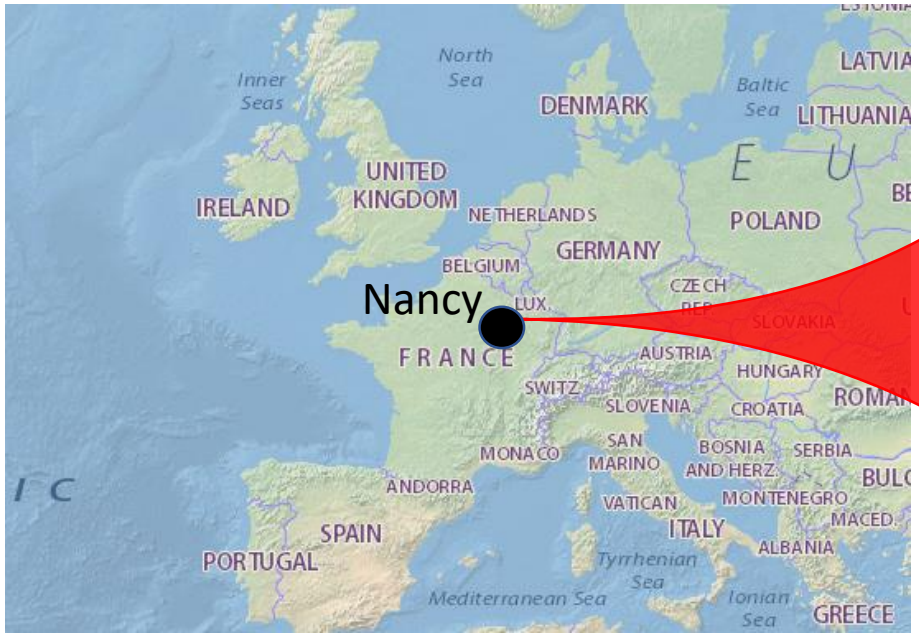
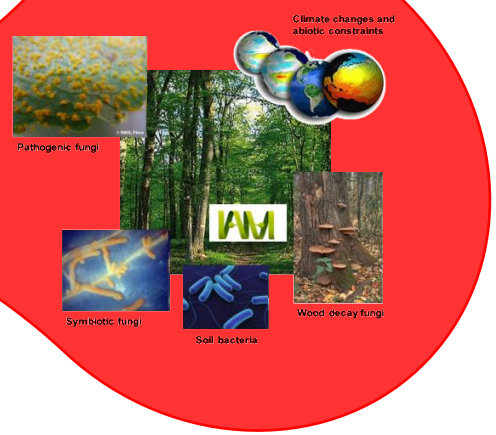
From fungal detoxification systems to Wood Natural Durability



