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**The comprehensive checklist of
myxomycetes of Ukraine based on
extended occurrence and reference
datasets**

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The comprehensive checklist of myxomycetes of Ukraine based on extended occurrence and reference datasets

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Abstract

Background

A significant body of valuable data about the myxomycetes of Ukraine lies in a “grey zone”. This encompasses undigitized historical books and articles published in languages such as Polish, French, or German, as well as proceedings from local conferences, articles featured in local scientific journals, and annual reports submitted to public authorities by employees of protected areas, published in Ukrainian or Russian. Yet, due to their exclusive existence in print and often the Cyrillic alphabet, these publications remain neither findable nor accessible to a wider audience.

New information

The datasets presented here aim to summarize over 150 years of myxomycetes research in Ukraine. The majority of the data has been extracted from published literature sources spanning the years 1842 to 2023, with a minor supplement from unpublished herbarium specimens. The datasets include 5036 georeferenced occurrences, 339 taxa and 91 literature sources. Seventy one of the used literature sources, mostly published before 2010, we uploaded to zenodo.org and available in open access.

Keywords

Historical literature, references, slime molds

Introduction

Myxomycetes (Myxogastrea) are macroscopic terrestrial eukaryotes, capable of forming giant multinucleate plasmodia and fruiting bodies with a relatively complicated structure. Because of their conspicuous fruiting bodies, first documented observations of these organisms date back into as far as 17th century (Leontyev et al. 2019).

First observations of myxomycetes at the territory of Ukraine appear in the first half of 19th century. In the monography named “Description of wild and domesticated plants in Lithuania, Volhynia, Podolia and Ukraine”, Polish professor Józef Jundziłł reported 12 species of Myxomycetes (Jundziłł 1830). However, due to the absence of exact locality data in this publication, we cannot allocate these findings from historical regions to modern countries, which could be Ukraine, Poland, Belarus or Lithuania. The first report containing more precise geographic data was offered by a French mycologist Joseph-Henri Lévillé, known as discoverer of a fungal basidium. He worked with herbarium, collected in southern Crimea, on the coastline between Sevastopol and Nikita, and identified two myxomycete species, namely *Lycogala epidendrum* and *Stemonitis axiera* (Lévillé 1842).

In 1845, the first mycological monograph written by Ukrainian researcher was published. Professor Vasyl Chernyaev from the University of Kharkiv described 11 species and 5 genera of gasteroid fungi. One of them, *Xyloidion delavignei* Czern., is a forgotten synonym of *Lycogala flavofuscum* (Leontyev 2023).

The first report on myxomycetes of the western part of Ukraine was published by Józef Krupa, who collected 75 species around Lviv and Stryi (Krupa 1886, Krupa 1887, Krupa 1889). At the same period, 20 species of myxomycetes were recorded in Chernihiv province (Borszczow 1869), and eight species were found around Kyiv (Valtz and Rishavi 1871).

The publication of influential monographs by Józef Rostafinskiy (Rostafinski 1875), and Arthur and Gulielma Lister (Lister 1894, Lister and Lister 1911) boosted studies of myxomycetes in Ukraine. In the period 1900–1914, slime molds became a common part of local biodiversity research. At this time, R. Gutwinski (Gutwiński 1901) and B. Namysłowski (Namysłowski 1909) reported lists of fungi and myxomycetes from the historical region of Galicia. Although most of the records from these lists were spotted on the territory of modern Poland, several of occurrences can be georeferenced to Western Ukraine. At the same time period, A. A. Jachevsky (Jachevsky 1907) reported myxomycetes from the Central part of Ukraine, and L. A. Benike (Benike 1914) in the East.

