Baseline Standards for Fluid Collections

Workshop by :

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Pfc 2018 – Preservation of natural history wet collections
MNHN Paris, 5th - 7th December, 2018

Baseline Standards for Fluid Collections II

Based on expertise gathered during the

Expert Workshop on Benchmark Standards for the Preservation of Wet Collections

funded by Cloth Makers Foundation (UK) & organised by Chris Collins (NHM, London)

Participants:

Andrew Bentley (Biodiversity Research Center, University of Kansas)

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Birger Neuhaus (Museum für Naturkunde, Berlin)

Dirk Neumann, (Bavarian Natural History Collections, Munich)

John E. Simmons (Museologica, Bellefonte, Pennsylvania)

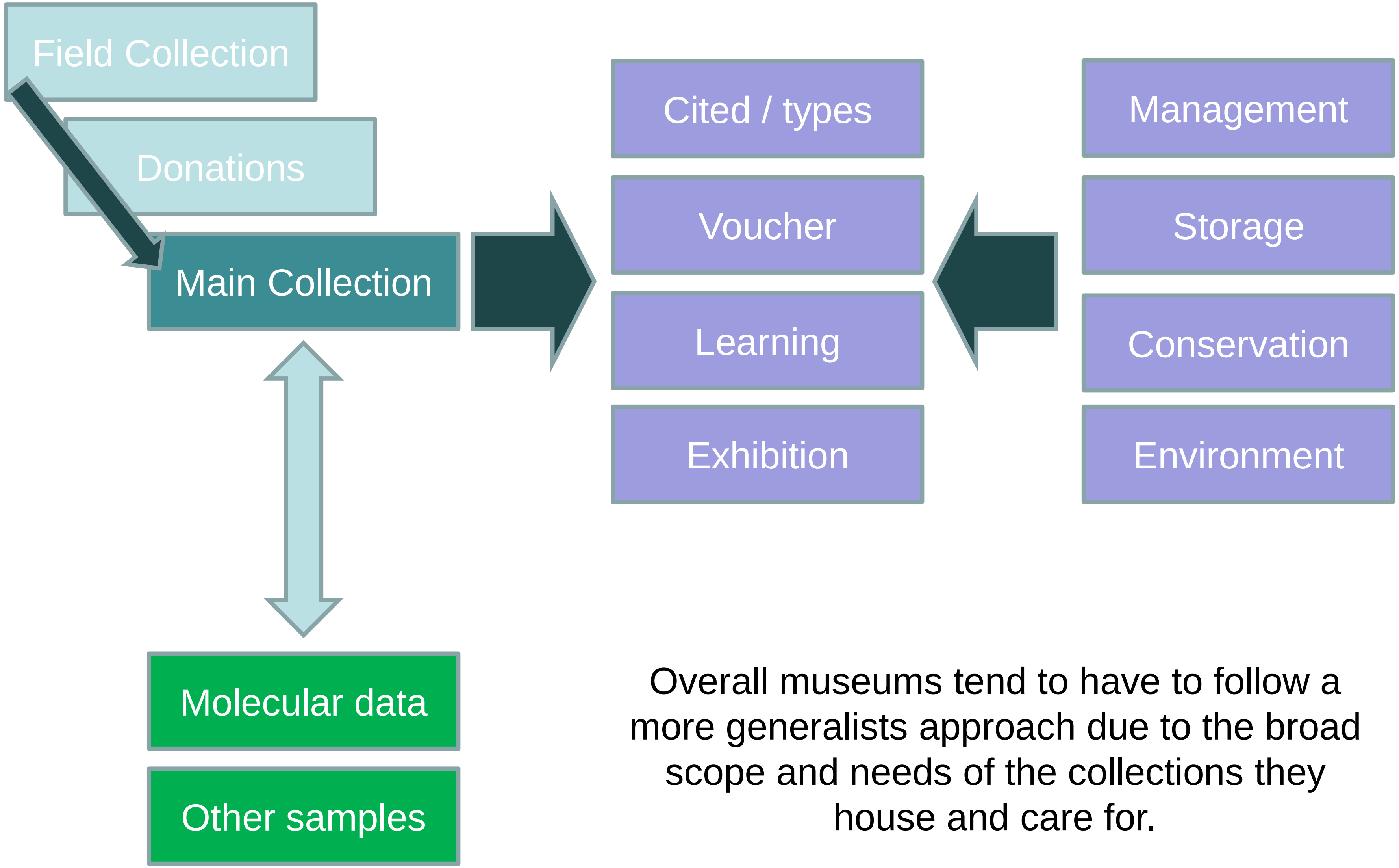
Andries van Dam (Leiden University Medical Centre)

held at NHM London, 16th - 17th October, 2012

Basic Requirements for Maintaining Fluid-Preserved Specimens

- Storage environment
- Review of factors that affect the long term usefulness of fluid preserved specimens
- Sustainability and future research

Specimens of *Hyloxalus fuliginosus* collected in 1860s (left) and 1970s (right)



Overall museums tend to have to follow a more generalists approach due to the broad scope and needs of the collections they house and care for.

Agents of deterioration

Understand the 10 primary threats to heritage objects and how to detect, block, report, and treat the damage they cause.

Services and information

Physical forces

Learn how to avoid, detect, report and treat the damage caused by physical forces.

Thieves and vandals

Learn how to avoid, detect, report and treat the damage caused by thieves and vandals.

Fire

Learn how to avoid, detect, report and treat the damage caused by fire.

Water

Learn how to avoid, detect, report and treat the damage caused by water.

Pests

Learn how to avoid, detect, report and treat the damage caused by pests.

Pollutants

Learn how to avoid, detect, report and treat the damage caused by pollutants.

Light, ultraviolet and infrared

Learn how to avoid, detect, report and treat the damage caused by light, ultraviolet and infrared.

Incorrect temperature

Learn how to avoid, detect, report and treat the damage caused by incorrect temperature.

Incorrect relative humidity

Learn how to avoid, detect, report and treat the damage caused by incorrect relative humidity.

Dissociation

Learn how to avoid, detect, report and treat the damage caused by dissociation.

Contributors

- Canadian Conservation Institute

https://www.canada.ca/en/conservation-institute/services/agents-deterioration.html

Importance of stable storage environment for long-term preservation

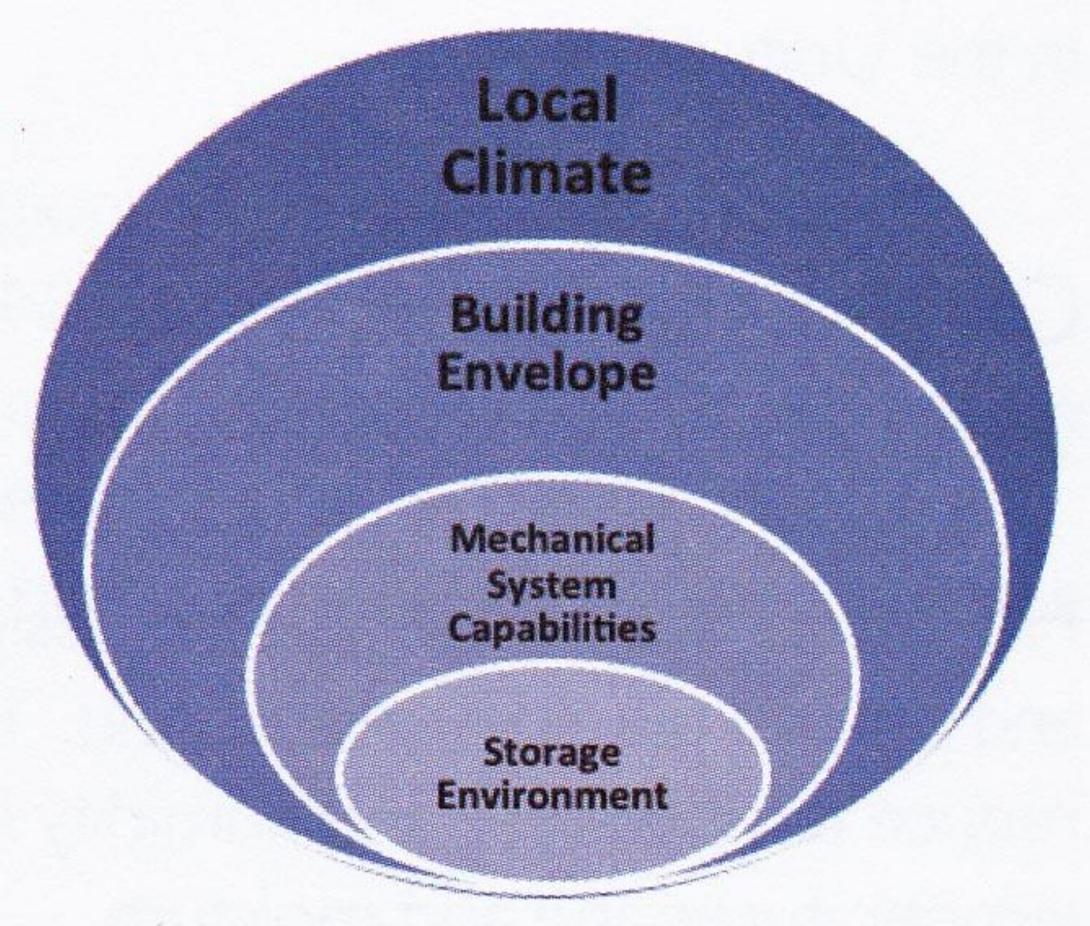
The container and the fluid preservative surrounding the specimen constitute the micro-environment, which will often have reached its own chemical equilibrium.