TREE-MICROBE iNTERACTIONS

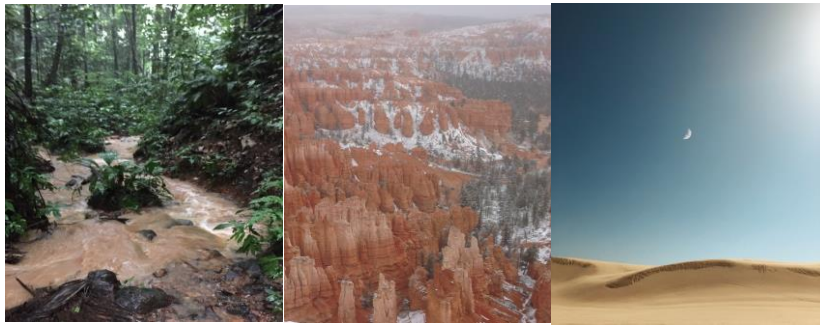


UNIVERSITÉ DE LORRAINE

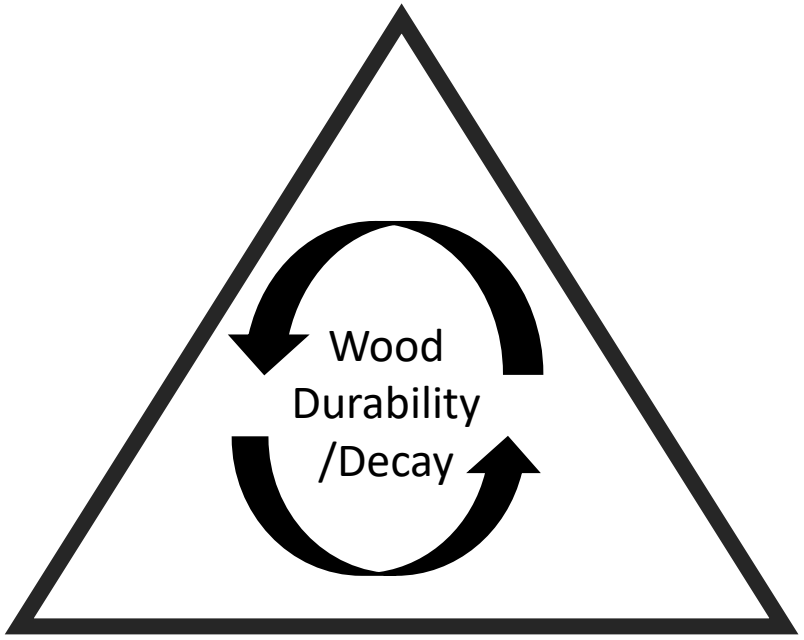
INRA SCIENCE & IMPACT

French agricultural research institute

Fungal wood decay

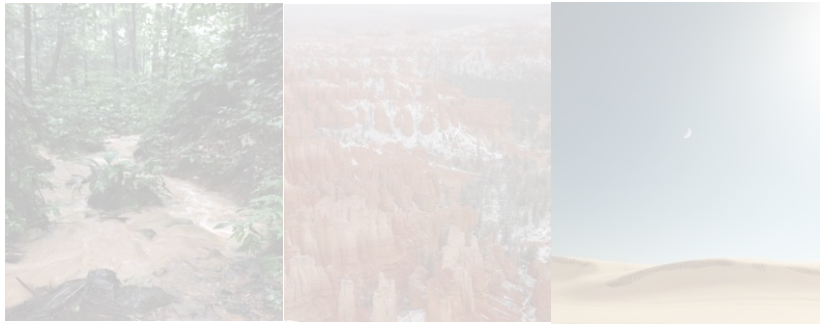


Abiotic Environment

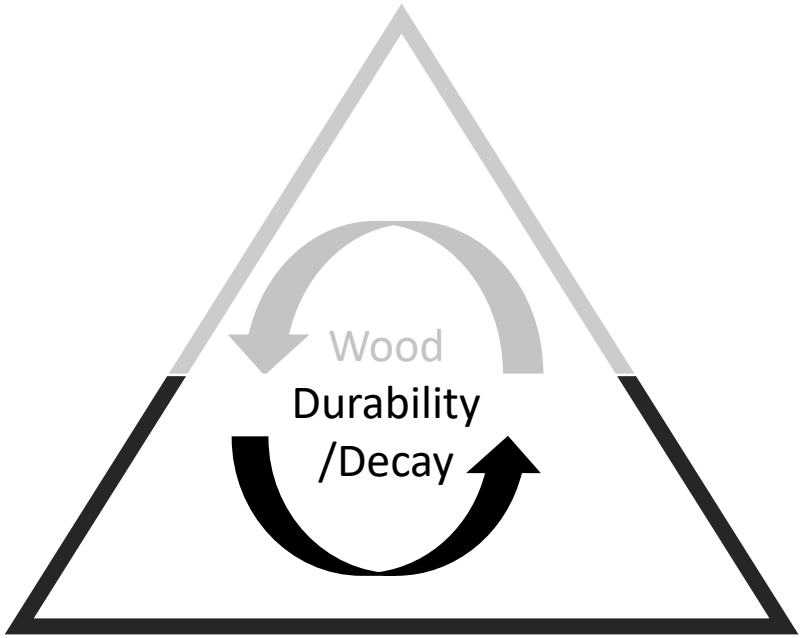


Wood features

Biotic environment



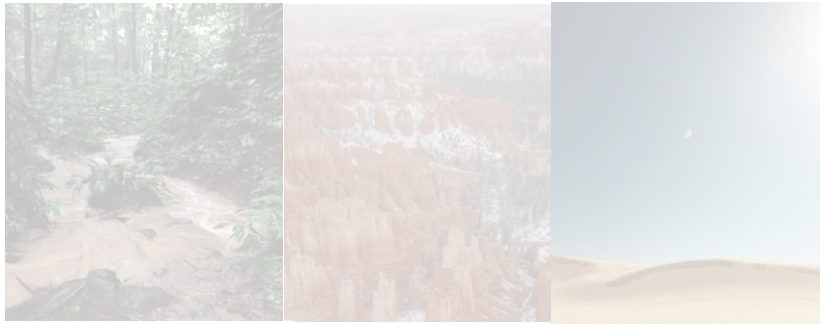
Environmental conditions



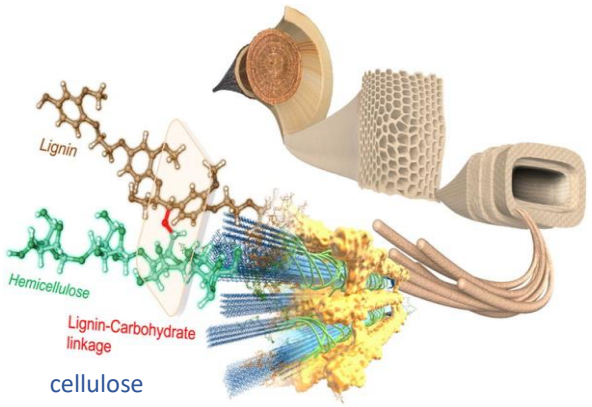
Wood

Fungi

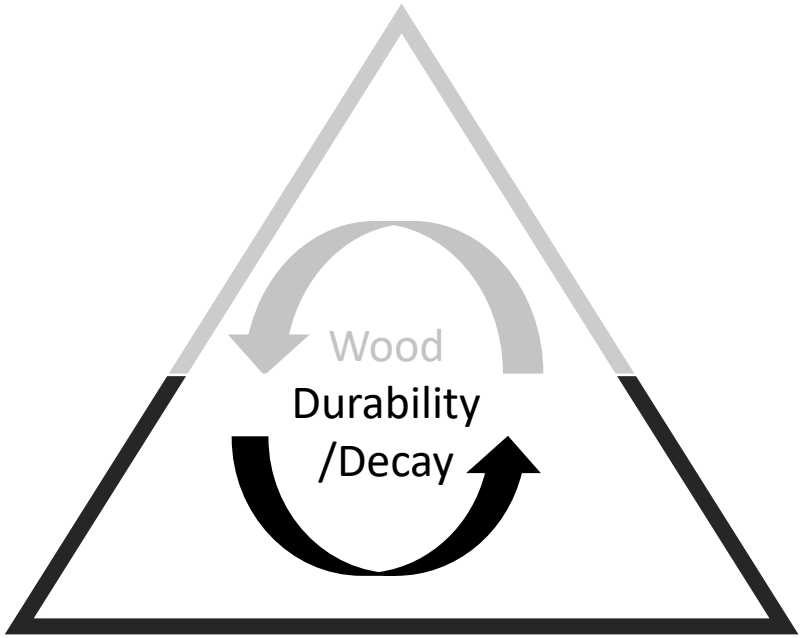
Adaptation



Environmental conditions



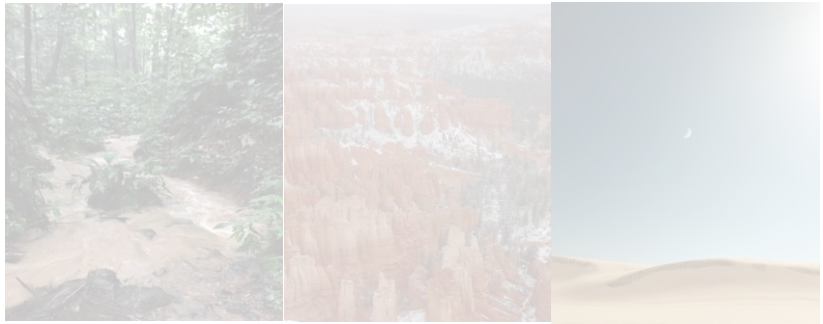
Nishimura *et al.*, 2018



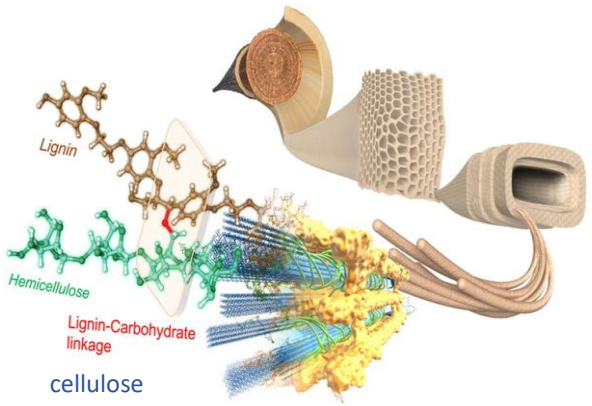
Recalcitrant wood Polymers

Adaptation

Fungi

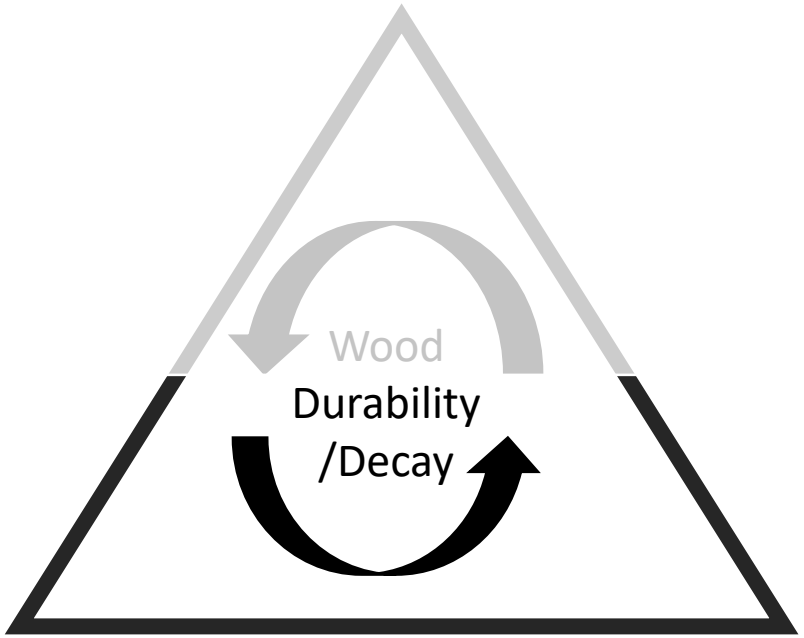


Environmental conditions



