Биоәртүрлілікті зерттеудегі цифрлық технологиялар
Digital technologies in biodiversity research
Цифровые технологии в исследовании биоразнообразия

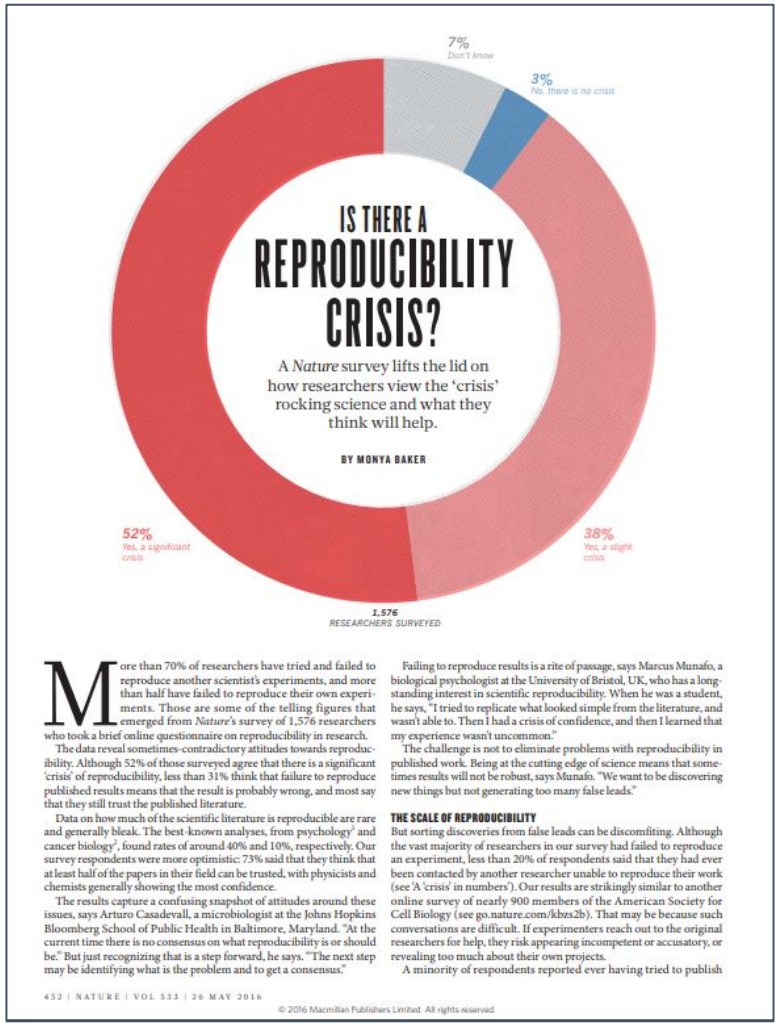
ЛЕКЦИЯ 1

Полевая биология в цифровом мире

Слайды CC BY:
Dag Endresen, GBIF Norway
Артём Созонтов, ИЭРИЖ УрО РАН
Наталья Иванова,
Максим Шашков

Есть ли кризис воспроизводимости научных исследований?

Результаты опроса 1576 исследователей показали, что более 70% исследователей пытались и не смогли воспроизвести эксперименты другого ученого, и более половины не смогли воспроизвести свои собственные эксперименты.



7%
Don't know

3%
No, there is no crisis

IS THERE A
REPRODUCIBILITY
CRISIS?

A *Nature* survey lifts the lid on how researchers view the 'crisis' rocking science and what they think will help.

BY MONYA BAKER

52%
Yes, a significant crisis

38%
Yes, a slight crisis

1,576
RESEARCHERS SURVEYED

More than 70% of researchers have tried and failed to reproduce another scientist's experiments, and more than half have failed to reproduce their own experiments. Those are some of the telling figures that emerged from *Nature*'s survey of 1,576 researchers who took a brief online questionnaire on reproducibility in research.

The data reveal sometimes-contradictory attitudes towards reproducibility. Although 52% of those surveyed agree that there is a significant 'crisis' of reproducibility, less than 31% think that failure to reproduce published results means that the result is probably wrong, and most say that they still trust the published literature.

Data on how much of the scientific literature is reproducible are rare and generally bleak. The best-known analyses, from psychology[1] and cancer biology[2], found rates of around 40% and 10%, respectively. Our survey respondents were more optimistic: 73% said that they think that at least half of the papers in their field can be trusted, with physicists and chemists generally showing the most confidence.

The results capture a confusing snapshot of attitudes around these issues, says Arturo Casadevall, a microbiologist at the Johns Hopkins Bloomberg School of Public Health in Baltimore, Maryland. "At the current time there is no consensus on what reproducibility is or should be." But just recognizing that is a step forward, he says. "The next step may be identifying what is the problem and to get a consensus."

Failing to reproduce results is a rite of passage, says Marcus Munafo, a biological psychologist at the University of Bristol, UK, who has a long-standing interest in scientific reproducibility. When he was a student, he says, "I tried to replicate what looked simple from the literature, and wasn't able to. Then I had a crisis of confidence, and then I learned that my experience wasn't uncommon."

The challenge is not to eliminate problems with reproducibility in published work. Being at the cutting edge of science means that sometimes results will not be robust, says Munafo. "We want to be discovering new things but not generating too many false leads."

THE SCALE OF REPRODUCIBILITY

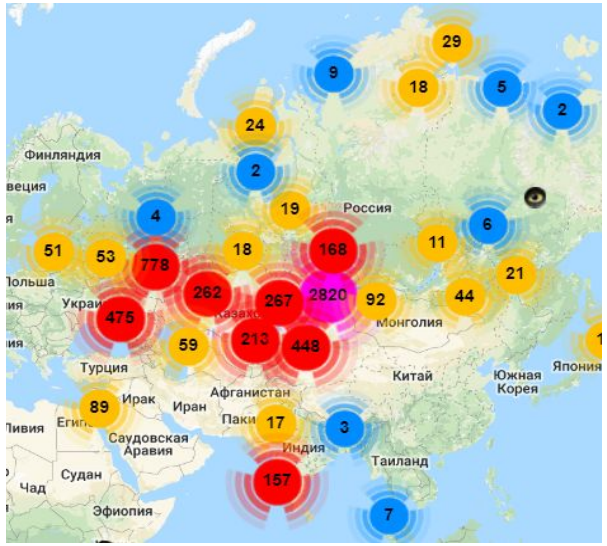
But sorting discoveries from false leads can be discomfiting. Although the vast majority of researchers in our survey had failed to reproduce an experiment, less than 20% of respondents said that they had ever been contacted by another researcher unable to reproduce their work (see 'A 'crisis' in numbers'). Our results are strikingly similar to another online survey of nearly 900 members of the American Society for Cell Biology (see go.nature.com/kbzs2b). That may be because such conversations are difficult. If experimenters reach out to the original researchers for help, they risk appearing incompetent or accusatory, or revealing too much about their own projects.

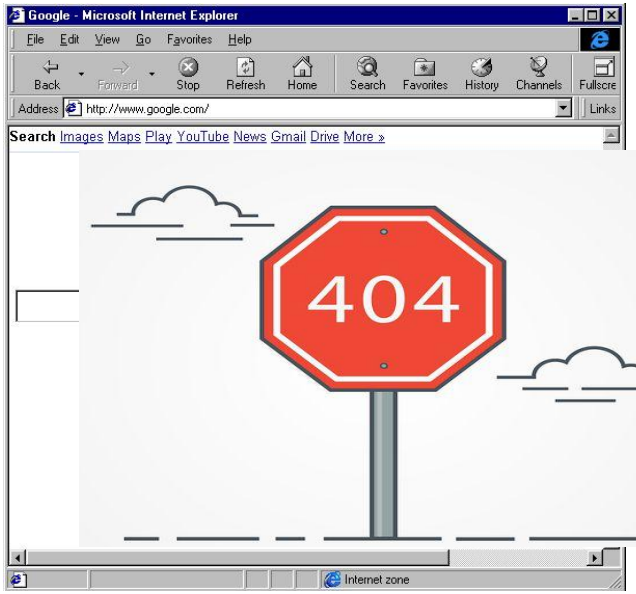
A minority of respondents reported ever having tried to publish

452 | NATURE | VOL 533 | 26 MAY 2016

Baker, M. 1,500 scientists lift the lid on reproducibility. Nature 533, 452–454 (2016). https://doi.org/10.1038/533452a

Полевые данные ценны сами по себе и должны быть доступны для повторного анализа





Biodiversity data

https://www.idigbio.org/

Оцифровка научных биологических коллекций

Making data and images of millions of biological specimens available on the web

iDigBio
Integrated Digitized Biocollections

Digitization
Learn, share and develop best practices

Sharing Collections
Documentation on data ingestion

Working Groups
Join in, contribute, be part of the community

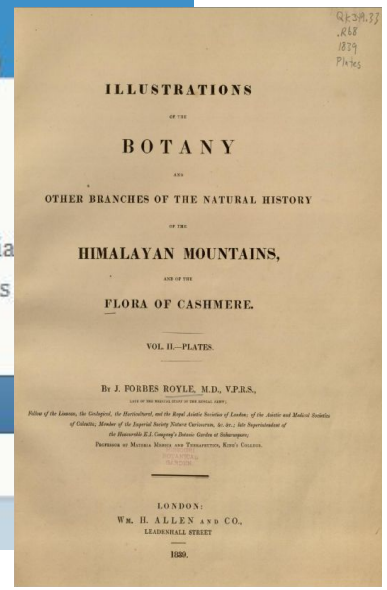
Proposals
New tool and workshop ideas

Citizen Scientists
How can you help biological collections?

Biodiversity Heritage Library

https://www.biodiversitylibrary.org/

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



https://www.biodiversitylibrary.org/page/2913426#page/35/mode/1up

Citizen science

Привлечение волонтеров к сбору научных данных под руководством профессиональных исследователей

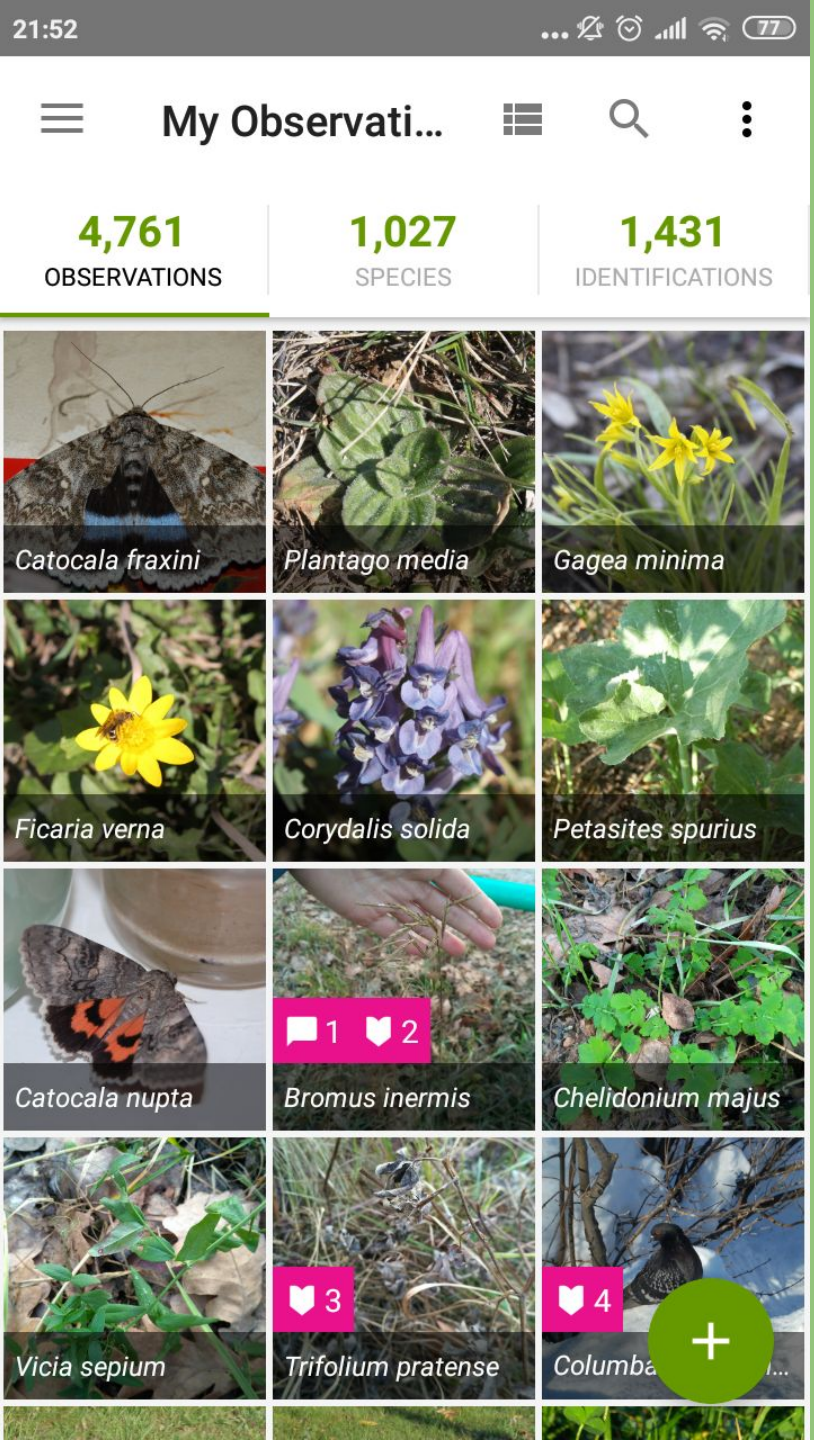
Подробнее: https://en.wikipedia.org/wiki/Citizen_science

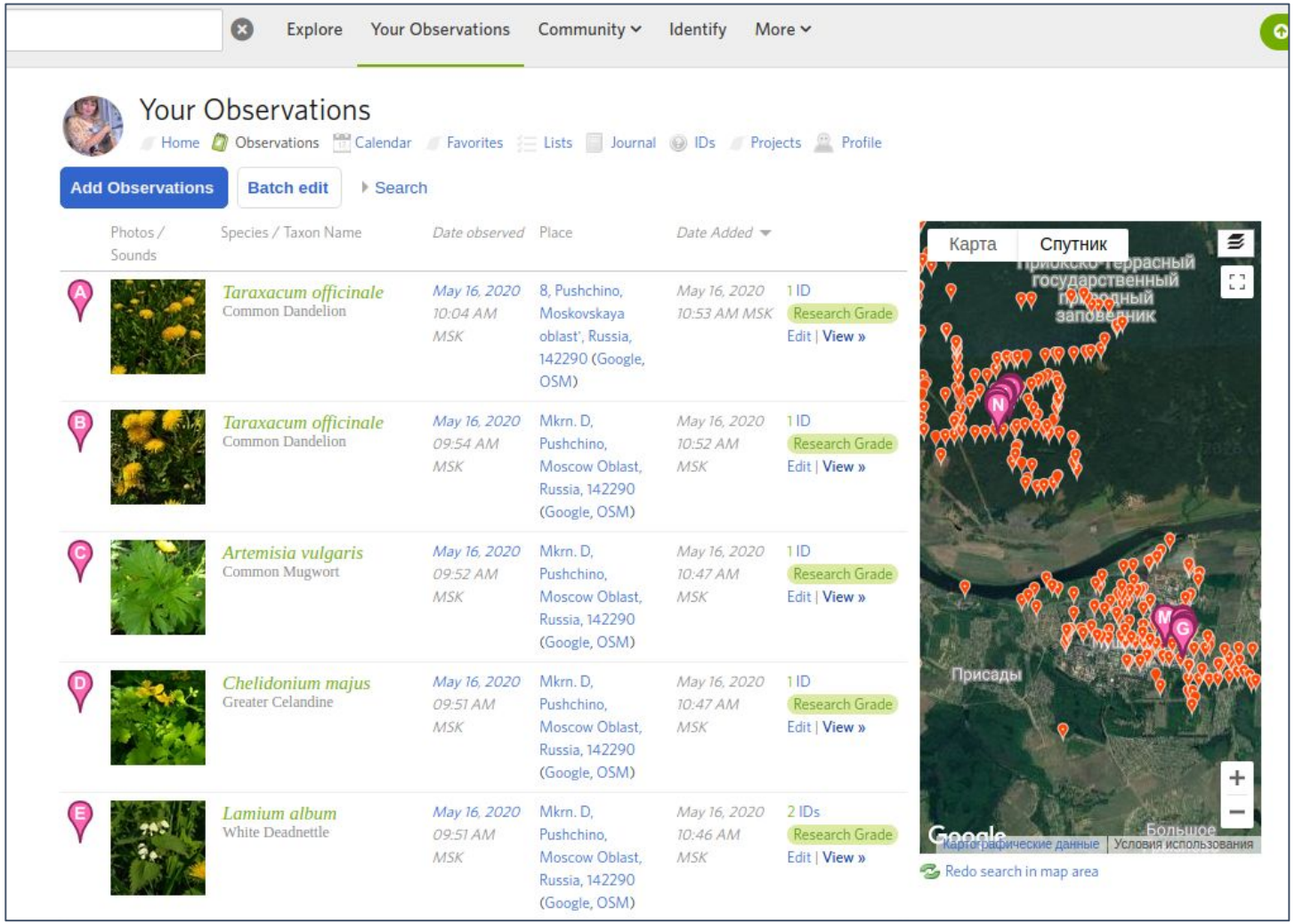
Объем данных, собираемых через системы любительских наблюдений,
в мире возрастает существенно быстрее по сравнению с «научными» источниками

Для данных, доступных через GBIF

- EOD – eBird Observation Dataset
  >1 млрд наблюдений
- Observation.org >58 млн наблюдений
- iNaturalist Research-grade Observations
  >40 млн наблюдений

Мобильное приложение iNaturalist





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

FAIR принципы данных

Данные можно найти в сети Интернет
! идентификаторы !
! метаданные !

Данные должны быть доступны
! бесплатно и в открытом доступе !

Данные должны быть совместимыми с другими подобными массивами данных
! стандарты !

Данные могут быть многократно использованы для решения разных научных и практических задач
! лицензии (правила использования) !

Wilkinson *et al*. 2016 doi:10.1038/sdata.2016.18

Политика научных журналов в отношении исходных данных: обзор издательства

SPRINGER NATURE

Тип 1
Журнал призывает авторов, когда это возможно и целесообразно, размещать данные, подтверждающие результаты их исследований, в общедоступном хранилище.

Тип 2
Журнал настоятельно рекомендует, чтобы все наборы данных, на которые опираются выводы статьи, были доступны для читателей. Авторам рекомендуется предоставить информацию о доступности данных в своей статье.

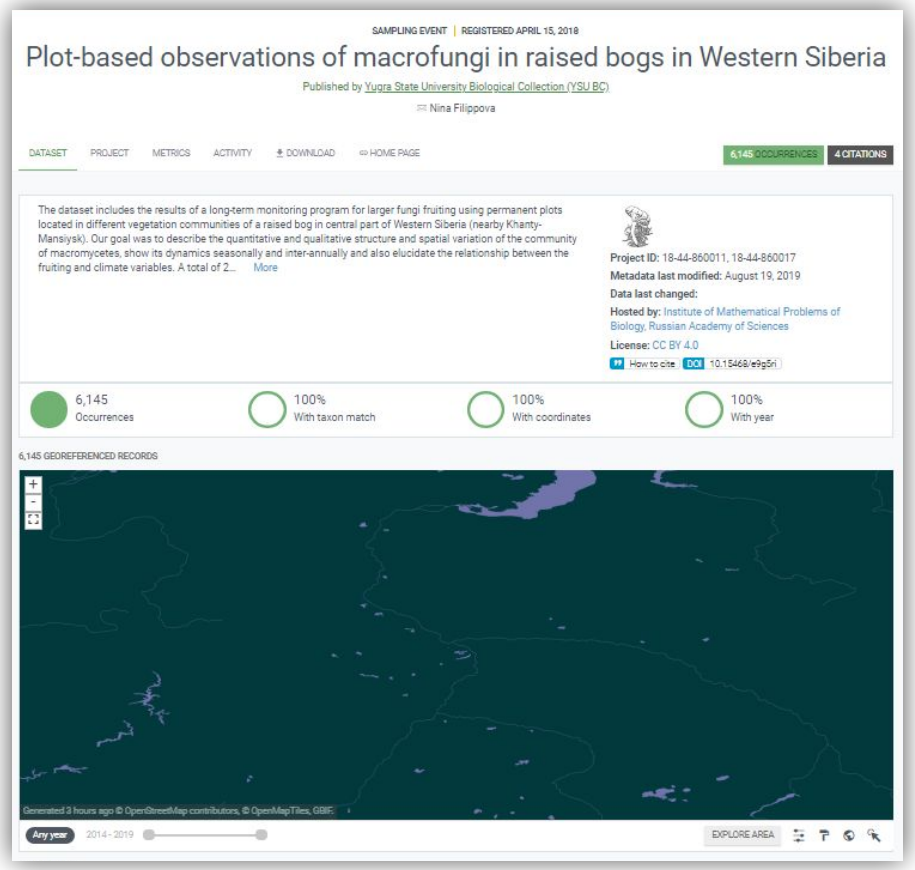
Тип 3
Журнал настоятельно рекомендует, чтобы все наборы данных, на которые опираются выводы статьи, были доступны для читателей. Авторам необходимо предоставить информацию о доступности данных в своей статье.

Тип 4
Журнал требует, чтобы все наборы данных, на которые опираются выводы статьи, были доступны рецензентам и читателям. Авторам необходимо предоставить информацию о доступности данных в своей статье.

