Malabaricus*. It lacks the gracefulness and realism of Ehret, the later artist of *Hortus Cliffortianus* who would make Clifford's garden as much a crucible for the art of modern botany as it was for the theory.

So we have seen Linnaeus arrive in the Netherlands, bristling with ideas and unpublished manuscripts. We have seen him conquer Dutch botany in the persons of Boerhaave, Gronovius and Burman. We have introduced him to George Clifford and walked with him in Clifford's garden. We have watched the banana flower and fruit with him and seen him publish his *Systema Naturae* and *Musa Cliffortiana*, both revolutionary works. But what of the real task that Clifford set him? Where is the catalogue, the book of this remarkable garden?

Linnaeus gave us two accounts of Clifford's garden. The first, *Viridiarum Cliffortianum* ('Clifford's Pleasure Garden') appeared in 1737. A small, slim volume, it is not especially exciting except in its firm application of the newly-minted Linnaean system. It is, rather, a sketch for the magnum opus, *Hortus Cliffortianus*, that was to appear a little while later. It does contain some points of horticultural interest, however – namely cultivation guidelines such as 'Alpine plants require soil that is windswept and dry or elevated; they die during winter in a humid climate, but never from exposure to dry cold'. Clifford, for all his bananas, aroids and orchids, had plenty of time for alpines and grew them on raised beds and in cold houses. It is, then, all the more poignant to discover that the list of the merchant's *Saxifraga* accessions is absent from the printed *Viridiarum Cliffortianum*, and that Linnaeus noted their names in manuscript under the forlorn heading 'Omissa' at the back of his own copy of the book. Poignant, but a great comfort to those of us who put together works of horticultural reference. By the time Linnaeus had completed compilation of *Hortus Cliffortianus* in October 1737, he had recognised seven species of *Saxifraga* at Clifford's garden, one fifth of the total number he would name sixteen years later in *Species Plantarum*.

The book, *Hortus Cliffortianus*, 'Clifford's Garden', finally appeared in 1738 following a three-year gestation and the usual types of publishing imbroglio, including late delivery of illustrations, trouble at the engraver's, time-lag at the printer's and uncertainty as to the number of books to be printed and the means of distribution. Linnaeus had completed the text in nine months and had it ready for press by October 1737, the year that appears on the title page. In five hundred-odd pages the work includes a short account of history's great gardens, the lyrical dedication to Clifford recounting Linnaeus' own astonishment on entering his garden, a preface laying out the *Methodus* and covering the cultivation requirements of different groups of plants, a classified catalogue of Clifford's botanical library, the new Linnaean system of classification, and a key-like break-down of leaf forms that was, in effect the first, standardized botanical glossary. Front matter is all too easily glossed over or ignored, but it is worth noting that each of these items marked a new departure in and set a new standard for the presentation of horticultural and botanical information. By far the greater part of *Hortus Cliffortianus*, however, is the account of the plants in the garden and herbarium. Arranged according to Linnaeus' sexual system, these amount to 2,538 dried specimens, and 1,251 living plants.

Engraved by Wanderlaar, the work's frontispiece is a rich allegory, glorifying Clifford and his garden, presenting some of his great horticultural triumphs, and telling in iconographic code the tale of Linnaeus' early life and his place in the Pantheon. The background features some of Clifford's elaborate topiary and the doors of his hothouses. Centre left is a bust of Clifford himself which the goddess Flora, crowned with a burst of Enlightenment sunshine, is busily wreathing. Her garland includes *Kaempferia*, *Sprekelia* and *Turnera*. To the far left, we see a female embodiment of Africa, standing by to present Clifford with an *Aloe*. Just before her in line, an Arabian woman proffers *Coffea arabica*. In the far left foreground, a South American Indian clutches a pot of *Hernandia*, a tree of which both Clifford and Linnaeus were especially proud, even if the latter was unsure as to whether it did in fact hail from South America. In the centre of the frontispiece, Mother Earth, Cybele, sits on a peculiarly contented-looking lion (perhaps one of Clifford's own menagerie), and holds the keys to the garden. Behind languishes the Moon Goddess,



The frontispiece of *Hortus Cliffortianus* engraved by Wanderlaar.

Selene, symbolising witchcraft, superstition and ignorance. To the right, a young Apollo is in the act of obscuring her with Flora's mantle.

Apart from his physique, this Phoebus bears an uncanny resemblance to Linnaeus himself. This suspicion is soon confirmed by a glance at Linnaeus' *Classes Plantarum*, published in 1738 (the year this frontispiece was engraved) and yet another of the nine works from his prodigious Dutch period. In *Classes Plantarum* Linnaeus offers a set of thirteen aphorisms, *pensées* on the feasibility of a natural system of classification. The fourth aphorism declares that whoever can create a truly natural system, filling the gaps, bringing together and resolving the 'few' plants and problems that remain, would indeed be proclaimed a great Apollo by all. If we needed any further proof of Linnaeus' self-identification with Apollo, there, slain at the god's feet in the frontispiece of *Hortus Cliffortianus*, lies a dragon, an allusion, perhaps, to the curious case of the Hamburg Hydra. To the right of Linnaeus-Apollo there soars, of course, the banana. In the foreground right, two rather coarse-looking cherubs are meant to represent horticulture.

Both of those cherubs hold garden tools – one a somewhat crutch-like spade, the other a thermometer. The cherub with the thermometer is clearly excited, and so he might be. Anders Celsius, nephew of Linnaeus' great protector Olof Celsius, is usually credited with having invented the centigrade thermometer in 1742. Curiously, Celsius made his freezing point 100 degrees and his boiling point zero degrees. Here we see a thermometer that is not only centigrade but also runs from freezing at zero to boiling at 100 degrees – Linnaeus' own, original system and the one we use today. We should not talk in terms of 'degrees Celsius', but 'degrees Linnaeus'. Centre foreground in the frontispiece lies a plan of De Hartekamp itself, one of the few shards of evidence that we have of the layout of this miraculous garden. The dividers lean against a pot of the African Rosaceous shrub *Cliffortia*, named for George Clifford.

Unlike the frontispiece, the botanical plates in *Hortus Cliffortianus* were the work of Georg Dionysus Ehret. It is yet another manifestation of the remarkable pattern of chance and fortune at work in Clifford's garden that this German artist, a year younger than Linnaeus, should have arrived at De Hartekamp just as work on the book began. Linnaeus and Clifford were impressed by Ehret's portfolio and retained him for about a month to draw all thirty-six plates at 3 gulden apiece. It should be said that at the time, Ehret had no clue that these images would be published. The plates were later engraved by Wanderlaar. Being kept in a fog as to what exactly he was working on is just one of several factors that might have placed Ehret's relationship with Linnaeus under strain. Here, in Ehret's own words, is another as described in his autobiography:

> "I profited nothing from Linnaeus in the dissection of the plants; for all the plants in *Hortus Cliffortianus* are of my own undertaking, and nothing was done by him in placing all the parts before me as they are figured."

To console himself for this shoddy treatment, Ehret produced the famous plate that illustrates the sexual system and published it without Linnaeus's consent, privately and profitably in 1736. Despite all of which, the love-hate relationship between these two botanical pioneers whose paths crossed in a garden continued in all its fertile fervor – at least, that is, until Linnaeus took it upon himself to reproduce Ehret's piratical plate of the sexual system in *Genera Plantarum* without acknowledgement or reward to the artist. Botanical publishing can be a rough game, and enough, it seems, was finally enough. Linnaeus and Ehret ceased even to play at tit for tat. Whether they could be said to have collaborated closely in the making of *Hortus Cliffortianus* or were more akin to two great and egotistical soloists performing at the same venue, the fact remains that their brief intersection in Clifford's garden spawned botanical art of a wholly new order of elegance and accuracy: as with Linnaeus' words, so with Ehret's pictures.

A Linnaean herbarium specimen of *Amaryllis formosissima* (now *Sprekelia formosissima*) from Clifford's garden which originally came from Clifford's own herbarium and includes the adhesive engraved pot-style attachment.

In the text of *Hortus Cliffortianus*, we see Linnaeus delineating a new heroic age of botany, a time of titans – patrons and explorers, botanists and horticulturists – who were forging an era of unprecedented discovery and description. He presents these characters most directly in the form of commemorative generic names, a dizzyingly self-confident act from someone still widely seen as a neophyte.

So it is that we encounter *Cliffortia foliis dentatis*, a name that supplants synonyms such as *Camphorata capensis*, *eryngii minoris folio* and which celebrates George Clifford, 'our great patron of botany, whom this shrub, for all its modesty, resembles in its everlasting vigour and rarity'. *Collinsonia* recalls Peter Collinson, the Eighteenth Century quaker merchant who corresponded with Linnaeus, and introduced so many North American plants at his gardens in Mill Hill north of London. In *Browallia*, a beguiling member of the Solanaceae, Linnaeus pays handsome tribute to Bishop Johan Browall (1707-1755), Swedish botanist and one of his earliest champions.

Turnera strikes a less contemporary note, looking back to one of Linnaeus' worthy antecedents, William Turner (1508-1568), protestant clergyman, physician and Father of English Botany. The much sought-after artist Jacob de Wit (1695-1754) chose to paint three people admiring the plate that accompanies Linnaeus' account of *Turnera ulmifolia* – surely an index of the excitement caused by publication of *Hortus Cliffortianus*. Other early moderns, past masters celebrated in Linnaeus' pantheon of plants, include John Parkinson (1567-1650), botanizer royal and author of the first great English gardener's dictionary, *Paradisi in Sole Paradisus Terrestris* (1629), 'The Earthly Paradise of Park in Sun' and so a worse punster than even Linnaeus himself. Parkinson rates highly with *Parkinsonia*, a graceful drought-tolerant legume. The two-lobed leaf of another woody legume suggested Johann (1541-1613) and Caspar (1560-1624) Bauhin, two brothers united in botany, so *Bauhinia* was coined. In *Kaempferia* we meet Engelbert Kaempfer (1651-1716), the great German physician-explorer who traveled widely in Asia and lived for two years in Japan.

It is in commemorative names such as these from *Hortus Cliffortianus* that we see Linnaeus launch a botany that was as personal as it was practical, in some ways as much about people as it was about plants. Not all of those people emerged well from this modern *Metamorphoses*. After an initial and wholly characteristic spat at the Chelsea Physic Garden in 1736, Linnaeus and Philip Miller (1691-1771) became amicable and constructive correspondents. Miller was even persuaded to adopt Linnaeus' work in later editions of his *Gardener's Dictionary*. Yet we find him damned with faint praise in *Hortus Cliffortianus*, commemorated in *Milleria*, a Mexican daisy that is hardly, as horticulturists used to say, in the first rank of garden ornamentals. Later, in his *Autobiographies*, Linnaeus finds another way of expressing his real opinion of the great Chelsea gardener: in the ranks of botany, he makes Miller a mere sub-lieutenant. Linnaeus himself is *Generalissimo*, Commander-in-Chief.

He chose another composite to immortalize the one and only corporal in his botanical legions, Johann Siegesbeck of St Petersburg. Throughout his career, this decidedly po-faced botanist was wont to accuse Linnaeus of depravity in proposing his sexual system. Siegesbeck feared that the young would be 'corrupted by the immorality that had broken out among the lilies and onions'. The thirty-year-old Linnaeus' Olympian response to all this censure was to name a plant for him –

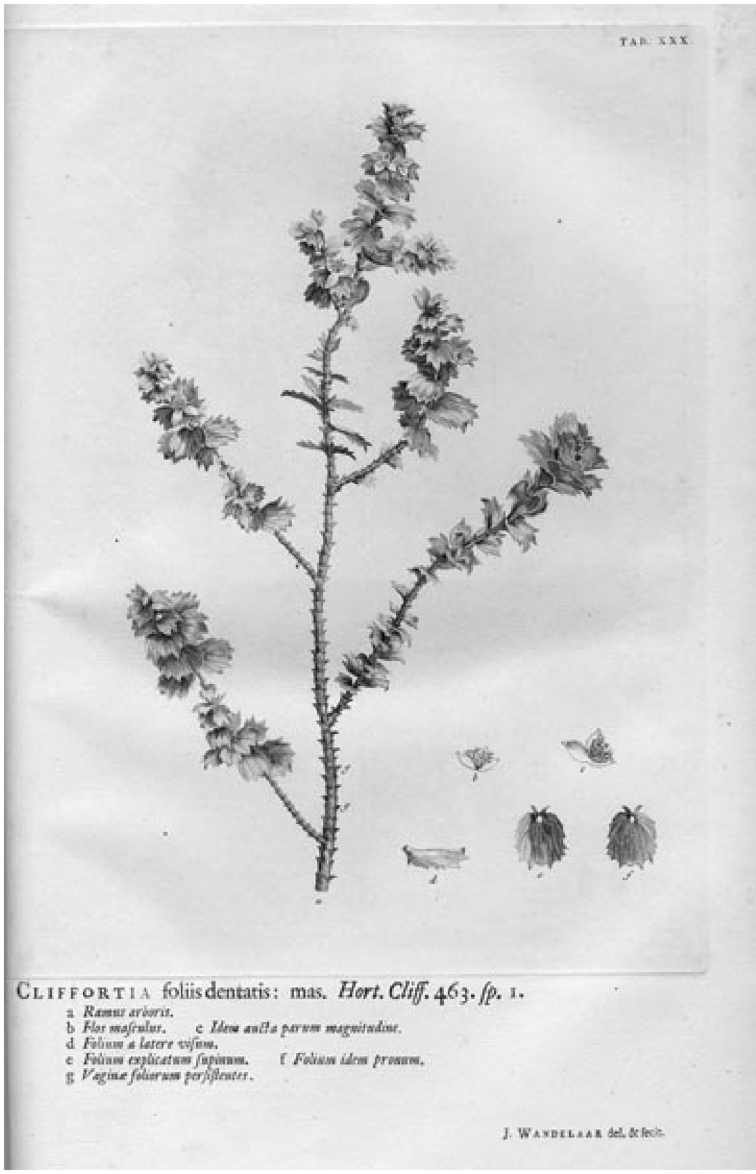
Sigesbeckia, insignificant, rank, and clammy, and, for many, the hapless Johann's only lasting claim to fame.

Enough personalities – what of the plants? Clifford's herbarium now resides at the Natural History Museum. The Linnean Society, however, holds numerous specimens taken by Linnaeus whilst he was working in Clifford's garden. They are often instantly identifiable as such for the specimen's stem is inserted in a two-dimensional pot, an engraved stick-on label. These were designed in the likenesses of a range of Baroque plant urns that were fashionable among princely Dutch gardeners of the period, from Clifford himself to the House of Orange. These paper pots, along with elaborately bordered adhesive cartouches for accession data, were the height of botanical *bon ton* in the Netherlands and were custom-made for various leading naturalists and gardens in Clifford's circle.

Sifting through the Linnaean Herbarium in search of these tell-tale pots, one soon gains a sense of the extraordinary diversity of the holdings at De Hartekamp and of the horticultural skills they must have demanded. Here are plants ranging from *Geranium maritimum*, whose foliage still perfumes the herbarium sheet as it did Clifford's garden 270 years ago to the type specimen of what today is *Nelumbo nucifera*. This particular sacred lotus retains a hint of rich carmine flower colour, which, coupled with its remarkably small stature, suggests it may not be quite so typical after all, but a cultivar, one of the miniature 'tea-bowl' lotuses that are still grown in China and Japan. It would not be fanciful to imagine it voyaging to De Hartekamp via the same Far Eastern trade routes that paid for the garden in the first place.

