

MYCOLOGIE ET SÉCURITÉ DES ALIMENTS



42nd Mycotoxin Workshop

Experimental archaeology reveals potential health risk in ancient populations due to storage mycotoxins

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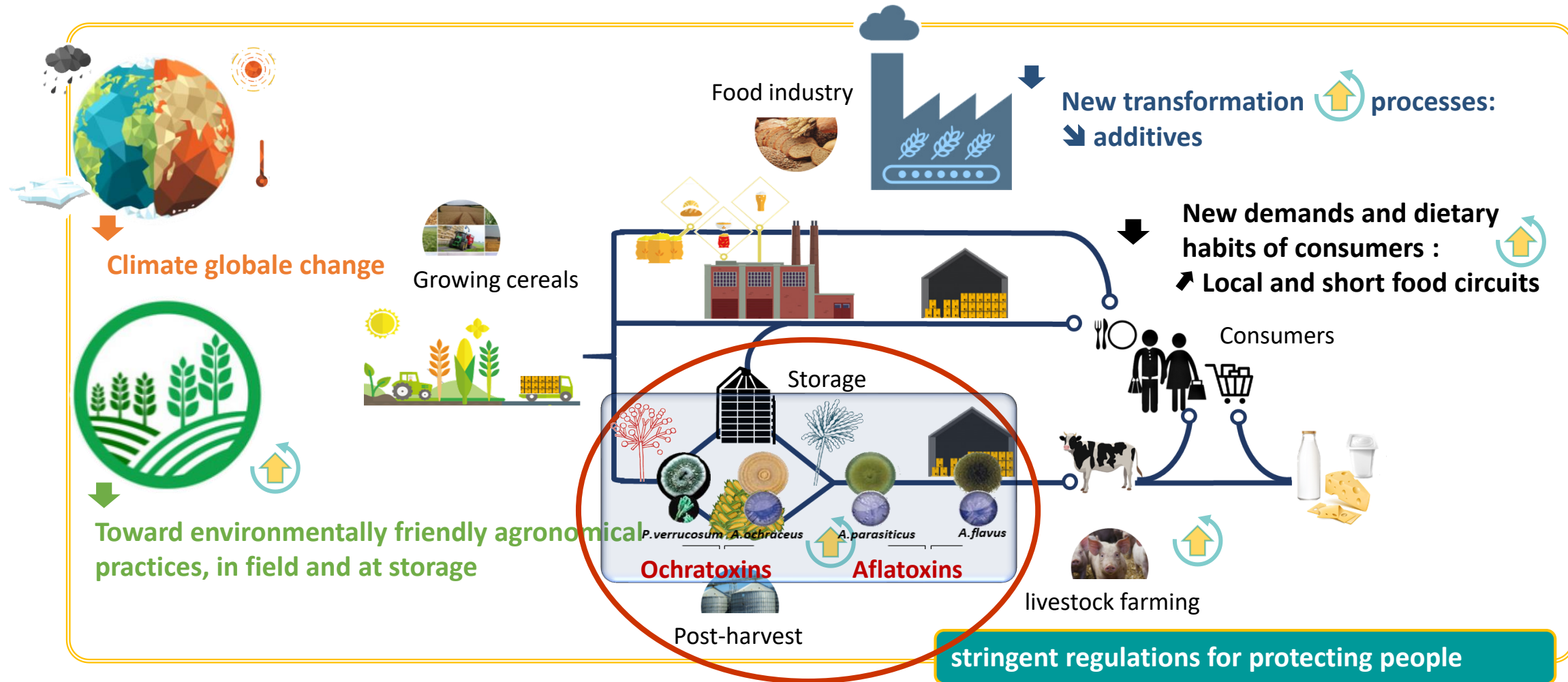



Gesellschaft für Mykotoxinforschung e. V.
Society for Mycotoxin Research

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Égalité
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Controlling the mycotoxin risk throughout the food chain: a constantly renewed challenge in the 21st Century



Mycotoxin risk in pre-industrial European societies ? Contaminations during storage ?