Файлы на вашем рабочем компьютере или USB-накопителе возможно содержат ценные знания, которые могут извлечь другие исследователи. https://www.springernature.com/gp/authors/research-data

Data paper Статья о данных

Рецензируемая публикация в научном журнале, содержащая описание набора данных, доступного через Интернет

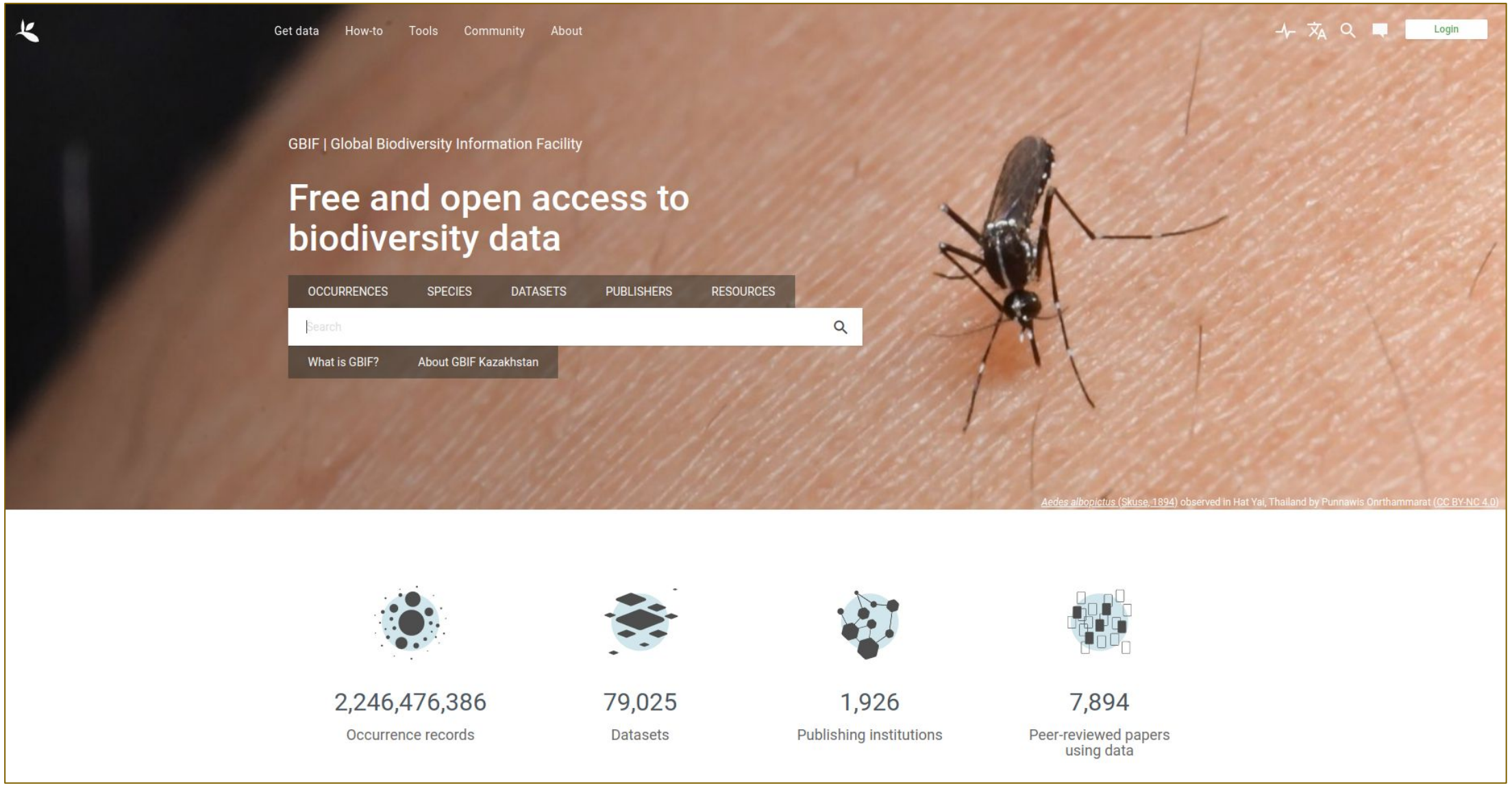


Filippova N., Lapshina E. (2019)
doi: 10.3897/BDJ.7.e35674

	Исследовательская статья **Research paper**	**Статья о данных** **Data paper**
ЦЕЛЬ	Проверка научной гипотезы	Описание первичных полевых данных, приведенных к требуемому формату
РАЗДЕЛЫ	Введение Материалы и методы Результаты Обсуждение Заключение	Введение Материалы и методы Описание данных
РЕЦЕНЗИРОВАНИЕ	Рецензирование текста рукописи	Аудит данных Рецензирование текста рукописи

- Подача рукописей **до 1 декабря**
- Набор данных должен быть опубликован в 2022 году и содержать **> 7 000 записей** о встречах видов
- Территория: Россия, Украина, Беларусь, **Казахстан**, Кыргызстан, Узбекистан, Таджикистан, Туркменистан, Молдова, Грузия, Армения, Азербайджан

https://www.gbif.org/news/B00TTCi85YIy3qNo5KXSM/call-for-data-papers-describing-datasets-from-northern-eurasia-extended

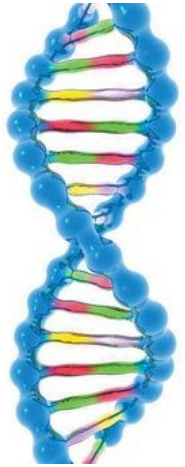


Глобальная Информационная Система о Биоразнообразии GBIF.org

Данные о коллекционных образцах

Данные об окаменелостях

Литературные данные



Биоматериалы

Наблюдения

Данные автоматических регистраторов

Данные площадных и маршрутных учетов

Какие данные доступны через GBIF

Типы наборов данных, доступных через GBIF

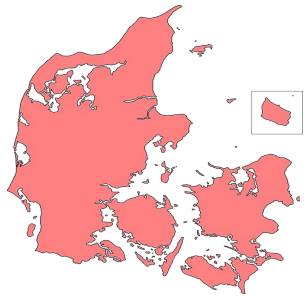
Метаданные (METADATA only)

\+

Таксономический список CHECKLIST

для публикации таксономических данных: списки охраняемых видов, тематические видовые списки и др.

1 строка – 1 таксон



\+

Находки OCCURRENCE DATA

Находка - простое полевое наблюдение или коллекционный образец

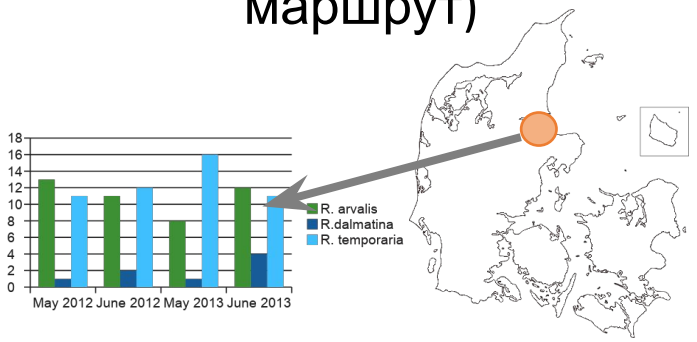
1 строка = 1 особь или 1 группа особей

\+

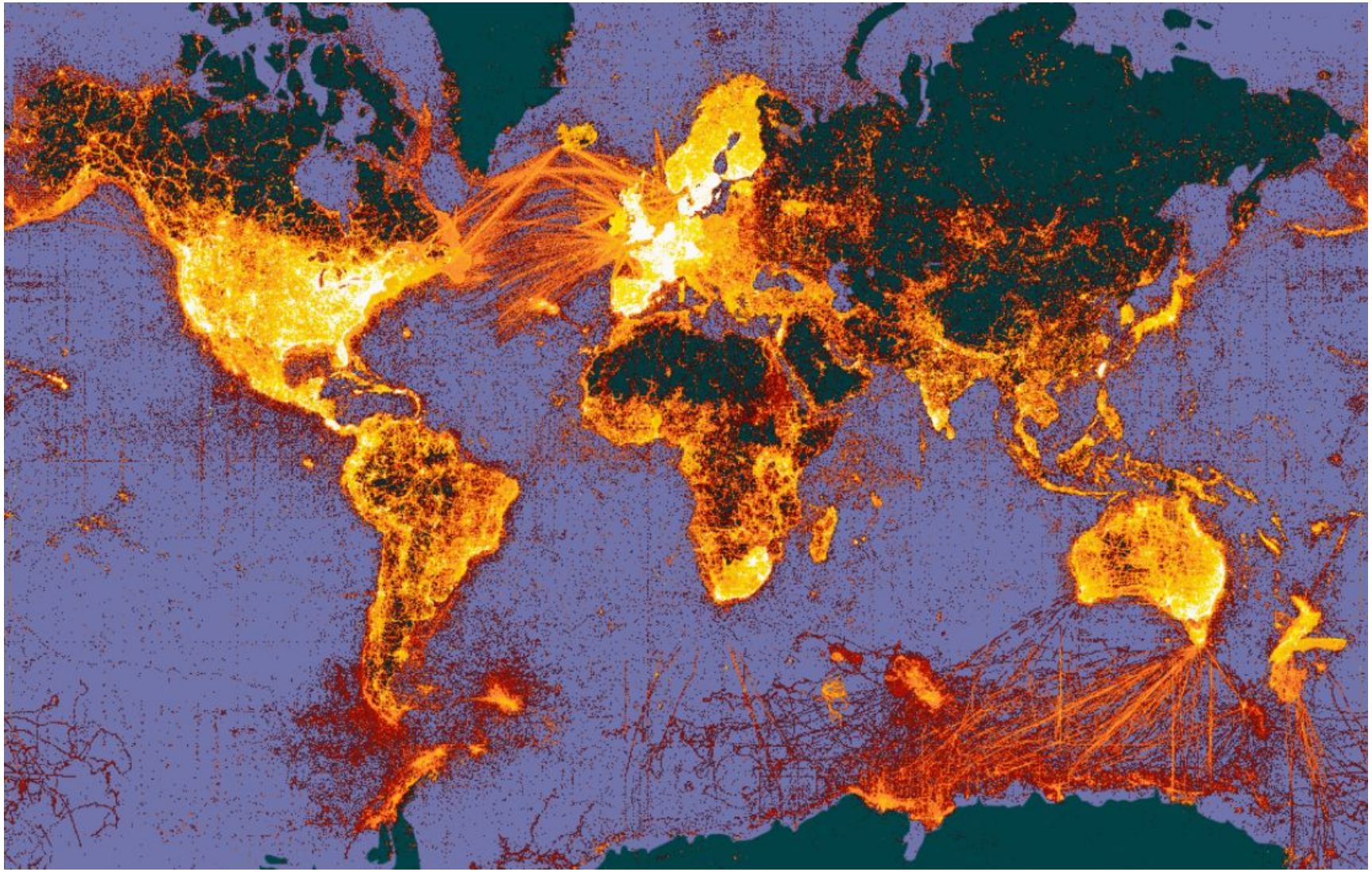
Описания, учеты или сборы SAMPLE EVENT DATA

2 таблицы: данные о сборе + данные о находках

1 запись на листе event = 1 событие (площадка, маршрут)

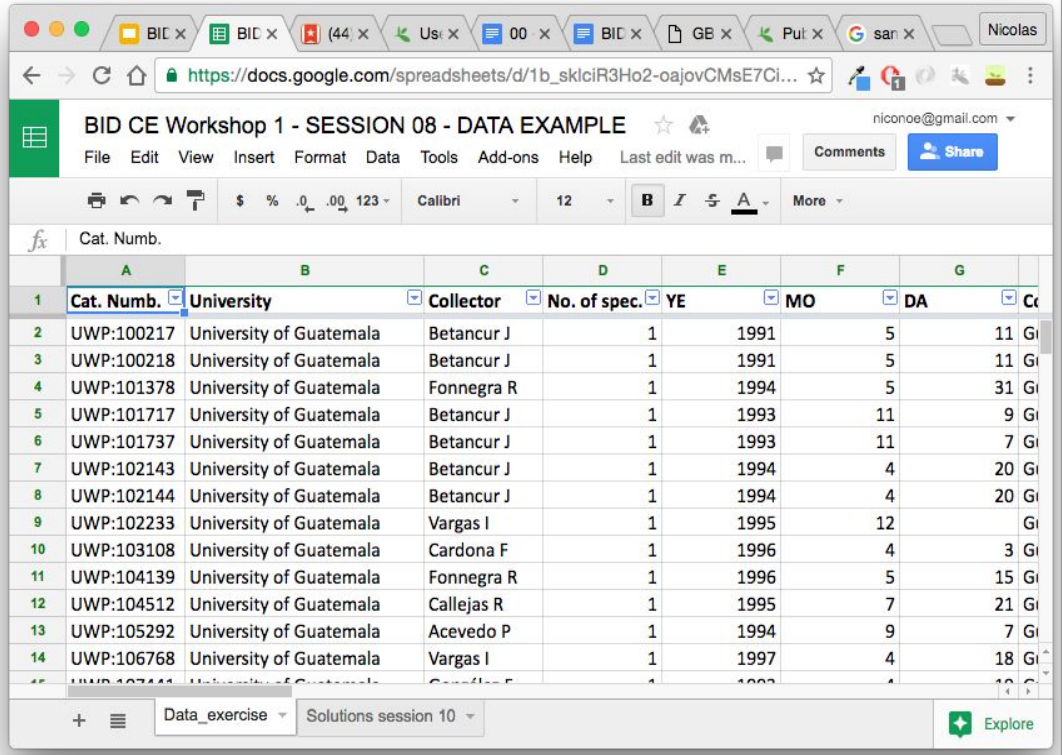


Карта глобального биоразнообразия GBIF

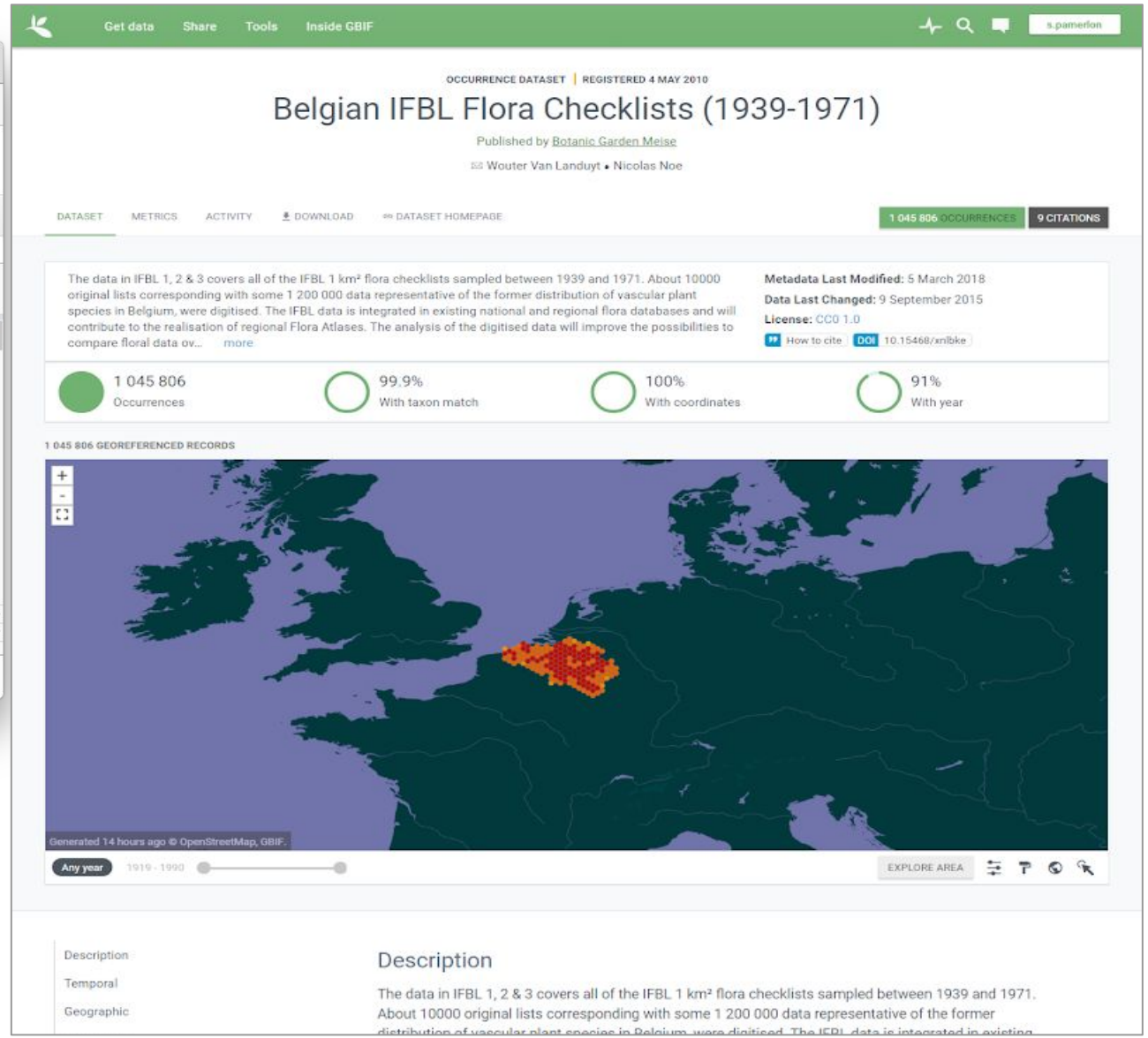


GBIF

Публикация данных в GBIF



Cat. Numb.	University	Collector	No. of spec.	YE	MO	DA
UWP:100217	University of Guatemala	Betancur J	1	1991	5	11
UWP:100218	University of Guatemala	Betancur J	1	1991	5	11
UWP:101378	University of Guatemala	Fonnegra R	1	1994	5	31
UWP:101717	University of Guatemala	Betancur J	1	1993	11	9
UWP:101737	University of Guatemala	Betancur J	1	1993	11	7
UWP:102143	University of Guatemala	Betancur J	1	1994	4	20
UWP:102144	University of Guatemala	Betancur J	1	1994	4	20
UWP:102233	University of Guatemala	Vargas I	1	1995	12	
UWP:103108	University of Guatemala	Cardona F	1	1996	4	3
UWP:104139	University of Guatemala	Fonnegra R	1	1996	5	15
UWP:104512	University of Guatemala	Callejas R	1	1995	7	21
UWP:105292	University of Guatemala	Acevedo P	1	1994	9	7
UWP:106768	University of Guatemala	Vargas I	1	1997	4	18



BioDATA

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PUBLISHER | SINCE AUGUST 8, 2022

Institute of Zoology of the Republic of Kazakhstan

ABOUT METRICS HOME PAGE 110 OCCURRENCES 1 DATASET

Description: Mission: To develop Kazakhstan zoology science from animal world investigations - from Republic of Kazakhstan to around of the globe. Vision: Institute of Zoology RK - leading world class science organization of fundamental and practical zoology. Institute of Zoology RK main directions: Kazakhstan wildlife investigation; animal population dynamics changes from environmental impact studying; studying of evolution, phylogeny, taxonomy diversity of present and past wildlife; ecologicaly valuable zoology problem solving.

