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IMPORTANCE OF FUNGAL COLLECTIONS FOR MYCOLOGY IN THE FRAME OF BIOLOGICAL TEACHING

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Abstract: The paper presents the importance of fungal collections for mycology, for systematical studies upon fungi taxa, for preservation of fungi species, for information transfer of the taxonomical data from a generation to another generation or elaboration of scientifical papers etc. A list of the most important collections from entire world and from our country is also presented.

Key words: fungi, collections, mycology, herbarium.

[HAWKSWORTH & MOUND, 1991] reported that the existence of collections representing the main component of the transfer system used for manipulation of information about biodiversity.

Now, there are registered only 11.500 taxons from all 345.000 taxons of known fungi, representing only 3% from their total and only 0.8% from their estimate number, approximately 1.5 millions [HAWKSWORH, 1991; TĂNASE & ŞESAN, 2006; ŞESAN & TĂNASE, 2006].

The importance of these collections [CONSTANTINESCU, 1972, 1978; HAWKSWORTH, 1991; STOICA & colab., 2002; KIRK & colab., 2001/republished 2004; TĂNASE & ŞESAN, 2006; ŞESAN & TĂNASE, 2006 etc.] was been evidenced into following directions:

- priority of preservation of species with a major importance for ecosystem biodiversity (*keystone species*);
- collections existence assures the time and materials for specialists of this domain;
- the bringing up to date of binary classified list for all taxon types;
- the assurance of information transfer concerning taxonomical data from a generation to another;
- the initiation and improvement of knowledge about these for specialists in this domain;
- the realisation of biological material changes;
- analysis of biological material;
- the comparison of information from different sources;
- elaboration of scientific paper for reviews which publish this kind of information;
- to form deposits for a huge quantity of information concerning distribution and ecology of fungi.

The collecting an preservation of fungi for mycological collections [CONSTANTINESCU, 1972, 1978; TĂNASE, 2002; KIRK & colab., 2001/2004, p. 120; ŞESAN & TĂNASE, 2004] is an important desideratum for biodiversity conservation.

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The dried macromycetes specimens kept carefully preserve their microscopic structure. This aspect makes them adequate for important mycologic collections or those used for their scientific and didactic purpose.

For the specialists who collect fungi, especiually mushrooms, for a collection, they have to follow some instructions:

- *preservation* has to be realized without affecting the specie continuity inside of collecting area;
- *quality of preserved material* – this material have to be collected in successive stages of development, including the stages with mature spores; it is recommended to collect only young and mature exemplars (cap, stalk, ring, volva, and gills), without free larva and snails. The mushrooms could be collected especially during spring, summer and autumn. Sporiferous bodies will be cleaned, throuing soil particles. It is recommended to be avoid an excessive manipulation because this material is very fragile (many elements used for identification could be destroyed).
- *quantity* – it will be collected enough biologic material only where this is possible; the collecting have to be done into substrate for a minimum deterioration of their structure.
- *notes about collecting areas* – have a major importance for species identifications; this information have to mentioned specific characteristics of fungi/mushrooms, especially those one which are deteriorated through drying process (dimensions, form, colour, texture, taste, smell etc.). The notes have to registered information about collecting area, association mode of individuals. It is recommended that collecting to be realized together with substrate, especially for parasite species. Species of lignicolous mushrooms, which growing up usually on wood, will be collect with their substrate. The same recommendations are available for saxicolous lichens.
- *colour photos* – will be done for all collected individuals, and these photos will be added to the „notes about collecting area" to completing information about: fungus/mushroom characteristics, their distribution and ecology.
- *necessary equipment* – is composed by a basket, paper bags or waxed paper bags used for mushrooms wrapping, each of them in different bags, especially for individuals with large sporiferous bodies; also, the collecting will be done in metallic or plastic boxes for mushrooms with medium dimensions, and in tubes or small boxes for little mushrooms. There is no recommended the depositing of mushrooms in plastic bags. For separation of mushrooms away from their substrate we have to use knives, scissors, mallet, all of them adequate for this kind of actions.

Chemical characters of pulpous mushrooms have a very important role in their macro- and microscopic determinations [TĂNASE, 2002; KIRK & colab., 2001/2004, p. 120; ŞESAN & TĂNASE, 2004].

The ferrous sulphate ($FeSO_4$) is used both as aqueous solution 10% and as crystals. The using of crystal depends on age and texture humidity (pulp, flesh) which are already tested. This is used for deterioration of some species from *Russula* and *Boletus* genera.

