The type collections of rust fungi (Uredinales) in Berlin

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Abstract

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The rust Herbarium in Berlin (B) is one of the world's richest collections of rust fungi. The author's inventory of *Uredinales* types at B has shown that the number of types not previously separated from the main herbarium is significant. Of the c. 100 000 images scanned, over 1900 rust type specimens, representing 1380 species, were recognized. With further scrutiny more type specimens and species are expected to surface.

Additional key words: herbarium holdings, taxonomy, mycological specimens

Introduction

Much of the herbarium in Berlin (B) was destroyed during WWII in March 1943 (Hiepko 1987). However, some of the cryptogam specimens and all the rust specimens had been moved to safer areas and were preserved (Kohlmeyer 1962; Hein 1988). While there is a list of exsiccatae that have been saved (Hiepko 1987), there is currently no database of the type specimens represented in the herbarium.

Type collections are indispensable tools for the taxonomy of organisms. Not only do they determine the application of names to taxa but they often also represent the original material from which a taxon was described and are therefore central to systematic appraisal and the advancement of biodiversity knowledge (e.g. see Daston 2004). Locating and accessing type specimens is an essential activity for any taxonomist, but can be a limiting step, as taxa have been described for more than 200 years and their types are sometimes separately archived in multiple locations. This project digitized information on specimens of *Uredinales* in the herbarium in Berlin (B). Similar efforts were made in the herbaria at Bern (BERN), Copenhagen (CP), Edinburgh (E), Paris (PC), St Petersburg (LE) and Zurich (Z+ZT) (Helfer 2010). It is now possible to identify the sites where many European type specimens are deposited, making collection information available to a worldwide audience via a web link (Helfer 2011). In previous publications of this kind (Alava 1988; Crane & Jones 1997) specimens were cited in the text, as online versions were not available then. Since the initial stages of herbarium specimen digitization, much progress has been made and dedicated digitization projects have been in operation (e.g. Haston & al. 2012). Early initiatives such as the Botanical Type Specimen Register (Shetler 1973), appear to have discon-

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Fig. 1. Screen shot from the web resource for the rust herbarium specimen database based at the Royal Botanic Garden Edinburgh.

tinued, and a new initiative of online information about the availability of type specimens is necessary, including for the fungi. The project described in this paper aims to contribute to such an initiative for type specimens of rust fungi (*Uredinales* or *Pucciniales*). The main advantage of the approach taken here, compared with initiatives involving dedicated digitization stations, is the speed at which whole herbaria can be imaged.

Material and methods

During a three-week visit to Berlin facilitated by SYNTHESYS the author had the opportunity to digitally photograph the majority of the *Uredinales* collection, extracting the types during the process. The remainder of the specimens was subsequently digitally photographed by herbarium assistants but no further types were extracted. The specimens were photographed using a portable digital camera setup (Nikon Coolpix models), allowing high specimen throughput of 3–11 specimens per minute (average 6). Type specimens, where identified, were separated from the main collections for curatorial processing. The digital image files were separated into folders comprising genera and species. A PADME (Microsoft Office Access Application) database is being used to accommodate the image files. Label data are being extracted on

Table 1. Type specimens at B: most significant taxon authors, collectors and countries of origin. For a full list of type specimens please see Helfer (2014).

Taxon authors	Taxa described on types at B
Paul Christoph Hennings	505
Paul & Hans Sydow	272
Paul Dietel	81
Collectors	**Specimens at B**
Ernst H. G. Ule	303
E. D. W. & M. M. Holway	131
Paul & Hans Sydow	55
Countries	**Specimens at B**
Brazil	391
U.S.A.	206
Japan	113

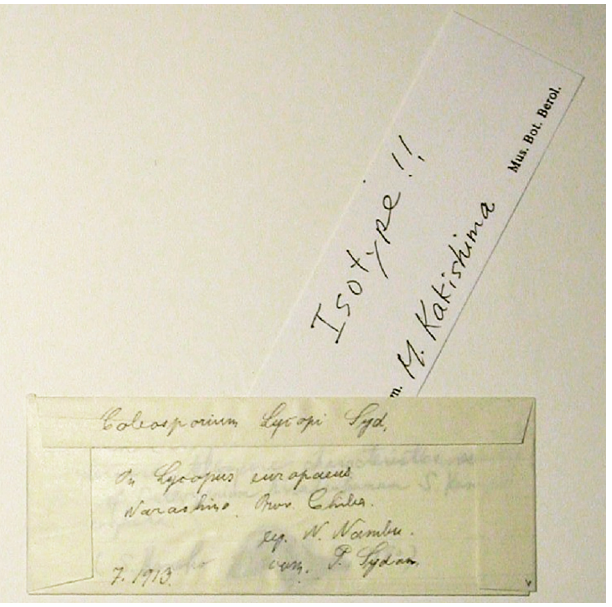

Fig. 2. Annotated type specimen of *Coleosporium lycopi* Syd. & P. Syd.

an ongoing basis and more type specimens are expected to surface. Fig. 1 shows a screen shot from the web resource for the database based at the Royal Botanic Garden Edinburgh (Anonymous 2014). This may evolve as the platform develops. Uredinologists interested in these collections are encouraged to participate in the effort of populating the text database. The accumulated information is published online and updated regularly.