Underground structures for grain storage - Used from Neolithic to 18th Century



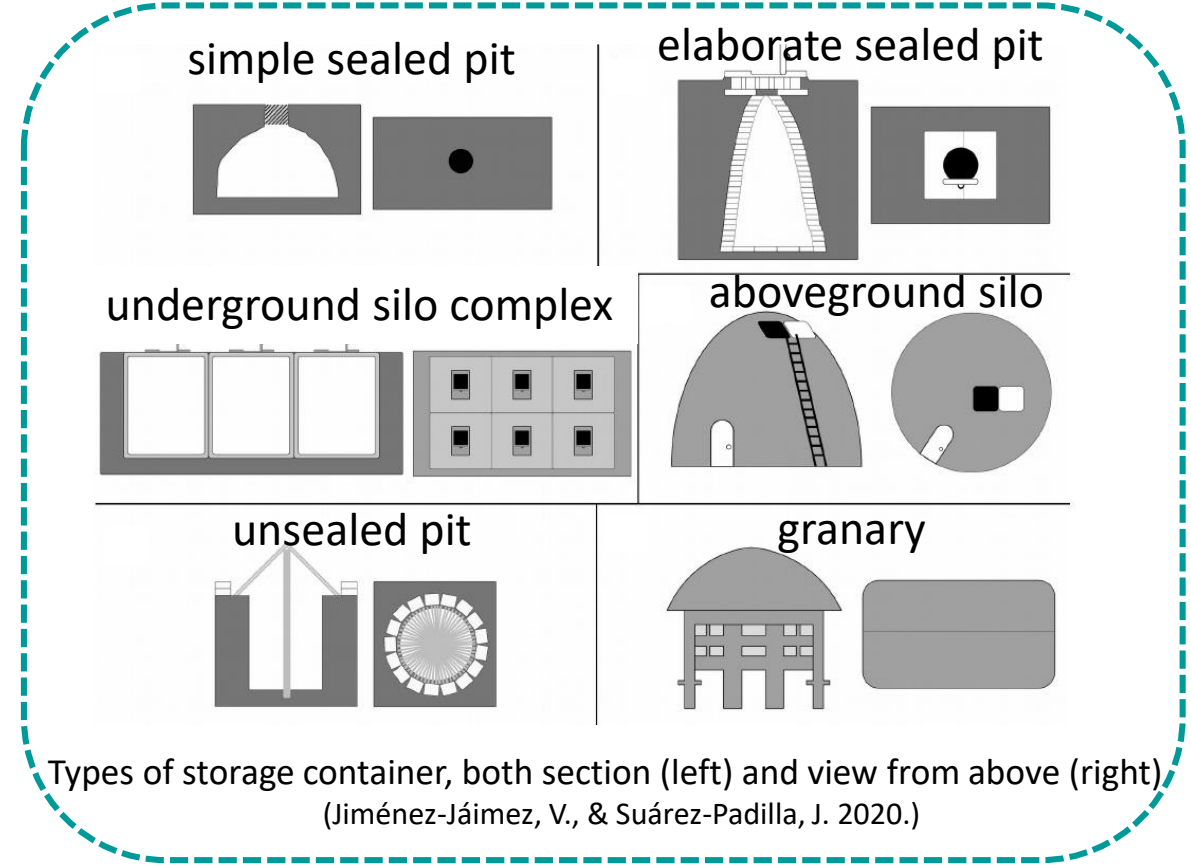
Pits of various shapes are frequently found in excavations of sites occupied by pre-industrial rural communities. Probably used for the storage of grain.



Ancient peasant skills that made it possible to preserve cereals either as food or for sowing ?



Simple airtight pits :
Experimental archaeology + 21st Century knowledge and analytical tools

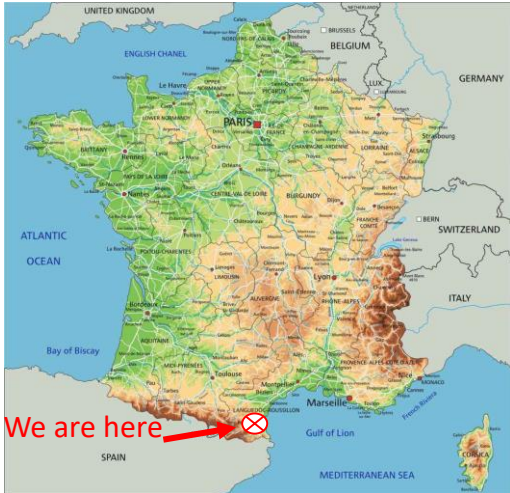


Types of storage container, both section (left) and view from above (right)
(Jiménez-Jáimez, V., & Suárez-Padilla, J. 2020.)