Specimen – Fluid – Jar – Collection – Storage Space

Upon this will be the wider effects of the macro-environment: light, temperature, pollutants, handling.

Reality more complex
– history of collection, use, resources etc

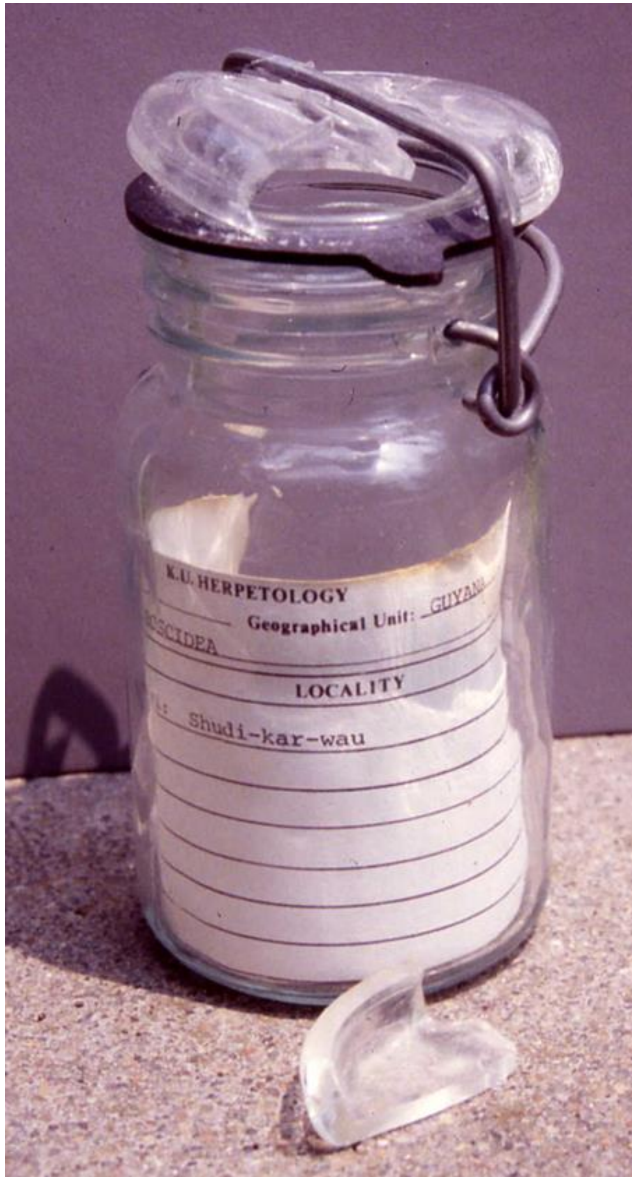
If in doubt keep it simple;
´….less harm than you thought….´



Importance of stable environment for long-term preservation

→ Unstable storage environment accelerates deterioration
- ✓ Warmer temperatures speed up deterioration processes
  - — An increase of 10°C doubles chemical reactions
  - — Extraction of lipids and proteins goes faster
- ✓ Cooler temperatures condense lipids and promote paraformaldehyde formation

→ Fluctuations
- ✓ Stress specimens
- ✓ Stress containers and container seals
- ✓ Relative humidity is temperature dependent
- ✓ Short-term exposure to relative humidity >65% can trigger mold outbreak

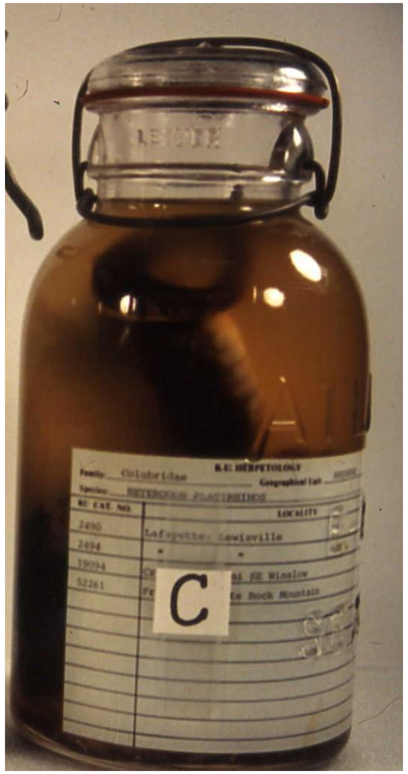


Glass lid that broke due to temperature fluctuations in storage

Importance of stable environment for long-term preservation

→ Temperature

- ✓ 18 – 20 °C is recommended (64 – 68 °F)
- ✓ Not below 15 °C (59 °F)
- ✓ Not above 25°C (77 °F)
- ✓ No more than 5% fluctuation from set point
- ✓ Storage below flash point?
  - — Theoretical, not practical
  - — No evidence that sub-flash point reduces fire danger
  - — Very expensive
  - — Lipids condense, paraformaldehyde forms
  - — Reduce fire danger by eliminating ignition sources

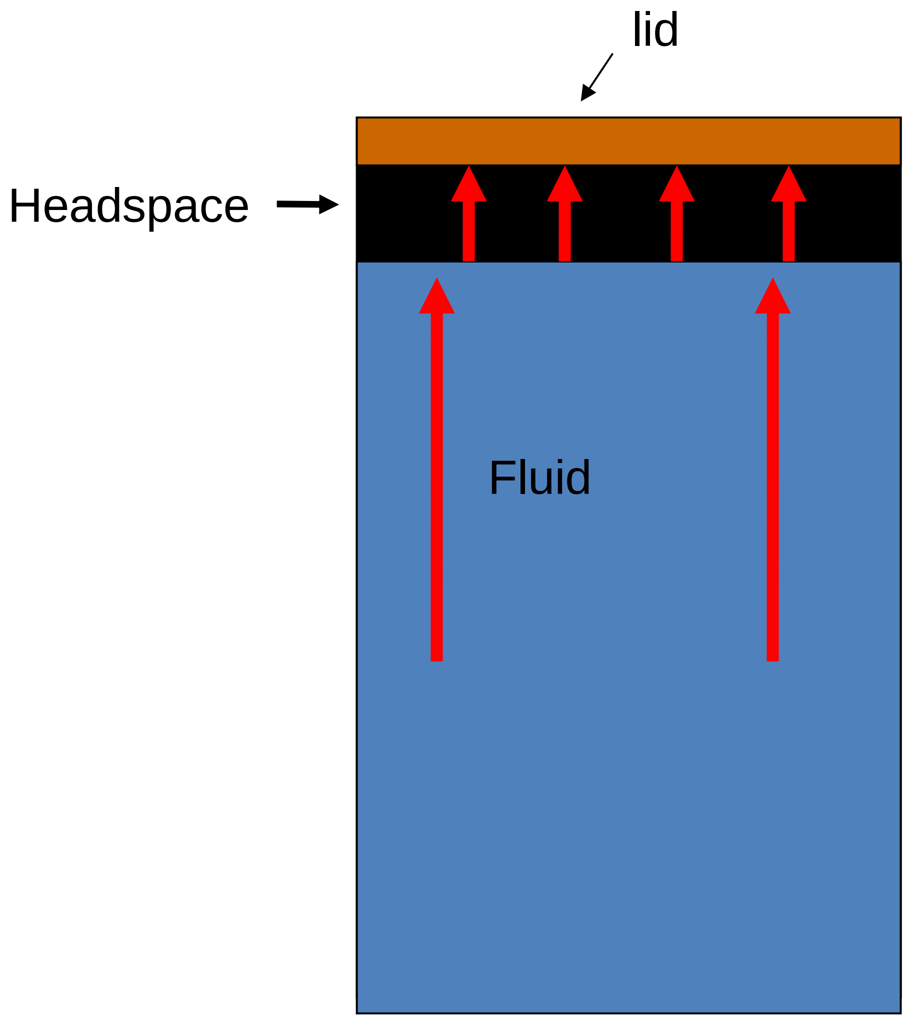


Cold alcohol

Hot alcohol

Thermal expansion

- At 20°C, ETOH has a coefficient of expansion 40x glass
- Water has a coefficient of expansion 8x glass
- An increase in temperature causes fluid level in jar to rise
- Rise in fluid level puts stress on lid and seal
- Leave 10% headspace in containers of alcohol-based preservatives