Phenol (phenol acid in aqueous solution 2%) is used for identification of some species of the genera as: *Russula, Amanita* and *Cortinarius*. The positive reactions could be common with a brown colour, but there could be registered intense reactions which coloured in red or black the tissues of some fungi/mushrooms.

The ammonia is used as aqueous solution. Reactions are coloured in red, yellow up to purple.

Sodium and potassium (5 or 10%) are used for identification of some species from *Cortinarius* taxon.

Guajac tincture generating positive reactions coloured in blue (sometimes purple) more or less intense, but sometimes, these reactions could be slow. This mixture could not be preserved during many months. This substance has either a positive reaction for *Russula vesca* Fr. or a negative reaction for *Russula fragilis* (Pers.) Fr.

The formol (as formaldehyde) determins a red colour, more or less intense, for mushroom texture (pulp, flesh).

The iodine is used either as iodine tincture or as Melzer reactive (chloral iodine). It reacts with pulp of some species from *Boletus* genus and colouring these in blue up to purple. This could be used for macroscopic identification of amyloidic spores directly from mushroom lamellae (gill) (if only the number of spores is sufficient). The presence of starch generates a reaction coloured in dark-blue.

Sulphurformol (a mixture composed by formol and sulphuric acid) and TL4 (basis for Thallium) are oxidative substances which generate intense colours as: blue, yellow, green or purple; but, all the time they are used for determination of individuals from species of *Tricholoma*, *Lactarius* and *Cortinarius*.

Sulpurvanillin (a mixture composed by H_2SO_4 and few vanillin granules) is used in microscopy and it generating reactions coloured in red or blue for species from *Russula* genus.

All characters, which were been evidenced from macroscopic point of view, have to be mentioned into „notes about collecting area" (excessively presence of cellular liquid, latex secretion, and changing of initial colour of sporiferous bosies after division into sections).

Also, it is recommended to realize a sporogame. The most simple technique used is as following: for a mushroom, we separate stem from cap; after that, we put the cap with hymenophore down on a white paper. We cover the cap with a glass tube or a Petri plate for keeping the humidity, and, after few hours, spores are positioned down on paper where they are fixed through pulverizing with a special solution (a mixture composed of 1:4 colophony and turpentine).

The sporogame could be obtained quickly during area exploration through a perforated paper sheet. We pass the mushroom stem through this aperture and, after that, we fold this paper together with the mushroom cap. This obtained product is preserved into a bag. The sporogame could be preserved into the Herbarium, inside of a transparent cellophane envelope, together with its own dried sample.

It is recommended to use standard methods for sporogames, because of spore colours are very unstable and they are easily changing. The standard method involves analysis of some sporiferous bodies closed into a box during 1/12 hours, depending on their size. Spores are collected on microscopic lama; they were been dehydrated during 15 minutes into a plastic container with sylicagel. And, after that, spores colour will be compared with a colour code from specialized literature.

The most important mycological collections are by two types (based on *Dictionary of the Fungi*, 9-th edition – KIRK & colab., 2001/2004, p. 447):

(1) *genetic resources collections* (q.v.[4]; *cultures collections*) are kept either as living material or in an *inactive metabolic stage* (which could be relieving);

[4] **q**(uod) **v**(ide) – **q.v.** = which that means

(2) *collections with dry materials*, including dried specimens from: plants, rocks, other substrates, dried cultures, microscopic preparations, coloured plastic files, drawings, pictures, preparations for studies concerning ultrastructure etc.

A dried collection is a part from an Herbarium (q.v.), but mushrooms are not plants and they have to be preserved in a different way. The word „herbarium" used for mycological collections is not correct, but it is using by International Mycological Institute Kew, UK. Usually, we use this word as herbarium / mycological collection / exsiccata.

The information concerning to deposits into both types of mycological collections is more often found in databases which are accessible for all persons who are interested in this domain.

Abbreviations used by the most important collections are keeping during a long period of time, even the name of some institutions were been changed. Therefore, some of the most used abbreviations are:

BPI – US National Fungus Collection (Beltsville, Md, USA), founded in 1869, as part of United States Department of Agriculture (USDA), Agricultural Research Service (ARS);

DAOM – Canadian National Mycological Herbarium (Ottawa, Canada), founded in 1929, as part of Centre for Land and Biological Resources Research, Agriculture Canada; **CCFC** – genetic resources collection;

IMI – International Mycological Institute Kew, Surrey, UK: Imperial Bureau of Mycology 1920-1929; Imperial Mycological Institute 1930-1947; Commonwealth Mycological Institute 1948-1985; CAB International Mycological Institute 1986-1990, part of CABI Bioscience, from 1992, at Egham, Surrey, UK;

K – Royal Botanic Gardens Kew, Surrey, UK, founded in 1841;

L – Oderzoekinstituut Rijksherbarium/Hortus Botanicus, founded in 1575, which is a part of Leiden University (Holland).

