
Accumulation versus collection – documentation makes a difference.

What is a botanical garden?

Schönbrunn, Austraia, 2015

What is a botanical garden?

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What is a botanical garden?

BG Bonn, Germany

BG Sao Paulo, Brazil

BG Rome, Italy

BG Rostock, Germany

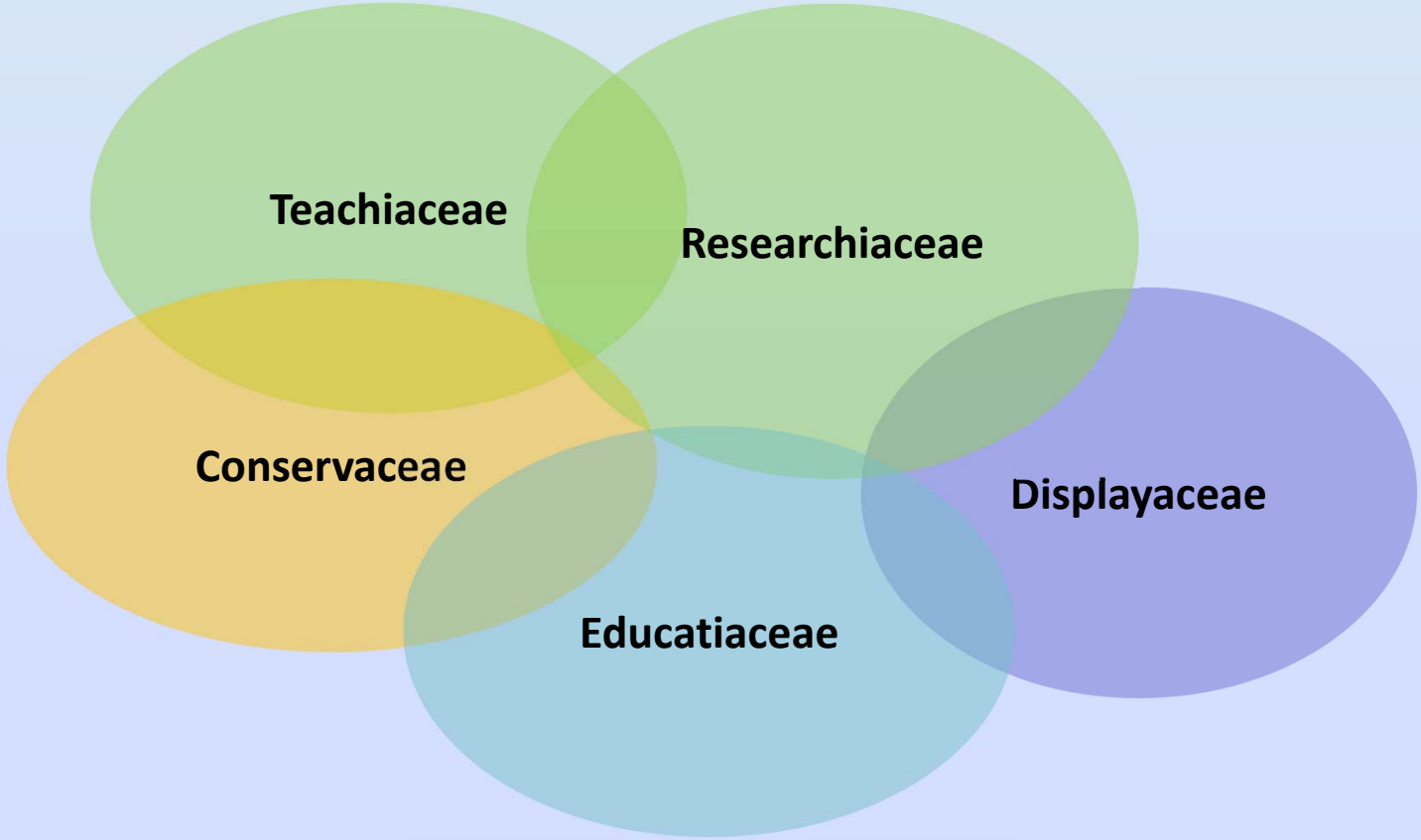
What is a botanical garden?

Botanical gardens are institutions cultivating **documented living collections** in order to fulfil functions in **scientific research** and **teaching**, **education** and **species** and **nature conservation**.

(Botanische Gärten sind Institutionen, die dokumentierte lebende Sammlungen kultivieren, um insbesondere Aufgaben in den Bereichen wissenschaftlicher Forschung und Lehre, der Bildung sowie des Arten- und Naturschutzes zu erfüllen - Rauer et al. 2000*)*

Plant families in collections

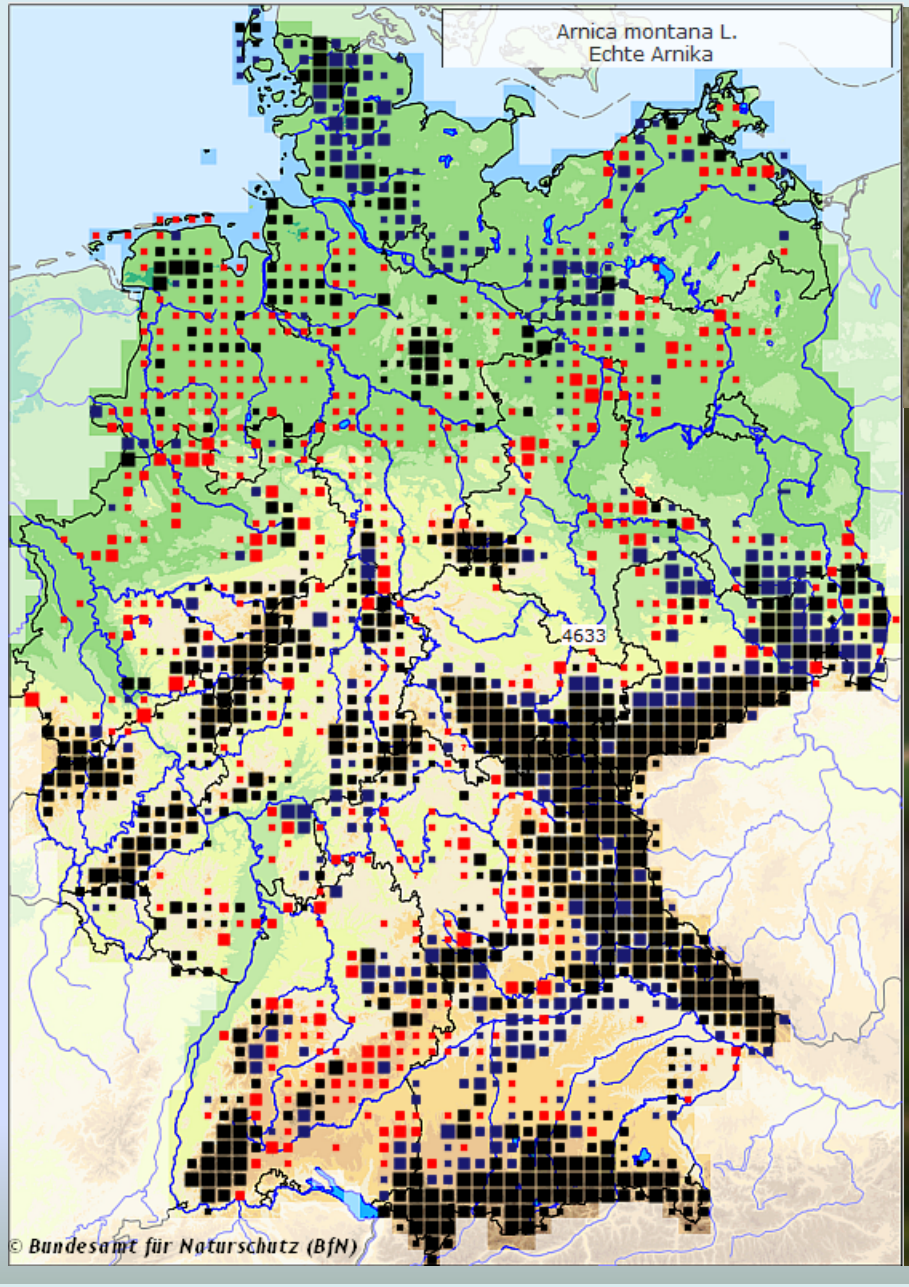
Botanical gardens are institutions cultivating **documented living collections** in order to fulfil functions in **scientific research** and **teaching**, **education** and **species** and **nature conservation**. (Rauer et al. 2000)



