Digitization of Bryophyte and Lichen Types

Global Plants Initiative / JSTOR Plant Science

2/17/2010

Summary

Partners scanning bryophytes and lichens have adopted somewhat different methods and standards. *The minimum requirement for bryophyte and lichen types is to digitize at the standard 600dpi.* The Natural History Museum in London has been scanning bryophyte and lichen types at the standard 600dpi and the New York Botanical Garden agrees with this practice. Some institutions, such as Geneva, choose to perform an additional scan at a higher resolution (1200dpi). This is completely at the discretion of the institution. If a higher resolution scan is done, the scale must be included.

Geneva, Helsinki, Paris, and Sweden have developed different approaches. They are reproduced here.

Conservatoire et Jardin botaniques de la Ville de Genève (G)

Michelle J. Price, Annick Lang and Philippe Clerc (michelle.price@ville-ge.ch, philippe.clerc@ville-ge.ch)

Introduction

Scanned images of cryptogamic plant specimens and their associated labels, when available electronically, allow researchers to easily verify label details but also to correctly identify potential type material for study, in terms of both the quality and quantity of the specimen, and to view the aspect of the organism in question, all at a distance. Taxonomically useful information in cryptogams is most often found at the micro-structural and anatomical levels and from both the vegetative and fruiting phases. Such characteristics cannot be captured during the scanning process. The value of scanning cryptogamic plant specimen must thus be judged differently than that applied to scans of non-cryptogamic plants which can often used for taxonomic determination.

In the cryptogams electronic access to information on the labels as well as to images of the specimens themselves is particularly important when dealing with historical collections which contain a proportionally large number of types but where the types are as yet un-studied and/or are not typified to today's standards, where the specimen labels do not clearly correspond with protologue information, where material of two different taxa are included within packets, or more particularly where the type material itself is depauperate or very small in size. Information provided through the scans of the bryophyte or lichen specimens, although not allowing for taxonomic determination to the specific level in most cases, does permit researchers to confirm the presence and quantity of type material, and to make a generic determination in many cases. The availability of images of the material, particularly for types from historical collections, facilitates the pre-selection of material to be loaned by researchers as well as providing a digital record of the quantity / quality of the type material which is of used to both researchers and collection managers alike. In addition, the provision of scan of the specimen itself provides unambiguous evidence that the specimen packet in not empty.

At G the presentation of the bryophyte or lichen type material alongside the herbarium label on the scans of our herbarium sheets was deemed to be of positive value despite the extra time needed for preparing the specimens and executing the scans. The inclusion of the bryophyte and lichen type material on the scans of our herbarium sheets has been adopted as part of our scanning protocol. To date, scans of the herbarium sheets, including the herbarium packet labels, type material, any annotation labels, and specimen bar codes, have been captured using the HerbScan Unit scanners at 600 dpi. Good images of the organisms, that would usually be inside the herbarium packets, are obtained in this way. For certain collections such as for historical herbaria, specimens of very small size or organisms where it is deemed appropriate to have a magnified image available we decided that the provision of a scan at high resolution alongside the scan at 600 dpi would facilitate the examination of the macro-structure of specimens electronically, the assessment of the material available and the observation of the quality / quantity of informative material. Macro-structure examination can be can be

particularly useful in the lichens but also provide access to a certain amount of useful information for the bryophytes. To obtain the high resolution image the specimen itself is selected from the 600 dpi scan and then re-scanned 1200 dpi. This scan is then super-imposed back onto the 600 dpi scan of the herbarium sheet and the ensemble is saved at 600 dpi in a .tif format. All scans and treatment of the images is done using the AdobePhotoshop© software. The composite scan provides a high quality image of the specimen at an appropriate scale to view the macro-structure of the organism that is presented alongside that of the herbarium sheet, specimen label and specimen itself at its actual scale.