After the end of World War I and the Ukrainian Revolution, myxomycete research was resumed. M.O. Zelle, using her own materials, collections of V.I. Kazanovskyi and available publications, provided a preliminary checklist of the myxomycetes of the Eastern and Central parts of Ukraine, which included 63 species (Zelle 1925). A comprehensive review on the topic was published by M.M. Pidoplychko (Pidoplychko 1932). Using his own collections, herbaria of G.F. Borisevich and V.T. Panasenko, as well as thoroughly

analyzed literature sources, he published the annotated checklist of 67 species. During the same period, J. Jarocki reported 69 species from Chornohora in the Eastern Carpathians (Jarocki 1931). A. Namysłowska critically studied the herbarium of Prof. E. Lubich-Niezabitowsky collected near Stryi and found 61 myxomycete species (Namysłowska 1938). In the 1930s, renowned Polish myxomycetologist H. Krzemieniewska conducted surveys in Western Ukrainian regions. Her research yielded the discovery of 83 species in the Carpathians and 46 species around Lviv (Krzemieniewska 1934, Krzemieniewska 1937).

Following the conclusion of World War II, research on myxomycetes in Ukraine came to a halt. For the period 1945–1991, only a few publications are known on this topic, including the species list of Kaniv Nature Reserve (Lavitska 1949) and “Handbook of the Fungi of Ukraine”, where 121 species of myxomycetes were listed based on the literature data, but with a first documented record of the *Licaethalium olivaceum* (Zerova and Morochkovskiy 1967). In the 1980s, Y.K. Novozhilov conducted in Southern Crimea a first investigation of myxomycetes, based on the moist chamber technique. Among reported 26 corticolous species, fourteen appeared to be new for Ukraine (Novozhilov 1986, Novozhilov 1988).

The resurgence of myxomycete research in Ukraine was instigated by Prof. I.O. Dudka. In 1994, she, together with her student T.I. Krivomaz, investigated the herbarium of H. Krzemieniewska deposited in Lviv National University and reexamined the data regarding the distribution of myxomycetes in the Ukrainian Carpathians (Dudka and Kryvomaz 1996). Working on the territory of the Carpathian Biosphere Reserve, together with B. Ing (UK), they recorded 45 species in this area. In 1995, I.O. Dudka and D. Minter (UK) published the preliminary checklist of the Fungi of Ukraine, which includes data on 113 myxomycete species, kept in the National Herbarium of Ukraine, KW (Minter and Dudka 1996). In 2010 T.I. Kryvomaz published the first online database of the myxomycetes of Ukraine, where the distribution of species within the country was provided according to the literature sources. Unfortunately, this database is not available on the web anymore.

Over the past two decades, the count of myxomycete species documented in Ukraine has doubled. The main efforts have been focused on the study of myxomycete biota in protected natural areas of Ukraine. Thorough investigations of the corticolous (Kochergina and Markina 2021) and nivicolous (Leontyev et al. 2021) myxomycetes in preserved areas were published. Studies of the myxomycete-insect relationships have been conducted (Dudka and Romanenko 2006, Perkovskiy and Krivomaz 1994). Modern techniques, such as cultivation (Morozova 2010), biochemical analyses (Romanenko 2006), SEM (Leontyev et al. 2015, Leontyev and Fefelov 2012, Leontyev and Moreno 2011), molecular barcoding (Leontyev et al. 2023, Yatsiuk et al. 2023) are now widely used by Ukrainian myxomycetologists.

In the period 2000–2010, scientific schools aimed at studying myxomycetes emerged in Kyiv and Kharkiv. Over ten Master theses, four PhD dissertations (Kochergina 2021, Kryvomaz 2010, Leontyev 2007, Romanenko 2006) and one DrSci dissertation (Leontyev 2016) were defended. Ukrainian collections were used for the description of 16 new species and two subspecies taxa; the holotypes of eight new taxa were collected in Ukraine. Two words of Ukrainian origin, Skovoroda (personal name) and palyanytsia

(round bread) were used to create species epithets for new taxa (Leontyev et al. 2023, Leontyev et al. 2015, Leontyev and Fefelov 2009, Leontyev and Moreno 2011, Yatsiuk et al. 2023, Leontyev and Fefelov 2012).

