

# Beyond the print and PDF prisons: Data about biodiversity want to be free

June 30, 2022

World Biodiversity Forum

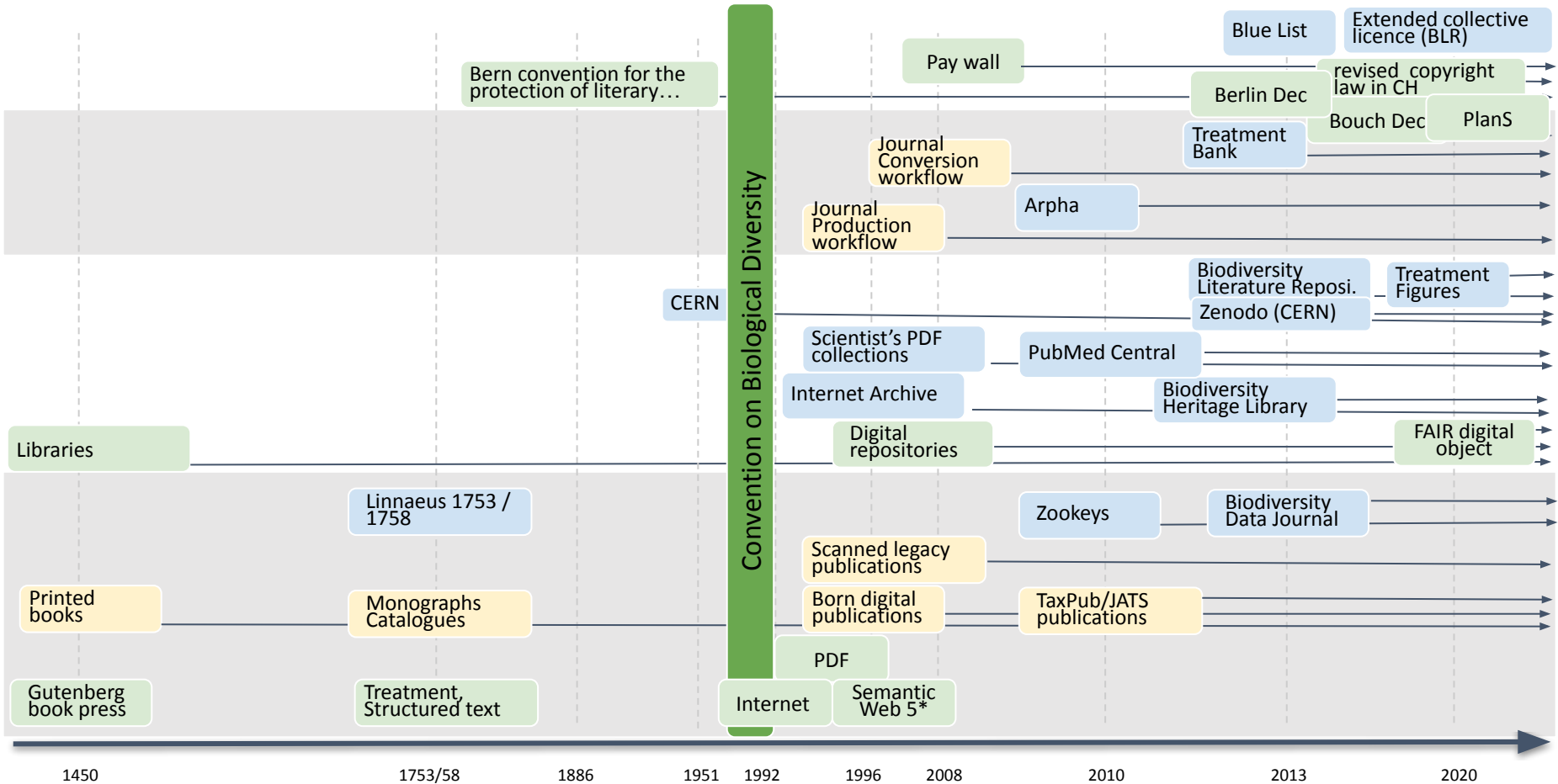
Davos, Switzerland

Donat Agosti

ORCID: [0000-0001-9286-1200](https://orcid.org/0000-0001-9286-1200); [@myrmoteras](https://twitter.com/myrmoteras)

Plazi, Switzerland

# Brief history of publishing in biodiversity / taxonomy





United Nations

### Article 7. Identification and Monitoring

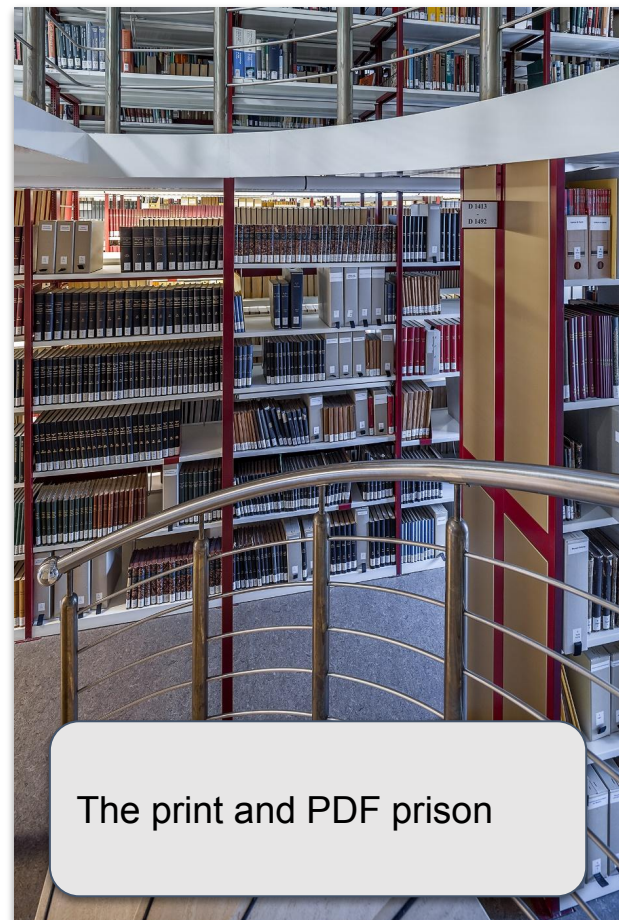
How many species do we lose?

How many species do we know?

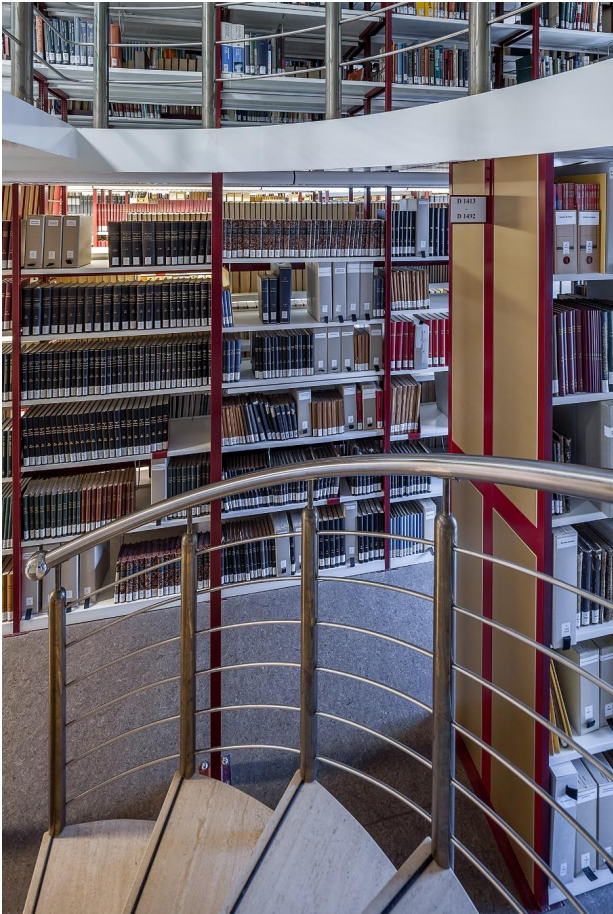
How many species are on Earth?

### Article 6. General Measures for Conservation and Sustainable Use

What do we know about the species?