Scanning procedures in the bryophytes and lichens at G

The treatment of non-vascular cryptogamic plants for digitalization differs from that involved in the treatment of the vascular cryptogams (ferns) and phanerogamic plants. These differences arise from the sizes of specimens, presentation of specimens and in the amount of taxonomically useful information that scanned herbarium sheets can provide for these two different groups. Cryptogamic plants are often small (a few millimetres to a few centimetres) and stored within labelled packets which are fixed to herbarium sheets (in G). An extra step and extra time are needed in order to prepare and scan cryptogamic material: packets must be opened to extract the material, the material must be carefully arranged for scanning and care must be taken that the often very small plants are not lost during the scanning process. In contrast, phanerogamic specimens are attached directly to an herbarium sheet with no need for additional manipulation. Problems are also encountered when cryptogamic specimens have been collected along with their substrate, such as rocks, bark or soil, as scanning these bulky objects can be difficult (not to mention cause damage to the scanning equipment). In these cases images of the specimens, specimen labels and herbarium sheets are captured using a digital camera system at the highest resolution possible.

Methodology

The scanning process is undertaken using a HerbScan unit and consists of eight steps (the preparatory, scanning and completion stages) for standard scans and eleven steps (the preparatory / two scanning and completion stages) for selected specimens (historical, small or appropriate collections):

Preparation:

- Removal of the specimen from the herbarium packet using tweezers and its placement on a piece of size appropriate white cardboard to efficiently highlight the specimen,
- Careful placement of the herbarium sheet, showing the herbarium packet with the specimen label, bar code , type label, annotations and the specimen itself, onto the bed of the HerbScan unit,
- Placement of the colour guide and scale bar onto the herbarium sheet,
- Careful closure of the HerbScan unit,

Scanning:

- Scan of the ensemble at 600 dpi,
- Scan of 1200 dpi (for pre-selected specimens only)
- Selection of plant material from the 600 dpi scan and re-scan of this material at 1200 dpi,
- Using an Adobe Photoshop© script addition of a scale and border to 1200 dpi scan to demarcate it clearly,
- Using Adobe Photoshop© the 1200 dpi specimen scan is then superimposed back onto the original scan of 600 dpi,

Completion:

- The scan or composite scan is saved at 600 dpi in a .tif format (around 200MB file size) using the specimen barcode as an identifier,
- Removal of the herbarium sheet and specimen from the bed of the HerbScan unit (checking the glass of the scanner to remove any small plant fragments stuck to the glass),
- Replacement of the material into the herbarium packet.

Information on the estimated time needed to process / scan cryptogamic specimens is provided in Table 1.

Table 1. Information on the processing (databasing and scanning) procedures of

Number of scans per month (incl. databasing)*	Average of 300
Time taken to perform scan	Average of 10 mins
Time needed for data entry	Average of 4-5 mins+

* person with 100% activity (5 days per week)

Problems to be taken into account during the scanning process

Several unexpected problems were encountered with some of the cryptogamic specimens which slowed down the scanning process:

- Frequently specimens were contained with sub-packets (or sub-packets within sub-packets) which added a considerable amount of time to the processing as all packets were opened to locate the specimens,
- Often specimens were extremely small and thus difficult to handle, care was needed to ensure that the specimens were not lost before, during or after the scan was performed,
- Specimens may also have had annotations or photographs associated with them that had to be either scanned separately and superimposed back onto the sheet or arranged prior to scanning,
- Some sheets held more than one packet (of identical material) which meant that each packet had to be dealt with separately in order to achieve an appropriate scan of the type material.

Conclusion

The benefits of scanning the type material of cryptogamic plants should be measured in terms of the value of information that is made available electronically on the types rather than in any potential taxonomic utility, at least at the specific levels, that they may provide. Benefits are summarized as follows:

- Digital record of the presence as well as the quantity and quality of type material (researchers and herbarium curators),
- Confirmation of the generic determination possible,
- Examination of certain macro-structural features possible,
- Ability to assess, electronically, type material in advance of loan requests (potentially reducing the necessity or repeated loans).

