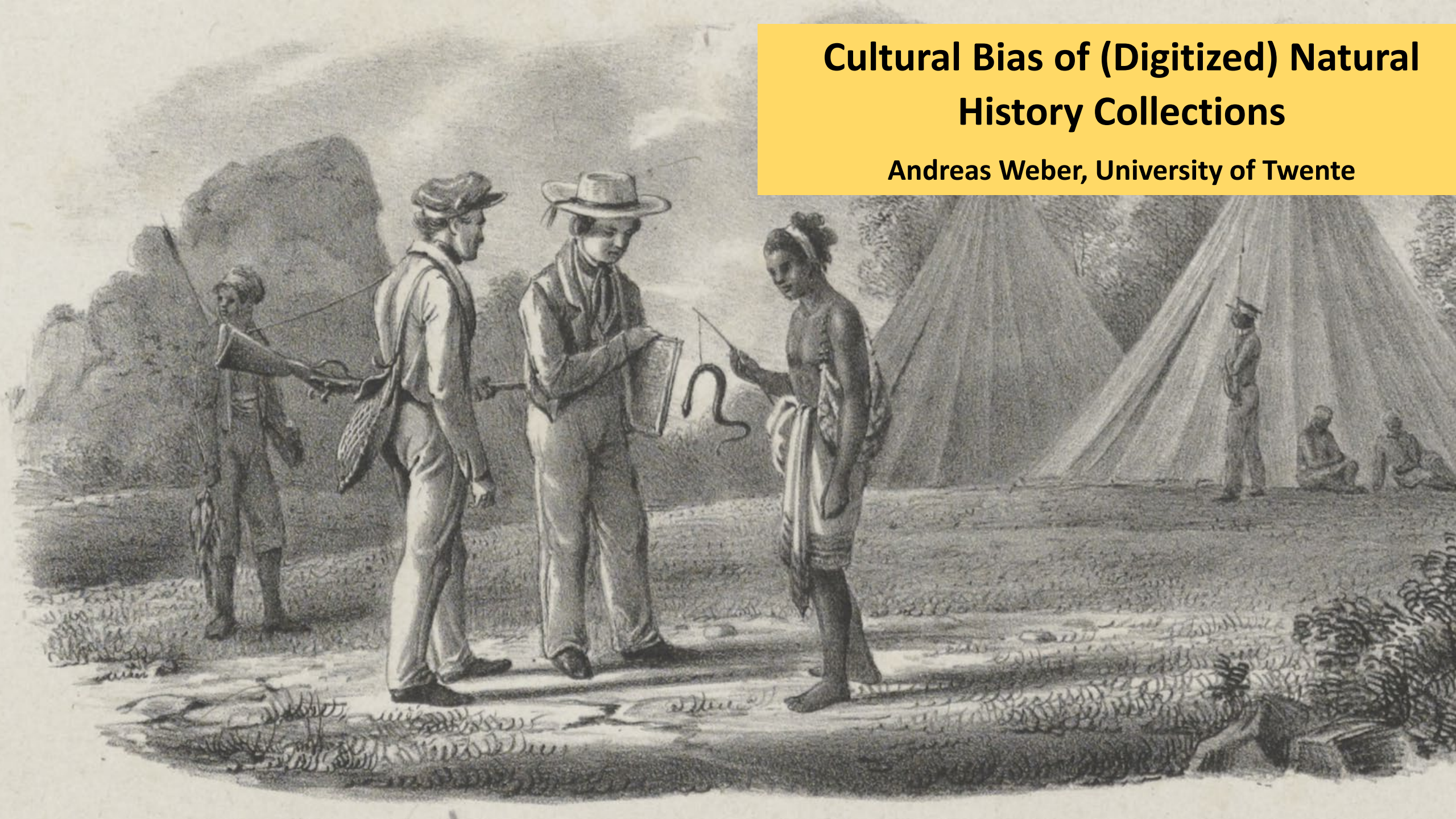


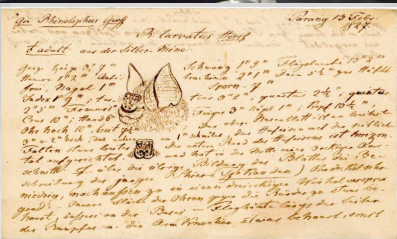


Cultural Bias of (Digitized) Natural History Collections

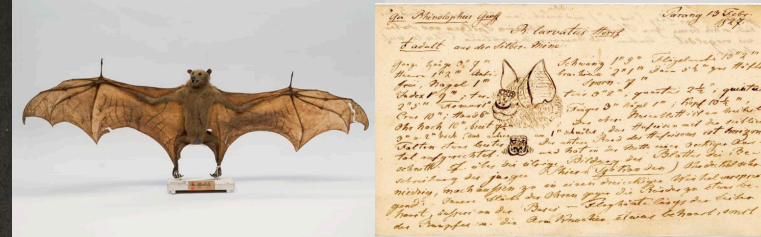
Andreas Weber, University of Twente



What is the challenge?



What is the challenge?



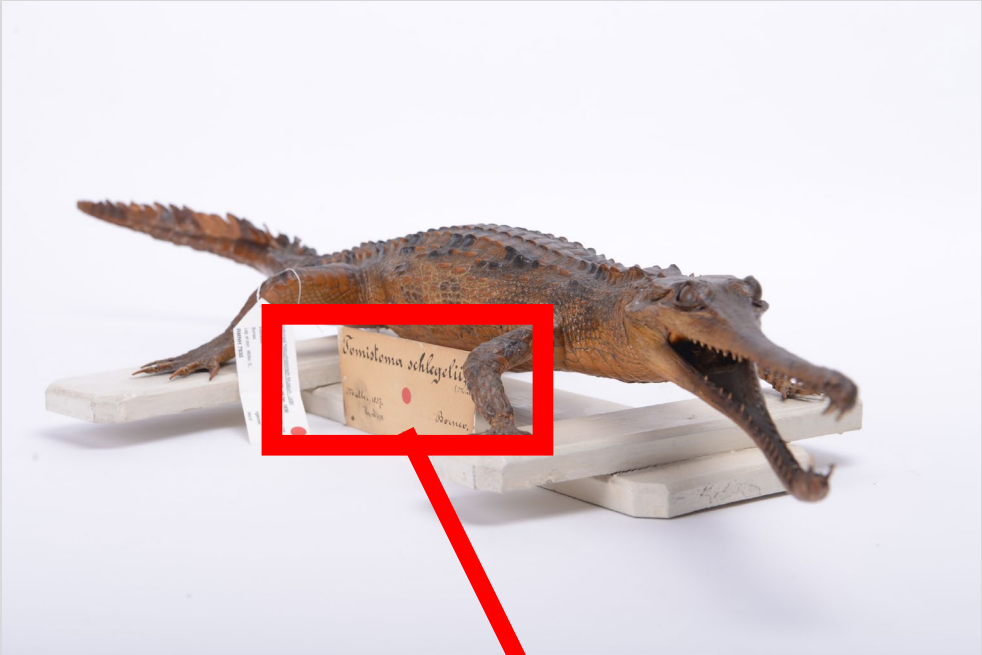
1,0-1,5 billion specimens
(=plants & animals)
+
documentation in Europe ...

(source: website DISCCo, <https://discco.eu/nl/>)

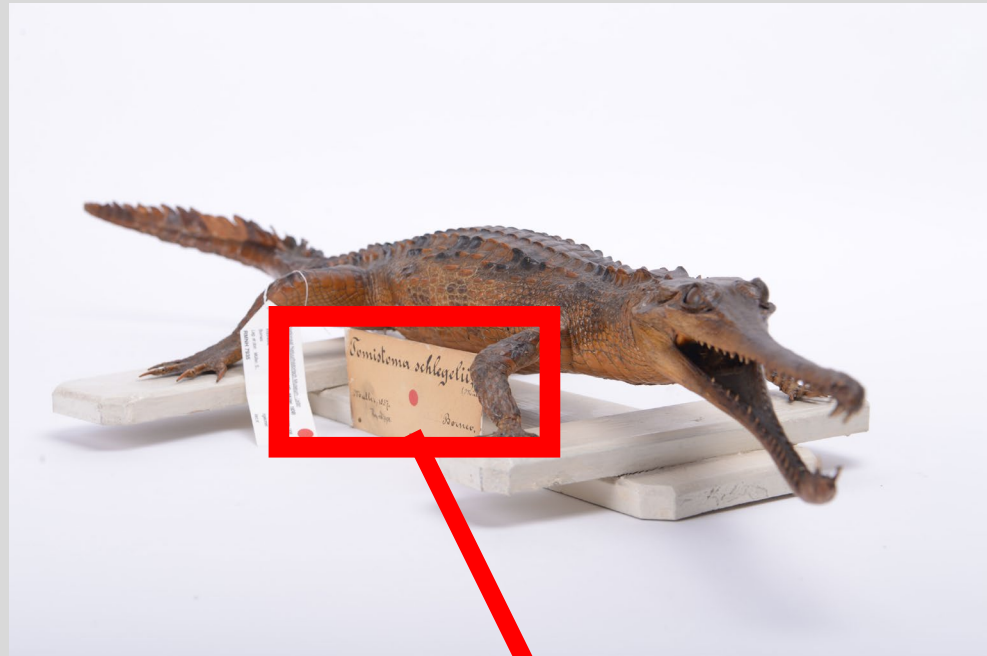
Distributed System of Scientific Collections

1,5 billion specimens, 5,000 scientists, 130+ institutions, 21 countries
... in 1 European collection.