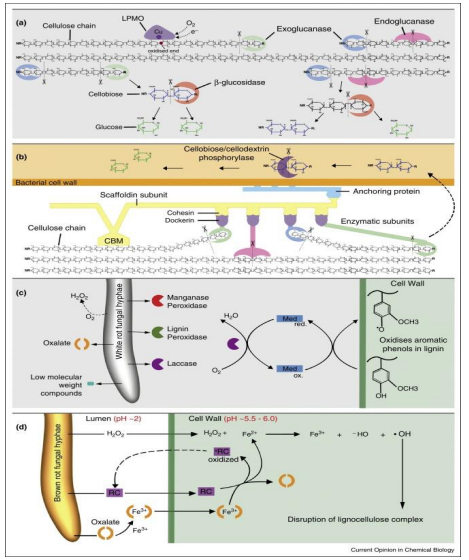
Nishimura *et al.*, 2018

Recalcitrant wood Polymers

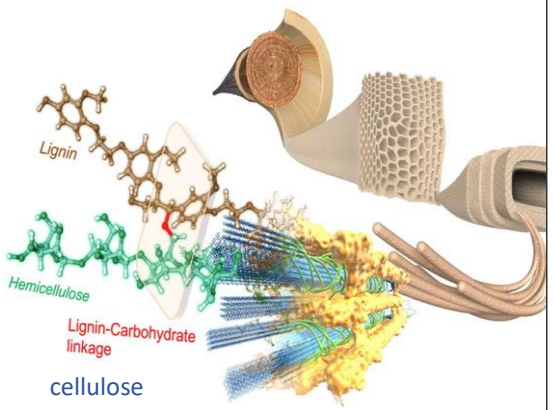


Adaptation

Extracellular systems



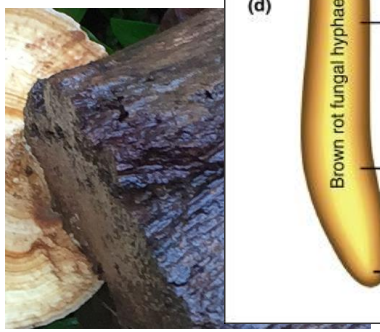
Cragg et al., 2015

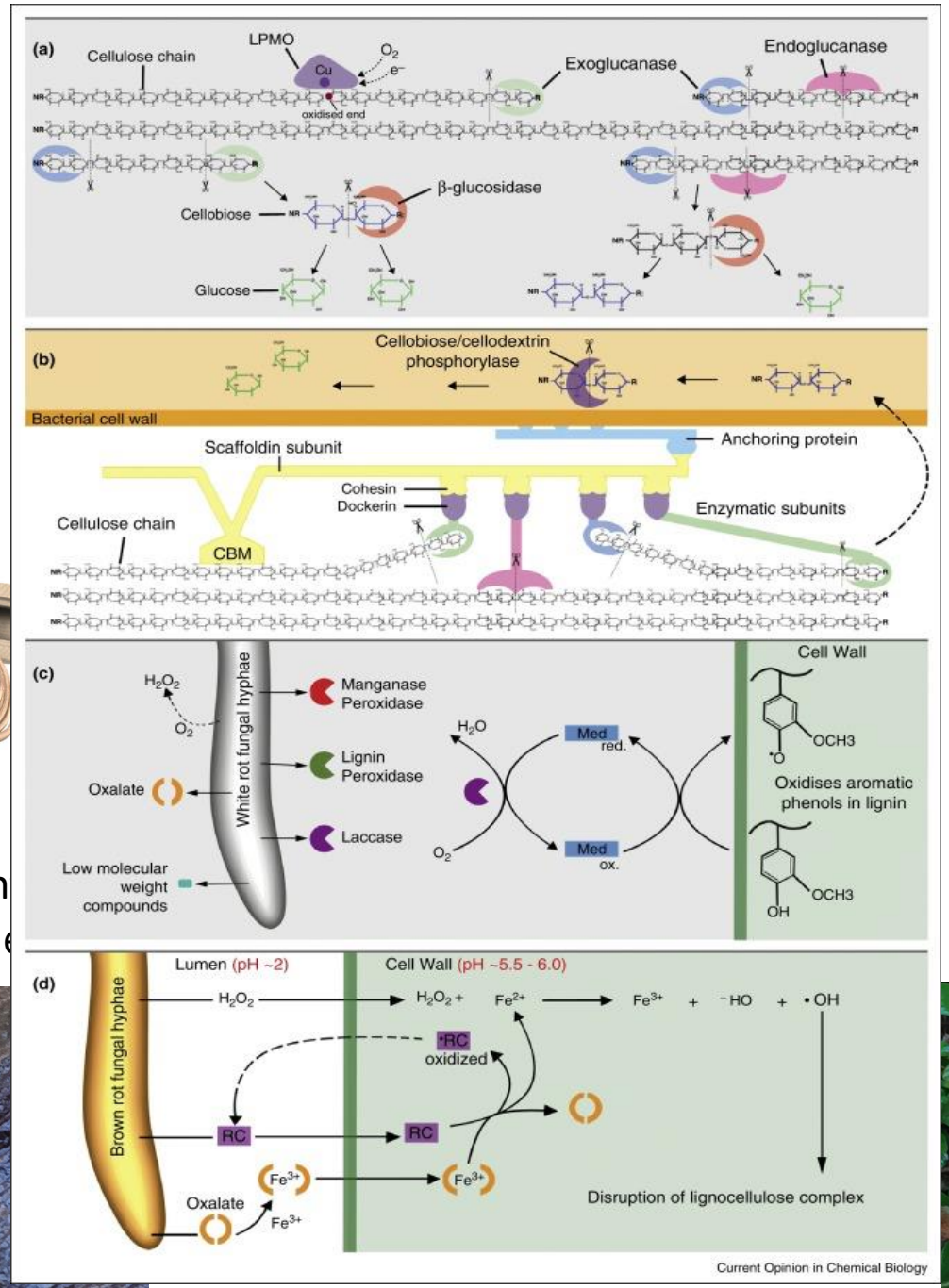


cellulose

Nishimura *et al.*, 2018

Recalcitran
Polyme

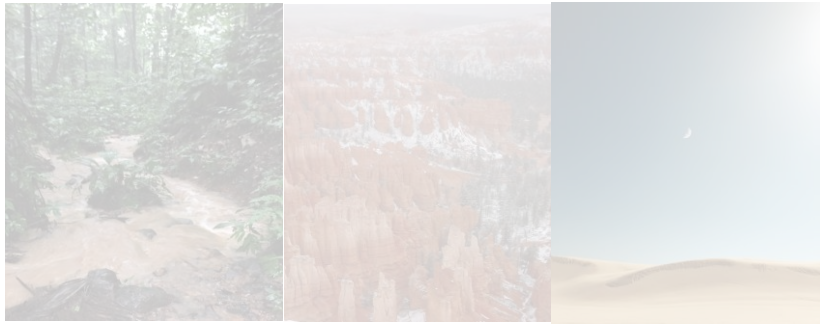




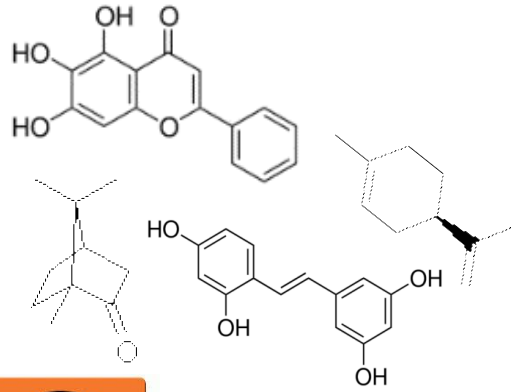
Cragg et al., 2015

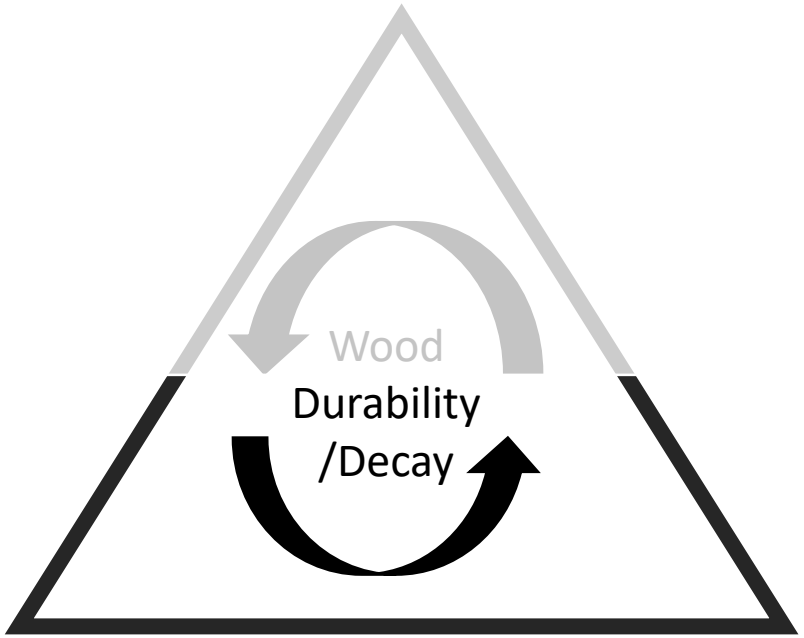
Extracellular systems

TREE-MICROBE INTERACTIONS



Environmental conditions

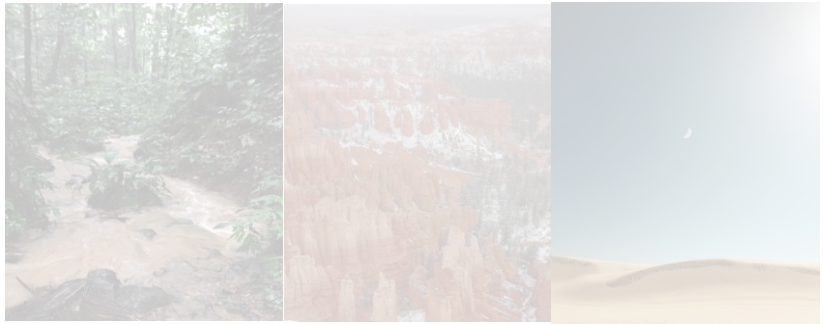




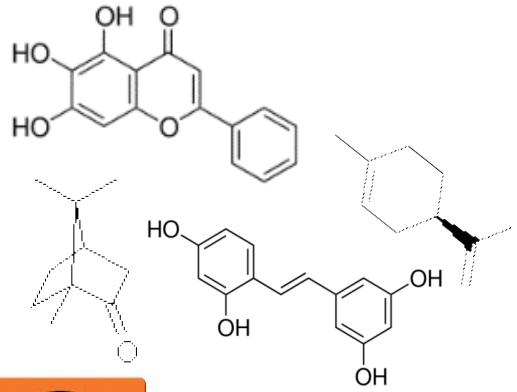
Wood Extracts

Adaptation

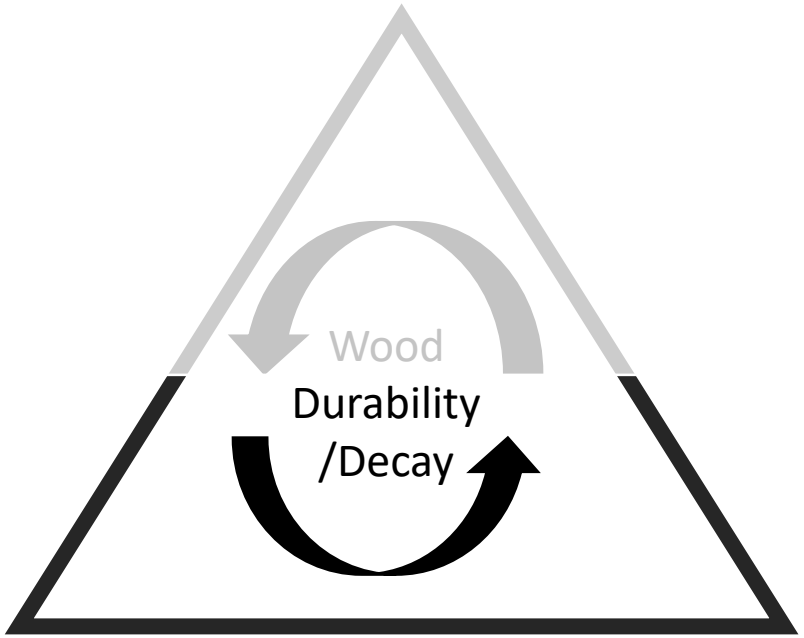
Fungi



Environmental conditions

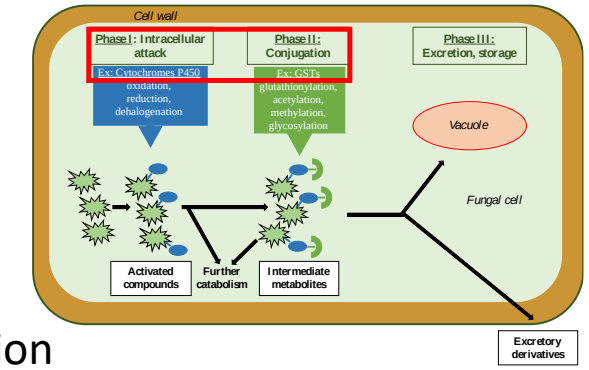


Wood Extracts



