The Biology Curator

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mercury had accumulated in the blood and urine of staff. Urine tests give accurate information relating to the exposure to contamination that has occurred in the last 3 months. Blood tests will only give information relating to the past 5 days, and if fish has been eaten within this period then the blood test will not be accurate as fish are extremely adept at storing heavy metals within the flesh and the liver.
One problem was that it took too long to actually implement the tests. By the time the staff had been sent for tests they had not been in contact with the main herbarium for at least 3 months which could have rendered the biological monitoring fruitless. However, even after this delay two members of staff did show slightly higher than normal mercury and arsenic levels at the first test.

Safe Standard Procedures Employed
Precautions were taken immediately and this included:
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Informing all visitors to the collections of the possible problems of contamination.

- Ensuring work was only carried out in well-ventilated areas.
- Wearing powder free, nitrile gloves (Fisher Scientific, UK) whenever accessing the collections. (These are thrown away after single use).
- Washing hands after handling collections, particularly before eating, drinking or smoking.

One year after these precautions were implemented, staff returned for their health surveillance and within this time all staff members' contamination levels had returned to normal.

Conclusion

The conclusive analysis on this collection singled it out as a hazard in its entirety, however its removal would not have provided a means to an end as the numerous other collections within the museum may well have been contaminated too. Until conclusive analysis has been done all historic natural history collections should be treated as potentially hazardous. If suitable precautions are carried out then maintaining and accessing the collection should continue as normal.

Future research has been initiated on the identification of organic residues present on the collections. The very number that may have been applied and the hazards they may pose should never be under estimated!

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Study Trip

Royal Botanic Gardens - Kew

Mike Palmer, Buckinghamshire County Museum

On the 19th June, one of the hottest days of the summer, a small band of seven curators congregated in the main reception of the Herbarium Building. We were met by Lourdes Rico of the Leguminosae Section who began with a brief introduction.

The main herbarium comprises some 7,000,000 specimens including at least 250,000 Types. What was previously a small botanical collection was substantially enlarged in 1866 by the purchase of Sir William Hooker's herbarium and library followed by the bequest of George Bentham's collection. The original purpose built herbarium building was brought into use in 1877. As the collections grew subsequent wings were added (1902, 1932 and 1960) eventually forming an enclosed quadrangle. Further storage space was completed under the quadrangle in 1989. Despite the recent addition of a further floor to the rear wing the annual addition of some 30,000 specimens to the collections means that a fifth wing will soon be required.

The collections are arranged broadly in the Family order of Bentham and Hooker (Genera Planetarium, 1862-1883) with some modifications. Within Families the arrangement follows the most recent major work while within genera specimens are arranged geographically.

Collecting is mainly from the tropics concentrating on poorly collected areas and areas of current research interests. Attempts are also made to avoid overlap with the Natural History Museum and the Royal Botanic Garden, Edinburgh. The main collecting areas are Tropical Africa, particularly East and South-Central

Africa, Southeast Asia, particularly Malaysia and Tropical South America, especially Brazil. All new collecting must have correct permits and meet all current agreements.

In the past, Mercuric Chloride was the preferred means of protecting herbarium sheets against pests, although this has now been discontinued for Health and Safety reasons. Other substances, including lauryl pentachlorphenate have been tried and rejected for similar reasons. Similarly, repellents, notably naphthalene and paradichlorobenzene are no longer used. Pest control now relies on good storage, good housekeeping, monitoring and freezing. Statistics for pest monitoring, observed later on the tour, showed *Stegobium, Lasioderma* and *Anthrenus* to be the main pest species. Two members of staff were assigned to monitoring as part of their wider duties with David Pinniger acting as consultant. Hanging and floor traps were observed throughout the collections.