*Should they **all** be "documented"? And if so, **why**? And **how**?*

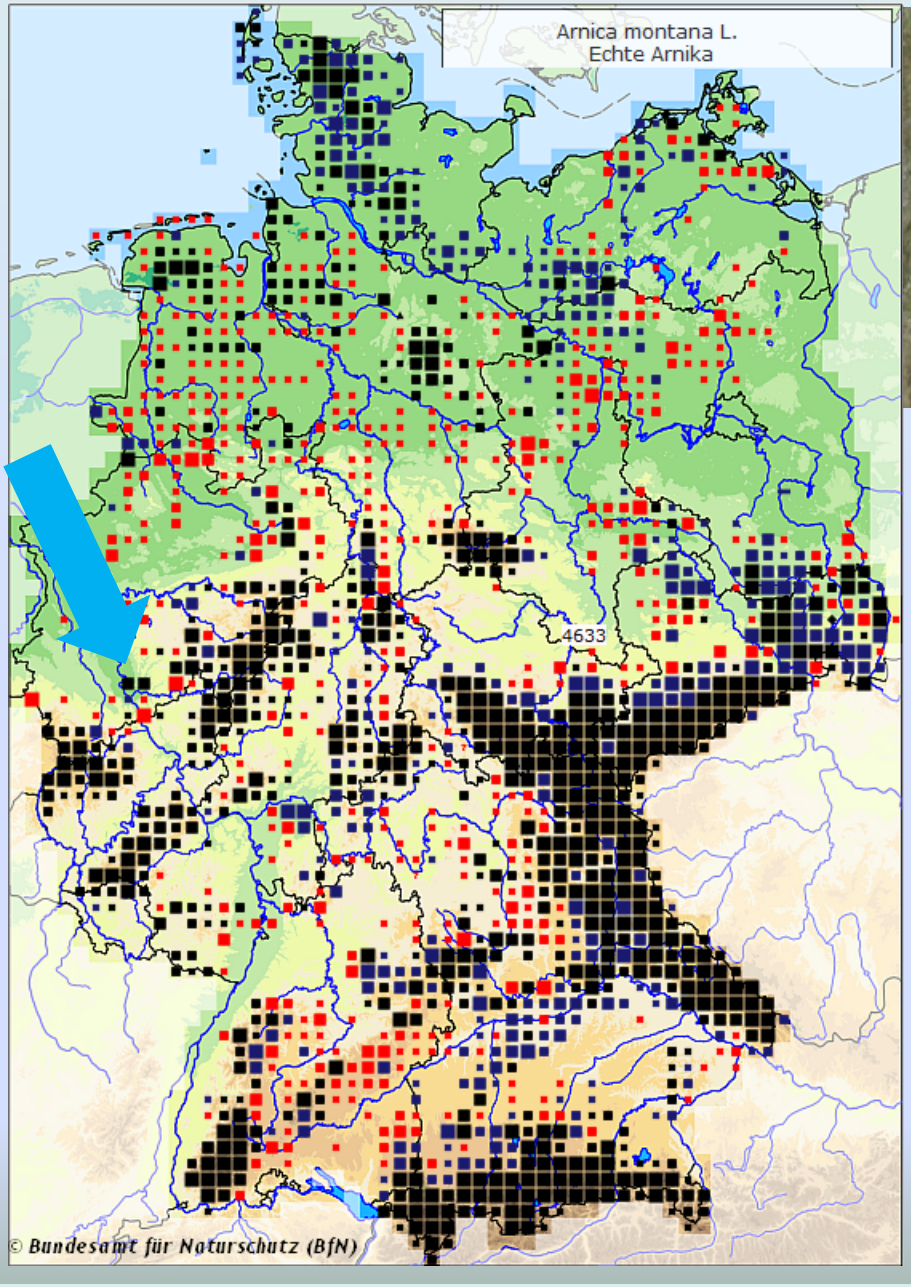
Conservaceae

Conservaceae



ex situ*-conservation *Arnica montana, Bonn BG

Conservaceae



***ex situ*-conservation *Arnica montana,* Bonn BG**

- conservation of **marginal populations** of a widespread species
- only makes sense, if the **local ecotype**, i.e. representatives of local metapopulation are conserved
- this requires a **detailed documentation** of source material

Conservaceae

***ex situ*-conservation website of Verband Botanischer Gärten –** with detailed documentation of source material for conserved populations.

Akzessionen:

Nr.	IPEN	Art	Level	Zugang	Herkunft
1	DE-0-TUEB-49	*Anthriscus sylvestris subsp. stenophylla*	1	2008	Baden-Württemberg, Lkr. Sigmaringen, Beuron, Finstertal östlich Irndorf
2	DE-0-TUEB-1415	*Anthriscus sylvestris subsp. stenophylla*	1	2009	Baden-Württemberg, Lkr. Sigmaringen, Beuron, Finstertal östlich Irndorf
3	DE-0-TUEB-54	*Anthriscus sylvestris subsp. stenophylla*	1	2003	Baden-Württemberg, Bad Urach, Lkr. Reutlingen
4	DE-0-TUEB-1027	*Apium graveolens subsp. graveolens*	1	2009	Baden-Württemberg, Lkr. Karlsruhe, Bruchsal, Salzquelle bei Ubstadt-Weiher
5	DE-0-TUEB-2149	*Athamanta cretensis*	1	2008	Baden-Württemberg, NSG Gräbelesberg bei Hossingen, Zollernalbkreis

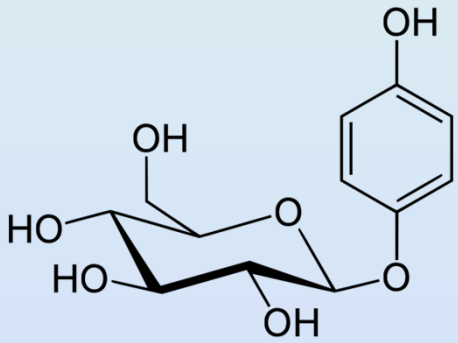
“chain of custody” makes conservation meaningful

Undocumented or incompletely documented material means:

- **legal status** unclear
- re-introduction in the wild (in a different population) may **contribute to genetic erosion** rather than reducing it
- preservation of the **genetic diversity** in *ex situ*-collections can not be verified
- in the case of clonal propagation a **single genotype** (= genetic individual) may be preserved

ex situ-conservation requires comprehensive documentation and record keeping

Researchiaceae



arbutin content of in different accessions of bearberry (*Arctostaphylos uva-ursi)*

source	arbutin-gehalt (% dw)	vitality
FRIESLAND	7,18	very good
FRIESLAND	8,23	very good
NATURWUCHS	9,19	moderate
FRIESLAND	9,25	good
RÜHLEMANNS	9,67	good
STAUDEN STADE	10,04	very good
FRIESLAND	10,23	moderate
ARKTISCH-ALPINER GARTEN	10,65	bad
Wild collected 1a	11,66	very good
Wild collected 1b	11,79	very good
Wild collected 1c	11,80	very good
Wild collected 1d	12,44	very good
Wild collected 1e	12,56	very good
Wild collected 2a	13,68	very good
Wild collected 2b	13,73	very good
Wild collected 2c	14,44	very good
Wild collected 2d	15,32	very good
Wild collected 2e	15,37	very good

