

Proposal for the GBIF DIGIT Programme 2004

## **Linking local databases for collections of plasmodial slime moulds (Myxomycetes) to create a global web-based herbarium**

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### **Project Summary**

The proposed project will link and extend five ongoing initiatives to database myxomycete collections in institutions with researchers working actively in that field. In case of funding the additional money will be used i) to speed up ongoing specimen digitalisation and ii) to create a global virtual herbarium using these databases via the GBIF network with an estimated total of 90,000 specimens, containing almost one third of all types. Since myxomycete specimens are difficult to gather, and many species are therefore seemingly rare, a joint virtual herbarium would enable taxonomists to access sufficiently large series of specimens.

The proposed project would complement a large research project funded by the Planetary Biodiversity Inventory (PBI) of the U.S. National Science Foundation by creating the baseline to access herbarium specimens. This would help to overcome the current situation characterized by numerous taxa described as new to science from a single collection due to the inaccessibility of comparison material. The data base will further provide a baseline for (still lacking) molecular studies in the group. Last, the project would be an effective way to share data with the countries of origin, since all of the five applicants have intensively worked in developing countries with a highly diverse flora and fauna. The project will be beneficial for the resolution of fundamental, applied, educational, and nature conservational tasks.

## Project description

### 1. Introduction

Plasmodial slime moulds start their life cycle as true micro-organisms, but form fruit bodies upon their morphological characters the taxonomy of the group is currently based. These fructifications are mostly 0.5-5 mm in size and can be kept as dried herbarium specimens. About 900 taxa are currently known (Lado 2001). The scientific community for the group is growing, indicated by 140 species described as new to science since 1990. However, about 20% of all taxa are still known only from the type collection (Schnittler & Mitchell 2000). The main reasons for this very unsatisfactory situation are i) problems to access specimens for loan (due to their fragility and the lack of searchable databases), ii) many descriptions are inadequate, based on drawings only, iii) most investigators work isolated and have no easy access to methods like scanning electron microscopy, and iv) both apomictic strains and environmentally-induced variations in fruit body development making the study of larger series of specimens indispensable to draw sound taxonomic conclusions. The crucial step for consolidating the taxonomy of the group would be to amass a critical number of specimens for taxonomic and molecular studies.

### 2. Ongoing activities

Currently there are several independent approaches to overcome the situation described above. All five project partners (here labelled after their home countries) work within larger natural history institutions or in close cooperation with them. This chapter describes ongoing activities and data exchange standards together with the respective web pages and hosting services. A last paragraph lists additional activities not connected directly with the proposed project but enhancing the value of the specimen data provided.

#### *Belgium*

The collection of N.E. Nannenga-Bremekamp bequeathed to BR (14,600 specimen) is already available on the internet, together with 2,000 other specimen of the herbarium BR. Accessing costs were significantly higher than usually, since all label information had to be extracted from the collectors hand-written notebooks. However, this collection is one of the most valuable among those for myxomycetes, comprising about 15% of all type specimens for the group. For at least 60% of all specimens the often fragmentary label information remains still to be completed and geo-referenced into detail. Up to know, accessing costs were covered by the institution (temporary position, 3 years one technician).

BR uses an own database, called MYCO-database, which has been developed within the application PROGRESS and runs under LINUX protocols. Data can be accessed via <http://www.br.fgov.be/RESEARCH/COLLECTIONS/HERBARIUMS/FUNGI/MYXO/NANNENGA/index.html>.

All the herbarium data will be transferred within two months of time into the herbarium module of BG-Base (UK) Ltd and BG-Base, Inc. ([www.bg-base.com](http://www.bg-base.com)). The data will be available on the web as a series of searchable database tables whose structure is compliant with the ABCD structure as well as with the Darwin Core V2. To reach this goal, computing programmes will be developed within the coming five months by BG-Base IT staff, making the ABCD, and Darwin Core V2 transfer programmes available to the more than 150 institutes using BG-Base world-wide.