Lichen type specimen digitization at the Herbarium of University of Helsinki (H), Finland

Herbarium collections of lichens are of various kinds and the specimen may include the substrate like a stone or a piece of bark. Large species or “macrolichens” and species that can be easily separated from substrate are often most suitable for imaging with a scanner as they are relatively flat and soft. Such genera are for example *Cladonia, Stereocaulon, Peltigera, Usnea, Alectoria, Bryoria* and *Ramalina*.

Lichen specimens in H are stored in envelopes of variable sizes, most often about size of A6 or A5. Herbarium sheets are not used for lichens. Specimens are often freely inside the envelope or, especially in case of old specimens, pasted on a piece of cardboard. The main label is pasted on the envelope, and other labels are usually pasted on the margins. Labels are often overlapping because of the limited space on the envelope. Sometimes additional labels are kept freely inside the envelope. Loose fragments may sometimes be kept in a small envelope or plastic bag inside the main envelope.

In principle, at least two images are scanned of each specimen (envelope):

1) A 600 dpi image with specimen, labels as much as they fit inside the A3 area of the scanner bed. Color checker, ruler are always scanned with the specimen itself to ensure right scale and color. Barcode and labels may be scanned separately and pasted on the main image.

2) A 2400 dpi image with specimen and ruler. Barcode and logo are pasted from the 600 dpi scan because that is sufficient resolution for them. Color checker is omitted in high resolution images.

Additional 600 dpi image(s) are scanned only if specimen and its labels do not fit within the standard A3 area of the scanner bed. Color checker and ruler are usually not necessary on images that contain only labels. However, logo and barcode are always included. Below is an example of imaging a lichen type specimen with many labels:

FIGURE 1



FIGURE 2

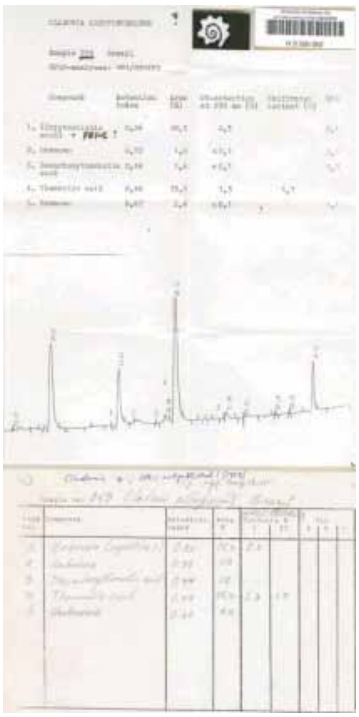

FIGURE 3



Figures 1-3:

1) 600 dpi image showing the specimen and all the separate labels that were laid out with Photoshop to use image area effectively while including all information. Labels on and inside the original envelope can be

numerous and often overlapping. Therefore, multiple scans or temporary removing of the pasted labels are sometimes needed. The image is named H9500062.tif.

2) A separate 600 dpi image of the large documents (A4 and A5) of chemical analysis, which were included as folded in the specimen envelope. Logo and barcode are pasted from a 600 dpi image. The image is named H9500062_a.tif.

3) 2400 dpi image of part of the specimen itself to show the surface structure and other important details of the specimen. The color checker is not included to keep image file size reasonable. Logo and barcode are pasted from a 600 dpi image. The image is named H9500062_b.tif.



Part of a 2400 dpi image (H9500062_b.tif) magnified to show the actual capabilities of the scanner.

