



MODERN APPROACH FOR BIODETERIORATION ASSESSMENT AND DISINFECTION OF HISTORICAL BOOK COLLECTIONS

Determination of microbial contamination
and biodeterioration in archival environments

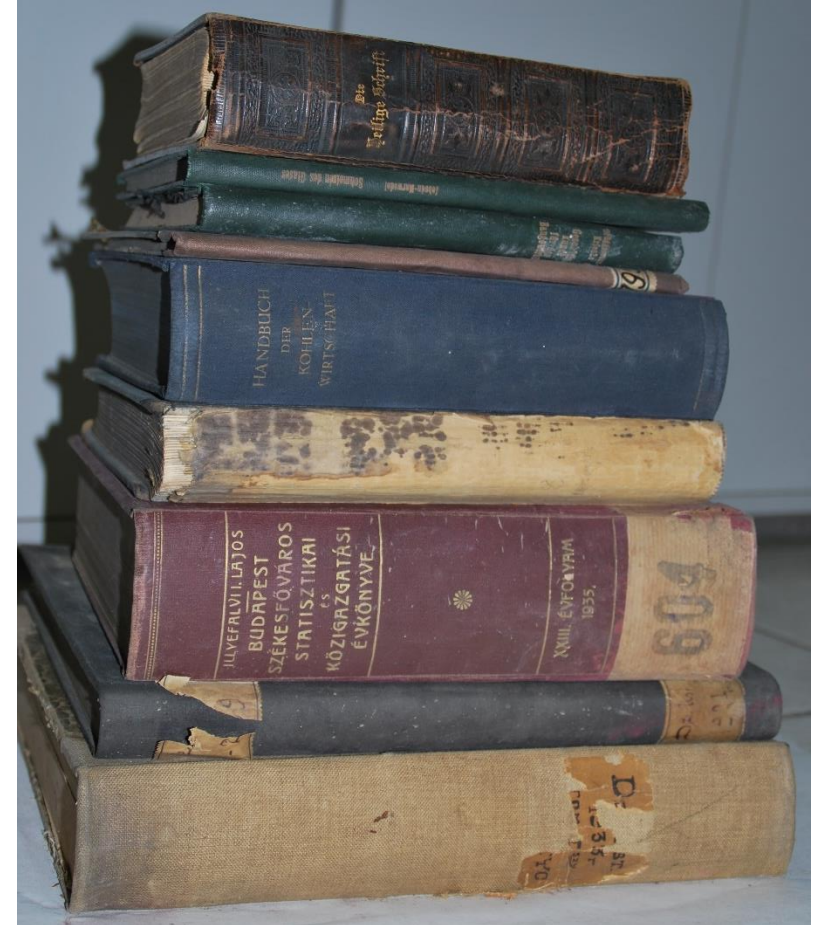
SMALL GRANT CO-FUNDED
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Book collections

- Jozef Pilsudski Regional and Municipal Public Library in Lodz (Poland)
- Archdiocese Archives in Lodz (Poland)
- National Archive in Prague (Czech Republic)