What is the challenge?



What is the challenge?



EUROPEAN/WESTERN NATURAL HISTORY MUSEUMS

400 YEARS OF COLONIALISM/GLOBAL TRADE



8
NATURAL HISTORY
COLLECTIONS AND EMPIRE
Andreas Weber

Natural history museums and herbaria in the Global North owe much of their authority to plants, animals, and minerals collected in the Global South. Naturalis Biodiversity Centre in Leiden, which is one of the largest natural history museums in Europe, houses for instances

Weber, A., "Natural History Collections and Empire," in: *Routledge Handbook of Science and Empire*, ed. by Andrew Goss (London 2021), 80-86.

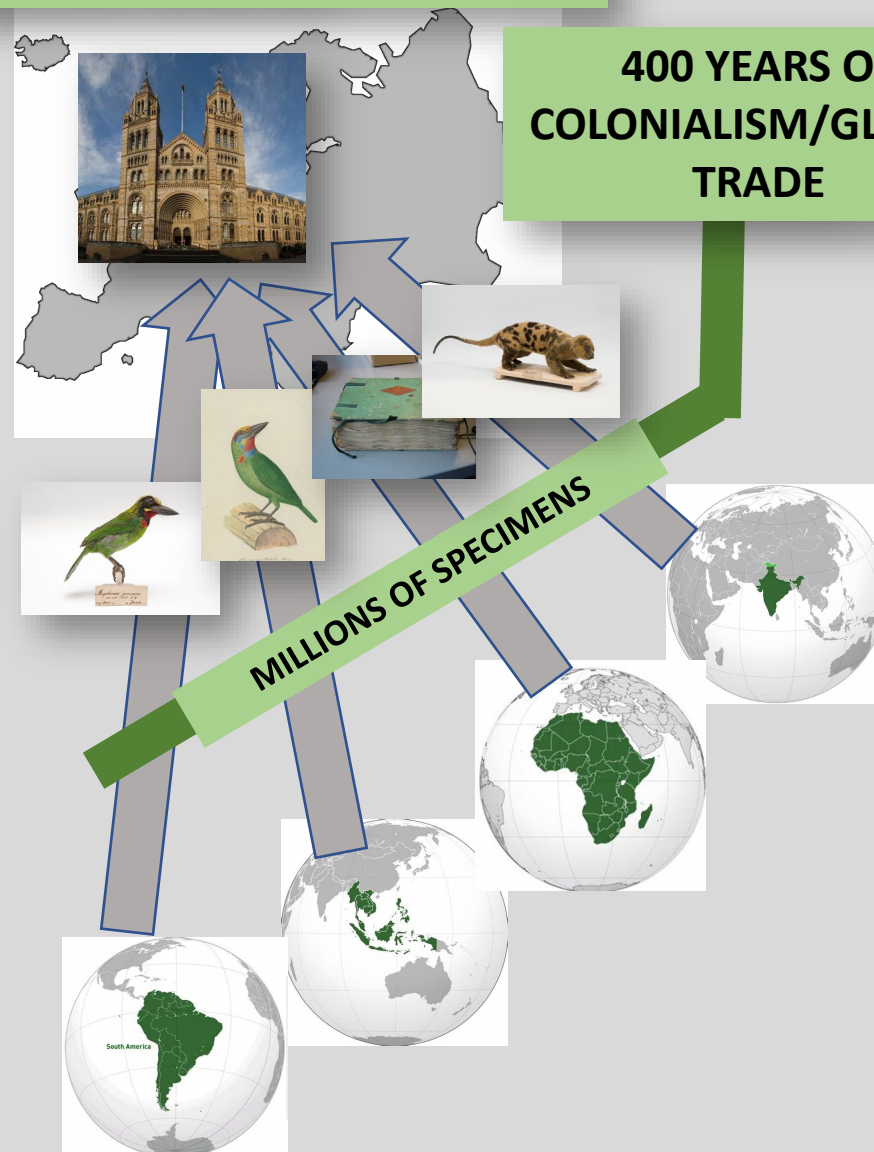
What is the challenge?

*“Many of these [natural history, A.W.] collections in museums of the Global North were built from mega-diverse countries in the global South through an **integrated legacy** [highlight, AW] of scientific exploration and colonialism.”*

Drew, et al. (2017), “Digitization of museum collections”, *Nature Ecology & Evolution*

EUROPEAN/WESTERN NATURAL HISTORY MUSEUMS

400 YEARS OF COLONIALISM/GLOBAL TRADE



What is the challenge?

EUROPEAN/WESTERN NATURAL HISTORY MUSEUMS

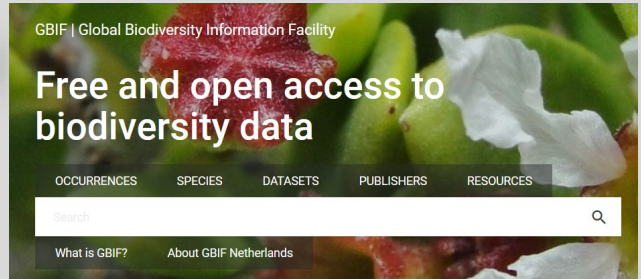
400 YEARS OF COLONIALISM/
GLOBAL TRADE

LARGE-SCALE DIGITIZATION &
AGGREGATION OF (META)DATA

MILLIONS OF SPECIMENS



The 'Entomology conveyor' is a machine that fills a complete museum hall. The version in Berlin is even bigger.



Distributed System of Scientific Collections

A world-class research infrastructure



The Distributed System of Scientific Collections is a new world-class Research Infrastructure. The DiSSCo RI aims to create a new infrastructure that digitally unifies all European natural history collections, policies and practices that ensure that all data is interoperable and Reusable (FAIR principles). This agreement between natural history museums and other natural history holding universities in the world.

What is the challenge?

EUROPEAN/WESTERN NATURAL HISTORY MUSEUMS

400 YEARS OF COLONIALISM/GLOBAL TRADE

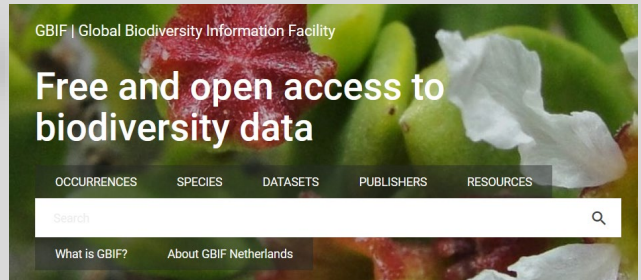
LARGE-SCALE DIGITIZATION & AGGREGATION OF (META)DATA

MILLIONS OF SPECIMENS

How to acknowledge & learn from cultural bias in (digitized) natural history collections?



The 'Entomology conveyor' is a machine that fills a complete museum hall. The version in Berlin is even bigger.



Distributed System of Scientific Collections

A world-class research infrastructure

The Distributed System of Scientific Collections is a new world-class Research Infrastructure (RI) for Natural Science Collections. The DiSSCo RI aims to create a new business model for one European collection that digitally unifies all European natural science assets under common access, curation, policies and practices that ensure that all the data is easily Findable, Accessible, Interoperable and Reusable (FAIR principles).

DiSSCo represents the largest ever formal agreement between natural history museums, botanic gardens and collection-holding universities in the world.

Dealing with cultural bias in (digitized) natural history collections...

Encoding the haunting of an object catalogue: on the potential of digital technologies to perpetuate or subvert the silence and bias of the early-modern archive¹

Alexandra Ortolja-Baird, Julianne Nyhan

Digital Scholarship in the Humanities, fqab065, <https://doi.org/10.1093/llc/fqab065>

Published: 19 October 2021

PDF Split View Cite Permissions Share

Abstract

The subjectivities that shape data collection and management have received extensive criticism, especially with regards to the digitization projects and digital archives of galleries, libraries, archives and museums (GLAM institutions). The role of digital methods for recovering data absences is increasingly **“Data absences”** the absence of non-hegemonic... Hans Sloane as an instance of textual haunting, this article will ask: to what extent do data-driven approaches further entrench archival absences and silences? Can digital approaches be used

Nature Read in Black and White: decolonial approaches to interpreting natural history collections

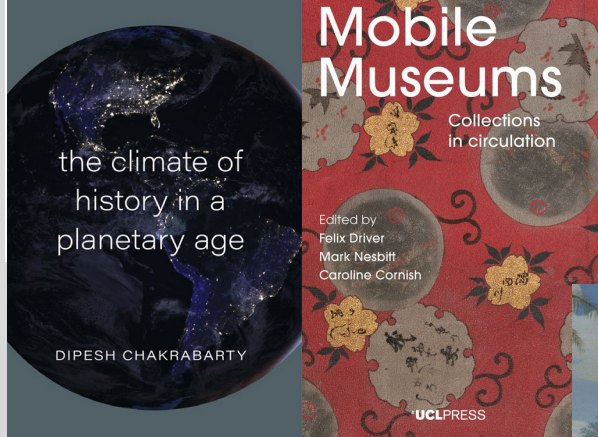
Subhadra Das^{1*} and Miranda Lowe²

¹Address: ¹UCL Collections (Science), 223 Wilkins Building, UCL, Gower Street, London, WC1E 6BT, UK