Endorsed by: Participant Node Managers Committee

Administrative contact: Roman Jashenko

Country or area: Kazakhstan

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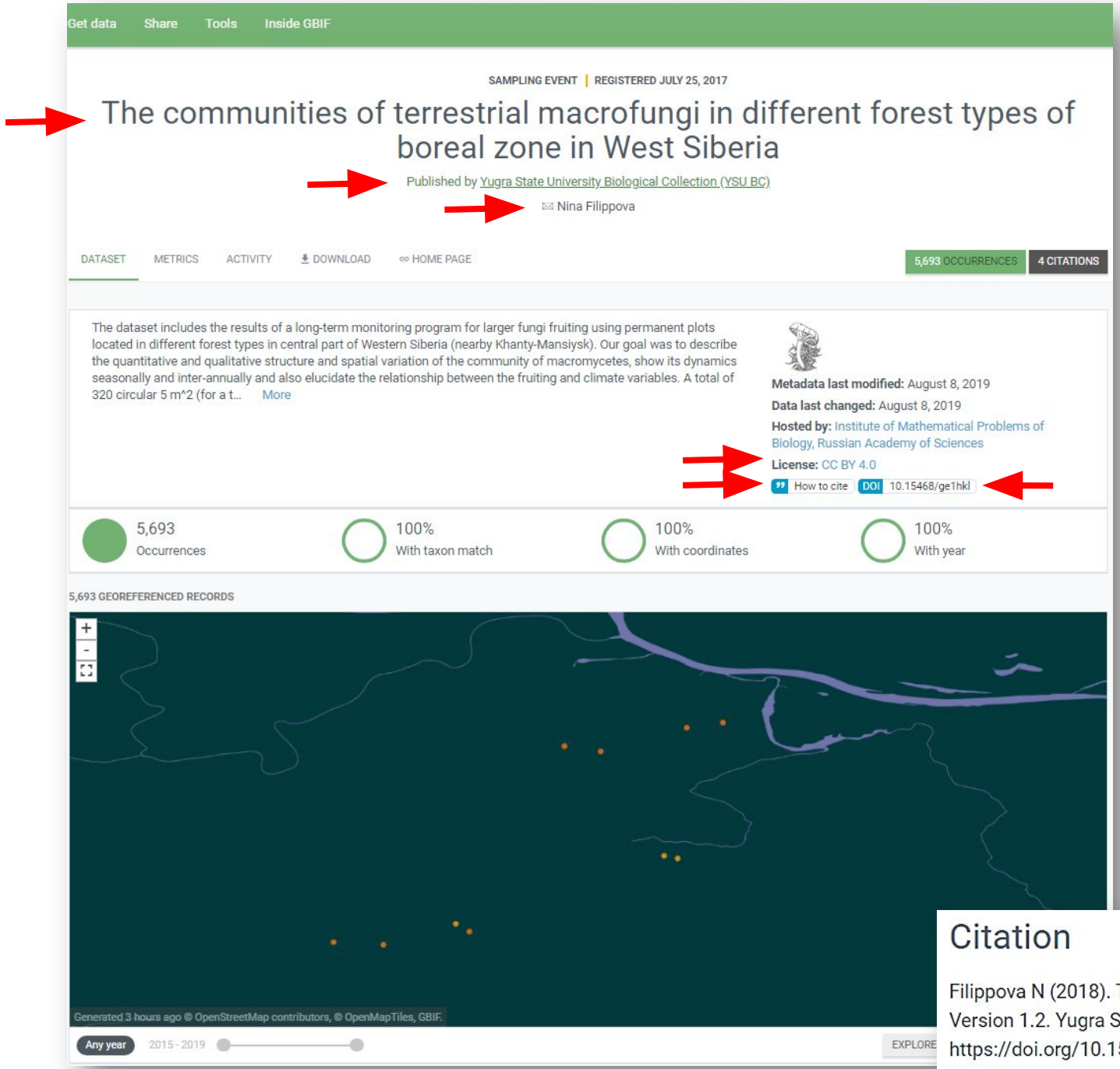
https://www.gbif.org/publisher/0255f116-fd08-4b15-9eb3-2b4e2062a323



Набор данных (dataset), доступный через GBIF

Citation

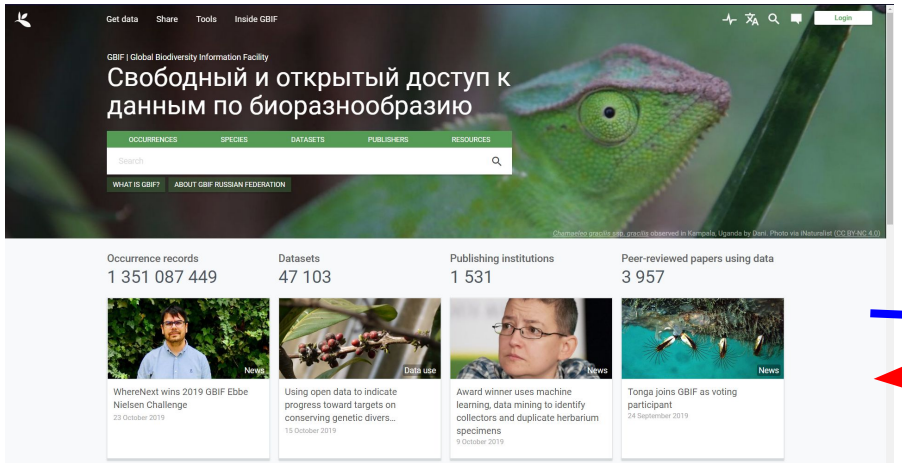
Filippova N (2018). The communities of terrestrial macrofungi in different forest types of boreal zone in West Siberia. Version 1.2. Yugra State University Biological Collection (YSU BC). Sampling event dataset https://doi.org/10.15468/ge1hkl accessed via GBIF.org on 2019-03-22.

Как устроена сеть GBIF

пользователь

данные

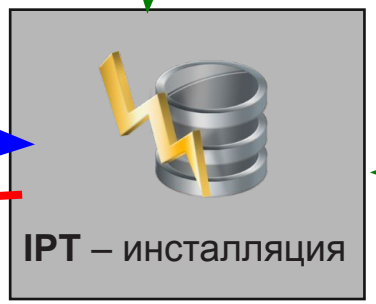
запрос



GBIF Data Publisher

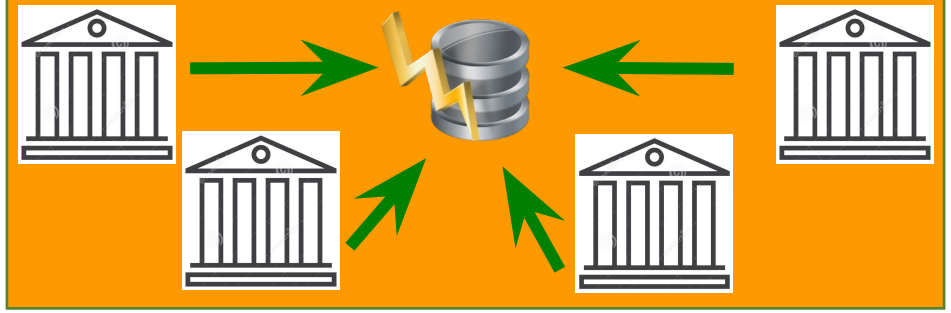
GBIF Data Publisher

GBIF Data Publisher



IPT – инсталляция

Национальный узел GBIF



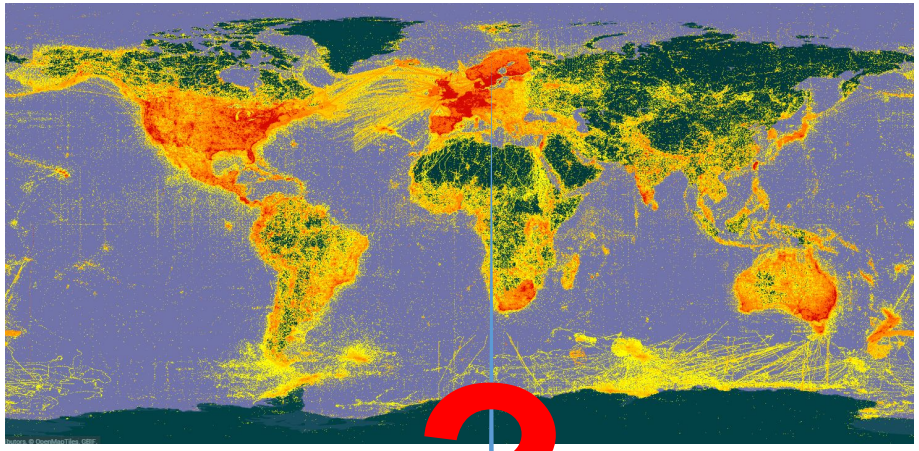
GBIF Data Publisher

Автор

Автор

Автор

Как объединить данные в глобальную систему?



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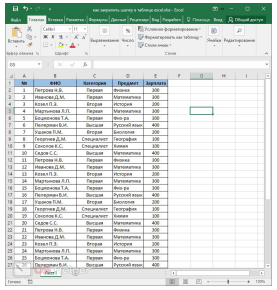
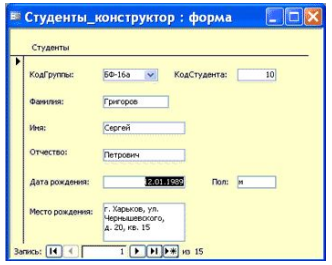
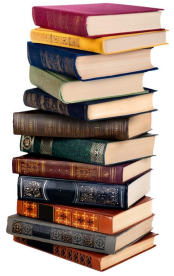
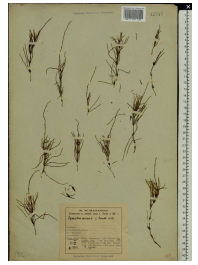


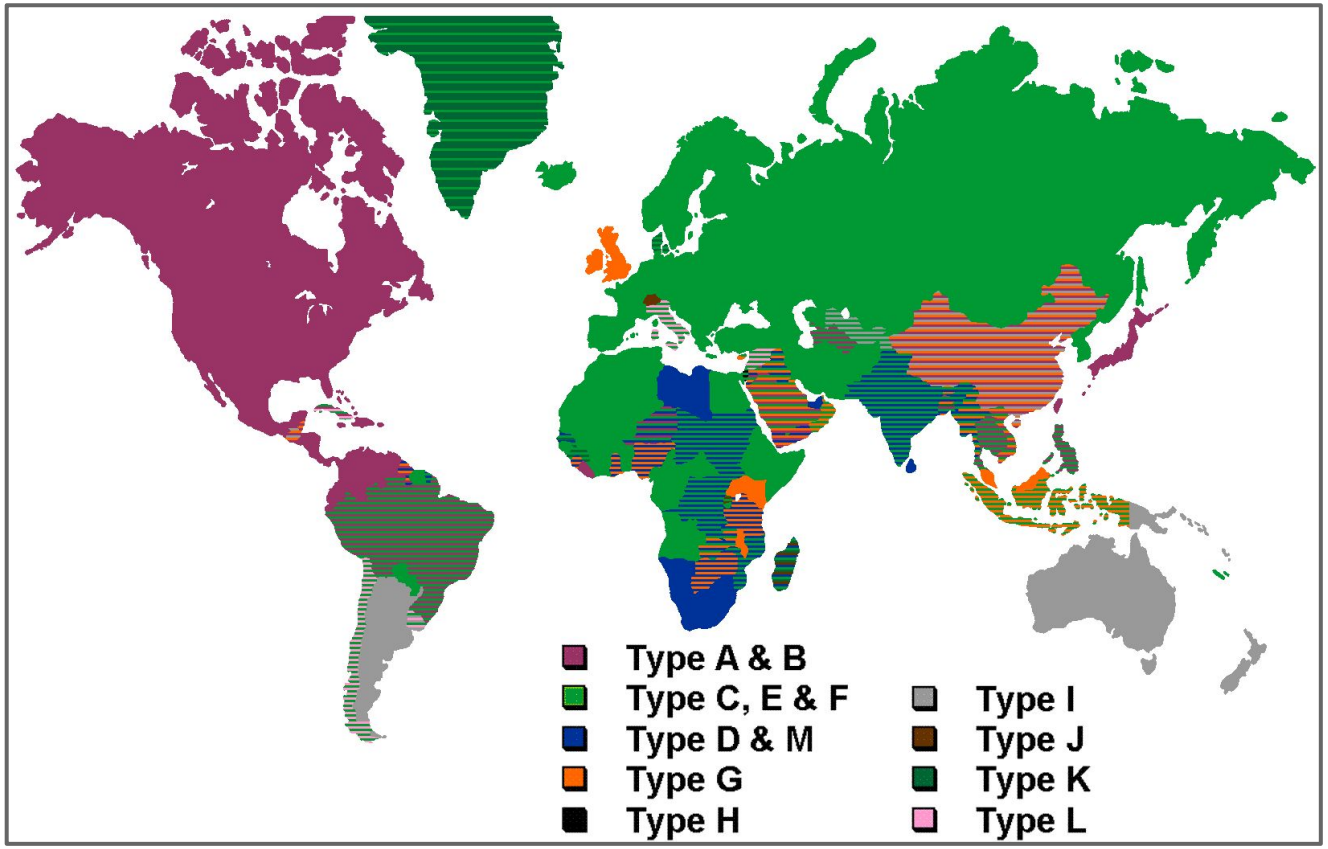






ИСТОЧНИКИ ДАННЫХ


Type A
Type B
Type C
Type D
Type E/F
Type G
Type H
Type I
Type J
Type L
Type N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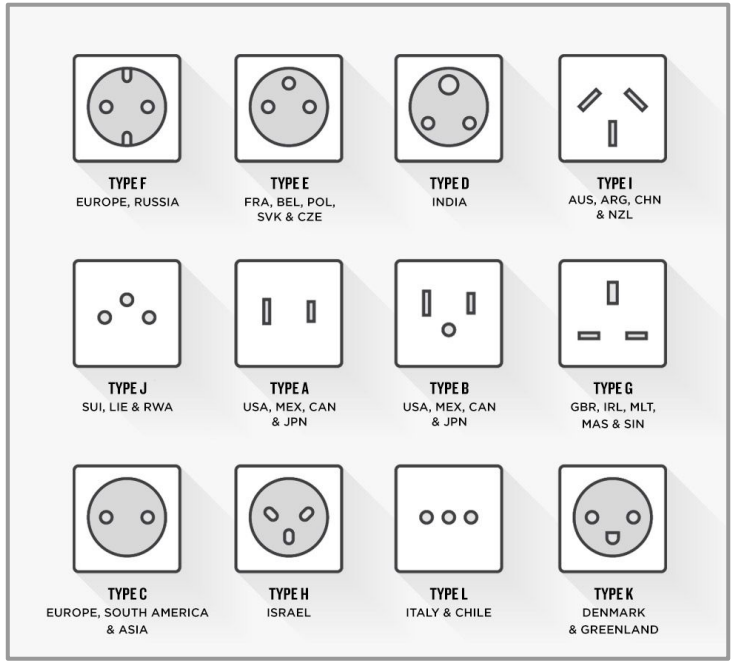
Type C, E & F
Type D & M
Type G
Type H
Type I
Type J
Type K
Type L


TYPE F
EUROPE, RUSSIA
TYPE E
FRA, BEL, POL, SVK & CZE
TYPE D
INDIA
TYPE I
AUS, ARG, CHN & NZL
TYPE J
SUI, LIE & RWA
TYPE A
USA, MEX, CAN & JPN
TYPE B
USA, MEX, CAN & JPN
TYPE G
GBR, IRL, MLT, MAS & SIN
TYPE C
EUROPE, SOUTH AMERICA & ASIA
TYPE H
ISRAEL
TYPE L
ITALY & CHILE
TYPE K
DENMARK & GREENLAND


Type A
Type B
Type C
Type D
Type E/F
Type G
Type H
Type I
Type J
Type L
Type M
Type N


creek
Integrated fuse T 10A
Indoor use only IP20/TA40
Made in Thailand
2500W
L
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TUV
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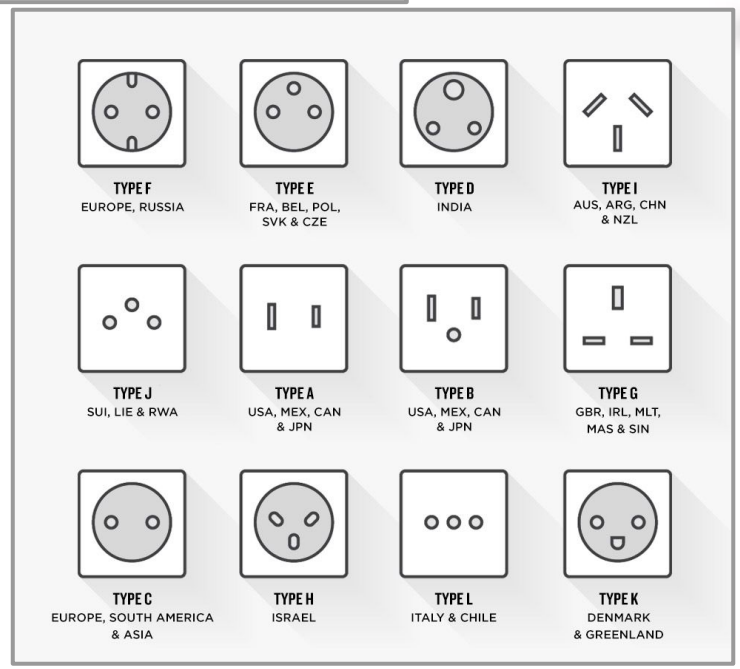

TYPE F
EUROPE, RUSSIA
TYPE E
FRA, BEL, POL, SVK & CZE
TYPE D
INDIA
TYPE I
AUS, ARG, CHN & NZL
TYPE J
SUI, LIE & RWA
TYPE A
USA, MEX, CAN & JPN
TYPE B
USA, MEX, CAN & JPN
TYPE G
GBR, IRL, MLT, MAS & SIN
TYPE C
EUROPE, SOUTH AMERICA & ASIA
TYPE H
ISRAEL
TYPE L
ITALY & CHILE
TYPE K
DENMARK & GREENLAND

Darwin Core – основной стандарт данных в GBIF

http://rs.tdwg.org/dwc/terms/

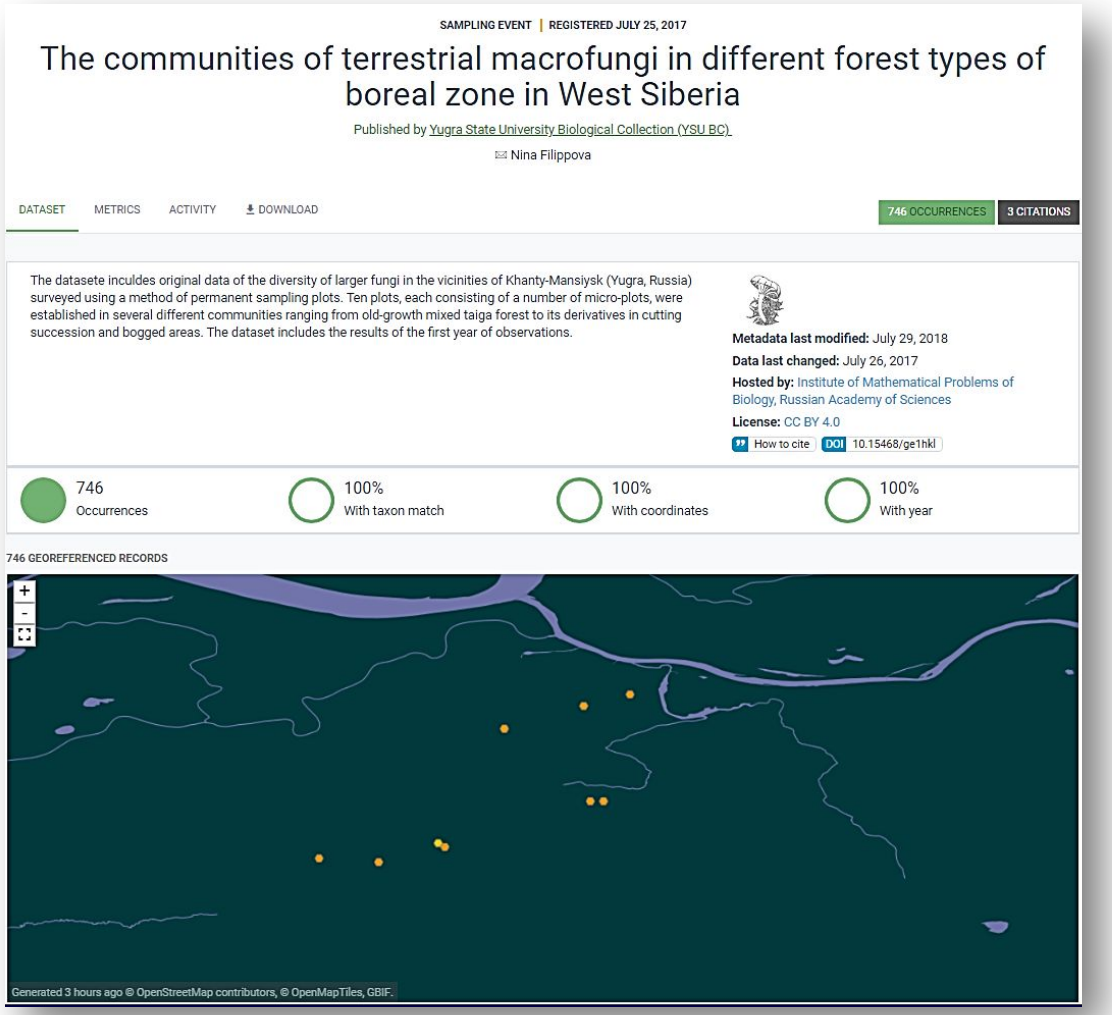
Система обмена информацией в GBIF построена на открытых стандартах, центральный из которых – **Darwin Core (DwC)**, стандарт, разработанный специально для хранения данных по биоразнообразию.

Стандарт – набор терминов (заголовки столбцов в таблице с данными) и правила использования этих терминов.

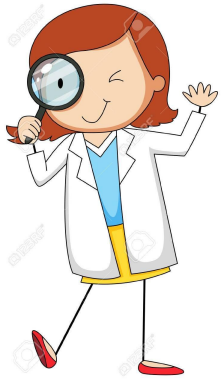
Biodiversity Information Standards TDWG

ЗАЧЕМ публиковать свои данные через глобальные порталы?

или



ЗАЧЕМ публиковать свои данные через глобальные порталы?