11 books, 2 documents and one journal

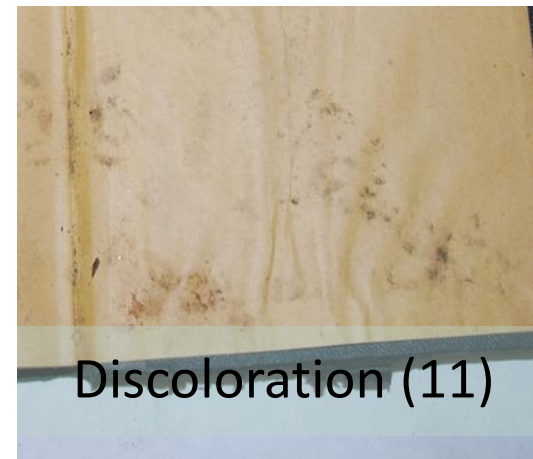
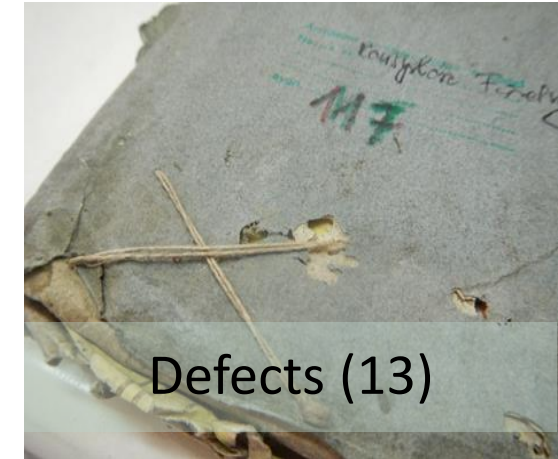
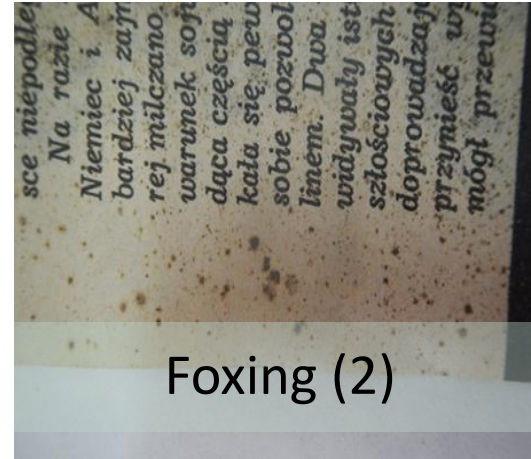
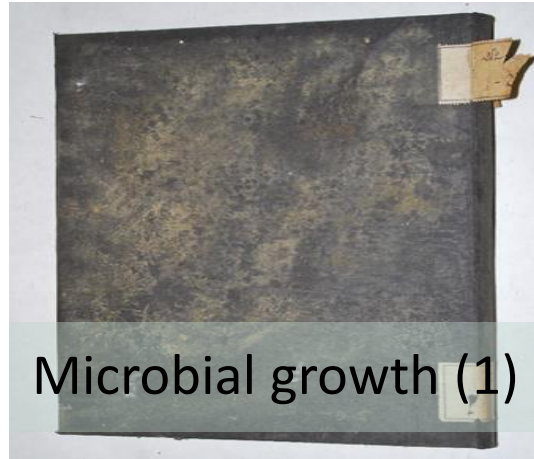