The print and PDF prison



## Known biodiversity knowledge

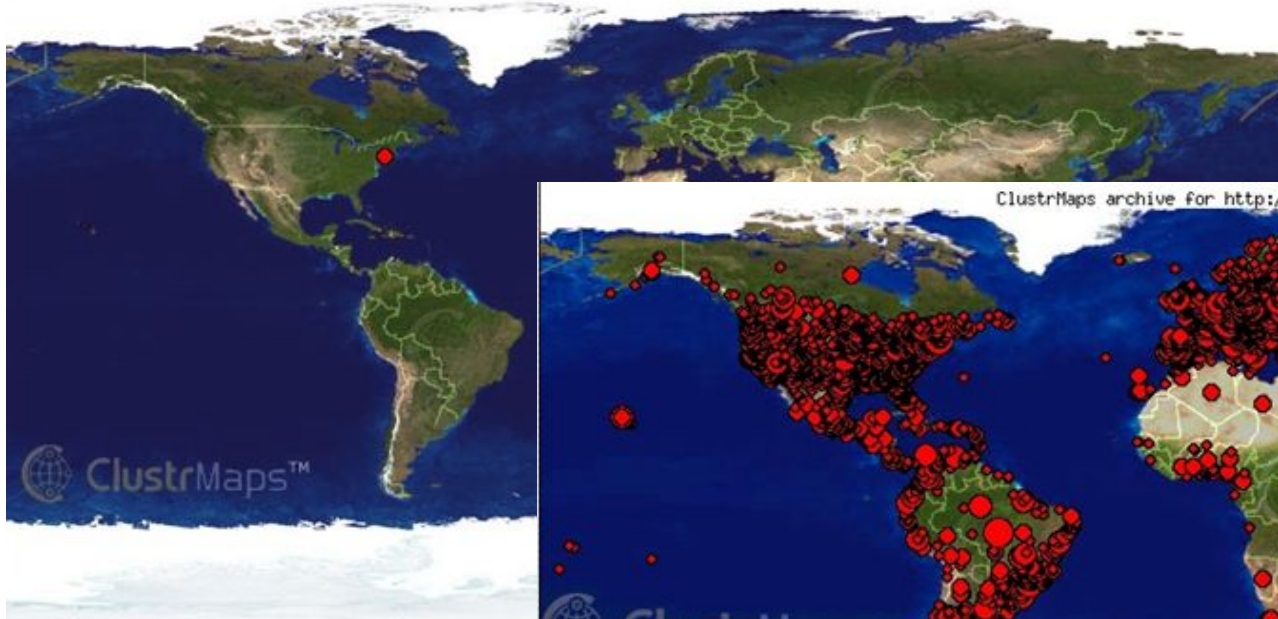
- Empiric science: all results published
- 500,000,000+ printed pages
- >> 1,000 journals publishing taxonomic content
- > 1,900,000 species described
- > 20,000,000+ taxonomic treatments
- approx. 18,000 new species discovered / year
- >> Millions of specimens identified by specialists (material citations)
- Billions of facts

BUT: only ca. 10-30% of the knowledge is digital.  
Most is “unknown known knowledge”, not Digital Accessible Knowledge (DAK)

# The impact of WWW in the 90ties



Before antbase.org, Harvard's Museum of Comparative Zoology could claim to be the only location with a complete set of ant systematics publications from 1758 - present.



109775 visits from 28 Aug 2006 to 29 Aug 2007

! distance in which individuals are clustered  
Total number of visits depicted above = 109457

Dot sizes:

● = 1000 +   ● = 100 - 999   ● = 10 - 99   ● = 1 - 9

Through antbase.org's digital library, access to this body of literature is worldwide, and it is actively used (>10,000 visits in one month only).



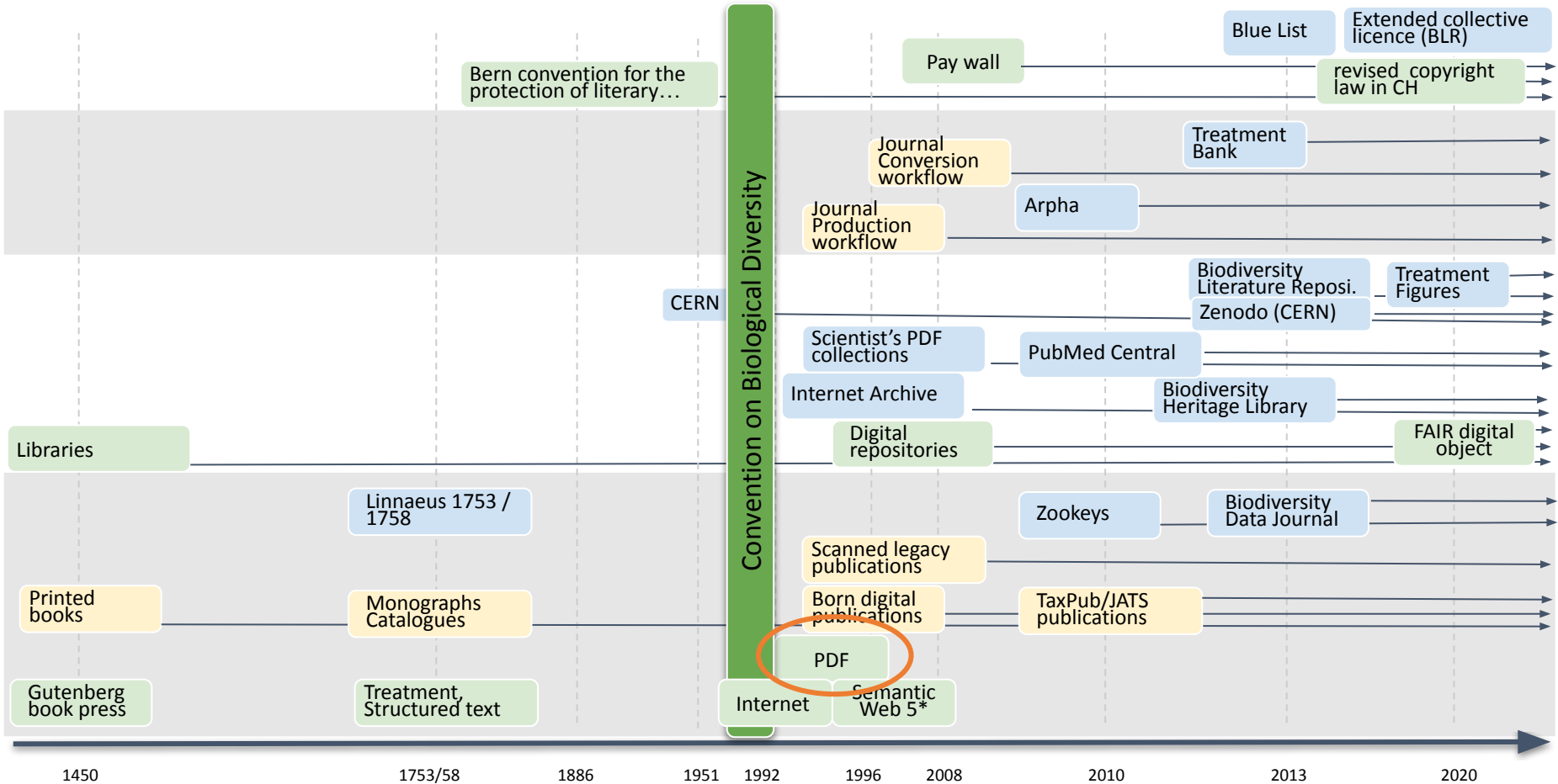
## **Discovering known biodiversity**

Create a list of the Earth' known taxa, and related digital accessible knowledge embedded in scholarly publications as open findable, accessible, interoperable and reusable data about the Earth's species (FAIR digital objects), as input to the biodiversity knowledge graph, liberated from scholarly publications.

