



Гербарийді цифрлау және GBIF IPT арқылы деректерді жариялау
Оцифровка гербария и публикация данных через GBIF IPT
Herbarium data digitization and publishing through GBIF IPT

Полевая биология в цифровом мире

Карагандинский университет имени академика Е.А. Букетова, 15-17 марта 2023 г.

План лекции

Открытая наука и FAIR-принципы для
данных о биоразнообразии

Глобальные порталы и инициативы по
оцифровке данных о биоразнообразии

Статьи о данных



Собирать полевые данные сложно



Natalya Ivashko



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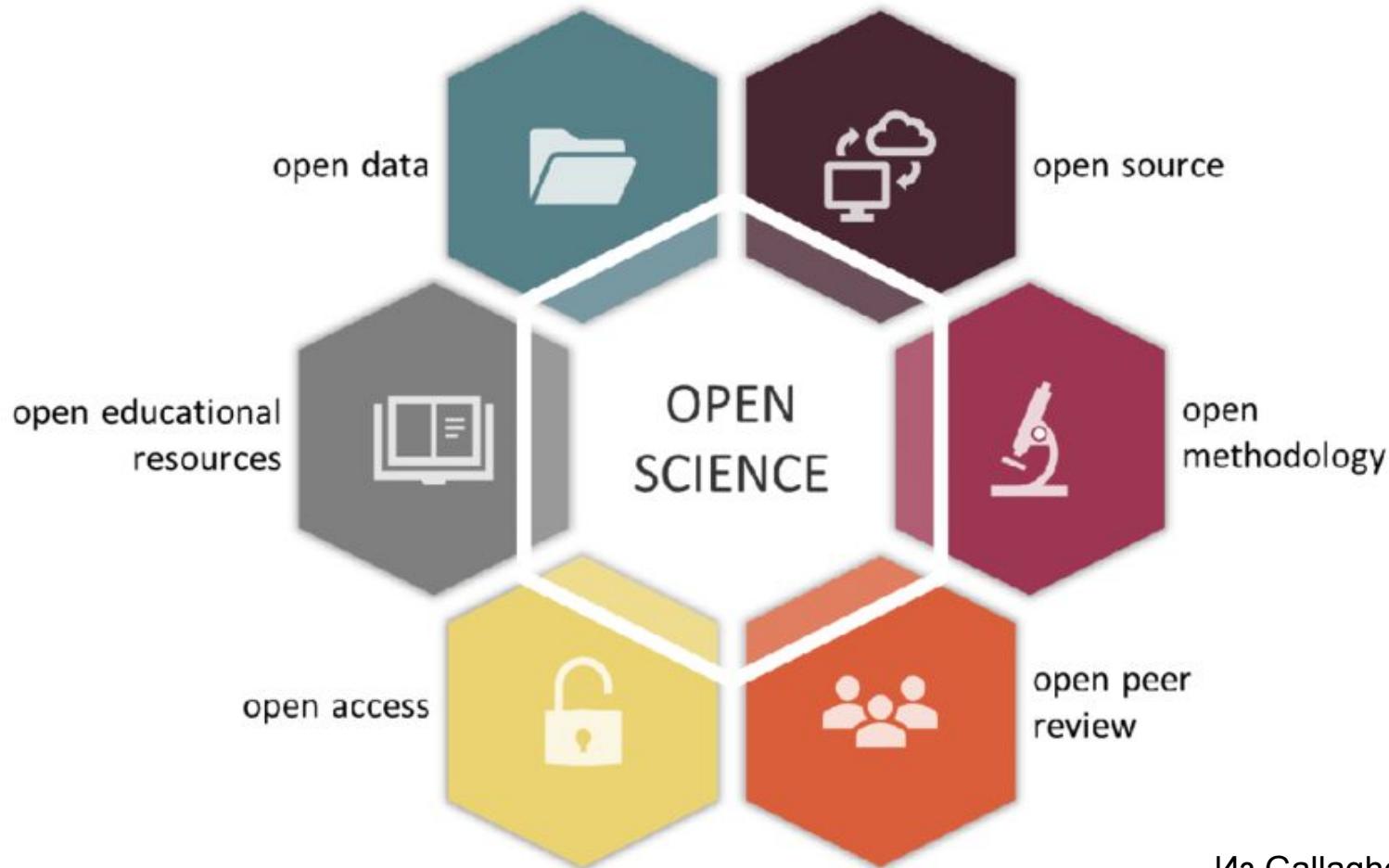


The image shows the homepage of the UNESCO Natural Sciences Open Science website. The header features the UNESCO logo and navigation links for Newsroom, Explore UNESCO, English, Our Expertise, Our Impact, Ideas & Data, Get Involved, and a search function. Below the header is a world map with various icons representing scientific fields like education, technology, and research. The main title 'Open Science' is prominently displayed in large white letters, with a green 'S' partially visible behind it. Below the title is the subtitle 'Making science more accessible, inclusive and equitable for the benefit of all'. The bottom right corner of the banner has the word 'UNESCO'.

Расширение доступа к научным процессам и результатам может повысить эффективность и продуктивность научных систем за счет сокращения расходов, связанных с дублированием усилий при сборе, создании, передаче и повторном использовании данных и научных материалов, что позволит проводить больше исследований на основе одних и тех же данных.

<https://www.unesco.org/en/natural-sciences/open-science>

UNESCO, [Проект рекомендации по открытой науке](#), Париж 2021



SCIENTIFIC DATA



Amended: Addendum

OPEN

SUBJECT CATEGORIES

- » Research data
- » Publication characteristics

Comment: The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson *et al.**

Received: 10 December 2015

Accepted: 12 February 2016

Published: 15 March 2016

There is an urgent need to improve the infrastructure supporting the reuse of scholarly data. A diverse set of stakeholders—representing academia, industry, funding agencies, and scholarly publishers—have come together to design and jointly endorse a concise and measurable set of principles that we refer to as the FAIR Data Principles. The intent is that these may act as a guideline for those wishing to enhance the reusability of their data holdings. Distinct from peer initiatives that focus on the human scholar, the FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. This Comment is the first formal publication of the FAIR Principles, and includes the rationale behind them, and some exemplar implementations in the community.