Archival objects characterization

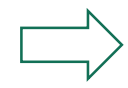
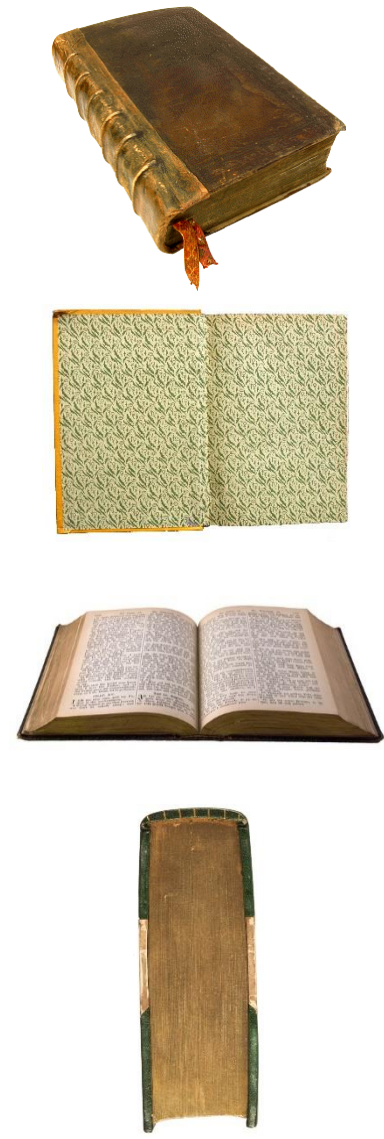
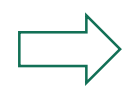
Category	Item number	Title	Year	Type of cover material	Size [cm] (L×W×H)	Macroscopic evaluation
Book	1	Dziennik Ustaw	1924	Cardboard and fabric	30.0×23.5×3.0	Fungal growth, discoloration, permanent staining
Journal	2	Przekrój	1988	Paper	34.6×24.5×0.3	Fungal growth, foxing
	3	Herakles (die zwolf Arbeiten und andern Thaten)	N.A.	Cardboard and paper	24.5×16.5×3.7	Fungal growth, discoloration, damp patches
	4*	N.A.	N.A.	Cardboard and paper	18.8×11.0×2.7	Fungal growth, discoloration, loss of structure
	5	Abwasserreinigungsanlagen: ihre Leistungen und ihre Kontrolle vom chemisch-praktischen Standpunkt	1914	Cardboard and paper	22.3×16.3×0.9	Fungal growth, discoloration, damp patches
	6*	Do čtyř artikulů	1915	Cardboard and paper	18.0×11.4×3.6	Fungal growth, discoloration, loss of structure
Book	7	Dziennik Ustaw	1933	Cardboard, paper and fabric	31.2×23.2×5.2	Damp patches
	8	Handbuch der Kohlenwirtschaft	1926	Cardboard and fabric	24.0×16.5×5.2	Fungal growth, discoloration, permanent staining
	9	Schmelzen des Glases	1928	Cardboard and paper	22.7×15.6×1.0	Fungal growth, damp patches, permanent staining
	10	Statisztikai és Közigazgatási Évkönyve	1935	Cardboard and fabric	27.0×19.0×6.2	Fungal growth, damp patches, discoloration, paper
	11	Geschäftskunde für der Baugewerbe	N.A.	Cardboard and paper	21.1×15.4×1.5	Fungal growth, discoloration, permanent staining, paper defects
	12	Die Heilige Schrift	N.A.	Cardboard and paper	21.2×13.8×4.3	Fungal growth, loss of structure, discoloration, foxing
Document	13	Acta Casus, Konsystorz Foralny Piotrkowski	1822	Paper	29.7×21.0×1.0	loss of structure, discoloration, foxing, paper defects
	14	Akta Kościoła Parafialnego w Moszczenicy Dekanaty Piotrkowskiego	1822	Paper	29.7×21.0×1.0	damp patches, permanent staining, paper defects

* - artificially contaminated; L×W×H – Length × Weight × High; N.A. – not available

Visual evaluation



Microbial sampling



MEA + chloramphenicol
(7 days, 28±2°C)