With the onset of Russian aggression against Ukraine, many research programs were frozen, and researchers moved abroad. However, myxomycete studies, including field research, are still ongoing. In 2022–2023, a previously unknown species of *Lamproderma* was found in the forests of the war-affected Kharkiv region (Viunnyk and Leontyev 2023).

While the modern papers about myxomycetes of Ukraine tend to be written in English and are, generally, accessible online, a significant body of earlier data remains in a “grey zone”. This encompasses undigitized historical books and articles published in languages such as Polish, French, or German, as well as proceedings from local conferences, articles featured in local scientific journals, and annual reports submitted to public authorities by employees of protected areas, published in Ukrainian or Russian. These publications often provide lists of species recorded in specific localities in Ukraine, such as nature reserves, national parks or “zakazniks” (small areas with a limited conservation regime), constituting a valuable source of biodiversity data. Yet, due to their exclusive existence in print and often the Cyrillic alphabet, these publications remain neither findable nor accessible to a wider audience.

Hence, this paper aims to provide a comprehensive summary of over 150 years of myxomycetes research in Ukraine and to enhance the accessibility of data from previously “invisible” sources.

Here we introduce three datasets: the Checklist dataset (core), the Occurrence dataset, the Reference dataset (extensions).

- The occurrence dataset includes records mined from the scientific literature that make up to 98% of it. Another 2% of the occurrences represent unpublished until now parts of a herbarium collection of H.S. Skovoroda Kharkiv National Pedagogical University (CWP, Kharkiv, Ukraine), collected during the student summer practical fieldwork in 2017–2018 years. The occurrences retrieved either from literature or herbarium specimens were taxonomically assessed, and, when necessary, georeferenced and quality-checked using the procedures described in Methods.
- The reference dataset includes digitized literature sources arranged in DarwinCore format. The list of literature sources encompasses 91 unique items. The essential part of the literature was procured from the institutional or private libraries and scanned starting from the 2000s by Dmytro Leontyev. Currently, it is stored in a digital form. The literature includes sources originally published in Ukrainian (38), Russian (21), English (22), Polish (8), German (1) or French (1) languages.
- The checklist is the final list of species derived from the occurrence dataset after the taxonomic assessment. New species, reported in recent publications, for which underlying data have already been published in GBIF, were added to the checklist individually.

These datasets represent the state of the art as of the beginning of 2023. Their purpose is to serve as a foundational resource for conducting countrywide ecological studies, particularly vital for evaluating the potential impact of the ongoing war on biodiversity in the future.

Project description

Title: Deciphering Cyrillic: the checklist from invisible sources

Personnel: Yuliia Leshchenko, Iryna Yatsiuk

Study area description: Ukraine

Design description: BioDATA grant for data mobilization including digitization, data quality assurance, data preparation, and publication of collection specimen and other species data from Ukraine to GBIF. Dataset preparation was supported within the project "Deciphering Cyrillic: the checklist from invisible sources". More details on the grant program here (<https://www.nhm.uio.no/english/research/projects/biodata/activities/data-mobilization-call-ukraine.html>).

Funding:

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- Ceba-LT-2017/10049
- University of Tartu
- Estonian Research Council project PRG1170 (author Iryna Yatsiuk)

Sampling methods

Sampling description:

- The literature sources selected for this dataset included only scientific literature, including monographs, peer-reviewed journal articles, conference abstracts, annual reports of protected areas, PhD and Master's thesis. Herbarium specimens included here, have either been identified or verified by academic myxomycetologists.
- The literature sources originally lacking a DOI, were published on Zenodo repository (zenodo.org) and assigned one. In total 71 sources were published.
- Information from the literature was extracted manually into comma-separated spreadsheets containing columns named according to the Darwin Core standard. To avoid duplication, sources, supported by datasets already published in GBIF, were not entered into the occurrence dataset, but added later on the stage of data analysis and checklist generation.