Researchiaceae

Urtica dioica phytochemistry

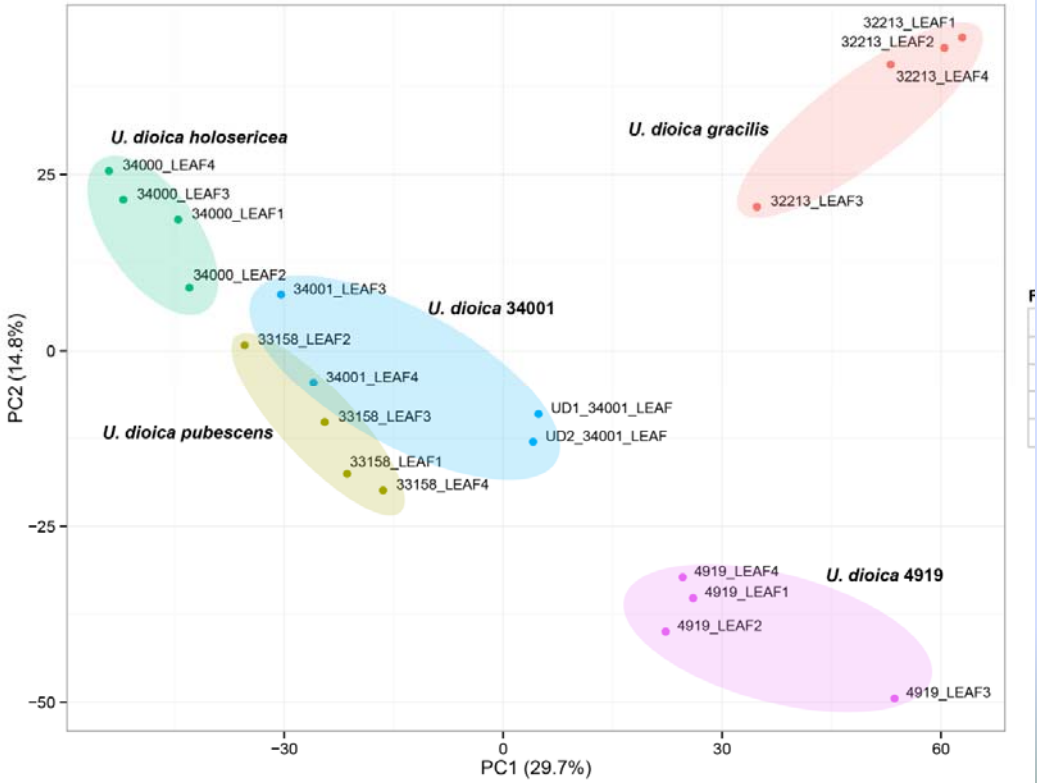
Urtica dioica subsp. *dioica* var. *pilosa*

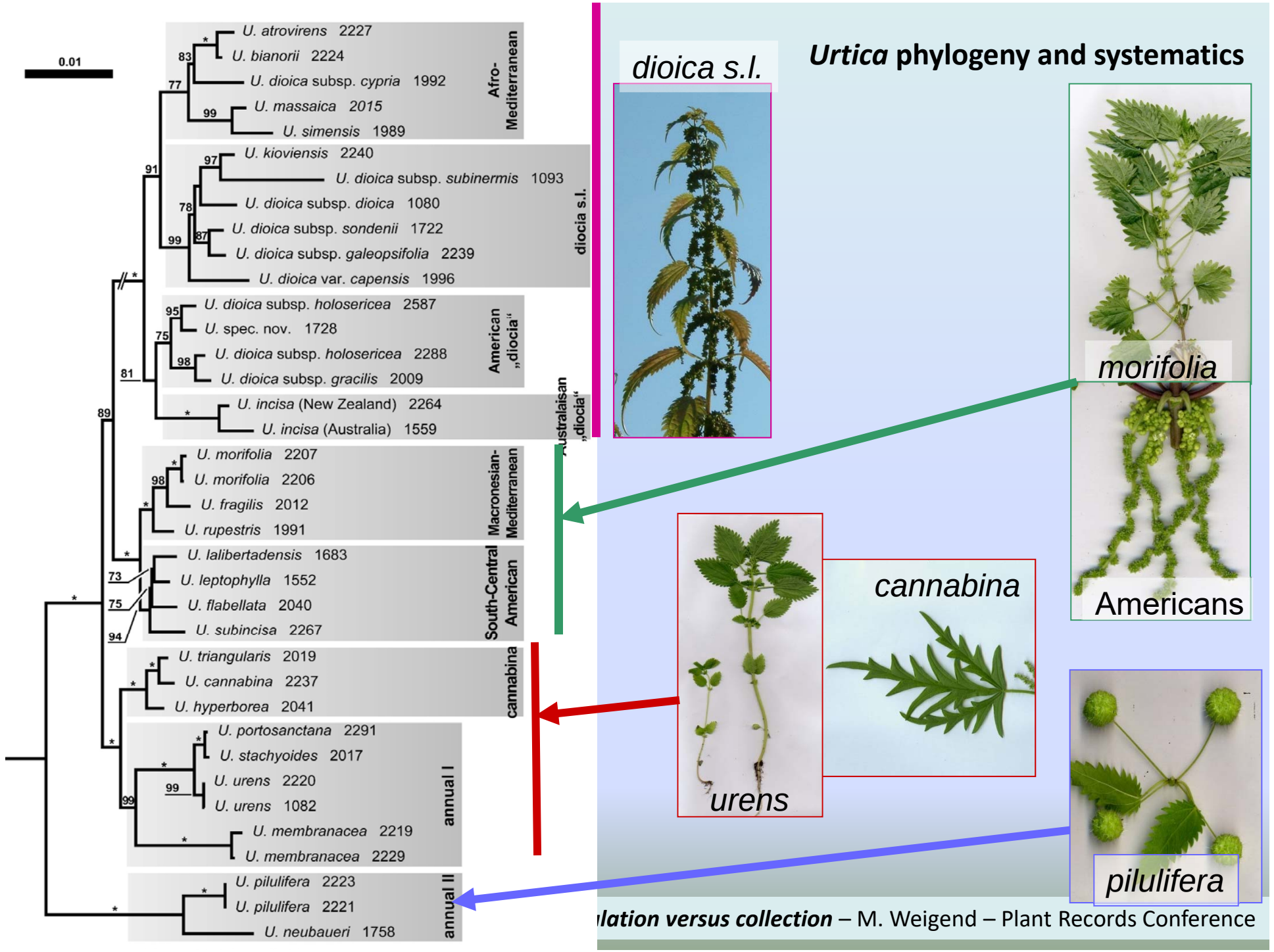
Researchiaceae

Urtica dioica phytochemistry

Principal component analysis shows highly divergent chemical composition between different accessions

- **analytical results can not be verified/falsified without direct reference to a plant individual/accession.**
- **complex infraspecific taxonomy**