Perhaps most evocative of all among these garden ghosts is Linnaeus' De Hartekamp specimen of the Jacobean Lily, *Sprekelia formosissima*, a bulb that echoes with Linnaean associations. First, it reminds us of Johann Jacob Dillenius, the grouchy Sherardian Professor of Botany at Oxford whom Linnaeus met during his summer sojourn in England in 1736. The Jacobean Lily was Dillenius' signature plant. As we have seen with Burman and Miller, a common theme in Linnaeus' dealings with his great contemporaries seems to have been his making a dreadful first impression on them and then winning them over with a mixture of charm and brow-beating about his new system. Dillenius was no exception. He loathed Linnaeus on sight, thought he was ignorant and that his innovations would wreak havoc. But, after a short demonstration of the system's power to place the unknown and resolve old confusions, Dillenius was won over completely. By the time they parted (Dillenius in tears), Linnaeus had been showered with the treasures of the Oxford Botanic Garden, among them the bulb that we now know as *Sprekelia*. It was with this same species that Linnaeus observed the mechanism of pollination, sitting in his study at Uppsala many years later.

But the Jacobean Lily and the dispute with Dillenius also epitomize the young Linnaeus' taxonomic advances in his De Hartekamp period. In *Hortus Cliffortianus*, the plant is listed as number three under *Amaryllis*. First of all, the genus *Amaryllis* was itself a Linnaean conception, and a sound one at that – until quite recently, most would have agreed that *Amaryllis*, *Hippeastrum*, *Rhodophaiala* and *Sprekelia* hold together fairly well. In *Hortus Elthamensis*, published only five years before *Hortus Cliffortianus*, Dillenius had published this plant as *Lilio Narcisus jacobaeus, flore*



A plate of *Cliffortia* from Ehret's drawing for *Hortus Cliffortianus.*

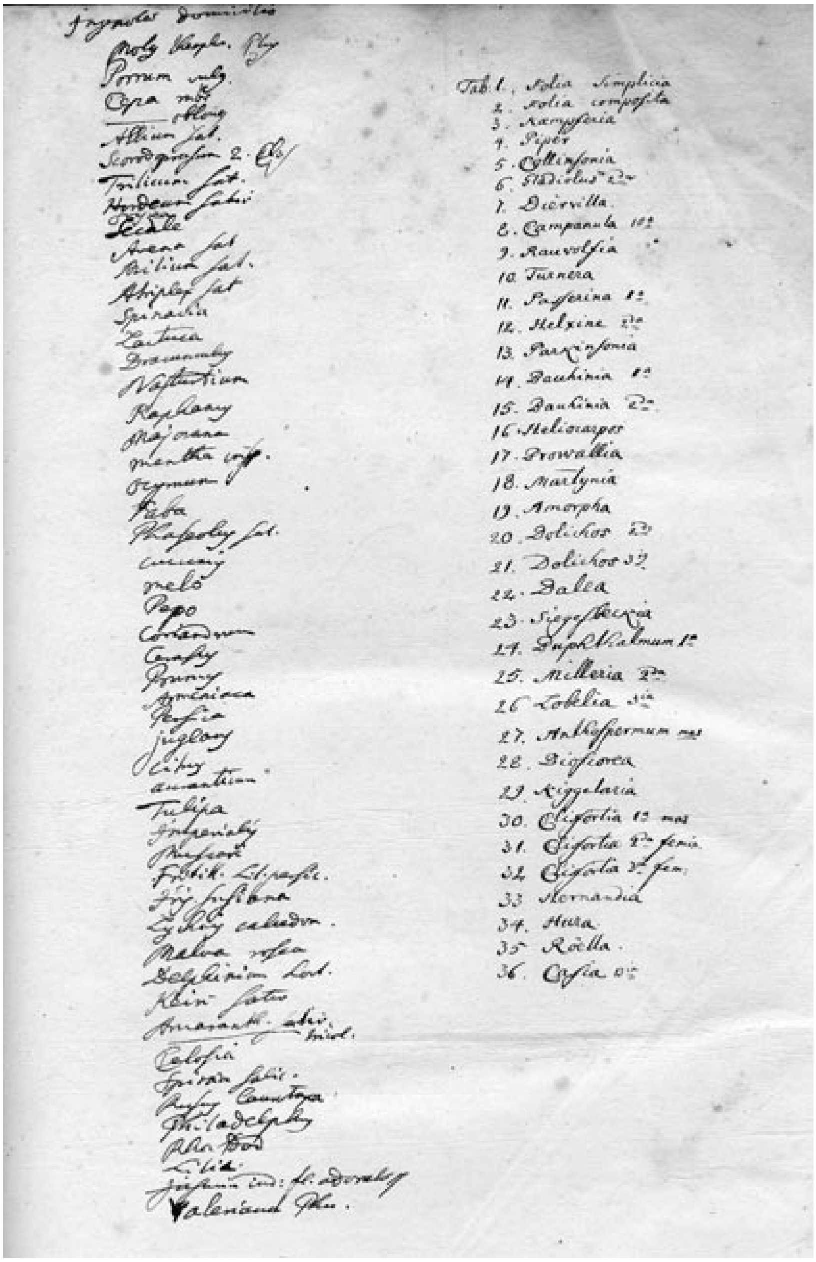
sanguineo nutante. Linnaeus rejected *Lilio Narcissus,* a) because it infringed his new rules on the formation and stability of generic names, and, b) because *Lilio Narcissus* had nothing like the conceptual clarity of his own *Amaryllis* – it was an antiquated mishmash of monocots.

At this time, it was the function of specific names not simply to name, to identify a species concisely and uniquely, but also to describe. So Dillenius' specific name for the plant we now know as *Sprekelia* was *jacobaeus*, *flore sanguineo nutante* ('Jacobean, with a blood red, nodding flower'). Whenever a new species was added to or subtracted from a genus, its own specific name had to contain enough information to distinguish it from its congeners. Moreover, all the names of existing species in that genus often had to be altered to contain enough information to distinguish them from each other and from their new congener. A typical genus checklist was like a constantly shifting botanical key. In adding Dillenius' plant to his new genus *Amaryllis*, Linnaeus had himself to change its specific epithet to *spathe uniflora, corolla inaequali, genitalibus declinatis* ('with a one-flowered spathe, a zygomorphic corolla and declinate sexual organs').

This state of affairs could not continue. It is hard enough to speak such names let alone to remember them. At this point, faced with a plethora of examples such as the Jacobean Lily and the job of curating a large living collection, Linnaeus began to envisage, if not yet to formalize, a system of binomial nomenclature. If we return to his own De Hartekamp specimen of *Sprekelia*, we can see in his autograph the addition of the word 'formosissima', this plant's future specific epithet. The fact that it means 'most handsome' is neither here nor there. It is of significance only as stable shorthand with all descriptive duties devolved elsewhere, a uniquely applied identifying tag. Sixteen years later in *Species Plantarum*, Linnaeus would supply the Jacobean Lily and all the other plants that he saw and grew in Clifford's garden with binomials – in this case, *Amaryllis formosissima*. The practical exigencies of cataloguing and curating a collection as comprehensive as Clifford's were as much a catalyst for Linnaeus' binomial innovation as his family's own, oft-cited adoption of the first name-surname style.

Linnaeus was employed at De Hartekamp until October 7, 1737. He stayed there again in the spring and summer of 1738 while convalescing from an illness that was variously attributed to rumours of his fiancée's perfidy and a bout of oyster poisoning. Aptly enough, the remedy the doctor prescribed himself was essence of cinnamon. The letters that George Clifford began to send Linnaeus soon after his departure indicate the patron's sadness at the going of his protégé. For Clifford, this sense of loss only deepened when he discovered that, rather than return directly to Sweden to pluck the Fair Lily of Falun, Linnaeus had made a detour to Leiden and the mantle of Adriaan van Royen. Once Linnaeus had indeed returned to Sweden, their correspondence assumed a character that gives little clue as to their short season of phenomenal collaboration – respectful and informative, but with a certain *froideur*.

Let us end with last things. At the back of Linnaeus' own copy of *Hortus Cliffortianus* there is a hand-written list titled *Fragmenta Domicilio*, 'bits and pieces at home'. It catalogues leeks, onions, garlic, rice, orach, spinach, lettuce, basil and melons; also modest ornamentals such as tulips and fritillaries, catchfly and hollyhocks, delphiniums and love-lies-bleeding, philadelphus and jasmine. To judge by the hand and the nomenclature, Linnaeus compiled this list toward the end of his life. It is a portrait in miniature of his garden at Hammarby and a haunting postscript to his heroic account of a period of astonishing discovery and productivity, a period when natural history was made in a different kind of garden entirely. This list is striking in the ordinariness of the plants that it names and the practicality with which it names them. It could be anyone's, or Everyman's, garden notes – which is the genius of the Linnaean approach, finding simplicity in profusion, fashioning a tool that is as useful in the potting shed as it is in the herbarium. But then, as Linnaeus himself knew well, to arrive at Hammarby one must start at De Hartekamp.



Fragmenta Domicilio, the list found at the back of Linnaeus' own copy of *Hortus Cliffortianus.* This is an interesting and rarely seen example of Linnaeus's autograph marginalia.

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The Linnaean shell collection at Burlington House

Kathie Way FLS

Natural History Museum, Cromwell Road, London SW7 5BD

In 1967 S. Peter Dance published a thoroughly researched and comprehensive account of the Linnaean shell collection held in the Linnean Society's rooms in London. It would be both futile and impertinent of me to try and improve on his work and thus it is fortunate that he has generously given his permission for me to quote it freely. This being the case I will include a shortened history here (with a recommendation to readers to consult and enjoy Peter's far more elegant original) followed by some remarks on the use and importance of the Linnaean material in the 21st century plus a short piece on Linnaeus' experimental pearls and an update on their involvement in a worldwide touring exhibition.

Linnaeus' interest in shells probably dates from his student years. When he arrived at Lund University in 1727 he sought tuition from one of that university's most eminent professors, Dr Kilian Stobaeus (1690-1742). Stobaeus was not immediately impressed with the young man but wisely Linnaeus became a regular attendee at Stobaeus' lectures on molluscs, and this strategy not only admitted him to Stobaeus' inner circle but also, and perhaps accidentally, seems to have initiated a real interest in shells. In 1731 he visited Stockholm where he acquired a large number of specimens for his growing

Argonauta argo Linnaeus, 1758. This Paper Nautilus shell is extraordinarily fragile but has survived the centuries almost intact.

collection, presumably given to him by fellow enthusiasts. Indeed, most of the shells present today originated from places never visited by Linnaeus and must be presumed to have been contributions from others. This method of augmenting his cabinet became Linnaeus' lifelong habit, its effectiveness borne out by the fact that his collection was said to have perhaps been the finest in Sweden, after that of Queen Louisa Ulrica. In a document discovered after his death Linnaeus stated that "The shell cabinet is valued at least at 12,000 dalers". (Jackson, 1923); 12,000 dalers would be worth around £276,000 today.

In April 1766 a fire that destroyed part of the town of Uppsala threatened Linnaeus' collections and prompted a move out of the town, eventually to his country home at Hammarby where they were housed in a small stone building on the estate. It would seem that the shells were not much affected by the ensuing damage from mould, insects and rodents which continued to ravage the more vulnerable material until Linnaeus' death in 1778; however, it could be said that more lasting damage was visited upon the shell collection during the following half century.

After the death of his father, Linnaeus' son Carl (1741-1783) took charge of the collections until he too died in 1787. He is known to have added specimens given to him by Joseph Banks, Daniel Solander, the Duchess of Portland and probably others to the collections during his custodianship. Thus there is evidence that before the shell collection left Sweden, it definitely contained shells additional to those amassed by Linnaeus. In 1784 James Edward Smith (1759-1828), later famous as a botanist, purchased nearly all of Linnaeus' scientific effects, including his shells (for an account of the transaction see Jackson, 1923). Smith retained the collections until his death in 1828, and they were purchased from his widow in the following year by the Linnean Society of London. Smith is known to have given specimens away, proven for instance in an exhibit caption listed in *A Companion to Mr. Bullock's Museum* (1810:77): "Bell Glass No. 4. 1. *Isis versicolor,* Many-coloured Isis Coral, orange var. New S. Wales. 2. *Physeter perspectivus,* Perspective or Stair-case-shell, China, *Trochus perspectivus* Linn. 3. *Scala grandis,* Great or True Wentletrap. Sumatra. *Turbo scalaris* Linn. These articles were presented to the Museum by Dr. J.E. Smith, president of the Linnaean Society, and were once the property of the celebrated naturalist, Sir Charles Linnaeus; a specimen of whose handwriting is likewise included."

I note that there is no material of *Turbo scalaris* (*Epitonium scalare*, the once much sought after "Precious Wentletrap") now extant in the Linnean Society collection.

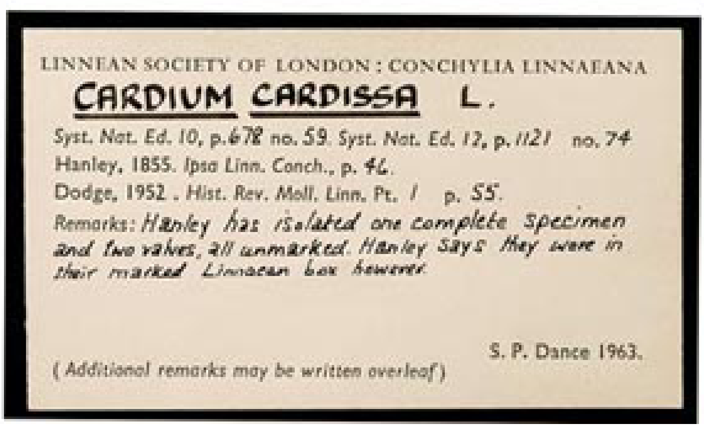
Dance (1967:7) notes that "Hanley examined marked shells of three Linnaean species which were too large to be housed with the rest of the collection: *Turbo marmoratus*, *Buccinum tuberosum* and *Strombus gigas*. None of these can now be found and it seems that they 'disappeared' after Hanley had finished compiling the manuscript of his Ipsa. It is possible that they (and perhaps others with them) were sold inadvertently in 1863 when the Linnean Society disposed of a large part of its miscellaneous collections (for details of this sale see Gage, 1938: 125; the Society has a priced sale catalogue)."

Interestingly, according to a list of donations to the collections of the Linnean Society published in the *Transactions* **XI**:430 (1815), "An extensive collection of

Conus miles Linnaeus, 1758.
The larger specimen was selected as the lectotype of this species by A.J. Kohn, 1963.

shells" was presented to the Society by Sir Joseph Banks, but this tantalisingly brief statement is all the information given; even the actual date of the gift is unknown, since a complete volume of the *Transactions* can cover a period of several years so that we can only conclude that the donation was made between the publication of volume **X** in 1811 and **XI** in 1815. William Swainson completes the description of a new species of *Mitra* with the following:"This superb shell is figured from the matchless specimen brought home by that illustrious and lamented patron of science, the late Sir J. Banks, from the Pacific Ocean; it is now, together with his entire collection of shells and insects, in the Museum of the Linnean Society." (1820: caption pl. 23).

Among the malacologists who worked on the collection in London were E.A. Smith (1847–1916) of the British Museum (Natural History), a meticulous curator who limited his intervention to isolating the "type" of *Patella unguis.* On the other hand, W.D. Roebuck (1851-1919) and J.W. Taylor (1845-1931), having been invited by the Society to validate all the British non-marine shells, labelled the shells they isolated with their then current generic and specific names, a truly pointless exercise, the results of which were never published. In 1856 an official inspection of the Linnaean collections revealed that the shells had been seriously disarranged and this was



LINNEAN SOCIETY OF LONDON : CONCHYLIA LINNAEANA

CARDIUM CARDISSA L.

Syst. Nat. Ed. 10, p. 678 no. 59. Syst. Nat. Ed. 12, p. 1121 no. 74

Hanley, 1855. Ipsa Linn. Conch., p. 46.

Dodge, 1952. Hist. Rev. Moll. Linn. Pt. I p. 55.

Remarks: Hanley has isolated one complete specimen and two valves, all unmarked. Hanley says they were in their marked Linnaean box however.