Can we safely store grain in simple airtight pits as in pre-industrial societies ?

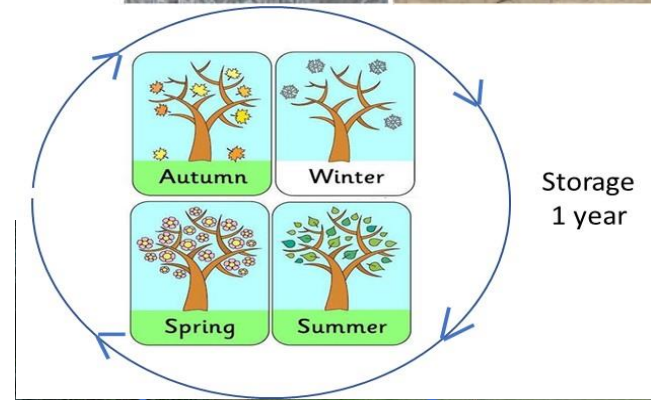
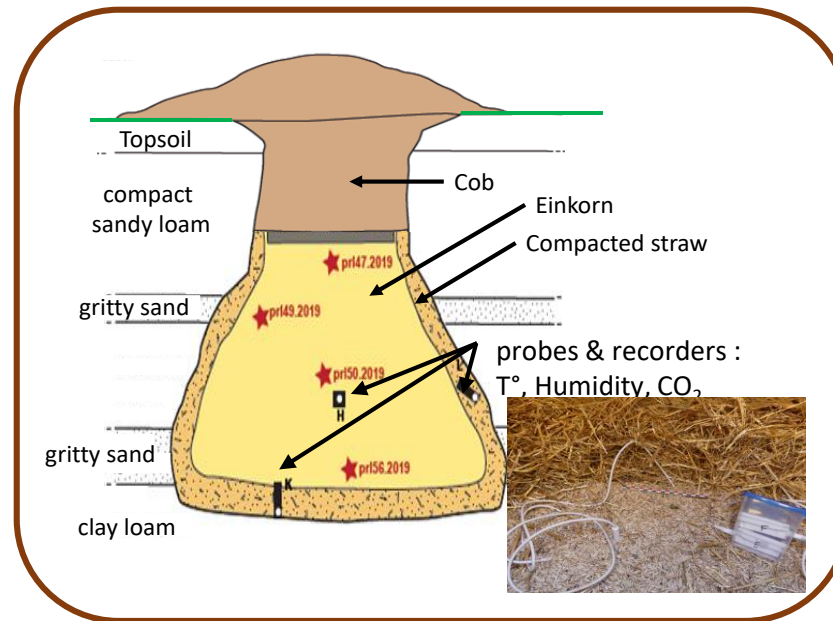
Filling with einkorn
(*Triticum monococcum*)