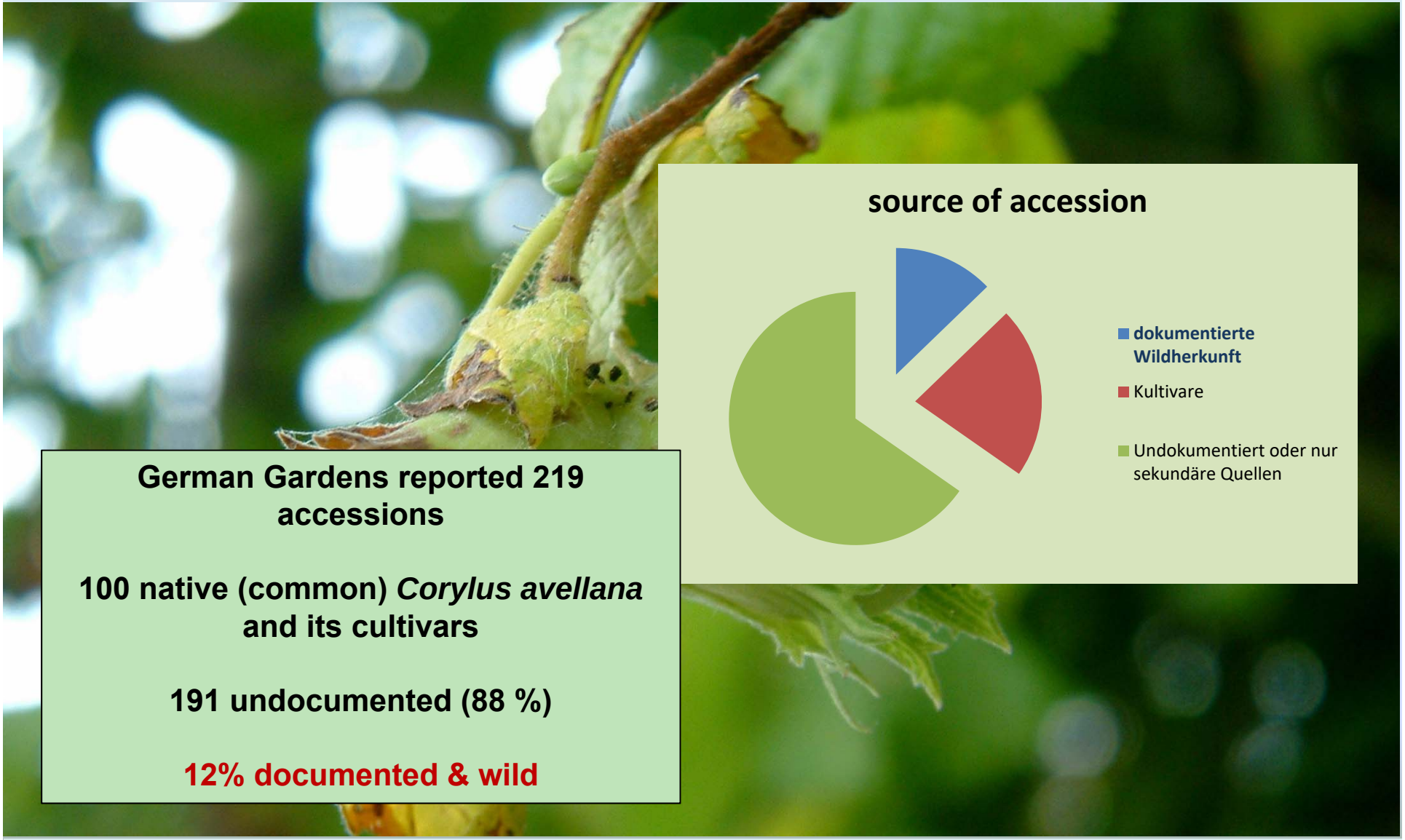

0.01
U. atrovirens 2227
U. bianorii 2224
U. dioica subsp. cypria 1992
U. massaica 2015
U. simensis 1989
Afro-Mediterranean
U. kioviensis 2240
U. dioica subsp. subinermis 1093
U. dioica subsp. dioica 1080
U. dioica subsp. sondenii 1722
U. dioica subsp. galeopsifolia 2239
U. dioica var. capensis 1996
diocia s.l.
U. dioica subsp. holosericea 2587
U. spec. nov. 1728
U. dioica subsp. holosericea 2288
U. dioica subsp. gracilis 2009
American „diocia"
U. incisa (New Zealand) 2264
U. incisa (Australia) 1559
Australaisan „diocia"
U. morifolia 2207
U. morifolia 2206
U. fragilis 2012
U. rupestris 1991
Macronesian-Mediterranean
U. lalibertadensis 1683
U. leptophylla 1552
U. flabellata 2040
U. subincisa 2267
South-Central American
U. triangularis 2019
U. cannabina 2237
U. hyperborea 2041
cannabina
U. portosanctana 2291
U. stachyoides 2017
U. urens 2220
U. urens 1082
U. membranacea 2219
U. membranacea 2229
annual I
U. pilulifera 2223
U. pilulifera 2221
U. neubaueri 1758
annual II
Urtica phylogeny and systematics
dioica s.l.
morifolia
Americans
cannabina
urens
pilulifera
lation versus collection – M. Weigend – Plant Records Conference

Researchiaceae in Botanic Gardens – in real life

Sourcing *Corylus* for a phylogenetic project from living collections

Researchiaceae in Botanic Gardens – in real life

Sourcing *Corylus* for a phylogenetic project from living collections



German Gardens reported 219 accessions

100 native (common) *Corylus avellana* and its cultivars

191 undocumented (88 %)

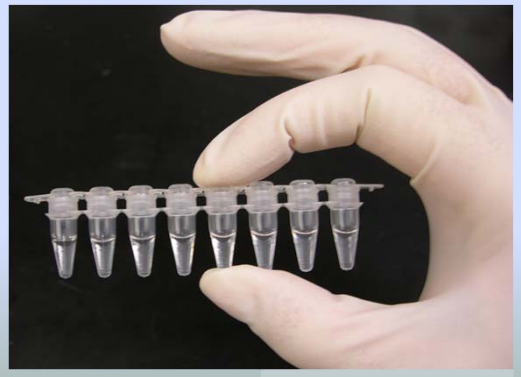
12% documented & wild

Implications of documentation for collection use in research

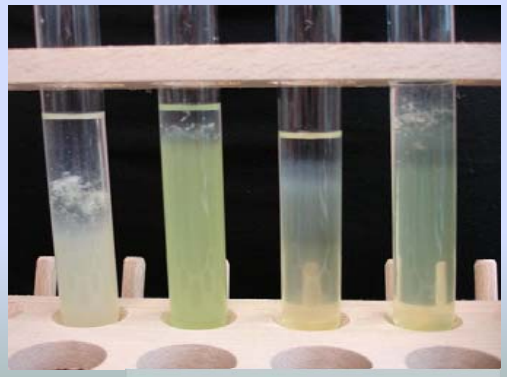
- research results are not (fully) **reproducible** if documentation incomplete
- same **or** different genotype may be present in different collections (clonal propagation)
- phylogeny or phytochemical screening (unpredictably) **biased** by multiple samples of same genetic individual/source population
- **representativeness** of data sets unclear (geographical, population level)
- **legality** of research unclear