Introduction out of the way we embarked on a circumnavigation of the four wings. The cabinets observed on the ground floor where all of wood and of high quality although the felt seals had caused some problems with insects. Newer cabinets, as seen in the Euphorbiaceae room, were of metal with plastic cushioned seals. Example specimens made available included plants collected by Charles Darwin and botanical material from the sarcophagus of Tutankamen. Kew has also made extensive use of cibachrome prints of specimens, for reference, certain loans etc., which are also stored within the main sequence.

In addition to the main collection a few separately stored named collections exist. The Wallich collection of trees from Calcutta, donated by the Linnean Society, includes stipulations of the gift that it be stored separately and that the material is not loaned out. The collections of Hewitt Cottrell Watson, William Borrer and the Rev. Lightfoot were also observed.

The Collections Management Room provided an indication of the amount of material moving in and out of Kew to and from the rest of the world. Loans in, loans out and exchange material where coded with different coloured tags with individual batches being assigned transaction numbers. All incoming material is quarantined in a separate building before being frozen for five days at –30 degrees Celsius and then passed to the Collection Management Room for subsequent distribution to the collections.

Passing into the long and expansive library we were presented with a choice display of contents. In addition to books library staff also manage the archives, maps, prints and drawings. On display was a selection of original watercolour from *Curtis's Botanical Magazine* sealed in Melanex. Originally these would have been stored in cabinets within the main herbarium, however, were later removed to the Library and cibachrome prints left in their stead. Illustrations in the magazine, founded in 1787, were hand coloured up to 1948. It was interesting to note that each member of the small illustrative team had particular responsibility for particular colours. A selection of books were also displayed including *Ortus Sanitatus* which, dating from 1484 is one of the earliest printed herbals. Throughout the library most books are on open shelf display with the exception of pre-1800 publishings which were locked behind glass and the *Banks' Florigeum* facsimiles which were secured with metal bars. Sheets of foam and pillows stuffed with polystyrene beads were available for viewing larger and more delicate volumes.

The spirit store, housed in the basement, comprised some 64,000 jars of which around half comprised orchid specimens, and to which around 1,000 new specimens were added per year. The majority of jars are housed in a compactorised system with a small number of larger jars stored in cupboards. For historical reasons a wide range of jar types are present although Copenhagen jars are presently used. The specimens are stored in Kew Mixture (53% IMS, 37% water, 5% formalin and 5% glycerol, 70% IMS, 29% water, 1% glycerol), however, when any specimen leaves the store for loan or just to a curator upstairs, it is transferred into a Copenhagen Mixture (76% IMS, 18% water, 5% Glycerol). Loans are sent out in plastic bottles. The collections are stored numerically so that the oldest specimens are at one end and the newest at the other. This is done so as to achieve maximum utilisation of space and avoid periodical reorganisations. The computerised numbering system is vital, therefore, in locating specimens, with numbers written in red on both lid and jar and coated in varnish. The stores are maintained at a temperature of 15 degrees Celsius. Formaldehyde and alcoholmeters are present throughout the store to detect atmospheric vapour levels with warning lights both within and without the store. The store has its own separate air conditioning unit and is kept at negative pressure to avoid any movement of fumes to other parts of the building. Large containers of premixed batches of both mixtures used are connected by pneumatic pipes to nozzles in the fume cupboard for easy filling and topping up.

The quadrangle store houses extensive compactor units, which contain, amongst other things, the Palm collections. The traditional technique of mounting palms on sheets has been superseded by a loose arrangement within four-folded folders (like a giant fragment capsule) or more rigid 'green boxes' of varying depth. Information labels were attached both

to the lid of the box and also lose within with the specimens. This allowed more material per specimen to be stored together and less need for pressing. Gymnosperms are stored similarly.

Next stop, the Mounting Room. Pressed plants are attached using watered down PVA glue. Labels and fragment capsules are similarly attached. Linen tape is used for thicker stemmed specimens. Specimens are laid out in accordance with standard considerations (as covered in the *Herbarium Handbook*). Sheets are stacked, separated by sheets of waxed and drying paper, and weighted down by small sandbags. The current team of six mounters process around 30 to 40 sheets each per day.