Additional activities: complete the hand-written descriptions and notes accompanying the collection, and make the information available for the scientific community.

#### *Germany*

Activities focus currently on accessing the myxomycete collection of M, ca. 3,000 specimens, and the collection of the PI, ca. 10,000 specimens. Both collections together constitute the largest in Germany of this group. Both activities are funded by a grant of the German Federal Ministry for Education and Research (BMBF), project „Development of the German GBIF node Mycology” (grant No. 01 LI 0202; see [www.gbif-mycology.de](http://www.gbif-mycology.de), 52,930\$), duration Jan. to Dec. 2004. Currently are 8,875 specimens data based, the remaining part is due with the end of the project in Feb. 2005 (Triebel & Schnittler 2003).

The BMBF grant includes also computer equipment and installation of the ABCD wrapper, to be used for the proposed project as well. The institution uses *DiversityCollection*, the data base component of the *Diversity Workbench* suite (<http://160.45.63.11/Workbench/download.html>, currently MS Access, MS-SQL-Server version in progress). This database framework delivers already specimen data of several groups of fungi into the GBIF network (<http://www.gbif.org/DataProviders/providerslist?sortby=records>). The GBIF registry index currently indicates that M is delivering 4,700 records. For the local BioCASE Provider Access with the prototype of an ABCD provider see [http://141.84.65.156/biocase/databases/DiversityCollection\\_BSM/](http://141.84.65.156/biocase/databases/DiversityCollection_BSM/).

Additional activity: Developing a web-accessible database of taxonomic and biogeographic literature about myxomycetes. Funding is secured through a separate BMBF project, duration July 2004 to June 2005. Currently 3,412 entries exist, all data based and keyed under Reference Manager V. 10.0.

### *Russia*

LE houses the largest myxomycete collection of the country, with currently 8,000 specimens. Currently the collection is being data based, with 70% already digitized. Funding is provided through salaries of personnel of the institution and by ongoing grants of the Russian Science Foundation (project ID: 02-07-90439), and the programme "Biodiversity Information System" (<http://www.zin.ru/bioDiv/index.html>; Russian Ministry of Industry, Science and Technology, ID: 43.073.1.1.2510). Progress in data basing is about 500 specimens per year, thus 1,000 additional specimens will be digitalized until March 2006.

Visual FoxPro is used as the database management system, but no internet portal for specimen data exists. Data will be made available via M through *Diversity Collection* and the ABCD wrapper. A conversion programme into the German system *Diversity Collection* used by M exists already, ensuring continued data export. Currently, the responsible curator for LE (Novozhilov) develops a data export protocol in the frame of a research stay in Germany funded by the BMBF project "Development of the German GBIF node Mycology". At a later stage, a decision to adopt a data base system and an upload mode will be made.

Additional activity: Building a complementary webpage with specimen images, description and electronic maps of their distribution in Russia within the programme "Biodiversity Information System" (Russian Ministry of Industry, Science and Technology, ID: 43.073.1.1.2510, [http://www.binran.spb.ru/infsys/fun\\_map/](http://www.binran.spb.ru/infsys/fun_map/)).

### *Spain*

The herbarium MA houses about 15,000 myxomycete specimens. Of these, 12,000 are already data based and geo-referenced, using resources of the institution. Anticipated progress is about 500 specimens per year.

All data are stored in a system HERBAR developed by the institution. An upload tool using the Darwin Core Fields is already in place, thus data are already available on the internet ([http://www.rjb.csic.es/colecciones\\_herbario\\_cripto\\_consult.php](http://www.rjb.csic.es/colecciones_herbario_cripto_consult.php)).

Additional activity: This partner provides and maintains the already published nomenclatural standard list for the proposed project (Lado 2001); the respective database NOMENMYX will be developed further within the Flora Mycologica Iberica project.