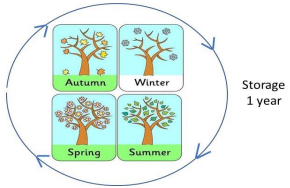
Digging – pits of 700 L



Airtight closing

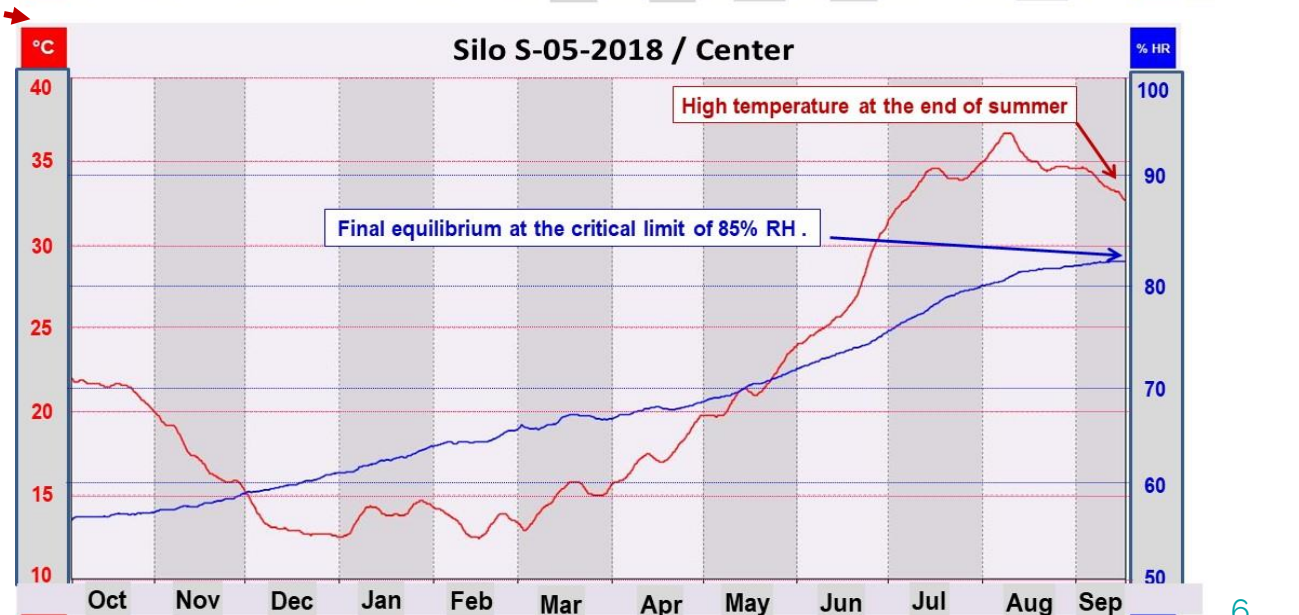
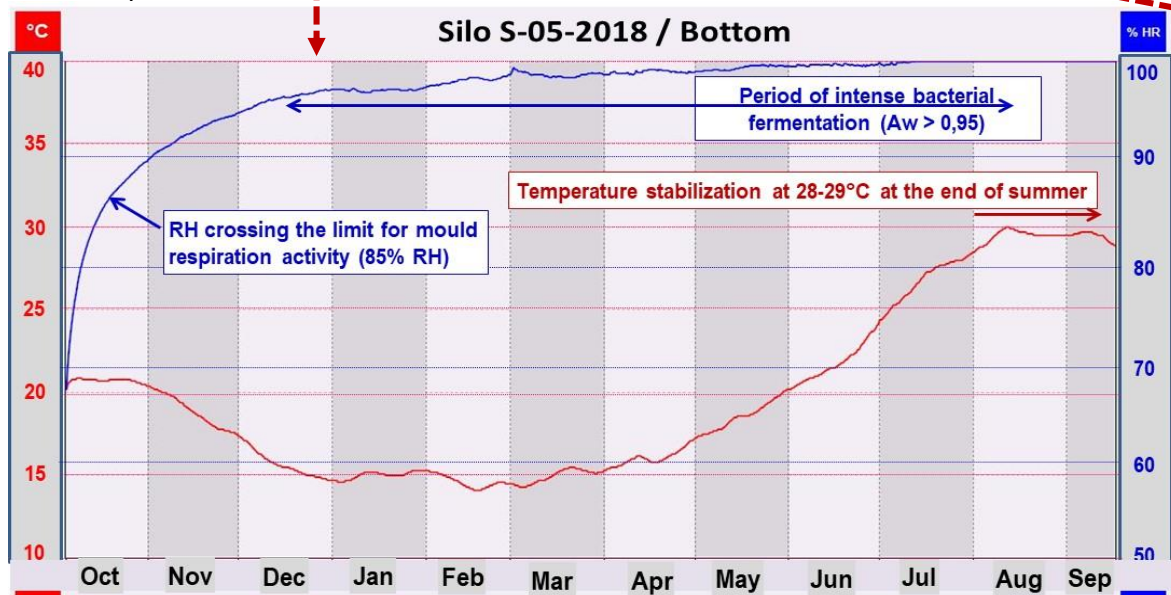
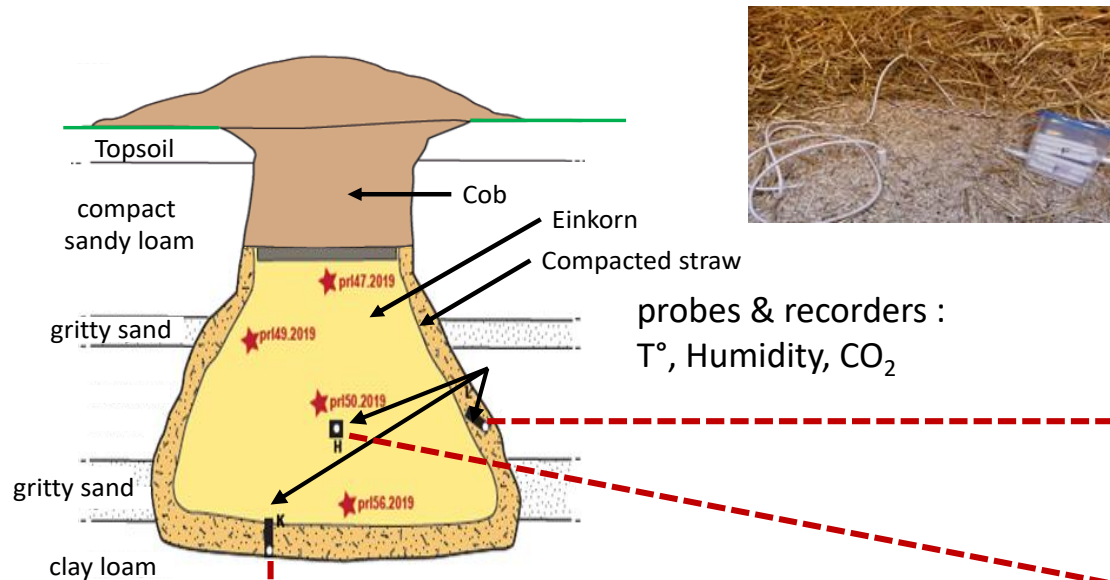