Importance of stable environment for long-term preservation

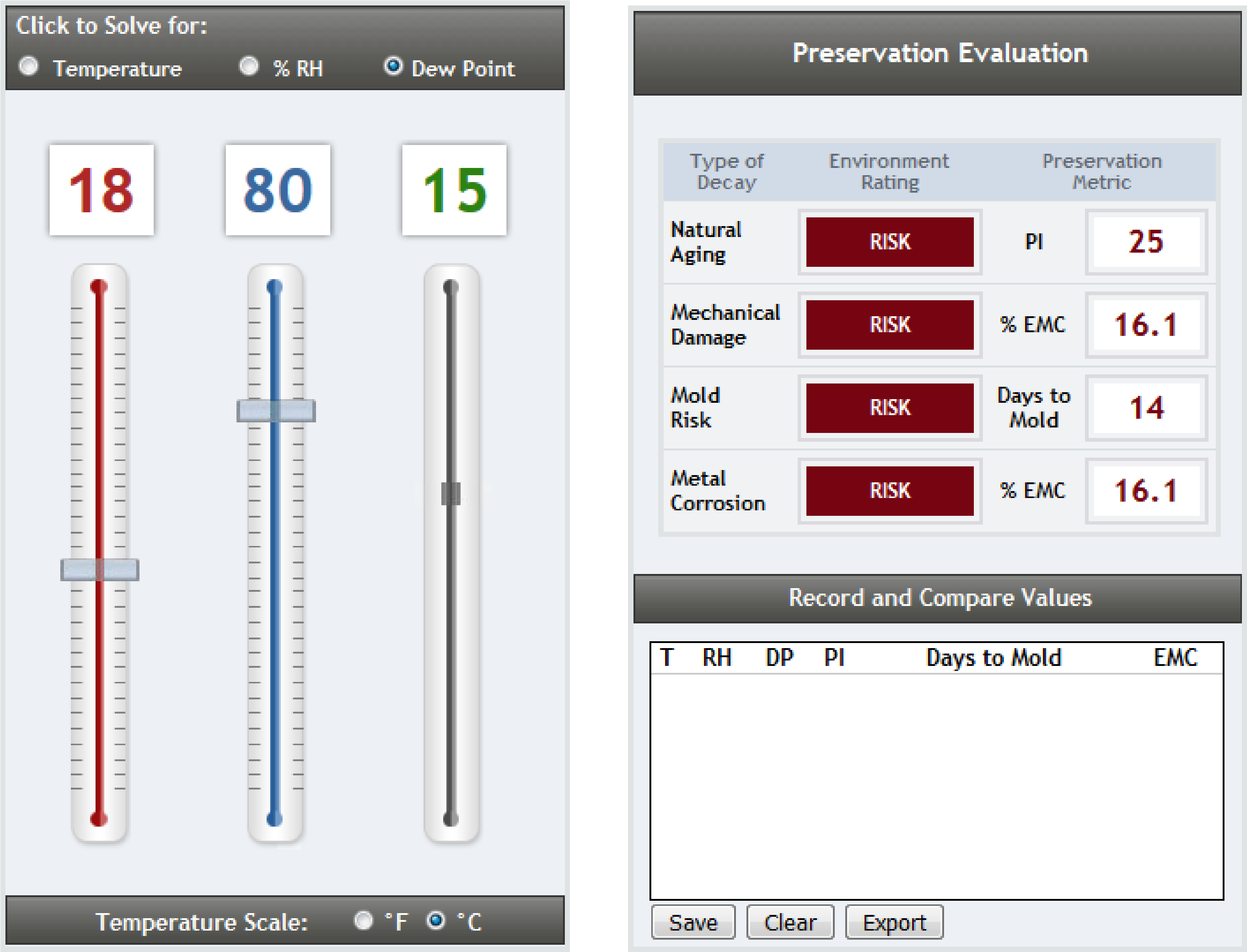
→ Relative humidity
- ✓ Recommended 35 – 55%
- ✓ Too low may affect container seals
- ✓ Too high
  - — Mold and mildew
  - — Higher risk of glass deterioration
- ✓ Relative humidity = the amount of moisture in the air compared to amount of moisture the air could hold if saturated
- ✓ Warm air can hold more moisture than cold air
- ✓ Cooling of warm air increases humidity
- ✓ Dew point = temperature at which relative humidity in the air reaches 100%

Importance of stable environment for long-term preservation

→ Mold and relative humidity

- ✓ Mold growth may begin at 65% RH
- ✓ Dew Point Calculator from the Image Permanence Institute
- ✓ www.dpcalc.org

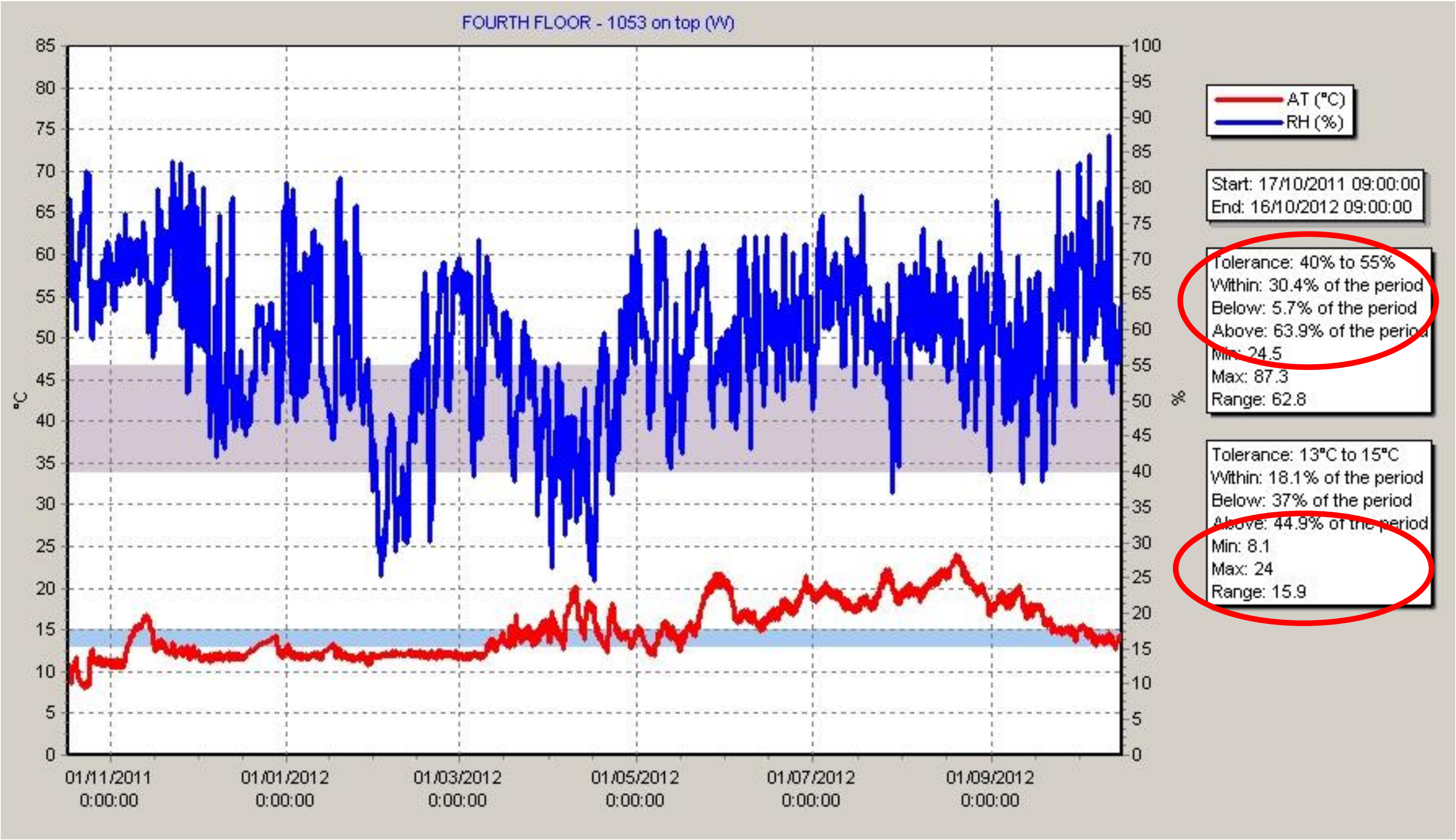
Condensation on specimen containers in storage eClimateNotebook® to analyze it.



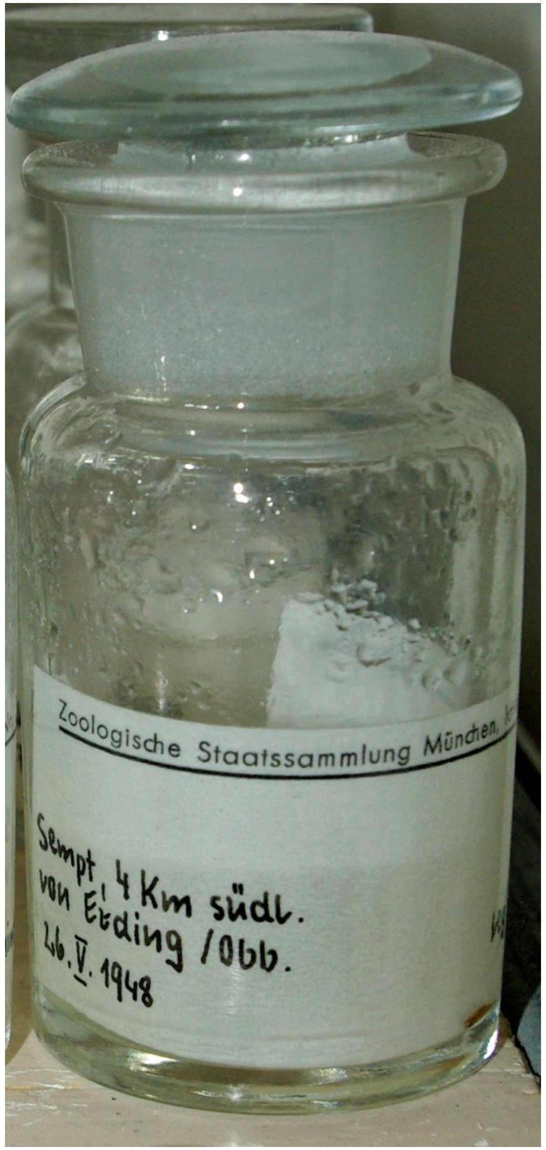
Relationship of Relative Humidity and Temperature to Mold Growth