LE – Komarov Botanical Institute, St. Petersburg, Rusia, founded in 1714, by Academy of Science from Russia;

UPS – Botanical Museum, Uppsala University, Sweden, founded in 1785;

UPSC - genetic resources collection.

Collections of living materials have acronyms elaborated by International Association of Plant Taxonomy which are – usually – kept and recognized by all specialized publications.

In 1890, František Kral organized in Prague, the first collection of bacteria and fungi from all around the world, which existed until 1911. Unfortunately, many of microorganism taxons were lost [STOICA, VASSU & SĂSĂRMAN, 2002].

Referring to the most important collections from Europe, recognized by the whole world, are collections from: International Mycological Institute, Great Britain and Centraalbureau voor Schimmelcultures (CBS), now Centre of Mycological Biodiversity, from de la Utrecht University - Holland (placed formerly in Baarn, Holland).

The reference collection from IMI (International Mycological Institute) Great Britain is characterized by following aspects:

– databases which including host distributions and variability of taxons, and where are registered all permanent results of the most recent studies concerning cariotype, chromatographic and electrophoresis profiles;
– studies concerning phylogenetic relationships, based on biological molecular techniques, PCR / DNA sequence etc.;

- different methods for permanent preservation of collections: into tubes with medium, into liquid nitrogen, through lyophilization etc.;
- living materials is very important for biochemical systematic studies, identification and screening of properties useful for humans;
- realization of changes, donations, assurance of authorized reference duplicates etc.;
- organizing the lists of species, host plants, cultures, areas, basic forms etc.;
- initiation of the scientific catalogue named *Species Fungorum*;
- courses for specialists in different domain as following: about taxons which are rare and very difficult to identify, knowing the identification clues, knowing the most recent information about expert systems which working assisted by computer, courses of bio-systemic at different level, specialists, practicing specialists, researchers after PhD stages etc.; learning materials, pictures, video tapes, TV channels etc.; catalogues, maps, identification lists.

If all species of fungi would be registered into IMI collection, this should have a depositing space by 70 Km long.

CBS (Centraalbureau voor Schimmelcultures) Utrecht (Holland) (formerly situated in Baarn), is the oldest fungi collection (including yeasts) from the world. It was initiated in 1903 as a proposal of Botanists International Association.

Since 1968, CBS is included into Royal Academy of Arts and Sciences, and it is subsidized by Govern of Holland. Since 2000 (November) it has the residence into Utrecht University, where are reunited both fungi collection from Baarn and bacteria collection from Technology University from Delft. In 2001, CBS had 50,000 fungi and bacteria cultures [DINULESCU, 2001]. Recently, CBS included into its inventory the *Basidiomycetes* specify for woods collection from Götteborg University.

In 2004, CBS celebrated 100 years of existence and activity, pointed through a Symposium in Trippenhuis (Amsterdam, Holland) during 13-14 of May 2004, named „*CBS Centenary: 100 years of Fungal Biodiversity and Ecology*".

With this special occasion, specialists of this domain presented 52 scientific papers which were been published in two volumes of *Studies in Mycology*, nr. 50, 2004, 580 pp., authors CROUS P.W., SAMSON R.A., GAMS W., SUMMERBELL R.C., BOEKHOUT T., HOOG G.S & STALPERS J.A. There were been described 118 taxons, 2 new families and 17 species, two new combinations and a new name.

This institution signed, together with some other 180 countries, The Convention of Biology Diversity (CBD). In fact, CBS was been reorganized in 2000 and it was named Centre of Mycological Diversity (Mycodiversity) and, after that, it was transferred from Baarn to Utrecht and was been included into University.

The collection is keeping as following: in tubes, on agarized media; in lyophylisated amphula, through freezing in liquid nitrogen at -130ºC; in tubes covered by oil.

Fungi cultures lists edited by CBS (2001) was been published in 35-th edition and it included a large number of pages (681 pp.).