Can we safely store grain storage in simple airtight pits as in pre-industrial societies ?



On-field observations - measurements - samplings

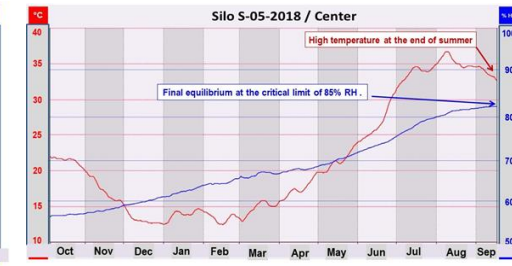
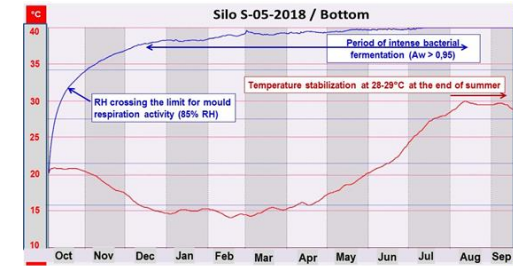
Grain storage in simple airtight pits: Temperature and humidity



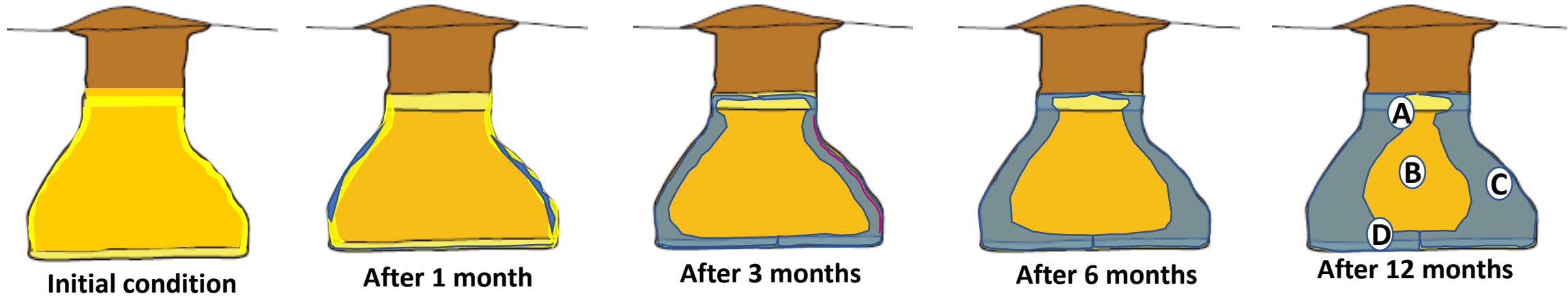
Grain storage in simple airtight pits: Temperature and humidity