Temperature	Relative humidity	Days to mold growth
18	65	No risk
18	70	No risk
18	75	40
18	80	14
18	85	7
22	75	37
22	80	13

Storage Environment



Storage Environment

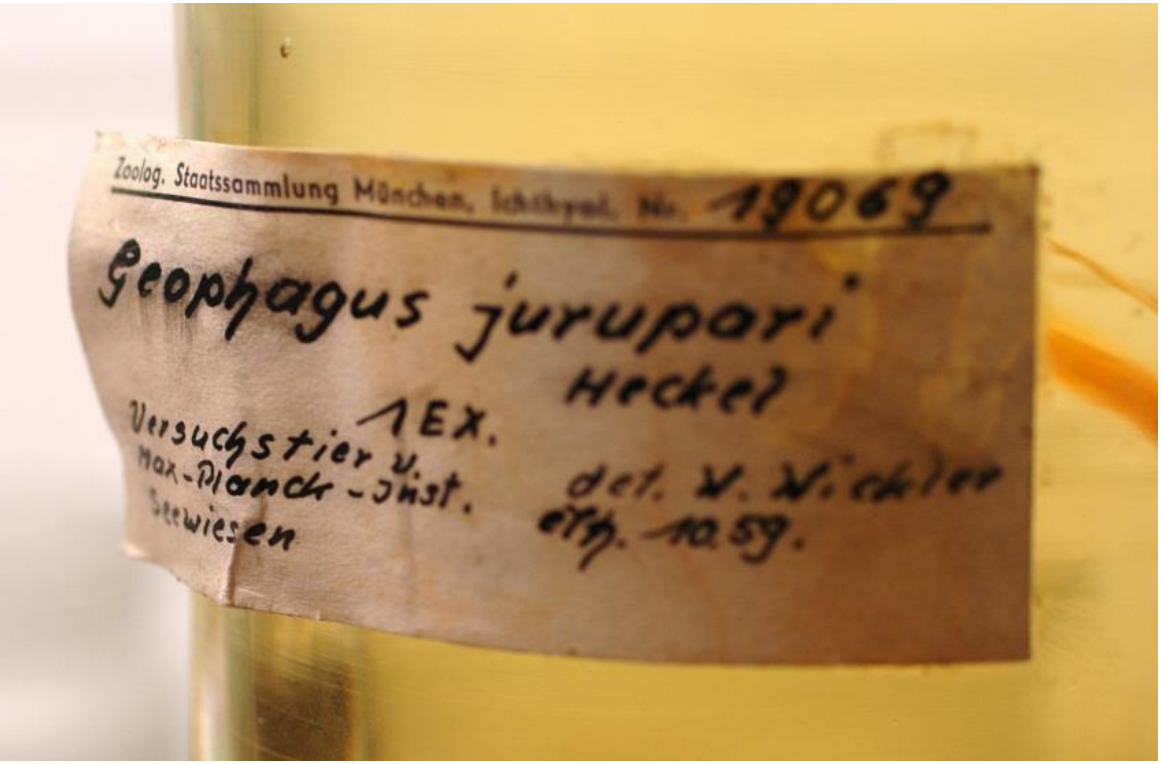


What caused mould on the pig bladder seal of this jar?

Environmental conditions:

- + 15°C
- Automated climate control
- Very high air exchange rate
- Subsurface storage

- Room = 15°C
- Outside air ~ 35 °C
- Condensation
- Oxidation of metals
- Mold


Zoolog. Staatssammlung München, Ichthyol. Nr. 19069
Geophagus jurupari
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1 EX.
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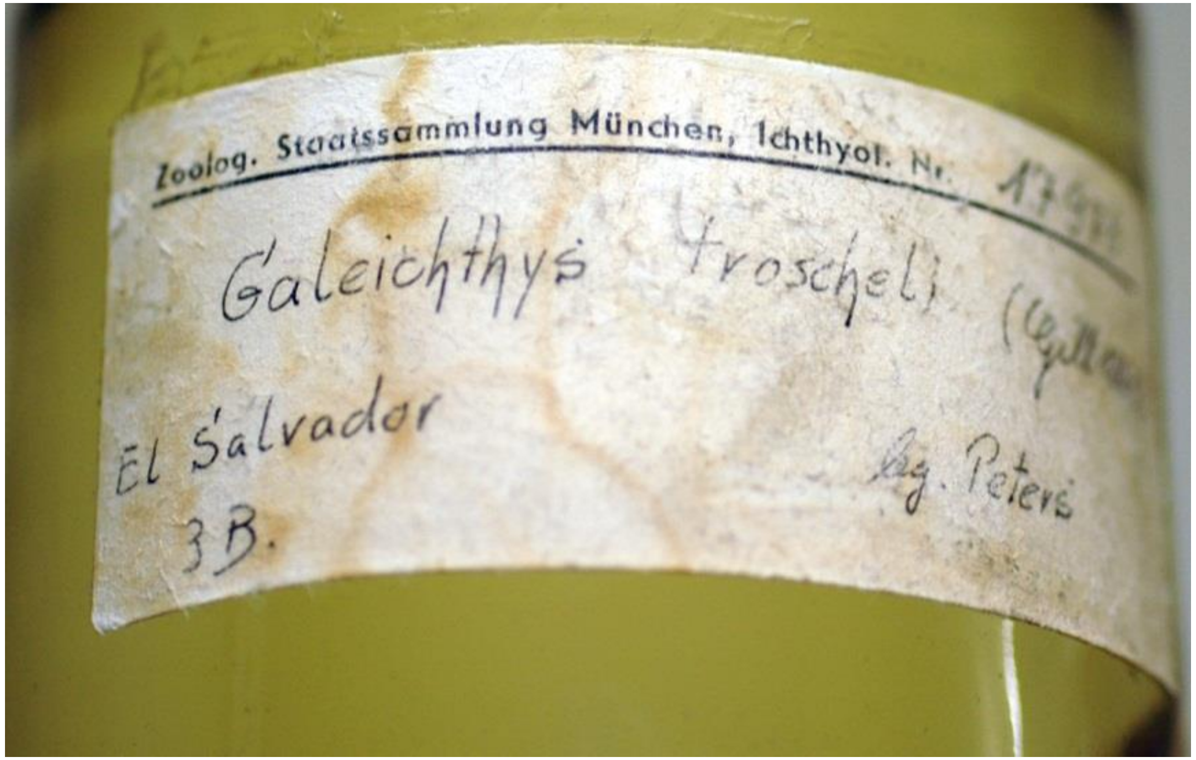
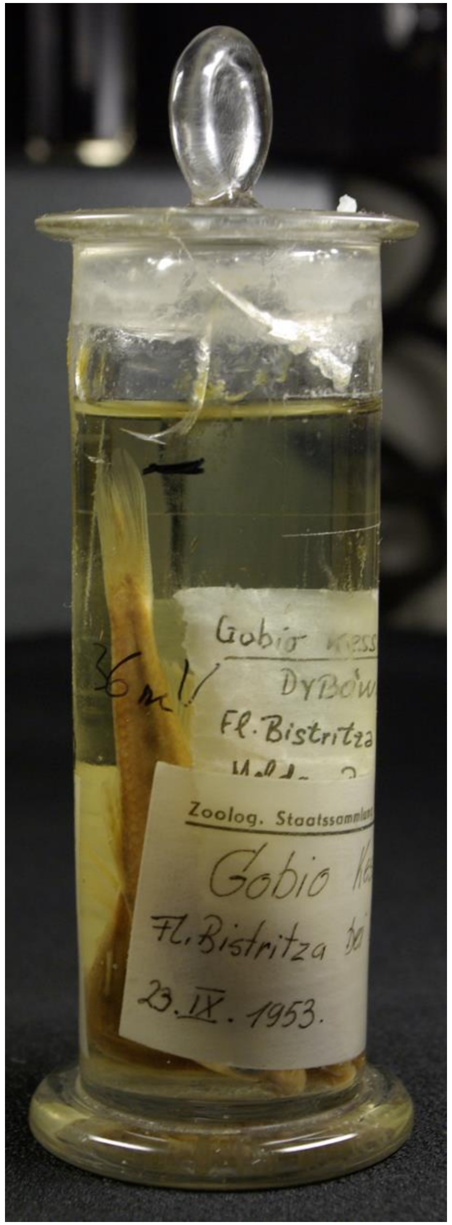
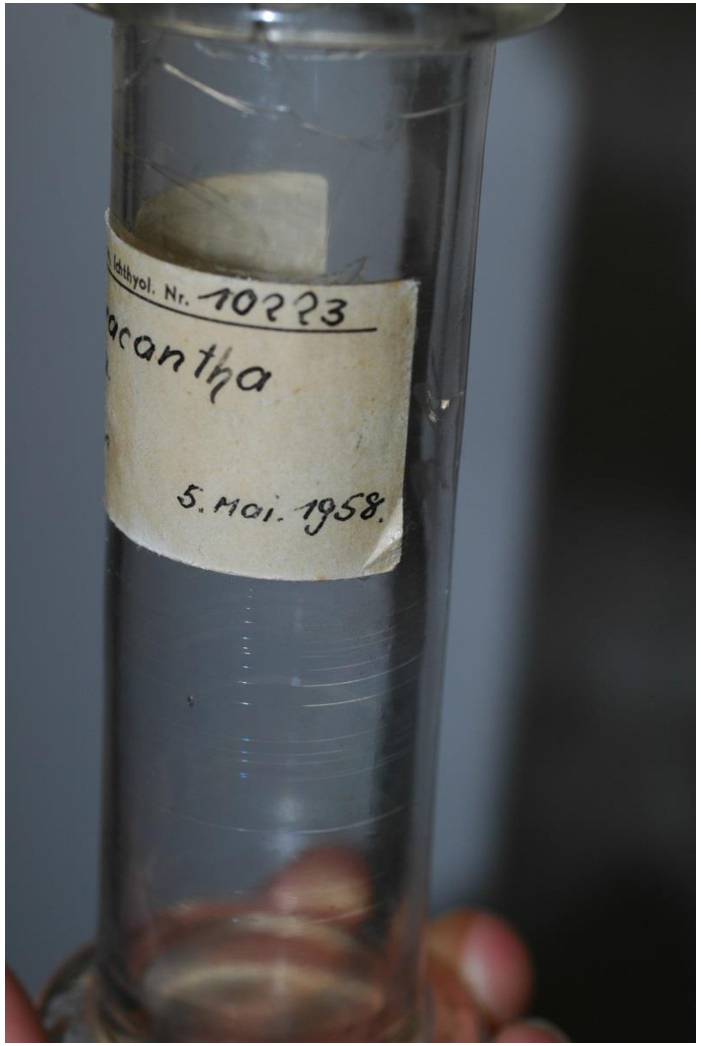