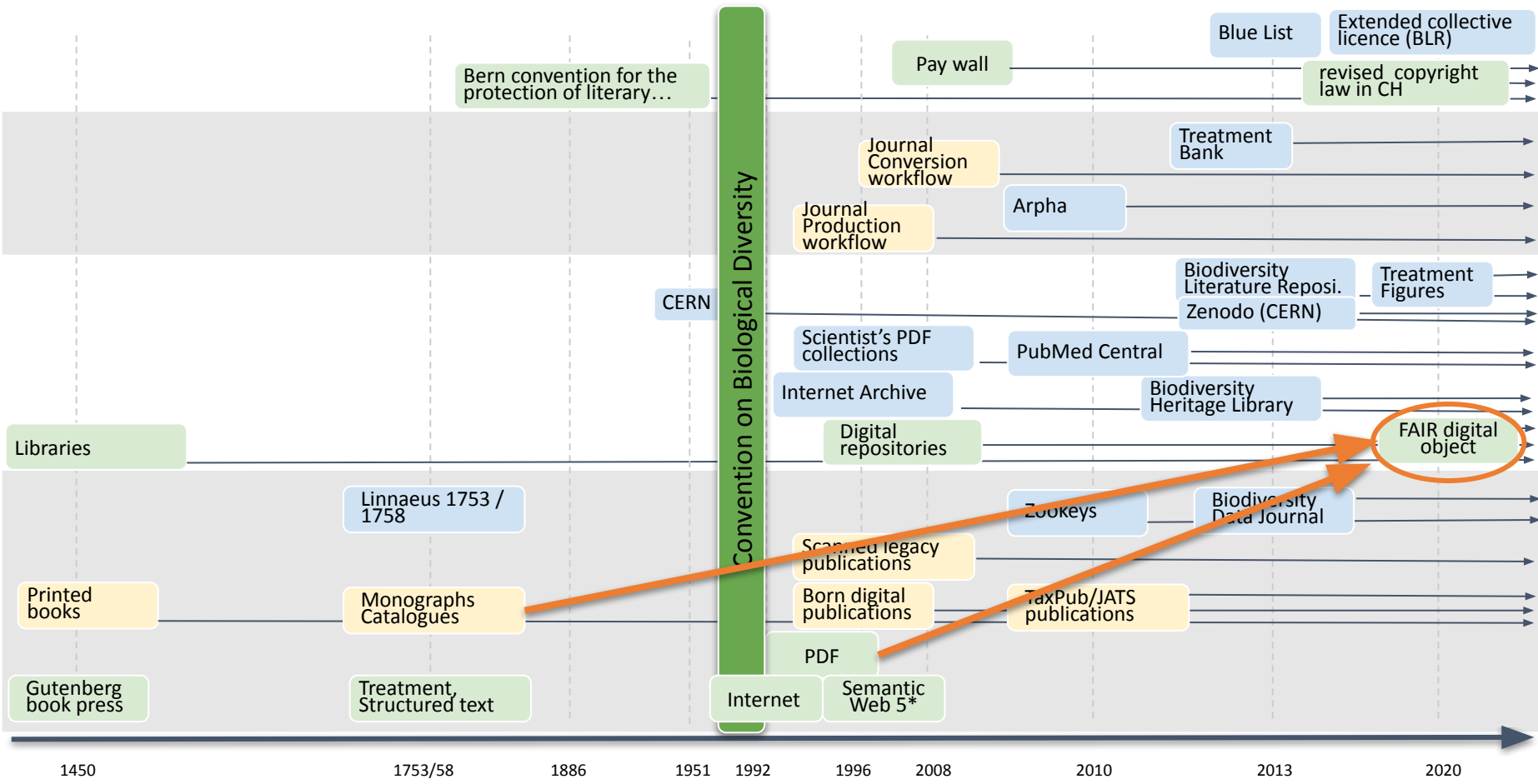
## **Digital accessible knowledge in biodiversity (DAK)**

- Data understandable by human and actionable by machine reflecting the growth of our knowledge and interdependence of biodiversity.
- Editorial structure including textflow, paragraphs, sections such as title, authors and affiliations, materials and methods, etc., tables, figures, bibliographic references and their citations in the text.
- Semantic annotated (e.g. using TDWG standards) data at the base of the biodiversity knowledge graph:
  - data about a taxon (taxonomic treatments with their nomenclature section)
  - cited previous treatments (treatment citations)
  - cited specimens (material citations)
  - named entities (persons, taxonomic names, accession -, collection -, institution - or specimen codes)
  - attributes including their persistent identifiers

# Brief history of publishing in taxonomy as seen by Plazi

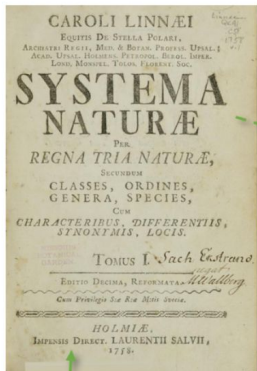


# Brief history of publishing in taxonomy as seen by Plazi





# Digital Accessible Knowledge: Treatment



*Apis mellifera* L.

Linnaeus, 1758

4 819 taxa  
LINNAEUS(2818) 1758

Type of  
*Apis mellifera* L.  
European honeybee

Type specimen = Standard

Natural Science Collections:

3.5 Billion objects

10 million types

2 million standards



576 INSECTA HYMENOPTERA. Apis.

fuccina. 14. *A. thorace flavescente subvillosa, abdomine nigro: cingulis quatuor albis.*  
*Habitat in Terris australibus.*  
*Reptum subulatum, conivum, bivalve.*

zonata. 15. *A. subpubescens fusca, abdomine cingulis quatuor caeruleis. M. L. U.*  
*Habitat in Indiis.*

**Taxonomic treatment**

mellifera. 17. *A. pubescens, thorace subgriseo, abdomine fusco, pedibus posticis glabris utrinque marginibus ciliatis.*  
*Fs. fove. 1003. Swamm. bibl. t. 17. f. 1. operaria.*  
*Musff. inf. 2. Aldr. inf. 20. f. 3. femina.*  
*Fonf. inf. 1. t. 2. f. 1. mares.*  
*Rag. inf. 240. Reaum. inf. 5. t. 21. 23. 2. 22. 3. 21. operaria.*  
*f. 2. mares. f. 4. femina.*

**Treatment citations**

**Distribution**

*Habitat in Europæ arboribus cavis, frequentius culta.*  
**REGINA (Femina) unica, altior, oblongior, aculeata.**  
**FUCI (Mares) ad 1600, incermes, antennis 11-articulatis. OPERARIE (Spadones) ad 20000, antennis 15-articulatis, ventriculus 2 melis ceræque, aculeata.**  
*Ense retrorsum serrato venosato latente intra vaginam cuspidatam.*  
**REPUBLICA Alvearii gynæocratica est, dum Femina imperans semper inclusa, operariorum custodiam satellitio assidue stipata, antennis obvium Marem quemcumque salubrem, ut in prælo compressit cum illius vitæ dispensatione, vna ad 40000 sæpe quotannis in adaptatis javi crevis: primum neutra, dein mascula, demum nonnulla feminina; his exclusi gradatim supra calorem afflatis ordinaria, adolebant Larvæ sexstrido, mox ad parietes cellæ, operuntur usque dum adulta evadant, alteroque die mellificæ. Mares, ignavum petas, ovarii apricantur ferentis debent, gula detriti. Spadones operarii, neutri, imbecilli, mel e cellare, ceram e palline florum scdulo legunt, miliaris spatio, quoties per calum licet, redeunt, savor ceræ.**

INSECTA HYMENOPTERA. Apis. 577

**ctd.** *cereæ struunt sexangulati-prismaticos, easque melle replent, feminam præcipue nutriunt, cellas inhabitatas reparant, vigiliis & stationibus ad portas institunt, dufces arcens aculei istis venosato sibi ipsis licet lethali, maresque demum transactis nuptiis expellunt. Noces imprimis sunt Matricæ, Hirundinæ, Pavonis, Bufonæ, Muræ, Crabronæ, Vespe, Pediculi, Apes fures, Mellonellæ, Vermis &c. Flores præcipue omnes, præcipui sunt Echium, Bor, Seryllum ali; imprimis Erica Sæ, Scaberrima, Scamus, Tilia Polonis, Romanicus, Thymus Atticis, Verbatus Cæstis, Alysanthum Sardinis, Aconitum Ponticis &c. hinc pretium varium mellis: Vide Reaumurium, Aubenton.*