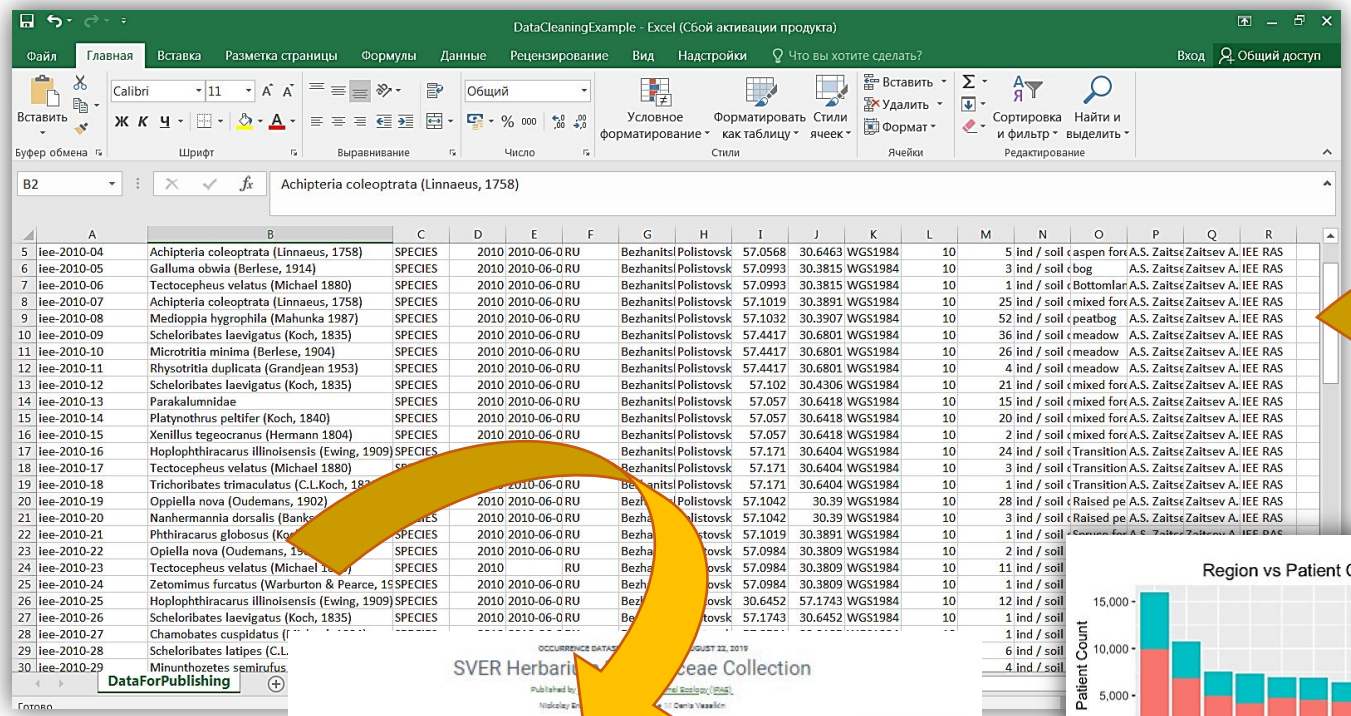
- Проверяемость результатов научных исследований
- Закрепление авторства собственных данных через DOI
- Повышение обнаружимости данных и исследований
- Возможности совместных исследований

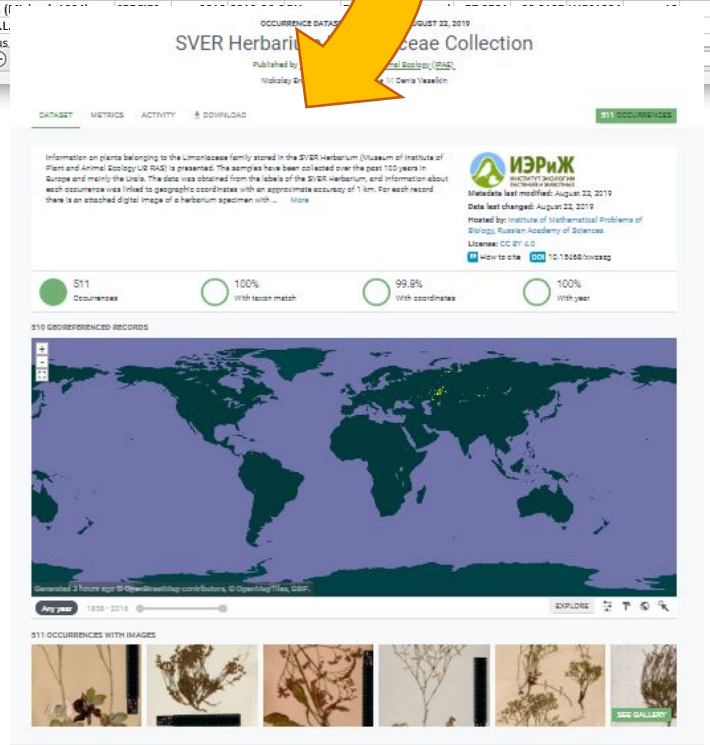
- Повышение научного использования коллекций
- Лучшая сохранность фондовых образцов
- Систематизация и улучшение качества данных

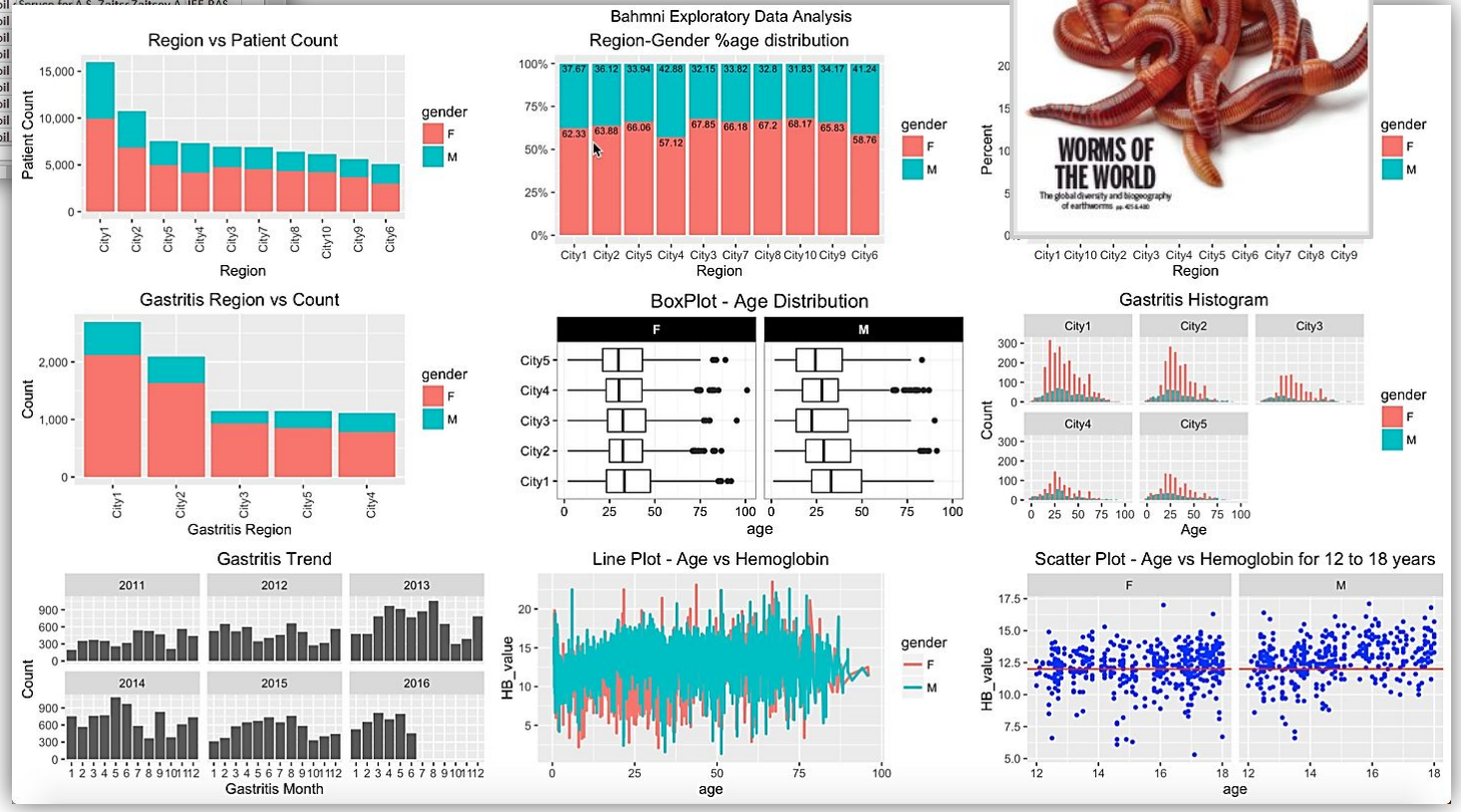
- Выполнение обязательств в рамках международных Конвенций.
- Достижение Целей в области устойчивого развития, в том числе связанных с здоровьем человека, продовольственной безопасностью и глобальным изменением климата, а также сохранением биоразнообразия на суше и в океане.

https://www.zin.ru/animalia/coleoptera/rus/j_angus.htm

Шашков и др. Возможности, решения и инструменты GBIF для оцифровки и развития естественнонаучных коллекций http://zmmu.msu.ru/files/seminary/ZM_confer2018_full.pdf

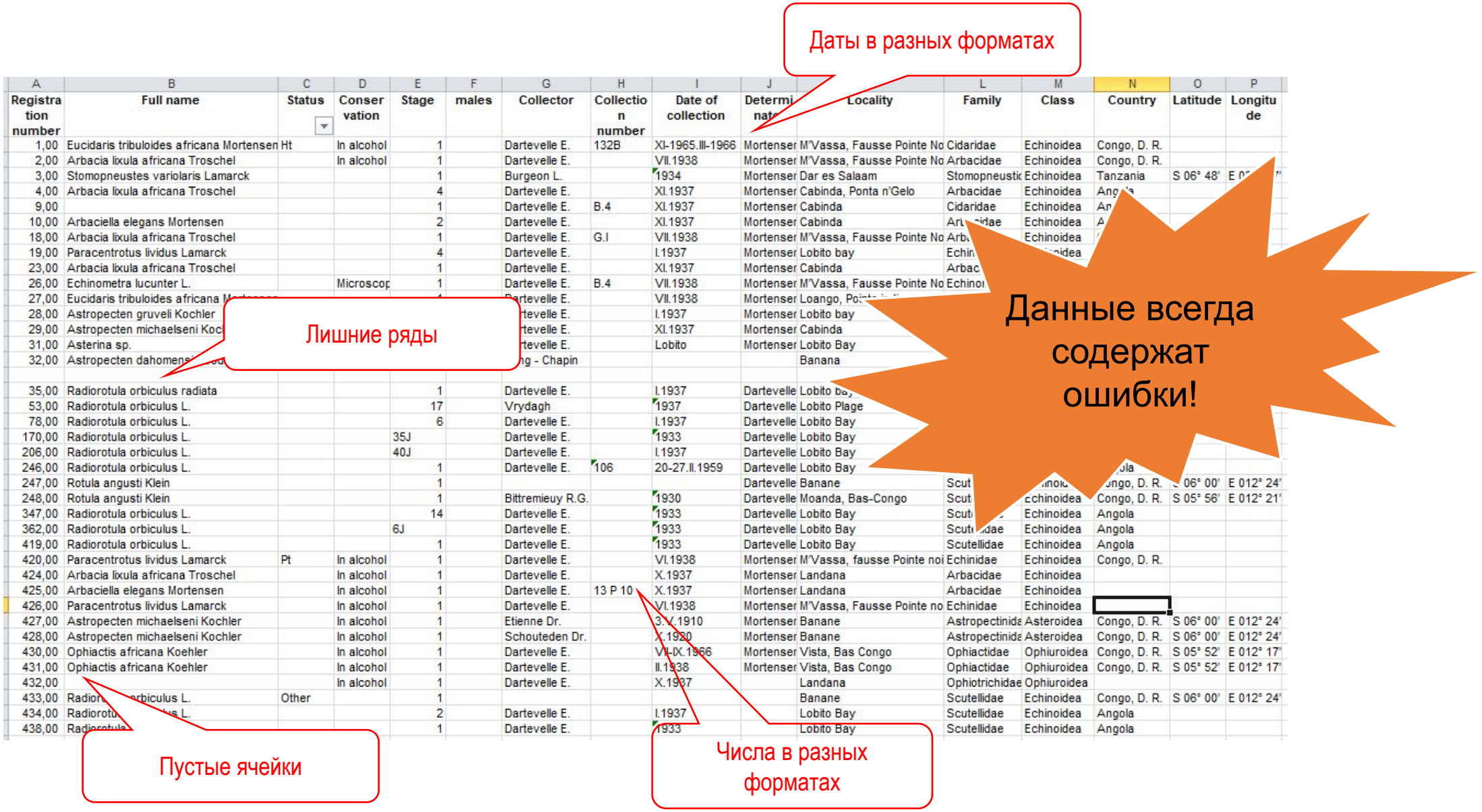






https://i.pinimg.com/originals/5c/e1/ab/5ce1ab055f79a92c5c6a42586ca67de7.png

Зачем нужна проверка данных (data cleaning) ?



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Registration number	Full name	Status	Conservation	Stage	males	Collector	Collection number	Date of collection	Determinate	Locality	Family	Class	Country	Latitude	Longitude
1,00	Eucidaris tribuloides africana Mortensen	Ht	In alcohol	1		Dartevelle E.	132B	XI-1965.III-1966	Mortenser	M'Vassa, Fausse Pointe No	Cidaridae	Echinoidea	Congo, D. R.		
2,00	Arbacia lixula africana Troschel		In alcohol	1		Dartevelle E.		VII.1938	Mortenser	M'Vassa, Fausse Pointe No	Arbacidae	Echinoidea	Congo, D. R.		
3,00	Stomopneustes variolaris Lamarck			1		Burgeon L.		1934	Mortenser	Dar es Salaam	Stomopneustic	Echinoidea	Tanzania	S 06° 48'	E 0
4,00	Arbacia lixula africana Troschel			4		Dartevelle E.		XI.1937	Mortenser	Cabinda, Ponta n'Gelo	Arbacidae	Echinoidea	Ang		
9,00				1		Dartevelle E.	B.4	XI.1937	Mortenser	Cabinda	Cidaridae	Echinoidea	An		
10,00	Arbaciella elegans Mortensen			2		Dartevelle E.		XI.1937	Mortenser	Cabinda	Ar idae	Echinoidea	A		
18,00	Arbacia lixula africana Troschel			1		Dartevelle E.	G.I	VII.1938	Mortenser	M'Vassa, Fausse Pointe No	Arb	Echinoidea			
19,00	Paracentrotus lividus Lamarck			4		Dartevelle E.		I.1937	Mortenser	Lobito bay	Echin oidea				
23,00	Arbacia lixula africana Troschel			1		Dartevelle E.		XI.1937	Mortenser	Cabinda	Arbac				
26,00	Echinometra lucunter L.		Microscop	1		Dartevelle E.	B.4	VII.1938	Mortenser	M'Vassa, Fausse Pointe No	Echinoi				
27,00	Eucidaris tribuloides africana M			1		Dartevelle E.		VII.1938	Mortenser	Loango, P					
28,00	Astropecten gruveli Kochler					tevelle E.		I.1937	Mortenser	Lobito bay					
29,00	Astropecten michaelseni Koc					tevelle E.		XI.1937	Mortenser	Cabinda					
31,00	Asterina sp.					tevelle E.		Lobito	Mortenser	Lobito Bay					
32,00	Astropecten dahomens					g - Chapin				Banana					
35,00	Radiorotula orbiculus radiata			1		Dartevelle E.		I.1937	Dartevelle	Lobito Ba					
53,00	Radiorotula orbiculus L.			17		Vrydagh		1937	Dartevelle	Lobito Plage					
78,00	Radiorotula orbiculus L.			6		Dartevelle E.		I.1937	Dartevelle	Lobito Bay					
170,00	Radiorotula orbiculus L.			35J		Dartevelle E.		1933	Dartevelle	Lobito Bay					
206,00	Radiorotula orbiculus L.			40J		Dartevelle E.		I.1937	Dartevelle	Lobito Bay					
246,00	Radiorotula orbiculus L.			1		Dartevelle E.	106	20-27.II.1959	Dartevelle	Lobito Bay			ola		
247,00	Rotula angusti Klein			1					Dartevelle	Banane	Scut	inoi	ongo, D. R.	S 06° 00'	E 012° 24'
248,00	Rotula angusti Klein			1		Bittremieuy R.G.		1930	Dartevelle	Moanda, Bas-Congo	Scut	Echinoidea	Congo, D. R.	S 05° 56'	E 012° 21'
347,00	Radiorotula orbiculus L.			14		Dartevelle E.		1933	Dartevelle	Lobito Bay	Scut	Echinoidea	Angola		
362,00	Radiorotula orbiculus L.			6J		Dartevelle E.		1933	Dartevelle	Lobito Bay	Scut idae	Echinoidea	Angola		
419,00	Radiorotula orbiculus L.			1		Dartevelle E.		1933	Dartevelle	Lobito Bay	Scutellidae	Echinoidea	Angola		
420,00	Paracentrotus lividus Lamarck	Pt	In alcohol	1		Dartevelle E.		VI.1938	Mortenser	M'Vassa, fausse Pointe noi	Echinidae	Echinoidea	Congo, D. R.		
424,00	Arbacia lixula africana Troschel		In alcohol	1		Dartevelle E.		X.1937	Mortenser	Landana	Arbacidae	Echinoidea			
425,00	Arbaciella elegans Mortensen		In alcohol	1		Dartevelle E.	13 P 10	X.1937	Mortenser	Landana	Arbacidae	Echinoidea			
426,00	Paracentrotus lividus Lamarck		In alcohol	1		Dartevelle E.		VI.1938	Mortenser	M'Vassa, Fausse Pointe no	Echinidae	Echinoidea			
427,00	Astropecten michaelseni Kochler		In alcohol	1		Etienne Dr.		3.V.1910	Mortenser	Banane	Astropectinida	Asteroidea	Congo, D. R.	S 06° 00'	E 012° 24'
428,00	Astropecten michaelseni Kochler		In alcohol	1		Schouteden Dr.		X.1930	Mortenser	Banane	Astropectinida	Asteroidea	Congo, D. R.	S 06° 00'	E 012° 24'
430,00	Ophiactis africana Koehler		In alcohol	1		Dartevelle E.		VII-IX.1966	Mortenser	Vista, Bas Congo	Ophiactidae	Ophiuroidea	Congo, D. R.	S 05° 52'	E 012° 17'
431,00	Ophiactis africana Koehler		In alcohol	1		Dartevelle E.		II.1938	Mortenser	Vista, Bas Congo	Ophiactidae	Ophiuroidea	Congo, D. R.	S 05° 52'	E 012° 17'
432,00			In alcohol	1		Dartevelle E.		X.1937		Landana	Ophiotrichidae	Ophiuroidea			
433,00	Radior rbiculus L.	Other		1						Banane	Scutellidae	Echinoidea	Congo, D. R.	S 06° 00'	E 012° 24'
434,00	Radiorotu us L.			2		Dartevelle E.		I.1937		Lobito Bay	Scutellidae	Echinoidea	Angola		
438,00	Radiorotula			1		Dartevelle E.		1933		Lobito Bay	Scutellidae	Echinoidea	Angola		

Качество данных

относительная концепция, которая зависит от способа использования этих данных

Наиболее распространенные ошибки в данных

Технические ошибки:

опечатки, пропущенные значения, лишние пробелы, корректность диапазонов для дат, соответствие типа данных полю, в котором они содержатся

Ошибки формата данных

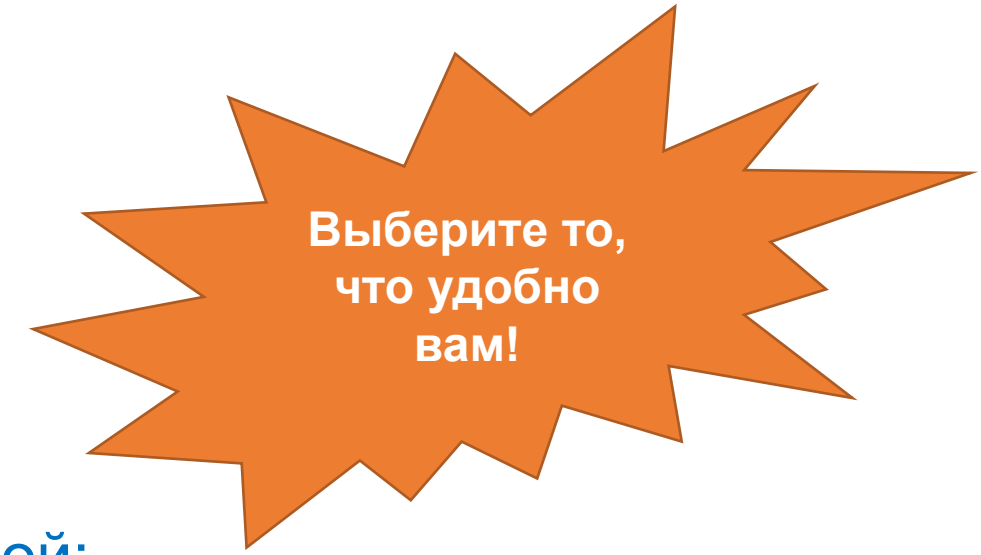
Согласованность данных: соответствие даты сбора, идентификации, обновления и оцифровки, координаты всех точек находятся в указанном регионе, точки находок сухопутных видов находятся на суше и т.д.

Номенклатурные ошибки: соответствие названия таксонов выбранному справочнику, соответствие других значений справочным

Инструменты для поиска и исправления технических ошибок и ошибок в данных

Текстовые редакторы:

- BBEdit (Mac)
- Notepad++ (Windows)
- Emacs, Vi (Unix, Linux)



Инструменты, работающие с командной строкой:

- R
- RStudio (графический пользовательский интерфейс)
- Скрипты: Perl, Python,...