CBS has databases with very important number of information concerning to: filamentous fungi, yeasts, bacteria, actinomycetes, *Aphyllophorales*, *Fusarium*, anamorphous – telemorphous etc.

Also, CBS deposits pattern-isolated since 1955. From 1981, CBS became authorized international deposit for: fungi (from 1981); yeasts, actinomycetes and bacteria (from 1984); plasmids and fagues (from 1991).

In USA, the most important collection was recognized by ATCC (American Type Culture Collection), founded in 1925. The predecessor of this collection was founded in 1899 by American Society of Bacteriology.

In Asia, one of the most famous collection of fungi are: GBCC (Gene Bank Culture Collection), Genes Bank from Tsukuba (Japan) and IFO Collection from Institute of Fermentation (Osaka, Japan).

The actual collections of microorganism cultures are assisted and supervised by specific software [CONSTANTINESCU & MOBERG, 1987 etc.]. Table 1 presenting the main collections recognized around the world.

Tab. 1. Culture collections of fungi recognized around the world (based on http://biodiversity.bio.uno.edu/~fungi/fcollect.html)

Nr. crt.	**Collections (in alphabetical order)**	**Abbre-viation**	**Organisms etc.**
1	**2**	**3**	**4**
1.	Agricultural Research Service Culture Collection (Peoria, IL, USA)	NRRL	*Penicillium; Aspergillus; Actinomycetes*
2.	American Type Culture Collection	ATTC	Filamentous fungi; Yeasts
3.	ARS Collections of Entomopahtogenic Fungi (USDA–ARS) (Ithaca NY, USA)	ARSEF	Entomophageous fungi
4.	Banque Européennes des Glomales	BEG	Micorrhyzant fungi from *Glomales* phylum for Europe
5.	Belgian Co-ordinated Collections of Microorganisms	BCCM	fungi; yeasts; bacteria; plasmids
6.	CABRI – **C**ommon **A**ccess to **B**iological **R**esources and **I**nformation	CABRI	European Collections (BCCM, CABI, CBS)
7.	**C**anadian **C**ollection of **F**ungal **C**ulture	CCFC	Over 10.000 fungi collections
8.	**C**entraal**b**ureau voor **S**chimmelcultures – The Netherlands	CBS	Filamentous fungi, yeasts, bacteria, actinomycetes, *Aphyllophorales, Fusarium,* anamorphous-telemorphous
9.	**C**ulture **C**ollection of **Bas**idiomycetes (Czech Republic)	CCBAS	Over 630 isolated fungi from 253 spp. from 115 species of *Agaricales, Aphyllophorales* and *Gasterales*.
10.	**C**zech **C**ollection of **F**ungi	CCF	~ 2000 isolated fungi
11.	**F**ungal **C**ultures, **U**niversity of **G**öteborg – Sweden	FCUB	Especially lignicol fungi
12.	**F**ungal **G**enetics **S**tock **C**entre (U.K. mirror site)	FGSC	*Aspergillus*; *Fusarium*; *Neurospora*; *Sordaria*; wild and mutants types; cloned genes; genes bank

Nr. crt.	Collections (in alphabetical order)	Abbre-viation	Organisms etc.
1	2	3	4
13.	Fungi Perfecti (Olympia, Washington, USA)		Equipments used for fungi cultures; books; dried comestible mushrooms; medicinal mushrooms; seminars about mushrooms cultivation (Paul Stamets); Photo Collection; fungi ultrastructure, especially ME scanning
14.	German Collection of Microorgansims and Cell Cultures	DSMZ	Filamentous fungi; yeasts
15.	GPDATA: Soil-borne fungi Institute of Arable Crops Research, Rothamsted, UK		
16.	Culture Collection of the Institute for Fermentation Osaka - Japan	IFO	
17.	International Culture Collection of Arbuscular and VA Mycorrrhizal Fungi	INVAM	*Glomales*
18.	Microbial Germoplasm Database		Fungi and other microoganisms
19.	Microbial Information Network of China		Cultures; herbarium; Mycosystema Review
20.	**M**icrobial **S**train **D**ata **N**etwork	MSDN	Microorganisms (included fungi); catalogues with culture collections
20a.	Czech Collection of Fungi (CCF)	CCF	
20b.	Moscow State University Yeast Database (MSU)	MSU	
20c.	National Bank for Industrial Microorganisms and cell Cultures Bulgaria (NBIMCC)	NBIMCC	
20d.	National Collection of Agriculture and Industrial Microorganisms Hungary (NCAIM)	NCAIM	
20e.	Peterhof Genetic Collection of Yeasts Russia		
20f.	**R**esearch **I**nstitute of Applied Microbiology Russia (RIAM)	RIAM	
20g.	Slovania filamentous fungi		