→ **Convention on Biological Diversity & Nagoya Protocol**

© BGBM Berlin

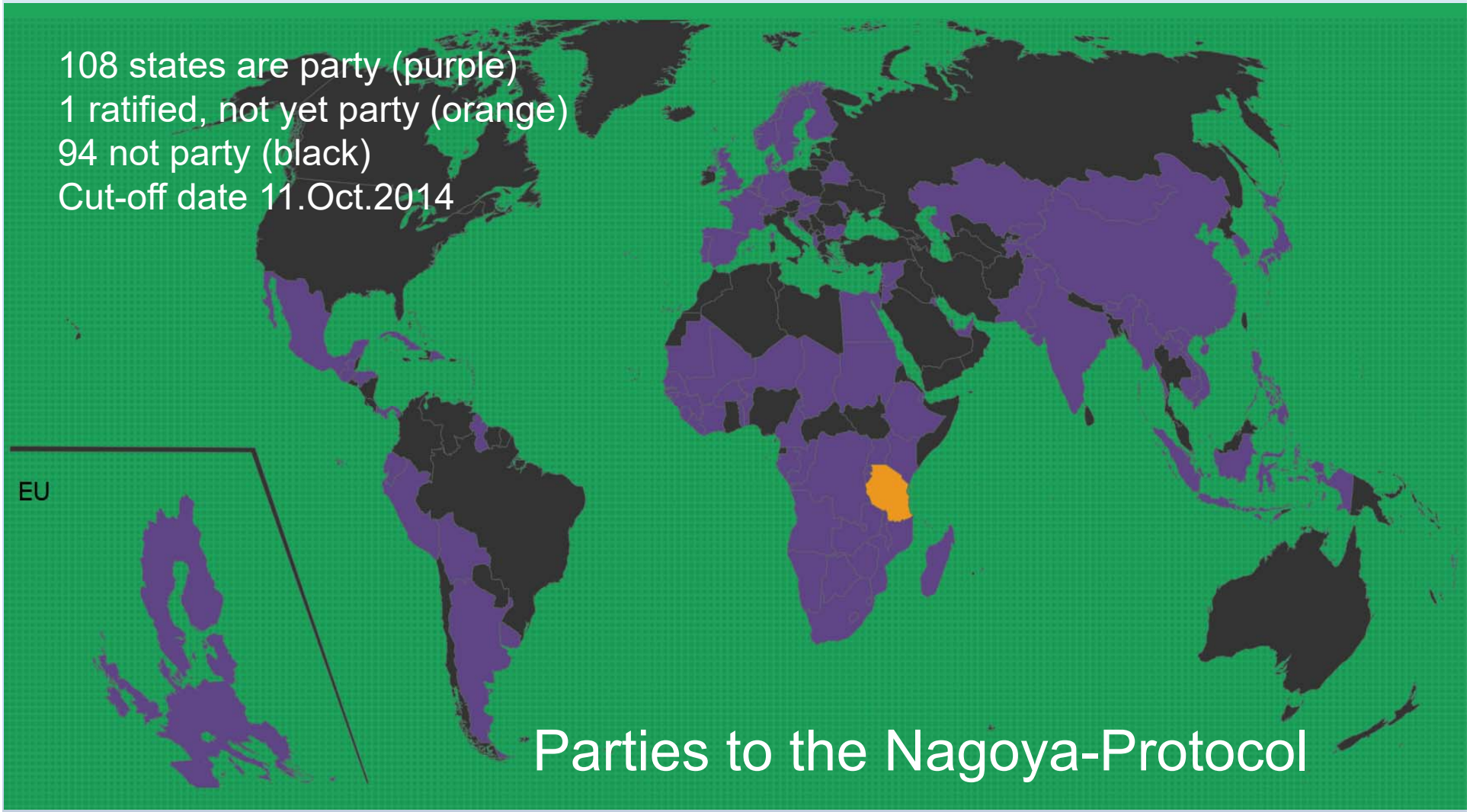


© Madeleine Price Ball



Quelle: Wikimedia Commons

Implications of documentation for collection use in research



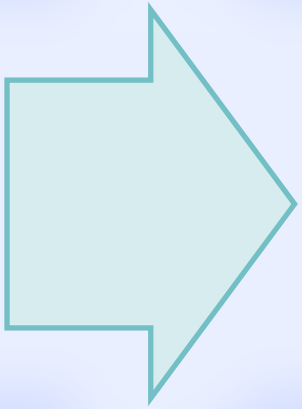
source: official clearing house-website of Nagoya Protocol, accessed 5.2.2019 (https://absch.cbd.int)

Implications of documentation for collection use in research

Access & Benefit-Sharing (ABS) – some terminology

access = obtaining genetic ressources
(from the wild or from a collection)

utilization = research and/or development on genetic and/or biochemical composition of genetic ressources



- ***rules apply both to commercial and non-commercial „utilization“***
- ***exact scope of „utilization“ differs from one country to the next***

Crucial information: **when** and **where** (exactly) was the material sourced?
which additional rules apply (e.g., collection permit)?

Implications of documentation for collection use in research

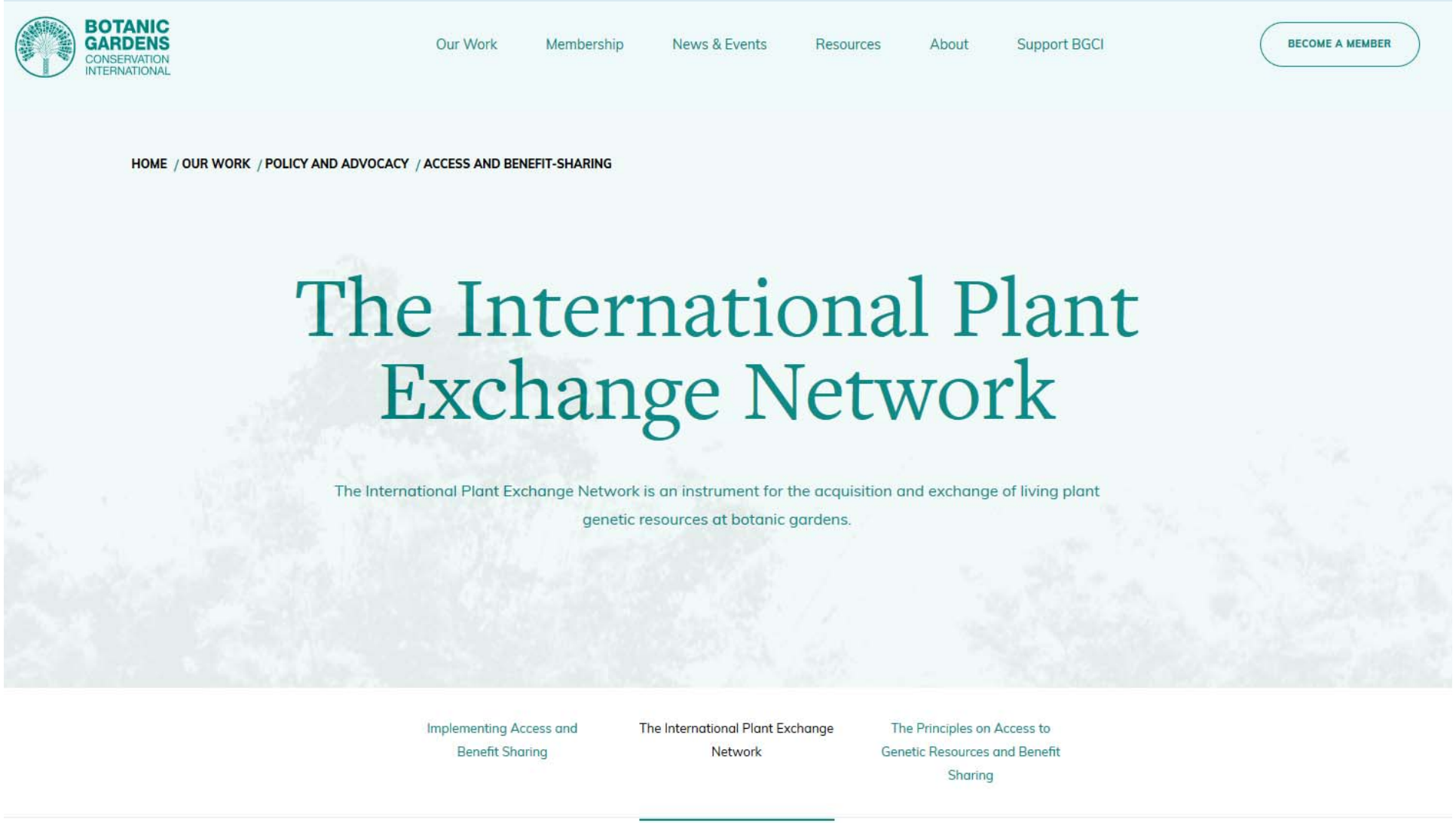
International Plant Exchange Network (IPEN) as a tool for increasing **legal certainty** (IPEN-numbers. e.g., GE-0-M-2012/3378)

- **standardizes** plant records and **transfer** of **information**
- regulates **access** from countries of origin
- regulates **exchange** between parties to IPEN
- regulates **transfer** to non-IPEN-members
- has provisions for **ABS**

- source of germplasm traceable throughout ("**chain of custody**")
- characterizes **legal framework** (Research permissible? Which conditions attached?)