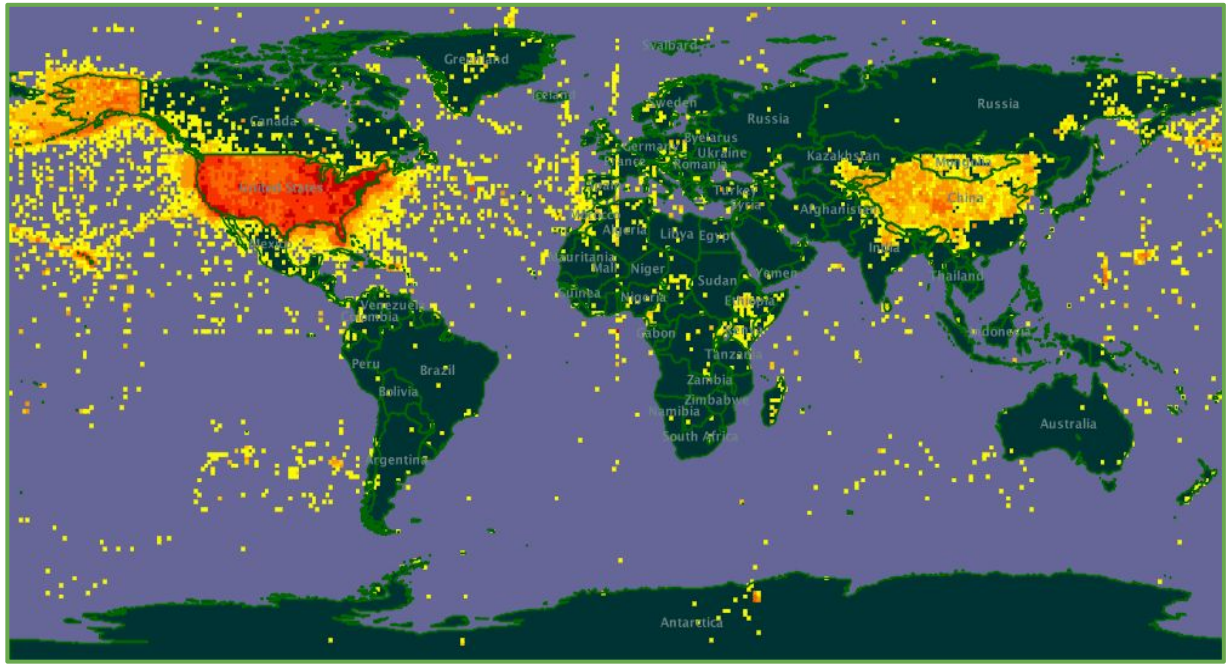
Excel

OPEN Refine

QGIS

Ошибки представления пространственных данных

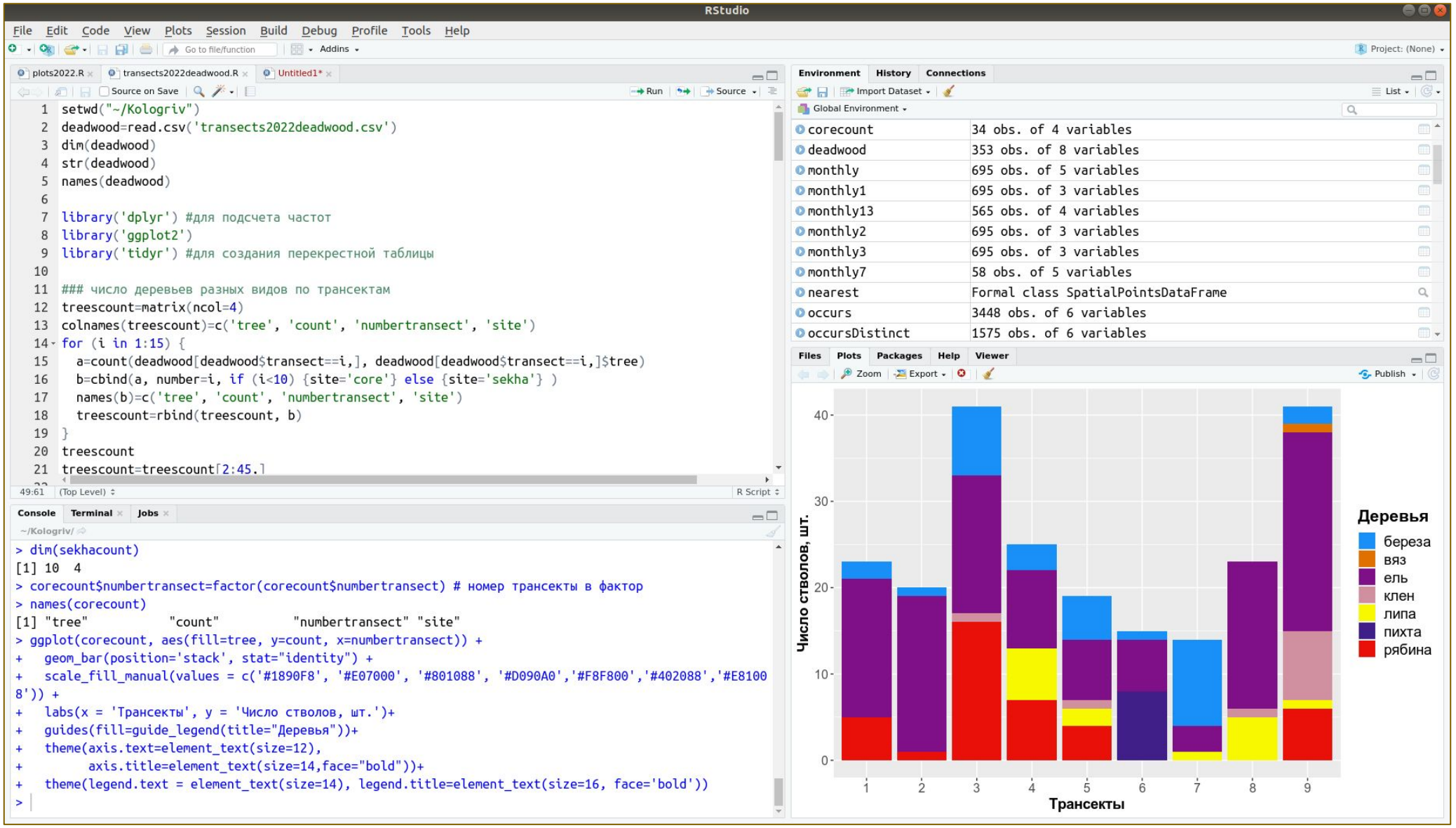
- Широта и долгота перепутаны местами
- Неправильно указано полушарие
- Нулевые значения
- Неизвестная система координат
- Ошибки преобразования координат из одной системы в другую или из одной формы представления в другую



Инструменты для верификации пространственных данных: QGIS

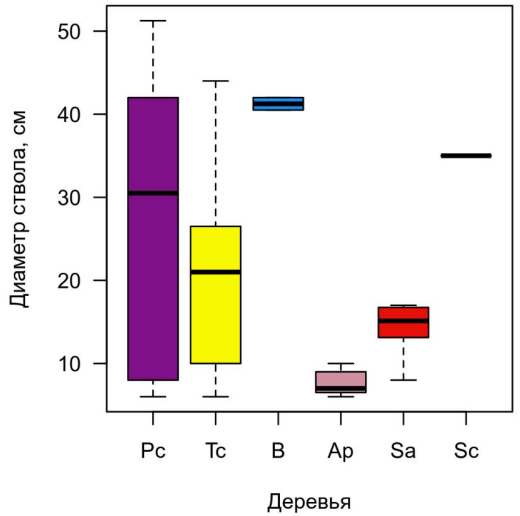
- Настольная (локальная) геоинформационная система (ГИС)
- Для трансформации, анализа, визуализации, проверки, верификации и т.д.
- http://www.qgis.org
- Open source!

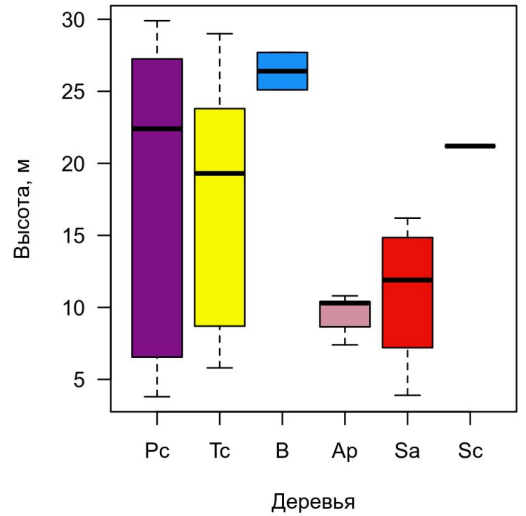
Среда статистического программирования R

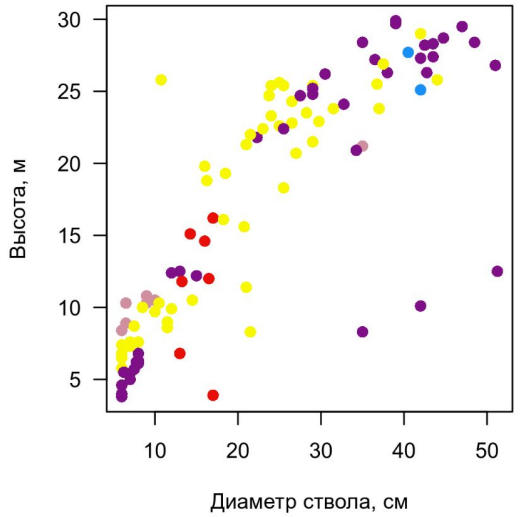


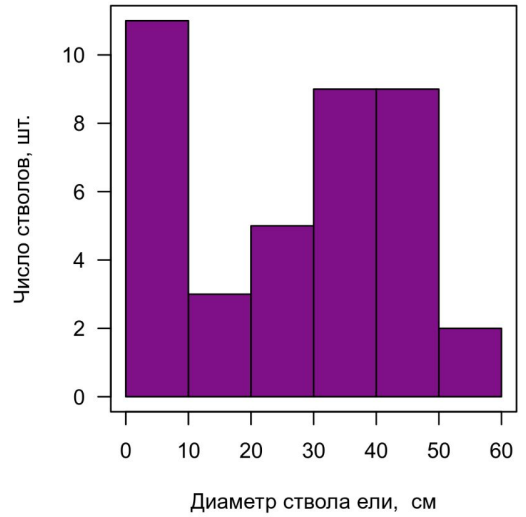

1) Что такое этот ваш R и почему я должен тратить на это своё время?
2) Чего R умеет такого, что я не могу сделать в Excel / Past / Statistica и другом ПО?
3) Считать это ладно, но сумеет ли R в два клика вывести мне на экран график, карту, диплом или диссертацию?
4) …
5) PROFIT !!!
А. Созонтов, CC-BY

Программный код - это не так страшно, как кажется





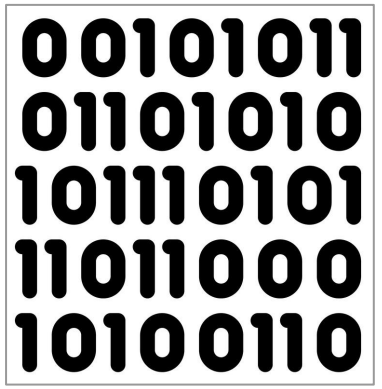




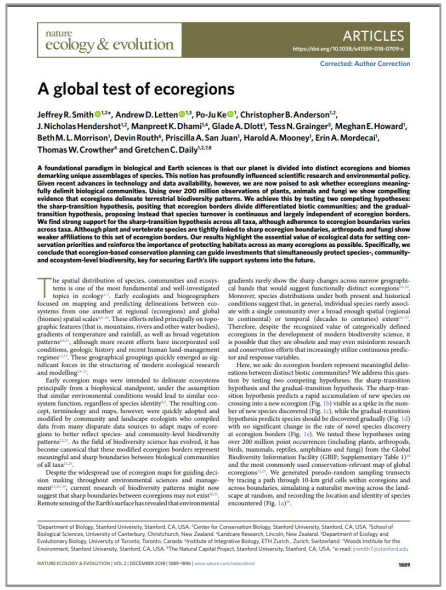
Дизайн эксперимента

Полевые исследования

Данные



Анализ данных



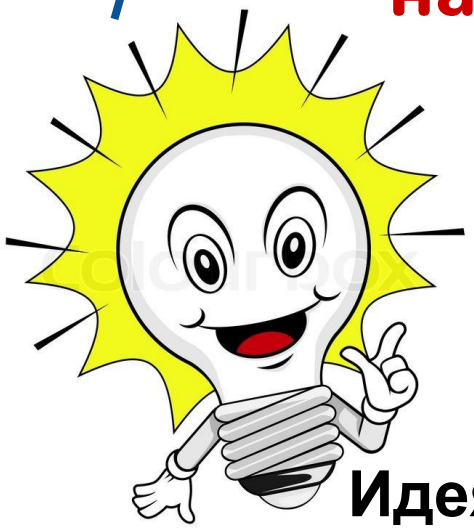
nature ecology & evolution ARTICLES

Corrected: Author Correction

A global test of ecoregions

Jeffrey R. Smith, Andrew D. Letten, Po-Ju Ke, Christopher B. Anderson, J. Nicholas Hendershot, Manpreet K. Dhami, Glade A. Dlott, Tess N. Grainger, Meghan E. Howard, Beth M. L. Morrison, Devin Routh, Priscilla A. San Juan, Harold A. Mooney, Erin A. Mordecai, Thomas W. Crowther and Gretchen C. Daily

A foundational paradigm in biological and Earth sciences is that our planet is divided into distinct ecoregions and biomes demarking unique assemblages of species. This notion has profoundly influenced scientific research and environmental policy. Given recent advances in technology and data availability, however, we are now poised to ask whether ecoregions meaningfully delimit biological communities. Using over 200 million observations of plants, animals and fungi we show compelling evidence that ecoregions delineate terrestrial biodiversity patterns. We achieve this by testing two competing hypotheses: the sharp-transition hypothesis, positing that ecoregion borders divide differentiated biotic communities; and the gradual-transition hypothesis, proposing instead that species turnover is continuous and largely independent of ecoregion borders. We find strong support for the sharp-transition hypothesis across all taxa, although adherence to ecoregion boundaries varies across taxa. Although plant and vertebrate species are tightly linked to sharp ecoregion boundaries, arthropods and fungi show weaker affiliations to this set of ecoregion borders. Our results highlight the essential value of ecological data for setting conservation priorities and reinforce the importance of protecting habitats across as many ecoregions as possible. Specifically, we conclude that ecoregion-based conservation planning can guide investments that simultaneously protect species-, community- and ecosystem-level biodiversity, key for securing Earth's life support systems into the future.



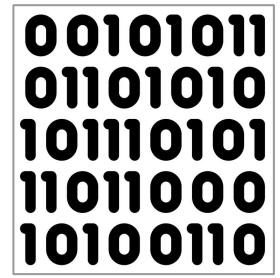
Идея

Классическая схема научного исследования

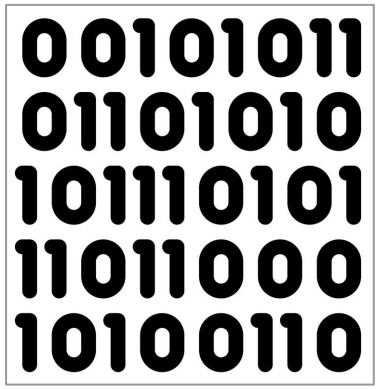
Дизайн эксперимента

Полевые исследования

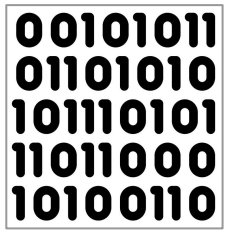
Данные из репозиториев



Объединенные данные

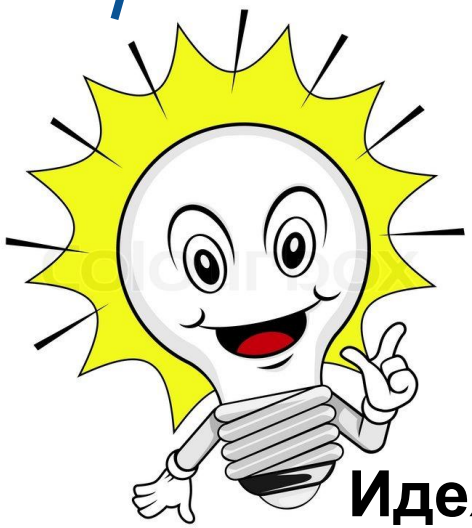


Данные из репозиториев



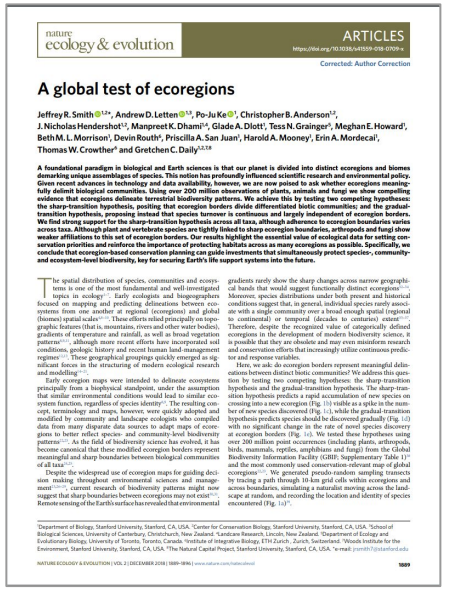
Гипотеза

Исследование с использованием объединенных данных



Идея

Анализ объединенных данных



nature ecology & evolution ARTICLES

Corrected: Author Correction

A global test of ecoregions

Jeffrey R. Smith[1,2*], Andrew D. Letten[1,3], Po-Ju Ke[1], Christopher B. Anderson[1,2], J. Nicholas Hendershot[1,2], Manpreet K. Dhami[1,4], Glade A. Dlott[1], Tess N. Grainger[5], Meghan E. Howard[1], Beth M. L. Morrison[1], Devin Routh[6], Priscilla A. San Juan[1], Harold A. Mooney[1], Erin A. Mordecai[1], Thomas W. Crowther[3] and Gretchen C. Daily[1,2,7,8]

A foundational paradigm in biological and Earth sciences is that our planet is divided into distinct ecoregions and biomes demarking unique assemblages of species. This notion has profoundly influenced scientific research and environmental policy. Given recent advances in technology and data availability, however, we are now poised to ask whether ecoregions meaningfully delimit biological communities. Using over 200 million observations of plants, animals and fungi we show compelling evidence that ecoregions delineate terrestrial biodiversity patterns. We achieve this by testing two competing hypotheses: the sharp-transition hypothesis, positing that ecoregion borders divide differentiated biotic communities; and the gradual-transition hypothesis, proposing instead that species turnover is continuous and largely independent of ecoregion borders. We find strong support for the sharp-transition hypothesis across all taxa, although adherence to ecoregion boundaries varies across taxa. Although plant and vertebrate species are tightly linked to sharp ecoregion boundaries, arthropods and fungi show weaker affiliations to this set of ecoregion borders. Our results highlight the essential value of ecological data for setting conservation priorities and reinforce the importance of protecting habitats across as many ecoregions as possible. Specifically, we conclude that ecoregion-based conservation planning can guide investments that simultaneously protect species-, community- and ecosystem-level biodiversity, key for securing Earth's life support systems into the future.

The spatial distribution of species, communities and ecosystems is one of the most fundamental and well-investigated topics in ecology[1–3]. Early ecologists and biogeographers focused on mapping and predicting delineations between ecosystems from one another at regional (ecoregions) and global (biomes) spatial scales[4–6]. These efforts relied principally on topographic features (that is, mountains, rivers and other water bodies), gradients of temperature and rainfall, as well as broad vegetation patterns[4,6,7], although more recent efforts have incorporated soil conditions, geologic history and recent human land-management regimes[8,9]. These geographical groupings quickly emerged as significant foci in the structuring of modern ecological research and modelling[10–12].

Early ecoregion maps were intended to delineate ecosystems principally from a biophysical standpoint, under the assumption that similar environmental conditions would lead to similar ecosystem function, regardless of species identity[6,9]. The resulting concept, terminology and maps, however, were quickly adopted and modified by community and landscape ecologists who compiled data from many disparate data sources to adapt maps of ecoregions to better reflect species- and community-level biodiversity patterns[12,13]. As the field of biodiversity science has evolved, it has become canonical that these modified ecoregion borders represent meaningful and sharp boundaries between biological communities of all taxa[12,14].

Despite the widespread use of ecoregion maps for guiding decision making throughout environmental sciences and management[12,15,16], current research of biodiversity patterns might now suggest that sharp boundaries between ecoregions may not exist[17,18]. Remote sensing of the Earth's surface has revealed that environmental gradients rarely show the sharp changes across narrow geographical bands that would suggest functionally distinct ecoregions[19–21]. Moreover, species distributions under both present and historical conditions suggest that, in general, individual species rarely associate with a single community over a broad enough spatial (regional to continental) or temporal (decades to centuries) extent[22–25]. Therefore, despite the recognized value of categorically defined ecoregions in the development of modern biodiversity science, it is possible that they are obsolete and may even misinform research and conservation efforts that increasingly utilize continuous predictor and response variables.

Here, we ask: do ecoregion borders represent meaningful delineations between distinct biotic communities? We address this question by testing two competing hypotheses: the sharp-transition hypothesis and the gradual-transition hypothesis. The sharp-transition hypothesis predicts a rapid accumulation of new species on crossing into a new ecoregion (Fig. 1b) visible as a spike in the number of new species discovered (Fig. 1c), while the gradual-transition hypothesis predicts species should be discovered gradually (Fig. 1d) with no significant change in the rate of novel species discovery at ecoregion borders (Fig. 1e). We tested these hypotheses using over 200 million point occurrences (including plants, arthropods, birds, mammals, reptiles, amphibians and fungi) from the Global Biodiversity Information Facility (GBIF; Supplementary Table 1)[26] and the most commonly used conservation-relevant map of global ecoregions[6,27]. We generated pseudo-random sampling transects by tracing a path through 10-km grid cells within ecoregions and across boundaries, simulating a naturalist moving across the landscape at random, and recording the location and identity of species encountered (Fig. 1a)[28].