²Natural History Museum, Dept of Life Sciences, Invertebrates Division, Cromwell Road, London, SW7 5BD, UK

*Corresponding author: subhadra.das@ucl.ac.uk

Citation: Das, S. and Lowe, M., 2018. Nature Read in Black and White: decolonial approaches to interpreting natural history collections. *BMGN — Low Countries Historical Review*, Volume 134-3 (2019), pp. 72-95



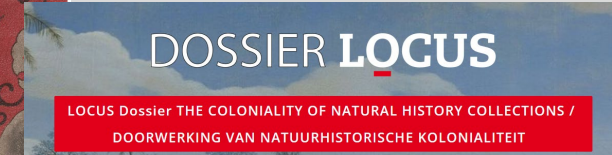
BMGN — Low Countries Historical Review | Volume 134-3 (2019) | pp. 72-95

Collecting Colonial Nature

European Naturalists and the Netherlands Indies in the Early Nineteenth Century

ANDREAS WEBER

The sheer variety and size of Dutch scientific collections of Indonesia's flora and fauna are unique in the world. Gathered over the last two hundred years, they



Problematizing of understanding of “nature” rooted in Europe’s colonial past.

Cultural bias = reading of (digitized) natural history collections rooted in and shaped by Europe’s colonial past.

DIFFERENT READINGS...



RMNH.RENA.7935:
Tomistoma schlegelii or False Gharial (Müller 1838), Naturalis Biodiversity Center, CC0)

Biodiversity heritage

- Natural history collections exclusively used as basis for biodiversity related research
- **Implies:**
 - need for large digital data sets/collections with limited metadata
 - cultural historical context of individual specimens/collections less important

Cultural heritage

- **Acknowledgment** of cultural bias of collections (e.g. colonial past)
- Willingness **to learn** from cultural bias of (digitized) natural history collections
- **Implies:**
 - Stories of individual specimens matter (provenance, collections circumstances)
 - Absences/silences matter
 - Link to archival materials matter

Reflective digital humanism?

A crocodile as example (1)



RMNH.RENA.7935: *Tomistoma schlegelii* or False Gharial (Müller 1838), Naturalis Biodiversity Center, CC0

Bijzondere collecties Over

Specimen
RMNH.RENA.7935

1 van de 1

Citeer als:
<https://data.biodiversitydata.nl/naturalis/specimen/RMNH.RENA.7935>

Details

Naturalis - Zoology and Geology	Preparatiemethode	air dried
Wetenschappelijke naam	Aantal	1
Populaire namen	Datum	—
Populaire namen van gerelateerd taxon	Verzamelaar	Müller, S.
Registratienummer	Plaats of streek	Indonesia, Borneo,
Bron	RMNH.RENA.7935	
Licentie	Naturalis - Zoology and Geology catalogus	
Instituut	CC0 1.0	
Collectienaam	Naturalis Biodiversity Center	
Beschrijving	Amphibia and Reptilia	
Typestatus	PreservedSpecimen	
Levensfase	syntype	
Sexe	—	
Onderdeel	skin	
Preparatiemethode	air dried	
Aantal	1	
Verzamelaar	Müller, S.	
Plaats of streek	Indonesia, Borneo, "lake Lamoeda, 8days upstream riv.Doeson"	

This and the next slide is based on a jupyter notebook put together by Dr. Sharif Islam (Naturalis Biodiversity Center, Leiden): <https://github.com/DiSSCo/demo/blob/master/notebooks/data-driven-story.ipynb>, accessed 31 May 2022.

A crocodile as example (2)

Salomon Müller
Müller; S. Müller
* April 07, 1804 – December 29, 1863 +
biologist, zoologist, ornithologist, naturalist, explorer

German ornithologist (1804-1863)
<https://www.wikidata.org/wiki/Q61390>
Grand Duchy of Baden

1,966 specimens collected from at least 7 countries
23 specimens used in 7 works

Collected From
Map List

Dates Collected
Chart List

Bionomia
<https://bionomia.net/Q61390>

Overview Specialties **Network** Deposited At Specimens Science Enabled

Co-collectors Identified For Identifications By

Has collected with: [JSON-LD](#)

 Boie, Heinrich * May 04, 1794 – September 04, 1827 + Duchy of Holstein Collected Rhinolophidae 6 specimens claimed	 Korthals, Pieter Willem * September 01, 1807 – February 08, 1892 + Netherlands Collected Rubiaceae and identified Dicranaceae 18,044 specimens claimed
 Macklot, Heinrich Christian * October 20, 1799 – May 12, 1832 + Germany Collected Pteropodidae 75 specimens claimed	 Poeppig, Eduard Friedrich * July 16, 1798 – September 04, 1868 + Germany Collected Asteraceae and identified Orchidaceae 12,015 specimens claimed

NETWORK: CO-COLLECTORS

SPECIMEN HOLDING
INSTITUTIONS

COLLECTED PLANTS AND ANIMALS

This and the next slide is based on a jupyter notebook put together by Dr. Sharif Islam (Naturalis Biodiversity Center, Leiden):
<https://github.com/DiSSCo/demo/blob/master/notebooks/data-driven-story.ipynb>, accessed 31 May 2022.

A crocodile as example (2)

Salomon Müller
Müller; S. Müller
* April 07, 1804 – December 29, 1863 +
biologist, zoologist, ornithologist, naturalist, explorer

German ornithologist (1804-1863)
<https://www.wikidata.org/wiki/Q61390>
Grand Duchy of Baden

1,966 specimens collected from at least 7 countries
23 specimens used in 7 works

Collected From
Map List

Dates Collected
Chart List

Bionomia
<https://bionomia.net/Q61390>

Overview Specialties **Network** Deposited At Specimens Science Enabled

Co-collectors Identified For Identifications By

Has collected with: [JSON-LD](#)

Boie, Heinrich * May 04, 1794 – September 04, 1827 + Duchy of Holstein Collected Rhinophidae 4 specimens claimed	Korthals, Pieter Willem * September 01, 1807 – February 08, 1892 + Netherlands Collected Rubiaceae and identified Dicranaceae 18,044 specimens claimed
Macklot, Heinrich Christian * October 20, 1799 – May 12, 1832 + Germany Collected Pteropodidae 75 specimens claimed	Poeppig, Eduard Friedrich * July 16, 1798 – September 04, 1868 + Germany Collected Asteraceae and identified Orchidaceae 12,815 specimens claimed