Schematic representation of the deterioration process by mould and bacterial spoilage of einkorn wheat stored for one year in an underground pit



- Moist grain deteriorated by mould and intense bacterial fermentation
- Sound grain below critical moisture content for mould spoilage
- Straw layer (wall, bottom and top)



A, B, C, D = Sampling points



Grain storage in simple airtight pits: Germinability and fungal communities

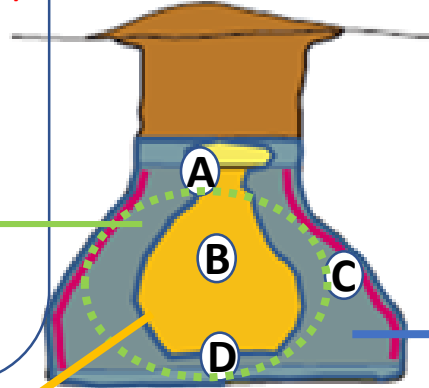
Sowing of grains



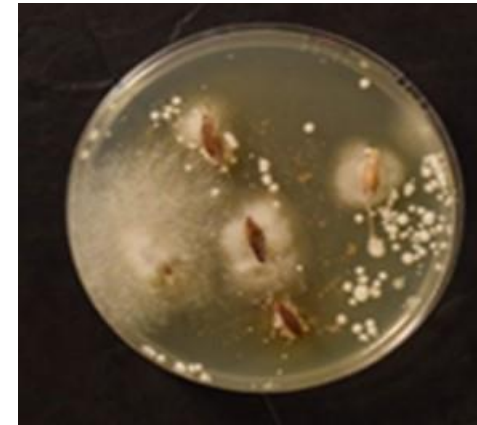
Control
(stored at the farm)



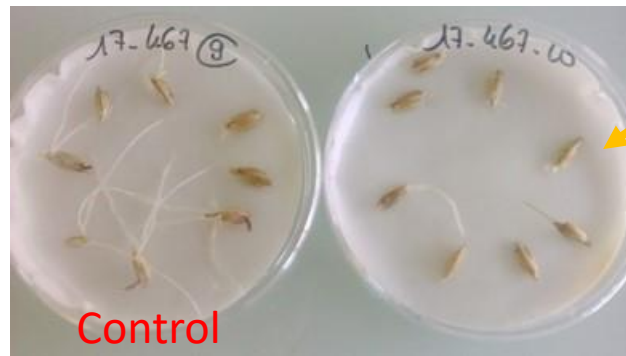
=> 0-10 % seed germination



12 month
storage in a pit



Control
(stored in lab at 4°C)



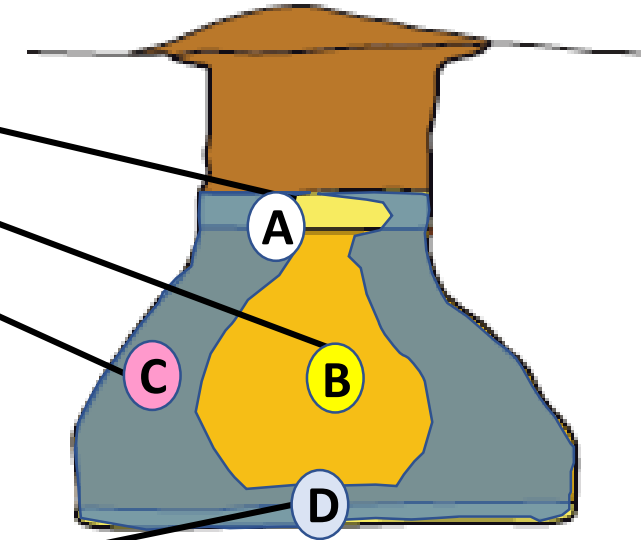
Control

➡ Loss of seed germinability

➡ Changes in fungal contaminant on the grain : from field to storage moulds

Grain storage in simple airtight pits: Mycotoxins

	Sample	OTA - ng/g
Without protecting straw lining	Silo S_02-2019 A	168
	Silo S_02-2019 B	102
	Silo S_02-2019 C	388
With protecting straw lining	Silo S-04-2019 A	59
	Silo S-04-2019 B	12
	Silo S-04-2019 C	11
Without protecting straw lining	Silo S-05-2018 B	46
	Silo S-05-2018 D	247
With protecting straw lining	Silo S-04-2018 B	41
	Silo S-04-2018 D	106