S. P. Dance 1963.

(Additional remarks may be written overleaf)

Cardium cardissa Linnaeus, 1758. According to Hanley these beautiful bivalves were in a Linnean box clearly marked with their name and thus are probably syntypes.

attributed partly to the carelessness of persons consulting them and partly to the attempt of an assistant, Henry Sowerby (1821–1891), to arrange them “according to a modern method” (Jackson, 1913). In 1929 Mr Spencer Savage, then Secretary of the Linnean Society, drafted an informal report entitled *Report on the present condition of the Linnaean collection of shells*. Savage commented on the state of the collection, reviewed past work on it, called attention to the need for it to be put in order, indicated the number of “types” still to be recognised, and gave a list of those he considered were present. Savage, though familiar with the Linnaean collections and their history, was not a malacologist and his report, though useful in several ways, is of limited scientific value; apart from a brief summary of its contents by Schenck (1935) it remains unpublished.

In the tenth edition of his *Systema Naturae* (1758) Linnaeus published the descriptions of over 700 molluscan species; nine years later, in the twelfth edition, the number was increased by over a hundred and 28 more were described in the “Regni Animalis appendix” of his *Mantissa Plantarum* (1771). Linnaeus’ molluscan species represent only a small percentage of the recent mollusc fauna now known and most of them are common and widespread. However, as species concepts in the Mollusca have undergone huge revision since the 18th century the taxonomic status of his work is being continuously re-assessed, although this ongoing evaluation is hampered by the fact that so many of Linnaeus’ descriptions and synonymies are now considered inadequate for identification purposes. Linnaeus’ method of describing new species from literary sources made subsequent interpretation of the material very difficult, and many of his taxa remained poorly known until the middle of the 19th century when his shell collection was studied by a competent malacologist, Sylvanus Hanley, whose *Ipsa Linnaei Conchylia*, published in 1855, resolved many of the outstanding problems. Ninety-seven years later Henry Dodge of Scarsdale, New York, U.S.A. produced seven un-illustrated reports totalling around 1000 pages between 1952 and 1959; he (1953) analyzed the Linnaean diagnoses, sub-descriptions, synonymies and references in detail, but he was unable to actually examine the collection. Dodge was convinced that Linnaeus indicated that an example of a species was in his possession by underlinings in his copies of the 10th and 12th editions of the *Systema Naturae* but later commentators, including Dance (1967:11), have found little or no evidence to support this theory. Tradition has it that Linnaeus marked all the shells himself, and the majority of the markings do seem to be in his hand; however, variations in style and in the nature of the ink used suggest that some were marked by others, including Linnaeus *fils* and, in pencil, J.E. Smith. Dodge mentioned type specimens of many species but did/could not designate any lectotypes; he also recommended the rejection of certain specific names but never carried this forward and his mammoth project ended prematurely when his eyesight failed.

The metal specimen boxes that survive in the Linnaean collection in London are made of tin-coated steel, soldered to form 5 cm square containers with a lip upon which the name of the specimen could be inscribed; the extant boxes from the Banks *Endeavour* cabinet are very similar in design apart from being made in reversible form with two depths available. Nearly all the label plates are rusted and few of the inscriptions are legible, even with the aid of a UV reader; but as Dance points out

(1967:7) “since the mishandling of shells and boxes has reduced the probative value of all the boxes we must rely almost entirely on Hanley’s published statements – if the former presence of specimens in inscribed boxes is acceptable evidence of what Linnaeus himself considered was representative of a given taxon. The blue card trays and glass-topped boxes may, and often do, contain Linnaean material; but it is rarely possible to state with certainty that they once formed part of the original collection.”

As we have seen, rather than mentioning his own specimens, Linnaeus identified which species he was describing by citing one or several earlier published figures from pre-Linnaean iconographies. Many modern workers have considered that the specimens illustrated in these works have equal syntype status to any in Linnaeus’ collection, a stance which only serves to further complicate matters since many of the original specimens illustrated in the cited works have long since been lost or sold and almost none are available for study today. One exception is the collection of specimens illustrated by Gualtieri (1742), preserved in the Museo di Storia Naturale e del Territorio, Università di Pisa, which yields a not uncommon example of the sort of dilemma which can face the modern systematist when trying to interpret Linnaean material. Gualtieri’s specimen of *Murex pileare* Linnaeus (1758:749) was designated the lectotype by Beu & Kay (1988) to stabilise the name, since the Linnaean specimen bearing the name *Murex pileare* in London is in fact the very well-known Mediterranean species *Cymatium corrugatum*.

One factor that must be taken into account by taxonomists wishing to cite Linnaean material in their revisions is that the Zoological Museum of the University of Uppsala holds over 1000 lots of Linnaean mollusca which have been listed by Wallin (1993) and should be consulted before lectotype designations are made. The experience of Dr Alan Beu when monographing the Indo-Pacific Ranellidae and associated families is, however, indicative of the need for caution: “A complication in this work has been the identity of the Linné syntypes in Uppsala University Zoology Museum… of species not represented in the collection of the Linnean Society of London. Photographs of the [three relevant taxa and the specimens catalogued as their ‘syntypes’…] were kindly supplied… Not one of these ‘syntypes’ agrees with the species it has usually been identified as, and not one agrees with the figures cited for these species by Linné (1758); the specimens seem to have been muddled or added to the collection since Linné’s time (Beu, 1998:16). In the early 1750’s, Linnaeus commissioned H.C.von Krus (1720-1787) to paint more than 400 gastropod shells from the museum of Queen Louisa Ulrica. These unpublished paintings, on 40 quarto leaves of vellum, are now housed in the Royal Swedish Academy of Sciences; they were intended to illustrate Linnaeus’ catalogue of the Queen’s collection, but the catalogue was eventually published without the plates. Many of the shells which served as models are still preserved in the Museum Louisa Ulricae collection in the University of Uppsala. Each shell is numbered on the paintings by the artist and these numbers correspond to those written by Linnaeus, or an assistant, in Linnaeus’ own copy of Argenville (1742). Because Linnaeus wrote his trivial name for the species depicted in Argenville in the margin of the plates, the name he intended to apply to the specimens painted by von Krus can be traced from the margin note, to the Argenville figure, to the handwritten figure number, to the Krus painting. (See Lovén, 1887, Kohn, 1991).

Ostrea malleus Linnaeus, 1758. Hanley cited this as a Linnean specimen but Dance doubted that so large and showy a shell would have remained in the collection.

Certainly the illustrated specimens afford new insights into Linnaeus' concept of several of the species he proposed

The Linnean Society is currently seeking funding to have all the molluscan specimens digitised, and the eventual availability of images of all the material via the website is bound to further raise the profile and accessibilty of this priceless resource for researchers worldwide.

Linnaeus' pearls

In 1761 Linnaeus received a letter from the President of the Swedish State Committee on Economics and Commerce, in which he was informed that the pearl fisheries of the kingdom were under consideration. In his reply, Linnaeus stated that he had heard of people who made gold, but had never heard of any who could make pearls; but he knew the art and could readily impart the simple procedure. He had busied himself with the problem since his visit to Purkijaur during his Lapland journey, though he had no opportunity of experimenting with the true pearl mussels, only using lake mussels, but even with these he had produced beautiful pearls… (Jackson, 1923:323–4)

Linnaeus indeed produced the first spherical pearls ever cultured in any mollusc, from salt or fresh water, and on July 8th 1761 the Committee on Pearl Fisheries invited him to come and demonstrate his invention.

This discovery was considered of great potential economic value for Sweden and was the reason why he received his noble title of "von". His experiments utilised the freshwater mussel *Unio pictorum* Linnaeus 1758 (the "Painter's Mussel", so called because artists would use the shallow valves to mix their pigment). He removed the mussels from the river, drilled a small hole in the shell and inserted a tiny granule of limestone or plaster between the mantle and the shell; to produce a free pearl rather than a blister pearl the "seed" was held away from the shell's inner surface by a t-

Linnaeus' pearls

shaped silver wire. The mussels were then returned to the riverbed for six years. Work on this project started from around the mid 1750s onwards when Linnaeus was just under 50 years old, and given that it took six years or so to get a result, it would appear that perhaps he saw the sale of the patent as a "nest egg" for his old age. The manuscript describing the method was re-discovered among other Linnaean manuscripts held at the Linnean Society of London and was the subject of a Presidential Address to the Linnean Society by W.A. Herdman in May 1905. Linnaeus sold the secret to a Swedish merchant called Peter Bagge in 1762 for 6000 dalars (approximately £1,250) and Bagge obtained a monopoly permit from the King of Sweden to develop pearl culture. Sadly, neither he nor his grandson ever took up the idea or put it into practice.

A set of Linnaeus' experimental pearls has been travelling the world since 2001 as part of the blockbuster exhibition *Pearls* organised and administered by the American Museum of Natural History in New York; the illustrated exhibition catalogue *Pearls: A Natural History* is available in the Society's Library.

The itinerary to date is given below. The pearls are back in London for the tercentenary celebrations until October, when they will join the rest of the exhibition in Paris, opening to the public on October 27 2007.

October 13, 2001 – April 14, 2002 American Museum of Natural History, New York

June 28, 2002 – January 05, 2003 Field Museum, Chicago

March 29 – July 30, 2003 Fernbank Museum of Natural History, Atlanta

September 27, 2003 – January 18, 2004 Houston Museum of Natural Science, Houston

March 13 – July 25, 2004 Midland Center for the Arts, Michigan

September 18, 2004 – January 09, 2005 Royal Ontario Museum, Toronto

March 05, 2005 – June 22, 2005 Milwaukee Public Museum, Milwaukee

October 08, 2005 – January 22, 2006 National Science Museum, Tokyo

April 08 – August 06, 2006 Australian Museum, Sydney

December 02, 2007 – January 15, 2007 Abu Dhabi Cultural Centre, Abu Dhabi

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The 'Linnaean' insect collection

Mike Fitton FLS and Kim Harman

Department of Entomology, Natural History Museum, Cromwell Road, London SW7 5BD, UK

Although known as 'Linnaean', almost two-thirds of the specimens in the insect collection held in the Society's strongroom were added by James Edward Smith. Besides insects as we understand them today, the collection also includes such things as spiders, scorpions and crabs – all 'insects' according to Linnaeus. Because of difficulties in recognising all the material interpolated by Smith it has been maintained as a single historic collection. The prime scientific importance of the Linnaean part of the collection is as type specimens of the species which he described. Smith's material is a valuable source of information on insects from around the globe in the late 18th and early 19th centuries, but so far has been little exploited.

In setting out this general account we have relied heavily on earlier accounts, such as those of Jackson (1890, 1913) and Gage (1938), and those of our contemporaries, for example Wheeler (1985), Robinson & Nielsen (1983) and Mikkola & Honey (1993).

History of the collection

This can be divided into three phases: the period of its growth whilst with Linnaeus and latterly his son (up to 1783); its possession by Smith (1784-1828); and its acquisition and tenure by the Linnean Society (from 1829).

Specimens must have accrued to Linnaeus's insect collection for almost three decades before publication in 1758 of the 10th edition of the *Systema Naturae*, which is used as the official starting point for zoological nomenclature. It is known that Linnaeus collected insects while he was a student at Uppsala and that he mounted them on pins as we still do today (Jackson, 1913). In the autumn of 1730 he was able to report to his benefactor Kilian Stobaeus that his insect collection included more than 400 specimens (Jackson, 1913). Many of the specimens Linnaeus collected on his travels within Sweden and described in the subsequent publications are still easily identifiable in the collection. He also received insects from across the world through the activities of his students, colleagues and correspondents including T. Bergman, E. Brander, J.R. Forster, P. Osbeck, D.D. Schreber, A. Sparrman and D.D. Vandelli.

It is not yet clear to what extent, if any, Linnaeus's son added to the collection, particularly after his father's death in 1778. However, it is clear that he put a lot of effort into caring for the collection and trying to remedy the deterioration that had taken place in the small, unheated museum building at Hammarby which contained the collection since 1769.

Following his acquisition of the collections in 1784, J.E. Smith kept them at various addresses in London until 1796, when he removed them to Norwich. Smith added greatly to the insect collection, interpolating his material into the Linnaean arrangement. Like Linnaeus, Smith collected insects himself and received specimens from a wide range of friends and colleagues. Contributors to Smith's collection included

S. Wilkin, T. Marsham, A. Macleay, W. Roe, B. Clark and G. Jones. Both in London and Norwich the collection was available for study by other entomologists, such as W. Kirby, and it includes type specimens of species described by Kirby, J.C. Fabricius and other contemporaries of Smith. Not all Smith's additions are clearly identifiable as such and this has caused problems for subsequent users of the collection.

In 1829 the Linnean Society purchased the collections from Smith's widow and they were stored in the Society's rooms at 32 Soho Square, formerly the home of Joseph Banks. In 1857 they were moved to Burlington House (in rooms now part of the Royal Academy) and were housed in newly constructed mahogany cases. Until the middle of the nineteenth century the Society maintained a general museum, so it is possible, but unlikely, that interpolation of new material into the Linnaeus-Smith insect collection continued in the early years of its possession by the Society. The Society divested itself of collections other than those of Linnaeus and Smith in 1863, when the important collections, such as those of Banks, went to the British Museum, although much material was also sold at auction (Wheeler, 1995). In 1873 the Society, its library and collections moved into its present rooms in the newly-built accommodation fronting onto Piccadilly.

Curatorial history of the collection

Linnaeus's personal insect collection acquired by Smith in 1784 comprised the following numbers of specimens:

Coleoptera	1153
Hemiptera	315
Neuroptera	66
Lepidoptera	923
Hymenoptera	362
Diptera	266
Aptera	113
Total	3198 specimens

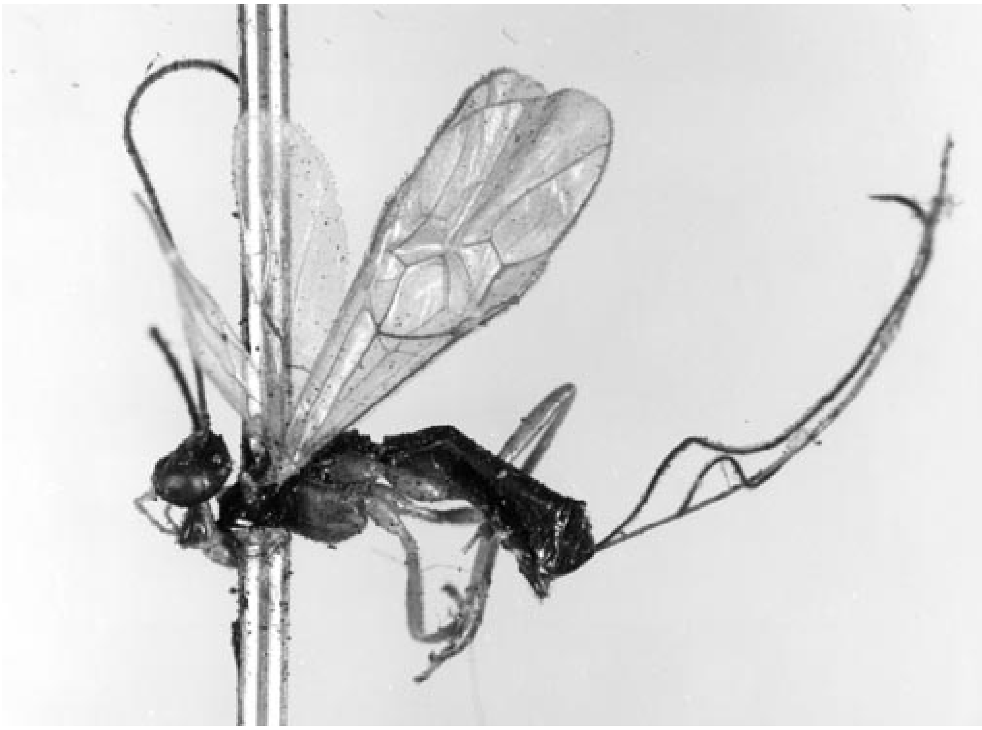
These numbers (reported by Jackson, 1890) are as given by Acrel in May 1784 in the catalogue of the Linnaean collections prepared for Smith. Another list published by C.G. Myrin gives slightly different figures (Wheeler, 1985), so we do not know how accurate Acrel's 'numbers in gross' are, but they must at least be a fair approximation to the number of pins in the collection at that time. Today there are about 9000 specimens in the collection, so that about 5800 must have been added by Smith.