NETWORK: CO-COLLECTORS

COLLECTING LOCALITIES

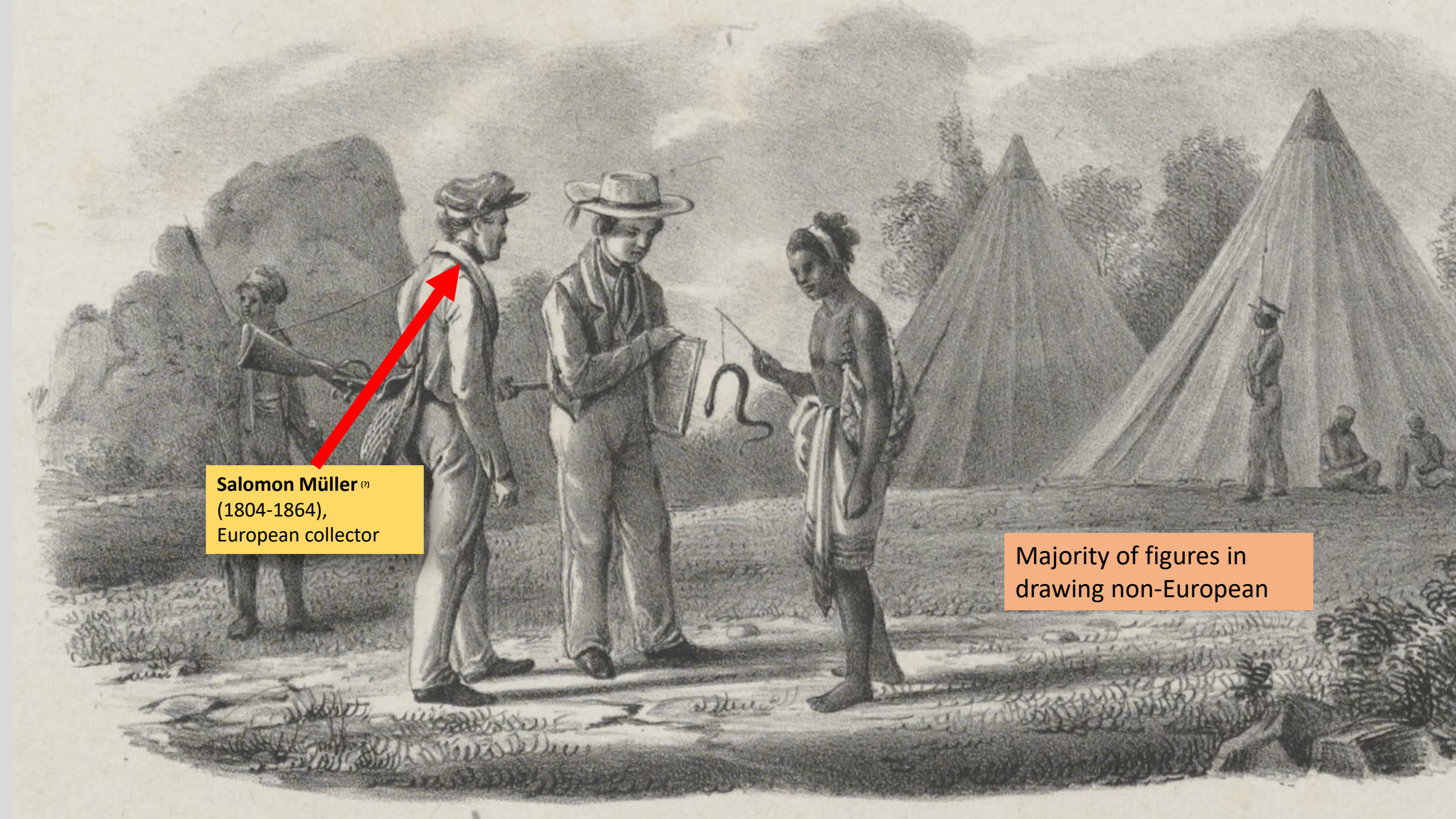
SPECIMENS HOLDING INSTITUTIONS

SPECIMENS (PLANTS/ANIMALS....)

NO REFERENCES TO ARCHIVAL MATERIAL

NO REFERENCES TO CULTURAL/COLONIAL HISTORICAL CONTEXT OF COLLECTING

This and the next slide is based on a jupyter notebook put together by Dr. Sharif Islam (Naturalis Biodiversity Center, Leiden):
<https://github.com/DiSSCo/demo/blob/master/notebooks/data-driven-story.ipynb>, accessed 31 May 2022.



Salomon Müller ^(?)
(1804-1864),
European collector

Majority of figures in
drawing non-European

Making Sense of Illustrated Handwritten Archives

Providing access to the hidden treasures of the 'Natuurkundige Commissie' (1820-1850)

See also the conference program of the international conference Collect & Connect: Archives and Collections in a Digital Age on 23/24 November 2020 ==> [here](#) <==.



Universiteit
Leiden

UNIVERSITEIT TWENTE.



rijksuniversiteit
 groningen



BRILL



Naturalis
Biodiversity
Center

www.makingsenseproject.org

BRILL

Home About Help



Natuurkundige Commissie Archives Online

Providing access to the hidden treasures of the
'Natuurkundige Commissie voor Nederlandsch-
Indië' (1820-1850)

Search

<https://dh.brill.com/nco/> (open access)

Gassó, E., Stork, L., Weber, A., Ameryan, M., Wolstencroft K, *Natuurkundige Commissie Archives Online*. Leiden: Brill, 2020. doi:10.1163/9789004336865

A big thanks to Brill!

Archive & Collection:

Committee of Natural History of the Netherlands Indies (1820-1850)

- **World-wide unique archive & collection** of flora and fauna of and brought together in colonial Indonesia in the first half 19th century
- Collected in the decade after the Tambora explosion (1815)
- Stored in **Naturalis, Leiden**
- Partly digitized:
 - **Archive:** ca. 20 000 individual pages
 - **Collection:** > 100 000 collected plants & animals

AREAS OF COLLECTING:
NATUURKUNDIGE COMMISSIE VOOR NEDERLANDSCH-INDIË (1820-1850)
COMMITTEE OF NATURAL HISTORY OF THE DUTCH EAST INDIES (1820-1850)



BATAVIA

DE UITGESTREKTHEID VAN NEDERLANDSCH OOST-INDIË.



DE NED.-INDISCHE KOLONIËN UITGEMETEN OP DE KAART VAN EUROPA.



Bonaparte's Warbler



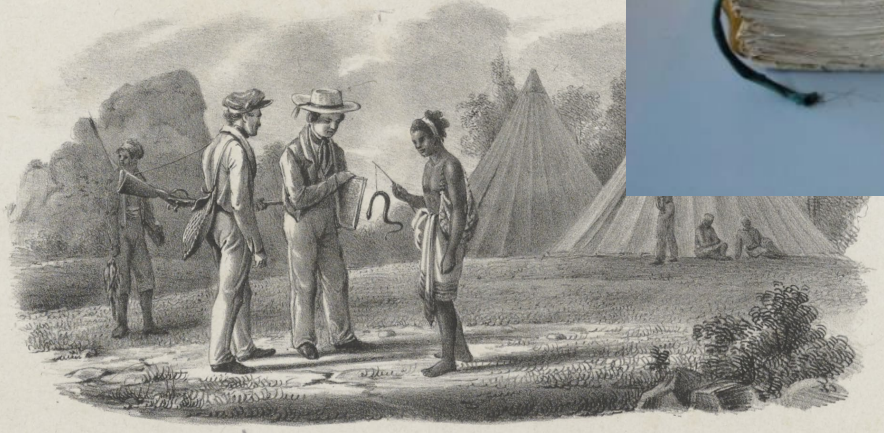
Varanus

Handwritten text in German, likely a collection list or description of specimens.



Small bird specimen

Handwritten text in German, likely a collection list or description of specimens.



Engraving of a group of people in a landscape.

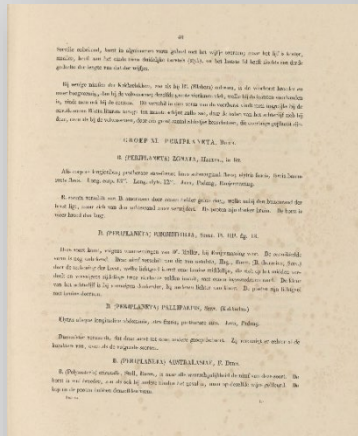


Handwritten text in German, likely a collection list or description of specimens.

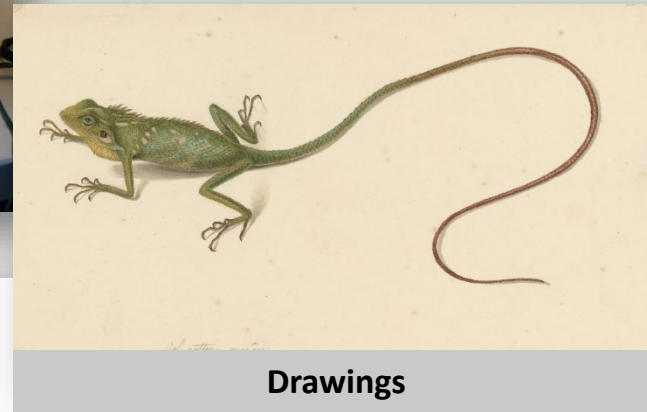


Challenge I: Missing link

Field notes / travel diaries



Publication



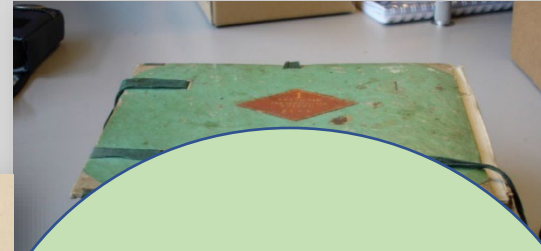
Drawings



Specimens

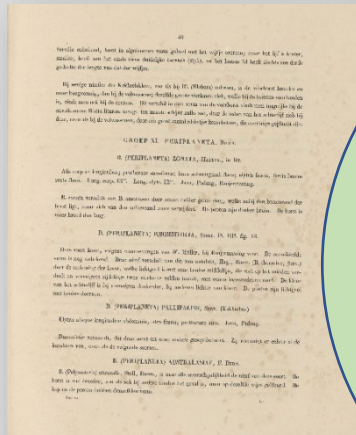
Challenge I: Missing link

Field notes / travel diaries

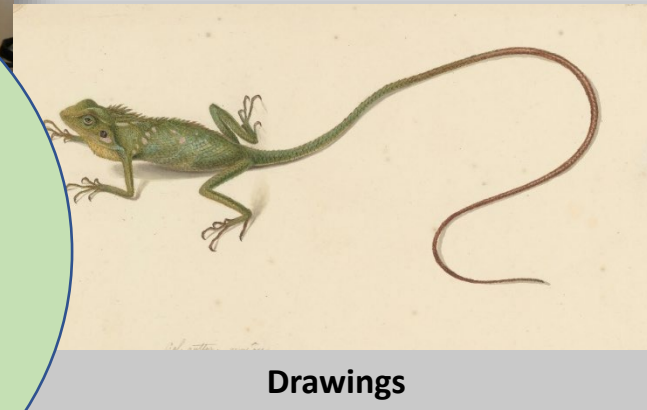


Links weak or missing

... necessary for humanities and biodiversity scholarship



Publication



Drawings



Specimens

Focus on (historical) species names as red thread through material

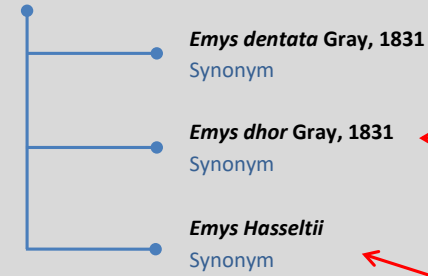
Challenge I: Missing link

Current scientific name



Cyclemys dentata (Gray, 1831)