Adaptation

Detoxification systems



TREE-MICROBE iNTERACTIONS

Cell wall

Phase I: Intracellular attack

Ex: Cytochromes P450

oxidation, reduction, dehalogenation

Phase II: Conjugation

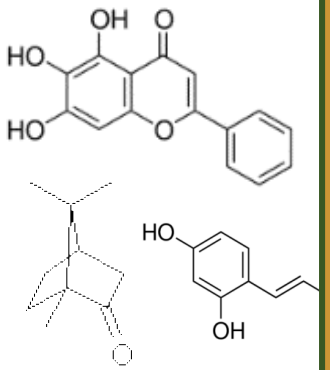
Ex: GSTs

glutathionylation, acetylation, methylation, glycosylation

Phase III: Excretion, storage

Vacuole

Fungal cell



Activated compounds

Further catabolism

Intermediate metabolites

Adaptation

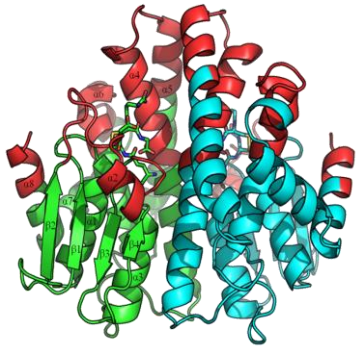
Excretory derivatives

Around 50 genes encoding GSTs in fungal genome

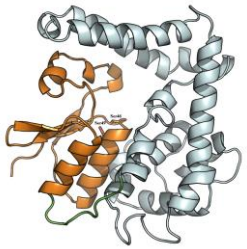
C Didierjean, F. Favier

Fungal GSTs (*P. chrysosporium*, *T. versicolor*)
- Protein production, biochemical and structural characterization
- Usually as dimer, each monomer with two domains : H and G