**Description**

**Biology & Ecology**

subterra. 18. *A. pubescens, thorace griseo, abdomine fusco, pedibus undique villosis.*  
*Habitat in Terra sabulosa siccare, quam foraminibus pluribus parum remotis penetrant & diffundunt adificanc plaves.*

variegata. 19. *A. thorace abdomineque albo variegato.*  
*Habitat in Europa.*

rostrata. 20. *A. labio superiore conico inflexo, abdominis fasciis glaucis repandis.*  
*Fs. fove. 999. Apis pedibus maxillisque flavis apice nigris, inclivis abdominis glabris margine nigris.*  
*It. gol. 356.*  
*Habitat in Europæ monticulis areosis.*

manicata. 21. *A. nigra, pedibus anticis hirsutissimis, ano multidentato, abdomine maculis flavis.*  
*Habitat in Europa.*

4-dentata. 22. *A. fusca abdominis cingulis quinque albidis, ano quadridentato: intermedis bidentis.*  
*Swamm. bibl. t. 26. f. 4.*  
*Habitat in Europa.*

florifera. 23. *A. nigra, abdomine subcylindrico incurvo apice bidentato, tibus posticis apice spinosis.*  
*Habitat in Europa, per noctes floribus inhaerens.*

24. A.

Each type has a published taxonomic treatment  
Each taxonomic treatment is multiple times augmented



Tens of millions of treatments exist as part of ca 500 Million published pages of biodiversity literature  
Each includes a numerous facts

# Treatments as FAIR digital objects in the Biodiversity Literature Repository



**zenodo** Search Upload Communities

June 3, 2022

**The trouts of the upper Kura and Aras rivers in Turkey, with description of three new species (Teleostei: Salmonidae)**

Turan, Davut · Kottelat, Maurice · Kaya, Cüneyt

The trouts of the upper Kura and Aras rivers in Turkey, with description of three new species (Teleostei: Salmonidae). Zootaxa 5150 (1): 43–62. DOI: <https://doi.org/10.11646/zootaxa.5150.1.2>

1 views 0 downloads

**Article**

**The trouts of the upper Kura and Aras rivers in Turkey, with description of three new species (Teleostei: Salmonidae)**

**Abstract**

The taxonomic status of the listed and addressed trout species in the Kura and Aras river drainages is evaluated.

Files (1 file)

1 file not publicly accessible

Name	Size
msd3259749196023814323363816	911.8 MB

References

Citations

1 Literature (1 Dataset) (1 Software) (1 Unknown) (0 Clonings to this version)

No citations.

**Article**

<https://zenodo.org/record/3626084#.X5AqkAzb2BA>

**zenodo** Search Upload Communities

June 3, 2022

**Salmo araxensis Turan & Kottelat & Kaya 2022, new species**

Turan, Davut · Kottelat, Maurice · Kaya, Cüneyt

**Salmo araxensis**, new species  
Figs 4–6

**Salmo trutta maculigula** (non Duméril, 1856), Aras, 1974–76–76 (Aras River).

**Salmo trutta caspius** (non Kessler, 1877), Tortorice, 1958–11 (Aras River).

**Holotype**: FFR 3224, 259 mm SL, Turkey, Kars Prov., Susuz district Kirkların Stream, a tributary of Kars Stream, Aras River drainage (40°51'N 43°01'E), D. Turan & S. Ergin, 3 September 2006.

**Paratypes**: FFR 3122, 6–140–200 mm SL, CMK, 19730; 2, 133–172 mm SL, same data as holotype (FFR 3114, 12, 116–201 mm SL, Kaya Prov., 50 km SW of Doğruyazı, 19 km SW of Kars Stream (40°49'N 43°07'E), D. Turan & S. Ergin, 3 Sept. 2006); 01907C, Porukulu (Aras) July 2006 = FFR 3111 (42°54'E, Aras River); 01907D, Aras River; 01907E, Aras River; 01907F, Susuz district, Inçilipinar Stream, Baybuz, 15 July 2002.

**Diagnosis**. *Salmo araxensis* is distinguished from all the species of *Salmo* in adjacent waters by a combination of the following characters: body grey to brownish in life, commonly one black spot behind eye; family marked; 3–10 black spots on preopercle and opercle; black spots on body few (7–21), scattered on back and upper part of flank, overlaid with a rounded narrow white ring; no spots few (20–29), small (about half of pupil diameter), family marked; scales surrounded by a narrow white ring in males and females, usually organized in 2–4 irregular longitudinal rows on median and lower part of flank, mesial length 40–10% SL. In males, 8–9 in females, reaching slightly beyond eye in males larger than 210 mm SL, and in females larger than about 100 mm SL. 109–114 branched scales; 27–28 scale rows between lateral line and dorsal-fin; 17–20 scale rows between lateral line and anal-fin; 10–13 scale rows between lateral line and base of adipose fin; 11–22 on outer side of first gill arch; 10–15 pan marks on flank, visible in specimens up to about 150 mm SL. No dark band on flank.

**Description**. General appearance is shown in Figs. 5–6. Morphometric and meristic data are given in Tables 2–3. Body somewhat deep, slightly compressed laterally. Dorsal profile arched in males, straight or slightly arched in females, ventral profile less arched than dorsal profile in males and females, head short, to length 54–29% SL, in males, 25–28% in females, upper profile convex in interorbital area and slightly concave at level of nostrils in males, markedly convex in interorbital area and stout in females. Mouth small, length of gape 1–16% SL, in males, 12–14% in females. Maxilla short, to length 10% SL, in males, 8–9 in females, 1–10 in males, 1–10 in females, up to about 180 mm SL, and in females larger than about 210 mm SL. Snout short, 1.5 in males, with prominent tip in males and slightly pointed in females. Adipose fin somewhat large, longer than snout, in males, 1.5–2.0.

**Lateral line** with 103–114 scales, 24–28 scale rows between lateral line and dorsal-fin; 17–20 scale rows between lateral line and anal-fin; 10–13 scale rows between lateral line and end of base of adipose fin. Dorsal fin with 3–4 simple and 0–1 branched rays, dorsal margin slightly reduced in males and 10–12 branched rays, outer margin convex. Anal fin with 1 simple and 0–3 branched rays, outer margin convex. Anal fin with 1 simple and 0–3 branched rays, outer margin convex. Caudal fin slightly convex anteriorly and concave posteriorly. Caudal fin slightly forked, upper part pointed and lower lobe rounded; 32 lateral scales 10–11 in 10–11 cm SL males and a slightly longer head than females (24–29% SL, upper 27 vs. 23–28 mean 25.6), a slightly deeper body (22–27% SL, mean 25.0 vs. 21–26, mean 23.6), a slightly longer snout (6–8%, mean 7.1 vs. 6–7, mean 6.5), a longer maxilla (9–10% SL, mean 9.3 vs. 8–9, mean 8.6) and a somewhat greater mouth gape (9–11% SL, mean 7.6 vs. 6–10, mean 8.7) than females.

**Coloration**. In live and preserved specimens; body grey to brownish on preopercle and flank, belly yellowish. Commonly one black spot behind eye, family marked; 3–10 black spots on preopercle and opercle; 10 or 1–8 black spots on top of head. Black spots on body few (23–27 in males, 7–9 in females), small (usually smaller than pupil), overlaid, surrounded by a narrow white ring, matched to black but usually missing medially in interorbital area and on upper part of flank. Red spots few (7–21), small (smaller than pupil), not conspicuous, overlaid surrounded by a narrow white ring, usually organized in two to three irregular longitudinal rows on median and lower part of flank. Back dark grey, with one or two rows of red spots and 2–4 rows of black spots, slightly marked. Caudal fin dark grey, preopercle and anal fin greyish or yellowish in anal fin dark grey, with or without one red spot along first dark ring; 10–13 pan marks on flank, visible in specimens up to about 150 mm SL, commonly vertically elongated.

**Distribution and notes on biology**. *Salmo araxensis* is only known from three tributaries of Kars Stream (Kirkların, Porukulu and Inçilipinar streams) in Aras River drainage (Fig. 3). During various surveys in the area, *araxensis* has been observed neither in the lower part of the stream, nor in the other tributaries of Aras River, therefore, we consider that the species is not endemism and is restricted to these streams. It breeds in headwaters, with clear and flowing water, with stone and pebble bottom. Its maximum known size is 275 mm SL. Mature individuals were observed in both sexes.