Current name



RMNH.RENA. 6062, "Java, Kuhl & van Hasselt", Naturalis collection
Paralectotype of *Emys dhor* = *E. dentata* Gray, 1831

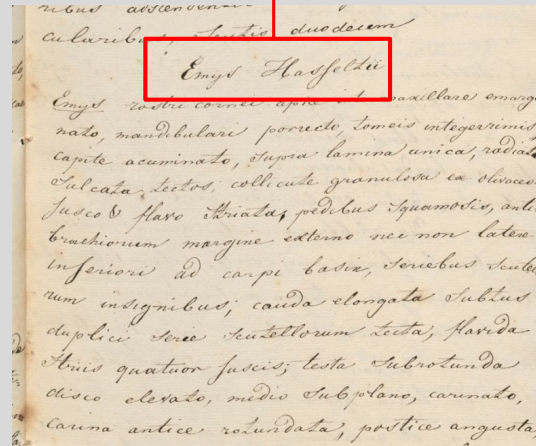
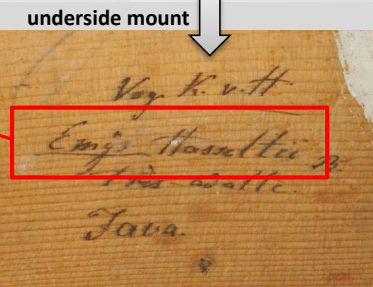


Figure composed by. E. Gassó Miracle

H. Boie's manuscript and drawings, Naturalis archives

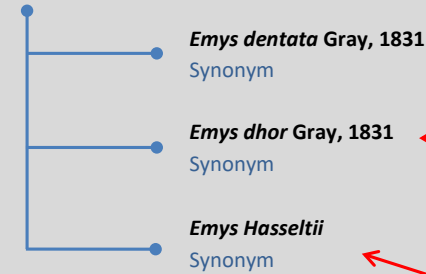
Challenge I: Missing link

Current scientific name

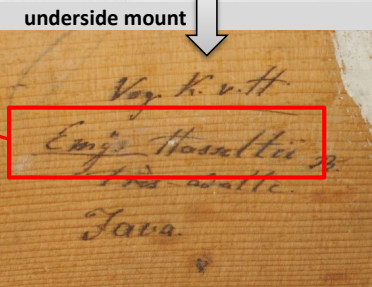


Cyclemys dentata (Gray, 1831)

Current name



RMNH.RENA. 6062, "Java, Kuhl & van Hasselt", Naturalis collection
Paralectotype of *Emys dhor* = *E. dentata* Gray, 1831



**EVOLUTION OF
CONCEPTS**

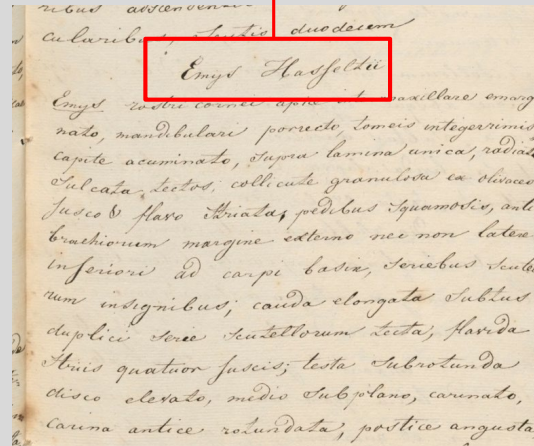


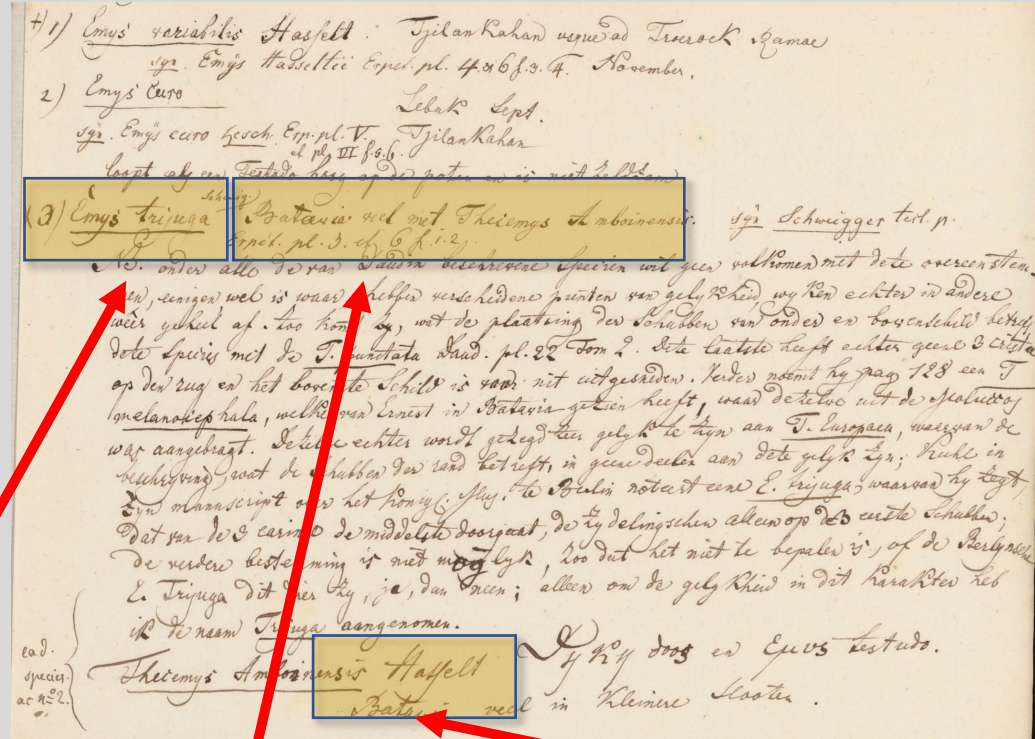
Figure composed by. E. Gassó Miracle

H. Boie's manuscript and drawings, Naturalis archives

I: Establishing missing links...



Field notes / travel diaries



Species name

Places of collection

Person names

Usual strategy:

Full text transcription + entity recognition

Our strategy:

Tooling for semantic annotation of field book annotation **without need for full text transcription.**



Stork, L. (2021)

Knowledge extraction from archives of natural history collections

Doctoral Thesis

Natural history collections provide invaluable sources for researchers with different disciplinary backgrounds, aspiring to study the geographical distribution of flora and fauna across the globe as well as other evolutionary processes. They are of paramount importance for mapping out long-term changes: from culture, to ecology, to how natural history is practiced. This thesis describes computational methods for knowledge

<https://hdl.handle.net/1887/3192382>

I: Establishing missing links - cultural bias?

<i>Sund.</i>	P	<i>Lat.</i>
<i>Pangany</i>		<i>Petasula</i>
<i>Poespa</i>		<i>schiuma</i>
<i>Pukue</i>		<i>Arctarachaeisum</i>
<i>Pete</i>		<i>Acacia gigantea</i>
<i>Puang</i>		<i>Arceca communis</i>

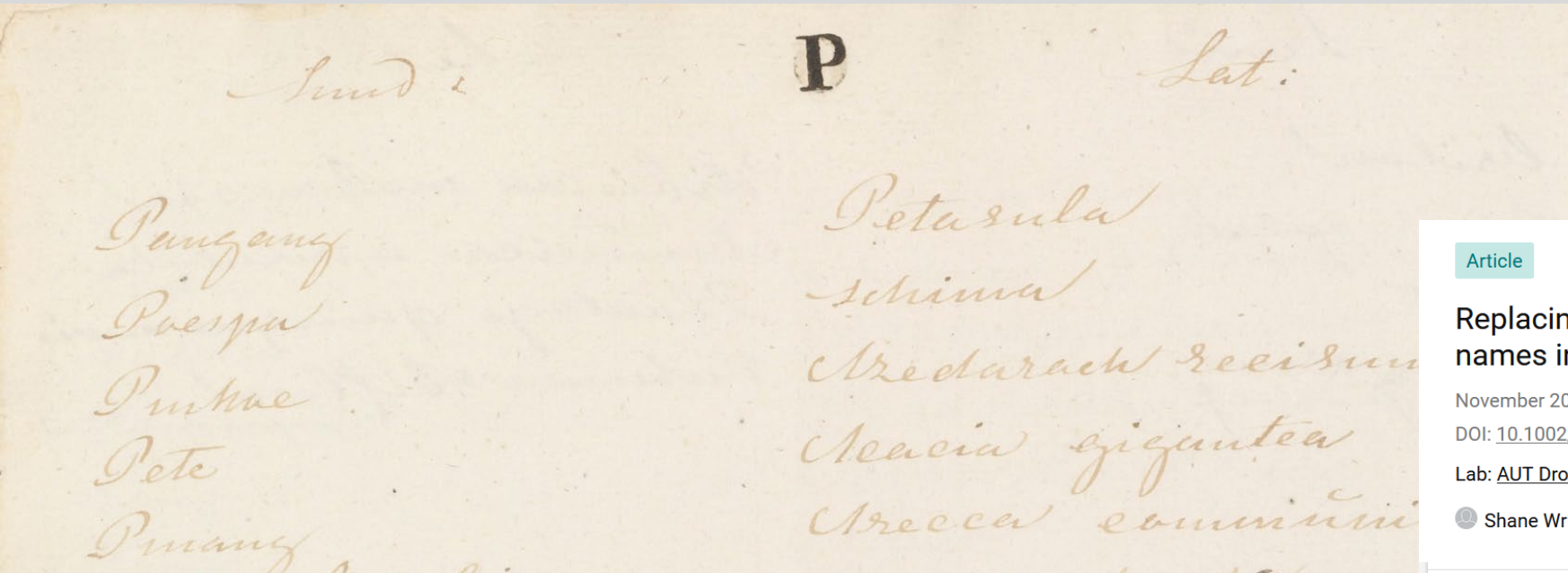
Source: Diary of Pieter van Oort, https://dh.brill.com/nco/view/nco_NNM001001117_011/makingsense

Local names

vs.