OTA contamination: D, C, A > B
Differences depending on the year and technics

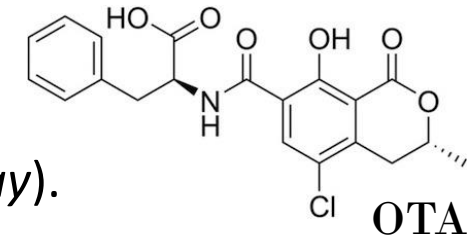
>>> EU rules (5 ng/g) ;
 Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for mycotoxins in foodstuffs.



health risk in ancient populations due to storage mycotoxins?

EFSA- SCIENTIFIC OPINION ADOPTED: 31 March 2020 doi: 10.2903/j.efsa.2020.6113

Risk assessment of *Ochratoxin A* in food

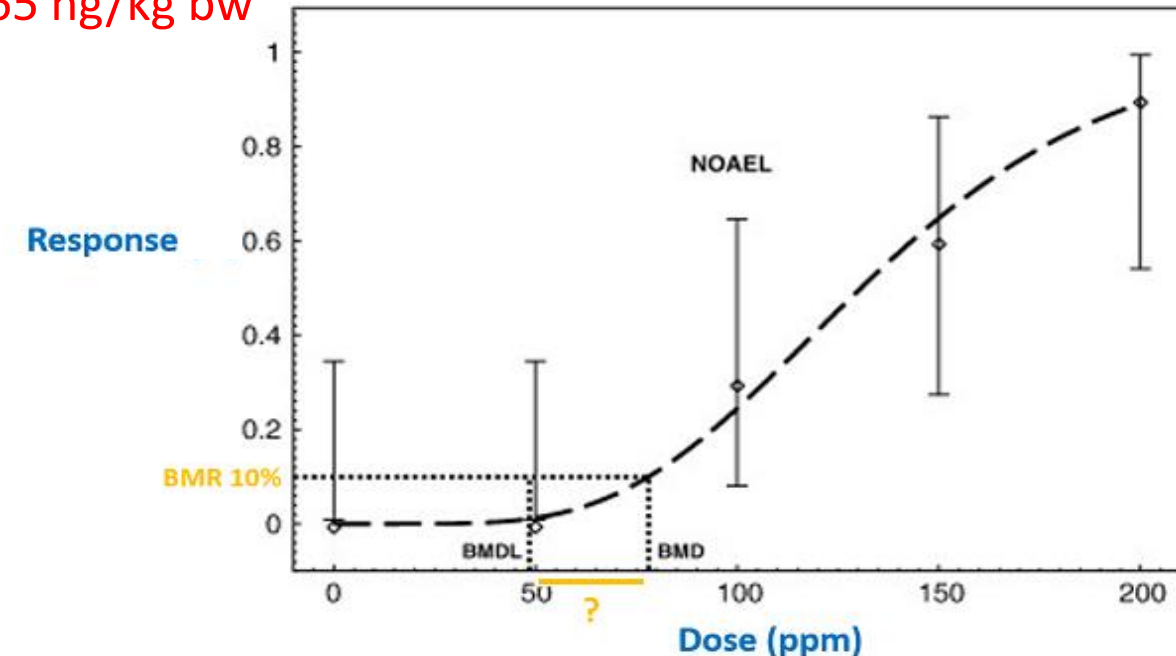


Non-neoplastic effects (kidney lesions observed in pigs),
 Benchmark dose lower confidence limit 10% (BMDL10) = 4.73 $\mu\text{g}/\text{kg}$ body weight (bw) per day).
 => 'Margin of exposure' ([MOE = BMDL10/Estimated Exposure Dose]
 for humans ≥ 200

Limit of daily intake before toxicity => BMLD10/MOE = 23.65 ng/kg bw

Neoplastic effects (kidney tumours in rats),
 BMDL10 = 14.5 $\mu\text{g}/\text{kg}$ bw per day
 With MOEs = 10,000 =>

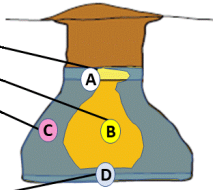
Limit of daily intake (BMLD10/MOE) = 1.45 ng/kg bw



OTA risk assessment, pre-industrial European society ?