These groups of 'insects' are as given in the *Systema Naturae* (edition 12, 1767) and the collection still follows this arrangement:

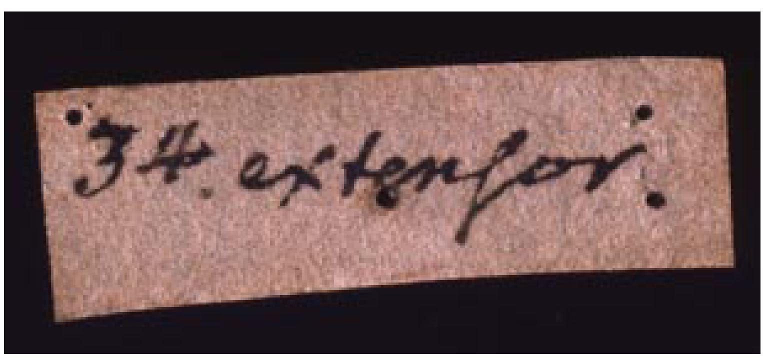
Coleoptera is more-or-less as understood today (beetles), but includes also Dermaptera (earwigs)

Hemiptera includes also the orthopteroid orders, thus true bugs, grasshoppers, crickets, cockroaches, mantids and stick insects (Dictyoptera, Mantodea, Orthoptera and Phasmida)

Neuroptera includes also dragonflies, mayflies, caddisflies, scorpionflies, snakeflies, booklice and stoneflies (Odonata, Ephemeroptera, Trichoptera,



The Linnaean specimen of *Ichneumon extensor*, incontrovertibly original because he mentions 'dua setae sive tentacula ad os'. In most specimens the maxillary palpi are concealed when viewed from above, but the pin has caused the head to rotate and the long white maxillary palps are clearly visible. Below is Linnaeus's label from the specimen of *Ichneumon extensor*.



Mecoptera, Raphidioptera, Psocoptera and Plecoptera)

Lepidoptera is as currently understood (butterflies and moths)

Hymenoptera is as currently understood (ants, bees, sawflies and all kinds of wasps)

Diptera is as currently understood (true flies)

Aptera is a mixture of wingless insects, such as fleas, lice, termites and scales (Siphonaptera, Phthiraptera, Isoptera, Hemiptera) and spiders, scorpions, crabs, etc (Arachnida, Chilopoda, Diplopoda, Pycnogonida and Crustacea)

One of the two cabinets constructed to hold the collections after the Society moved to Burlington House in 1857.

Mikkola & Honey (1993) concluded that Linnaeus probably had his insect collection arranged similarly to that of his contemporary C.A. Clerck. The specimens would have been closely spaced in shallow wooden drawers the bottoms of which were lined with a 2-3 mm deep layer of wax. They surmised (as did Jackson, 1913) that Smith moved the collection into new drawers to allow for the addition of his own material. At 32 Soho Square, some years after the collections had been purchased by the Linnean Society, the insects were described as being in 'a good and secure cabinet', almost certainly Smith's rather than Linnaeus's, and 'in an excellent state of preservation'.

Following the move to Burlington House the Society provided two purpose-built cabinets to house the insects, fishes, shells, herbarium and books. The cabinet which included the insects was constructed to hold the drawers in which the insects were at that time contained. The facings of these drawers were of timber different in colour and texture from the rest of the mahogany cabinet. It is also known that the drawers were glazed (Jackson, 1890). Unfortunately, none of them is any longer in the Society's possession, having been disposed of after transfer of the insects to the new strongroom in 1971 and modification of the cabinet to house Smith's herbarium.

In expanding the collection and interpolating his own specimens Smith seems to have maintained Linnaeus's arrangement and classification and this has been a great help to researchers studying the material. In 1856 proposals were made to separate Smith's additions. A committee of the Society's Council recommended that 'as soon as opportunity offers, these insects be separated from the Linnean, and the two collections be arranged in distinct parts of the cabinet' (Jackson, 1890). It appears that an opportunity did not present itself and as far as we are aware little or nothing was done. Mikkola & Honey (1993) assumed that after 1856, as the first step towards regaining the Linnaean arrangement, labels were moved from the drawer linings and put back onto the specimen pins (see notes on labels, below). However, the evidence for this is purely circumstantial.

Thirty years later another committee looked into the state and arrangement of the collections and reported to Council in February 1887. This time they sensibly recommended 'that the insects should be carefully examined with a view to secure any loose specimen or fragment, but that they should **not** otherwise be disturbed'. They did say 'that the remaining invertebrates [which would include many larger crustaceans falling into Linnaeus's insect group Aptera] and tortoises be placed in glass-topped boxes, as far as practicable'.

In the late 1920s the insects were rehoused in new glass-lidded boxes which were in turn kept in the drawers in which the insects were previously contained. The work was carried out by A.G. Gabriel of the Natural History Museum, who reported to W.T. Calman of the Linnean Society as follows:

Sir,

I have to report that the work on the Linnean Collection of Insects has now been completed.
The specimens have been transferred to over 200 glass-topped boxes, and a supply of napthalin placed in each box.
The specimens have been replaced in approximately the same position in the boxes, as they occupied in the old drawers.
It has been necessary to remove the cork lining from the old drawers, in order to make room for the new boxes.
The whole collection has been overhauled – i.e.
(1) Broken specimens have been mended, and wherever possible loose wings, bodies, antennae, etc have been refixed.
(2) Many of the Coleoptera have been cleaned, and numerous cases of verdigris around the pins have been dealt with.

(3) All labels have been carefully moved with the specimens they refer to, and any notes written on the paper lining of the old drawers have been cut out and transferred to the new boxes.

It has not been necessary to shorten any of the pins, so that the original pin heads remain as before.

September 16th 1929 *Alfred G. Gabriel*

The insects were to remain in the Gabriel arrangement for many years and while some studies of Linnaean species in the middle part of the twentieth century paid attention to material in the collection, none were comprehensive or entirely satisfactory (sometimes mistaking Smith specimens for those of Linnaeus). The extent to which Smith added specimens has often not been appreciated. Some entomologists did not even realise that Linnaeus's insect collection survived at all, perhaps because so much attention was focussed on Linnaeus's herbarium in references to the Society's holdings. As recently as 1975 and 1976 K. Harz designated 'neotypes' for 16 Linnaean species of Orthoptera, baldly stating that the original types were lost, apparently completely unaware of the collection in Burlington House (Marshall, 1983).

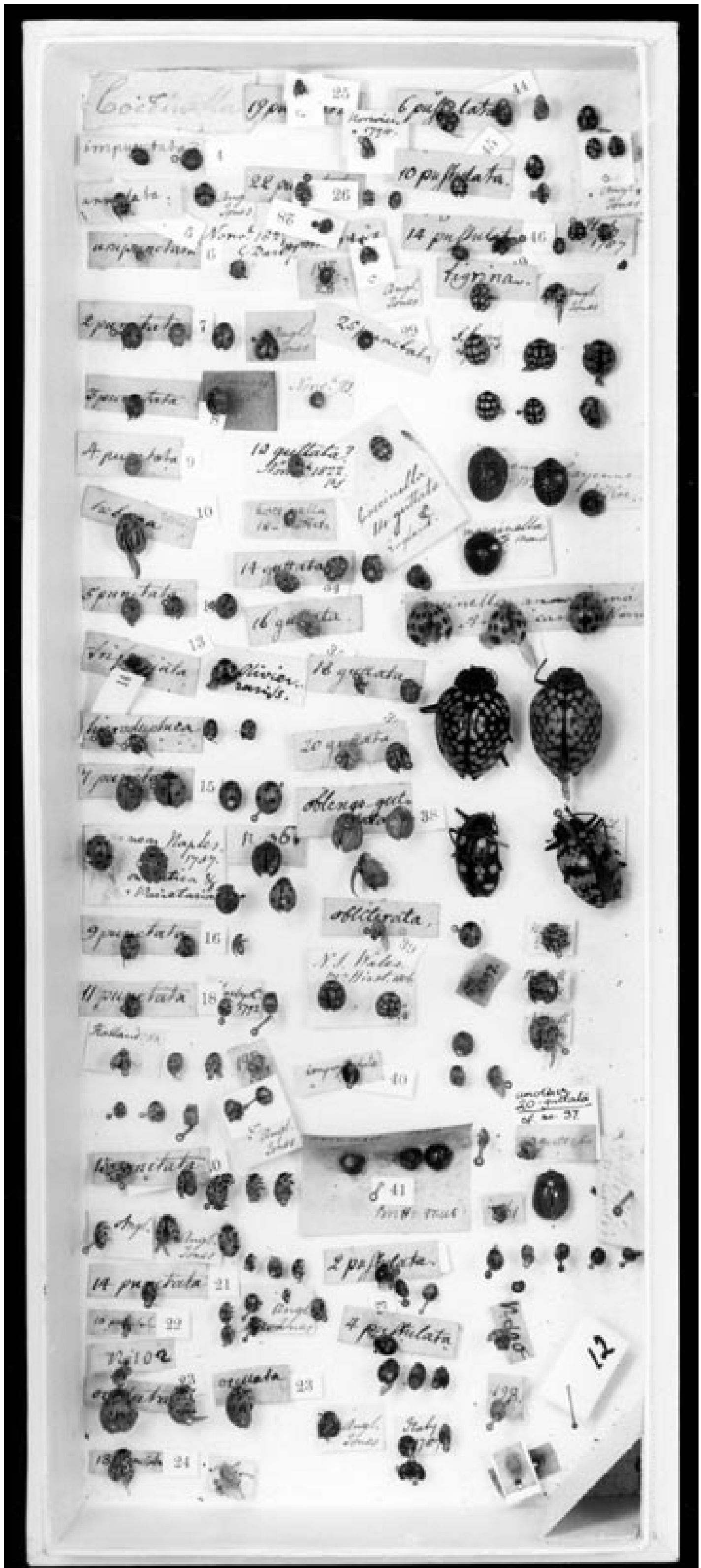
A significant event was the evacuation of the collections during the Second World War, first to Woburn Abbey and then to the Natural History Museum outstation at Tring. During this time a photographic record was made of the collections (Norman, 1942) and although the images are not very high quality they prove useful in determining earlier spatial arrangements and in detecting the occasional gross misplacement of specimens. (Incidentally, during the First World War the collections were moved to the cellar of Burlington House for safety.)

As part of the transfer of the insect collection in 1971 to the newly constructed strongroom, plans were made to recurate it into a much larger number of small glass-topped boxes in a kind of unit-tray system within the new drawers (P. Whalley and W.H.T. Tams, personal communication to MGF), but a few years later when the work started it became clear that this was impractical and larger boxes containing groups of species were eventually used. The commencement of this recuration was signalled by a letter (14 April 1976) from L.A. Mound, Deputy Keeper of Entomology at the Natural History Museum, to T. O'Grady, Executive Secretary of the Society. The work was undertaken at the Natural History Museum as a series of projects coupling reassessment and/or typification with rehousing of the material. The first group to be treated was the Hymenoptera (Day & Fitton, 1977, 1978; Fitton, 1978; Day 1979). The final specimens to be rehoused were the butterflies, together with a detailed paper on typification of all Linnaeus's butterfly species (Honey & Scoble, 2001).

Pins, collectors, labels and types

Establishing the provenance of individual specimens in the insect collection is often very difficult. Specimens may have no labels at all, and where there are labels they bear at most one or two fragments of information. Other evidence and clues must often be used.

Mikkola & Honey (1993) made a detailed study of the pins in the collection and found that it is possible in most cases to distinguish the older Linnaean ones from those



A box of beetles (*Coccinella*) as arranged by A.G. Gabriel in 1929.

of British or Smith origin, and also various other types indicative of individual collectors who contributed material to Linnaeus. Linnaeus's own older pins are typically stout with rough longitudinal markings, including a deep and irregular groove, a coarse wire-bound head, below which is a long neck, and the tip is rather roughly sharpened. In contrast the British-type pins typical of Smith's material are shorter and thinner, with a smooth surface, a finer head, at most a short neck and a much more perfectly sharpened tip. In addition to these two main kinds they also identified the following types:

T. Bergman – large smooth pins in specimens originating from the Uppsala area.

D.D. Schreber – large smooth pins, but with the specimens set (spread).

D.D. Vandelli – pins with oblique-cut tips to make them sharp (and often with 'n' labels – see below).

J.R. Forster – long pins, with rough longitudinal ridges, often shortened by having their tips cut off obliquely to leave a sharp tip, or with the upper end bent over (again often with labels giving further evidence of their origin (Day & Fitton, 1977)).

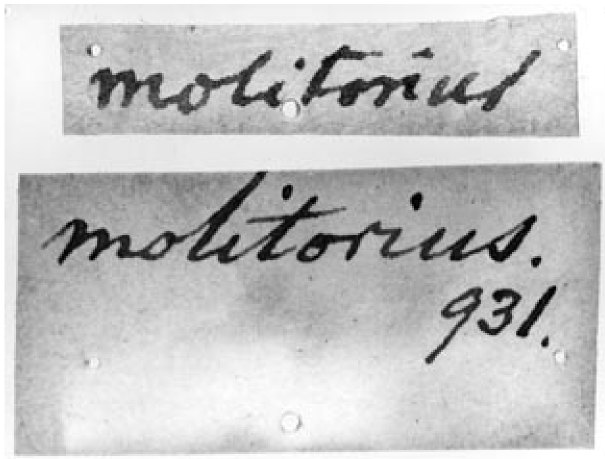
E. Brander – pins smooth and sharp, reminiscent of British ones, specimens from North Africa.

Unknown collector (possibly C.R. Tulbagh) – pins covered with brown lacquer, specimens with a southern, mostly South African origin.

Unknown collector – rusty pins with longitudinal fibrous appearance, often cut, some in specimens of southern origin.

It is clear from this that in order to determine the origin of a specimen it is sometimes necessary to consider evidence from the pins combined with label data or the method of setting or spreading the specimen (that is, how the wings, etc are arranged). For moths and butterflies this can be very important. Robinson & Nielsen (1983) noted that Linnaeus did not spread the wings of his moths and butterflies and positioned them relatively high on the pin, whereas Smith's British specimens have the wings 'spread' and are positioned relatively low on the pin, because the wings had to be held against the bottom of the box while they were drying.

Specimens if labelled at all, generally have one or two labels dating back to the period before 1829. Most of the specimens which have been regarded as Linnaean 'types' bear on the pin a narrow label in his own or his son's handwriting which shows the trivial name and often the number given to the species in the 10th edition of the *Systema Naturae*. Many specimens with these Linnaean labels also bear larger, nearly square labels prepared by Smith giving the name of the species and the page number in the 12th edition of the *Systema*. These are in Smith's neat copperplate handwriting, as are similar labels such as 'A-us bus ex. descr.' which Smith added to what appear also to be original Linnaean specimens. Other than the specific name Linnaeus's specimens rarely have labels with additional information. However, those that do include a range of data. Three figure numbers, sometimes with a question mark, refer to species numbers in the first edition (1746) of the *Fauna Suecica*. It is probable that some of these label original specimens. Those with a question mark probably are identifications which postdate the descriptions, but predate 1758, when names were employed, or at the latest 1761 when the second edition of *Fauna Suecica* was published. Another series of labels consists of three figure numbers preceded by the letter 'n'. These relate to a collection,



Linnaeus's and Smith's labels from the lectotype of *Ichneumon molitorius*.