Latin (scientific) names)

I: Establishing missing links - cultural bias?



Source: Diary of Pieter van Oort, https://dh.brill.com/nco/view/nco_NNM001001117_011/makingsense

Local names

vs.


Latin (scientific) names)

Article

Replacing current nomenclature with pre-existing indigenous names in algae, fungi and plants

November 2021 · [Taxon](#)
DOI: [10.1002/tax.12599](https://doi.org/10.1002/tax.12599)
Lab: [AUT Drone Lab](#)

Shane Wright · Len N Gillman



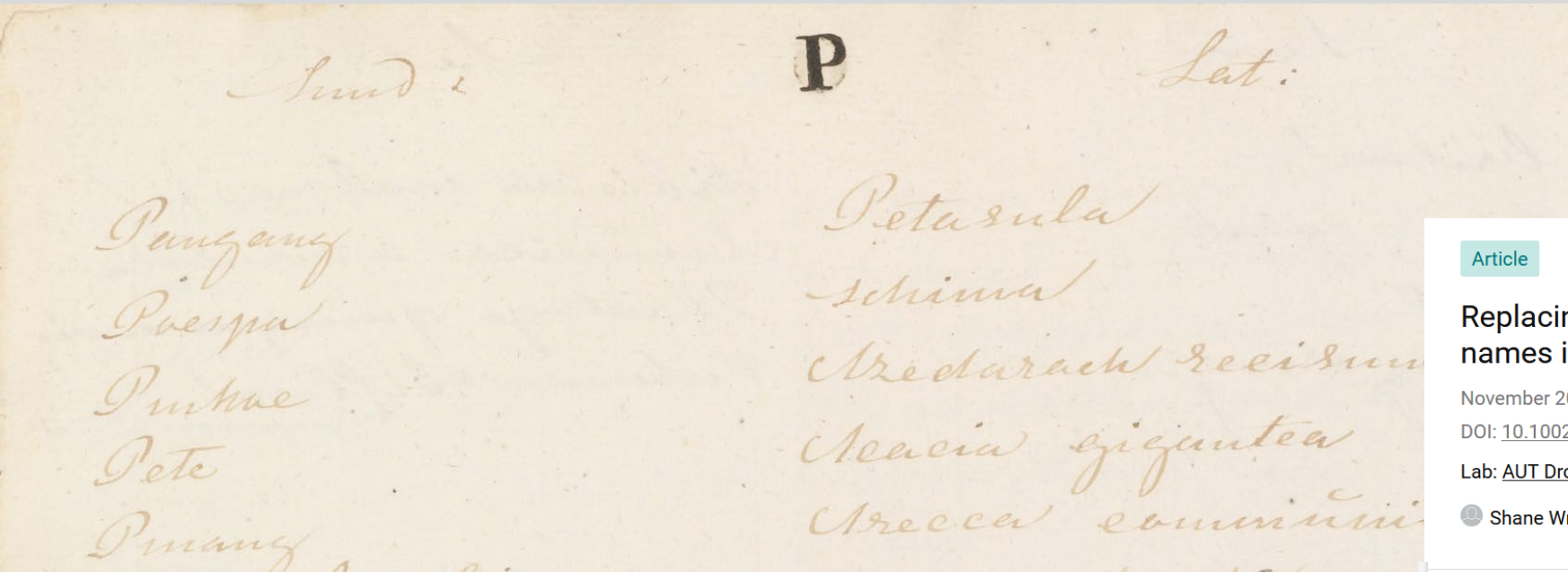
Dec 20, 2021

Nice 'woke' idea, but totally impracticable. How many years would it take just to decide on an 'international' vernacular name for each species?

[Recommend](#) [Reply](#) [Share](#)

3 Recommendations

I: Establishing missing links - cultural bias?

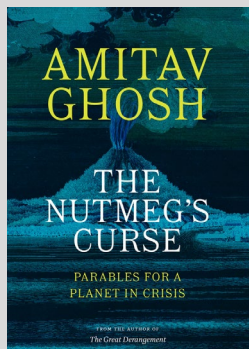


Source: Diary of Pieter van Oort, https://dh.brill.com/nco/view/nco_NNM001001117_011/makingsense

Local names

vs.

Latin (scientific) names)



Naming practices deeply connected with colonial past and colonial agriculture. Establishing 'universality' of names also part of a historical process in which (colonial) nature is framed as 'exploitable' natural resource.

Article

Replacing current nomenclature with pre-existing indigenous names in algae, fungi and plants

November 2021 · [Taxon](#)

DOI: [10.1002/tax.12599](https://doi.org/10.1002/tax.12599)

Lab: [AUT Drone Lab](#)