Katse Alpine Garden (Lesotho)

Implications of documentation for collection use in research



Botanic Gardens Conservation International (BGCI):
http://www.bgci.org/policy/ipen/ (all IPEN-documents as download)

“chain of custody” retains crucial information

Material brought into gardens is nearly never „representative“ of a species or even a population.

Here three **wild collected „forms“** of one species - explicitly advertized as such. **Neither of them is „typical“ of the species.**

(Zingiberaceae)
Cautleya spicata 'Bleddyn's Beacon' - BSWJ2408

Pot Size: 2 litre (deep)
Price: £10.00
Description:
One of the best forms we have grown, outperforming in flower, any of our other collections. Which means the plant's energy is concentrated on flowering rather than increasing at the root, unfortunately meaning it is in short supply. Of a stocky nature with strong dark red stems (hence old species name of C. robustum, not the cultivar) bearing longer than normal terminal inflorescences of dark red overlapping bracts with sizeable protruding yellow flowers over a long period June to October. Easily grown in any type of humus rich but drained soil in sun to light shade, protect the rhizomes from freezing in cold areas, with a mulch. Hardy to -15C. Our collection from the Darjeeling area of northern India.

add to wheelbarrow >>

(Zingiberaceae)
Cautleya spicata 'Arun Flame' - HWJK2172

Pot Size: 4 litre (deep)
Price: £12.00
Description:
A distinct collection of this ornamental perennial we gathered from Eastern Nepal in 2002 with Dan Hinkley and Jamaica Kincaid. Which has the darkest red stems to about 1m tall, of yellow orange flushed flowers in dense terminal spikes, sheathed by dark red bracts July-September, while the backs of the leaves are tinged purple-red. We have found this collection to be perfectly hardy in an open field even in full sun, all we have done is to apply an 8cm bark mulch every winter. Multi-stemmed mature plants.

(Zingiberaceae)
Cautleya spicata 'Crûg Canary' - BSWJ2103

Pot Size: 2 litre (deep)
Price: £10.00
Description:
Our own wild collection of this rhizomatous perennial, from the Darjeeling area of Northern India. Forming wide clumps of vertical mahogany-red stems, with broadly lanceolate ribbed leaves, to 1m tall. Bearing June-Oct. terminal spikes of deep-red bracts with protruding orange-yellow orchid-like flowers. Sun or shade in humus rich well drained soil, protect in cold areas. Hardy to -10c.

add to wheelbarrow >>

“chain of custody” is what makes science science

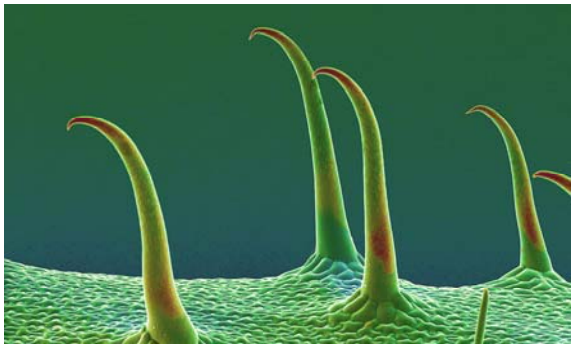
38698 + *Chaerophyllum bulbosum* DE-0-BONN-38698

Index seminum BG Bonn 2017

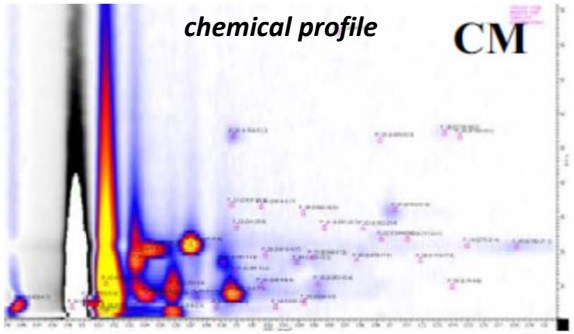
Deutschland, Rheinland-Pfalz, Rechtes Moselufer bei Neumagen-Dhron, höher gelegener Uferbereich, R. Wisskirchen, 38/16, 01.09.2016

living plant in collection

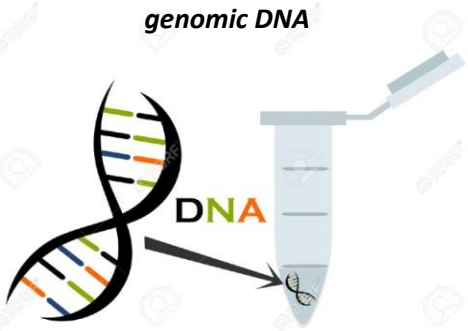
images and observational data



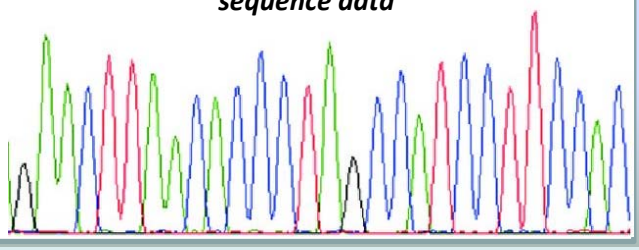
chemical profile



genomic DNA



sequence data



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seed sample

voucher for verification

accumulation versus collection – M. Weigend – Plant Records Conference

“chain of custody” is what makes science science

38698 + *Chaerophyllum bulbosum* DE-0-BONN-38698

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=

seed sample

Why herbarium specimens?

Aquilegia vulgaris, wild type und introgression of horticultural varieties [© Ackermann, Weigend]

… herbarium specimens (and possibly genomic DNA) are also important to track possible hybridization or effects of domestication in garden material

voucher for verification

“chain of custody” is what makes science science

38698 + *Chaerophyllum bulbosum* DE-0-BONN-38698

Index seminum BG Bonn 2017

Deutschland, Rheinland-Pfalz, Rechtes Moselufer bei Neumagen-Dhron, höher gelegener Uferbereich, R. Wisskirchen, 38/16, 01.09.2016

Why herbarium specimens?

Caiphora lateritia – wild type from Argentina

… herbarium specimens (and possibly genomic DNA) are important to track possible hybridization or effects of **domestication** in garden material

Caiphora lateritia – „garden type“ after ca. 140 years in cultivation (© Ackermann)

“chain of custody” is what makes science science

Which parts of the collection need to be documented?

Displayaceae

Keukenhof, Netherlands, 2017

Which parts of the collection need to be documented?

Displayaceae

Which parts of the collection need to be documented?