**Etymology**. The name *araxensis* is derived from Arax, the ancient name of the Aras River. An adjective.

Published as part of Turan, Davut, Kottelat, Maurice & Kaya, Cüneyt. 2022. The trouts of the upper Kura and Aras rivers in Turkey, with description of three new species (Teleostei: Salmonidae). op. 43–64 in Zootaxa 5150 (1) on pages 51–53. DOI: <https://doi.org/10.11646/zootaxa.5150.1.2>

Files (7 files)

Name	Size
treatment.html	7.0 KB

ms53ec79c4af4042b43ef8300f916

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June 3, 2022

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Turan, Davut · Kottelat, Maurice · Kaya, Cüneyt

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Files (7 files)

Name	Size
treatment.html	7.0 KB

ms53ec79c4af4042b43ef8300f916

**Metadata**

Keywords: *Salmo araxensis*, *Salmo trutta maculigula*, *Salmo trutta caspius*, Turkey, Kars Province, Susuz district, Kirkların Stream, Aras River drainage, 40°51'N 43°01'E, D. Turan & S. Ergin, 3 September 2006.

**OpenAIR**

**Identifier API**

**License**

**Standard vocabularies**

**Findable**

**Accessible**

**Interoperable**

**Reusable**

**Treatment DOI**

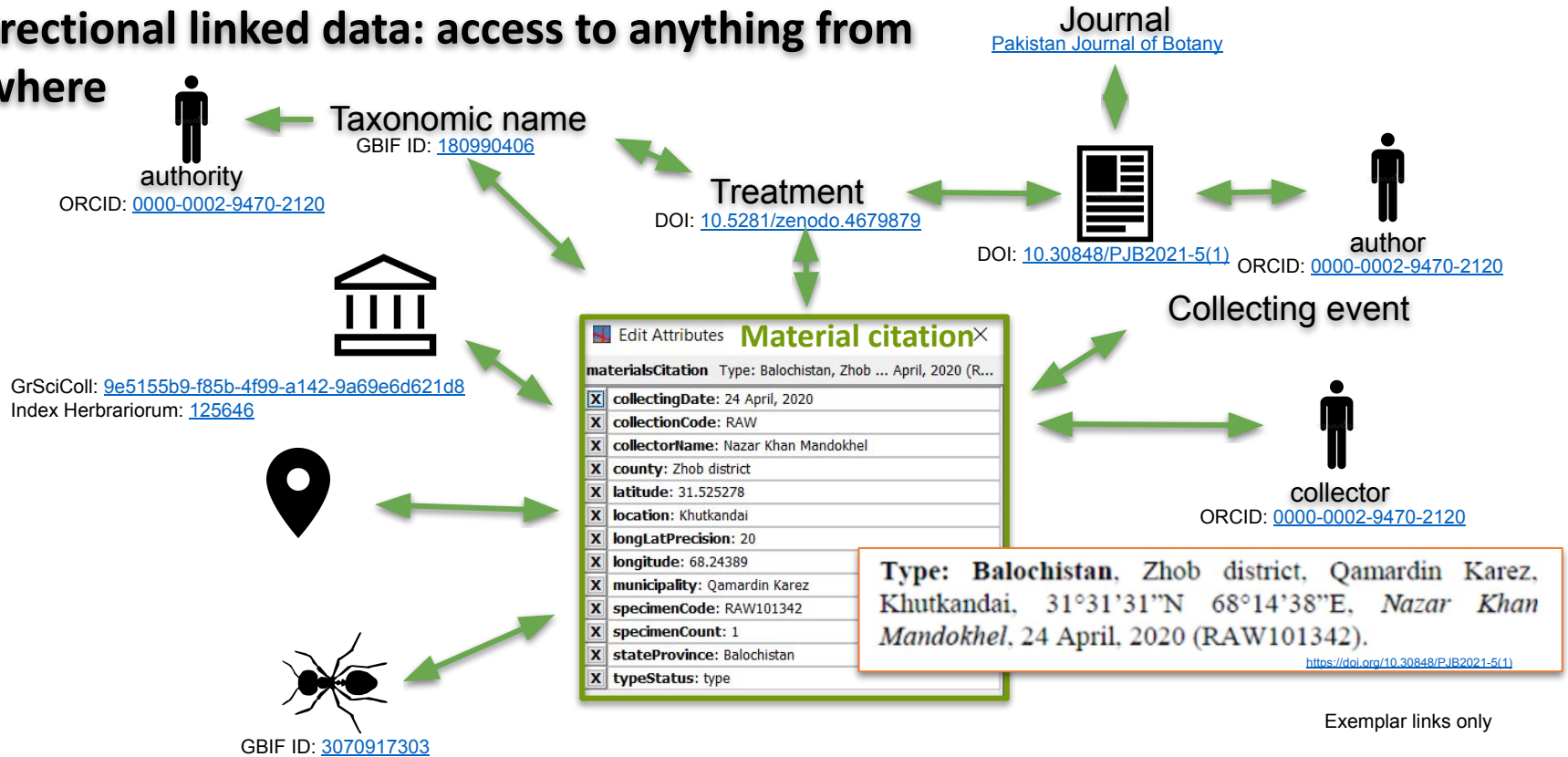
**Journal article BLR Record**

**Article DOI**





## Bi-directional linked data: access to anything from anywhere



Imagine the possible applications enabling making use of this big data?  
Imagine the time saved if all these links are hyperlinks?



# Treatment citation: Catalogue of life



PLAZI  
THE CARE OF PRESSION

FactsMission

Home Advanced About Settings

SynoSpecies

Input Genus and species here:

2019 2021

- Kiotina spatulata Wu, 1948
- Hemacroneuria spatulata Li, 2019
- Hemacroneuria spatulata Wu, 1948

**Kiotina spatulata Wu, 1948**

Defining treatment not yet on Plazi

Augmenting Treatments:

- Du, Yu-Zhou; Zhu, Bin-Qing; Huo, Qing-bo (2021) 3D6DA32CFFA5B65124F7FB445E7FBF50
  - Deprecates Hemacroneuria spatulata Li, 2019

Deprecating Treatments:

- Murányi, Dávid; Li, Weihai; Mo, Raorao (2019) 038A001F4228DD396287FB84FB04FA8E
  - Deprecates by Hemacroneuria spatulata Wu, 1948

Kingdom: Animalia  
Phylum: Arthropoda  
Class: Insecta  
Order: Plecoptera  
Family: Perlidae  
Genus: Kiotina  
Species: spatulata

**Kiotina spatulata Wu, 1948**, status revised

**Kiotina spatulata: Wu 1948: 148**. Holotype male: Sichuan, China.

Illies 1966: 342 — Du et al. 1999: 64 — Stark & Sivec 2008: 162 — Murányi & Li 2016: 191 — Yang & Li 2018: 47.

**Hemacroneuria spatulata: Li et al. 2019: 354** [View Cited Treatment](#). Combination.

Remarks: The original description and illustrations of Wu (1948) show that this species has large paraprocts and paired sensilla basiconica patches on the male 10th tergum. However, these characteristics are not unique to *Hemacroneuria* and also exist in the genus *Sinacroneuria*. In

Family: Perlidae  
Genus: Hemacroneuria  
Species: spatulata

Wikidata Resource: <http://www.wikidata.org/entity/Q6387012>

- Taxon Name Kiotina spatulata
- Is subject of: [https://ca.wikipedia.org/wiki/Kiotina\\_spatulata](https://ca.wikipedia.org/wiki/Kiotina_spatulata)
- Is subject of: [https://ceb.wikipedia.org/wiki/Kiotina\\_spatulata](https://ceb.wikipedia.org/wiki/Kiotina_spatulata)
- Is subject of: [https://nl.wikipedia.org/wiki/Kiotina\\_spatulata](https://nl.wikipedia.org/wiki/Kiotina_spatulata)