Supporting discovery through good data management

Good data management is not a goal in itself, but rather is the key conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the community after the data publication process. Unfortunately, the existing digital ecosystem surrounding scholarly data publication prevents us from extracting maximum benefit from our research investments (e.g., ref. 1). Partially in response to this, science funders, publishers and governmental agencies are beginning to require data management and stewardship plans for data generated in publicly funded experiments. Beyond proper collection, annotation, and archival, data stewardship includes the notion of ‘long-term care’ of valuable digital assets, with the goal that they should be discovered and re-used for downstream investigations, either alone, or in combination with newly generated data. The outcomes from good data management and stewardship, therefore, are high quality digital publications that facilitate and simplify this ongoing process of discovery, evaluation, and reuse in downstream studies. What constitutes ‘good data management’ is, however, largely undefined, and is generally left as a decision for the data or repository owner. Therefore, bringing some clarity around the goals and desiderata of good data management and stewardship, and defining simple guideposts to inform those who publish and/or preserve scholarly data, would be of great utility.

This article describes four foundational principles—Findability, Accessibility, Interoperability, and Reusability—that serve to guide data producers and publishers as they navigate around these obstacles, thereby helping to maximize the added-value gained by contemporary, formal scholarly digital publishing. Importantly, it is our intent that the principles apply not only to ‘data’ in the conventional sense, but also to the algorithms, tools, and workflows that led to that data. All scholarly digital research objects—from data to analytical pipelines—benefit from application of these principles, since all components of the research process must be available to ensure transparency, reproducibility, and reusability.

There are numerous and diverse stakeholders who stand to benefit from overcoming these obstacles: researchers wanting to share, get credit, and reuse each other’s data and interpretations; professional data publishers offering their services; software and tool-builders providing data analysis and processing services such as reusable workflows; funding agencies (private and public) increasingly

Correspondence and requests for materials should be addressed to B.M. (email: barend.mons@dtls.nl).

*A full list of authors and their affiliations appears at the end of the paper.

Универсальная концепция, которая применяется в разных областях науки

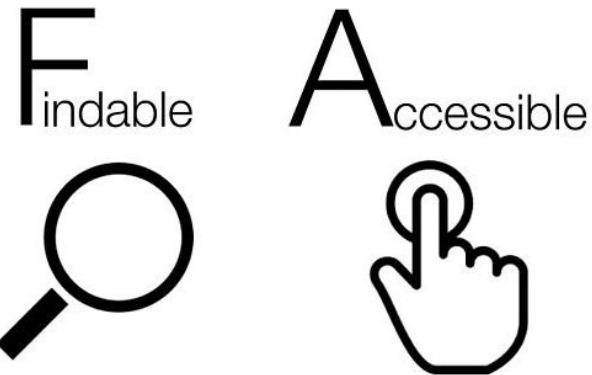
Применение FAIR-концепции в исследованиях одобрено на саммите G20 в Ханчжоу в 2016 году

GO FAIR International Support and Coordination Office (GFISCO) - международный офис поддержки этой инициативы

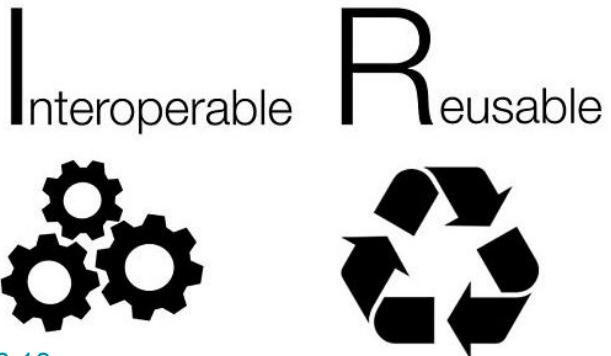
<https://www.nature.com/articles/sdata201618>

FAIR принципы данных

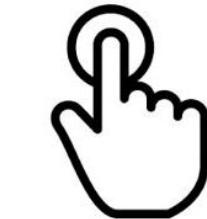
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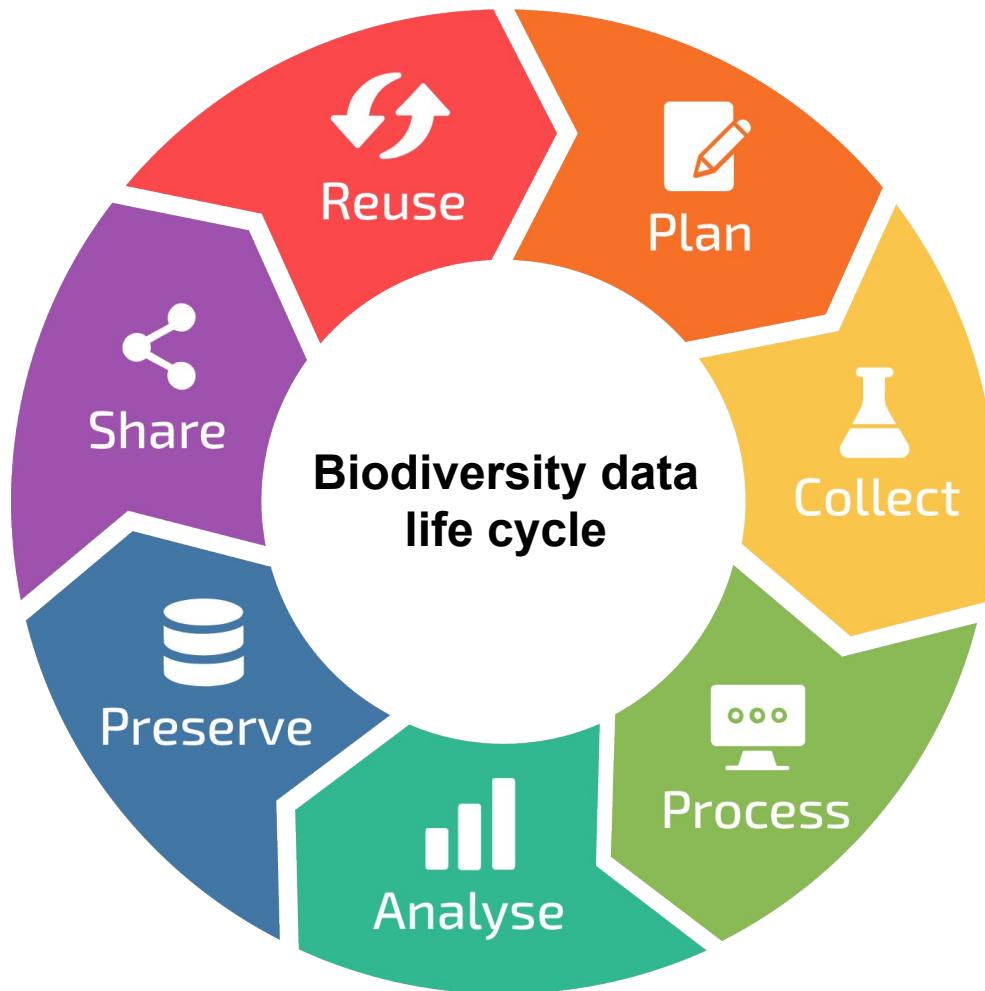