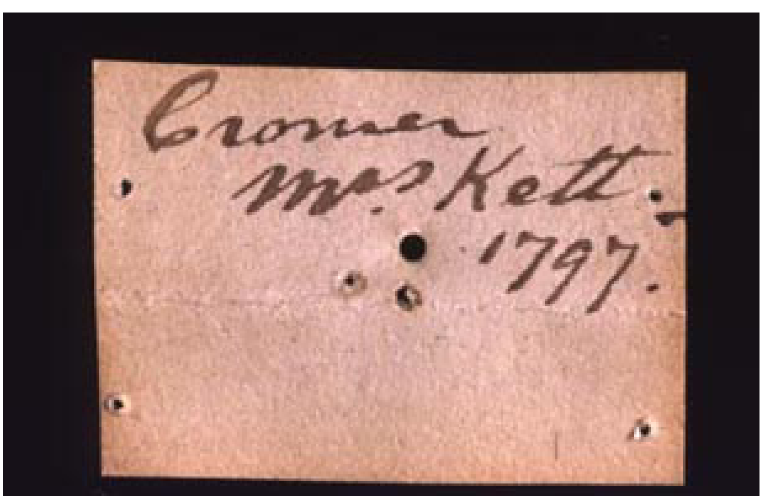
seemingly from southern Europe sent by D.D. Vandelli to Linnaeus (Mikkola & Honey, 1993). A few Linnaean specimens bear locality information, but this practice seems to have been adopted only late in the collection's history with Linnaeus; for example some specimens have a simple label 'Ryby' (*Pandora Rybyensis*, 1771). J.R. Forster sent specimens to Linnaeus in 1772 and these bear labels with the Forster species names followed by 'NS' or 'NSF'. The labels are either cut from Forster's publications or are handwritten and relate to published and manuscript descriptions (Day & Fitton, 1977).

Smith's own material often has quite detailed labels with some or all of identification, date, locality and collector. Some examples, 'Cupido 787. Surinam, March[ione]ss of Rockingham.', 'Marsham 1797', 'Angl[ia]. Jones', 'England JES.' and 'Cromer Mrs Kett 1797'. Pencilled labelling, written on the paper box-lining and referred to by Gabriel (see above) all relate to Smith additions, for example, 'Oryssus coronatus Latr.'.

A major problem with the labelling of the Linnaean specimens is that the name labels have apparently been moved from the specimen pins to the drawer lining and back again at times in the past. We have not found any record of this, but the evidence is very clear. In each Linnaean (and Smith) name label there are small holes at either end, showing that they were at some stage pinned into the drawer independent of the specimens. Mikkola & Honey (1993) describe the most likely sequence of events. Linnaeus's labels were almost certainly originally on the specimen pins. It seems that Smith removed these and pinned them on top of his own new labels directly into the drawer. The small holes at either end of the pairs of labels match perfectly. At a later stage the pairs of labels were moved on to the specimen pin. The sizes and positions of the various holes in the labels allowed Mikkola & Honey to deduce this sequence. What is not known is when these changes took place and who made the second one. Smith may have been responsible for both changes, although Mikkola & Honey postulate that the second change was made following the 1856 recommendation that Smith and Linnaean material be separated. Since some species must have been represented by multiple specimens, switching of Linnaean labels between specimens is a clear possibility and Robinson & Nielsen (1983) cite evidence of this among the microlepidoptera.

A sawfly (Hymenoptera) collected by Smith.

Although it may be decided that a specimen is actually or potentially of Linnaean origin, a problem of contemporaneity with the description still remains to be resolved. Clearly this cannot apply in all cases. Certain specimens are incontrovertibly original, and can be associated positively with their descriptions as a consequence of some grotesque or unusual peculiarity of arrangement. For example, the hairs on the propodeum of a specimen of *Sphex bidens* are so matted together that they form lateral conical projections, hence *bidens*. In the event that a specimen agrees sufficiently well with Linnaeus's description, and provided that it is not positively invalidated it should be regarded as a member of the type series and available for type restriction. Some latitude



A Smith label with fairly full data and also showing that it was once folded and pinned at each end into the drawer lining.

The Linnaean specimen of *Papillio* (*Danaus*) *plexippus*. Linnaeus's description refers to more than one species as now recognised and since designation of a neotype by the ICZN the name has applied not to this species but to the North American Monarch butterfly. Left: Linnaeus's and Smith's labels from this butterfly.

for superficiality of description must also be allowed. Ultimately the decision arrived at will depend on the utility of the particular situation: see, for example, the procedure adopted for the mosquito *Culex pipiens* by Harbach, Dahl & White (1985).

Digitisation

High quality digital images of the insect specimens are currently being produced as part of the Society's CARLS programme. The project will create an electronic archive, enable increased access and aid conservation of the collection. It is being undertaken at the Natural History Museum. For most specimens four images are taken, but sometimes three or five. This may be views of (i) dorsal, ventral, detail and labels, or (ii) dorsal, lateral, ventral and labels, or (iii) dorsal, lateral, detail and labels. At the same time as specimens are imaged a new label will be attached to each one with a unique identifier and an initial database entry will be created. A further step will be to augment this database with much more information about each specimen. It is anticipated that all the Linnaean elements of the collection will be digitised in 2007, with the Smith material to follow, and the images accessible via the Society website.

Conclusions

Much emphasis has in the past been placed on suspicions that original specimens in early collections were often discarded or given away when a 'better' specimen became available with which to replace it. Though doubtless this sometimes happened, there is no evidence to indicate that Linnaeus habitually discarded material. Many of his specimens are in poor condition and almost certainly came into Smith's possession in their present state. Some are part of series that include others in better condition. Subsequent identifications, for example by reference number to *Fauna Suecica*, also indicate that Linnaeus was not motivated to dispose of specimens in order to maintain as fine a collection as possible of single exemplars. We conclude that the Linnaean elements of the collection survive very much as Linnaeus left them at the end of his life. This general view is supported by all recent work on the insect collection.

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Linnaeus' Butterflies

R.I. Vane-Wright FLS

Department of Entomology, Natural History Museum,
Cromwell Road, London SW7 5BD, UK
and
Durrell Institute of Conservation and Ecology (DICE)
University of Kent, Canterbury, Kent CT2 7NR, UK

By the time of his death in 1778, Linnaeus had introduced some 305 species names into his omnibus genus *Papilio*, all but 6 of which apply to butterflies as currently understood (Honey & Scoble, 2001). By the mid 1770s, his great student J.C. Fabricius had not only taken over the mantle of insect description, but was also joined by other prolific entomologists such as Pieter Cramer and Dru Drury, who were busy visiting existing collections (e.g. Fabricius) or very actively encouraging traveller-collectors (e.g. Drury) to increase the numbers of known species. Thus only a few years later William Jones was able, in the 2nd volume of the Society's *Transactions*, to report that he had examined specimens or seen good quality illustrations of over 1400 different sorts of butterflies (Jones, 1794). Less than a hundred years later over 7000 species were recognised (Kirby, 1871), and we now accept maybe as many as 18,000 species, with perhaps two or three times that number of subspecies. Thus, with a clear field, Linnaeus accounted for less than 2% of the world butterfly fauna. To what extent were his efforts on the butterflies of minor significance – or of fundamental importance?

Lectotype female of *Papilio machaon* L., from Sweden. This is the designated type species of the genus *Papilio* Linnaeus, 1758. Were the true butterflies (Papilionoidea) ever restricted to a single species, this would have to be it – if this is not a butterfly in a nomenclatural sense, then nothing is! Papilionidae. © LSL.

Geographical origins

We can start to assess this question close to the home of the Linnean Society. The British Isles is currently considered to have just 59 species of native butterflies (Fox *et al.*, 2006), including *Colias croceus* (Geoffroy), which can now survive the UK winter. At species level (I will ignore subspecies in this article), 38 of them were named by Linnaeus – almost 65 per cent. If we focus on those dozen or so species likely to be seen in an English garden on a summer's day, including the common whites, the brimstone, and the familiar nymphalids, comma, holly blue, meadow brown, gatekeeper and so on, the proportion rises to 100 per cent. To this day, Linnaeus is "the main man" when it comes to formal names for the common western European butterflies. Does this simply reflect the fact that the butterfly fauna of Britain is largely a subset of the fauna of southern Sweden? What was the impact of Linnaeus's work on the names of butterfly species outside north-western Europe?

The richest country on Earth for butterflies is Peru, with some 4000 species recorded (Lamas, 2000), and even more anticipated. Peru has a number of endemics, and a high proportion of species restricted to the Andes and its slopes, from Colombia to Bolivia and into the upper reaches of the Amazon. The butterfly fauna of this region was virtually unknown in Linnaeus's day. Likewise, other global hotspots of butterfly diversity, such as East Africa, western China and New Guinea, were equally unknown to mid-18th century entomologists. So what can explain the sources of Linnaeus's exotic butterflies?

Vane-Wright & Hughes (2005) made an analysis of the geographical origins of the type-localities of extra-European butterflies named by Linnaeus (1707-1778), for comparison with the exotic sources available to two of his approximate contemporaries, the Dutch lepidopterist Pieter Cramer (1721-1776), and the English collector Henry Seymer (1714-1785). Linnaeus named a total of 184 non-European butterflies from 12 areas (Table 1). The sources available to Cramer and Seymer were similar, although the proportions differed (e.g. Seymer had far more material from Jamaica and West Africa than either Linnaeus or Cramer, but far less from the Moluccas than either, while Cramer seemingly had access to more material from India than the other two, and Linnaeus had more from South Africa). Undoubtedly there are personal and national 'networking' reasons for these differences, but the striking fact is that all three men were essentially sampling the same areas of the non-European world – notably eastern North America, Jamaica, Surinam, southern Brazil, west Africa, south Africa, India and Sri Lanka, south-eastern China and Java. These destinations were very largely determined by the trade routes plied by European sailing ships in the mid 18th century. In contrast, California, the Andes, Congo Basin, Kenya, Arabian Peninsula, the Himalaya, western China, the Malay Peninsula, Borneo, New Guinea and the Pacific were among those many regions not on the mid 18th century entomological map – and Cook, Banks, Forster, Sparrman *et al.* only started to fill some of the gaps from 1771.

Does this mean that Linnaeus's species have little "presence" when it comes to this long list of regions and countries that, in his time, were essentially unknown territory? To some extent this is true. Focusing just on the Papilionidae (significantly over-represented in the butterflies known to Linnaeus), only 1 out of 29 species listed by DeVries (1987) for Costa Rica was named by Linnaeus, while for Tanzania the ratio is

Table 1. Type localities of extra-European butterflies named by Linnaeus (reproduced from Vane-Wright & Hughes, 2005: 255).

SOURCE OF MATERIAL NAMED	NO. OF TAXA	% OF TOTAL (184 TAXA)
Guyana / Surinam	62	33.7
China	34	18.5
Ambon	23	12.5
South Africa	18	9.8
Java	14	7.6
North Africa	11	6.0
North America	8	4.3
West Africa	7	3.8
India	3	1.6
Jamaica	2	1.1
Virgin Islands	1	0.55
Réunion	1	0.55

even lower, 1/40 (Kielland, 1990), although for Vietnam it is a respectable 12/65 (Monastyrskii, 2007), and in the remote Solomon Islands the ratio rises still further, to 5/17 (Tennent, 2002). This contrasts with 6/14 for eastern North America (based on the rather conservative treatment of Klots, 1951), and 10/19 for Hong Kong (Bascombe *et al*., 1999), two areas already well sampled in Linnaeus's time. However, the ratio for South African swallowtails, from where Linnaeus received butterflies obtained by Ryk Tulbagh (1699-1771), is also low, at just 1/16 (van Son, 1949). Even so, it is difficult to go anywhere in the world where butterflies fly and not encounter at least one Linnaean species – although in places such as Hawaii and New Zealand this is due to introductions or migrants, such as *Danaus plexippus*, *Pieris rapae*, *Phoebis sennae*, *Hypolimnas misippus*, *Vanessa cardui* and *Lampides boeticus* – six butterflies named by Linnaeus that, collectively, occur throughout almost the entire temperate and tropical world.

Human origins

Linnaeus named butterflies from a number of sources, notably his own collection (now in the Linnean Society of London: LSL), the collection of Queen Ludovica Ulrica of Sweden (now in Uppsala University: MLU), and the literature (Honey & Scoble, 2001). However, only a few of his species are based solely on references to the literature – such as, for example, the single species he named from Réunion (*Papilio phorbanta*). His own collection was the most important, and the exotic material that it contained was derived, to a large extent, from his ex students and correspondents. These included Erik Brander and Morten Thrane Brünnich for North Africa, Brünnich for various Dutch colonies and the Virgin Islands (*Heliconius charithonia*), Tulbagh for South Africa, Pehr Osbeck for China, Osbeck and Hans Johan Nordgren for Java, and Anders Sparrman for other, mainly Oriental material. The MLU was, in contrast, the main source for South America (mostly the Surinam region) and Ambon (Moluccas, Indonesia), but the collectors of the MLU material, and various specimens thought to be from West Africa in MLU and LSL, seem largely unknown.

Type material of Linnaeus's butterflies

Analysis of Honey & Scoble (2001) reveals basic data regarding the existence of Linnaean type material of the butterflies and its disposition, summarised below. All of the names listed were originally included by Linnaeus in the genus *Papilio*, and the year date (e.g. as 67 for 1767) is only given in the lists for those species *not* named in 1758. Publications regarding neotypes not listed by Honey & Scoble are added.

Nominal species for which lectotypes (for designations see Honey & Scoble, 2001) are in the LSL:

agamemnon, agenor, aglaja p. 481 (not p. 465), *almana, antiochus* 67, *antiopa, apollo, arcania* 61, *argiolus, argus, ariadne* 63, *arion, assimilis, atalanta, atlites* 63, *augias* 63, *belia* 67, *betulae, boeticus* 67, *brassicae, briseis* 64, *c-album, c-aureum, canace* 63, *cardamines, cardui, cassus* 64, *charithonia* 67, *chrysippus, cinxia, cleopatra* 67, *clytus* 64, *comma, crataegi, dissimilis, doris* 71, *electo* 63, *euippe, euphrosyne, galathea, glaucippe, hecabe, helice* 64, *hermione* 64, *hero* 61, *hippothoe* 61, *hyale, hyperantus, hyperbius* 63 (*niphe* 67 is an objective synonym), *hypermnestra* 63, *janira, jasius* 67, *jurtina, laomedia* 67, *lara* 64, *lathonia, leda, lemonias, leucothoe, levana, ligea, lucina, machaon, maera, malvae, maturna, megera* 67, *melpomene, metis* 64, *midamus, mineus, misippus* 64, *mneme* 63, *mnemosyne, napi, nesaea* 64, *niobe, niso* 64, *pammon, pamphilus, panope, paphia, paris, pasithoe* 67, *phaedra* 64, *phidippus* 63, *philenor* 71, *philomela* 63, *pitho* 64, *polychloros, populi, protumnus* 64, *pruni, pyranthe, pyrene* 64, *quercus, rapae, rhamni, rubi, sarpedon, scylla* 63, *semele, similis, sinapis, spio* 64, *tages, thalia, thero* 64, *thespis* 64, *thrax* 67, *thyra* 64, *thysbe* 64, *tulbaghia* 64, *turnus* 71 [designated by Honey & Scoble, 2001: 389, in ignorance of which Pavulaan & Wright, 2002: 7, designated a "neotype"], *ulysses, virgaureae, xuthus* 67, *zeuxo* 64.

Nominal species for which lectotypes (for designations see Honey & Scoble, 2001) are in the MLU:

acesta, achilles, aeneas, aeropa, anacardii, anchises, asterie, bolina, calliope, caricae, cassiae, clio, cupido, cytherea, deiphobus, demoleus, dido 63, *diomedes, eurypylus, eurytus, euterpe, hector, helenus, horta* 64, *idea* 63, *idomeneus, jatrophae* 63, *lampetia, lysippus, marsyas, memnon, menelaus, nireus, orithya, panthous, perius, phaetusa, phidias, philocles, philoctetes, piera, pipleis, polydamas, polymnia, polytes, priamus, proteus, psidii, pyrrhus, ricini, sophorae, telamon, teucer, thamyras, urania, vanillae, venilia, xanthus*.

Nominal species for which lectotypes are housed elsewhere:

bixae (Museum Wiesbaden), *podalirius* (location unknown, perhaps lost - see Honey & Scoble, 2001: 368), *stelenes* (BMNH London, Petiver Collection).