Currently accepted name

Synonymized taxonomic name

Original name or new combination

**Treatment Citations**

<https://synospecies.plazi.org/#Kiotina+spatulata>

# Open access to FAIR data: A visual index to taxonomic publications

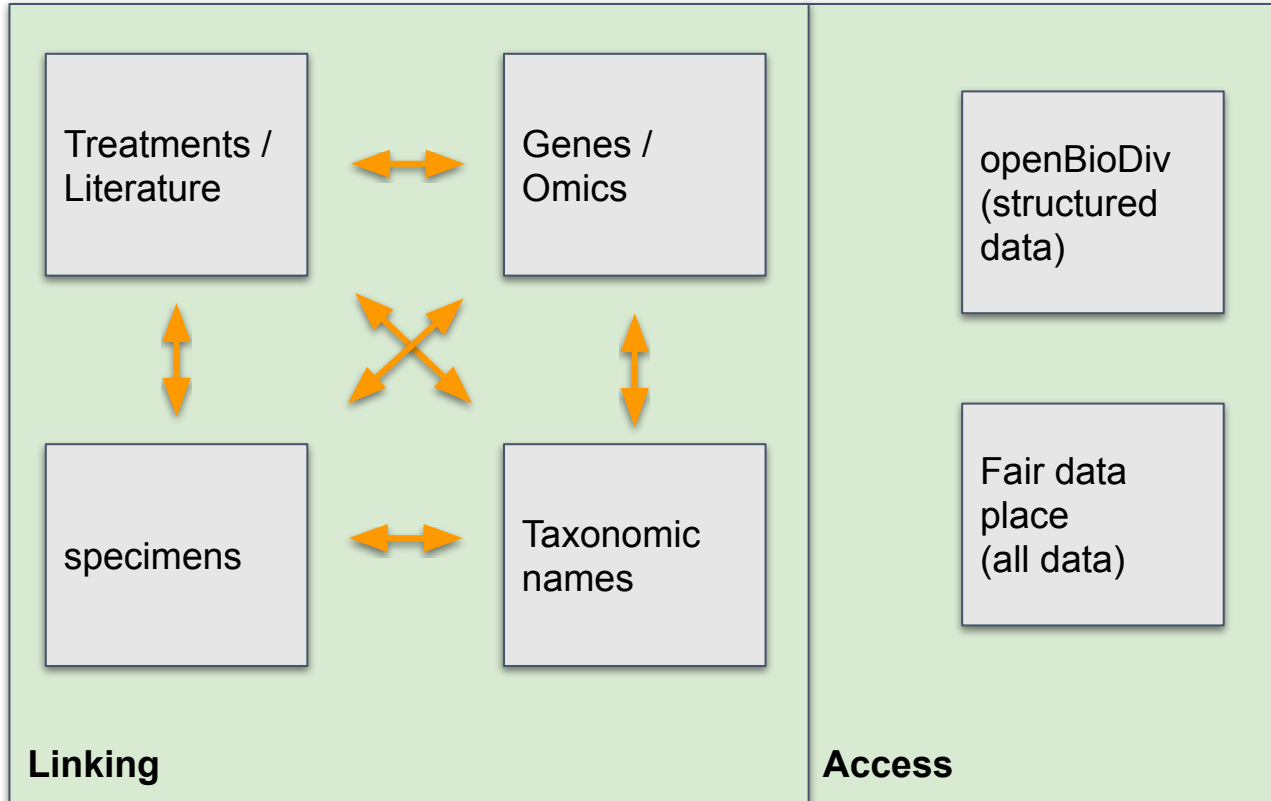


Beyond PDF...

<https://ocellus.info/>











# Research Data Life Cycle

**Get publications:**

- PDF (library access)
- Zenodo via microservice

**Receive publications:**

- PDF
- Born digital
- Scanned
- XML
- JATS
- TaxPub/JATS
- HTML / XHTML

**Decode**

- manual
- automated

**Enhance**

- semantics
- link

**Data Quality Control**

- Criteria
- Corrections

**Create**

- Open FAIR data

**Access / Metrics**

- User Interface
- API
- Dashboards

**Disseminate**

- GBIF
- NCBI

**Reuse**

**GBIF**

**Treatment Article Dataset**

New illustrations, new species and new combination of *Hemacronera Enderlein* (Psecoptera: Perlidae) from China