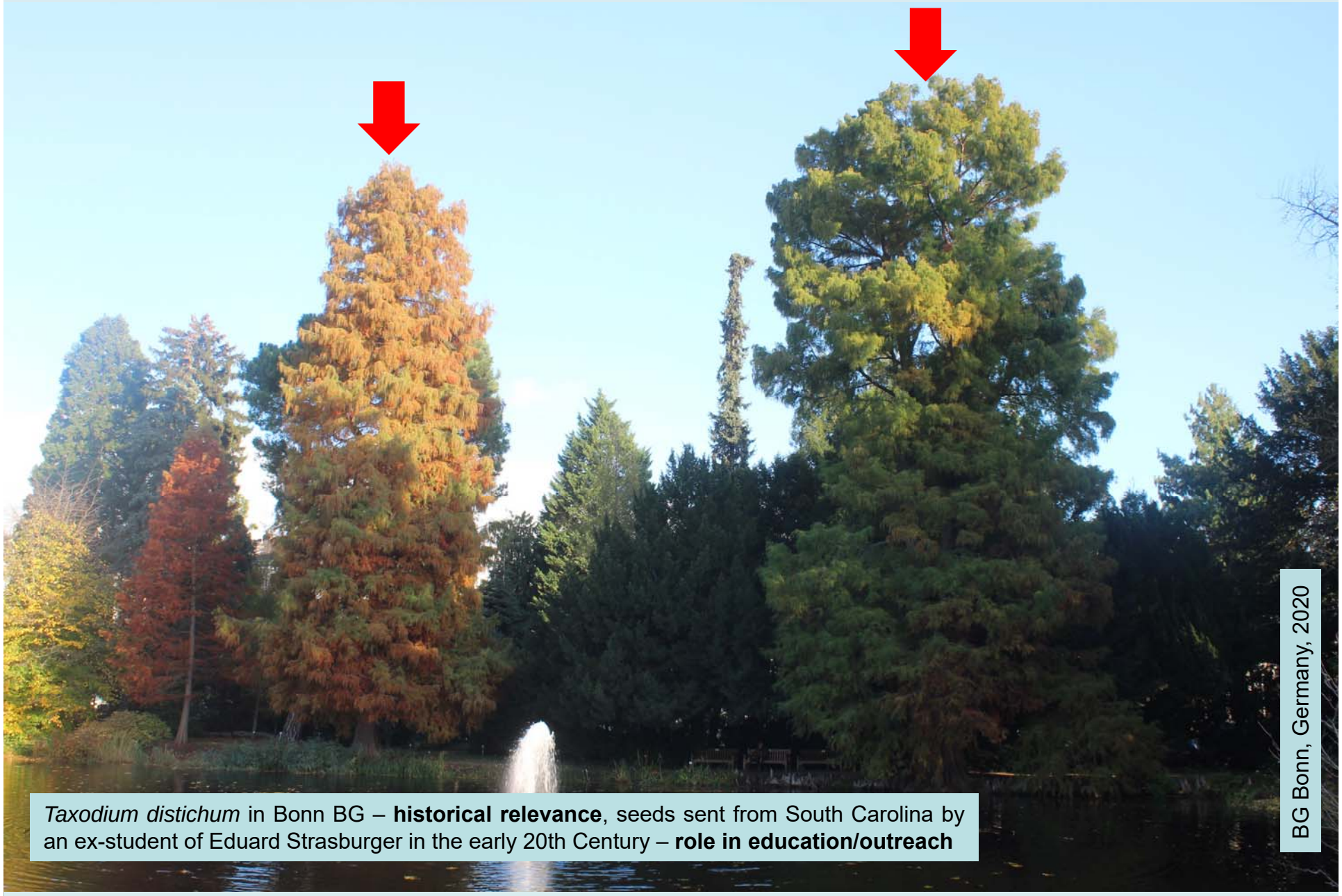
Educatiaceae

.. …or may be an integral - albeit primarily ornamental - part of the collection

BG Pisa, Italy, 2018

Which parts of the collection need to be documented?

Educatiaceae

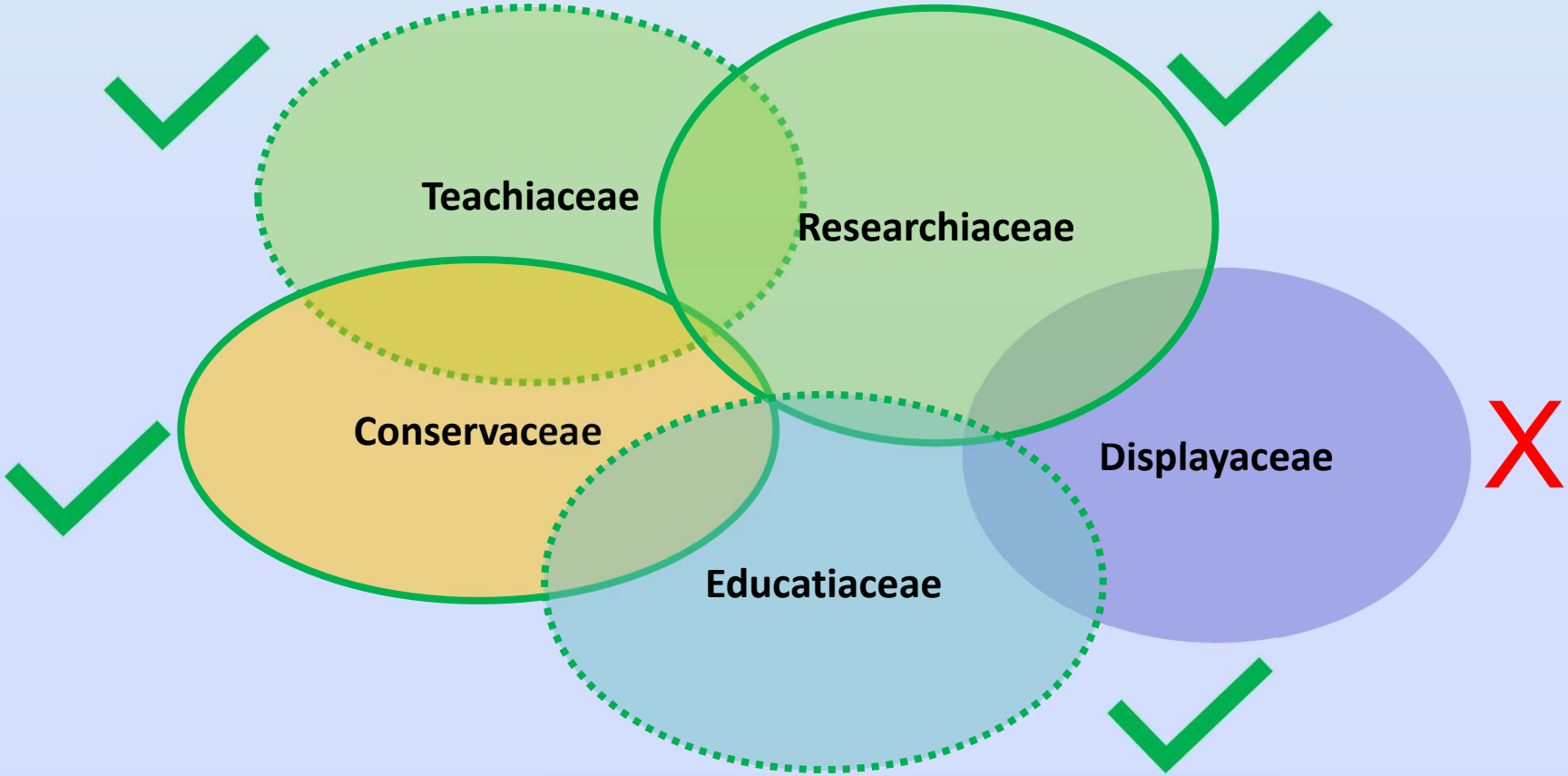


Taxodium distichum in Bonn BG – **historical relevance**, seeds sent from South Carolina by an ex-student of Eduard Strasburger in the early 20th Century – **role in education/outreach**

BG Bonn, Germany, 2020

Which parts of the collection need to be documented?