### *U.S.A.*

This partner, himself responsible as a curator for the myxomycete collection UARK, currently oversees the digitalization of several major collections of myxomycetes. The largest of these (and simultaneously the largest myxomycete collection world-wide) is BPI (>50,000 specimens). Although not allocating money directly for the digitalisation of specimens, a NSF-funded project within the Planetary Biodiversity Inventory programme (PBI, DEB-0316284) "Global Biodiversity of Mycetozoans" provides the infrastructure upon the proposed project will build (<http://cavern.uark.edu/ua/mycetozo/>).

The largest among ongoing activities is to digitalise the BPI collection, with ca. 12,000 specimens already data based by BPI personnel (responsible curator: D. Farr). Anticipated progress is ca. 1,000 specimens per year; funding will be secure for two more years. A second activity includes data basing the myxomycete collections of the Universities of

Mississippi, Florida, and Costa Rica (ca. 5,000 specimens) by technicians of these institutions. Completion is planned for 2006.

Landcare Research (the New Zealand government's environmental research agency) is collaborating with the PBI team to provide some data management and data delivery services. Jerry Cooper, based at Landcare Research, is also the GBIF Node Manager for New Zealand, and a member of the ECAT GBIF Science Committee. Landcare Research has provided a database framework for digitizing collection information. This framework incorporates the Darwin Core version 2 standard with enhancements to include more robust geo-spatial and literature data. This database framework delivers already specimen data into the GBIF network (<http://www.gbif.net/portal/provider.jsp?providerKey=77>). The GBIF central index currently indicates that PBI is delivering 12,084 records for 531 taxa.

Additional activity: the generic information portal developed at Landcare Research (for example see <http://nzflora.landcareresearch.co.nz/>) will shortly be installed at Arkansas in order to provide access to a range of integrated 'species bank' services, including nomenclatural and taxonomic views, associated indexed literature, descriptions, images, maps, primary collection data, and a suite of secure web-services providing programmable access to these data.

### *3. Data basing systems and data exchange standards*

Throughout the project, the nomenclatural standard NOMENMYX developed by one of the applicants (Lado 2001) will be used. The database will be maintained by MA and is available for all project partners; its content will be included into Index Fungorum as well.

Myxomycetes as a group are strongly assumed to be monophyletic (Baldauf & Doolittle 1997); and from traditional reasons "Fungi" will be used as a kingdom identifier.

All uploaded specimens are part of the officially registered herbaria (see partner institutions) and will have as a unique identifier for the field UnitID (ABCD standard) or CatalogNumber (Darwin Core) the respective herbarium code (e.g., LE-0017583 for the Russian partner). Country names following the ISO standard will be used throughout.

Most contemporary collections come with detailed information on geographical coordinates due to the use of GPS devices in the respective surveys. In all cases, precision of the given coordinates will be mentioned. For older specimens, reconstruction of this information is often extremely time-consuming since the scarce locality information has to be checked with a gazetteer or a regional map.

However, two of the applicants (BPI, M) use data base systems where a scan of the original label is stored together with the data. This allows to post pone the exact reconstruction of coordinates if this information is very hard to access or the specimen belongs to a common species and comes from a region already covered by comparable records. Moreover, a whole set of specimens originating from a certain collector (often representing a series of collections from one locality) can be extracted and geo-referenced in a single step. This will secure steady progress in data basing to meet the designated project milestones.

All partner institutions are major herbaria funded directly by the respective federal (BPI, BR, LE, MA) or regional governments (M, Bavaria). This institutional affiliation will guarantee the free availability of the respective specimens for loan. Three institutions have a curator being himself a specialist for myxomycetes (BR, LE, MA), the two remaining have a stable cooperation with one of the applicants (BPI – Stephenson, M – Schnittler, both working at universities), thus providing continuing support for hosting the specimen data bases. Fig. 1 shows the data basing systems and ways of information upload the partner institutions will use.