- The checklist dataset was created automatically by extracting unique values from the scientificName column within the occurrence dataset, following the completion of the taxonomic assessment.
- The References dataset was generated through manual extraction of information from literature sources, with the data organized into a comma-separated spreadsheet with the columns in the Darwin Core standard.

Quality control:

- Spreadsheets were checked and cleaned with Openrefine v. 3.2 (Ham 2013). Taxa names were checked for misspelling by matching against the GBIF [Species Matching tool](https://www.gbif.org/tools/species-lookup) (<https://www.gbif.org/tools/species-lookup>). The results of georeferencing were checked visually by plotting occurrences with QGIS software (QGIS Development Team 2020).
- The taxonomic assessment was based upon “An online nomenclatural information system of Eumycetozoa”(Lado 2023), except in cases where subspecies or forms were reported. In instances involving subspecies/forms, as these are not recognized as valid taxa in the aforementioned nomenclature database, taxonomic treatments were based on several monographs (Martin and Alexopoulos 1969, Nannenga-Bremekamp 1991, Poulain et al. 2011), as well as expert taxonomic opinions.

Step description:

The occurrence dataset was produced with the following steps:

1. Survey and digitization of professional literature resources on myxomycetes occurrences in the territory of Ukraine in its borders as of 1991 (total 91 sources);
2. Preparation of Darwin Core-formatted template;
3. Data extraction from the literature sources into corresponding columns;
4. Data extraction from the herbarium labels into corresponding columns;
5. Taxonomic assessment of names;
6. When necessary, automatic georeferencing of occurrences. If the coordinates of the occurrence were missing in the literature or on herbarium labels, the occurrence was georeferenced based on text description of the occurrence location. Georeferencing was done automatically using the Geocode by Awesome Table extension for Google sheets (https://workspace.google.com/marketplace/app/geocode_by_awesome_table/904124517349). Precision was determined according to the accuracy of the distance to the occurrence from the authors' description in the text. The accuracy of the given coordinates is determined as follows: one number in decimal place corresponds to the precision of 11.1 km, two numbers = 1.11 km, with each subsequent sign, the distance is reduced by a factor of 10. In the case of localities indicated by names that have been renamed or no longer exist, georeferencing was carried out by the method of digitizing available maps using QGIS 3.16.3 (QGIS Development Team 2020), followed by the extraction of coordinates. WGS84 was used as a spatial reference system.

7. Data cleaning using OpenRefine;
8. Matching species names;
9. Plotting of occurrences on the map and visual checkup of coordinates.

The Reference dataset was prepared with the following steps:

1. Preparation of Darwin Core-formatted template;
2. Data extraction from the literature sources into corresponding columns;
3. Data cleaning using OpenRefine.

The checklist dataset was derived from the occurrence dataset with the following steps:

1. Preparation of Darwin Core-formatted template;
2. Extraction of unique values from a scientificName column of the occurrence dataset to a scientificName of the checklist dataset.
3. Exclusion of identifications higher than species level (e.g. *Arcyria* sp.)

Geographic coverage

Description: The entire territory of Ukraine in 1991 borders.

The distribution of occurrences in our dataset clearly mirrors the invested research effort (Fig. 1). The majority of records are concentrated in proximity to major cities and within protected areas situated in the forested regions of Ukraine, notably in the Carpathians, mountainous regions of Crimea and forest-steppe zone in the Eastern Ukraine. There is a noticeable data deficit in the southern regions of Ukraine, particularly in the steppe zone. Addressing this gap will necessitate dedicated research efforts as well as collaboration with citizen scientists in the future.

Coordinates: ; .