Zoolog. Staatssammlung München, Ichthyol. Nr.
Galeichthys troscheli
El Salvador
3 B.
leg. Peters

Storage Environment

Relative humidity





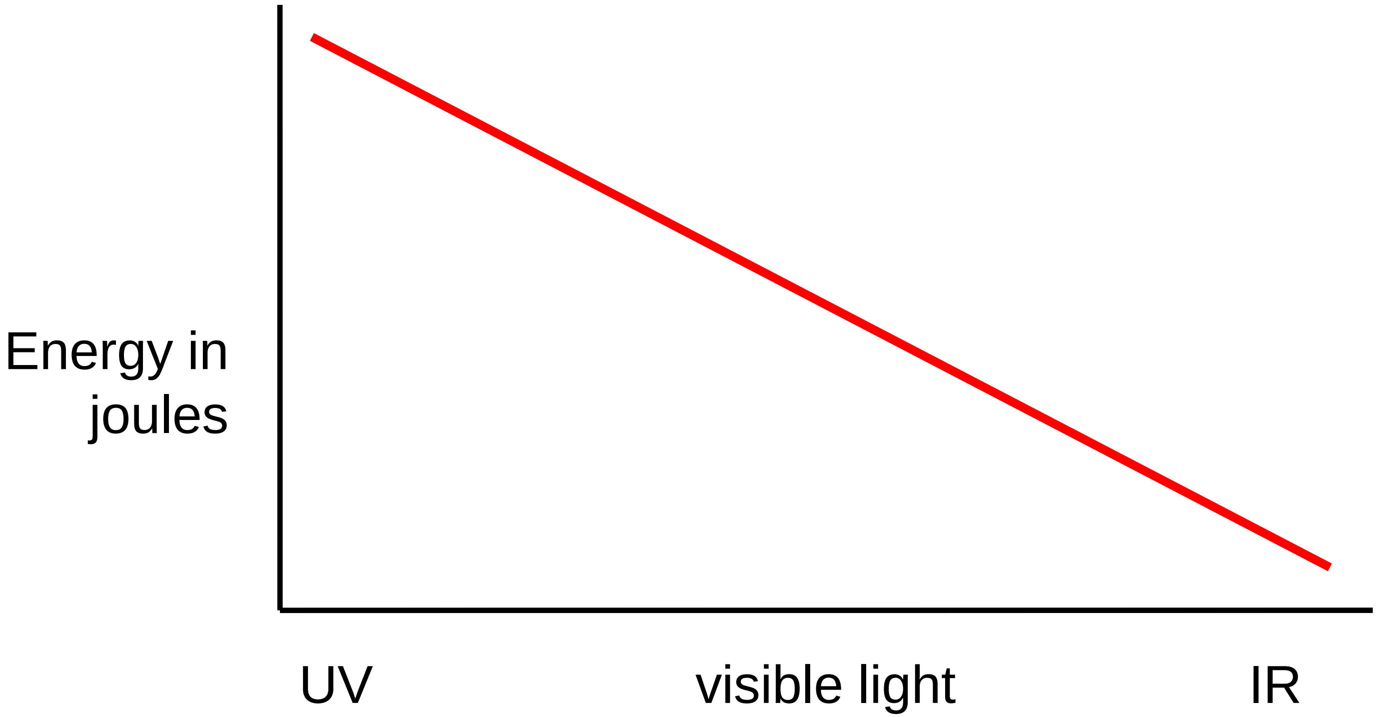
Glass Deterioration

- Fluctuations in relative humidity can cause changes in preservative concentration at extreme levels and may increase the rate of glass deterioration.
- Most container glass is composed of silica (SiO_2), an alkali (usually Na_2O), and a stabilizer such as lime (CaO).
- The main weathering agent of glass is water, particularly in the form of repeated wetting and drying which extracts alkaline materials from the glass.
- The rate of extraction depends on the composition of the glass, ambient temperature, and amount of moisture.
- Historic glass is more likely to be weakened by the extraction of alkali components than is contemporary glass.

Importance of stable environment for long-term preservation

→ Light

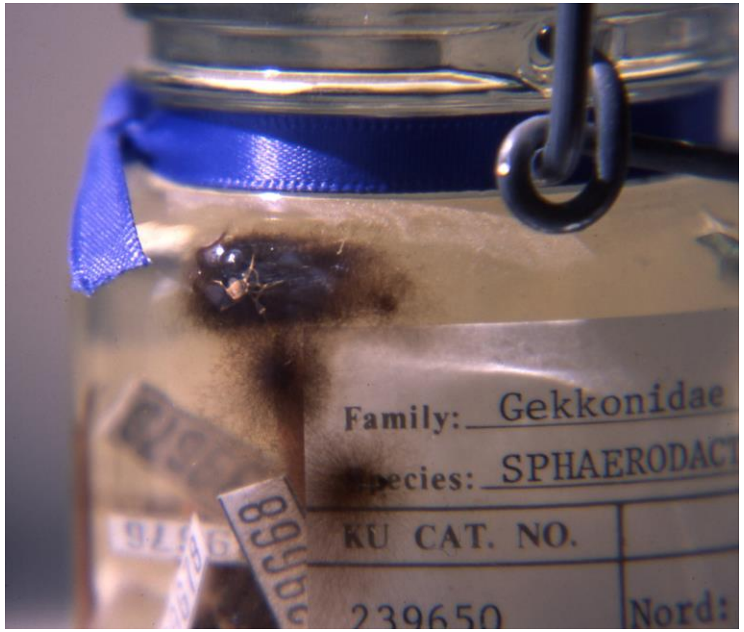
- ✓ All light causes fading
- ✓ Ultraviolet radiation is particularly damaging



Importance of stable environment for long-term preservation

→ Light
- ✓ All light causes fading
- ✓ Ultraviolet radiation is particularly damaging
- ✓ Avoid fluorescent
- ✓ Avoid natural light
- ✓ LEDs are UV free
- ✓ Use filters on UV producing light sources
- ✓ Reduce overall lighting as low as practical

Importance of stable environment for long-term preservation



→ Pests
- ✓ Bacteria
- ✓ Mold
- ✓ Arthropods damage external labels

→ Vibrations
- ✓ Earthquakes
- ✓ Roadways
- ✓ Rail vehicles
- ✓ Construction
- ✓ Gradual
- ✓ Catastrophic