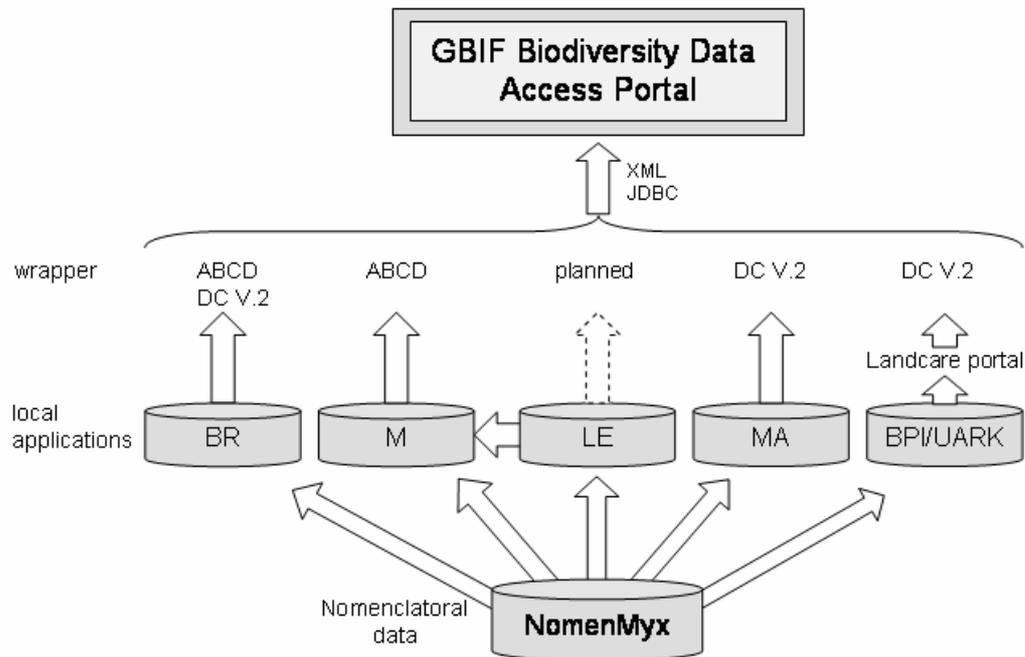


Fig. 1 Data basing systems and data exchange standards used by the five partner institutions.

#### 4. Working programme

The proposed project is planned for beginning of October 2004 to end of March 2006 (18 months). In compliance with the intention of GBIF, but also acknowledging the infrastructure built by the additional activities of other projects, activities solely focus on specimen data basing. The goal is to make information for myxomycete biodiversity from all major vegetation zones of the world available (see description of expected outcome). Five work packages according to the five partner institutions are designated; information about the anticipated progress for a mid term milestone (1) and a final milestone (2) is given separately for each partner.

##### *Work package 1 – Belgium (BR)*

This work package focuses on accessing the collection Nannenga-Bremekamp. Due to her lifelong activities in myxomycete taxonomy this collection is still the most valuable source of taxonomic information, including about 150 types. Due to her profuse exchange of specimens, the collection is extremely diverse in both geographic origin and collector. Consequently, geo-referencing of ca. 9,000 specimens is the main task of this work package. Second, a gazetteer linking collector and specimen data will be produced. Additionally, specimens from Central Africa (400) and Belgium (200) have to geo-referenced as well.

*Milestone 1:* 5,000 specimens geo-referenced, information uploaded to GBIF,

*Milestone 2:* further 4,000 specimens plus 600 from collection BR geo-referenced, information uploaded to GBIF, collector gazetteer posted at the already existing web page for the Nannenga-Bremekamp collection (URL see under ongoing activities).