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International Biodiversity Informatics Landscape

Информатика биоразнообразия в мире

Vocabularies & Standards

Biodiversity Information Standards
T D W G



Catalogue of Life

Soft & Data analysis



International Portals



GBIF

Global Biodiversity Information Facility



BOLD SYSTEMS



Citizen science

eBird



Digitization

BHL



DISCO

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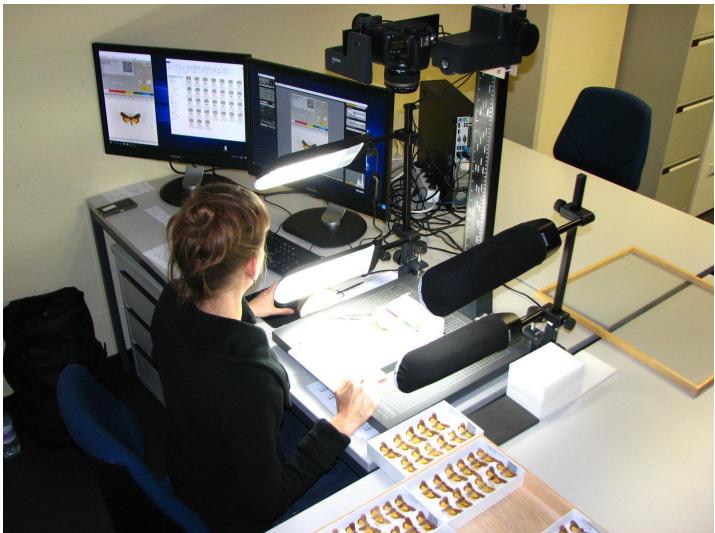


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49,005,850

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**Sharing Collections**

Documentation on data ingestion

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**Proposals**

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**Citizen Scientists**

How can you help biological collections?

Biodiversity Heritage Library

<https://www.biodiversitylibrary.org>



Biodiversity Heritage Library

- Открытый доступ к литературе о биоразнообразии
 - >147000 источников, опубликованных с 1450 по 2022 гг.



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The Biodiversity Heritage Library improves research methodology by collaboratively making biodiversity literature openly available to the world as part of a global biodiversity community.

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ADVANCED SEARCH

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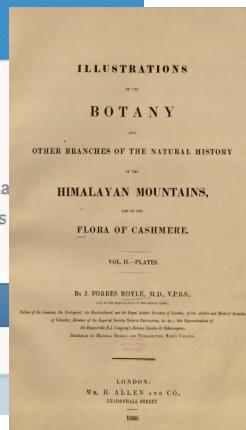
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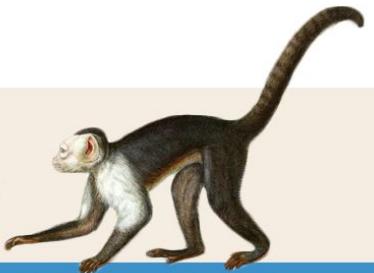


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Details
title: [Notes on the Sand Cat, *Felis margarita* Loche, 1858](#)
... (1,2,3,6) *Felis margarita* thinobia 75,9 – (29) 70,4 (28) *Notes on the Sand Cat, Felis...*
... (2) *Felis nigripes* 0,60 O.Ol (2) *Felis margarita* scheffeli 0,69 O.Ol
... (7) These values
text: [... *Felis margarita* margarita Loche, 1858 1858 *Felis margarita* Loche, Rev. Mag. Zool. 10: 49. ...](#)
text: [... *Felis margarita* scheffeli Hemmer, 1974 1974 *Felis margarita* scheffeli Hemmer, Zschr. ...](#)
text: [... *Felis margarita* harrisoni ssp. n. ...](#)

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GBIF | Global Biodiversity Information Facility

Free and open access to biodiversity data

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About GBIF Kazakhstan

Giraffa camelopardalis subsp. *peralta* Thomas, 1898 observed in Niger by RBT-WAP/GIC-WAP (CC BY-NC 4.0)



2,285,946,277

Occurrence records



83,105

Datasets



1,969

Publishing institutions



8,420

Peer-reviewed papers
using data

<https://www.gbif.org/>



BIS

OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

OBIS OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

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OBIS is a global open-access data and information clearing-house on marine biodiversity for science, conservation and sustainable development



Taxa Search OBIS

55,449,268 OCCURRENCES 2,949 DATASETS 123,894 SPECIES



Находки синего кита из OBIS (17280 записей)

BOLD SYSTEMS

BOLD SYSTEMS

DATABASES IDENTIFICATION TAXONOMY WORKBENCH RESOURCES LOGIN Q

BARCODE OF LIFE DATA SYSTEM v4

Advancing biodiversity science through DNA-based species identification.