XML-data stored for the specimen H9500062:

<Unit>

<UnitID>H9500062</UnitID>

<DateLastModified>2009-11-18</DateLastModified>

<Identification StoredUnderName="true">

<Family>Cladoniaceae</Family>

<Genus>Cladonia</Genus>

<Species>obscurata</Species>

<Author>Ahti</Author>

<Identifier>T. Ahti</Identifier>

<IdentificationDate>

<StartYear>1995</StartYear>

</IdentificationDate>

<TypeStatus>Holotype</TypeStatus>

</Identification>

<Identification StoredUnderName="false">

<Family>Cladoniaceae</Family>

<Genus>Cladonia</Genus>

<Species>albofuscescens</Species>

<Author>Vainio</Author>

<Identifier>T. Ahti</Identifier>

<IdentificationDate>

<StartYear>1978</StartYear>

</IdentificationDate>

<TypeStatus>-</TypeStatus>

</Identification>

<Identification StoredUnderName="false">

<Family>Cladoniaceae</Family>

<Genus>Cladonia</Genus>

<SpeciesQualifier>cf.</SpeciesQualifier>

<Species>turgidior</Species>

<Author>(Nyl.) Ahti</Author>

<Identifier>T. Ahti</Identifier>

<IdentificationDate>

<StartYear>1988</StartYear>

</IdentificationDate>

<TypeStatus>-</TypeStatus> </Identification>

<Identification StoredUnderName="false">

<Family>Cladoniaceae</Family>

<Genus>Cladonia</Genus>

<Species>turgidior</Species>

<Author>(Nyl.) Ahti</Author>

<Identifier>G. Follmann</Identifier>

<IdentificationDate>

<StartMonth>7</StartMonth>

<StartYear>1977</StartYear>

</IdentificationDate>

<TypeStatus>-</TypeStatus>

</Identification>

<Collectors>F. Mattick</Collectors>

<CollectorNumber>s.n.</CollectorNumber>

<CollectionDate>

<StartMonth>1</StartMonth>

<StartYear>1965</StartYear>

</CollectionDate>

<ISO2Letter>BR</ISO2Letter>

<Locality>Südbrasilien, Est. Minas Gerais. Nordostschulter des Pico Inficionado im Carassagebirge.</Locality>

<Altitude>1500 meters</Altitude>

<Notes>G. Follmann: Lichenes Exsiccati Selecti A Museo Historiae Naturalis Casselensi Editi No. 228. Polsterbildend auf schwachgeneigten flachgründigen Grobsandböden in lichtoffenen Vegetationslücken des Campo cerrado im Cladonietum turgidioris (MATT.) FOLLM., NO-SO, pH 6,1. Leg. F. Mattick (comm. G. Follmann 1999).</Notes>

</Unit>

Imaging bryophytes at the Paris Herbarium (P) for JSTOR Plant Sciences

The imaging of Bryophytes for the JSTOR Plant Sciences' Global Plants Initiative is a valuable record of both label data and morphology of Bryophyte type specimens. For Bryophytes in general, studies of leaf and sporophyte anatomy are required for species identification. Nevertheless, the magnification tools (8X) provided on the GPI site are adequate to view details, and for identification to genus level. For each type specimen included in GPI, one scan is made at 600 dpi (Figure 1.) of the closed envelopes containing material, or of a general view of exposed specimens on the herbarium sheet, and a second scan at 1200 dpi details the specimen itself (Figures 2 & 3.).

Arrangement of collections on herbarium sheets

At the Paris Herbarium, the Bryophyte Collections are generally mounted in small envelopes and pinned to herbarium sheets. Single herbarium sheets generally hold mixed collections.

One herbarium sheet may include:

- several different taxa (specimens of different species and genera)
- specimens originating from different localities and major geographical regions
- a mixture of type specimens and non-type material

Note: For some specimens at PC, duplicate collections are found on separate herbarium sheets. In such cases, envelopes are pinned to a single new herbarium sheet for each type collection.

Figure 1. Scan at 600 dpi showing Bryophyte specimens in envelopes, a ruler and a colour checker as well as bar codes for each of the specimens (Bar codes = PC0131035 & PC0131036) on the herbarium sheet.



Bar coding

A bar code is associated with a single specimen collection (one specimen, or several specimens labelled as originating from the same collector, with the same collector's number). Several bar codes corresponding to distinct specimens (of the same or different taxon) may therefore appear on the same herbarium sheet (Figure 1.).