**Treatment**

**Treatment**

**Occurrence / Material Citation**

**Reuse**

**New data**

**FAIR Digital Objects**

**zenodo**

**zenodo**

**OpenAIRE**

**Publication**

**FAIR Digital Objects**

**Biodiversity Literature Repository**

**Access / Metrics**

- User Interface
- API
- Dashboards

**ocellus<sup>4</sup>**

A PLAZI PROJECT

**zenodeo<sup>2</sup>**

A PLAZI PROJECT

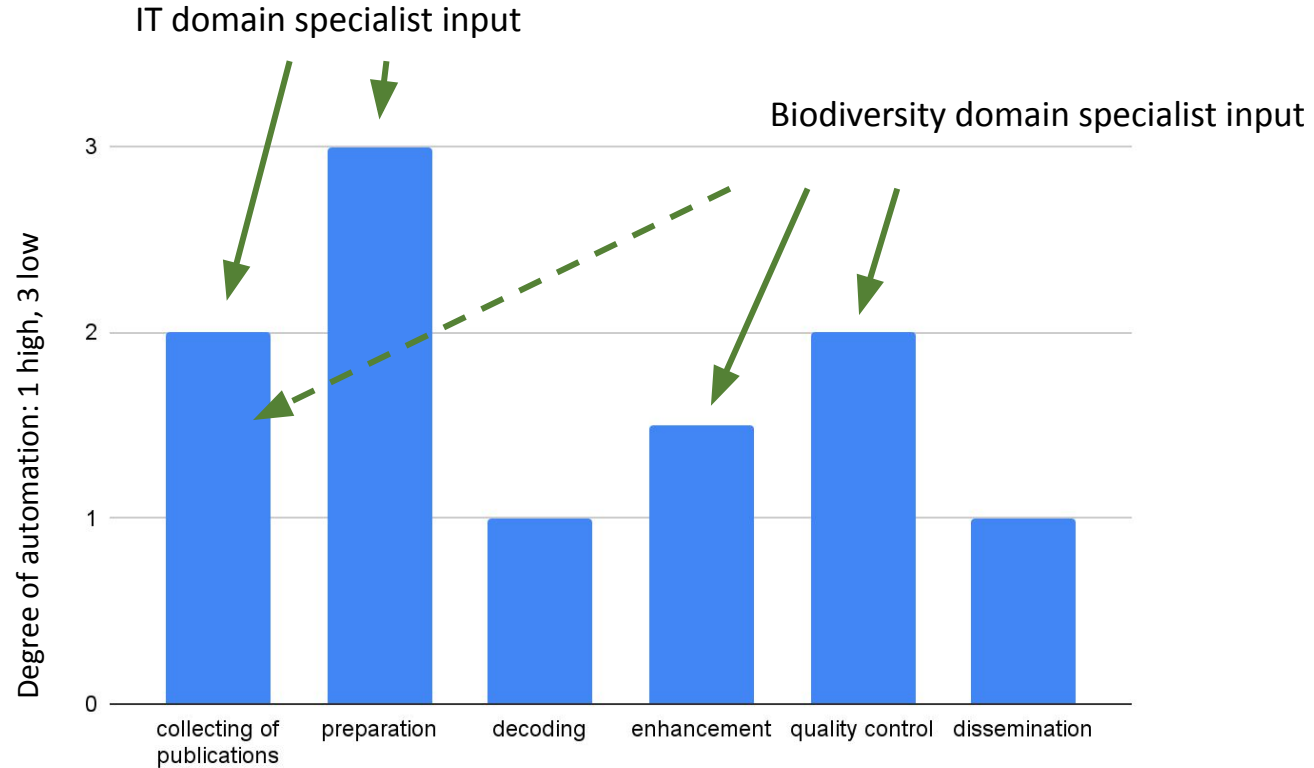
**TreatmentBank**

**SynoSpecies**

Taxonomic names  
Treatments

**Research publications**



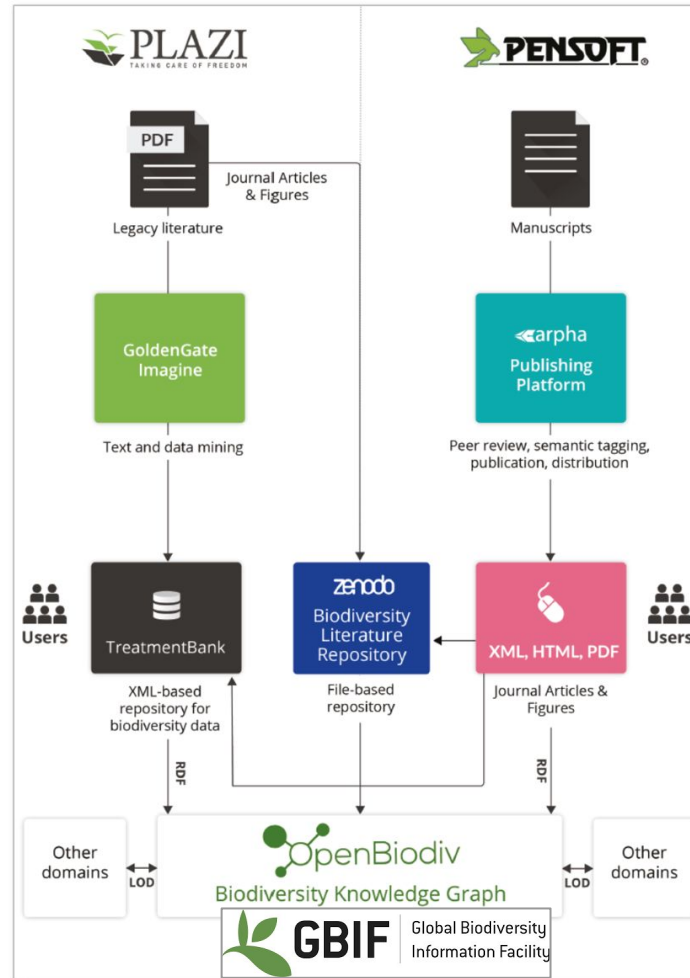


This is a very expensive effort, has to be shared by partners avoiding duplications as much as possible, and needs to be avoided by changing the way we publish.



Legacy publications

Prospective publishing





## TreatmentBank



Data conversion and access service

73,000 articles

762,000 taxonomic treatments

1,118,000 materials citations

>50% of annually described new species

production in 2021: 25,000 articles, 224,000 treatments, 180,000 images

## Biodiversity Literature Repository



Repository for data liberated from publications

453,000 images

72,000 articles

400,000 taxonomic treatments

Collaboration with Zenodo /CERN

Recognized as EU research infrastructure

Mints DOI for treatments and figures

## Global Biodiversity Information Facility



Reuse of treatment articles mediated by Plazi

39,700 treatment article data sets (58% of total data sets in GBIF)

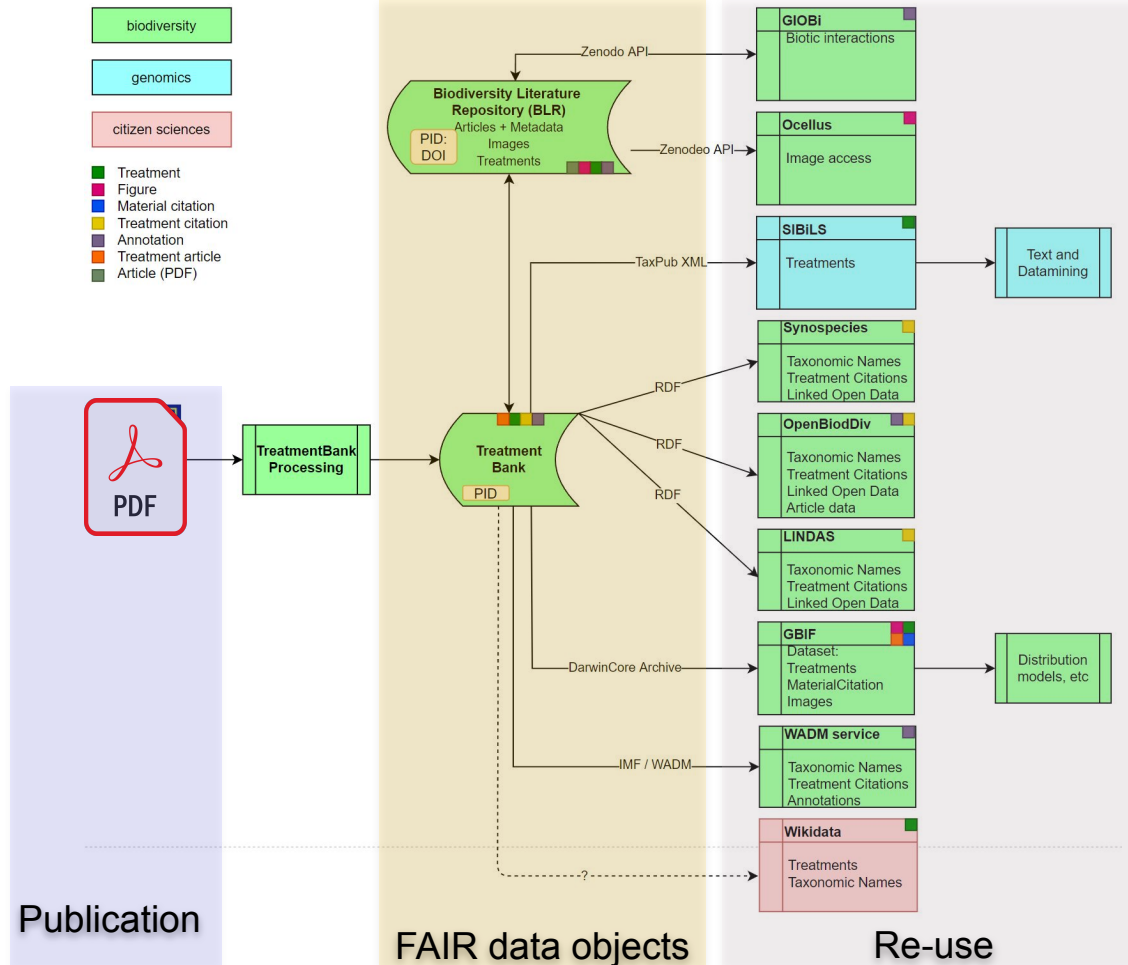
377,000 taxonomic treatments (90,000 unique species)

224,000 figures

591,000 materials citations (occurrences)

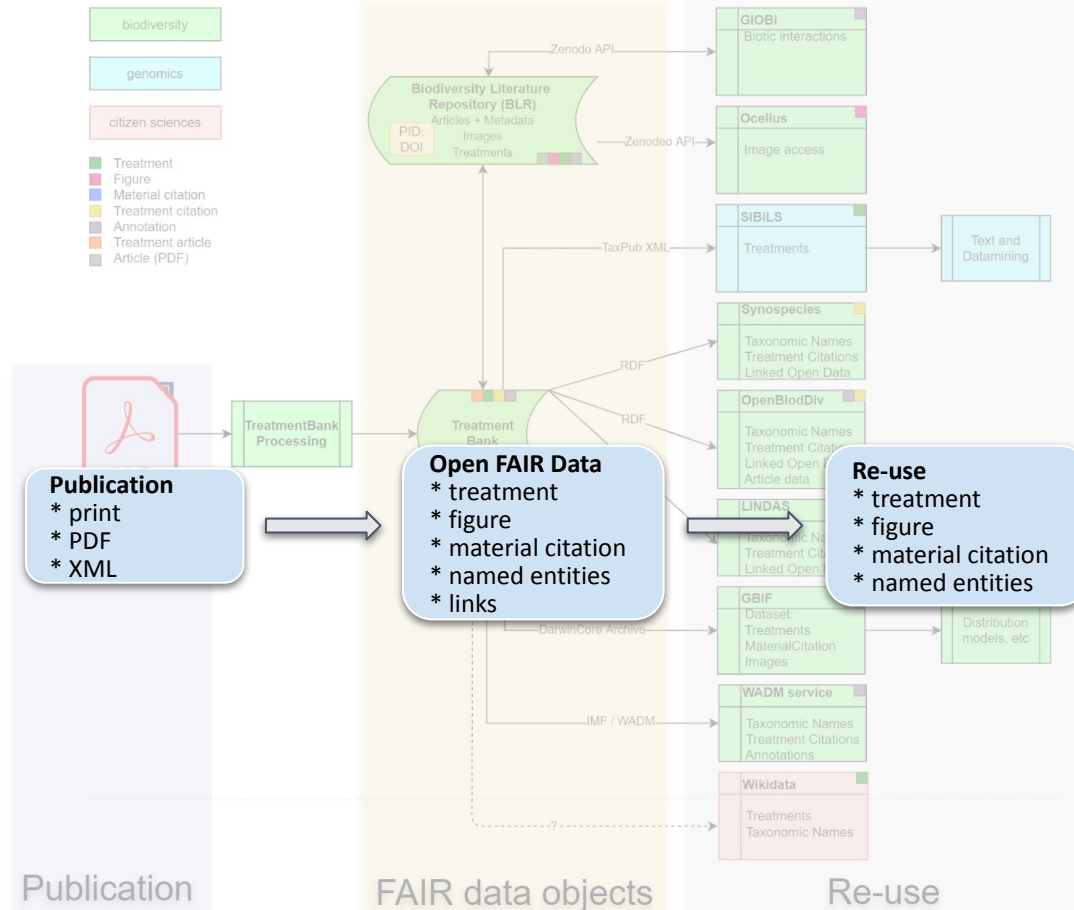
The figures are lower in GBIF because of Quality Control measures