EXPLORE THE DATA

BOLD - это облачная платформа для хранения и анализа данных, разработанная в Центре геномики биоразнообразия в Канаде. Он состоит из четырех основных модулей, портала данных, образовательного портала, реестра BIN (предполагаемых видов) и инструмента сбора и анализа данных.



DATA PORTAL

A data retrieval interface that allows for searching over 1.7M public records in BOLD using multiple search criteria including, but not limited to, geography, taxonomy, and depository.



EDUCATION PORTAL

A custom platform for educators and students to explore barcode data and contribute novel barcodes to the BOLD database.



BIN DATABASE

A searchable database of Barcode Index Numbers (BINs), sequence clusters that closely approximate species.



WORKBENCH

A data collection and analysis environment that supports the assembly and validation of DNA barcodes and other sequences.



Citizen science

Привлечение волонтеров к сбору научных данных под руководством профессиональных исследователей

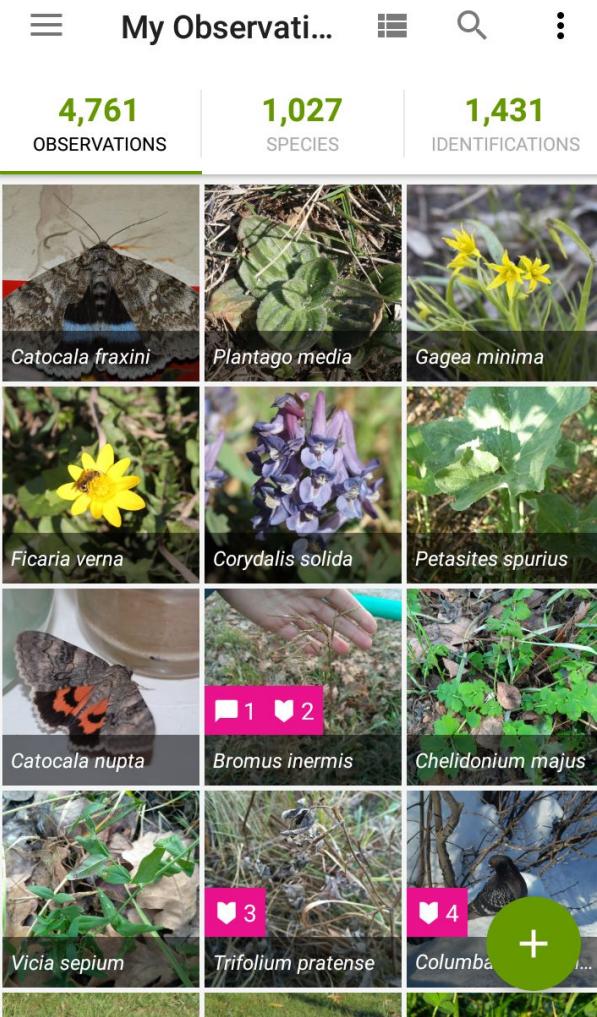
Подробнее: https://en.wikipedia.org/wiki/Citizen_science



Объем данных, собираемых через системы любительских наблюдений, в мире возрастает существенно быстрее по сравнению с «научными» источниками

Для данных, доступных через GBIF

- EOD – eBird Observation Dataset
> 1 млрд наблюдений
- Observation.org > 58 млн наблюдений
- iNaturalist Research-grade Observations
> 52 наблюдений



Мобильное приложение iNaturalist

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Photos / Sounds	Species / Taxon Name	Date observed	Place	Date Added	Actions
	<i>Taraxacum officinale</i> Common Dandelion	May 16, 2020 10:04 AM MSK	8, Pushchino, Moskovskaya oblast, Russia, 14290 (Google, OSM)	May 16, 2020 10:53 AM MSK	1 ID Research Grade Edit View
	<i>Taraxacum officinale</i> Common Dandelion	May 16, 2020 09:54 AM MSK	Mkrn. D., Pushchino, Moscow Oblast, Russia, 14290 (Google, OSM)	May 16, 2020 10:52 AM MSK	1 ID Research Grade Edit View
	<i>Artemisia vulgaris</i> Common Mugwort	May 16, 2020 09:52 AM MSK	Mkrn. D., Pushchino, Moscow Oblast, Russia, 14290 (Google, OSM)	May 16, 2020 10:47 AM MSK	1 ID Research Grade Edit View
	<i>Chelidonium majus</i> Greater Celandine	May 16, 2020 09:51 AM MSK	Mkrn. D., Pushchino, Moscow Oblast, Russia, 14290 (Google, OSM)	May 16, 2020 10:47 AM MSK	1 ID Research Grade Edit View
	<i>Lamium album</i> White Deadnettle	May 16, 2020 09:51 AM MSK	Mkrn. D., Pushchino, Moscow Oblast, Russia, 14290 (Google, OSM)	May 16, 2020 10:46 AM MSK	2 IDs Research Grade Edit View