EFSA :
 Non-neoplastic effects < **23.65 ng/kg bw**
 Neoplastic effects < **1.45 ng/kg bw**

Sample	OTA - ng/g
Silo S_02-2019 A	168
Silo S_02-2019 B	102
Silo S_02-2019 C	388
Silo S-04-2019 A	59
Silo S-04-2019 B	12
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Silo S-04-2018 D	106
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Silo S-05-2018 D	247



Ancient population storing grain in pits : Contamination 10 to 100 ng OTA /g grain

Non-neoplastic effect => intake should be < 0.24 to 2.4 g grain/Kg bw

i.e. for 50 Kg bw < **12 to 120 g grain** /day

Neoplastic effect => 0.0145 to 0.145 cereal/Kg bw

i.e. for 50 Kg bw < **0.7 to 7 g grain** /day



In the Middle Age : cereals provide the main food for peasants (bread and gruel)

+ other contaminated sources in daily food :

Preserved meat, Cheese, Dried and fresh fruits, Nuts



Conclusion: potential health risk in ancient populations due to storage mycotoxins

Issues with storage mycotoxins (and probably other mycotoxins) in pre-industrial societies :
Consequences on the health of people ?

Experimental archaeology of food storage plus lab analyses => levels of contamination in food

+

Archaeologist, historians => data on food ration (> 200 g cereals)

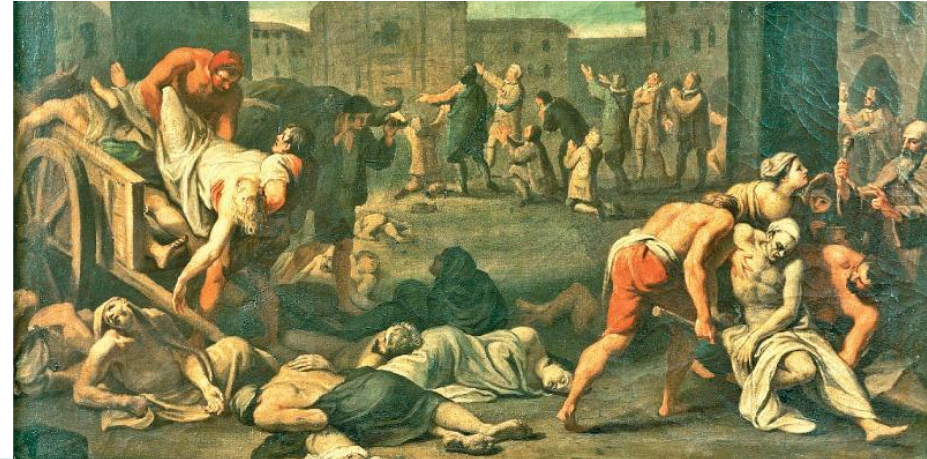


Risk assessment of OTA and other mycotoxins in 'ancient' food
+ Know-how of the ancient peasant for controlling moulds



Conclusion: potential health risk in ancient populations due to storage mycotoxins

**Issues with storage mycotoxins (and probably other mycotoxins) in pre-industrial societies :
Consequences on the health of people ?**



A challenge : Proofs of contaminations in food and of health issue

Tracking mycotoxins in remains (carporests) ?

Etiopathogenic studies on the potential effects of consumption of contaminated grains by ancient people ?



Thank you for your attention



Not only but also?



Experimental archaeology reveals potential health risk in ancient populations due to storage mycotoxins

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42nd Mycotoxin Workshop
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Experimental archaeology reveals potential health risk in ancient populations due to storage mycotoxins (Jean-Michel.Savoie@inrae.fr)

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