##### *Work package 2 – Germany (M)*

In addition to the 3,000 myxomycete specimens hosted at M, two incoming large private collections (Schnittler, 10,000, Neubert, 7,500) will mount up to the largest German myxomycete collection. Since the first collection will be digitalized through GBIF Germany using *DiversityCollection*, a module of the Diversity Workbench, this work package aims on

data basing the collection of the late Dr. Neubert, using the same IT-infrastructure. His monograph on German and Austrian myxomycetes is based on that collection (Neubert et al. 1993, 1995, 2000) bequeathed to M in Dec. 2003. All data were keyboarded by the collector into a raw format. Curatorial work remains to do. Geographical coordinates are accessible via conversion from the German MTB-format except for 500 specimens from abroad (mainly Ecuador). Upload of data will use the ABCD wrapper model.

*Milestone 1:* 4,000 specimens digitalized and geo-referenced, information uploaded to GBIF,  
*Milestone 2:* further 3,500 specimens digitalized and geo-referenced, information uploaded to GBIF.

#### *Work package 3 – Russia (LE)*

This part will first complete data basing of the collection LE (ca. 1,400 specimens remaining) and provide the hitherto missing funds to make the data in co-operation with M accessible to the internet. A second task is to access the collection Novozhilov (4,000 specimens). These data are already available under FoxPro, curatorial work and geo-referencing is necessary. This project part will fill in information about myxomycetes of the boreal zone and the Central Asian steppe and desert biomes.

*Milestone 1:* data about 4,000 specimens (collection Novozhilov) converted, geo-referenced and uploaded to GBIF.

*Milestone 2:* further 1,400 specimens (collection LE) digitalized and geo-referenced, information uploaded to GBIF.

#### *Work package 4 – Spain (MA)*

This institution has moderate resources for digitalizing specimens of its main collection. Within the proposed project, additional 3,000 specimens of the collection Lado will be accessed; mainly collected on research trips to South America (Ecuador, Chile, Mexico). These collections are still not accessed to MA and will be determined in the course of the applicant's research.

*Milestone 1:* 1,500 specimens digitalized, geo-referenced and uploaded to GBIF.

*Milestone 2:* further 1,500 specimens digitalized, geo-referenced and uploaded to GBIF.

#### *Work package 5 - U.S.A. (BPI)*

As for Spain, the proposed project will concentrate on accessing information from underrepresented parts of the world, digitalizing specimens from the Stephenson collection, mainly originating from Central America, Alaska, Australia, the Antarctic Islands and New Zealand. Anticipated is a total of 7,700 specimens currently housed at UARK. All data are already in Excel spreadsheets and geo-referenced by GPS; the curatorial work remains to do.

*Milestone 1:* 4,000 specimens digitalized, geo-referenced and uploaded to GBIF.

*Milestone 2:* further 3,700 specimens digitalized, geo-referenced and uploaded to GBIF.

### *5. Capacity building*

Within the frame of the proposed project several workshops would use the enfolding global herbarium for training of future users. M offers yearly one course "Herbarium Management Training" (<http://www.botanischestaatssammlung.de/general/training.html>). This course includes a special introduction to work with the SQL-server based collection management system *DiversityCollection*. Within the American PBI project, several courses for students and/or organisations on mycetozoa will be held, each including a collection access and data basing component (Univ. of Greifswald, Germany: Aug. 2004; Mycological Society of America, Georgia: July 2004; U.S. National Park Service: June 2005; Organisation of Tropical Studies, Costa Rica: July 2005; Thailand: Fall 2005).

### *6. Data sharing with countries of origin*

All applicants have worked in countries situated in biodiversity hotspots and/or underrepresented in major herbaria. Examples of such collections included in the proposed project (herbarium code and number of specimens given in parentheses) are: East and Central Africa (BR: 600), *Costa Rica* (LE: 800, M: 2000, BPI: 1500), *Ecuador* (BPI: 500, M: 1000, MA: 500), *India* (BPI: 500), *Kazakhstan* (M: 500, LE: 800), *Mongolia*: (M: 300, LE:

100), *Puerto Rico* (BPI: 2000, LE: 300). Countries written in *Italics* have mycologists working with myxomycetes, often in co-operation with one of the applicants. Fig. 2 shows a world map indicating regions with significant biodiversity information on myxomycetes that will be made available by the project.