Карта Спутник

Прииско-террасный государственный природный заповедник

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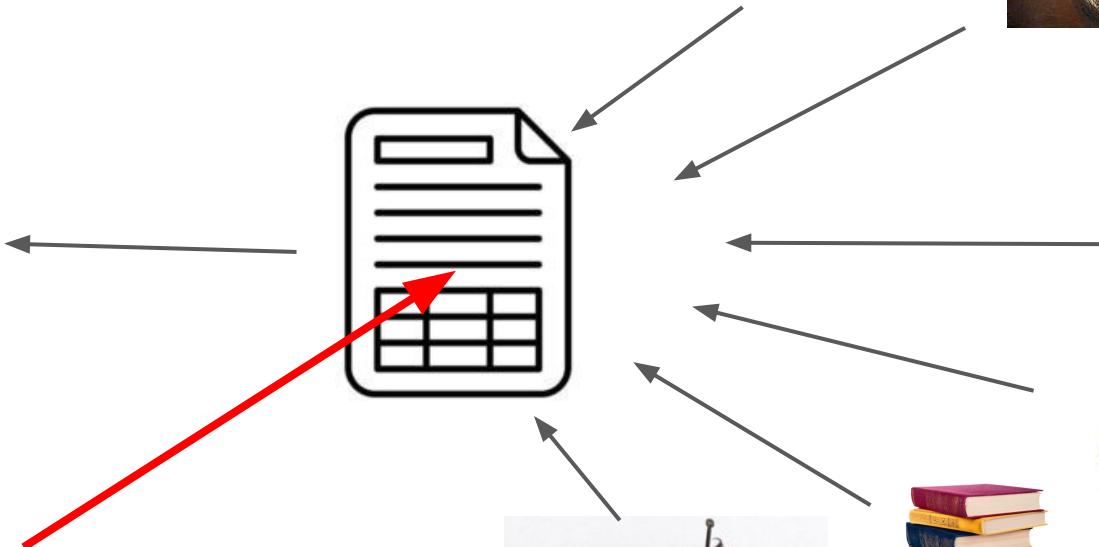
Большое

Google Картографические данные Условия использования

Redo search in map area

Версия, доступная через браузер
www.inaturalist.org/home

Как объединить разные данные?



Правила (стандарты)



Biodiversity Information Standards (TDWG)

We are a non-profit organization and a community dedicated to developing biodiversity information standards.

Image by Jennifer Lahuperisa-Andresen

Historically known as the Taxonomic Databases Working Group, today's Biodiversity Information Standards (TDWG) is a not-for-profit, scientific and educational association formed to establish international collaboration among the creators, managers and users of biodiversity information and to promote the wider and more effective dissemination and sharing of knowledge about the world's heritage of biological organisms.

To achieve its goals, TDWG:

- Develops, ratifies and promotes standards and guidelines for the recording and exchange of data about organisms
- Acts as a forum for discussing all aspects of biodiversity information management through meetings, online discussions, and publications

See the [About](#) section to learn how TDWG operates and how you can participate. Active Interest Groups are described under [Community](#).



Biodiversity
Information
Standards
TDWG

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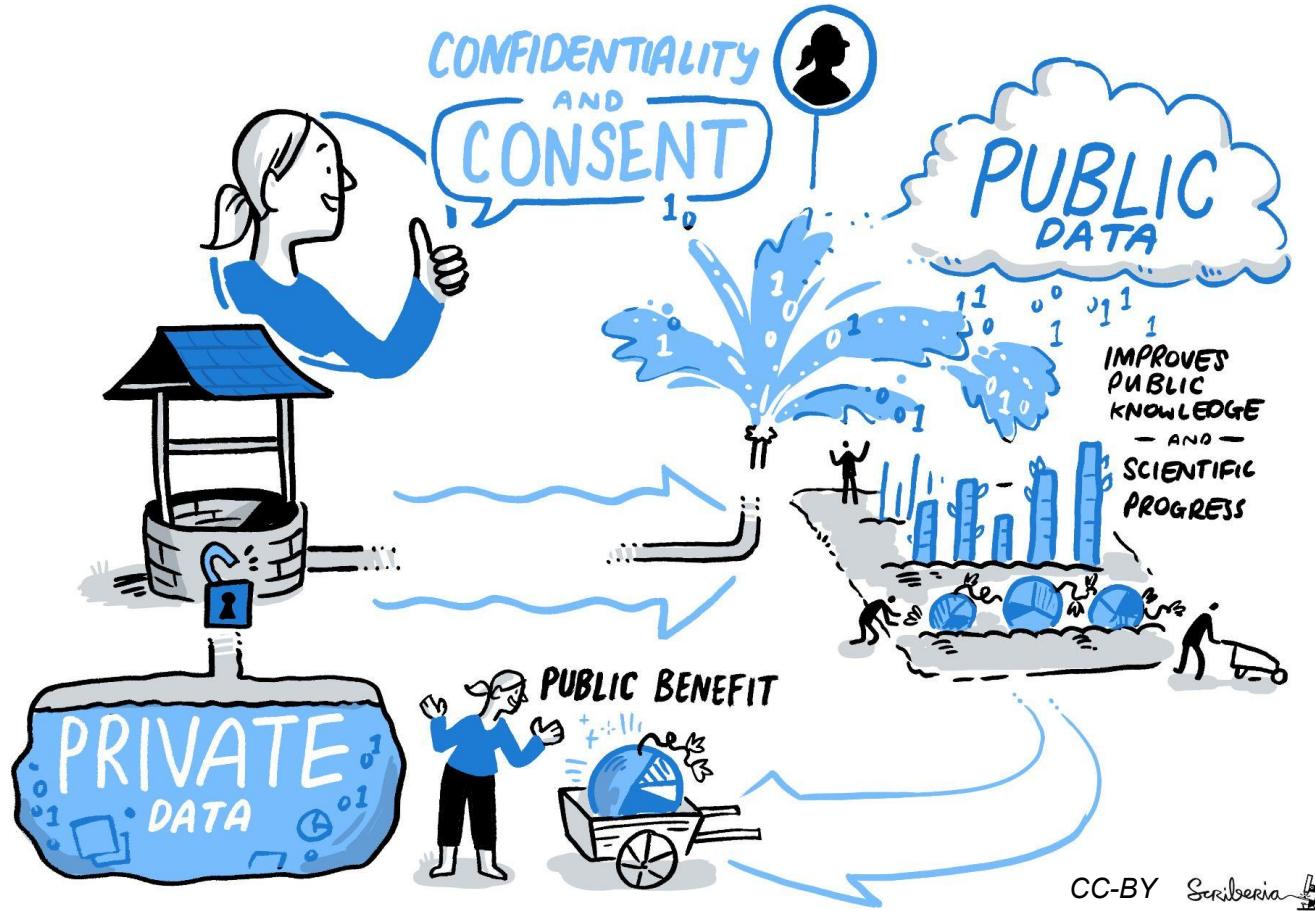
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TDWG 2023 will be held in Hobart, Tasmania, Australia, **9-13 October**. Save the date!