[1]Department of Biology, Stanford University, Stanford, CA, USA. [2]Center for Conservation Biology, Stanford University, Stanford, CA, USA. [3]School of Biological Sciences, University of Canterbury, Christchurch, New Zealand. [4]Landcare Research, Lincoln, New Zealand. [5]Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Canada. [6]Institute of Integrative Biology, ETH Zurich , Zurich, Switzerland. [7]Woods Institute for the Environment, Stanford University, Stanford, CA, USA. [8]The Natural Capital Project, Stanford University, Stanford, CA, USA. *e-mail: jrsmith1@stanford.edu

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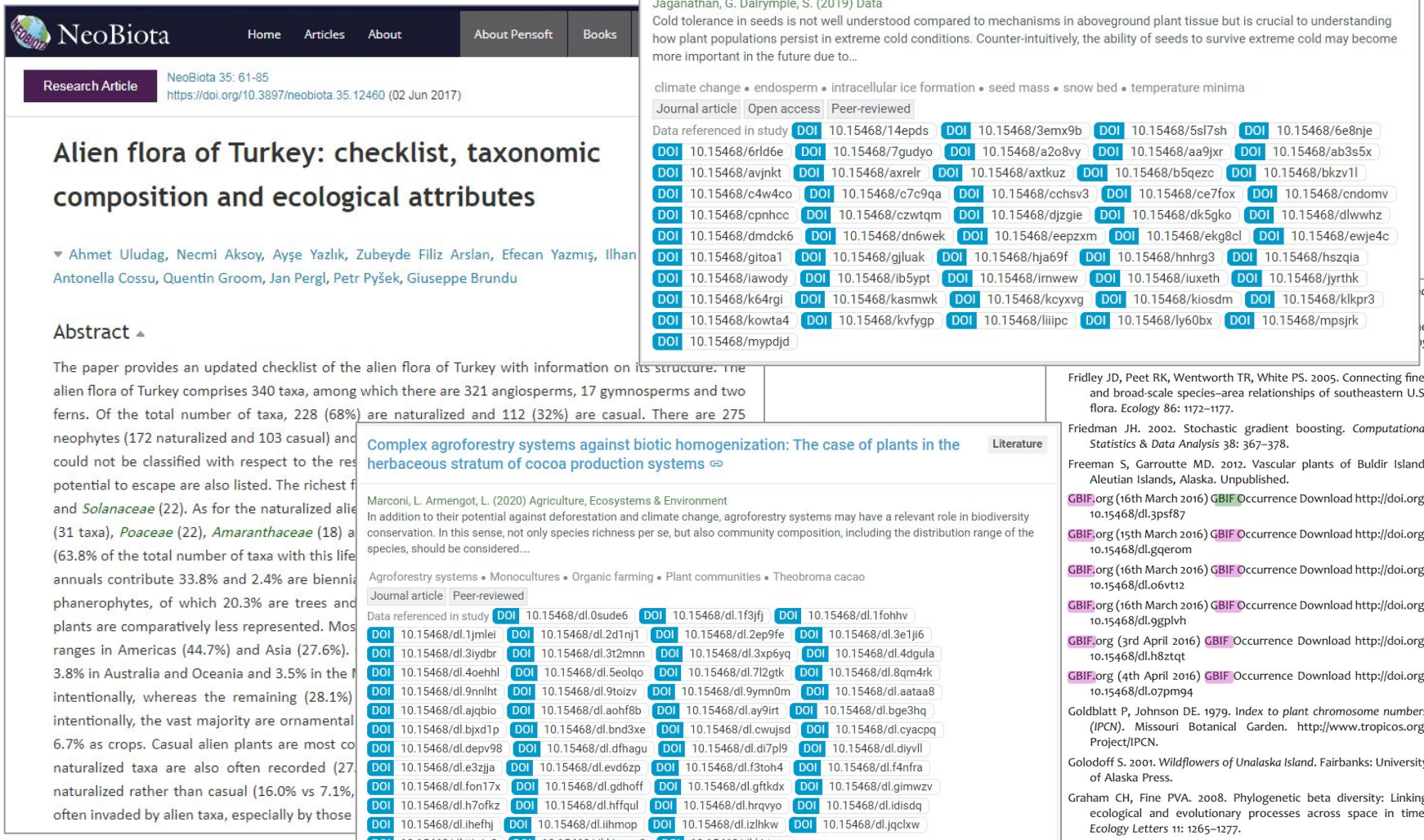

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Research Article

NeoBiota 35: 61-85
https://doi.org/10.3897/neobiota.35.12460 (02 Jun 2017)

Alien flora of Turkey: checklist, taxonomic composition and ecological attributes

Ahmet Uludag, Necmi Aksoy, Ayşe Yazlık, Zubeyde Filiz Arslan, Efecan Yazmış, Ilhan Antonella Cossu, Quentin Groom, Jan Pergl, Petr Pyšek, Giuseppe Brundu

Abstract

The paper provides an updated checklist of the alien flora of Turkey with information on its structure. The alien flora of Turkey comprises 340 taxa, among which there are 321 angiosperms, 17 gymnosperms and two ferns. Of the total number of taxa, 228 (68%) are naturalized and 112 (32%) are casual. There are 275 neophytes (172 naturalized and 103 casual) and could not be classified with respect to the res potential to escape are also listed. The richest f and *Solanaceae* (22). As for the naturalized alie (31 taxa), *Poaceae* (22), *Amaranthaceae* (18) a (63.8% of the total number of taxa with this life annuals contribute 33.8% and 2.4% are biennia phanerophytes, of which 20.3% are trees and plants are comparatively less represented. Mos ranges in Americas (44.7%) and Asia (27.6%). 3.8% in Australia and Oceania and 3.5% in the N intentionally, whereas the remaining (28.1%) intentionally, the vast majority are ornamental 6.7% as crops. Casual alien plants are most co naturalized taxa are also often recorded (27 naturalized rather than casual (16.0% vs 7.1%, often invaded by alien taxa, especially by those

Internal Seed Structure of Alpine Plants and Extreme Cold Exposure — Literature

Jaganathan, G. Dalrymple, S. (2019) Data

Cold tolerance in seeds is not well understood compared to mechanisms in aboveground plant tissue but is crucial to understanding how plant populations persist in extreme cold conditions. Counter-intuitively, the ability of seeds to survive extreme cold may become more important in the future due to...

climate change • endosperm • intracellular ice formation • seed mass • snow bed • temperature minima

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DOI 10.15468/mypdjd

Complex agroforestry systems against biotic homogenization: The case of plants in the herbaceous stratum of cocoa production systems — Literature

Marconi, L. Armengot, L. (2020) Agriculture, Ecosystems & Environment

In addition to their potential against deforestation and climate change, agroforestry systems may have a relevant role in biodiversity conservation. In this sense, not only species richness per se, but also community composition, including the distribution range of the species, should be considered....

Agroforestry systems • Monocultures • Organic farming • Plant communities • Theobroma cacao

Journal article | Peer-reviewed

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Corrected: Author Correction

A global test of ecoregions

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A foundational paradigm in biological and Earth sciences is that our planet is divided into distinct ecoregions and biomes demarking unique assemblages of species. This notion has profoundly influenced scientific research and environmental policy. Given recent advances in technology and data availability, however, we are now poised to ask whether ecoregions meaningfully delimit biological communities. Using over 200 million observations of plants, animals and fungi we show compelling evidence that ecoregions delineate terrestrial biodiversity patterns. We achieve this by testing two competing hypotheses: the sharp-transition hypothesis, positing that ecoregion borders divide differentiated biotic communities; and the gradual-transition hypothesis, proposing instead that species turnover is continuous and largely independent of ecoregion borders. We find strong support for the sharp-transition hypothesis across all taxa, although adherence to ecoregion boundaries varies across taxa. Although plant and vertebrate species are tightly linked to sharp ecoregion boundaries, arthropods and fungi show weaker affiliations to this set of ecoregion borders. Our results highlight the essential value of ecological data for setting conservation priorities and reinforce the importance of protecting habitats across as many ecoregions as possible. Specifically, we conclude that ecoregion-based conservation planning can guide investments that simultaneously protect species-, community- and ecosystem-level biodiversity, key for securing Earth's life support systems into the future.

The spatial distribution of species, communities and ecosystems is one of the most fundamental and well-investigated topics in ecology[1–7]. Early ecologists and biogeographers focused on mapping and predicting delineations between ecosystems from one another at regional (ecoregions) and global (biomes) spatial scales[8–10]. These efforts relied principally on topographic features (that is, mountains, rivers and other water bodies), gradients of temperature and rainfall, as well as broad vegetation patterns[8,9,11], although more recent efforts have incorporated soil conditions, geologic history and recent human land-management regimes[12,13]. These geographical groupings quickly emerged as significant forces in the structuring of modern ecological research and modelling[14–21].

Early ecoregion maps were intended to delineate ecosystems principally from a biophysical standpoint, under the assumption that similar environmental conditions would lead to similar ecosystem function, regardless of species identity[8,9]. The resulting concept, terminology and maps, however, were quickly adopted and modified by community and landscape ecologists who compiled data from many disparate data sources to adapt maps of ecoregions to better reflect species- and community-level biodiversity patterns[12,22]. As the field of biodiversity science has evolved, it has become canonical that these modified ecoregion borders represent meaningful and sharp boundaries between biological communities of all taxa[16–22].

Despite the widespread use of ecoregion maps for guiding decision making throughout environmental sciences and management[7,23–29], current research of biodiversity patterns might now suggest that sharp boundaries between ecoregions may not exist[30,31]. Remote sensing of the Earth's surface has revealed that environmental gradients rarely show the sharp changes across narrow geographical bands that would suggest functionally distinct ecoregions[32–34]. Moreover, species distributions under both present and historical conditions suggest that, in general, individual species rarely associate with a single community over a broad enough spatial (regional to continental) or temporal (decades to centuries) extent[35–37]. Therefore, despite the recognized value of categorically defined ecoregions in the development of modern biodiversity science, it is possible that they are obsolete and may even misinform research and conservation efforts that increasingly utilize continuous predictor and response variables.

Here, we ask: do ecoregion borders represent meaningful delineations between distinct biotic communities? We address this question by testing two competing hypotheses: the sharp-transition hypothesis and the gradual-transition hypothesis. The sharp-transition hypothesis predicts a rapid accumulation of new species on crossing into a new ecoregion (Fig. 1b) visible as a spike in the number of new species discovered (Fig. 1c), while the gradual-transition hypothesis predicts species should be discovered gradually (Fig. 1d) with no significant change in the rate of novel species discovery at ecoregion borders (Fig. 1e). We tested these hypotheses using over 200 million point occurrences (including plants, arthropods, birds, mammals, reptiles, amphibians and fungi) from the Global Biodiversity Information Facility (GBIF; Supplementary Table 1)[38] and the most commonly used conservation-relevant map of global ecoregions[22,23]. We generated pseudo-random sampling transects by tracing a path through 10-km grid cells within ecoregions and across boundaries, simulating a naturalist moving across the landscape at random, and recording the location and identity of species encountered (Fig. 1a)[39].

[1]Department of Biology, Stanford University, Stanford, CA, USA. [2]Center for Conservation Biology, Stanford University, Stanford, CA, USA. [3]School of Biological Sciences, University of Canterbury, Christchurch, New Zealand. [4]Landcare Research, Lincoln, New Zealand. [5]Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Canada. [6]Institute of Integrative Biology, ETH Zurich , Zurich, Switzerland. [7]Woods Institute for the Environment, Stanford University, Stanford, CA, USA. [8]The Natural Capital Project, Stanford University, Stanford, CA, USA. *e-mail: jrsmith7@stanford.edu

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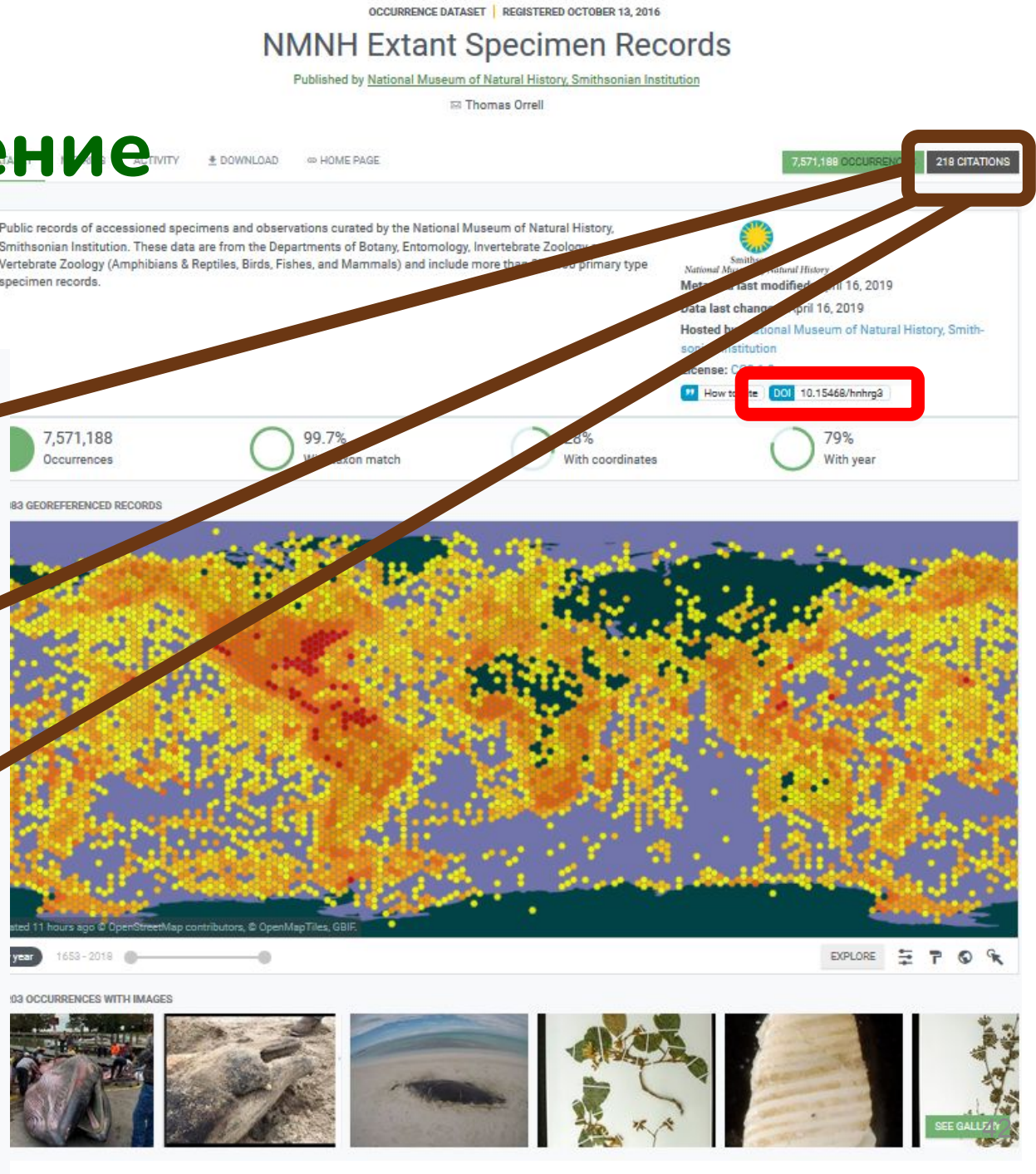

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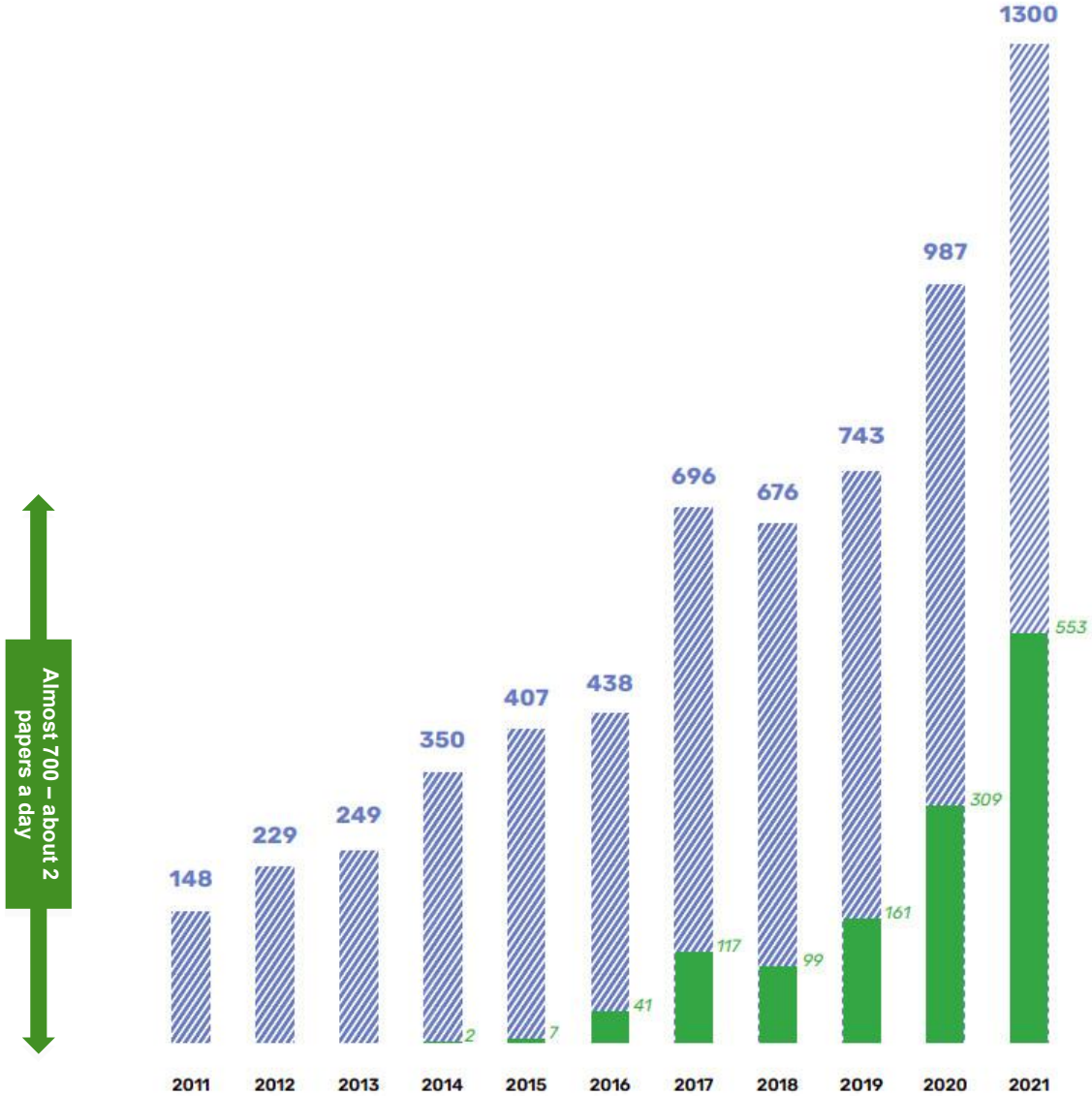