Results and Discussion

The result is a compilation of c. 100 000 images, some with multiple specimens, representing the total *Uredinales* collection at B as at 2005. From this compilation 1900 type specimens have been recognized to date, representing 1370 species (Helfer 2014) with further specimens being added as more information becomes available. In this work, sifting through all available specimens in the herbarium, it was shown that the number of types, not formally separated from the main herbaria at the time, was significant. Furthermore, image quality and specimen label appearance (comprising handwriting, faint print, annotations, see Fig. 2) may not be amenable to an easy and standardized methodology of digitization of label information, requiring a concerted effort by trained specialists (uredinologists in this case) and curators. The main statistical results on the respective herbaria are comparable with complementary herbarium data that already exist online (e.g. the USDA's fungal databases and the IMI and Kew databases; see Table 2). Herbarium B contains at least 303 type specimens of the botanist and explorer Ernst Heinrich Georg Ule (1854–1915; see Fig. 1), mostly from Brazil, which is the country with most types represented here (more than 390). Many of

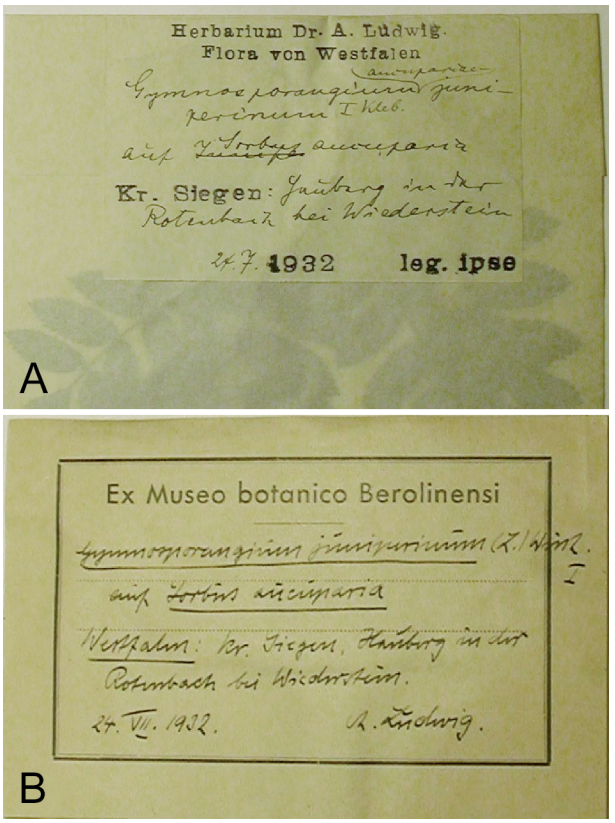

Fig. 3. Split specimen of *Gymnosporangium aucupariae-juniperinum* (not an accepted name). – A: original packet; B: split-off packet.

the species were first described by the mycologists Paul Christoph Hennings (1841–1908), father and son Paul and Hans Sydow (1851–1925 and 1879–1946), and Paul Dietel (1860–1947). Table 1 shows the most significant taxon authors, collectors and countries of origin represented at B. Not many specimens have been specifically identified in their type category (however, see Fig. 2, an isotype), and additional study is necessary. For a full list of types, including bibliographic citations and links to protologues via Index Fungorum, see Helfer (2014).

There are excellent databases of herbarium specimens of rust fungi (see Table 2), and a future aim will be either to find a common or compatible format or to at least provide links similar to Rainer & al. (2010) using the Taxonomic Databases Working Group (TDWG) platform. An attractive possibility will be to use the BRAHMS software (Anonymous 2010). During visits to other herbaria the author noticed that isotypes of a number of names were widely distributed, whereas others were unique. Holotypes have been identified wherever possible.

As a side benefit, the work has shown the practice of one of the previous curators of the collection to split specimens into two (Fig. 3). This adds considerably (20–30 %) to the number of packets, and it is recommended that the packets be brought together again where possible. It is not known what was the purpose of this practice.

Table 2. Some current online herbarium resources. Herbarium codes follow Index Herbariorum (IH) (Thiers 2014+).

Herbaria	IH code	URL	Comments
Brussels	BR	http://www.br.fgov.be/RESEARCH/COLLECTIONS/HERBARIUM/simplesearch.php	
USDA Beltsville & Purdue University	BPI, PUR	http://nt.ars-grin.gov/fungaldatabases/ Farr & Rossman (2014)	
Edinburgh	E	http://elmer.rbge.org.uk/bgbase/vherb/bgbasevherb.php	mainly phanerogams
French herbaria	FABR, MPU, NCY, P, PC	http://coldb.mnhn.fr/colweb/TreeView.do	including some photos
Kew fungarium	K (M), IMI	http://apps.kew.org/herbtrack/search http://www.herbimi.info/herbimi/home.htm	
Netherlands herbaria	L, U, WAG	http://vstbol.leidenuniv.nl/	including some photos
Stockholm	S	http://www.nrm.se/krypto-s	including some photos
Uppsala	UPS	http://130.238.83.220/botanik/home.php	
Vienna	WU	http://herbarium.univie.ac.at/database/search.php	
Zurich	Z+ZT	http://www.herbarien.uzh.ch/herbarienz/rostpilze_en.html	including photos

Conclusions

Rapid digital-camera-based evaluations of herbarium specimens provide the information for a first assessment of specimen location, label details and annotations. However, they are limited by the external appearance of herbarium sheets and do not allow critical taxonomic evaluation of small specimens. For fungal and cryptogamic specimens, where high image resolution and magnification are essential, other methods of examination are required, and the physical loan of specimens may still be necessary. Additionally, data-extraction from the images is a limiting step in the speed at which text-dependent databases can be made available for public use.

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