Having completed the main building we moved on to the three-storey Mycology Building where we were met by the head of Section, Dr Brian Spooner. The fungi collection comprises around 800,000 specimens including 35,000 Types stored throughout the sequence. The British collection, 40,000 is stored in compactorised herbarium boxes in the Mycology Building with the remaining tropical collections housed in the quadrangle store of the main building.

A separate collection of Myxomycetes is kept in shallow white boxes which again includes Type material. In accordance with the Morton Agreement with the Natural History Museum, Kew doesn't officially collect Lichens, however, some are maintained due their importance in the taxonomic understanding of Ascomycete fungi.

Fresh material is dried in an oven with airflow of 40 degrees Celsius. Most specimens only require a day; however, larger specimens are sliced and may require longer. Once dried they are frozen a t –40 degrees for 5 days. They are then stored paper packets and glued to sheets using a spot of PVA (the spot allowing easy removal of the packet from the sheet for loans). Each sheet may consist of a number of packets with the packets being positioned to avoid lopsidedness within the stack. Genus covers contain species covers, which may be further sub-divided on geography for common or numerous species. Bar coding of specimens was introduced six years ago linked to the Herb Track database. Currently new and loaned material is being bar coded with a plan to include Type specimens as well. The collection was formerly arranged according to Saccardo, however, Kew, over the last few years have evolved their own system based on a range of published works.

Although some fungi are stored in spirit this methods of preservation is not encouraged as it means that many important stain reactions cannot be carried out, it leaches colours and, depending on the type of spirit, has adverse effects on the DNA. At one point it was considered that freeze drying fungi specimens would be beneficial for DNA extraction, however, with improvements of DNA extraction and amplification techniques air dried specimens are producing good results.

Spore prints are kept either on paper or on slides some of which are stored with the specimens in packets while other form part of a separate slide collection. Spores are also dried and frozen for lab cultures and molecular investigation.

Culture collections are kept in three mediums; under mineral oil, dried (need growing on every six months) or in liquid nitrogen. Liquid nitrogen levels need to be checked every two weeks – a fairly simple process, as we were able to observe.

Next on the programme was the Centre for Economic Botany (CEB) where we were met by Dr Hugh Prendergast. Unfortunately, this coincided with a power cut plunging the collections into near darkness. This, however, could not disguise the large size of the collections, around 76,000. Parts of the collection dates back to the days of Sir William Hooker who had a keen interest in what plants around the world were being used for. Acquisition tries to focus on those plants and products which are disappearing whether due to the product having been replaced, changing culture or because the species itself is threatened. The collection is stored in a compacterised storage. To avoid earlier experiences with pests, primarily *Stegobium*, the store is maintained at a temperature of 12-13 degrees Celsius. Relative humidity is maintained at 64-65 percent. It was interesting to note that the collection included both raw materials and finished products (by comparison Liverpool Museum's economic botany collection contains generally only the raw materials with the finished products being part of Humanities ethnographic collections.

The collections are stored systematically down to genus and then alphabetically. Included here were important collections such as objects made from the Paper Mulberry from Japan c. 1860/1870 and Japanese Lacquer while collection of plant products used in Chinese medicine provides an important reference for checking material currently being sold in this country. Just before we left the CEB the lights came back on and we were briefly able to view many of the things we had only heard about.

With high noon long gone and still know sign of lunch we trekked across to the other side of the Gardens in search of the Jodrell Laboratory where we were met by Dr Nigel Veitch. Founded in 1876 to allow greater scientific research the laboratories were built well away from the herbarium so as not to pose a fire risk. Today Jodrell covers four broad areas of research

Cytogenetics, Anatomy, Molecular Systematics and Biological Interactions.