# Re-use of scholarly publication's FAIR data





## Data flow









## Open FAIR Data

- \* represent knowledge about biodiversity, i.e.g what we know about a gene, specimen, species as well as assess a gene, specimen in its scientific knowledge, and allows exploring by machine
- \* is basis for conservation, biodiversity research, society, CBD's post 2020 Global Biodiversity Framework
- \* depends on complex infrastructures, funding, collaborations producing FAIR data that
- \* can be used anywhere, at any time by anyone by human or machine.
- \* increased by accelerating switching to advanced semantically enhanced publishing
- \* a complex process in need of teaching how to use the results and create innovations
- \* Access and Benefit Sharing (ABS): **Open FAIR access as part of benefit sharing**



# Thank you!

Questions, answers, participation <https://github.com/plazi/community>  
Introduction to digitizing taxonomic literature with Plazi [DOI](#)

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swissuniversities



eBioDiv



datafutures



ARCADIA

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SWISS INSTITUTE OF BIOINFORMATICS  
LITERATURE SERVICES



PLAZI  
TAKING CARE OF FREEDOM

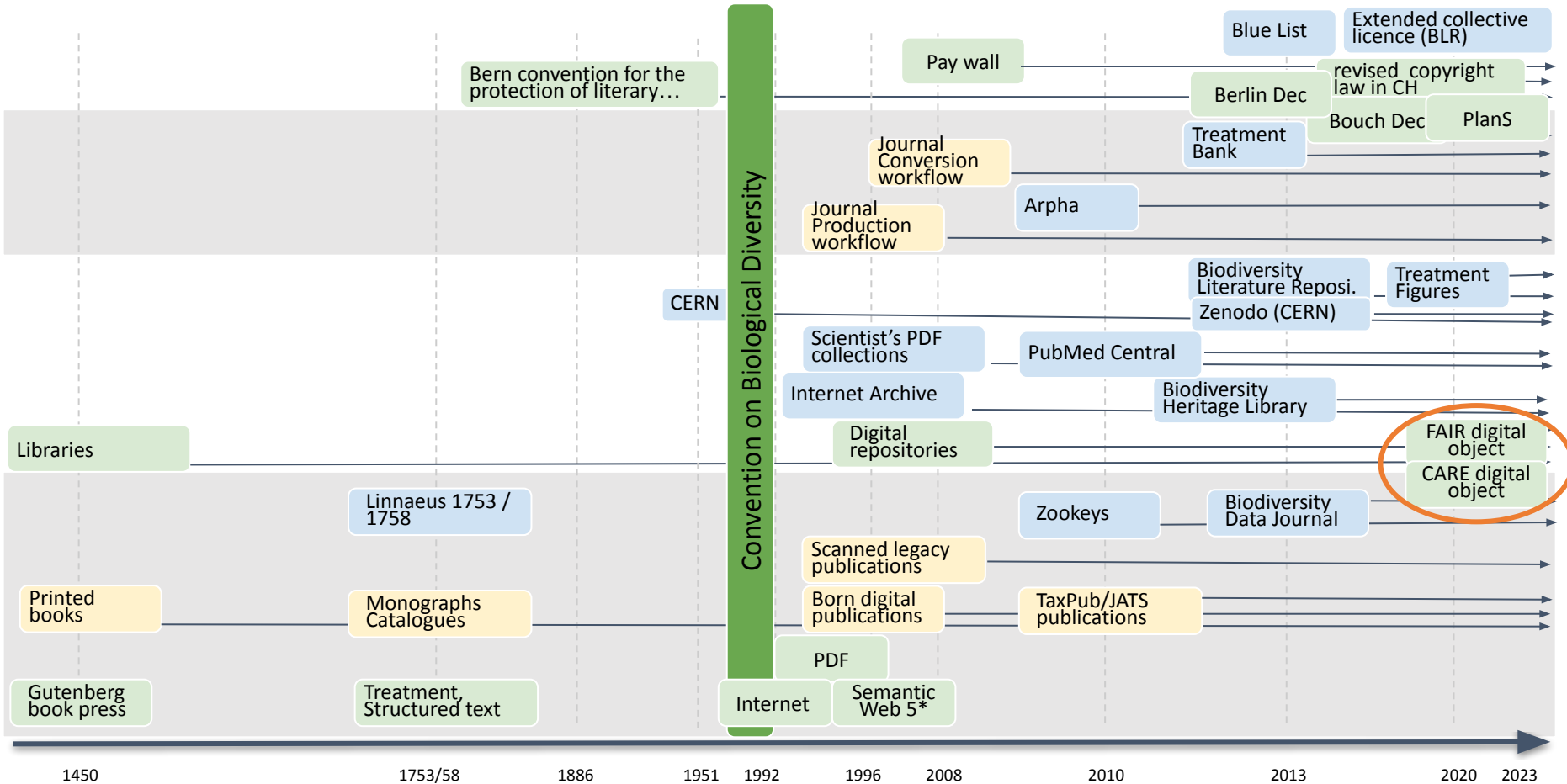


Biodiversity  
Literature  
Repository



TreatmentBank

# Brief history of publishing in biodiversity / taxonomy





## Further reading:

- Plazi: [further reading](#)
- Pensoft: doi: [10.3897/zookeys.50.543](https://doi.org/10.3897/zookeys.50.543) (e.g. Zookeys, BDJ)
- CETAF: doi: [10.5252/adansonia2018v40a1](https://doi.org/10.5252/adansonia2018v40a1) (e.g. European Journal of Taxonomy)

## Data usage:

- Rivera-Quiroz et al. 2020, doi: [10.1038/s41598-020-72549-8](https://doi.org/10.1038/s41598-020-72549-8)
- Dikow & Agosti, 2015, doi: [10.3897/BDJ.3.e5707](https://doi.org/10.3897/BDJ.3.e5707)

## Data access:

- Brief introduction into Treatmentbank stats: [PDF](#)
- Treatment statistics: <https://tb.plazi.org/GgServer/srsStats>
- Article statistics: <https://tb.plazi.org/GgServer/dioStats>
- Biodiversity Literature Repository API introduction: <https://developers.zenodo.org/>
- Biodiversity Literature Repository: <https://zenodo.org/communities/biosyslit/search?q=>

## Applications based on and reuse of TreatmentBank and BLR data:

- Images via Ocellus: <https://ocellus.info/>
- Treatment citations via Synospecies: <https://synospecies.plazi.org/>
- TreatmentBank data in GBIF: <https://www.gbif.org/publisher/7ce8aef0-9e92-11dc-8738-b8a03c50a862>



[Plazi](#) is a Swiss based international association supporting and promoting the development of persistent and openly accessible scholarly digital taxonomic publications

NGO, SME owned by the NGO; Founded in 2008 as spin-off from a former US/DFG binational digital library award (2003-06); Supported by service contracts, EU-research funding, philanthropic funds, voluntary contributions. Plazi GmbH SME as service provider.

13 persons working for Plazi in Brazil, France, Germany, Spain, Switzerland, USA

Collaborations with Global Biodiversity Information Facility (GBIF), Zenodo at CERN, Pensoft Publishers Ltd, Consortium of European Taxonomic Facilities (CETAF), Swiss Institute of Bioinformatics (SIB), National Center for Biotechnology Informatics (NCBI), Muséum nationale d'Histoire Naturelle, Paris, Data Futures.

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A mission of Plazi is to **discover, make accessible, and disseminate known biodiversity data**, not publications *per se* and to promote semantic enhanced publishing (TaxPub/JATS).