Nr. crt.	Collections (in alphabetical order)	Abbre-viation	Organisms etc.
1	2	3	4
20h.	Universidad National de Córdoba, Argentina (LAM)	LAM	
20i.	LE(BIN) Basidiomycete Collection Russia	LE(BIN)	
20j.	VKM Russia	VKM	
21.	**M**icrobial **S**train **D**ata **N**etwork: mushroom databases	MSDN	Public and commercial resources for mycologists
22.	Mycobase (LCP) Cryptogamy Laboratory (LCP) and Natural History Museum from Paris	LCP	4000 isolated fungi
23.	Spanish Type Culture Collection / La Colection Espanola de Cultivos Tipo (CECT)	CECT	Fungi Bacteria
24.	**U**nited **K**ingdom **N**ational **C**ulture **C**ollection – CABI Bioscience (anterior IMI) + National Collection of Yeasts (NCYC)	UKNCC NCYC	
25.	**U**niversity of **A**lberta **M**icrofungus **C**ollection and **H**erbarium - Canada	UAMH	Over 9500 isolated ascomycetes, hyphomycetes, fungi which producing human and animal diseases, micorrhyzant fungi
26.	Uppsala University Culture Collection Sweden	UPSC	Over 3000 isolated fungi
27.	**W**orld **D**ata **C**entre for **M**icroorganisms	WDCM	Over 400 collections registered from more than 50 countries

The techniques used inside to living cultures of microorganism's deposits, including fungi, are correlated with a Brevet Request, become a common fact around the world [STOICA, VASSU & SĂSĂRMAN, 2002].

For the guarantee of a complete recognition of an invention concerning microorganisms (including fungi) it was initiated Treaty from Budapest (1977). It was signed by World Intellectual Property – WIPO and it starting to act since 1980. This international organization included the culture collections into International Depositary Authority (IDA) as (micro) biological material depositor used for strain patents. The states which have signed the Treaty from Budapest decided that the basic principle used for obtained patents is to deposit the microorganisms into a single deposit IDA [STOICA, VASSU & SĂSĂRMAN, 2002].

A culture collection could become an IDA if it receives this noun from state which comes from, but this collection has to accomplish all demands from Treaty from Budapest Statutes. Until now, only 30 microbial collections obtained IDA Collection Statute. IDA Collections has to offer facilities for analysis, keeping alive and maintaining pure (free from contaminants) during a period about 30 years minimum [STOICA, VASSU & SĂSĂRMAN, 2002].

The all quality criteria used for microbial cultures were been imposed by Standards Committee of the World Federation of Culture Collections (WFCC) which mentioned these aspects both into *Laboratory Practical Guide* (GPLC) and *Guide of Proper Techniques used for Laboratory* (GBPL). These aspects are mentioned into this *Guide* and they were been applied to many experimental domains (medicine industry, different kinds of biotechnologies etc.).

GPLC Guide including:

- minimal endowments list necessary for activities developed into Culture Collections which permitting accumulations of certain data concerning: culture quality and current information about microorganism cultures; contacts lists of organizations which make acquisition, preservation, distribution and transport;
- standards concerning organization and specialists activities, infrastructure and scientific activity;
- control methods of quality for evidencing the defects of function or troubleshooting. A proper protocol including rigorous references, specific information, simple responsibilities and correct solutions for problems which appeared during research processes [STOICA, VASSU & SĂSĂRMAN, 2002].

Applications of GPLC Standard for Microorganism Collections (including fungi) generate many advantages:

- productivity increase and knowledge quality in the same time with decreasing of potential errors;
- work conditions improvement;
- efficient using of laboratory equipment;
- decreasing of utilities consumed into those institutions;
- optimizing of time and financial resources used for successive verifications;
- obtained results well done documented;
- transactions with authentic cultures etc.

Fungi collections preserved into herbarium. If we talk about herbarium/collections, these are institutions which functioning since over 400 years [SĂVULESCU & al., 1968; CONSTANTINESCU, 1978). These kinds of institutions accomplish the main roles into biological sciences development (for example, mycology). The most important idea from Constantinescu's article (1978) concerning herbarium/collections is that herbarium is instruments for biological researches.