Nominal species now represented by neotypes:

antilochus (Museum of the Hemispheres, Goose Creek, South Carolina—Pavulaan & Wright, 2002: 6), *bates* (BMNH London—Willmott *et al.*, 2001: 186), *dirce* (BMNH London—Willmott *et al.*, 2001: 186), *erato* (BMNH London), *eurydice* 63 (USNM

Washington), *fidia* 67 (LN Karlsruhe), *glaucus* (Museum of the Hemispheres, Goose Creek, South Carolina – Pavulaan & Wright, 2002: 6), *iphiclus* (BMNH London – Willmott, 2003: 110), *plexippus* (USNM Washington).

Nominal species for which no type material is known but identity is currently stable:

acontius 71, *aegeria, aegisthus* 63, *alimena, amathea, amphinome* 67, *amphion, ancaeus, aonis, arcius* 63 (*butes* 67 is an objective synonym), *argyrius* 68, *arsalte, athemon, camilla* 64, *canidia* 68, *ceneus, cepheus, clytia, cydippe* 63, *cyrene, demophile* 63, *dia* 67, *echion* 67, *eleus, eryx* 71, *eubule* 67, *eupheno* 67, *eurydice* 63 (*canthus* 67 is an objective synonym), *feronia, hecuba* 71, *hedonia* 64, *helena, hylas, hyparete, hyperbius* 64, *io, janassa* 64, *java* 68, *lena* 67, *libye* 67, *medon* 63, *melite* 63, *monuste* 64, *mopsus, nauplius, neaerea, neleus, nestor, niavius, obrinus, oenone, oileus* 67, *palaeno* 61, *pandarus, peleus* 63, *phaleros* 67, *phereclus, philea* 63, *phlaeas* 61, *phorbanta* 71, *pinthous, pirithous* 67, *polybe* 63, *polycletus, polydorus* 63, *priassus, prorsa, rumina, sennae, sibilla* 67 (*prorsa* 64 is an objective synonym), *talaus* 63, *telemachus, thoas* 71, *typhus, tithonus* 71, *trite, troilus, urticae, zetes.*

Nominal species for which Linnaean material exists but identity is in some doubt:

daplidice, deianira 64, *demophon, idas* 61, *iris* (location of so-called “lectotype” uncertain: Honey & Scoble, 2001: 337), *protesilaus*.

Nominal species for which no Linnaean material is known and identity is in some doubt:

actorion 63 (see Vane-Wright & Boppré, 2005), *encedon, philiasus* 67, *terpsicore.*

Nominal species which remain unidentified:

acastius, damone, enceladus, eribotes, helie (probably *Fountainea* sp.), *idmon, ixilion* (probably *Actinote* sp.), *jason, strilidore* 63, *timanetes*.

Rejected names:

adippe 67, *aglaja* p. 465 (not p. 481), *ajax*, *ascanius* 68, *caeneus*, *cydippe* 61, *idas* 58.

Fake Linnaean butterflies:

Finally, it must be noted that one celebrated “species” fits none of the above categories – *Papilio ecclipsis* Linnaeus, 1763. This name was based by Linnaeus on an illustration in William Petiver’s 1702 publication *Gazophylacii Naturae & Artis.* According to Honey & Scoble (2001: 321), Linnaeus also saw specimens from North America in the De Geer collection. James Edward Smith (1814) recounts how the original Petiver *ecclipsis*, a cleverly painted specimen of *Gonepteryx rhamni*, once it had been revealed as a fake by William Jones, was “indignantly stamped … to pieces” by Edward Grey. Vane-Wright & Whalley (1985) raised doubts over the existence of supposed De Geer specimens, discussed the possible origins of the two fake *ecclipsis* “specimens” now included in the LSL collection (Honey & Scoble, 2001: 321), and speculated that William Jones was most likely responsible for their manufacture, based on his two original paintings (now in the Hope Library, University Museum Oxford) of the Petiver specimen made before its destruction by Grey. A remarkable story, which may yet have more twists to come!

Linnaean butterflies‘top five’

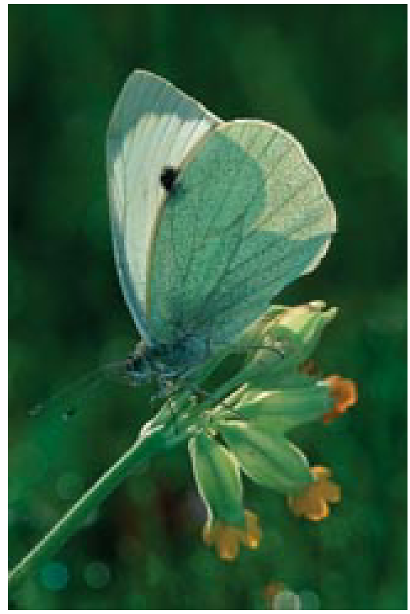
As already noted, some of the most common butterflies found in almost any part of the world were named by Linnaeus. As a result, many of the best known, most intensively studied and most important species were christened by him. In this section I have made a personal ‘top five’ selection, briefly indicating why I think these well-known species are of particular interest.

Danaus plexippus (L., 1758)

The American Monarch is perhaps the best known butterfly in the world. During the 19th century it colonised the Pacific and Atlantic Ocean, and remains established as

Overwintering Monarchs, *Danaus plexippus* (L.), cling to tree trunks at 3,000 metres in the Neovolcanic Range of Mexico. Nymphalidae. © Thomas Marent.

far as Australia and parts of Indonesia, and the Canary Islands and parts of Spain. The larvae feed on Asclepiadaceae, from which they can sequester cardenolide heart poisons. Studies of the Monarch and the Viceroy (*Limenitis archippus* (Cramer, 1776)), commenced in the late 1950s and continuing to this day, have revealed the complexity of chemical ecology and given great insights into the evolution of mimicry. Most spectacular of all, the remarkable annual migration of almost countless millions of Monarchs from the Great Lakes to a narrow belt of mountains in central-southern Mexico have inspired wonder and awe, as well as bringing innumerable new insights into the ecology and physiology of this remarkable insect (Brower, 1995; Brower *et al.*, 2007).



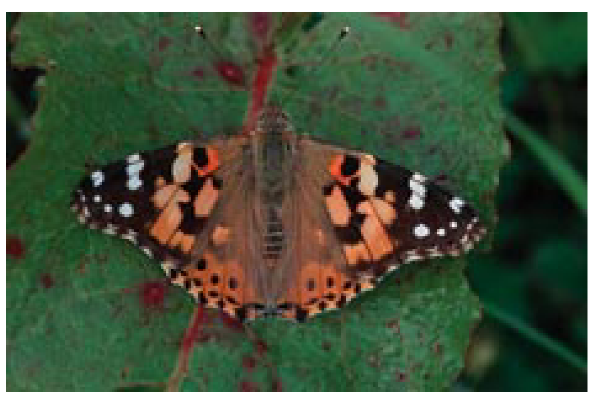
Pieris brassicae (L.), Europe. Pieridae. © Thomas Marent.

Pieris brassicae (L., 1758)

Almost everyone likes butterflies – unless you happen to be a cabbage grower! The Large White, like its smaller congener *Pieris rapae* (the Small White – also formally named by Linnaeus), is an archetypal agricultural pest. The females seem able to locate even isolated Brassicas with the utmost efficiency, their larvae subsequently wreaking havoc. The Large White has been investigated not only as a pest but also as a very convenient insect for all manner of biochemical, physiological, ecological and behavioural investigations (Feltwell, 1981).

Vanessa cardui (L., 1758)

As its common name implies, the Painted Lady is one of the most beautiful of the common nymphalids. However, the most remarkable feature of this insect is its incredible geographical range (Field, 1971) and its ability to disperse (e.g. Pollard *et al.*, 1998). Although it has been found on literally every continent except Antarctica, wherever it occurs it appears to be the same: despite much individual variation, unlike most butterflies it forms no local races or exhibits any clinal variation, apparent testament to its great dispersive powers and resultant gene flow. Familiar to me during hot summers in Kent as a child, I was

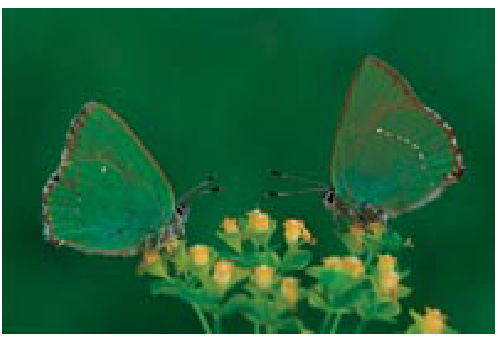


Vanessa cardui (L.)—the Painted Lady. This lovely insect is perhaps the most widespread of all butterflies. Nymphalidae. © Thomas Marent.

amazed to encounter it many years later in the Fish River Canyon in the middle of the Namib Desert, where it was the only butterfly flying. Ever since then I have been fascinated how it is that certain species of animals and plants can exist in a very wide range of conditions, while the majority seem far more specialised and restricted.

Callophrys rubi (L., 1758)

One of the best camouflage colours for insects that live in a world dominated by plants is green. Unsurprisingly, Lepidoptera caterpillars often have green pigments to take advantage of this. Many adult butterflies sit, with their wings folded, in among green leaves, and one might expect their undersides to be largely or entirely green as a result. This however is rarely the case, and even when it is, it is rarely if ever due to the presence of green pigments. The green colours of adult butterflies, possibly without exception, result from an admixture of yellow and blue pigments, the juxtaposition of black and yellow scales (as on the hindwing underside of *Anthocharis cardamines* (L.)), or photonic interference effects produced by scale ultrastructure. Structural colours usually show some degree of iridescence (change of hue with angle), and would not seem well-fitted for camouflage. At first sight the Green Hairstreak (*Callophrys rubi*) seems to be an exception: the underside is a wonderful, even, non-iridescent green, able to make this busy little butterfly almost melt from view as it settles among leaves. However, as first discovered by Clyde Mason, and later demonstrated by Richard Morris, the non-iridescent green of *C. rubi* is produced by the most remarkable "crystal-like nanostructures" (Prum *et al*., 2006: 764). The pioneering discoveries made by Mason in the 1920s and Morris in the 1970s concerning this amazing system have contributed to an explosion of interest in the biophysics of photonic structures, and their potential value as inspiration for modern technology (Vukusic & Sambles, 2003).



Callophrys rubi (L.), Europe. Lycaenidae.
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Papilio paris L., 1758

The Paris Peacock is one of the most stunningly beautiful of all butterflies. This was established as a 'fact' by Colonel M.A. Wynter-Blyth (1957) in his idiosyncratic but still valuable book on Indian butterflies. Wynter-Blyth made up a box of 20 or so species of what he thought were among the most attractive of all Indian sorts, and showed it to a large number of people, asking them to rank them in order of their perceived beauty. *P. paris* was the overwhelming winner. This wonderful butterfly and its various close relatives (often referred to as "gloss-papilios") give a perfect example of how the colour patterns of butterflies are built up from individual scales, each of which produces essentially just one colour. These butterflies also demonstrate the key importance of intense black, melanin-filled scales for giving the perfect background to enhance colour contrast, and, by absorbing almost all scattered light, ensure maximum

Papilio paris L., Indian Region. Papilionidae. © Thomas Marent.

colour saturation. The Paris Peacock is an object lesson in how to make every single coloured scale really count.

Butterflies and plants

Late in life, J.C. Fabricius, Linnaeus's greatest entomological student (Vane-Wright, 2007), proposed to rename butterflies and other insects, where information was available, using the names of the plants on which they fed. Although Fabricius's idea, with the concomitant upheaval in butterfly species nomenclature that it would have entailed, was never accepted (his paper was not formally published until 1938), it might appear that this was an original and potentially clever suggestion. Over 150 years later, following the lead of sensory physiologist Vincent Dethier, Paul Ehrlich and Peter Raven spawned a veritable entomological industry with their citation classic "Butterflies and Plants" (Ehrlich & Raven, 1965). If Fabricius had had his way, perhaps their painstaking task of gathering data on what butterfly caterpillars eat might have been just that little bit easier, the basic patterns perhaps just that little more obvious. For example, Fabricius (1938) proposed to change the specific epithet of the Monarch butterfly from *plexippus* Linnaeus to *curassavicae*. How convenient to be reminded of one of its principal foodplants (*Asclepias currassavica*) every time you read or muttered its name!

However, as in so many things, Fabricius was in reality just following to its logical conclusion a trend started by his inspiration and master. If we just confine ourselves to the 38 resident British butterflies named by Linnaeus, even to my uncertain botany, it is evident that at least 29% have names that speak of their foodplants (although in some cases incorrectly!). Thus we have *Pyrgus malvae*, *Leptidea sinapis* (which unlike other European "whites" does not feed on Brassicaceae), *Gonepteryx rhamni*, *Pieris brassicae*, *Pieris rapae*, *Anthocharis cardamines*, *Thecla betulae* (which does not feed on *Betula*), *Quercusia quercus*, *Satyrium pruni*, *Vanessa cardui*, and *Aglais urticae*. Thus the idea of naming insects based on their foodplants was well to the fore in Linnaeus's thinking. Given the level of errors and disputes that surround our knowledge of butterfly hostplants, not to mention frequent overlaps and host-shifts, it is probably just as well that Fabricius's scheme was never formally adopted.

Higher classification: Linnaeus's divisions of the genus *Papilio*

To facilitate identification, Linnaeus typically divided his large Genera into a number of named sections, and *Papilio* was no exception. These sections had a major influence on the development of butterfly taxonomy because, taking Linnaeus's *Papilio* as equivalent to the 'suborder' Rhopalocera (= Hesperioidea + Papilionoidea), his divisions operate at a level equivalent to modern family-group taxa. Presumably botanists are responsible for the fact that family group names (Linnaeus did not make use of families in his classifications) are now employed at a rank intermediate between genera and orders, rather than as equivalents to *subgenera* – which seems to have been the understanding or intention of at least some 18th century entomologists, such as Thomas Pattinson Yeats (1773) and William Jones (1794).

To what extent do Linnaeus's named divisions of *Papilio* anticipate the modern higher classification of the butterflies? In his *10th Systema Naturae*, Linnaeus (1758: 458) divided the 192 butterflies to which he gave species names among 6 major subdivisions, numbered a-f, and named respectively Equites, Heliconii, Danai, Nymphales, Plebeii and Barbari (the last of these being a 'rag-bag' of species that he clearly felt uncertain about). By coincidence, the current and now seemingly stable family-level classification of butterflies recognises the same number of primary divisions: Hesperiidae, Papilionidae, Pieridae, Lycaenidae, Riodinidae and Nymphalidae *sensu lato* (Vane-Wright, 2003).

Lectotype male of *Gonepteryx rhamni* (L.) – the Brimstone. The word "butterfly" is peculiar to the English language, and this familiar over-wintering insect may be responsible, arguably being "the butter-coloured fly of spring". If so, then if this is not a butterfly in an English language sense, nothing is! Pieridae. © LSL.

Parnassius apollo (L.), Europe. Papilionidae © Thomas Marent.

Although our present understanding is based on two orders of magnitude more species, nonetheless it seems reasonable to ask, how well do Linnaeus's divisions of *Papilio* correspond to the current family classification of the butterflies? In the *12th Systema*, Linnaeus (1767) recognised only five major subdivisions, having redistributed the Barbari amongst the other groupings. At the same time, the number of species increased to 273 – and it is this system, in essence Linnaeus's most coherent statement on butterfly classification, which is analysed below in an attempt to answer that question. (All references to Linnaeus in the remainder of this section refer to the *12th Systema* of 1767, unless otherwise stated.)

Linnaeus included 49 species in the Equites. Of these, 32 belong to the Papilionidae (65%), the remainder comprising large Nymphalidae (14 species), and 3 species of Uraniidae (moths, often with long hind wing tails, that share many features with the butterflies: de Jong *et al.*, 1996). The Equites were subdivided into two subgroups, Equites Troës and Equites Achivi. Most of the non-papilionids are included in the latter subgroup, with all but one of the 19 species placed in the former being Papilionidae. Thus the Equites approximate, but with quite a few misfits, to the swallowtail family as now recognised. However, Linnaeus did include some swallowtails in two other divisions, the Heliconii and the Nymphales. So at best Linnaeus's Equites represent a paraphyletic assemblage of Papilionidae, with some other butterflies and even a few moths included.