Taxonomic coverage

Description: The checklist includes 339 taxa of slime molds, among them 331 are species, and the rest are identified to the genus level. Nearly all records represent the class Myxomycetes (Eumycetozoa, Amoebozoa). One species belongs to the class Ceratiomyxomycetes (Eumycetozoa, Amoebozoa), and one represents the family Acrasidae (Heterolobosea, Excavata). Subclasses Lucisporomycetidae (bright-spored) and Columellomycetidae (dark-spored) are represented by similar number of occurrences, 47% and 50% accordingly (Fig. 2). Among the genera of bright-spored myxomycetes, *Arcyria* (12.7%), *Cribraria* (6.7%), and *Lycogala* (5.7%) are recorded most often. For the dark-spored myxomycetes genera *Physarum* (8.9%), *Stemonitis* (7.3%) and *Fuligo* (4.3%) are represented by the highest number of occurrences.

The estimated species richness, as determined by the bias-corrected Chao1 estimator, as shown in Fig. 3, is 397 species. Consequently, the portion of known species accounts for 83% of the estimated overall diversity.

Taxa included:

| Rank | Scientific Name |
|--------|-----------------|
| phylum | Eumycetozoa |
| family | Acrasidae |

Temporal coverage

Notes: Data range: 1830/1840s-2021 (Fig. 4)

The majority of occurrences were registered in the late summer and early autumn months (Fig. 5). However, in April, there is a visible shift in taxonomic structure, namely increases the share of the order Meridermatales. This reflects the specificity of nivicolous myxomycetes, the group of species that form fruiting bodies on the border of melting snow.

Usage licence

Usage licence: Open Data Commons Attribution License

Data resources

Data package title: The comprehensive checklist and extended occurrence and reference datasets of myxomycetes of Ukraine

Resource link: <https://doi.org/10.15468/7g9d74>

Alternative identifiers: <https://ukraine.ipt.gbif.no/resource?r=myxomycetesukraine>

Number of data sets: 3

Data set name: taxon.txt

Download URL: <https://www.gbif.org/dataset/7f90f977-1004-40f8-a471-7bbf517a006d>

Data format: Darwin Core

Description: The Taxon dataset includes a tabulation-delimited table with 11 fields in Darwin Core terms and 339 records.

| Column label | Column description |
|--------------|--------------------|
|--------------|--------------------|

| | |
|--------------------------|--|
| taxonID | http://rs.tdwg.org/dwc/terms/taxonID ; a unique identifier for the taxon, that serves as a foreign key between three datasets presented here. The universal unique identifier (UUID) was used for this purpose. |
| taxonRank | http://rs.tdwg.org/dwc/terms/taxonRank ; the lowest taxonomic rank of the occurrence in the acceptedNameUsage column |
| scientificName | http://rs.tdwg.org/dwc/terms/scientificName ; The full name of the currently accepted taxon, name after the taxonomical assessment performed as described in Methods. |
| kingdom | http://rs.tdwg.org/dwc/terms/phylum ; The full scientific name of the kingdom according to the authoritative source |
| phylum | http://rs.tdwg.org/dwc/terms/phylum ; The full scientific name of the phylum according to the authoritative source |
| class | http://rs.tdwg.org/dwc/terms/class ; The full scientific name of the class according to the authoritative source |
| order | http://rs.tdwg.org/dwc/terms/order ; The full scientific name of the order according to the authoritative source |
| family | http://rs.tdwg.org/dwc/terms/family ; The full scientific name of the family according to the authoritative source |
| genus | http://rs.tdwg.org/dwc/terms/genus ; The full scientific name of the genus according to the authoritative source (https://eumycetozoa.com/) |
| specificEpithet | http://rs.tdwg.org/dwc/terms/specificEpithet ; The species epithet of the dwc:scientificName |
| scientificNameAuthorship | http://rs.tdwg.org/dwc/terms/scientificNameAuthorship ; The authorship information for the dwc:scientificName formatted according to the conventions of the ICN |