Importance of stable environment for long-term preservation

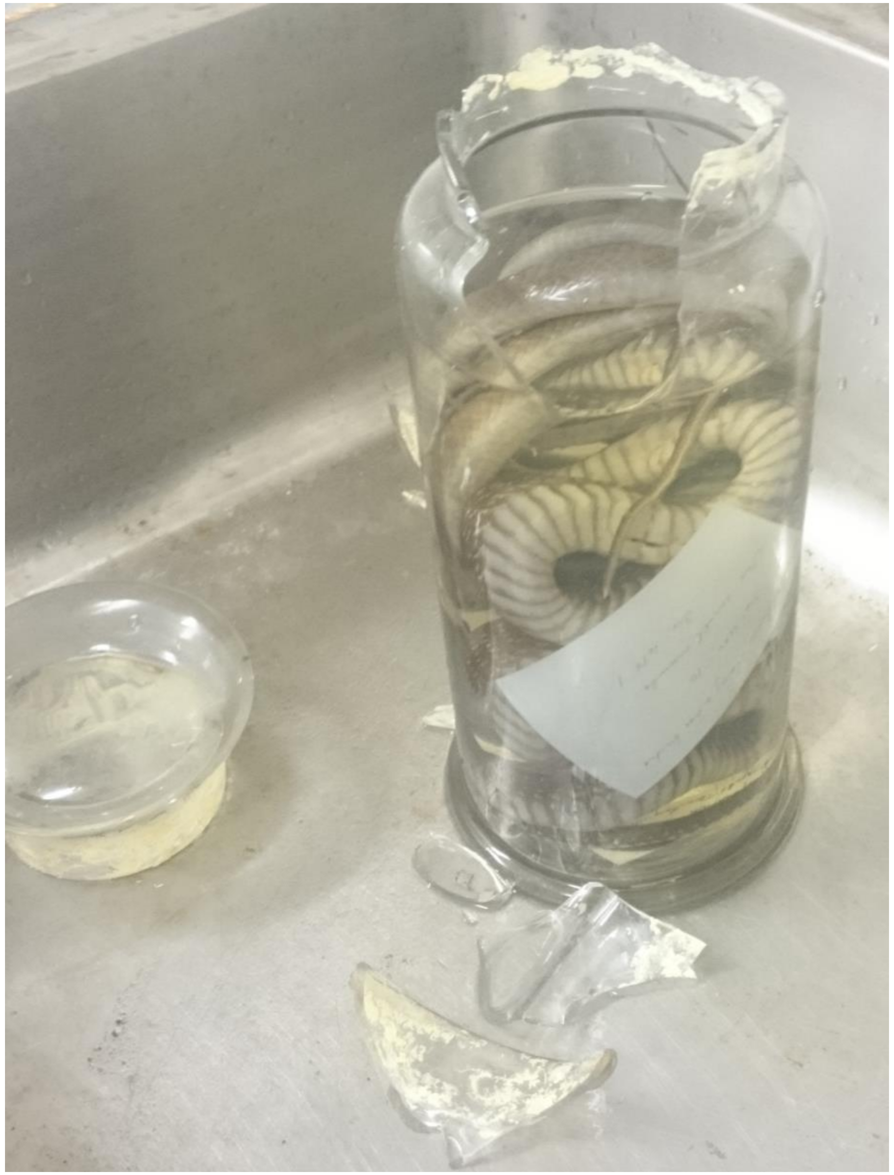
→ External environment
  - ✓ Temperate
  - ✓ Tropical

→ Building structure
  - ✓ Quality of insulation
  - ✓ Windows
  - ✓ Avoid outside walls
  - ✓ Above or below ground
    - — Below ground is more stable
    - — Alcohol vapors are heavier than air.
    - — Most US fire codes prohibit below ground storage of ethanol

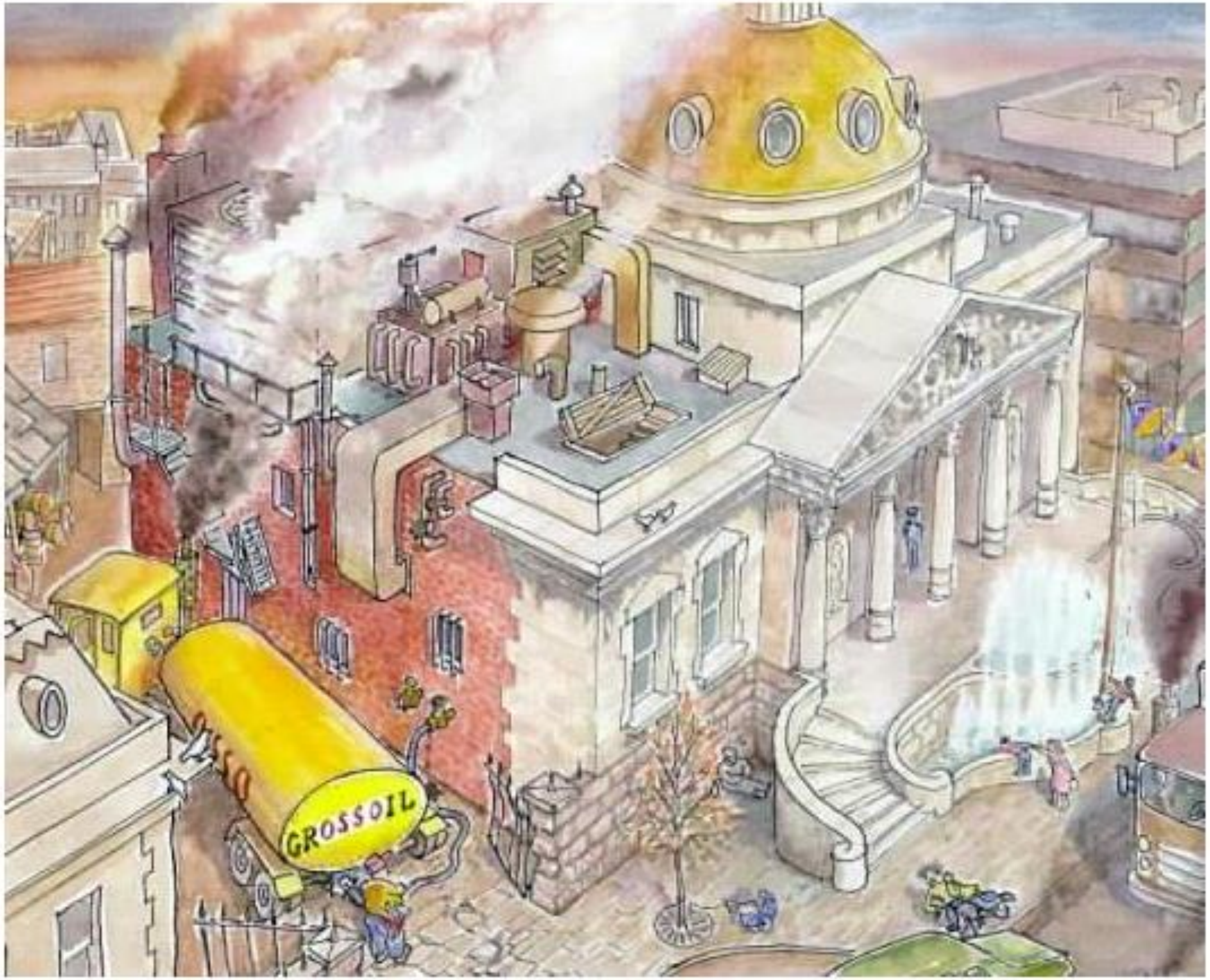
Importance of stable environment for long-term preservation

→ Set points

- ✓ HVAC system
- ✓ Air circulation
  - — Circulating air can reduce mold growth
- ✓ Budget
- ✓ Set points not as critical as stability
- ✓ Set points may differ seasonally
- ✓ Gradual transitions between seasonal set points



Sustainable Building Design?



https://www.conservationphysics.org/

<u>Monitoring the collection storage environment</u>

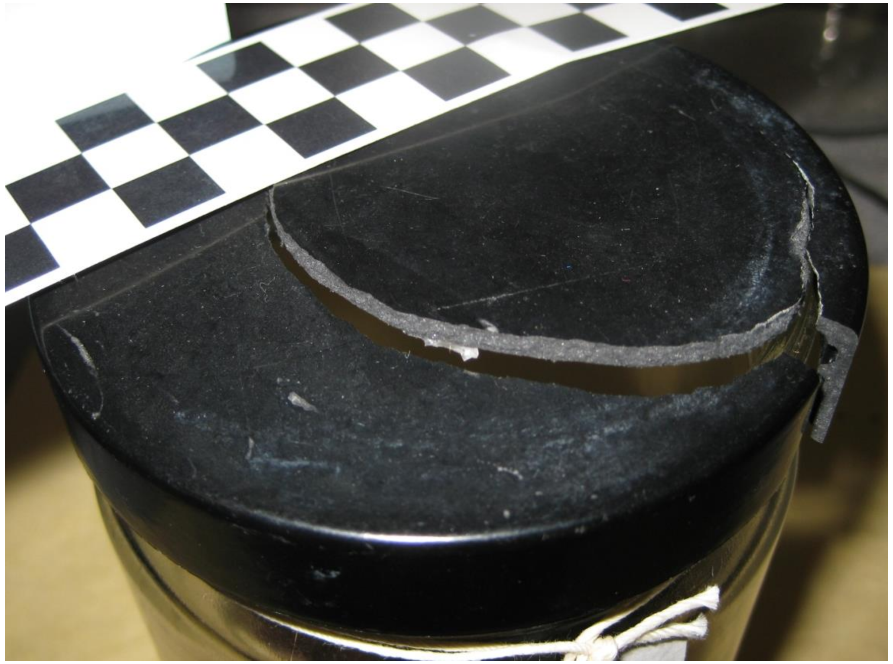
→ What should we monitor?
- ✓ Temperature
  - — Fluctuations from set point
- ✓ Relative humidity
  - — Fluctuations from set point
- ✓ Light and UV radiation
  - — Measure annually or when lights are changed
- ✓ Collection storage array
  - — Order
  - — Shelf security
- ✓ Container condition
- ✓ Specimen condition
- ✓ Preservative fluid

Monitoring the storage environment

→ Monitoring the storage environment
- ✓ Dataloggers
  - — Cost effective
  - — Small
  - — Digital readout
- ✓ Daily readings of thermometer and hygrometer
  - — Low tech
  - — Least expensive
- ✓ Light and UV meters

Monitoring the storage environment

→ Monitoring the storage environment
  ✓ Container condition
    — Overall condition
    — Closure
      ➢ Integrity of seal
      ➢ Oxidation of metals
      ➢ Cracking of glass and plastics
      ➢ Loss of regain of compressible stoppers