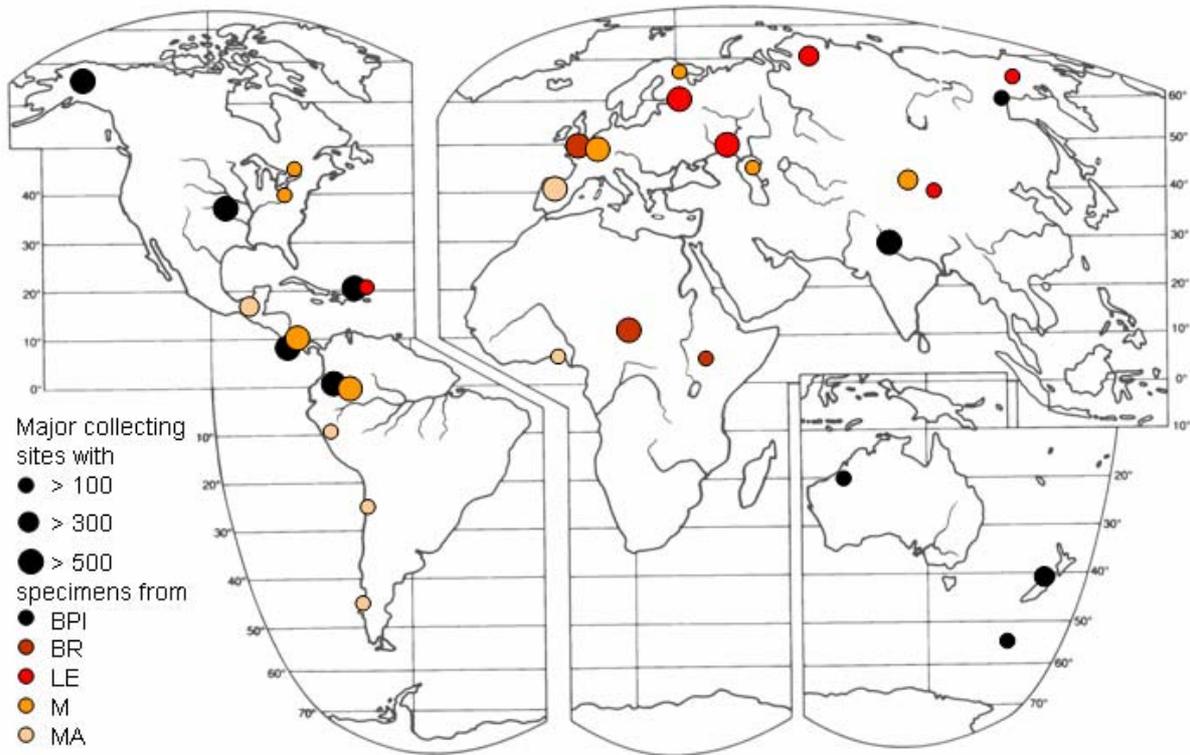


Fig. 2 Regions represented by significant (> 100 specimens) myxomycete collections whose information will be made accessible by the proposed project. The size of the dots is an estimate for the contributed number of specimens, colours indicate the responsible project partner.

### 7. Description of expected outcome

Within the duration of the project, a data base comprising 91,800 specimens could be created (Table 1). Upload of specimen data would be made available for LE. Most beneficial for the scientific community would be the augmentation of these digitalisation efforts by specimen descriptions and digital images, carried out within the U.S. PBI project, and by a key worded literature data base, funded through the German project. This together would create an expert system for myxomycete identification, comprising an estimated 85% of the world's described taxa. Such a virtual herbarium will serve the following purposes:

- consolidating the myxomycete taxonomy via an easy opportunity to access specimen,
- taxonomic reference for specimens with molecular data or deposited in culture collections,
- capacity building and information of the public and taxonomists in developing countries.