Herbarium is used at different levels of living world investigations.

- at submolecular level where are used methods from physics and chemistry, the herbarium have no role;
- at molecular level where are used methods from chemistry and genetics, the herbarium are used for documentation and bibliography;
- at cell level, herbarium are very important for their preserved material which is used for study of cell structures;
- at organism level, herbarium have a major importance as information source which permit to know the organism biodiversity, relationships between them or between them and the environment, and some other aspects derivate from this kind of researches. Work methods used in those researches including areas studies, experiments in greenhouse and field conditions, and the extension of these results across time and space;

– at populations and species levels, herbarium containing information deposits concerning distribution, succession or their disappearance.

Until now, we could say that the most important herbarium role is referring to taxonomic domain, in all 5 phases of this science development: descriptive, floral-phytogeographic, systemic, bio systemic, ecologic.

Herbarium accomplishes the following functions:

– *it is precious information sources* – information sources in plant biology are formed by study object (organism), as primary element, and knowledge about it (scientific literature), as secondary element. As any other science, is very important to have the study object presented into an accessible form, and this is realized through collections. A collection [SMITH, 1969, mentioned by CONSTANTINESCU, 1978] is *„an essential documentation referring to general concepts from fundamental biology, which needs to be verified again and again with real, tangible and material evidences, but not with what somebody told about these objects”*. Herbarium contains a sum of data from taxonomy and other domains until identification moment. Herbarium seems to by a library, but, in contrast with scientific literature, herbarium materials containing a bigger quantity of information which could be adapted and completed during time depending on evolution of concepts and researches methods. Individuals from herbarium are samples of vegetal populations from a specific area and specific species from which these plants are just a part. Herbarium samples offering to us the scientific basis of studies concerning to: species variability phenomena, permitting to realize maps of species spreading and migration ways, giving us the possibility to make investigations on dissemination mechanisms and gene changes between populations etc. Herbarium is a secondary source for making maps processes which are based on chromosomes number etc.;

– *assurance of scientific material preservation for samples which have scientific and historical values* – it is compulsory for herbarium to collect and preserve *types* as objects from national patrimony; the Law of National Cultural Patrimony stipulates that national patrimony includes „pieces from nature which disappear or are very rare” and „preserved types”. This law stipulates that these institutions have to accomplish some obligations referring to preservations of biologic materials;

– *herbarium are taxonomical research centres and learning institutions* – the existence of an herbarium is essential for researchers and teachers from extended plant taxonomy domain [SHETLER, 1969, mentioned by CONSTANTINESCU, 1978];

– *herbarium is important for identification services* etc. Herbarium has comparative material used for identification. Specialists who working in a herbarium have to identify precisely and competent all organisms. These notions permitting to specialists from other domains to have access to stored information concerning its objects.

Herbarium structure was been developed during time. Now, it is compulsory to be equipped with computers and specific software, new solutions for stored material and deposits structures, fast finding of information etc.

The conclusion of this article elaborated by CONSTANTINESCU (1978) is drowing from SHETLES words (1969): *„The true herbarium value for science and society, from a strictly point of view, is priceless. Herbarium development is influenced by general level of education, science and economy as a global. A country, without traditions and mature scientific institutions, has neither developed herbarium nor scientific education institutions to support them”*.

Around the world, there are recognized few herbarium / mycological collections with major importance which are presented in the following Table 2:

Tab. 2. Mycological collections recognized around the world (in alphabetical order) (based on http://biodiversity.bio.uno.edu/~fungi/fcollect.html)