If the same herbarium sheet contains more than one type specimen, this sheet will be scanned and the resulting TIFF file renamed several times according to the different bar codes for each type specimen e.g. PC0131035, PC0131036 for the image in Figure 1.

For each Bryophyte type specimen included in GPI, a minimum of two images are associated with each bar code, for example:

- PC0131035 for the image at 600 dpi
- PC0131035_a for the image at 1200 dpi
- PC0131035_b for the image of an associated illustration (600 dpi)

Note: As complementary microscopic slides have not been included in GPI at present, these are not included for the Paris Collections. However, provision for such additions (e.g. PC0131035_c) could be made for such a future eventuality.



Figure 2. High resolution (1200 dpi) image of the Bryophyte specimen PC0131035 showing scanned ruler. Note: The bar code is scanned at 1200 dpi and pasted onto the scanned high resolution image.

Standard for imaging

- One image at 600 dpi, including specimens, bar codes, colour checker and ruler
- One image at 1200 dpi, including detail of specimen, ruler and (pasted) bar code



Figure 3. High resolution (1200 dpi) image of the Bryophyte specimen PC0131036 showing scanned ruler and pasted bar code.

XML exports for JStor Plant Science

Images the site, and XML exports (Figure 4.), are sent to JStor for inclusion in GPI. On two images are linked to a single specimen entry.

Figure 4. XML export of Bryophyte data for PC.

<Unit>

<UnitID>PC0075704</UnitID>

<DateLastModified>2008-08-04</DateLastModified>

<Identification StoredUnderName="true">

<Family>BRYOPSIDA</Family>

<Genus>Leucoloma</Genus>

<Species>perrieri</Species>

<Author>Thér.</Author>

<Identifier>Not on sheet</Identifier>

<IdentificationDate>

<OtherText>Not on sheet</OtherText>

</IdentificationDate>

<TypeStatus>-</TypeStatus>

</Identification>

<Collectors>Perrier de la Bâthie H</Collectors>

<CollectorNumber>s.n.</CollectorNumber>

<CollectionDate>

<StartMonth>11</StartMonth>

<StartYear>1927</StartYear>

</CollectionDate>

<ISO2Letter>MG</ISO2Letter>

<Locality>forêt à l'Est de Tananarive</Locality>

</Unit>

Digitisation of type material at the Department of Cryptogamic Botany, Swedish Museum of Natural History (S)

By Ramona Ubral Hedenberg, photographer

Our objective for the digitising project was to make it possible for a visitor to our on-line database Krypto-S <http://www.nrm.se/krypto-s> to view type specimens in 3D. To reach this objective we have used digital photography and computer programs. The herbarium material is of various size and form. Some of the lichen specimens are small and are found on various substrates such as stones, bark, leaves, etcetera.

In order to facilitate the work by saving time and reducing the risk of dust attaching to the camera sensor (when shifting lenses) we use 2 cameras. We work with 2 Canon EOS-1 Ds Mark II Digital. The first camera is used for photos of the label, annotation slips, specimen overview including colour checker and ruler, and moderate close-ups. The lens and flashlight used with the first camera is a Canon Macro Lens EF 100 mm 1:2.8 and a Micro Twin Lite MT-24EX. The second camera is only used for real specimen close-ups, including a millimetre ruler. For these close-ups we use a Canon Macro Photo Lens MP-E 65 mm f/2.8 1-5x 1:2.8 and a Canon Extender EF 2x11, remote switch RS-80N3 and a Micro Ring Lite MR-14EX flashlight. Several pictures is taken of each specimen and we use the stands LPL L1815 Copy Stand CS-5 and LPL Copy Stand Type-II.

At least three or four pictures are made out of every type specimen. 1) label; 2) overview; 3) moderate close-up; 4) composite, real close-up. The pictures are always taken in RAW image file (ca. 14,6 MB; 4992 x 3328 pixels). With the first camera the pictures are taken with f11, 1/125 seconds, ISO 100 and with the second camera f8, 1/125 seconds and ISO 1600.