Table 1. Numbers of specimens to be digitalized within ongoing activities and the proposed project.

| Project partner       | Belgium                   | Germany              | Russia                    | Spain                  | U.S.A.                    | Total         |
|-----------------------|---------------------------|----------------------|---------------------------|------------------------|---------------------------|---------------|
| Specimens             |                           |                      |                           |                        |                           |               |
| Currently databased   | 16,600                    | 7,200                | 5,600                     | 12,000                 | 12,000                    | 53,400        |
| Funding secured for   |                           | 5,800                | 1,000                     | 1,000                  | 7,000                     | 14,800        |
| Planned               |                           | 7,500                | 5,400                     | 3,000                  | 7,700                     | 23,600        |
| Total outcome         | 16,600                    | 20,500               | 12,000                    | 16,000                 | 26,700                    | <b>91,800</b> |
| Number of types       | ca. 150                   | ca. 15               | 4                         | ca. 25                 | ca 75                     | ca. 275       |
| Additional activities | descriptive specimen data | literature data base | descriptive specimen data | nomenclatural standard | descriptive specimen data |               |

## Proposed budget

Funding of the proposed project would complement the U.S. PBI project (were three of the five partners are included) with the necessary specimen data base. All five institutions together apply for \$ **48,456** (see detailed budget below), equalling the accession of additional 23,600 specimen plus internet upload for data from those and already existing data bases. For preparation and upload of related information (SEM images, descriptions etc. enhancing the value of the respective specimen data) additional funds of ca. 11,000 \$ per year are available from the PBI research project.

To calculate costs per record for indexing by the GBIF network, average time needed for accession tasks was compared with the respective salaries. All calculations are based on experiences with the ongoing German Project (average time per task per specimen, see Table 2) and on monthly salaries for technicians. For Germany, the Bundesangestelltentarif applies (BATIIa with ca. 5,000 \$ for scientists and programmers; BAT Vb with ca. 4,000 \$ for technicians, both including social security and fringe benefits). Costs of labour are comparable for all parties except for Russia, having 40% lower costs. As working time, 40 hrs (2,400 min) per week were estimated. For salaries and existing grants, Euros were converted into Dollars using an exchange rate of 1.25. This equals costs per specimen of 1 \$ for digitalisation, 1.25 \$ for the curatorial work (which is the precondition to have a specimen on loan) and 1 \$ for geo-referencing.

Table 2. Estimation of the average accessing effort per specimen

| Money (\$) | Time (min) | Task  |
|------------|------------|---|
| 1.00       | 2.5        | A - digitalisation of label data (deciphering and keyboarding)  |
| 1.25       | 3          | B - accessioning (handling, printing and application of electronic labels as barcodes, schedules)                     |
| 1.00       | 2.5        | C – geo-referencing (reconstruction of missing label data, searching for coordinates in a map tool or in a gazetteer) |
| 3.25       | 8.0        | Total   |

### 1. Budget for GBIF project support (20%)

Specimens included in this project are already determined but in different stages of curatorial work, depending from the collector and the institution where they are deposited. From this reason, the budget for specimen digitalisation is split into the three basic tasks keyboarding label data (A), accession work (B) and geo-referencing of coordinates (C). The following calculations for the work packages are based on the amount of these three tasks per specimen (Table 3). The money will be spent at all five institutions to create temporary positions for a technician (2.5 – 3 months, depending from local conditions for fringe benefits and the social situation of the colleague hired) or to fund a comparable work contract for personnel already employed at the institution but not working full time. Time for uploading specimen data will be covered by the institution.

#### Work package 1 – Belgium (BR)

- geo-referencing of 9,600 specimens, approximate cost 1\$ per item = **9,600 \$**.