Cytogenetics are largely occupied with surveying chromosome numbers, shape, size and DNA content across the plant kingdom to provide a better understanding of how different species are related and thus a more realistic classification of the plant kingdom. The behaviour of hybrid species chromosomes is also studied to aid prediction in future natural and cultivated hybrids.

The Anatomy Section complements the main herbarium botanists through maintaining and adding to Kew's anatomical microscope slide collection, currently totalling 95,000. These are stored vertically in metal fireproof cabinets. The Section also receives a large number of enquiries from identifying tree roots to food contaminants to charcoal from archaeological digs. The Section is also responsible for publishing the *Anatomy of Dicotyledons* and the *Anatomy of Monocotyledons* book series.

Molecular Systematics studies variations in DNA, RNA and proteins. The Section has a major input into the understanding of the taxonomy and classification of Angiosperms while the determination of genetic diversity within endangered plants species plays a major role in planning their conservation. The DNA Bank contains some 10,000 samples of plant genomic DNA (and still growing). These are stored a –80 degrees Celsius. As and when required this material can be extracted and amplified for further research.

Biological Interactions is primarily concerned with the identification of biologically active compounds in plants. Useful compounds, once identified can then be sought for in related species to find the best source. Such chemicals can be used for pharmaceutical drugs e.g. taxol from the Pacific Yew, and pest control e.g. *Calceolus* spp being investigated as a whitefly deterrent. It was noted that while fresh material generally contains a wider selection of active compounds, many of the more stable chemicals can still be extracted from herbarium specimens and thus can help to refine costly field searches.

With the time now approaching 3.00 p.m. we retired in search of shade, seating and food and a chance to reflect on the large number of Kew staff who enthusiastically welcomed and showed us around their respective territories. Thanks to all.

Book reviews

The Liverwort Flora of the British Isles, by J.A. Paton (1999). Harley Books, Colchester. 626pp, + glossary and scale. Price: £52.50. ISBN 0-946589-60-7.

This lavish production is a joy to scholars as much as to artists and bibliophiles. The British liverwort and hornwort flora is not only described in detail hitherto unmatched in this country, but every species is copiously illustrated by a full plate of immaculate line drawings.

There can be no doubt about the authoritative nature of this book. It includes accounts of life history and anatomical characters of taxonomic importance, as well as the wider ecological and biogeographical features of liverworts, and touches, too, on considerations of conservation.

In presenting this encyclopaedic volume to bryologists, the author expresses the hope that it will help all of them, whether amateurs or professionals, beginners or the more experienced, to identify liverworts accurately. Those of them who rely on the dichotomous keys, however, will unfortunately encounter difficulty. This is often a consequence of the complexity of critical groups and of language, but not always.

Successful discrimination between entire-level species of two very common genera, *Nardia* and *Mylia*, for instance, depends on two attributes of the underleaves. Whether they are free or jointed to the lateral leaves is variable in the former, invalidating the use of this character as an infallible means of discrimination. Dependence must therefore be placed on the underleaves being said to be "small but usually conspicuous" in *Nardia*, but "absent, or usually minute and inconspicuous" in *Mylia* (p. 43, couplet 72). Dimensions quoted for their length in *N. scalaris* are "to 400 (600) :m" (p. 291) compared with illustrations showing those of *M. taylorii* (p. 261) and *M. anomala* (p.263) to be in the order of 475 :m and 570 :m, respectively. The beginner would therefore not find his way to one or other of these species by means of the key. Nor would he be able to name *Lejeunea patens* and *L. lamacerina* correctly, for these two species are distinguished by the differing angle each presents at the junction of the postical margin of the lobe with the keel of the leaf. Couplet 5 on p.490, however, describes instead the angle between the postical margin of the leaf (*i.e.* the margin of the lobule) and the keel. In nearly every case, this would lead to each species being mistaken for the other. These are the sorts of problems that only a thorough testing of keys by keen bryologists will bring to light.