Shane Wright · Len N Gillman



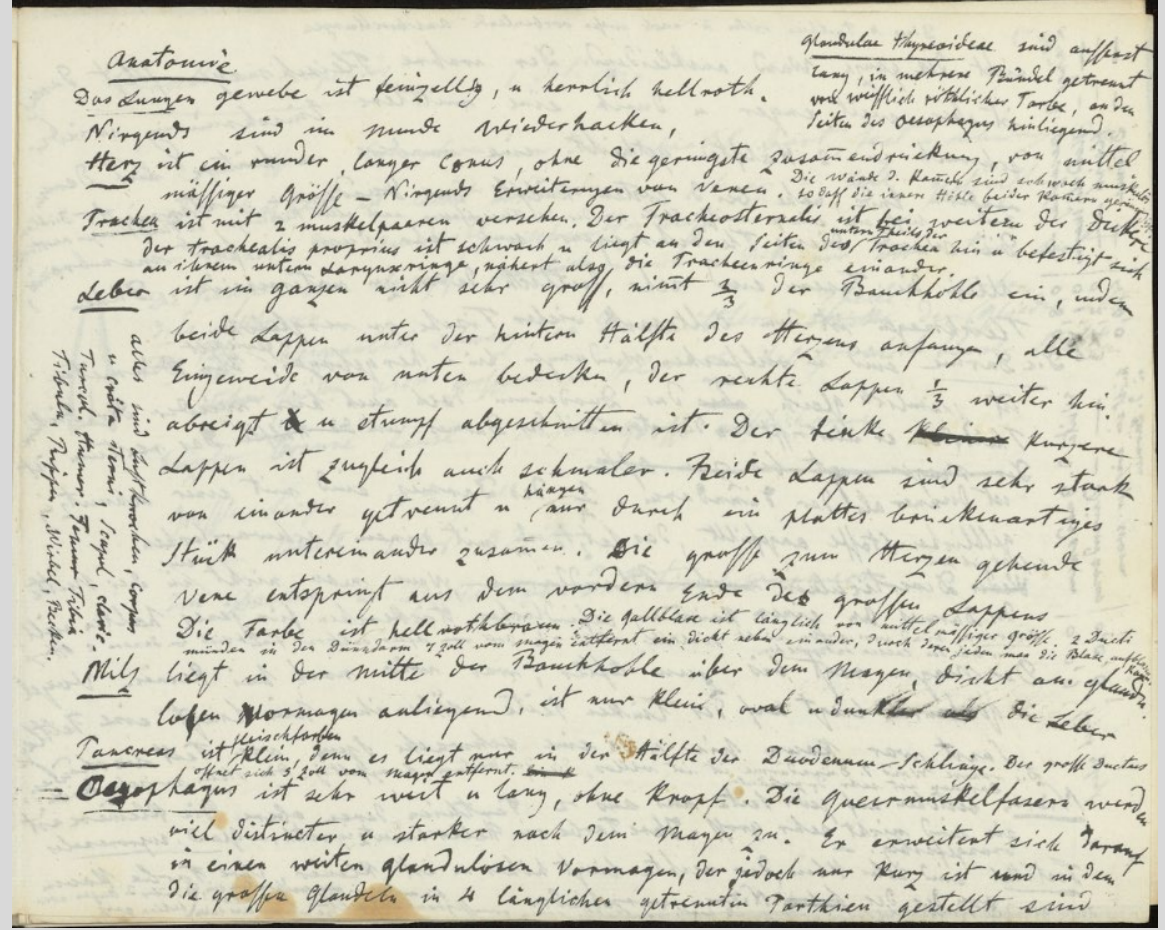
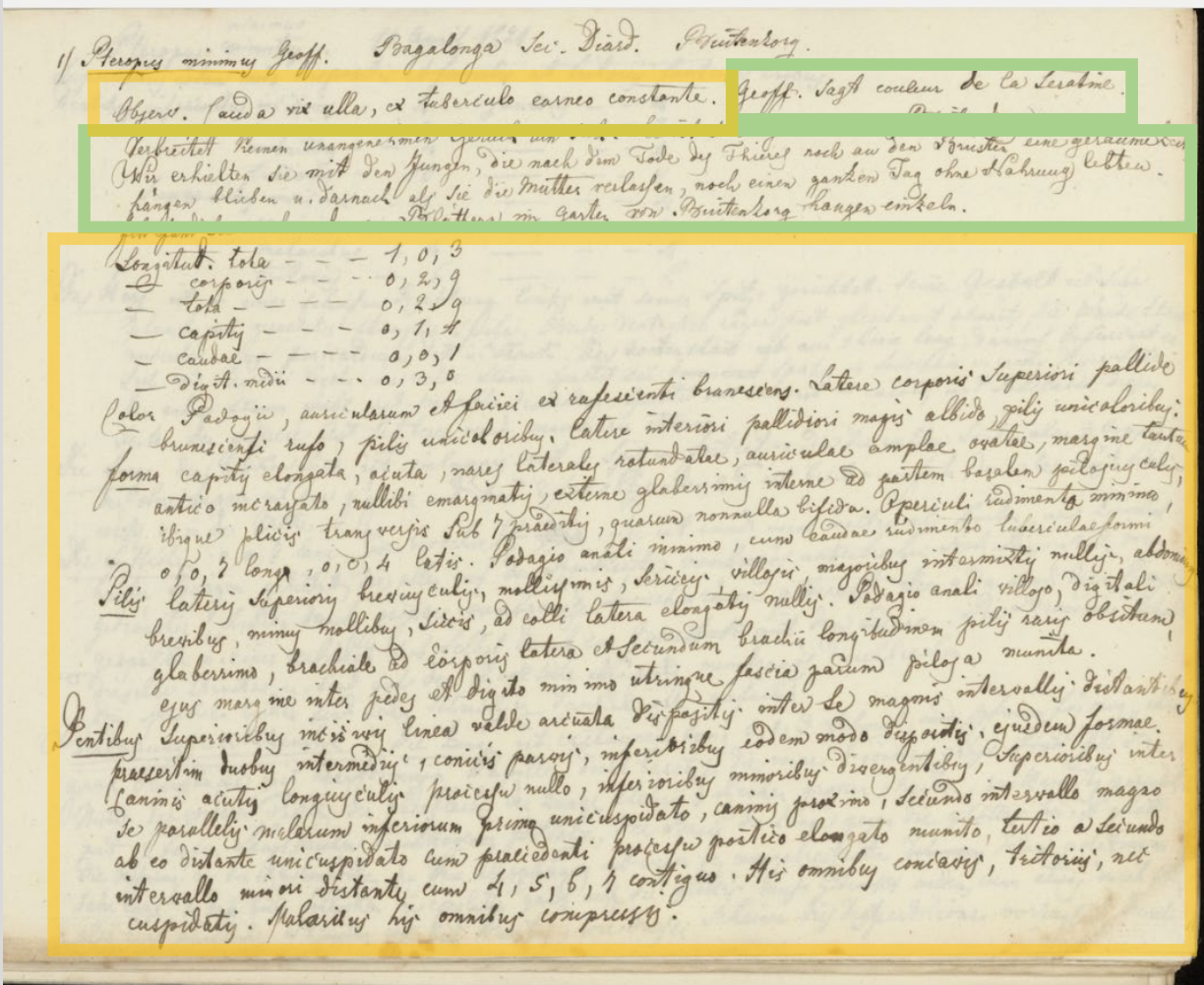
Dec 20, 2021

Nice 'woke' idea, but totally impracticable. How many years would it take just to decide on an 'international' vernacular name for each species?

[Recommend](#) [Reply](#) [Share](#)

3 Recommendations

II: Broaden the scope – rapid indexing with MONK



Mix of languages

Mix of writers (some notes copied / heavy variation in structure)

II: Broaden the scope – exploration & rapid indexing with MONK



MONK in Practice:
Indexing Heterogeneous Handwritten Collections

Anna Caceres¹, Andreas Weber², Lambert Schomaker³

¹Leiden University, Postbus 9500, 2300 RA Leiden, The Netherlands
 annacaceres@googlemail.com

²University of Twente, BMS-STePS, 7500 AE Enschede, The Netherlands
 a.weber@utwente.nl

³University of Groningen, Bernoulli Institute, Nijenborgh 9, 9747 AG Groningen, The Netherlands
 l.r.b.schomaker@rug.nl

Abstract: This short paper describes how MONK, a machine-learning driven handwriting recognition system, can be used to rapidly index a heterogeneous handwritten collection with the help of volunteers. We discuss the setup and results of an event which saw volunteers come together to enrich a subset of the digitized Prize paper collection, a collection of historical handwritten documents of the High Court of Admiralty (1652-1815).

Keyword: handwriting recognition, user study, heterogeneous archives, archives, active learning, Prize papers, machine learning

Over the last decades archives, museums, research institutions and publishers have undertaken major efforts to digitize their collections. However, the large amount of handwritten documents in these collections is often not fully indexed. This is due to the fact that the manual indexing of handwritten documents is a labor-intensive task. To address this problem, we have developed a machine-learning driven handwriting recognition system developed at the University of Groningen. MONK does not require

<http://dx.doi.org/10.5281/zenodo.3860811>

Items in hit list of Bloch numbered: 0-493. (now showing: 0-49)

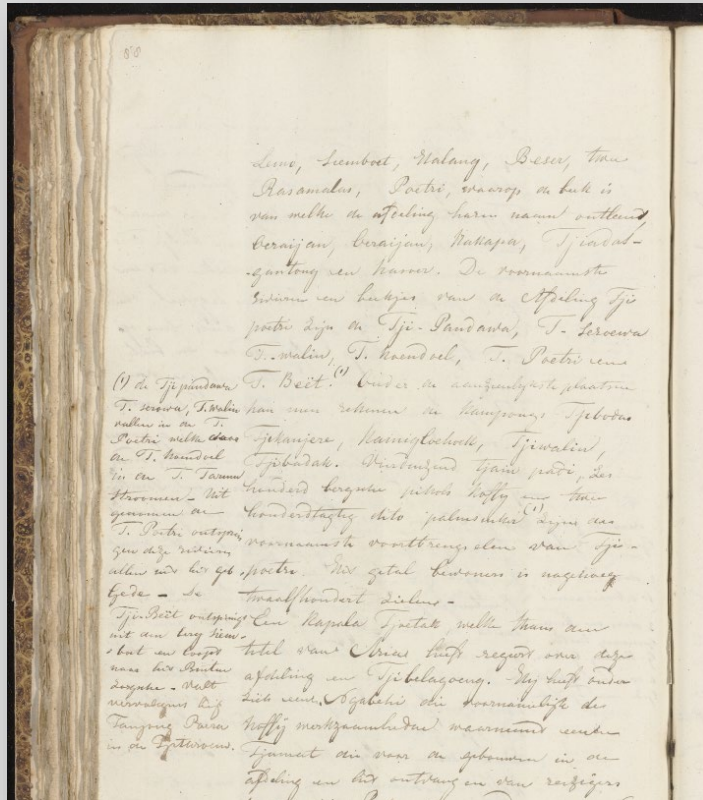
<i>Bloch</i> Bloch	<i>Bloch</i> Bloch	<i>Bloch</i> Bloch	<i>Bloch</i> ovarium	<i>Bloch</i> Bloch	<i>Bloch</i> Bloch	<i>Bloch</i> aeusserst
<i>Bloch</i> Blochi	<i>Bloch</i> Babi	<i>Bloch</i> obgleich	<i>Bloch</i> obgleich	<i>Bloch</i> durch	<i>Bloch</i> obgleich	<i>Bloch</i> durch
<i>Bloch</i> velum	<i>Bloch</i> velum	<i>Bloch</i> Bronchien	<i>Bloch</i> Bronchien	<i>Bloch</i> Blochi	<i>Bloch</i> durch	<i>Bloch</i> Blochi
<i>Bloch</i> Reiche	<i>Bloch</i> Bloch	<i>Bloch</i> velum	<i>Bloch</i> Balkens	<i>Bloch</i> robusto	<i>Bloch</i> Bloch	<i>Bloch</i> Bloch
<i>Bloch</i> Bloch	<i>Bloch</i> Reiche	<i>Bloch</i> Ban	<i>Bloch</i> Bloch	<i>Bloch</i> obschon	<i>Bloch</i> obschon	<i>Bloch</i> Batavia
<i>Bloch</i> coeruleo	<i>Bloch</i> coeruleo	<i>Bloch</i> Nobis	<i>Bloch</i> curvato	<i>Bloch</i> Blochi	<i>Bloch</i> coeruleo	<i>Bloch</i> Bohne
<i>Bloch</i> coeruleo	<i>Bloch</i> streicht	<i>Bloch</i> streicht	<i>Bloch</i> streicht	<i>Bloch</i> streicht	<i>Bloch</i> durch	<i>Bloch</i> Bloch
<i>Bloch</i> durch						