From the name alone, we might associate the Heliconii with the Nymphalidae – and indeed, 14 of the 23 included species (61%) do belong to the Nymphalidae *sensu lato*. However, two of the nine 'misfits' belong to the Riodinidae, two are parnassiine Papilionidae (*Parnassius mnemosyne* (L.) and *P. apollo* (L.)), two are zygaenid moths, and three are Pieridae.

Part of Linnaeus's butterfly collection, as now preserved in "Rhopalocera Box [no.] 22" in the collection of the Linnean Society of London. The three upper specimens are female *Hypolimnas misippus* (L.) (Nymphalinae: Kallimini), including the lectotype (top). The lower-most specimen is the lectotype male of *Danaus chrysippus* (L.) (Danainae: Danaini), the two being very distantly related members of the Nymphalidae *sensu lato*. Linnaeus (1767) included both in the Danai Festivi, as species 118 and 119 respectively. The striking resemblance is generally thought to be the result of mimicry, a phenomenon unsuspected by early butterfly taxonomists, and a source of much confusion. Male *H. misippus* look totally different, and it seems likely that Linnaeus misidentified a male *misippus* in the MLU with the related *H. bolina* (L.). Nymphalidae. © LSL.

In the Danai, Linnaeus listed 58 species belonging to four modern families, of which the Hesperiidae and the moth family Geometridae are represented by just one species each. However, a much better fit is obtained if we go by Linnaeus's two named subdivisions. Of the 35 Danai Candidi, all but six belong to the Pieridae, while all but 3 of the 23 Danai Festivi belong to the Nymphalidae *sensu lato*, including 4 that would now be included in the subfamily Danainae. This basic duality of the Danai confused butterfly taxonomists for some time, with the genus *Danaus* Oken, 1815, being a synonym of *Pieris* Schrank, 1801, while the familiar *Danaus* Kluk, 1780 (with *Papilio plexippus* Linnaeus, 1758, as the type species) applies to the Monarch and other milkweed butterflies (Nymphalidae: Danainae) as currently recognised.

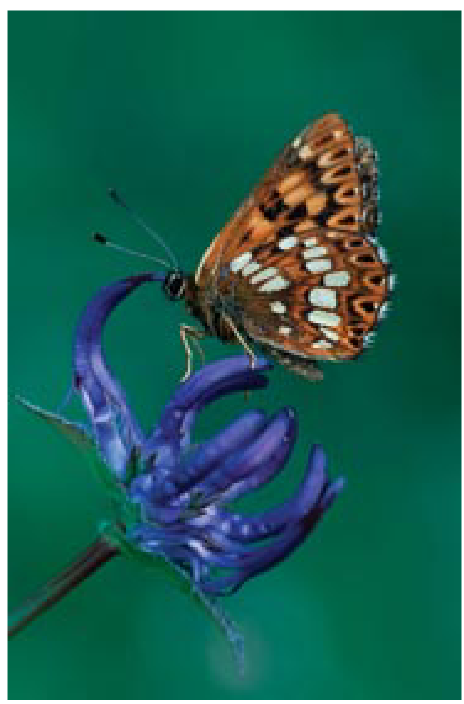
Linnaeus's fourth group, the Nymphales, included 86 species. The great majority, as one might expect from the name, belong to the Nymphalidae *sensu lato*: 80 species, or 93%. This group was also formally divided by Linnaeus into two. All 31 Nymphales Gemmati belong to the Nymphalidae (100%). The six misfits all fall in the other section, the Nymphales Phalerati, comprising four Papilionidae, one unidentified species, and one species of Riodinidae – *Hamearis lucina* which, with its common English name of Duke of Burgundy Fritillary, still carries the mark of its Linnaean misplacement.

Most of the smaller butterflies known to Linnaeus were placed in the Plebeii, with 57 species included. These belong to four families, 27 being Lycaenidae, 16

Erynnis tages (l.), Europe, Hesperiidae. © Thomas Marent.

Hesperiidae 7 Riodinidae, and 6 Nymphalidae – with one further species still unrecognised. Taking Linnaeus's division of the group into Plebeii Rurales and Plebeii Urbicolae, the former assemblage of 39 species largely comprises members of the sister-group pairing Lycaenidae (23 species) + Riodinidae (5 species), while the latter consists mainly of Hesperiidae (11 out of 18 species).

In summary, Linnaeus's 1767 classification of the butterflies into 9 named groups and subgroups does very roughly correspond to present-day family divisions. Some of the inadequacies may be due to over-representation, e.g. of Papilionidae (14% of his sample, compared with less than 4% on current numbers), and under-representation, e.g. of Hesperiidae (6% compared with 20%). However, the main source of difficulty is Linnaeus's choice of superficial characters, notably wing shape, and to some extent coloration, as soon pointed out by Yeats (1773) and Jones (1794), among others. Most notably, sexual dimorphism (which can affect both wing-shape and coloration) and mimicry (something that only became apparent a century later, when the combination of increasingly refined classification, field experience and evolutionary theory combined to reveal this phenomenon) conspired to lead Linnaeus astray.



Hamearis lucina (L.), Europe, Riodinidae. © Thomas Marent.

For example, Linnaeus consistently classified the female of the species now known as *Nessaea obrinus* (*Papilio obrinus* L., 1758) in the Danai Festivi, but its dimorphic male (as *Papilio ancaeus* L., 1758) he initially placed in the Barbari (Linnaeus, 1758), and then in the Nymphales Phalerati (Linnaeus, 1767 – see Vane-Wright, 1979; Honey & Scoble, 2001). According to Linnaeus, the Danai have the margins of the wings entire, while those of the Nymphales are "indented or scolloped" (Yeats, 1773: 131). Male and female *Nessaea obrinus* hardly differ in this regard, both having lightly scalloped hindwing margins. The main difference between the two is the striking orange-yellow band of the male hindwing upperside, which the female completely lacks. The undersides of the two sexes are practically identical, with a very unusual green ground (produced by a mixture of blue and yellow pigments: Vane-Wright, 1979) and a pattern of fasciae, lines and small spots. It was almost certainly this concordance of underside features that led Clerck (1764: pl. 31, figs 2, 3) to synonymise the two names (but too late to change the arrangement in the *12th Systema*, in which no reference is made to Clerck's 1764 figures). It seems that Linnaeus's scheme of characters was too weak to bring these two phenotypes, which only differ substantially in one major colour pattern element, reliably into the same "family".

The unrecognised phenomenon of mimicry was also a source of confusion, almost certainly accounting for Linnaeus's inclusion of e.g. the riodinid *Stalachtis calliope* in the Heliconii, the kallimine nymphalid *Hypolimnas misippus* in the Danai Festivi, and both the danaine *Ideopsis similis* and the swallowtail *Papilio clytia* close together in the Nymphales Phalerati.

However, even with the limitations of the characters used, it is notable that some of Linnaeus's nine named subdivision approximate to sub-samples of monophyletic groups at modern family level (Equites Troës ≈ Papilionidae; Danai Candidi ≈ Pieridae; Danai Festivi = Nymphalidae; Nymphales Gemmati ≈ Nymphalidae; Plebeji Rurales ≈ (Riodinidae + Lycaenidae); Plebeji Urbicolae ≈ Hesperiidae). But in all cases other members of these groups are scattered elsewhere in his system, and half a dozen moths are included as well. Perhaps most surprising is simply that, by 1767, with scarcely 100th part of the species-level diversity of butterflies known, Linnaeus was able to name representative species of all six butterfly families that we recognise today – 250 years of collecting and describing has not revealed any further major divisions of the butterflies.

In final conclusion, we need only repeat the words of William Jones to get a balanced view of the great pioneer's real contribution to butterfly systematics: *The specimens that had been inspected by that great observer of nature were few in proportion to those since known; it was difficult therefore to ascertain, with the precision necessary, those distinctions that a further and more extensive acquaintance with a far greater number afforded; and yet, though his characters were not sufficiently marked, they have gone far to lay a foundation for a more correct division; and that, so far from raising new difficulties, I think points out the very scheme more clearly which Linnaeus himself had adopted* … (Jones, 1794: 63).

Acknowledgements

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Linnaeus' Fishes, Past, Present and Future

Gordon McGregor Reid PPLS

North of England Zoological Society, Chester, UK

A Great White shark, *Carcharodon carcharias*, 6 metres long and 3000 kilogrammes engaged in a bloody attack on its prey may not be the first image that springs to mind when contemplating our distinguished and apparently gentle forebear Carl Linnaeus. Nonetheless, this shark and many other fishes are actually Linnean species and described in the 10th edition of *Systema Naturae* (1758), the recognized starting point for contemporary biological classification. Of course, long prior to the 18th century, pre-industrial Scandinavian cultures valued fishes as food. Archaeological studies of Neolithic kitchen waste heaps (9000-6000 BC) demonstrate marine capture fisheries for herring, *Clupea harengus*, Atlantic cod, *Gadus gadus*, flounder, *Platichthys flesus* and Atlantic eel *Anguilla anguilla* – all later formally recognized by Linnaeus. He first focused on fishes well-known in Europe and which would have been commonly encountered in Swedish waters such as sturgeon *Acipenser sturio*, carp *Cyprinus carpio*, three-spined stickleback *Gasterosteus aculeatus*, perch *Perca fluviatilis* and Atlantic salmon *Salmo salar*. Such names have stood the test of time and, considering fishes from the current British freshwater list alone, a remarkable 41 out of 57 (or 72%) are Linnean species.

The first complete historical portrait of the progress of ichthyology in which Linnaeus' contribution is fully recognized was by Baron Georges Cuvier in 1828 (also crediting Cuvier's student the late Achille Valenciennes). This 'portrait' was originally prepared as a section of the *Histoire naturelle des poissons*, begun post 1820 (see the excellent English translation by Abby J. Simpson republished by John Hopkins University and edited by Professor Theodore Pietsch, 1995). Dr Albert Günther FRS, a Past President of the Linnean Society of London, provided a historical account of Linnaeus' fishes in 1880 and also in his Anniversary Address of 1899 to the Linnean Society. Additional distinguished contributions have been made by others, notably including Alwyne Wheeler* (1979, 1980, 1987, 1991, 1995) one-time curator emeritus of fishes in the Collections of the Linnean Society of London.

Historical influences

In developing his knowledge of fishes, Linnaeus respectfully drew on the work of Aristotle (384-322 BC), the founding father of systematic zoology. Aristotle, in turn, reflected on the work of Homer, who strangely considered fishes not to be worth eating, especially by heroes. This idiosyncrasy persists to the present day in some cultures, mainly for scale-less, eel-like species which resemble snakes. In any event, Aristotle had a considerable knowledge of fishes, particularly of the Mediterranean region. He recognized about 118 different kinds from the Aegean Sea and was aware

* Alwyne Wheeler died 19 June 2005. An obituary by Oliver Crimmen (2006), together with a selected fish bibliography, is in *The Linnean* **22** (4): 27-33.

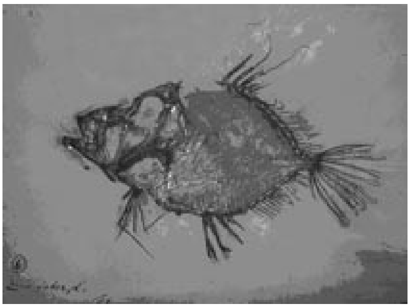
Aristotle contemplating the bust of Homer. Rembrandt van Rijn, 1653; oil on canvas. Courtesy Metropolitan Museum of Art, New York.

of population migrations for the purpose of reproduction. Interestingly, he noted that eels had mysterious breeding habits and knew of egg-laying (oviparity) in ‘scaly fishes’ (teleosts) and live-bearing (viviparity) in sharks and rays, which are now grouped among cartilaginous fishes or elasmobranchs. Aristotle was aware of, but misinterpreted, the mode of reproduction in broad-nosed pipefish, a teleost species later recognized by Linnaeus as *Syngnathus typhle*. Aristotle believed that pipefish somehow burst apart to release their eggs, the wound subsequently healing.

Among much later historical accounts, the English naturalist John Ray (1627-*ca* 1705) probably had the strongest influence on Linnean ichthyology. Ray developed a scheme of fish classification based not simply on earlier works and the rough manuscripts of his deceased student and patron Francis Willughby, but on direct observations, personal dissections, visiting many sea ports throughout Europe and close dialogues with fishermen. Including Willughby’s name, Ray published the *Historia Piscium* in 1686 in two expensively produced volumes with the imprint of the Royal Society. The volumes evidently did not sell well, leading the Society to offer the editor Edmond Halley (also the editor of Newton’s *Principia Mathematica*) fifty copies of Ray’s *Historia* in lieu of full monetary payment for his services! Ray’s concluding work, the *Synopsis methodica avium et piscium* (1713), published posthumously, summarized the state of knowledge at that time and reinforced an earlier Aristotelean observation that whales and dolphins (cetaceans) were, despite superficial similarities, taxonomically very different to fishes; a disposition ultimately accepted by Linnaeus. A good facsimile edition of the *Synopsis*, edited by W. Derham, was published in 1978 by the Arnos Press, New York.

Contemporary influences

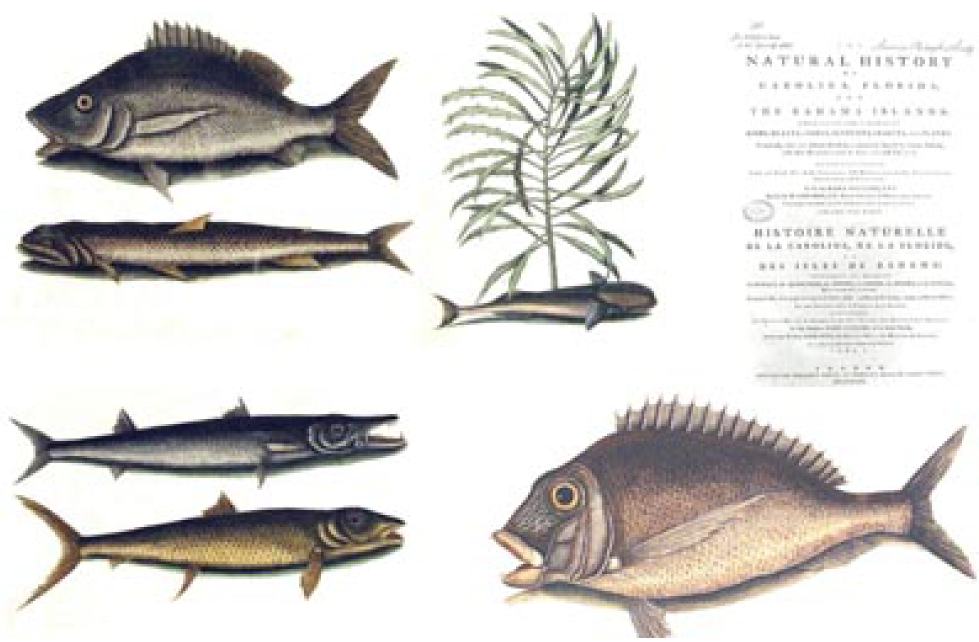
Linnaeus observed fishes when traveling around Sweden and likely collected directly 49 of the 168 specimens (mostly dried skins from one side incorporating one-half of the head skeleton) held today in the strong room of the Linnean Society of London. Linnaeus assiduously wrote up his findings in various published accounts,



Dried specimen of John dory *Zeus faber*, L. 1758 in the Collection of the Linnean Society of London. Courtesy of Curator Emeritus Kathie Way.
In life, the dory or Apostle fish has dusky patches on each flank, said in mythology to mark the impression of the thumb and forefinger of St Peter who held this fish by the Sea of Galilee to retrieve tribute money from its mouth. Actually, this species does not occur in the freshwaters of Galilee (=Lake Tiberius) but a species of *Tilapia* (now *Sarotherodon*) does, originally described as *Sparus galilaeus* L., 1758.

including *Wästgöta-resa* (abbreviated as *It. wgot*., 1747, in the *Systema Naturae*); *Öländska och Gothländ-ska Resa* (*It. oel*., 1745) and *Fauna Suecica* (Stockholm, 1745; second edition 1755). Linnaeus published *Museum S:ae R:ae M:tis Adolphi Friderici* (Stockholm, 1754) and *Museum S:ae R:ae M:tis Ludovicae Ulricae Reginae* (Stockholm 1764), based on his study of indigenous and exotic material in the Royal Collections of King Adolf Fredrik I of Sweden and Queen Lovisa Ulrika, respectively. Specimens from these collections are extant in the Naturhistoriska Riksmuseet, Stockholm (Fernholm & Wheeler, 1983). An inventory of Linnean specimens in the collections of the University of Uppsala is given by Lönnberg (1896).