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	Исследовательская статья Research paper	Статья о данных Data paper
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РАЗДЕЛЫ	Введение Материалы и методы Результаты Обсуждение Заключение	Введение Материалы и методы Описание данных
РЕЦЕНЗИРОВАНИЕ	Рецензирование текста рукописи	Аудит данных Рецензирование текста рукописи

В чем польза статей о данных*

- Регистрация приоритета и авторства данных в общепринятой научной публикации в журнале
- Публикация и цитирования статьи о данных дает авторам те же бонусы, что и публикация исследовательской статьи
- Возможность отслеживать использование и цитирование опубликованных данных
- Метаданные, опубликованные в виде статьи о данных хранятся и архивируются различными способами, что обеспечивает стабильно доступное через Интернет описание соответствующего набора первичных данных

*Chavan & Penev, 2011 <https://doi.org/10.1186/1471-2105-12-S15-S2>

Примеры журналов, публикующих статьи о данных*

Журнал	Издательство	Стоимость публикации	Импакт-фактор
Biodiversity Data Journal**	Pensoft	EUR 650	1.54
Scientific Data	Nature Publishing Group	EUR 1790	8.501
Taxon	IAPT	EUR 1800	2.586
Diversity	MDPI	CHF 2000	3.029
GigaScience	Oxford University Press	EUR 1089	7.658
Earth System Science Data	Copernicus GmbH	0	11.815

*полный список см. <https://www.gbif.org/data-papers>

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Q3

Scopus® Scopus CiteScore 2021: 1.8

Q2

CiteScoreTracker 2022: 1.9 (updated monthly)

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Biota of Northern Eurasia

Edited by Dmitry Schigel

In collaboration with the Finnish Biodiversity Information Facility (FinBIF) and Pensoft Publishers, GBIF has announced a call for authors to submit and publish data papers on Northern Eurasia in a special collection of *Biodiversity Data Journal* (BDJ).

In correspondence with the funding priorities of this programme, at least 80% of the records in a dataset should have coordinates that fall within the priority area of Northern Eurasia, defined as Russia, Ukraine, Belarus, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan, Moldova, Georgia, Armenia and Azerbaijan.

See [full description](#) of the call and additional resources.

doi [10.3897/BDJ.10.e95910](https://doi.org/10.3897/BDJ.10.e95910)

Endemic vascular plants in the Ukrainian Carpathians

Andriy Novikov, Mariia Sup-Novikova

Abstract

Background

This dynamic dataset aims to gather all available data, extracted mostly from the preserved material deposited at the leading Ukrainian herbaria, on the distribution of the endemic vascular plants in the Ukrainian Carpathians and adjacent territories. This dataset is created in the framework of mapping the distribution of the endemic plants and is aimed to unveil the patterns of their spatial distribution, ecological preferences and temporal trends in the flora of the Ukrainian Carpathians. A total of 76 species and subspecies of vascular plants belonging to 49 genera and 27 families are reported herein to occur in the Ukrainian Carpathians and close regions. Amongst the total number of reported 6,427 occurrence records, 1,961 records are georeferenced and supported with a translation of Cyrillic information into English. The remaining occurrence records will be georeferenced and translated into English in the near future, as well as the dataset being completed with new records obtained from the new sources.

[doi: 10.3897/BDJ.10.e95910](https://doi.org/10.3897/BDJ.10.e95910)

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doi [10.3897/BDJ.10.e95910](https://doi.org/10.3897/BDJ.10.e95910)

The dataset of bat (Mammalia, Chiroptera) occurrences in Ukraine collected by the Ukrainian Bat Rehabilitation Center (2011-2022)



Alona Prylutska, Maryna Yerofeieva, Valeria Bohodist, Alona Shulenko, Anzhela But, Ksenia Kravchenko, Oleh Prylutskyi, Anton Vlaschenko

10.3897/BDJ.11.e99243 07-03-2023

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Data Paper

Biodiversity surveys of grassland and coastal habitats in 2021 as a documentation of pre-war status in southern Ukraine

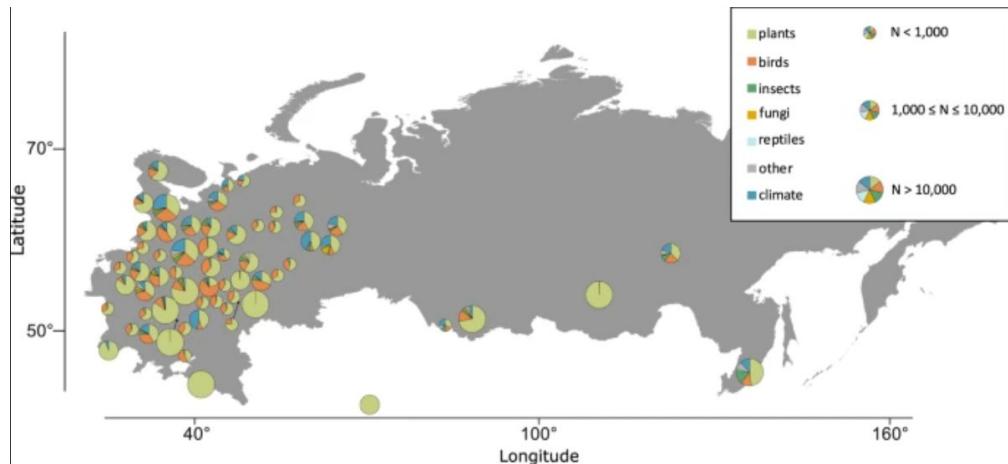


Nadiia Skobel, Dariia Borovyk, Denys Vynokurov, Ivan Moysienko, Andriy Babetskiy, Iryna Bednarska, Olesia Bezsmertna, Olha Chusova, Polina Dayneko, Jürgen Dengler, Riccardo Guarino, Kateryna Kalashnik, Alexander

My tasks

Contacts

Данные, оцифрованные по проекту “Летопись природы Евразии”



506186 фенологических
наблюдений
из **471** заповедника,
расположенных в России,
Украине, Узбекистане,
Беларуси и Кыргызстане
(Ovaskainen et al., 2020).