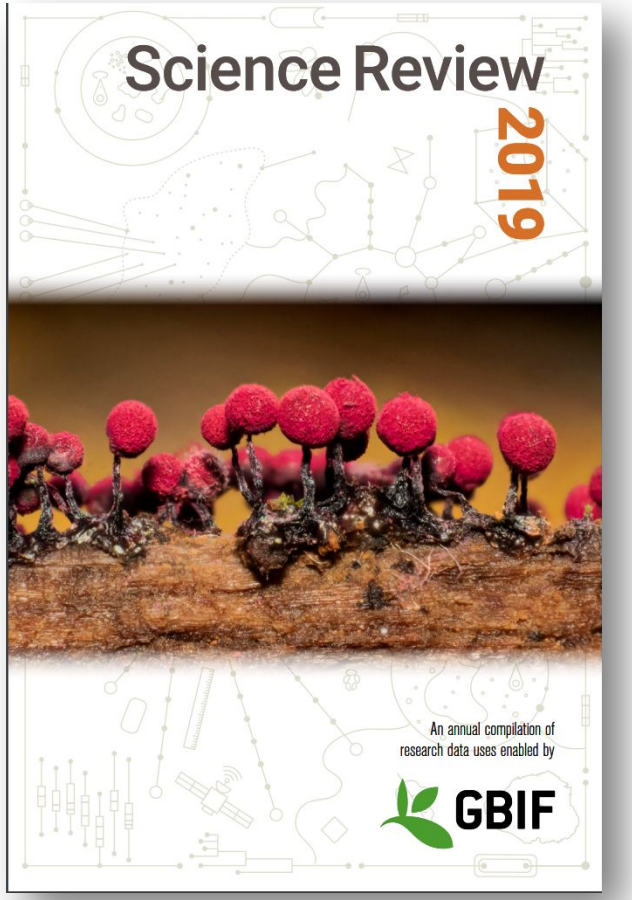

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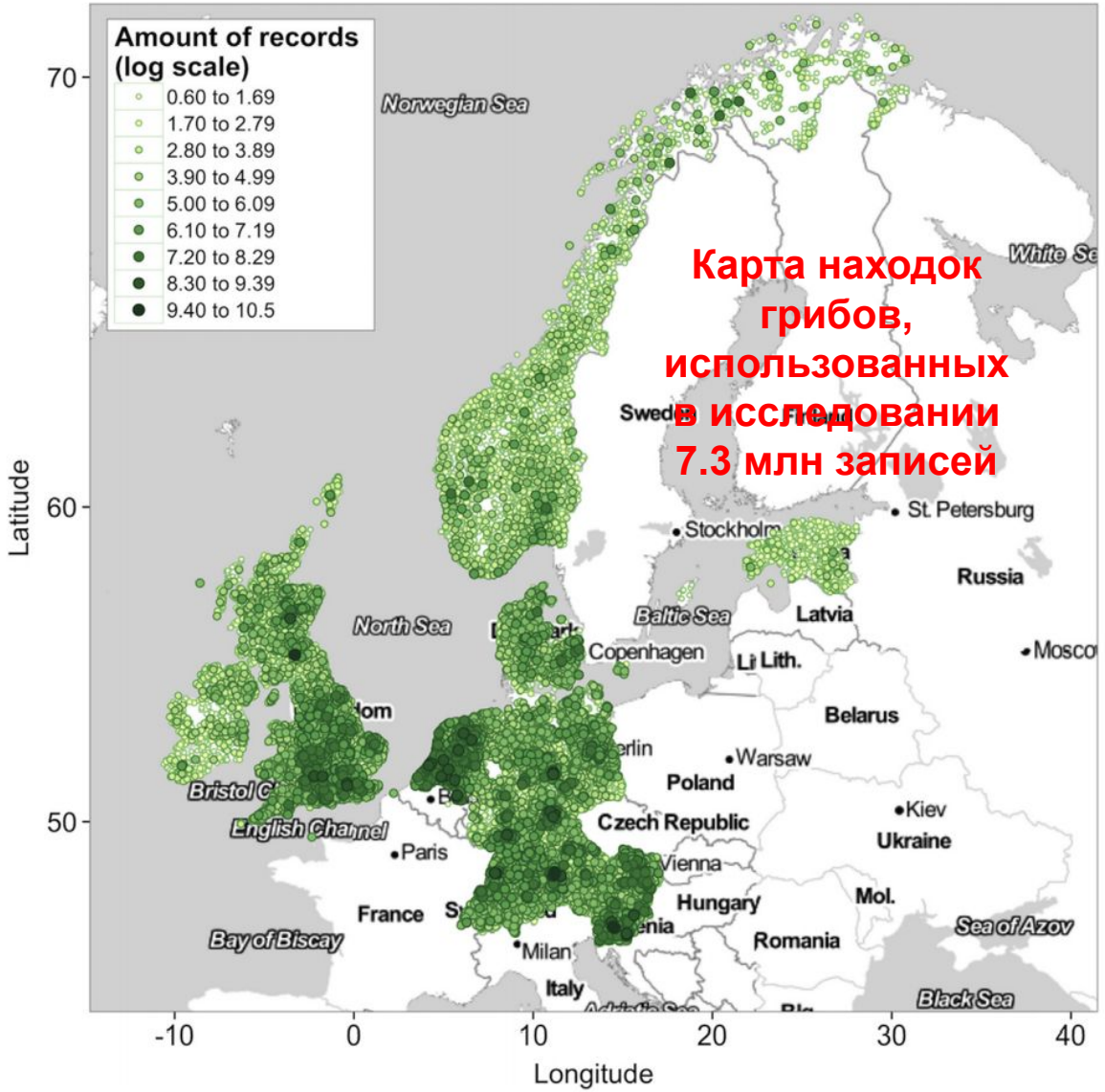
Big data integration: Pan-European fungal species observations assembly for addressing contemporary questions in ecology and global change biology

- Таксономический анализ
- Анализ сходства сообществ грибов в разных регионах
- Фенология появления плодовых тел
- Научный потенциал собранного набора данных
- Анализ данных с позиций глобальных изменений климата

Technical Focus

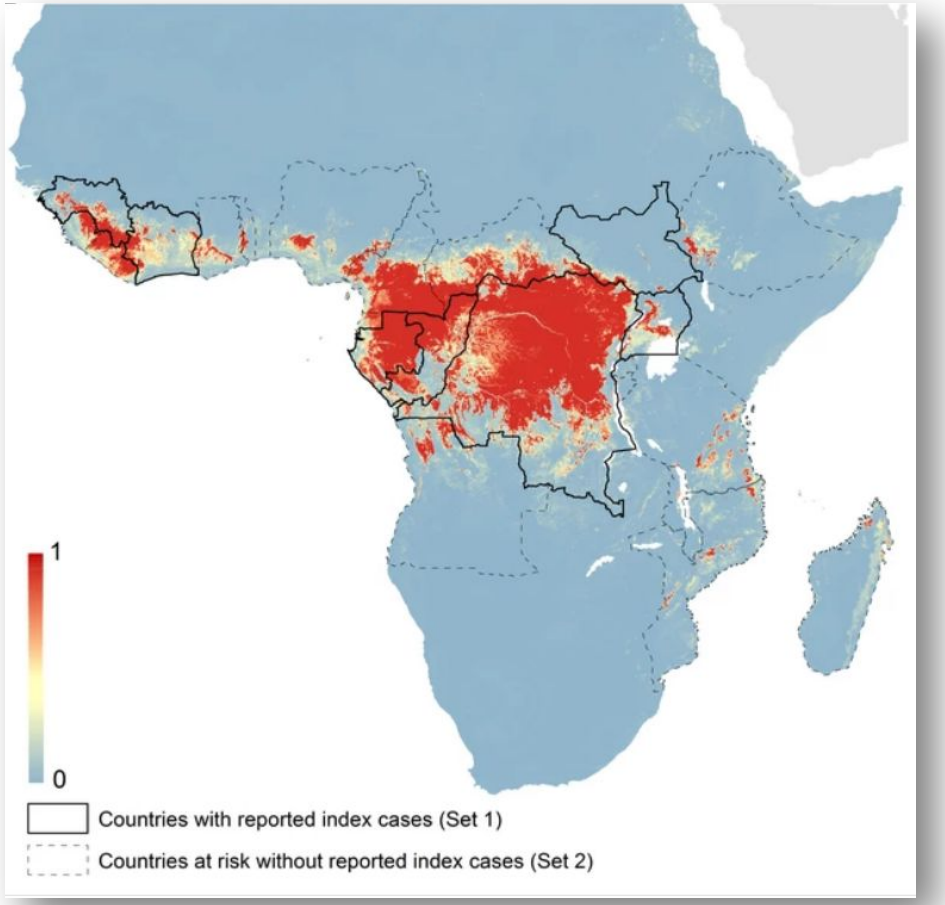
Big data integration: Pan-European fungal species observations' assembly for addressing contemporary questions in ecology and global change biology

Andrew et al.
Fungal Biology Reviews, 2017
https://doi.org/10.1016/j.fbr.2017.01.001



Mapping the zoonotic niche of Ebola virus disease in Africa

- Смоделированы экологические ниши трех видов летучих мышей, связанных с передачей вируса Эбола
- Данные получены из глобальной базы по биоразнообразию GBIF
- Результаты показали, что зоны риска охватывают 22 страны, население 22 миллиона чел.
- Результаты помогают расставить приоритеты в области эпидем. надзора и диагностики в зонах повышенного риска

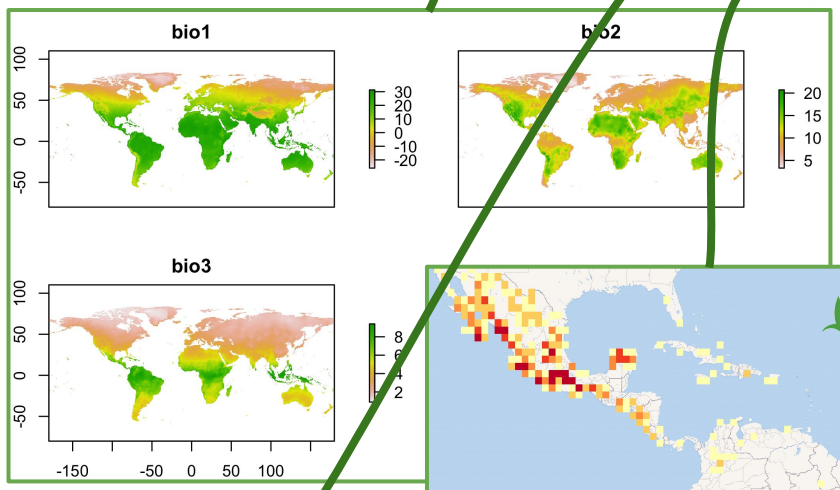


Распространение вируса Эбола, предсказанное моделью

Pigott et al., 2014
https://doi.org/10.7554/eLife.04395.001

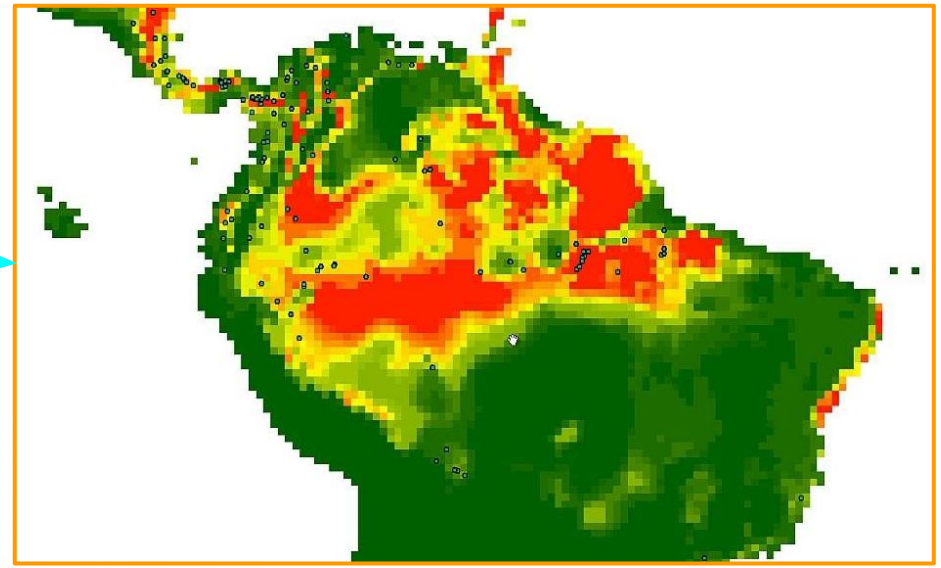
Species Distribution Modelling (SDM)

source data



algorithm

model



Глобальное распределение разнообразия дождевых червей

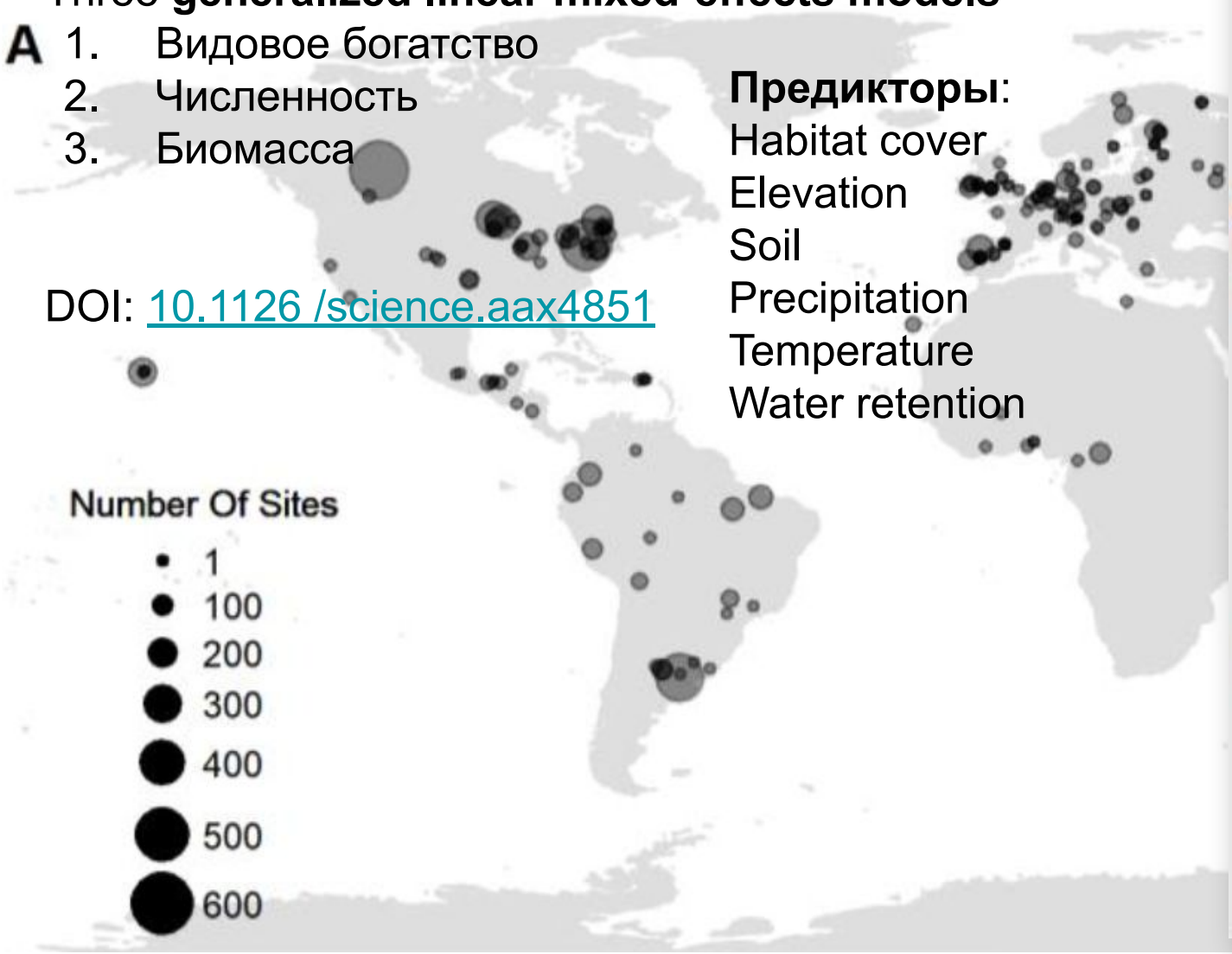
6928 точек сбора в 57 странах

Three **generalized linear mixed-effects models**

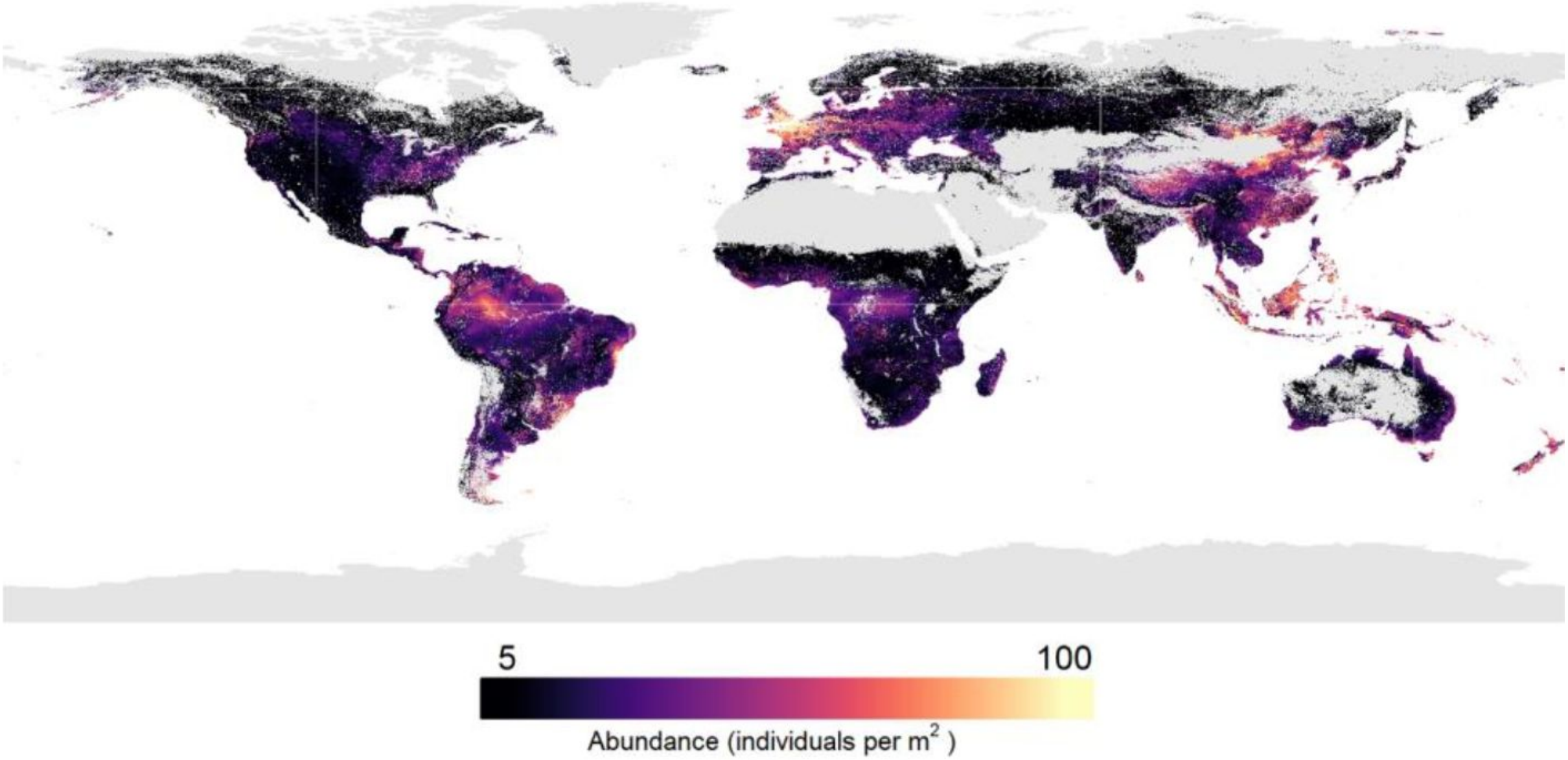
1. Видовое богатство
2. Численность
3. Биомасса

Предикторы:
Habitat cover
Elevation
Soil
Precipitation
Temperature
Water retention

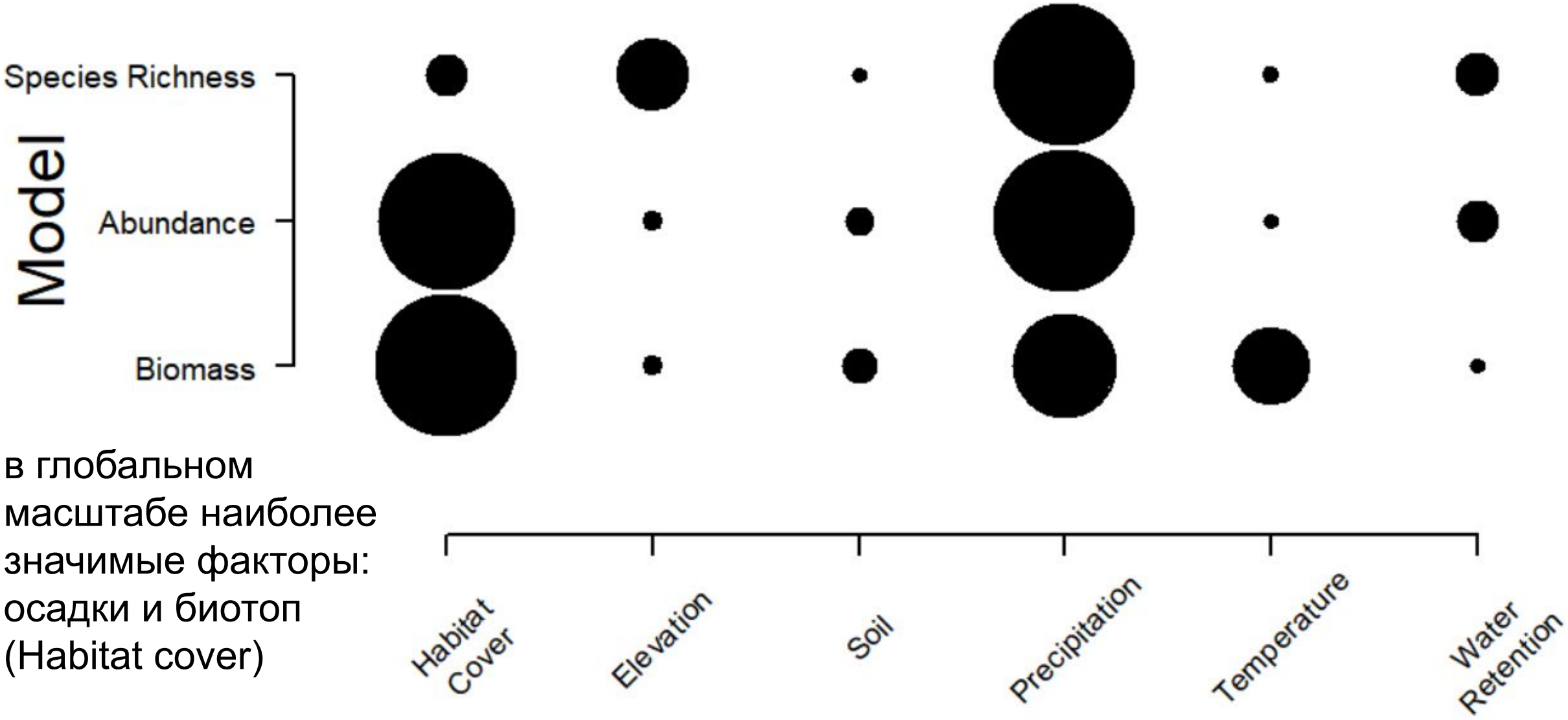
DOI: 10.1126 /science.aax4851



Распределение обилия, в экз. на кв. м

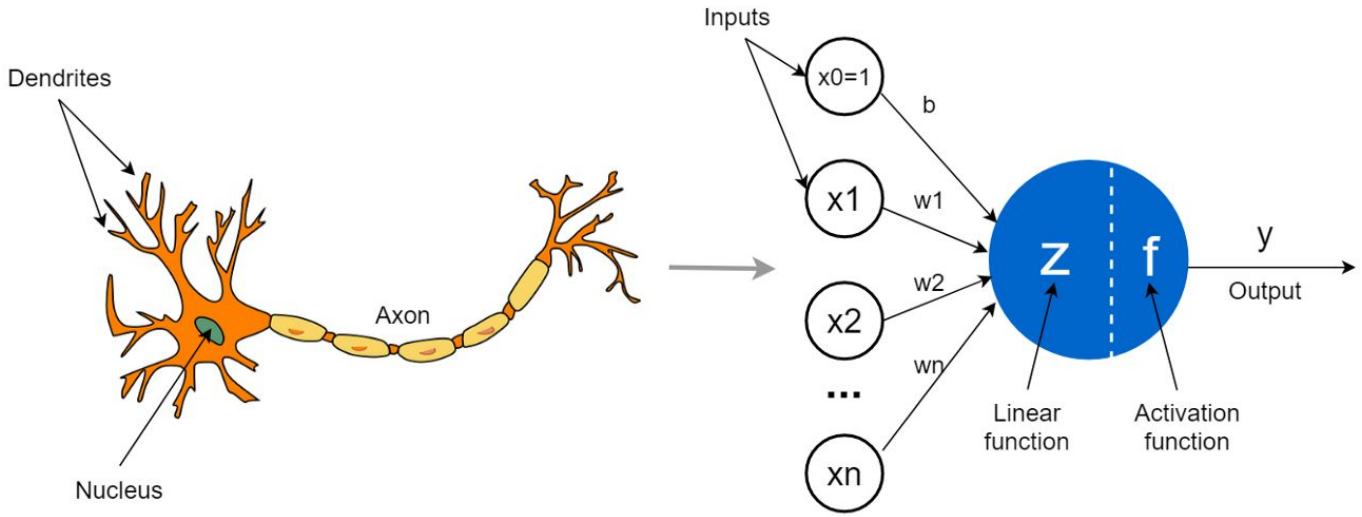


Влияние факторов на население дождевых червей



в глобальном масштабе наиболее значимые факторы: осадки и биотоп (Habitat cover)