The *Museum Ichthyologicum* (1754-56) and *Zoophylacium Gronovianum* (1763-81) of Laurens Theodore Gronovius (1730-1777) inspired Linnaeus, as did Mark



Title page and some plates from Mark Catesby's (1729-47) *Natural History of Carolina, Florida and the Bahama Islands.* A Remora is figured top, centre.

Catesby's (1729-47) *Natural History of Carolina, Florida and the Bahama Islands*. Interestingly, this seminal work featured *Remora remora,* with anterior dorsal fin greatly modified as a 'sucker' allowing it to cling to sharks bellies to eat external parasites and for an energy-efficient means of transport. Alexander Garden sent to Linnaeus fish specimens from the colonial New World, mainly from Charlestown, South Carolina between 1760 and 1771 which were incorporated in the collection of dried skins. Living specimens – at least in the form of two goldfish *Carassius auratus* (L. 1758) – were also kept. These were transported from London to Uppsala in 1759 and fed on board ship with "sugared biscuits and flies".

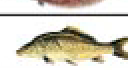
The strongest contemporary ichthyological and other taxonomic influence on Linnaeus was his good friend Petrus Artedi (1705-1735); both were graduates of Uppsala University in Sweden. Certainly, Artedi was a brilliant ichthyologist and leading figure in designing the innovative system of binomial nomenclature and hierarchical classification developed fully by Linnaeus. Artedi died in 1735 under mysterious conditions in Amsterdam. He drowned in a canal following a dinner one evening with his patron the Dutch apothecary Albertus Seba (who also wrote on fishes in his '*Thesaurus*', 1759). The ichthyological historian Professor Theodore Pietsch explored the mystery of the drowning in an address to the Artedi Tricentennial Symposium on Ichthyology (held at the Swedish Royal Academy, September 2005) and wondered whether, in fact, it was an accident. Whatever the case, Linnaeus fortunately rescued Artedi's work on fishes and edited it, publishing it posthumously as the *Ichthyologia* (1738), a magnificent starting point for both fish systematics and general descriptive taxonomy.

Ichthyological disciples

Linnaeus also incorporated in the *Systema Naturae* ichthyological findings from expeditions made to distant lands by his 'disciples', including Daniel Solander, Fredrik Hasselqvist, Pehr Osbeck, Pehr Löfling and Pehr Forsskål. He referred to Hasselqvist's *Iter Palaestinum eller Resa til Heliga Landet förråtted ifrån år 1749 til 1752.* (*Hasselq. Iter*, 1757) and to Osbeck's *Dagbok öfver en Ostindisk Resa åren 1750, 1751, 1752* (*Osbeck. Itin.*, 1757). A dried specimen of a pipefish (*Syngnathus* sp.) taped to a letter sent by Osbeck to Linnaeus is present in the Linnean correspondence held in the Linnean Society of London. Undoubtedly Pehr Forsskål was a personal favourite. He was born in 1732 in Helsingfors (now Helsinki) Finland and educated in Uppsala University and Gottingen University in present-day Germany. In 1761 Forsskål, on Linnaeus' recommendation, joined a Danish expedition to the Ottoman Empire, Egypt and the Arabian peninsula; but he died in the Yemen in 1763, along with other colleagues. The German scientist Carsten Niebuhr (1733-1815) was the only survivor and he saved some of the expedition's collections, returning with them to Denmark and publishing the edited results in *Descriptiones animalium avium, amphibiorum, piscium* (1775). The batfish *Platax orbicularis* Forsskål, 1775 and the blue spotted ribbontail ray *Taeniura lymma* (Forsskål, 1775) were among the more colourful and distinctive species he discovered in the Red Sea. Linnaeus was somehow held partly responsible for Forsskål's death by encouraging his journey to Arabia. Certainly, it pained Linnaeus to lose his beloved student at only 31 years (paradoxically from the 'ague' or malaria a disease researched by Linnaeus for his doctorate). To symbolise the sharp sting felt at this loss, Linnaeus named a genus of nettle (of the family Urticaceae) *Forsskaolia* in the publication *Opobalsamum*, 1764. He named the type species *F. tenacissima* with reference to the clinging bristly hairs of the plant and also as a tribute to the spirit and tenacity of Forsskål in pursuing his scientific activities while gravely ill (Dr John Edmonson, personal communication).

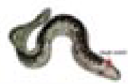
A substantial number of fishes eventually came to be included as exotic components of the *Systema* including the Nile perch, *Lates niloticus* L. 1758. This species is widespread and famous in tropical freshwaters of the Nilo-Sudanian region and would have been familiar to migratory (transhumant) fisherfolk since early times. Today, this giant perch – reaching a length of up to 2 m and a weight of 80 kg – remains the prize target of ten thousand or more indigenous fishermen, using traditional homa or butterfly nets at the Argungu fishing festival held each year on a tributary of the Niger. The electric catfish (*Malapterurus niloticus* – a siluroid capable of generating through muscular electroplaques a 350 volt shock to a predator), Nile perch and many other extraordinary Linnean fishes are known to have been celebrated in pre-dynastic Egyptian animal cults dating back to at least the fourth millennium BC. Millions of mummified animal corpses, including many fishes, have been discovered by archaeologists. Evidently, these animals would have been embalmed by priests for sale to temple pilgrims who placed them as votive offerings to the gods. A splendid Egyptian 4th dynasty wall painting of a Nile perch being carried by two men can be seen at the mastaba of Rahotep at Medum.

From his own work and that of other authorities, Linnaeus provided his fullest account of fishes in the twelfth edition of *Systema Naturae* (1766-67). The only aquatic (or rather amphibious) life detectable in the title page of that edition is a rather

LINNEAN CLASSIFICATION OF LOWER VERTEBRATES (1758)			
III	AMPHIBIA (Amphibians)		
i.	Reptilia	Turtles, tortoises, lizards, frogs	
ii.	Serpentes	Snakes	
iii.	Nantes	Rays, sturgeons	
IV	PISCES (Fishes)		
i.	Apodes	Eels, barbels	
ii.	Jugulares	Cod, blennies, gurnards	
iii.	Thoracici	Flatfish, stickleback, gobies, butterfly fishes	
iv.	Abdominales	Catfish, salmon, trout, pike, herring, carp	
v.	Branchiostegi	Puffer fish, trigger fish, sea dragons	

Linnaeus' classification of 'lower chordates': Amphibia and Pisces.

CONTEMPORARY CLASSIFICATION OF 'FISHES'

Higher Category		Orders	Families	Genera	Species
Jawless fish (Agnatha)		2	4	17	72
Cartilaginous fish (Chondrichthyes)		14	50	130	711
Bony fish (Osteichthyes)		45	436	3,700	24,374
Total:		61	490	3,847	25,157

Contemporary classification of 'fishes'
(chordates with and without jaws, bone and scales).

misshapen frog: but then Linnaeus' original concept of 'amphibia' included taxa that we would now recognize as 'fishes' *sensu lato*. About 118 species of fish were recognized by Aristotle, 150 in Roman times and 414 in the lifetime of Linnaeus. Following this, there was an explosion of knowledge with about 5000 species being recognized in Baron Cuvier's time, 9000 in Darwin's time and more than 25,0000 species recognized today (*ca* 14,000 or 54% in freshwater and 12,000 or 46% in seawater). Currently, about 200 fish species new to science are described each year with (on the existing trajectory) a projected total of above 35,000 – 296 times more species than recognized by Aristotle and 85 times more than by Linnaeus.

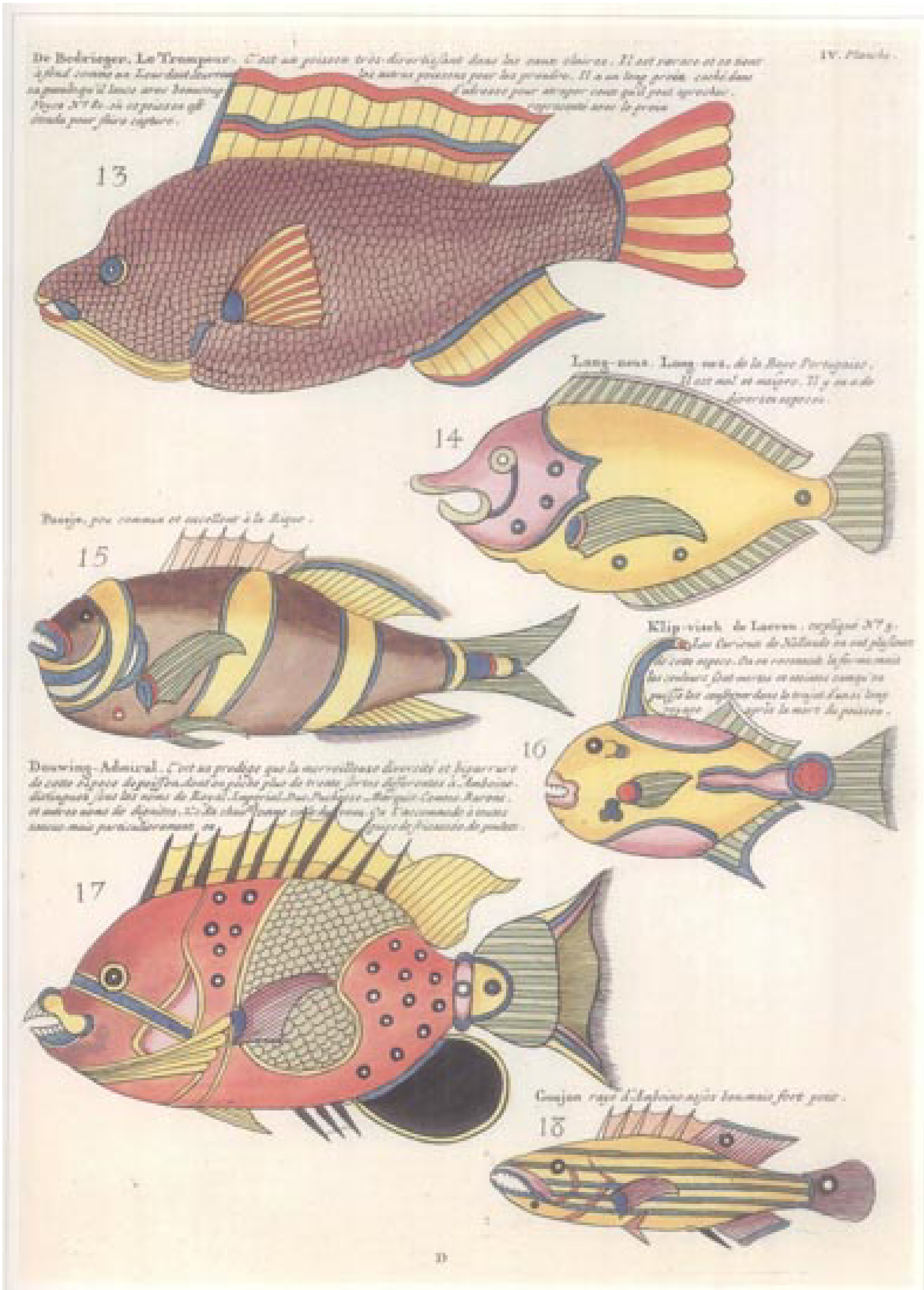
The development of fish photography in the Victorian period probably helped accelerate an interest in underwater life and speed-up the process of recognition and naming. The first fish ever to be photographed was the pike *Esox lucius* L., 1758. This was made by the Count of Montizon in about 1854 in the world's first ever public 'Aquavivarium' in London Zoo, Regents Park. A Fellow of the Linnean Society, the Count was an unsuccessful pretender to the thrones of both Spain and France. He died in modest circumstances in Hove near Brighton.

Conservation and sustainability

Expeditions to the Indian Ocean by the Dutch in the late 16th century, and the 17th and 18th centuries, were primarily for the purposes of economic exploitation but did yield interesting natural history finds – probably perused by Linnaeus during his academic sojourn in Harderwijk University, Amsterdam, where he graduated with a doctorate in medicine in 1735. One such expedition was by Van Warwick to Mauritius, captured in a woodcut print of 1598 and probably by Willem van Zanen. This dramatic woodcut, published in 1602, may be the earliest depiction of negative human impact on natural resources and wildlife, including several different kinds of fishes (later to

European pike, *Esox lucius* L., 1758, photographed by the Count of Montizon FLS in 1854. Courtesy of the Zoological Society of London.

Exploitation, by Dutch seafarers, of the natural resources of Mauritius including fishes. Willem van Zanen, 1602; woodcut.
Courtesy of Carl Jones, Mauritius Wildlife Conservation Foundation.



Possibly the first published colour illustrations of tropical fishes appeared in Louis Renard's Poissons, Écrivisses et Crabes (Amsterdam, 1719). This plate IV, from Volume 2, is a vibrant hand-coloured copper engraving based on original paintings by Samuel Fallours of coral fishes from the former Dutch East Indies. Curiously resembling contemporary abstract art, these biologically inaccurate representations are at best 'generic'.

be categorized in Linnean genera). As well as recognizable 'generic' flatfish and cod (based on erroneus European conceptions of the Mauritian ichthyogauna), the wood cut contains the first illustrations of the Mauritian fruit bat (in unorthodox vertical position!), pink pigeon, echo parakeet and (centre right) the dodo, an abiding symbol of extinction. Conservation (as we now conceive it) did not loom large in Linnaeus' thinking and there is no evidence that he was concerned about over-exploitation of fisheries; but he did ponder on the destruction of forests in northern Europe – considering this to be a temporary and reversible blunder (Koerner, 1999: 85, 86).

Today, on incomplete assessments, there are 752 fish species listed by the World Conservation Union (IUCN) as threatened. These represent roughly 10% of all threatened vertebrates. The causes of fish population declines and extinctions relate mainly to over-fishing, pollution, damming, drought and the introduction of alien species of fish. Ironically, in the latter case, two Linnean species are infamous: the Nile perch for its deleterious predatory impact on the haplochromine cichlid species 'flock' in Lake Victoria, East Africa; and the Nile tilapia *Oreochromis niloticus*, which out-competes indigenous fishes and which has been introduced into tropical and sub-tropical habitats world-wide, remarkably including the Galapagos World Heritage Site. Proposed introductions of exceedingly tough, genetically 'improved' (engineered) 'GIFT' *Tilapia* are an ever-present risk to global fish populations. Sadly, the Great White Shark of Linnaeus is now listed as Vulnerable in an IUCN Status Survey of 2005. In Europe, Maurice Kottelat and Jörg Freyhoff will in 2007 complete on behalf of the IUCN the first major survey of European freshwater fishes since Günther's *Catalogue of fishes in the British Museum* (1859-1870). These authors now recognize (personal communication) 543 native species in European freshwaters, as many as 293 species more than were hitherto recognized in standard works. A shortage of well-trained, specialist ichthyologists to cover the extraordinarily wide range of global fish diversity is a major problem in completing species surveys, genetic and phyletic analyses, conservation assessments and action plans. The need for outstanding fish taxonomists to follow in the grand tradition of Linnaeus has never been greater.

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