Chronicles of nature calendar, a long-term and large-scale multitanon database on phenology

Otso Ovaskainen¹, Evgeniy Mekve¹, Coono Lo¹, Gleb Tikhonov¹, Maria del Mar Delgado¹, Tomes Roslin¹, Eliezer Gurarie², Marina Abadonova³, Ozbudak Abduraimov⁴, Oleg Adrianov⁵, Tatiana Akimova⁶, Muzhijit Akkiv⁷, Aleksandr Ananin⁸, Elena Andreeva⁹, Natalia Andryushuk¹⁰, Maxim Antipin¹¹, Konstantin Arzamashev¹², Svetlana Babina¹³, Miroslav Babushkin¹⁴, Oleg Bakin¹⁵, Anna Barabancova¹⁶, Irina Basulskaja¹⁷, Nina Belova¹⁸, Natalia Belyaeva¹⁹, Tatjana Bespalova²⁰, Evgeniya Bitikova²¹, Anatoly Bobretsov²², Vladimir Bobrov²³, Vadim Bobrovskiy²⁴, Elena Bochkareva²⁵, Gennady Bozdonov²⁶, Vladimir Bolshakov²⁷, Svetlana Bondarchuk²⁸, Evgeniya Bukharova²⁹, Alena Buturina³⁰, Yuri Bykov³¹, Anna Byulova³², Elena Chakhireva³³, Oleg Chashchina³⁴, Nadezhda Cherenkova³⁵, Sergej Chigizakov³⁶, Svetlana Chuhontseva³⁷, Evgenij A. Davydov³⁸, Viktor Demchenko³⁹, Elena Diadiuchko⁴⁰, Aleksandr Dobrolyubov⁴¹, Ludmila Dostoyevskaya⁴², Svetlana Dronina⁴³, Zoya Drozdova⁴⁴, Akyntay Dubanayev⁴⁵, Yury Dubrovskiy⁴⁶, Sergey Elisukov⁴⁷, Lidia Epova⁴⁸, Oleg S. Ermakova⁴⁹, Oleg Ermakova⁵⁰, Aleksandra Esengulova⁵¹, Oleg Evstigneev⁵², Irina Fedchenko⁵³, Violetta Fedotova⁵⁴, Tatjana Filatova⁵⁵, Sergey Gashev⁵⁶, Anatoliy Gavrilov⁵⁷, Irina Gavrilova⁵⁸, Dmitrii Golovcov⁵⁹, Nadezhda Goncharova⁶⁰, Elena Gorbanova⁶¹, Tatjana Gordeeva⁶², Vitaly Grishchenko⁶³, Ludmila Gromyko⁶⁴, Vladimir Hohryakov⁶⁵, Alexander Hritankov⁶⁶, Elena Iognatenko⁶⁷, Svetlana Igoshova⁶⁸, Ulja Ivanova⁶⁹, Natalya Ivanova⁷⁰, Yury Kalinin⁷¹, Evgenij Keygorodov⁷², Fedor Kazarstko⁷³, Darya Kiseleva⁷⁴, Anastasia Knorre⁷⁵, Leonid Kolpashikov⁷⁶, Evgenii Korobov⁷⁷, Helen Korolova⁷⁸, Natalia Korotkikh⁷⁹, Gennadiy Kosenev⁸⁰, Sergey Kosenev⁸¹, Elvira Kotlaglyamova⁸², Evgeny Kozlovsky⁸³, Vladimir Koshechkin⁸⁴, Alla Kozurak⁸⁵, Irina Kozy⁸⁶, Aleksandar Krasnopravtsev⁸⁷, Sergey Krupikov⁸⁸, Oleg Kuberskiy⁸⁹, Aleksey Kudryavtsev⁹⁰, Yelena Kulebyakina⁹¹, Yulia Kulits⁹², Margarita Kupriyanova⁹³, Murad Kurbanbaevayev⁹⁴, Anatolij Kutenkov⁹⁵, Nadezhda Kutenkova⁹⁶, Nadezhda Kuyantseva⁹⁷, Andrey Kuznetsov⁹⁸, Evgenij Larin⁹⁹, Pavel Lebedev¹⁰⁰, Kirill Litvinov¹⁰¹, Natalia Lurkzova¹⁰², Azzizbek Mahmudov¹⁰³, Lidija Makovskina¹⁰⁴, Viktor Mamontov¹⁰⁵, Svetlana Mayorova¹⁰⁶, Irina Megalinskaja¹⁰⁷, Artur Meydus¹⁰⁸, Aleksandr Minin¹⁰⁹, Oleg Mitrofanov¹¹⁰, Mykhailo Motruk¹¹¹, Aleksandr Myaslenkov¹¹², Nina Nasonova¹¹³, Natalia Nemtseva¹¹⁴, Irina Nesterova¹¹⁵, Tamara Nezdol¹¹⁶, Tatjana Nirode¹¹⁷, Tatjana Novikova¹¹⁸, Darja Panicheva¹¹⁹, Alexey Pavlov¹²⁰, Klara Pavlova¹²¹, Polina Petrenko¹²², Sergei Podolski¹²³, Natalja Polikarpova¹²⁴, Tatjana Polivanska¹²⁵, Igor Pospelov¹²⁶, Elena Pospelova¹²⁷, Ilya Prokhorov¹²⁸, Irina Prokoshova¹²⁹, Lyudmila Puchkina¹³⁰, Ivan Putrashvili¹³¹, Julia Raiskova¹³², Yury Rozhkov¹³³, Oleg Rozhkov¹³⁴, Marina Rudenko¹³⁵, Irina Rybnikova¹³⁶, Svetlana Rykova¹³⁷, Miroslava Sahevich¹³⁸, Alexander Samoylov¹³⁹, Valeri Sanko¹⁴⁰, Irina Sapelenkova¹⁴¹, Sergo Sezonov¹⁴², Zoya Selivyrn¹⁴³, Ksenia Shalacheva¹⁴⁴, Maksim Shashkov¹⁴⁵, Anatolij Shcherbakov¹⁴⁶, Vasilij Shevchuk¹⁴⁷, Sergej Shubin¹⁴⁸, Elena Shukskaja¹⁴⁹, Rustam Sibgatullin¹⁵⁰, Natalia Sikkila¹⁵¹, Elena Sitsikova¹⁵², Andrej Sivkov¹⁵³, Natalija Skol¹⁵⁴, Svetlana Skorokhodova¹⁵⁵, Elena Smirnova¹⁵⁶, Galina Sokolova¹⁵⁷, Vladimir Sopin¹⁵⁸, Jurij Soosavski¹⁵⁹, Sergei Stepanov¹⁶⁰, Vitalij Stratij¹⁶¹, Violetta Strelakova¹⁶², Aleksander Sukhov¹⁶³, Gulyaia Suleymanova¹⁶⁴, Lilia Sultangareeva¹⁶⁵, Viktorija Telepanova¹⁶⁶, Viktor Teplov¹⁶⁷, Valentina Teplova¹⁶⁸, Tatjana Terlitsa¹⁶⁹, Vladislav Timoshkin¹⁷⁰, Dmitry Tirsik¹⁷¹, Andrej Tolmachev¹⁷², Aleksey Tomilin¹⁷³, Ludmila Tselsilcheva¹⁷⁴, Mirabdulla Turgunov¹⁷⁵, Yury Tyulik¹⁷⁶, Van Vladimir¹⁷⁷, Elena Vargot¹⁷⁸, Aleksander Vasin¹⁷⁹, Aleksandra Vasin¹⁸⁰, Anatolij Vekliuk¹⁸¹, Lidia Vetchinnikova¹⁸², Vladislav Vinogradov¹⁸³, Nikolay Volodchenkov¹⁸⁴, Irina Voloshina¹⁸⁵, Tura Xoliqu¹⁸⁶, Eugenia Yelisovska¹⁸⁷, Grishchenko¹⁸⁸, Vladimir Yakovlev¹⁸⁹, Marina Yakovleva¹⁹⁰, Oksana Yanystse¹⁹¹, Jurij Yarema¹⁹², Andrey Zahvatov¹⁹³, Valery Zakharov¹⁹⁴, Nikolay Zelenetskiy¹⁹⁵, Anatolij Zhebtukhin¹⁹⁶, Tatjana Zubina¹⁹⁷ & Juri Kurihinen¹⁹⁸