Cracked
Bakelite closure

Oxidizing metal closure

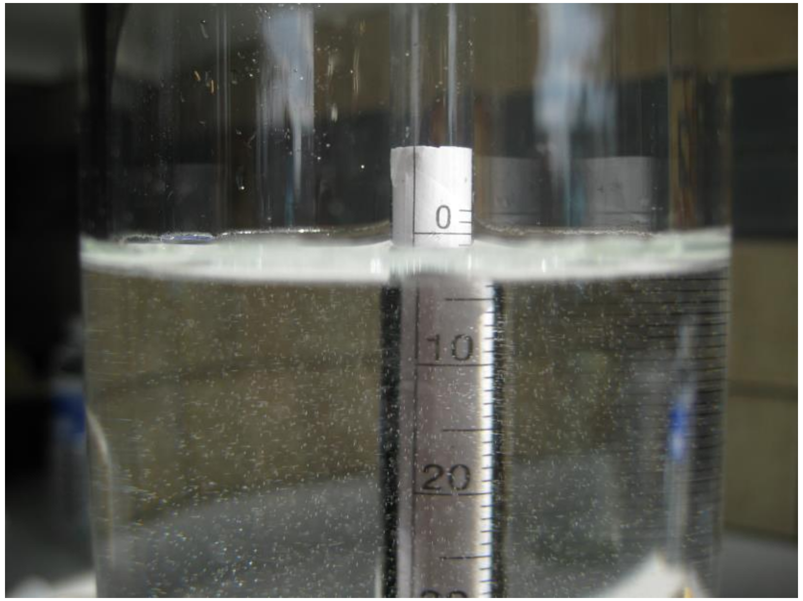
Compressible
stopper failure

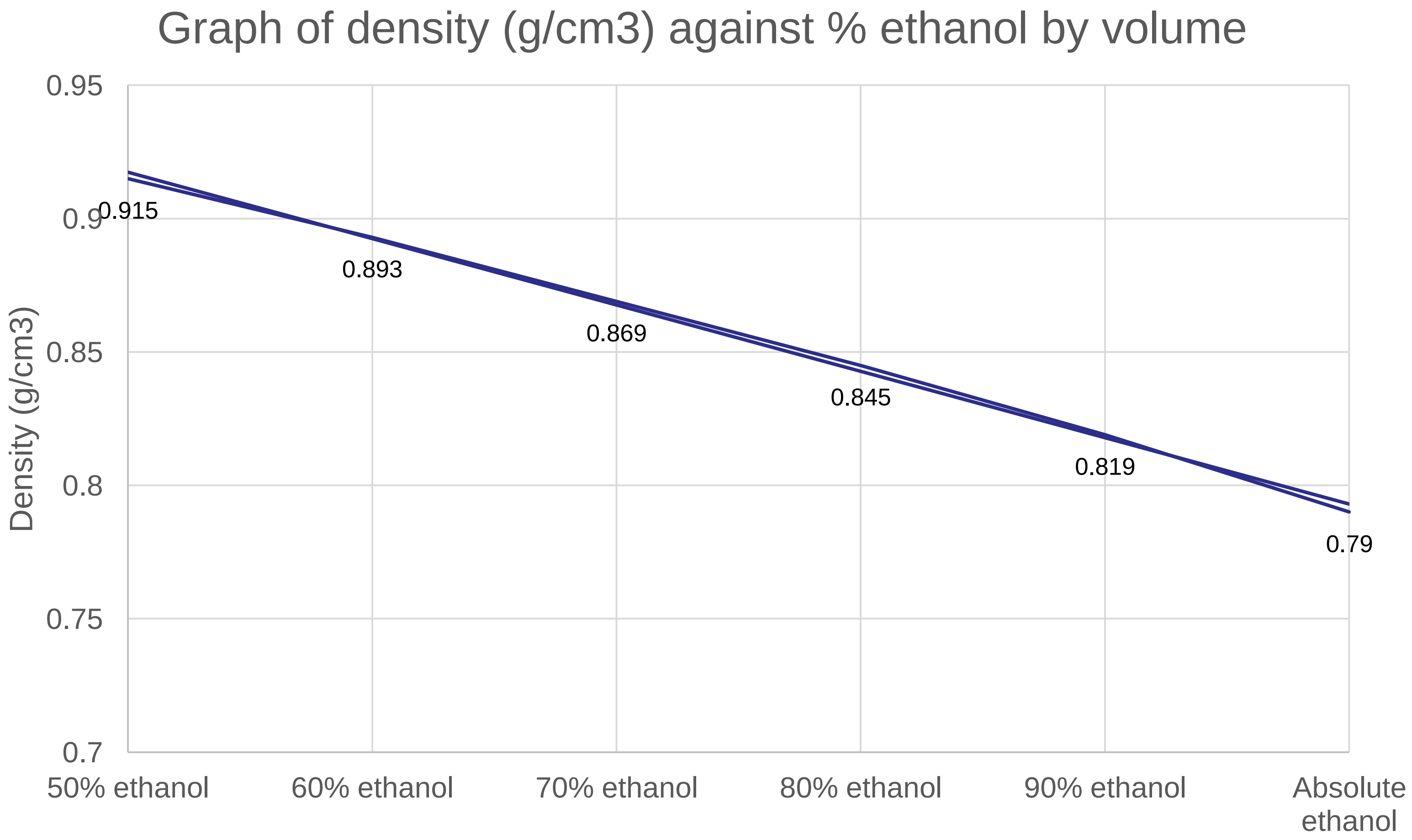
Monitoring the storage environment

→ Monitoring the storage environment
- ✓ Specimen condition
  - — Overall appearance
  - — Fading
  - — Color changes
  - — Dimensional changes
    - ➢ Shrinkage
    - ➢ Swelling

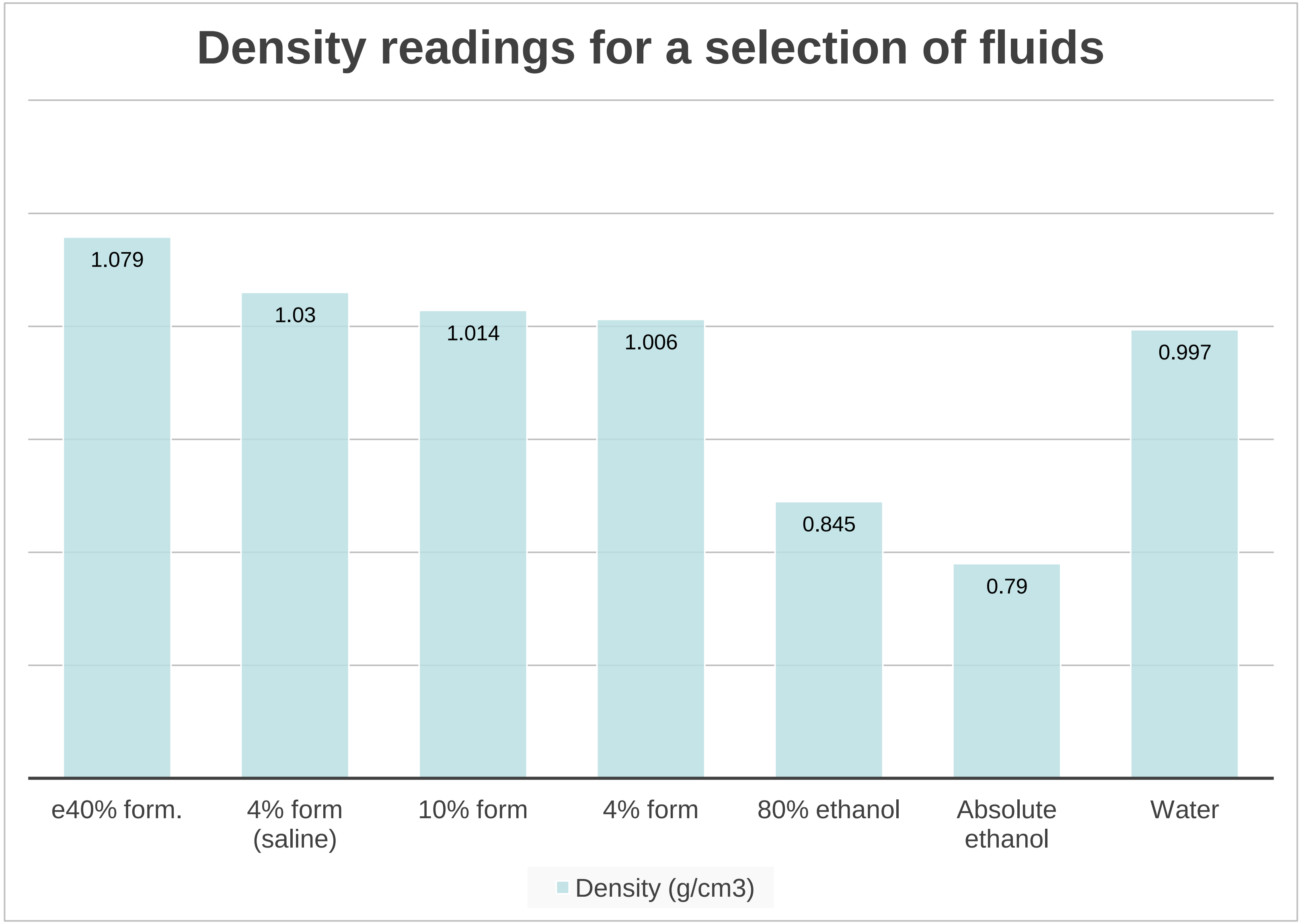
Monitoring the storage environment

→ Monitoring the storage environment
- ✓ Preservative fluid
  - — Fluid level and preservative concentration are closely linked
    - ➢ Alcohol + water = binary azeotrope
    - ➢ Each component retains its own properties
    - ➢ Alcohol evaporates faster than water
  - — Preservative concentration
    - ➢ Digital density meter
    - ➢ Hydrometer
    - ➢ Alcomon Indicator System (>60%)