Data set name: occurrence.txt

Download URL: <https://www.gbif.org/dataset/7f90f977-1004-40f8-a471-7bbf517a006d>

Data format: DarwinCore

Description: The Occurrence dataset includes a tabulation-delimited table with 24 fields in Darwin Core terms and 5036 records.

| Column label | Column description |
|---------------|--|
| occurrenceID | http://rs.tdwg.org/dwc/terms/occurrenceID ; the identifier for the occurrences, the universal unique identifier (UUID) was used for this purpose; the identifier for the occurrences, the universal unique identifier (UUID) was used for this purpose |
| basisOfRecord | http://rs.tdwg.org/dwc/terms/basisOfRecord ; MaterialCitation for the majority of occurrences derived from literature; PreservedSpecimen for herbarium records not cited in the literature |

| | |
|-------------------------------|---|
| catalogNumber | http://rs.tdwg.org/dwc/terms/catalogNumber ; herbarium number of specimens |
| eventDate | https://dwc.tdwg.org/terms/#dwc:eventDate ; the full date of the observation as precisely as it could be extracted from the publication |
| year | http://rs.tdwg.org/dwc/terms/year ; the four-digit year in which the occurrence was recorded |
| month | http://rs.tdwg.org/dwc/terms/month ; month in which the occurrence was recorded |
| day | http://rs.tdwg.org/dwc/terms/day ; day of the month in which the occurrence was recorded |
| verbatimEventDate | http://rs.tdwg.org/dwc/terms/verbatimEventDate ; the original representation of the date/s in which the occurrence was recorded, mostly the dates referring to expeditions or surveys |
| habitat | http://rs.tdwg.org/dwc/terms/habitat ; description of macrohabitat such as vegetation type, and microhabitat, such as a substrate type |
| country | http://rs.tdwg.org/dwc/terms/country ; one country (Ukraine) |
| countryCode | http://rs.tdwg.org/dwc/terms/countryCode ; one value (UA) |
| stateProvince | http://rs.tdwg.org/dwc/terms/stateProvince ; the highest-level administrative region of Ukraine (oblast') |
| municipality | http://rs.tdwg.org/dwc/terms/municipality ; the second-level administrative region of Ukraine, according to the official administrative division of Ukraine of 2020 |
| locality | http://rs.tdwg.org/dwc/terms/locality ; more specific description of the locality than municipality, derived from the original |
| minimumElevationInMeters | http://rs.tdwg.org/dwc/terms/minimumElevationInMeters ; elevation a. s. l. if this information was stated in the original |
| decimalLatitude | http://rs.tdwg.org/dwc/terms/decimalLatitude ; geographic latitude in decimal degrees |
| decimalLongitude | http://rs.tdwg.org/dwc/terms/decimalLongitude ; geographic longitude in decimal degrees |
| geodeticDatum | http://rs.tdwg.org/dwc/terms/geodeticDatum ; The geodetic datum upon which the geographic coordinates given in dwc:decimalLatitude and dwc:decimalLongitude is based |
| coordinateUncertaintyInMeters | http://rs.tdwg.org/dwc/terms/coordinateUncertaintyInMeters ; the distance (in metres) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location. Set as described in Methods |
| georeferencedBy | https://dwc.tdwg.org/terms/georeferencedBy ; name of the person who georeferenced the occurrence |

| | |
|------------------------|---|
| taxonID | http://rs.tdwg.org/dwc/terms/taxonID ; a unique identifier for the taxon, that serves as a foreign key between three datasets presented here. The universal unique identifier (UUID) was used for this purpose |
| verbatimIdentification | http://rs.tdwg.org/dwc/terms/verbatimIdentification ; A string representing the taxonomic identification as it appeared in the original record. |
| institutionCode | http://rs.tdwg.org/dwc/terms/institutionCode ; The name (or acronym) in use by the institution having custody of the object(s) or information referred to in the record. |
| collectionCode | http://rs.tdwg.org/dwc/terms/collectionCode ; The name, acronym, coden, or initialism identifying the collection from which the record was derived. |
| taxonRank | http://rs.tdwg.org/dwc/terms/taxonRank ; the lowest taxonomic rank of the occurrence in the scientificName column |