#### Work package 2 – Germany (M)

- conversion of raw data for 7,500 specimens (covered by the institution);

- curatorial work for 7,000 specimens, 1.25 \$ per item = 8,750 \$;

- curatorial work and geo-referencing for 500 specimens, 2.25 \$ per item = 1,125 \$;

Total: **9,875 \$**.

#### Work package 3 – Russia (LE)

- digitalising, accessing and geo-referencing of 1,400 specimens, 1.95\$ per item = 2,730 \$;

- curatorial work and geo-referencing for further 4,000 specimens, 1.35\$ per item = 5,400 \$.

The Komarov Institute has to charge an overhead of 20% for maintenance of the buildings (heating and power), equalling 1,626 \$. Total budget: **9,756 \$**.

*Work package 4 – Spain (MA)*

- digitalising, accessing and geo-referencing of 3,000 specimens, 3.25 \$ per item = **9,750 \$**.

*Work package 5 - U.S.A. (BPI)*

- curatorial work for about 7,700 specimens at UARK, data in Excel sheets, already geo-referenced by GPS, 1.25 \$ per item = **9,625 \$**.

Table 3. Overview about calculation of funds from GBIF project support.

| Party        | No. of specimens planned to access | Work planned (tasks A-C) | Cost per specimen (\$) | Total Costs (\$) |
|--------------|------------------------------------|--------------------------|------------------------|------------------|
| Belgium      | 9,600                              | C                        | 1.00                   | 9,600            |
| Germany      | 7,000                              | B                        | 1.25                   | 8,750            |
|              | 500                                | B,C                      | 2.25                   | 1,125            |
| Russia       | 1,400                              | A, B, C                  | (3.25) 1.95            | 2,730            |
|              | 4,000                              | B, C                     | (2.25) 1.35            | 5,400            |
| overhead 20% |                                    |                          |                        | 1,626            |
| Spain        | 3,000                              | A, B, C                  | 3.25                   | 9,750            |
| US           | 7,700                              | B                        | 1.25                   | 9,625            |
|              |                                    |                          |                        | <b>48,456</b>    |

Since the project will focus on specimens that are already partly accessed, the remaining effort (cost per specimen) varies between project partners. Except for Russia, none of the involved institutions will charge overheads.

*2. Budget for complementary support (80%)*

The complementary support for the project can be divided into three parts:

- Personal experience and infrastructure provided by other projects (PBI USA, GBIF Germany, not calculated),
- basic computer equipment and internet infrastructure provided by all institutions, here assumed to be worth **\$ 500** of matching funds per institution,
- effort for digitalisation of specimens already completed or anticipated through already secured funds or institutional resources until end of March 2006 (see Table 4 for calculations).

The figures for specimens accessed are explained under “ongoing activities”, tasks A to C are explained in Table 1.

Table 4. Calculation of matching funds for the project.

| Party                   | No. of specimens accessed / funded | Work performed (tasks A-C) | Cost per item (\$) | Total Costs (\$) |
|-------------------------|------------------------------------|----------------------------|--------------------|------------------|
| Belgium                 | 16,600                             | A, B                       | 2.25               | 37,350           |
| Germany                 | 13,000                             | A, B, C                    | 3.25               | 43,350           |
| Russia                  | 6,600                              | A, B, C                    | (3.25) 1.95 *      | 12,870           |
| Spain                   | 13,000                             | A, B, C                    | 3.25               | 42,250           |
| US                      | 17,000                             | A, B, C                    | 3.25               | 58,500           |
|                         |                                    |                            |                    | <b>194,320</b>   |
| Computer infrastructure |                                    |                            | 5 x 500            | <b>196,820</b>   |

\*For Russia, cost of labour is about 40% lower.

Based on these calculations, a total of **\$ 196,820** results; the proposed GBIF budget of \$ 48,456 would require \$ 193,824 in matching funds.

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