Botanical gardens are institutions cultivating **documented living collections** in order to fulfil functions in **scientific research** and **teaching**, **education** and **species** and **nature conservation**. (Rauer et al. 2000)



*Detailed (incl. historical) information on a plant may play **a crucial role in education**.*
*Record keeping for plants **exclusively for display** seems of little relevance.*

The importance of record keeping in Botanical Gardens

Botanical gardens are institutions cultivating **documented living collections** in order to fulfil functions in **scientific research** and **teaching**, **education** and **species** and **nature conservation**. (Rauer et al. 2000)

Detailed records of plant accessions is a **key requirement** for botanical gardens to fulfil their **defining missions in research, teaching, conservation** and helpful in education and outreach.

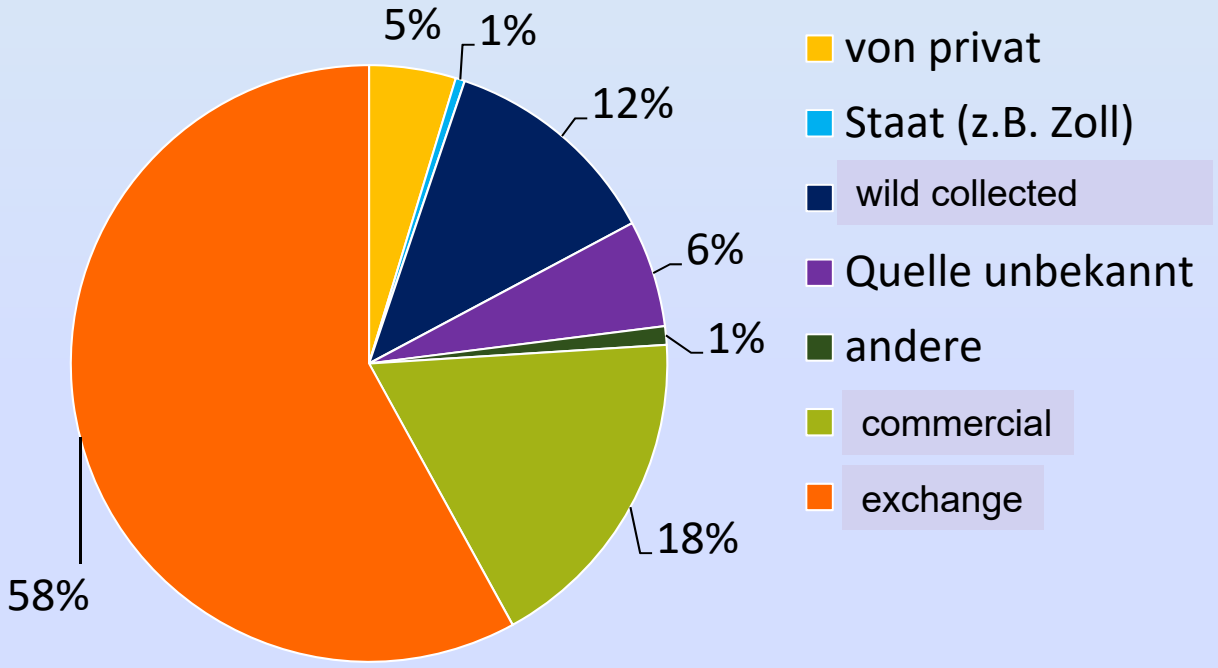
Both **reseach** and **conservation** can **only meaningfully be carried out** with (fully) documented collections („chain of custody“).

There is an **added value** for documented collections in **teaching and outreach/education**.

Increasingly, record keeping is becoming a **key legal requirement** for the **scientific work** with or even **possession of plants** (e.g., CITES, Nagoya - chain of custody!).

Particular challenges in record keeping?

Exchange of plants and seeds is the single most important source of new plants in German BGs



Can record keeping aid quality control?

Krebs et al. 2002: Samentausch von Botanischen Gärten […]. Gärtnerisch-Bot. Brief Nr. 149 (2002/4)

Particular challenges in record keeping?

an accession should be **subset of the genetic/phenotypic diversity of a wild population** of a single, defined species.

Pulmonaria spec. (Boraginaceae) – nearly all species hybridize if cultivated side by side in the garden (here *Pulmonaria mollis, P. saccharata, P. obscura, P. vulgaris* © Ackermann, Mohr, Weigend)

major problem: obligate outcrossers, esp. trees – possibly (only) hybrid seeds

Particular challenges in record keeping?

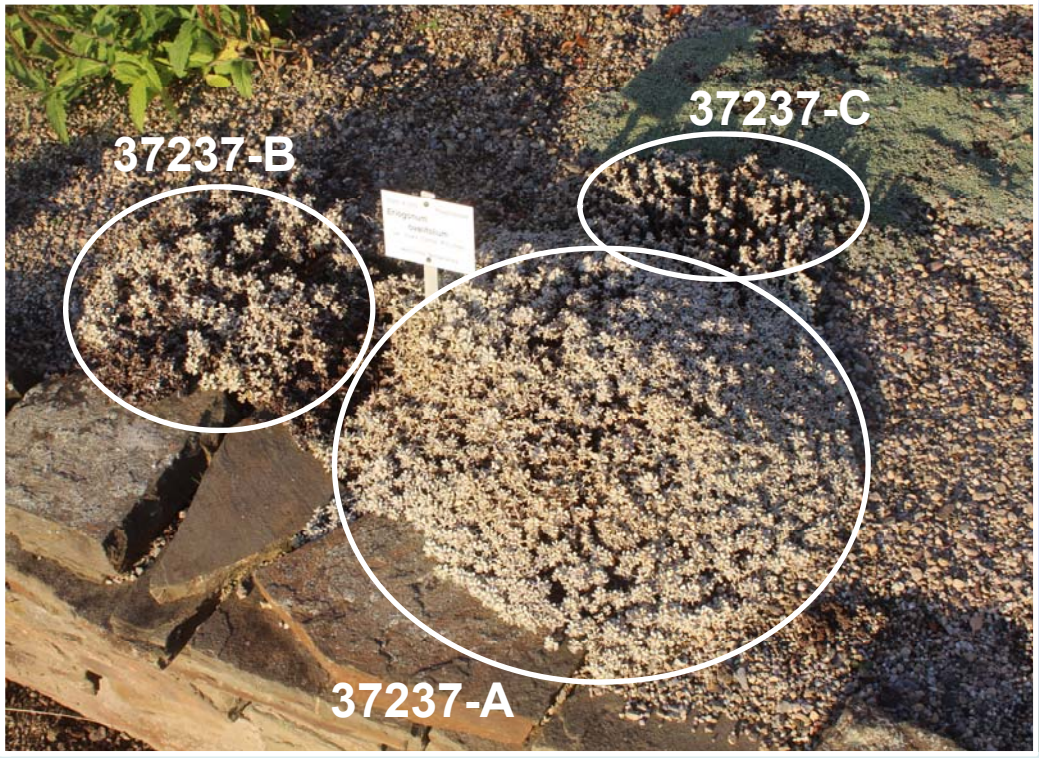
an accession should be **subset of the genetic/phenotypic diversity of a wild population** (seedlings from wild collected *Rhus copallinum*)…

Particular challenges in record keeping?

… but clonal propagation (cuttings, divisions) is common – esp. in perennial herbs and shrubs - „**accessions**“ may be represented by **single genotypes**

Particular challenges in record keeping?

clonal propagation potentially „homogenizes“ accessions - no standard way for keeping track of this in record keeping.



Particular challenges in record keeping?

„homogenous“ accessions may be self-sterile or even represent a single gender - all ***Laurus nobilis*** in Bonn BG were male – until we sourced cuttings of a female clone

Conclusion – record keeping and collection quality

match with garden mission

taxonomic diversity

collection size

genetic integrity

phylogenetic diversity

genetic diversity

record keeping

horticultural quality

documentation of legal framework

horticultural merit

Conclusion – record keeping and collection management