Data set name: reference.txt

Download URL: <https://www.gbif.org/dataset/7f90f977-1004-40f8-a471-7bbf517a006d>

Description: The Reference dataset includes a tabulation-delimited table with 8 fields in Darwin Core terms and 2182 records.

| Column label | Column description |
|-----------------------|--|
| identifier | http://purl.org/dc/terms/identifier ; Digital Object Identifier was used for this purpose. If the publication originally was not assigned any DOI, it was issued by Zenodo after publishing it on zenodo.org |
| bibliographicCitation | http://purl.org/dc/terms/bibliographicCitation ; A text string referring to an un-parsed bibliographic citation |
| title | http://purl.org/dc/terms/title ; Title of the referenced item |
| creator | http://purl.org/dc/terms/creator ; The author or authors of the referenced item |
| source | http://purl.org/dc/terms/source ; the name of the journal, abstracts book or larger book (if any) where the item was published |
| date | http://purl.org/dc/terms/date ; the full date of the publication as precisely as it could be extracted from the publication |
| language | http://purl.org/dc/terms/language ; ISO 639-1 language code indicating the language of the publication |
| id | equals to http://rs.tdwg.org/dwc/terms/taxonID (created automatically by the IPT as a replacement for taxonID); contains the unique identifier for the taxon that serves as a foreign key between three datasets presented here. The universal unique identifier (UUID) was used for this purpose |

Additional information

List of sources that were excluded from the occurrence dataset for various reasons are provided in Table 1.

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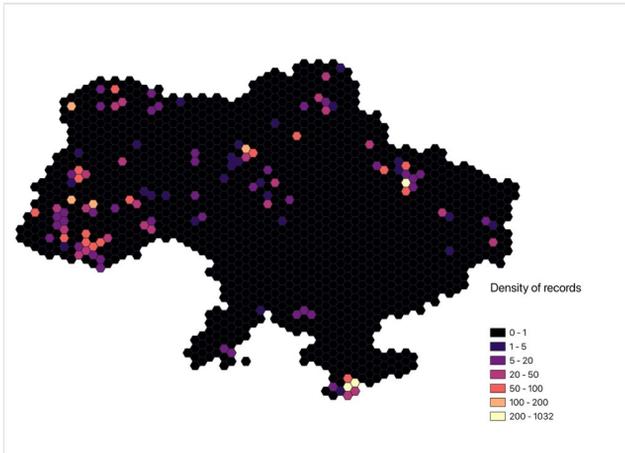


Figure 1.
Distribution of occurrences of myxomycetes on the territory of Ukraine.

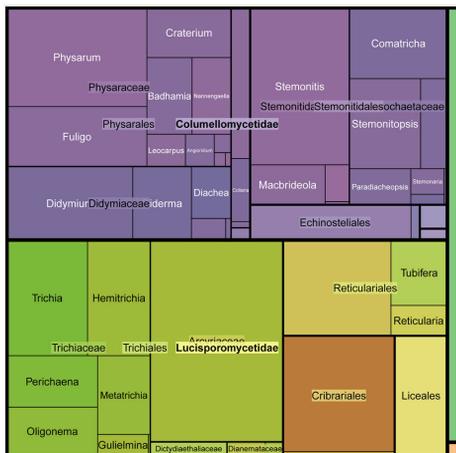


Figure 2. Taxonomic structure of occurrences of myxomycetes of Ukraine by the number of occurrences.