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Chronicles of nature calendar, a long-term and large-scale multitanon database on phenology

Otso Ovaskainen *et al.*¹

We present an extensive, large-scale, long-term and multitanon database on phenological and climatic variation, involving 506,186 observation dates acquired in 471 localities in Russian Federation, Ukraine, Uzbekistan, Belarus and Kyrgyzstan. The data cover the period 1890–2018, with 96% of the data being from 1960 onwards. The database is rich in plants, birds and climatic events, but also includes insects, amphibians, reptiles and fungi. The database includes multiple events per species, such as the onset days of leaf unfolding and leaf fall for plants, and the days for first spring and last autumn occurrences for birds. The data were acquired using standardized methods by permanent staff of national parks and nature reserves (87% of the data) and members of a phenological observation network (13% of the data). The database is valuable for exploring how species respond in their phenology to climate change. Large-scale analyses of spatial variation in phenological response can help to better predict the consequences of species and community responses to climate change.

Background & Summary

Phenological dynamics have been recognised as one of the most reliable bio-indicators of species responses to ongoing warming conditions.¹ Together with other adaptive mechanisms (e.g. changes in the spatial distribution and physiological adaptations), phenological shifts are key mechanisms through which species adapt to a changing environment. Species have communicated their phenological shifts to a greater extent in the last century, whereas autumn events are occurring later than before, mostly due to rising temperatures^{2–4}. Despite this broadly shared response, there are systematic differences in phenological responses to climate change among individual species^{5–8}, different taxonomic groups and trophic levels^{9–11}. Further, while some studies have reported that different species are likely to have evolved distinct phenological responses to environmental cues^{11,12}, others suggest that many species are synchronised because phenotypic plasticity in phenological response to climate may be limited.

Comprehensive understanding of phenological responses to climate change requires community-wide data that are both long-term and spatially extensive^{12,13}. Such data are still not common and, with few exceptions^{13,17,18}, the assessments of broad-scale taxonomic and geographic variation in phenological changes have generally involved meta-analyses^{5–8}, or analyses of large observational databases that either represent individual species or are characterized by low species richness.^{19–21} Thus, the lack of spatial variation in phenological responses of species to community-level climate change is well known^{13,17}. Yet, this information is essential for understanding how species and communities respond to climate change.¹ A further common problem with many previously published data sets is publication bias. Few scientific journals ask to publish papers reporting no detectable signs in species response to climate change – which can result in strongly biased conclusions in meta-analyses (but see^{13,17}). Assembling monitoring data which has been consistently collected over long time and a large spatial extent addresses these potential shortcomings.

We present a large-scale and long-term dataset that can be used to examine community-level spatial variation in phenological dynamics and its climatic drivers. The database consists of 506,186 observation dates collected in 471 localities in the Russian Federation, Ukraine, Uzbekistan, Belarus and Kyrgyzstan (Fig. 1) over a 129-year period (from 1890 to 2018). During this period, researchers intensively conducted regular observations to record dates at which a predefined list of phenological and climatic events (Fig. 2) occurred. Although 96% of

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Материалы для самостоятельного изучения

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