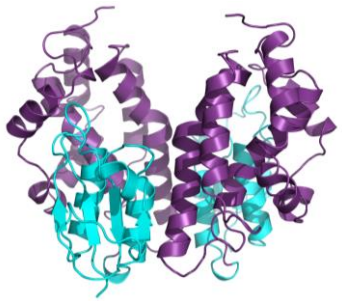
Structural diversity



PcUre2p
Thuillier et al., FEBS lett 2013
Roret et al., FGB 2015

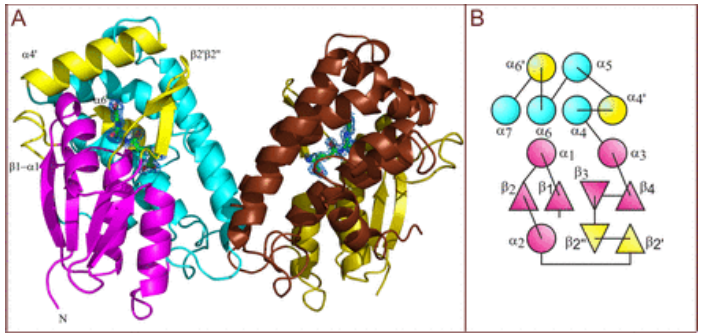


PcGTT2
Roret et al., unpublished

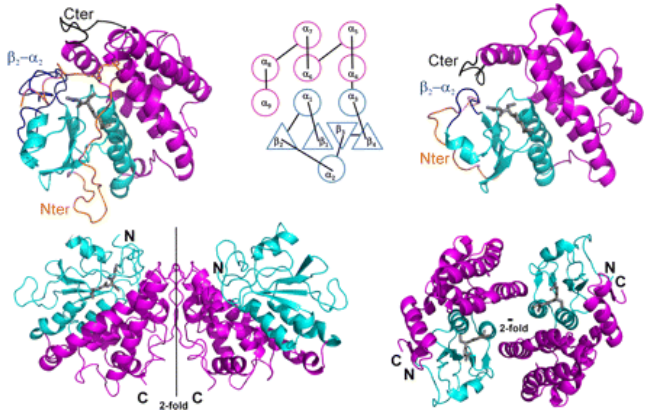


TvGSTO
Perrot *et al*., ACS chemistry & engineering, 2018
Schwartz *et al*., Scientific reports, 2018

PcGSTFuA (1, 2, 3)



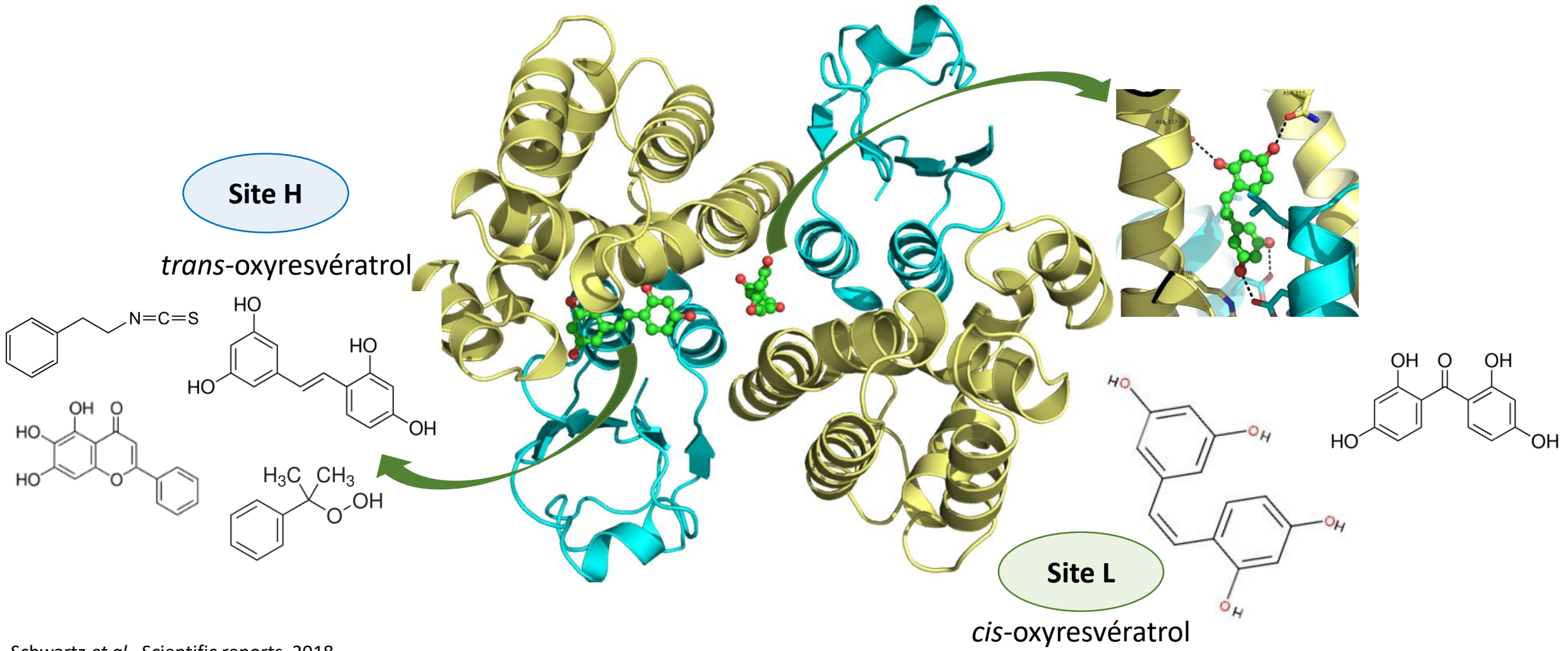
Mathieu et al., JBC, 2012; Plos one, 2013



GHR (PcGHR1, TvGHR1, TvGHR2)

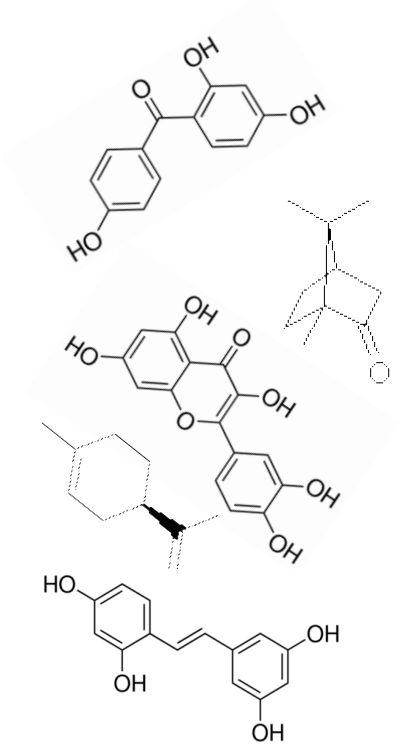
Meux et al., JBC, 2012; Schwartz et al., FEBS lett, 2018