Graph of density (g/cm3) against % ethanol by volume
Density (g/cm3)
0.95
0.9
0.85
0.8
0.75
0.7
0.915
0.893
0.869
0.845
0.819
0.79
50% ethanol
60% ethanol
70% ethanol
80% ethanol
90% ethanol
Absolute ethanol



Density readings for a selection of fluids
1.079
1.03
1.014
1.006
0.845
0.79
0.997
e40% form.
4% form (saline)
10% form
4% form
80% ethanol
Absolute ethanol
Water
Density (g/cm3)

Monitoring the storage environment

→ Monitoring the storage environment

- ✓ Preservative fluid
  - — Precipitates
  - — Discoloration
  - — Accumulation of lipids and oils
  - — Cloudiness

Precipitate from mixing ETOH with tap water

Conservation: the preservation of a specimen so as to retain as completely as possible its 'original condition'.

Simmons 1987

- How is the specimens to be used?
- What is the preservation history?
- Does the specimen have good data available?
- What is the storage or display environment?
- Identifying the preservative used, and monitoring the concentration levels.
- Evaporation problems; topping up/ and or changing preservative.
- Environmental monitoring.
- pH Levels and relevance of in different fluid types?
- Removal of deteriorated / dried out specimens for further conservation?
- Labelling.

Factors determining long-term usefulness of specimens	
Pre-preservation chemical treatments and handling methods	a. Capture (e.g., glycol-based pitfall trap). b. Narcotization (relaxation). c. Euthanasia.

Factors determining long-term usefulness of specimens	
Quality of initial fixation	Time interval between death and fixation (as short as possible)
	Quality of fixative
	Rate of penetration of fixative
	Temperature of fixation process (warmer is better than colder)
	Proportion of fixative fluid to specimen (ideal 7:3)

Factors determining long-term usefulness of specimens	
Post-fixation processing	Washing time (keep short)
	Transfer to preservative (use graded steps)
	Hydration and dehydration of specimen

Factors determining long-term usefulness of specimens

Storage environment	Temperature set point and fluctuations (18-21°C +/- 5°C	
	Light intensity and exposure (reduce as low as possible)	
	Ultraviolet radiation intensity and exposure (eliminate or reduce)	
	Relative humidity set point and fluctuations (35-50% preferred)	
	Vibrations (minimize)	
	Integrity of container and seal	Evaporative loss
		Contamination
	Handling and use of specimens	Physical damage
		Dehydration
		Rehydration

Preserving Molecular data

- Most of the NH collections are research based.
- Need to consider current and emerging research needs.
- DNA only discovered in 1950s. Museum collections are valuable archive of molecular information.
- Currently best options are to keep samples cold and dry or use absolute ethanol.
- Balancing act between morphological preservation and biomolecular preservation
- Research on collection preservation always needed!
- Big improvements in technology – can now use very degraded DNA.
- Good quality, welllsealing storage tubes are essential.

Where Do We Go From Here?

→ Future research?

- ✓ Improved baselines and standards
- ✓ Improved fixation and preservation methods
- ✓ Fixatives and preservatives that are safer to use
- ✓ Ways to preserve specimens that make them more useful for research
- ✓ Better preservation of color
- ✓ Better preservation of DNA
- ✓ Secure containers that prolong the useful life of specimens (especially for large specimens)
- ✓ New collection storage furniture designed for easier monitoring of specimen condition

Where Do We Go From Here?

→ Future research?

✓ Databases that help manage collections, not just make collection information available

→ Incorporate environmental monitoring data

→ Track collection use more closely

→ Documentation of specimen fixation and preservation history

→ Collection Management Systems that will help us figure out how to prolong the useful life of fluid-preserved specimens

Current and future resource challenges

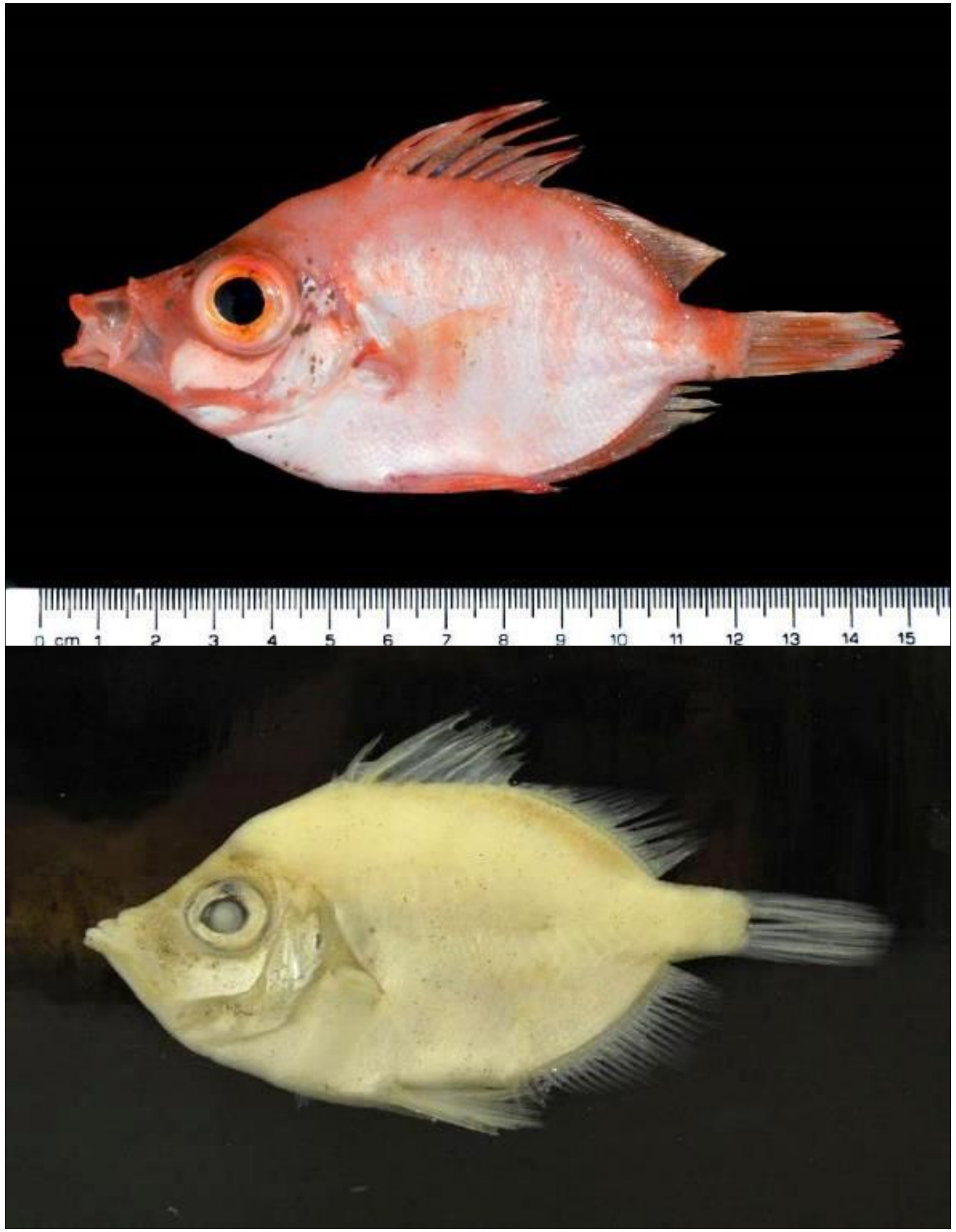
- Available expertise
- Financial resources
- Accessibility to materials and chemicals
- Political and geographical situation

Safer exhibition and display?

- Glycerol solutions
- Propylene Glycol
- DMDMH (formaldehyde releasers)

Good collection care, conservation and management will allow for a more sustainable and cost effective approaches to caring for fluid preserved collections.

How these collections by society is also an important factor and should be valued for their cultural heritage as well as their scientific wealth.



Purpose of the Symposium

The idea of Sophie, Veronique and the MNHN team was to:

- Bring together a diversity of current viewpoints and collection management strategies
- Discuss these during the meeting
- Identify commonly observed gaps and issues we have in the care and management of our collections
- Develop coherent and sustainable strategies and research needs that help us to improve our preservation, care and management of fluid collections

Homework for you the audience is to write down interesting challenges or collection management issues from your personal observation and experience. Submit this information on Thursday.

Next steps – Friday we will synthesize the results of this survey to carry forward networks to promote informed research proposals e.g. what and where are our analytical needs?

For example, which synergies can we distillate from a vivid exchange when discussing qualities of museum jar, availability, and their supply?

Thank you!

staatliche
naturwissenschaftliche
sammlungen bayerns

national museum wales
amgueddfa cymru