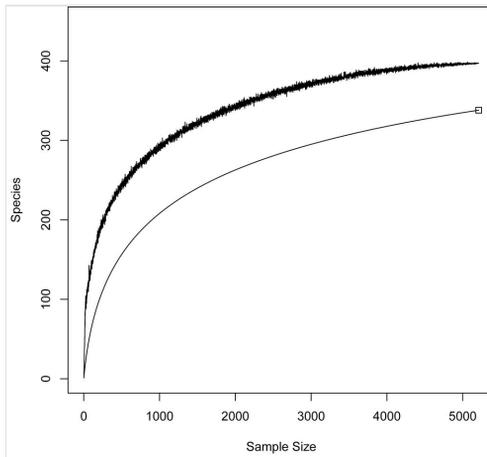


Figure 3.

Species accumulation curve (line below) and expected species richness (Chao1, jagged line above).

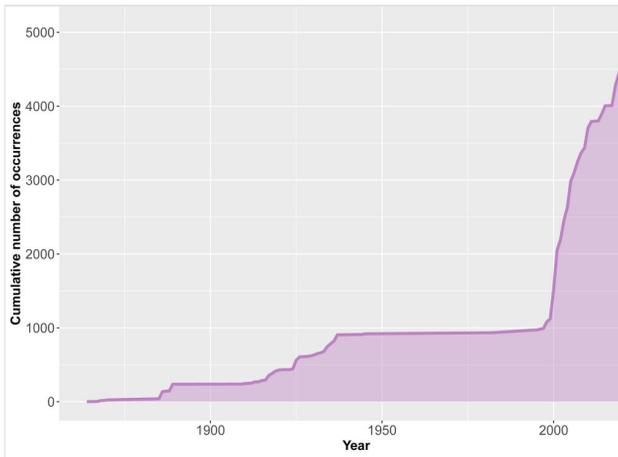


Figure 4.
Temporal accumulation of records of myxomycetes in Ukraine.

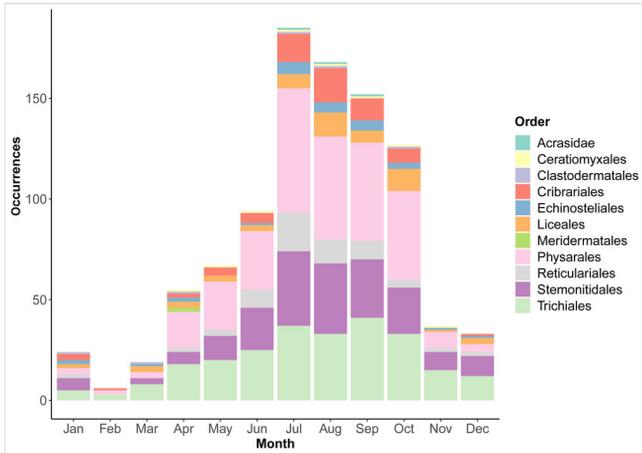


Figure 5. Distribution of occurrences of myxomycetes in Ukraine by month.

Table 1.

List of sources that were excluded from the occurrence dataset.

| Source | Reason |
|---------------------------|--|
| Jundziłł 1830 | Impossible to georeference records to the country level |
| Namysłowski 1914 | Summary from other articles |
| Glushchenko et al. 2002 | Textbook, no data about occurrences |
| Dudka et al. 2009 | Summary from other articles |
| Dudka et al. 2009 | Summary from other articles |
| Yatsiuk et al. 2018 | Already published in GBIF, excluded from the Occurrences dataset to avoid duplication. However, data from this source are included in the taxon.txt, reference.txt and the analysis/ vizualizations presented herein |
| Yatsiuk and Leontyev 2020 | Already published in GBIF, excluded from the Occurrences dataset to avoid duplication. However, data from this source are included in the taxon.txt, reference.txt and the analysis/ vizualizations presented herein |
| Yatsiuk et al. 2023 | Already published in GBIF, excluded from the Occurrences dataset to avoid duplication. However, data from this source are included in the taxon.txt, reference.txt and the analysis/ vizualizations presented herein |