Искусственные нейронные сети

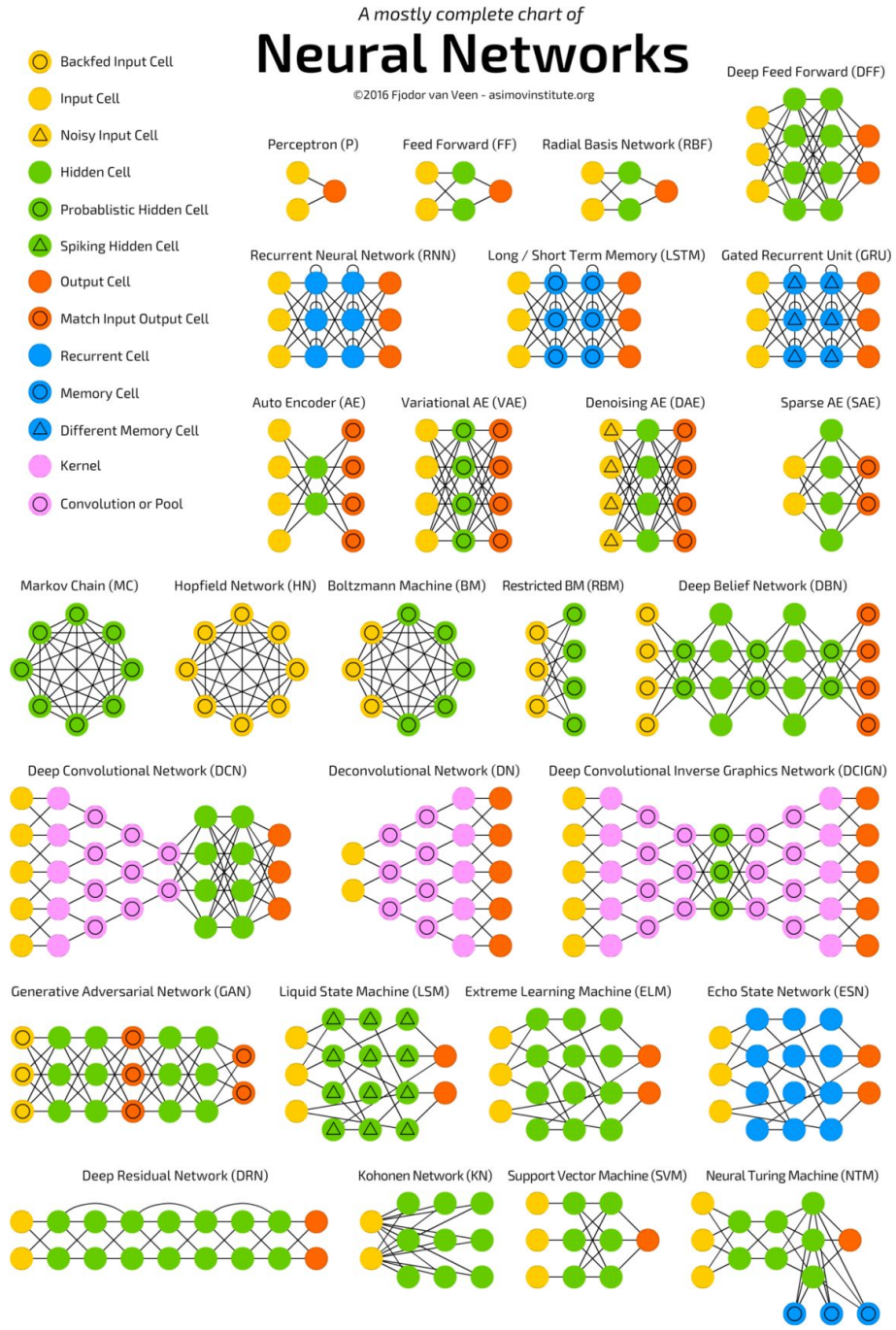


Для выполнения задачи нет заранее определенного алгоритма, но есть архитектура нейронной сети разработанная для решения какого-то определенного класса задач

У каждого искусственного нейрона есть свой вес - "мощность исходящего сигнала"

Обучение нейросети - стохастический процесс, который меняет вес нейронов

В процессе обучения происходит кросс-валидация на тестовой выборке размеченных данных



Сверточные нейронные сети

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$0_{\times 0}$	$1_{\times 1}$	$1_{\times 0}$	1	0
$0_{\times 1}$	$0_{\times 0}$	$1_{\times 1}$	1	1
0	0	1	1	0
0	1	1	0	0

Image

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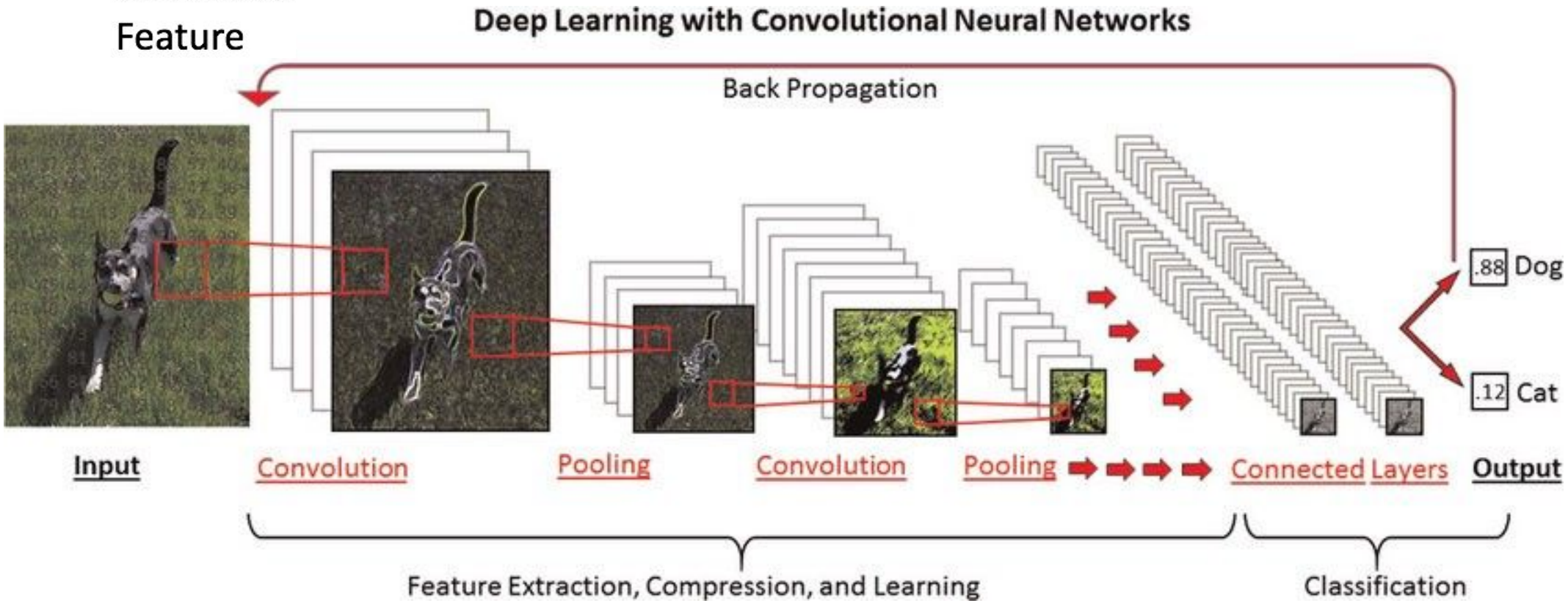
Convolved Feature

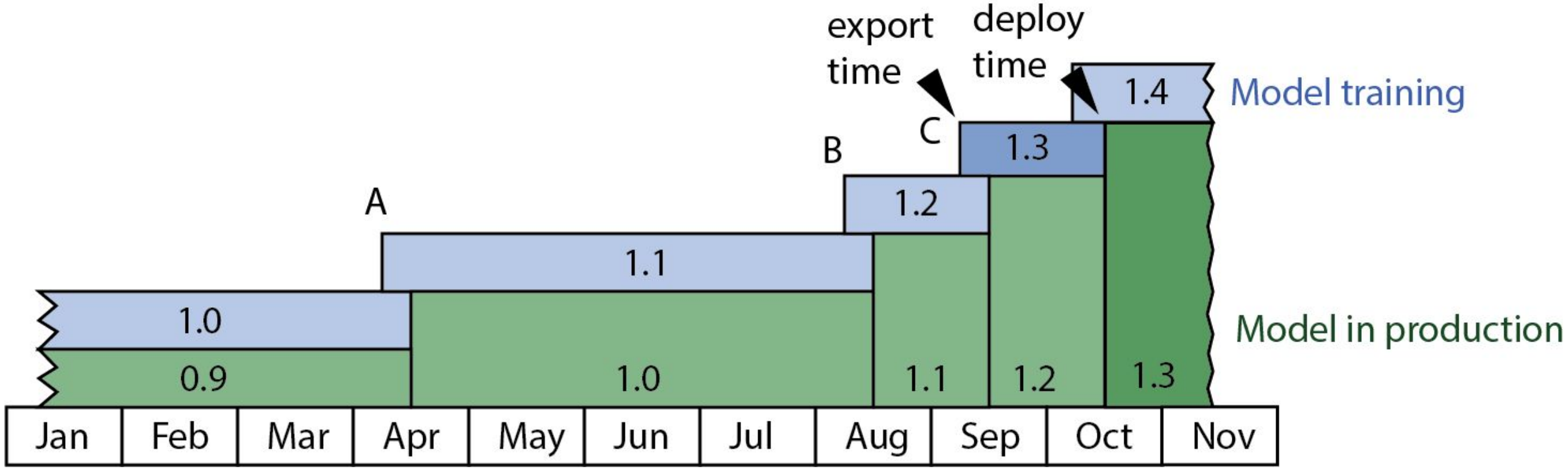
Convolutional Neural Network
основа работы сети - свёртка изображений

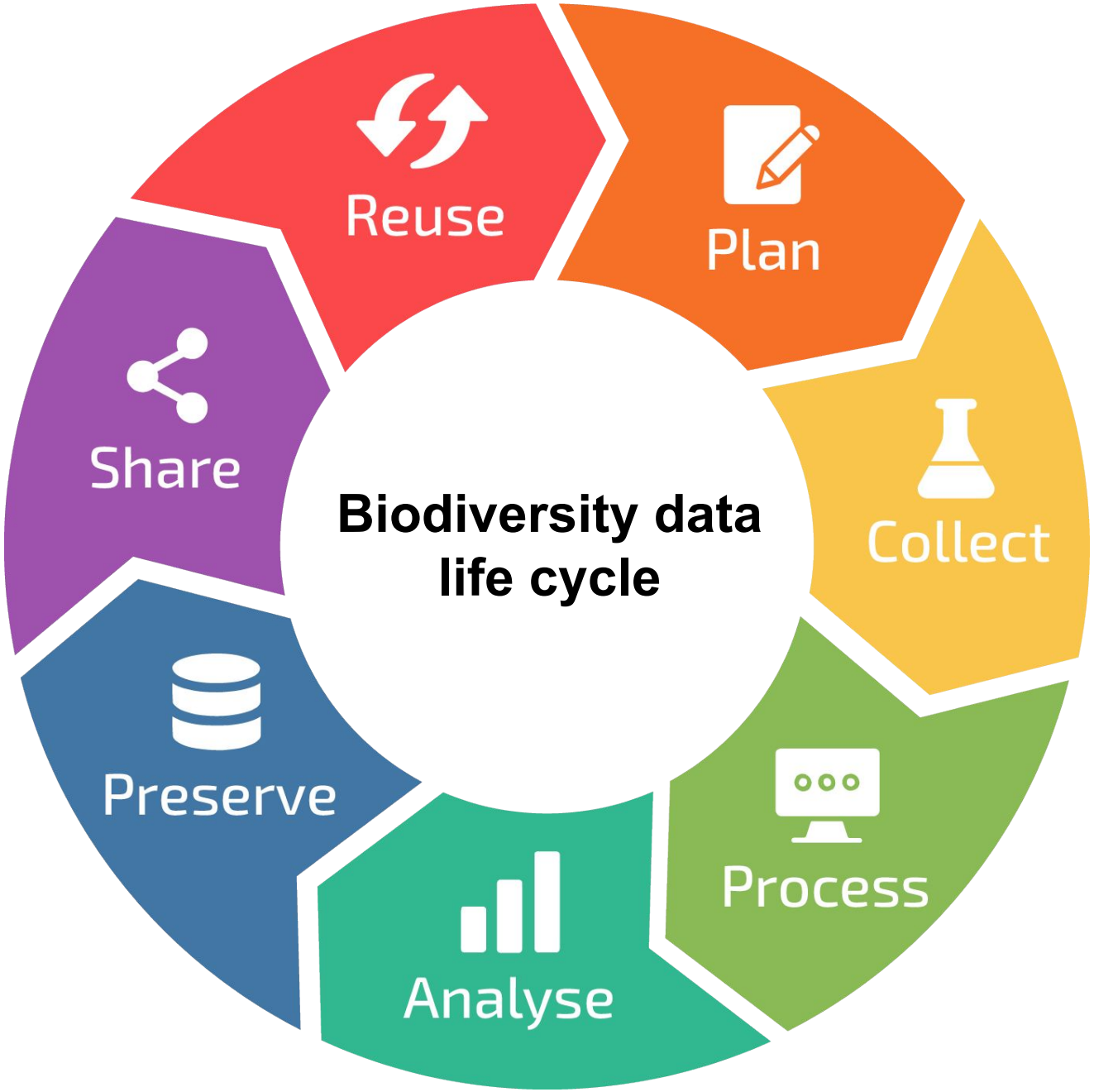


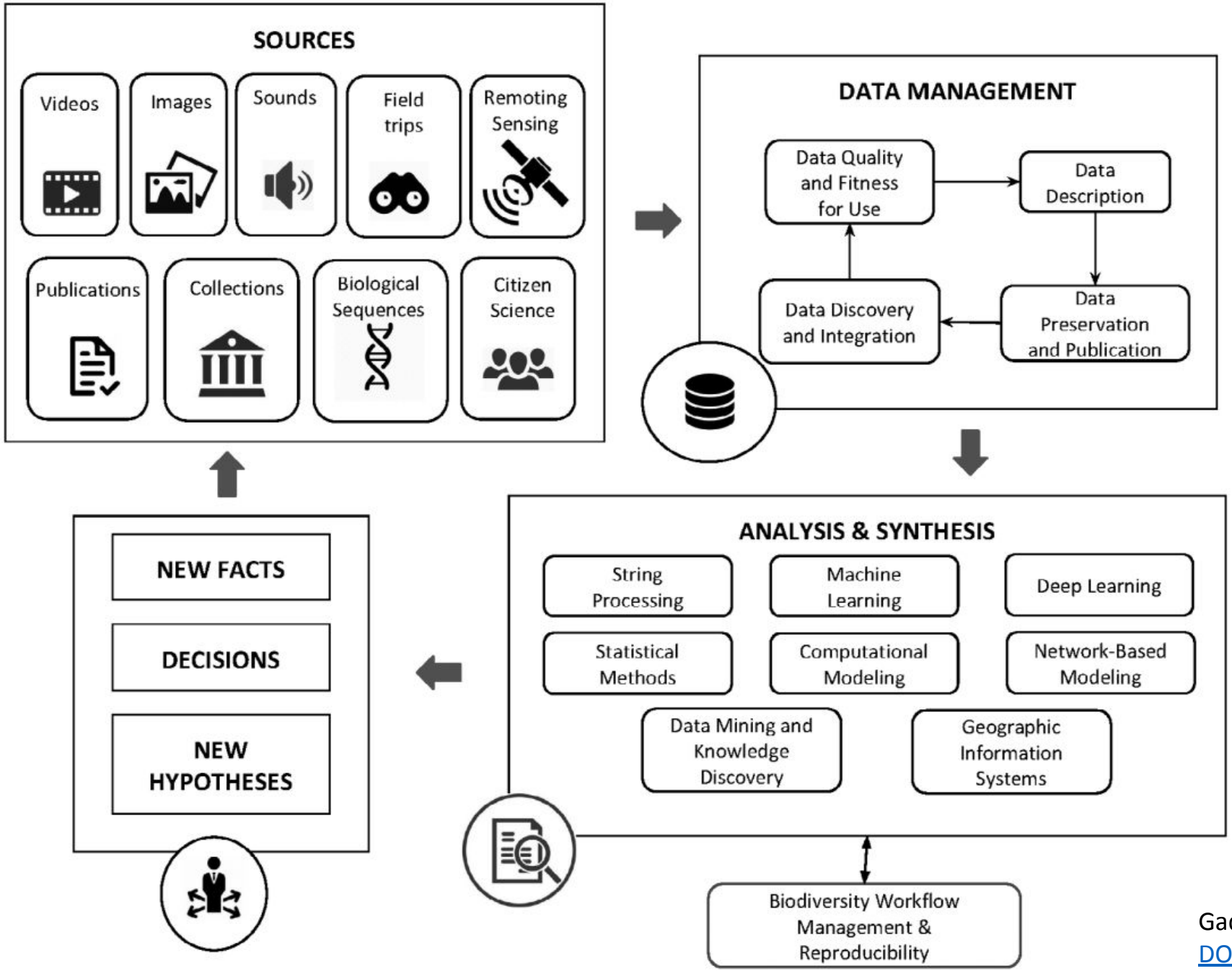
Нейронная сеть в iNaturalist

первая система распознавания изображений была запущена в 2017 году, включала 5089 таксонов. Обучение проводилось на 579 184 учебных изображений и 95 986 тестовых.

Актуальная Computer Vision Model включает 66 214 таксонов, для каждого из которого отобрано как минимум 50 качественных изображений




Biodiversity data life cycle
Plan
Collect
Process
Analyse
Preserve
Share
Reuse



Gadelha et al., 2020
DOI: 10.1002/widm.1394

International Biodiversity Informatics Landscape
Информатика биоразнообразия в мире

Vocabularies & Standards

Biodiversity Information Standards
TDWG

CETAF
CONSORTIUM OF EUROPEAN TAXONOMIC FACILITIES

Catalogue of Life

International Portals

GBIF
Global Biodiversity Information Facility

LifeWatch ERIC

BOLD SYSTEMS

OBIS
OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

Digitization

BHL

iDigBio
Integrated Digitized Biocollections

DiSSCo
Distributed System of Scientific Collections

Soft & Data analysis

R

QGIS

ATLAS OF LIVING AUSTRALIA
sharing biodiversity knowledge

Citizen science

eBird

iNaturalist

Share

PENSOFT

arpha
Journal Publishing Platform

Материалы для самостоятельного изучения

Luiz M. R. Gadelha Jr et al., 2020. A survey of biodiversity informatics: Concepts, practices, and challenges

Bisby F.A. (2000) The quiet revolution: Biodiversity informatics and the internet. *Science,* 289: 2309-2312 DOI: 10.1126/science.289.5488.2309

Edwards J.L., Lane M.L, and Nielsen E.S. (2000) Interoperability of Biodiversity Databases: Biodiversity Information on Every Desktop. Science, 289, 5488, 2312-2314 DOI: 10.1126/science.289.5488.2312

The future is already here —
it's just not very evenly distributed

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