Glutathione transferases: able to bind diverse molecules



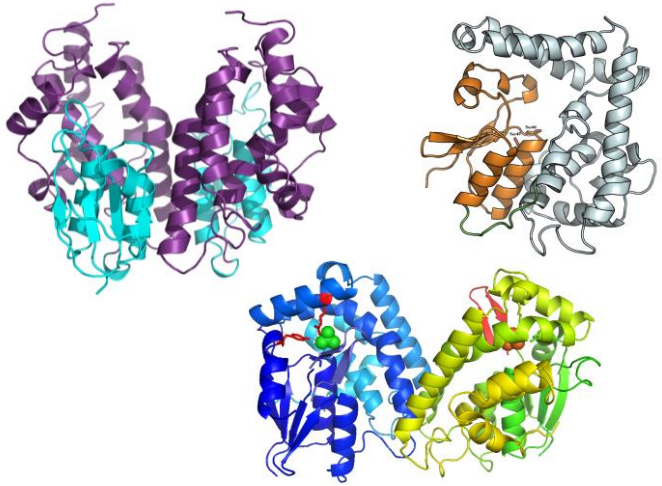
Schwartz *et al*., Scientific reports, 2018

Wood extracts



?

Detoxification proteins (GSTs)



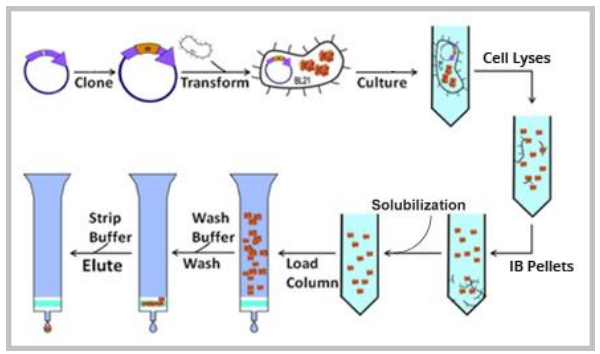
Tropical woods
(20 species)

TvGSTs
(6 isoforms)

5 g

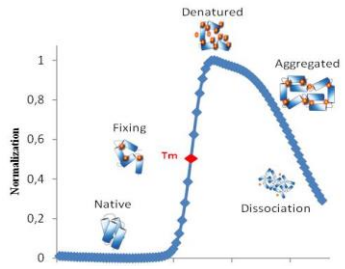
Extraction
(Dichloromethane,
acetone,
toluene/Ethanol,
water)

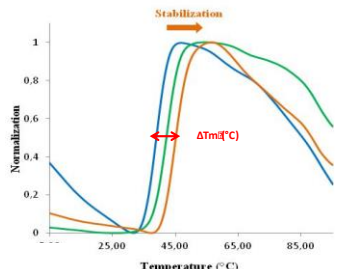
2.5 µg



10 µM

Thermostability of 6 TvGSTOs
(Fluorescence)