To be able to achieve 3D pictures and pictures with good resolution, each specimen is photographed several times. Hence, to receive one composite 3D picture we successively take several pictures of the same sample with focus approximately one millimetre at each level. Depending on the material in question this may lead to everything between 5 to 150 pictures taken of the same sample. The pictures are then transferred to the computer. They are opened in Camera Raw to ensure the right colour. Photos taken for the 3D pictures are saved and opened in Helicon Focus 3.60 PRO. Helicon Focus is a program that creates one completely focused image from several partially focused images by combining the focused areas.

The steps taken to capture each specimen are as follows:

1. Photos on labels, notes, annotations, the overview of the specimen and the first close-ups.
2. The specimen is moved to the second camera for the real close-ups.
3. The pictures are transferred to the computer, and the pictures are converted from CR2 to dng files.
4. All the pictures are opened in Camera Raw and adjusted; some are saved and later opened in Helicon Focus; others are opened without going through Helicon Focus.
5. Pictures not to be processed in Helicon Focus and those already made in Helicon Focus are opened in Photoshop.
6. From Photoshop the pictures are saved into several different sizes and designs.
7. The pictures are saved as is (nothing is done to them!) into 16 and 8 bits/channel. The pictures not processed in Helicon Focus are saved as TIFF and dng. The pictures made by Helicon Focus are saved as TIFF.
8. Pictures are cropped and given some extra sharpness and saved once again. At the second and third savings all images are saved as jpg. As we cut the pictures we remove the ruler with the text copyright and the colour.
9. Finally, we save the pictures a third time. Now the pictures automatically receive some extra sharpness and they are saved into 3 different sizes:

   Ca. 300 - 600 kB Ca. 100 - 150
   kB Ca. 50- 95kB

   This is a way of adapting the pictures to the Internet and to our homepage. It is also to make it possible for the viewer to see the picture in different close-ups, that is, to be able to click on the picture several times to zoom in on a detail.

Pictures worked out in Helicon Focus are saved 5 times and the other ones 6 times. The resolution of pictures on screen is 240 pixels/inch (their dpi) and the pixel dimensions are about 47,5 M. All image sizes are dependent on whether or not the images have been cut or not. The images saved as tiff and dng are always the same size in width and height. The original images are saved as dng.

Picture size are shown in the table below: Label, notes and overview picture

File	+/-*kB*	+/-*Width* (pixels)	+/-*Height* (pixels)
dng	15000	4992	3320
tiff	97400	4992	3328
jpg	6300	4768	3000
jpg	215	512	300
jpg	60	80	50
jpg	88	150	115

The largest close-ups

File	+/-*kB*	+/-*Width* (pixels)	+/-*Height* (pixels)
tiff	97440	4992	3328
jpg	15000	4200	3200
jpg	330	512	395
jpg	65	80	62
jpg	120	150	116

Processing time

Specimen [degree of complexity]	Camera image capture	Computer data processing	Total
easy	5 min	24 min	29 (20) min
medium	8 min	31 min	38 (28) min
difficult	9 min	35 min	43 (30) min

- Degree of complexity range from very flat specimens (easy) to very bulky, three dimensional, specimens (difficult).
- Camera work, image capture include images of: 1) label; 2) overview; 3) moderate close-up; 4) composite, real close-up.
- (Number in parentheses) = Note that a skilled photographer can often work in parallel on image capturing while waiting for computer processing, i.e. when images are being converted, saved, processed in Helicon Focus and/or are being uploaded to database. That may reduce total time up to 30% .
- The calculated time shown in the table does not include bringing and returning specimens to and fro the herbarium.

Example of a published specimen:

[These and all other pictures can be viewed in museum database Krypto-S (http://www.nrm.se/krypto-s) where it is possible to click on every picture several times for close-ups.]



The label



The overview including colour checker and ruler

The overview after being cropped in Photoshop





The moderate close-up. Scale mm The real close-up. Scale mm