Nr. crt.	Collections (in alphabetical order)	Abbre-viation	Organisms etc.
1	2	3	4
1.	British Antarctic Survey Herbarium	AAS	lichens; macromycetes; alga; plants
2.	Collection Micro- et Macromycetum Natural History Museum of Hungary	BP	macromycetes; micromycetes; over 90,000 species and 66 types ; based on data for almost 20,000 macromycete species
3.	Cornell Plant Pathology Herbarium	CUP	400,000 spp. of phytopathogenic fungi etc.
4.	Dutch Herbaria: catalogue of type specimens		55,000 species of lichens and fungi are deposited in Amsterdam (AMD), Leiden (L), Utrecht (U) and Wageningen (WAG); fungi and lichens photos
5.	Farlow Herbarium Harvard University (MA, USA)	FH	fungi; lichens
6.	Forest Mycology and Mycorrhiza research team, Mycology Research Herbarium – US Forest Service Corvallis, OR.	OSUF	28.000 species
7.	Forest Pathology Herbarium Pacific Forestry Centre (Canadian Forest Service)	DAVFP	Fungi and Hosts Index from British Columbia (Canada); macromycetes
8.	Herbaria Online		Fungi
9.	Herbarium Hamburgense	HBG	fungi; lichens
10.	Herbarium Pacificum Bishop Museum Hawaii, USA	BISH	Species and types of fungi
11.	Index Herbariorum New York Botanical Garden		
12.	Julian H. Miller Mycological Herbarium Georgia University, USA	GAM	Fungi in arts; Myxomycetes; fungi from Georgia and Tropics; history of mycology
13.	Kriebel Herbarium Purdue University		Fungi from Indiana and Centre of USA
14.	MA Herbarium fungus type Real Jardin Botanico, Madrid, Spain		Dotideales; Sphaeropsidales; R. Gonzales Fragoso, R. Cifferi and F. Bubak collections
15.	Microbial Information Network of China		Mycological Herbarium; Mycosystema Review
16.	National Botanic Garden of Belgium – Herbarium	BR	Myxomycetes (E. Klopfenstein; N. E. Nannenga-Bremekamp)

Nr. crt.	Collections (in alphabetical order)	Abbre-viation	Organisms etc.
1	2	3	4
	Mycologicum		Living species A. Marchal Collections from Africa, Europe, Belgium
17.	National Herbarium of the Netherlands	NHN	Founded in 1999 from Leiden (L), Utrecht (U) and Wageningen (WAG) Herbarium
18.	New York Botanical Garden USA	NYBG	macromycetes; *Agaricales*; G. Massee collection; *Uredinales*
19.	New Zealand Fungus Herbarium	PDD	Fungi; bounded with NZ Fungi and Global Plant (Pest Information System)
20.	Oregon State University Herbarium USA	OSC	Fungi specimens
21.	Penn State Mycological Herbarium Pennsylvania USA	PACMA	Fungi
22.	Personal Herbaria of Professor Seaward		Lichens
23.	Royal Botanic Gardens Melbourne Australia		Fungi Maps of fungi
24.	Rutgers Mycological Herbarium Rutgers University, NY, USA	RUTPP	
25.	SUNY College of Environmental Science and Forestry Herbarium State University of New York College of Environmental Science and Forestry (Syracuse, NY, USA)	SYRF	Fungi
26.	Swedish Museum of Natural History Lichen Herbarium, Stockholm, Sweden	S	Lichens; macrofungi Elias Fries photos
27.	New York State Museum Mycological Collection: Herbarium NYS NY State Museum (Albany, NY, USA)		C.H. Peck Collection (1868-1913) – over 2.700 new described species (1868-1913)
28.	U.S. National Fungus Collections databases - USDA-ARS		Fungi on plants and plant products from USA; Guide for pathogenic fungi identification; List of species from Fungi National Collection (BPI); Index Syloge Fungorum (Saccardo); Index of fungi
29.	U.S. National Herbarium Lichen Type Specimens – Smithsonian Institution		lichens; lichenizated fungi from Guiana

Nr. crt.	Collections (in alphabetical order)	Abbre-viation	Organisms etc.
1	2	3	4
30.	University and Jepson Herbaria, University of California, Berkeley, USA		fungi; lichens
31.	University of Arizona Lichens database		Lichens from Sonoran Desert
32.	University of British Columbia Herbarium	UBC	over 14.000 fungi and 35.000 lichens
33.	University of Michigan Herbarium - USA	MICH	Over 9.000 truffle collections and macroascomycetes from West of America
34.	University of Minnesota Lichen Herbarium	MIN	Lichens
35.	University of Oslo, Lichen Herbarium Norway	O	Lichens
36.	University of Trieste, Lichen Herbarium Italy	TSB	Lichens

Also, there are known some other herbarium which included lichens and they are mentioned into Table 3.