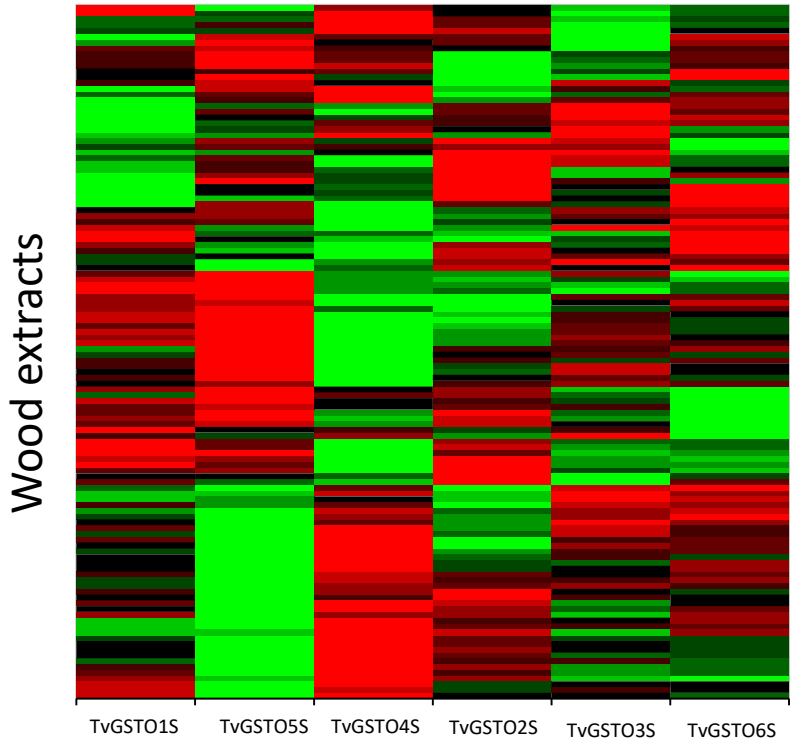
96 wells/ 2 hours

Quantitative
value : ΔTd

Perrot et al., 2018, ACS Sustainable Chemistry and Engeenring

Quantitative value : ΔTd

20 species, 80 extracts, 6 GSTS

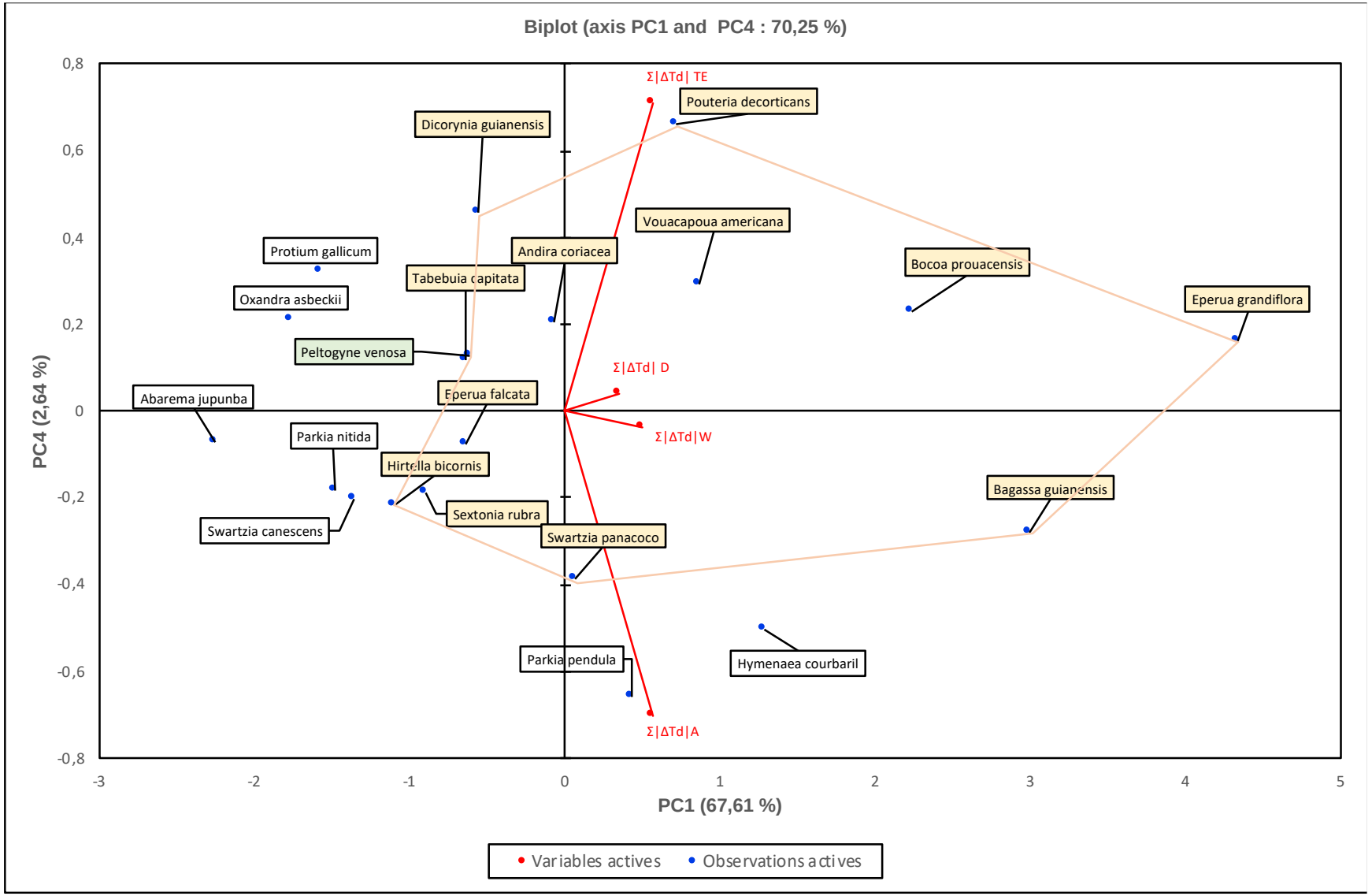


For each extract : GST reactivity defined as Σ|ΔTd|

For each wood :

Σ|ΔTd|D, Σ|ΔTd|A, Σ|ΔTd|TE, Σ|ΔTd|W

Principal component analysis



Very Durable/ Durable

Classes III, IV and V

Degrad Database

(soil bed tests)

PC1 correlated with natural durability
(Tukey test, p= 0,046)

Correlation between GST reactivity and wood natural durability

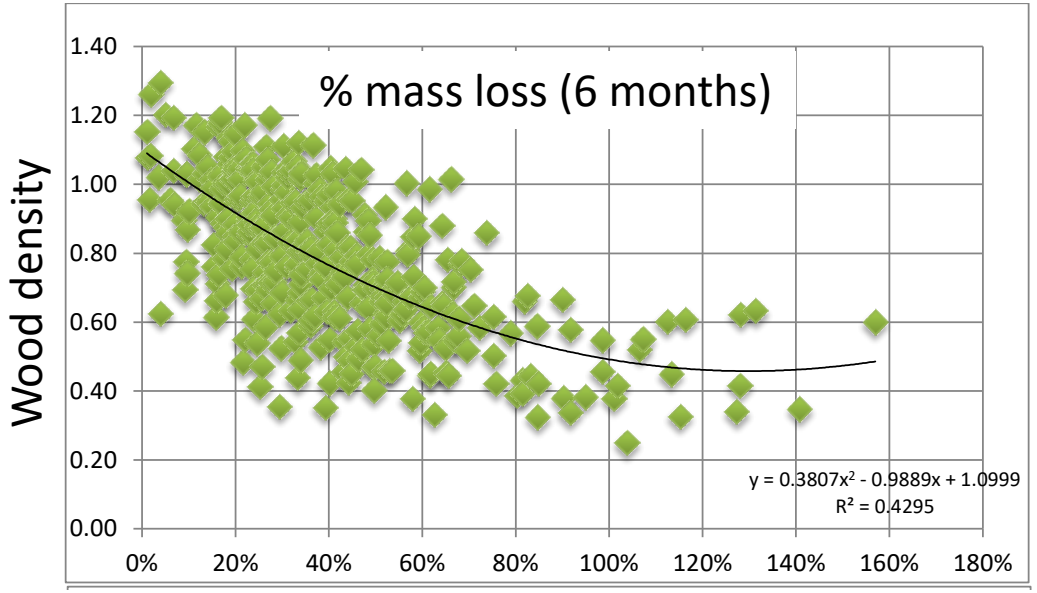
DEGRAD Database (J. Beauchene, 2012)

400 species from French Guiana

Soil tests

(Adapted from ENV 807 Stantard)

+ Wood density (12% humidity)

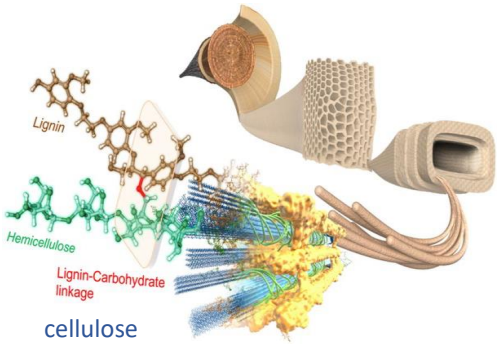


Confirm that wood density is an indicator of wood natural durability

(explain 43 % of the variability)

Recalcitrant wood Polymers

Wood chemical Features

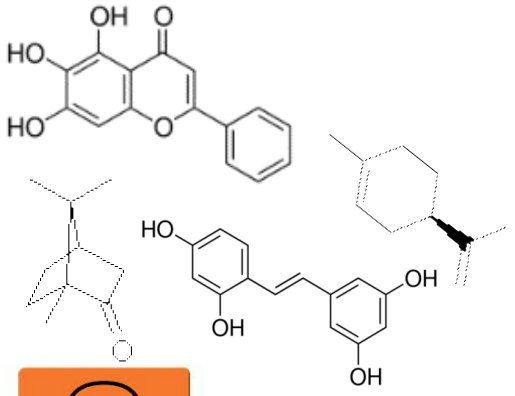


Nishimura *et al.*, 2018

Density

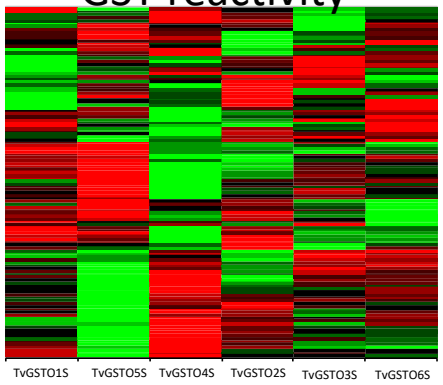
Natural durability ?