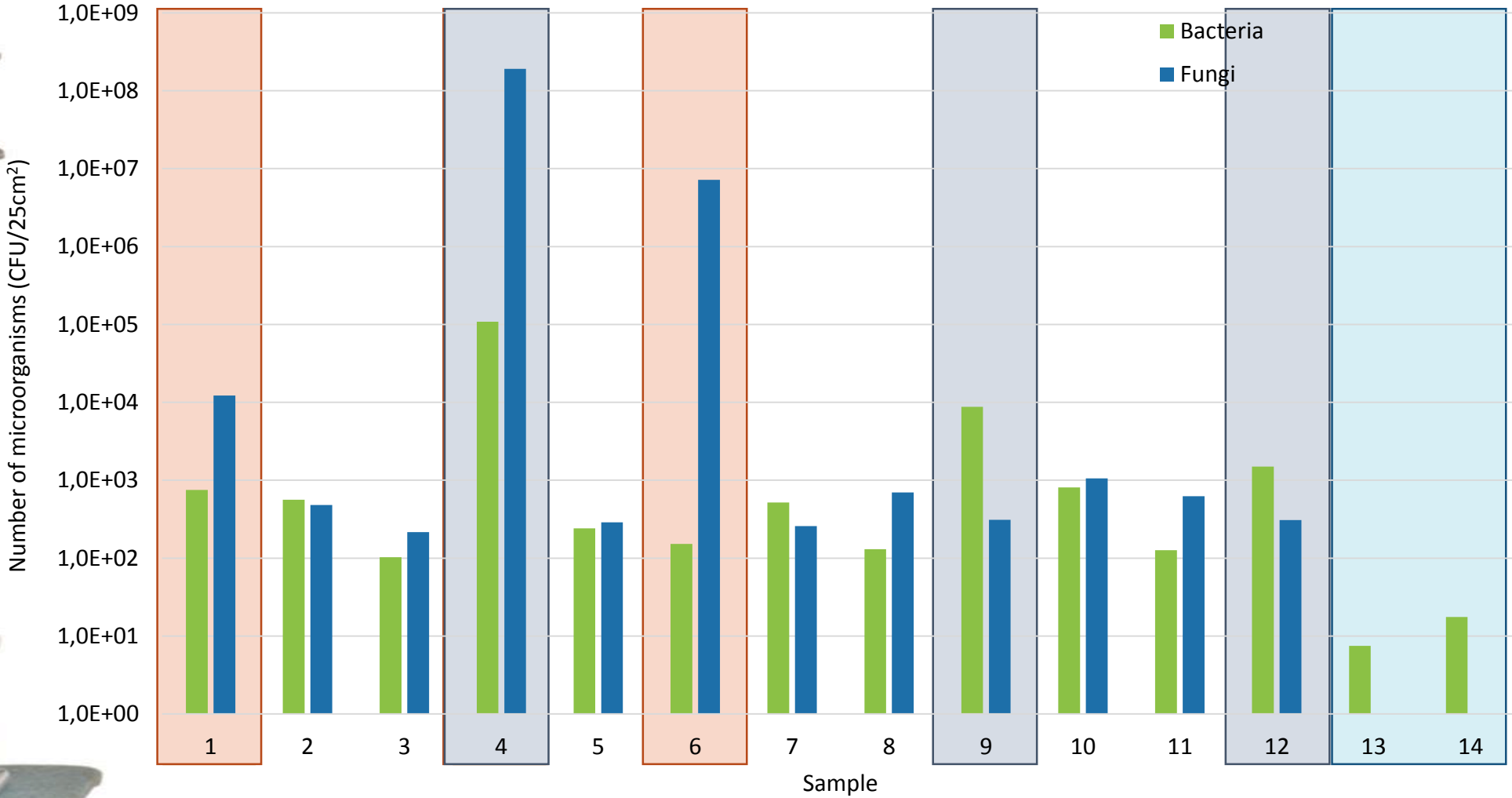
CFU/25 cm²



TSA + nystatin
(2 days, 28±2°C)

MEA – Malt Extract Agar; TSA – Tryptic Soy Agar

Microbial contamination



Fungal identification

- macroscopic and microscopic morphological features
- nucleotide sequences of ITS1/ITS2 regions

Item	Fungi	Percentage
1	<i>Rhodotorula mucilaginosa</i>	66.8
	<i>Penicillium spinulosum</i>	29.2
	<i>Penicillium chrysogenum</i>	3.0
	<i>Chaetomium elatum</i>	0.3
	<i>Chaetomium globosum</i>	0.3
	<i>Fusarium sp.</i>	0.2
	<i>Chaetomium murorum</i>	0.2
4	<i>Aspergillus niger</i>	100
6	<i>Aspergillus niger</i>	100
10	<i>Penicillium chrysogenum</i>	48.4
	<i>Penicillium spinulosum</i>	43.0
	<i>Chaetomium globosum</i>	5.8
	<i>Fusarium sp.</i>	2.1
	<i>Myxotrichum deflexum</i>	0.4
	<i>Aspergillus versicolor</i>	0.2
	<i>Aspergillus ochraceus</i>	0.1
	<i>Cladosporium globisporum</i>	0.1



Conclusions

- Analyses included 11 books, 2 documents and one journal.
- The visual evaluation of archival objects revealed fungal growth, discoloration, permanent staining, foxing, loss of structure, damp patches and paper defects.
- The bacterial contamination of archival objects was in the range of $8 - 1 \times 10^5$ CFU/25cm² and fungal in the range of $2 \times 10^2 - 2 \times 10^8$ CFU/25cm².
- Book 1 was chosen for identification studies (ITS, MALDI-MS, NGS) and 4 for disinfection (essential oils, plasma, AgNPs misting).
- Isolated fungi belonged to genera: *Aspergillus*, *Chaetomium*, *Cladosporium*, *Fusarium*, *Myxotrichum*, *Penicillium* and *Rhodotorula* (identified by ITS).