Items in hit list of Bloch numbered: 0-493. (now showing: 0-49)

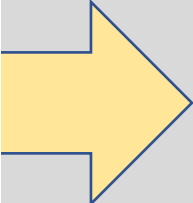
- ➔ MONK as visual exploration tool (*surfing through collection*)
- ➔ Rapid indexing
- ➔ Means of involving volunteers

Index: <https://monk.hpc.rug.nl/monk/Slex/NatCom-FieldNotes-words/index.html>

III: Broaden the scope – manual labour

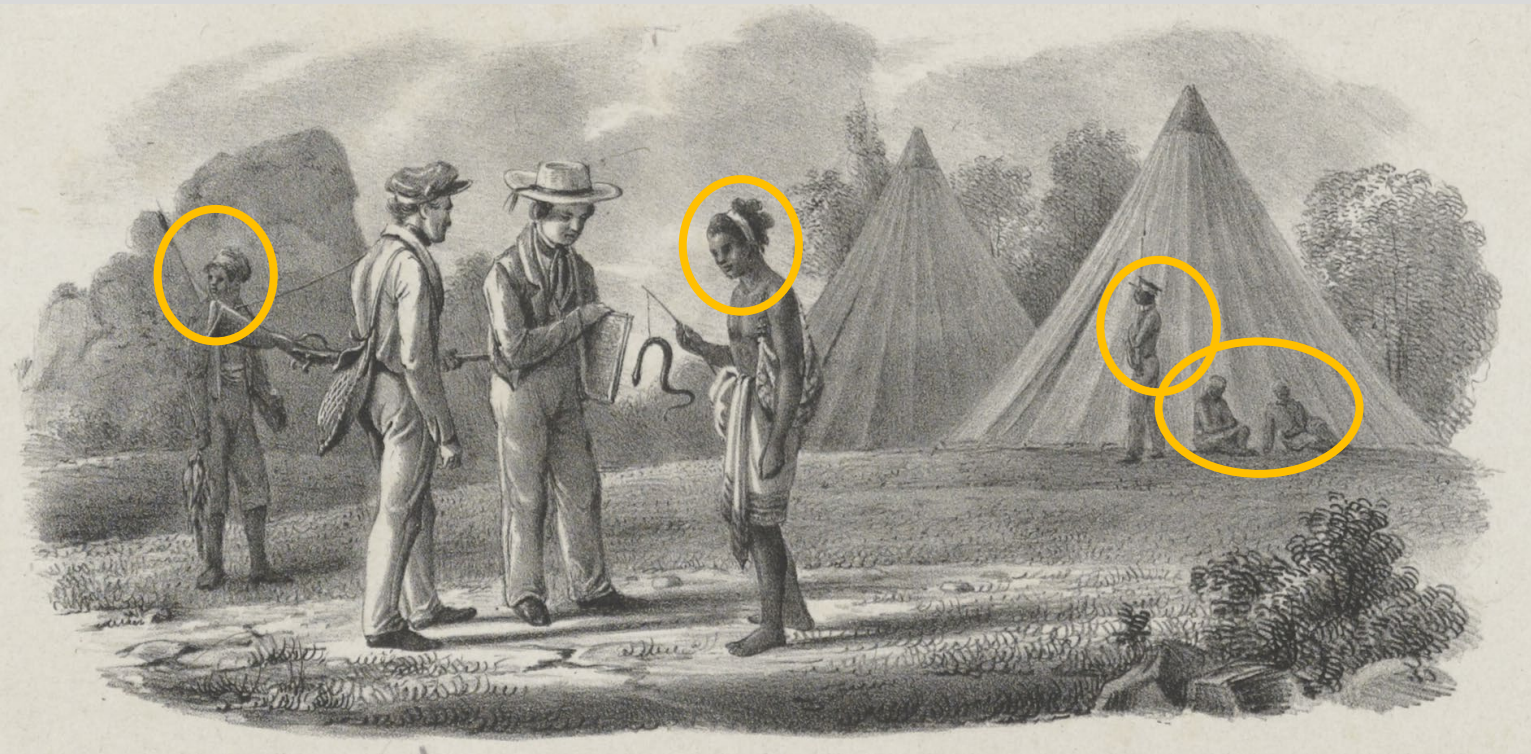


001 ... Lemo ... Siemboet ... Malang ... Beser ...
002 Rasamales, Poetri, waarop de beek is ...
003 ... van ... welke ... afdeling ... haren ... naam ... ontleend ...
004 beraijan, beraijan, ?, Tjiandat- ...
005 gantong en haroer. De voornaamste ...
006 ... rivieren ... en ... beekjes ... Afdeling ...
007 poetri zijn de Tje-Pandawa, T-Seroewa ...
008 ... T-walin ... T-Hoendoel ... Poetri ...
009 T. Beët.(1) Onder de aanzienlijkste plaatsen ...
010 T. serowa, T. walin kan men rekenen de kampongs Tjibodas ...
011 Tjikanjere, Kainigloehoek, Tjiwalin ...
012 en T. hoendoel. Tjibadak. Vierduizend ...
013 Tjibadak. Vierduizend tjin padi, zes ...
014 strooien uit honderd bergsche pikols koffij en twee ...
015 genomen en honderdtachtig dito palmsuiker zijn den ...
016 gen deze rivieren. voornaamste voortbrengselen van Tji- ...
017 allen uit het ge. poetri. Het getal bewoners is nagenoeg ...
018 Gede - De twaalfhondert zielen - ...
019 Tji-Beët ontspringt Een Kapala Tjoetak welke thans den ...
020 ... uit ... den ... berg ...
021 ... loopt ... titel ... van ... Arias ... heeft ... regeert ... over ... dezen ...
022 ... naar ... het ... Buiten ... a ...
023 ... zorgsche ... valt ... afdeling ... Tjibelagoeng ... Hij ... heeft ... onder ...
024 ... vervolgens ... zich ... eenen ... Agabehi ... die ... voornamelijk ...
025 ... koffij ... werkzaamheden ... waarneemt ... even ...
026 ... Tjamat ... die ... voor ... gebouwen ... in ...
027 ... afdeling ... en ... het ... ontvangen ... van ... reizigers ...
028 ... zorgt ... vier ... P ... Patingies ... s ... die ... onder ... Aga ... z ...
029 ... behi ... Tjamat ... staan ... 8 ... mandor's ...
030 ... drie ... twaalf ... Loera's ... die ...
031 ... voornamelijk ... het ... rijst ...
032 ... zamelen ...



- Diaries of P. van Oort (part of NC archive)**
- More than **1000 handwritten pages**
 - Produced between **1826-1834** in the midst of two major colonial wars

III. Broaden the scope – Cultural bias?



=> in contemporary illustrations and present day **digital infrastructures** only the 18 European travellers would surface!

- Local draftsmen Tsing Wang Ho
- During his travels Van Oort heavily relied on colonial infrastructure (**thousands of local porters, guides, hunters**)

III. Broaden the scope – Cultural bias?



So what?

Concluding remarks

- Why does **cultural bias** matter? What does it mean for digital humanists in the context of (digitized) natural history collections?
 1. Danger of **replicating & enforcing cultural bias** in large scale digital infrastructures related to natural history collections
 2. **Design of digital & analogue infrastructures** co-creates their **users** and their worldviews!
 3. Digital humanists can/should play a key role in developing **digital infrastructures** that read natural history as natural/biodiversity & cultural heritage rooted in and shaped by Europe's colonial past!

... not only a source for the “**study of nature**” but also an incredibly rich source for continuously **questioning our understanding of nature** in the 21st century world!



Acknowledgments

This talk draws upon **more than ten years of research** and enormously enriching conversations across disciplines (biology, taxonomy, computer science, history of science). I am indebted to the following persons for sharing their insights and wisdoms over the years:

Leonard Blussé (Leiden University)
Lissa Roberts (University of Twente)
Sylvia van Zanen (self-employed)
Eulàlia Gassó Miracle (Naturalis)
Maarten Heerlien (KB, National Library of the Netherlands)
Chris Smeenk† (Naturalis Biodiversity Center)
Lise Stork (LIACS/LCDS Leiden University)
Katy Wolstencroft (LIACS/LCDS Leiden University)
Jaap van den Herik (LCDS Leiden University)
Lambert Schomaker (Groningen University)
Mahya Ameryan (Groningen University)
Fons Verbeek (LIACS Leiden)
Aske Plaat (LIACS Leiden)
Ernest Suyver (Brill Publishers), Leiden)
Etienne Posthumus (Brill Publishers, Leiden; self-employed)
Michiel Thijssen (formerly Brill)
Marti Huetink (Brill Publishers, Leiden; WBooks)
Sally Chambers (Ghent University / DARIAH)
Sharif Islam (Naturalis, Leiden)
and many more...