Tab. 3. Lichens Herbarium recognized around the world
(based on http://biodiversity.bio.uno.edu/~fungi/fcollect.html)

Nr. crt.	Collections (in alphabetical order)	Abbreviation	Organisms etc.
1	2	3	4
1.	British Antarctic Survey Herbarium	AAS	lichens macrofungi
2.	Dutch Herbaria: catalogue of type specimens		55.000 standard species of fungi and lichens, deposited in Amsterdam (AMD), Leiden (L), Utrecht (U) and Wageningen (WAG) photos of fungi and lichens
3.	Farlow Herbarium Harvard University (MA, USA)	FH	fungi lichens
4.	Herbarium Hamburgense	HBG	fungi lichens
5.	Index Herbariorum New York Botanical Garten		
6.	National Herbarium of the Netherlands	NHN	Founded in 1999 from Leiden (L), Utrecht (U) and Wageningen (WAG) Herbarium
7.	Personal Herbaria of Professor Seaward		Lichens
8.	Swedish Museum of Natural History Lichen Herbarium, Stockholm, Sweden	S	lichens macrofungi Elias Fries photos
9.	U.S. National Herbarium Lichen Type Specimens –		lichens; lichenizated fungi from Guiana

	Smithsonian Institution		
10.	University and Jepson Herbaria, University of California, Berkeley, USA		fungi lichens
11.	University of Arizona Lichens database		lichens from Sonoran Desert
12.	University of British Columbia Herbarium	UBC	Over 14.000 fungi and 35.000 lichens
13.	University of Minnesota Lichen Herbarium	MIN	Lichens
14.	University of Oslo, Lichen Herbarium Norway	O	Lichens
15.	University of Trieste, Lichen Herbarium Italy	TSB	Lichens

The main mycological collections from Romania are: *Exsiccata Herbarium Mycologicum Romanicum* (acronym BUCM) from Biology Institute (Bucureşti), collection from The Botany Department from University of Bucureşti (BUC), The Botanical Garden Collection from Cluj-Napoca (CL) and The Plant Biology Department from „*Al.I.Cuza*" University of Iaşi (I) [CONSTANTINESCU, 1972].

Herbarium Mycologicum Romanicum (HMR) from Biology Institute (Bucureşti) founded by Tr. Săvulescu inside of Agronomic Research Institute of Romania Building (ICAR). In 1960, it was been moved into Academy of Romania Building and there it is situated now [NEGREAN, 1996]. It is considering the largest mycological collections from South-Est of Central Europe. Since 1975, BUCM was been declared an object from National Patrimony of Bucureşti with No. 2619 [NEGREAN, 1996].

Specialists from Romanian mycology domain, recognized as international authorities of these domain, acting during time into BUCM: Tr. Săvulescu, T. Rayss, C. Sandu-Ville, A. Racoviță, Al. V. Alexandri, Vera Bontea, Ana Hulea, O. Constantinescu, G. Negrean, M. Petrescu. BUCM is improving constantly based on their works and efforts. The development of this large collection could be presented in the following Table 4.

Tab. 4. Development of Mycological collection from BUCM (after NEGREAN, 1996)

Period	Years	Number of objects	Individuals/year	Total BUCM
1928-1957	30	26.000	866	26.000
1958-1969	12	10.000	833	36.000
1979-1980	10	28.000	2.800	64.000
1981-1990	10	56.000	5.600	120.000
1991-1996	6	15.000	2.800	137.000

Beyond the mycological collection, BUCM has a mycological library which containing: mycological catalogues, collections of international mycological reviews, a collection of maps (about 700), microscopic preparations (over 2000), abstracts concerning to Romanian Mycota (over 900), abstracts concerning to their countries mycota (over 3700), mycological objects, colour film-slides collection with macromycetes (over 900) etc.

The changing basis of BUCM is exsiccata *Herbarium Mycologicum Romanicum* (HMR), created by Tr. Săvulescu in 1928 and which is edited into 70 copies. Until now, there was been edited 63 fascicles (numbers), each of them presenting 50 different species. Exssicata spreads information about Romanian Mycobiota through mycological material

changes between this institution and more than 40 other institutions from Romania and abroad. BUCM becomes important as isotypes distributor [Negrean, 1996].

Many of those fungi species representing an adequate material could be used for experimental researches from microbiology, taxonomy and genetics domains, where this material is considered as experimental models.

From those species, we could mention: *Neurospora crassa* Shear & B.O. Dodge, *Coprinus cinereus* (Schaeff.) Gray, *Schizophyllum commune* Fr. (model used for genom study), *Allomyces macrogynus* (R. Emers.) R. Emers. & C.M. Wilson, *Phycomyces blakesleeanus* Burgeff, *Aspergillus nidulans* (Eidma) G. Winter [teleomorpha *Emericella nidulans* (Eidam) Vuill.], *Ustilago maydis* (DC.) Corda, *Saccharomyces cerevisiae* Meyen ex E.C. Hansen etc.

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