GST reactivity



Wood Extracts

GST reactivity



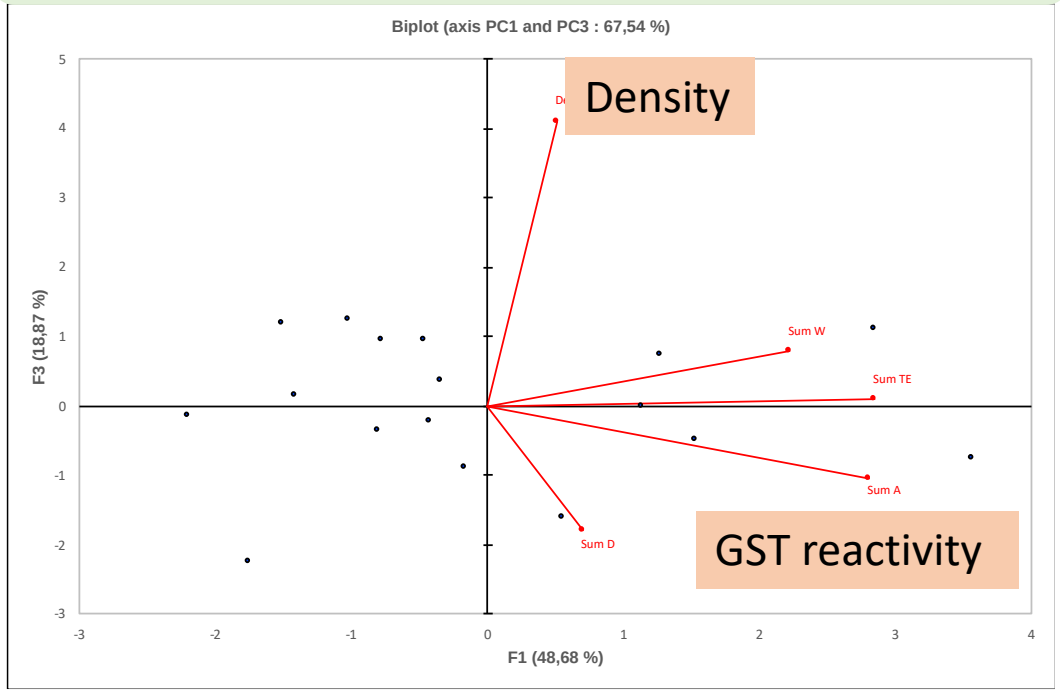
+

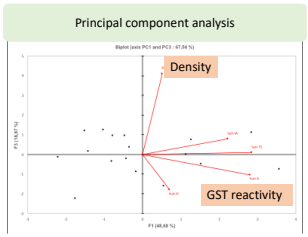
Wood density from DEGRAD Database
(J. Beauchene, 2012)

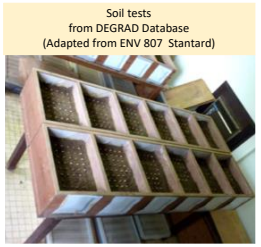
Density and GST reactivity are independent variables in this set of data

Principal component analysis

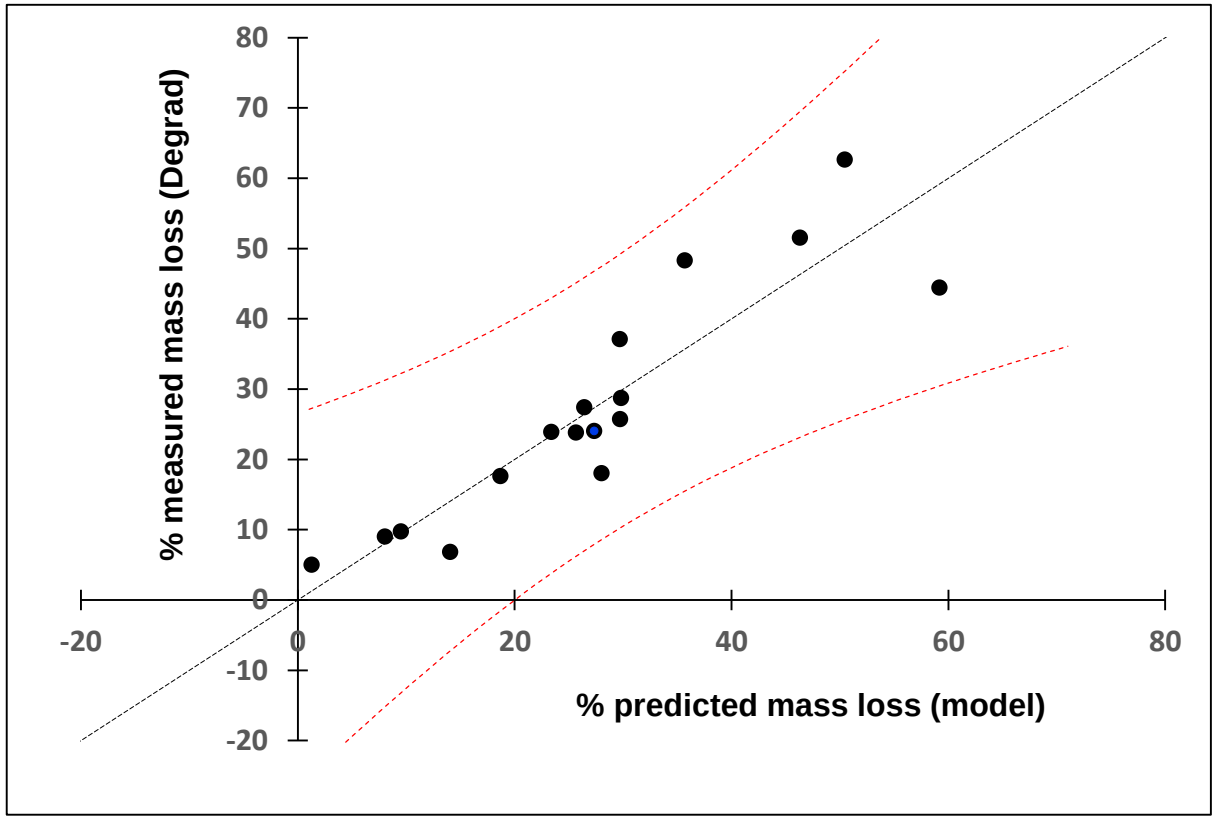
% contribution	PC1 (54%)	PC2 (74%)	PC3 (89%)	PC4 (98%)	PC5 (100%)
Density			**78**		
Σ|ΔTd|A	**37**				**50**
Σ|ΔTd|D		**58**		**23**	
Σ|ΔTd|W	**24**	**22**		**52**	
Σ|ΔTd|TE	**37**				**46**







model to explain mass loss (soil tests) from wood density and GST reactivity)



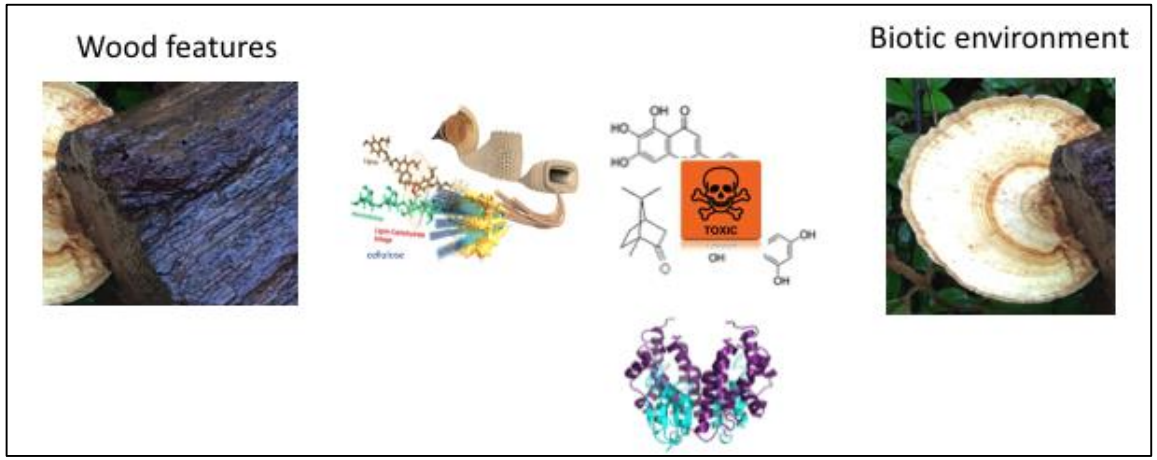
Statistic	Learning samples	
Observations	17,000	
Weight sum	17,000	
DDL	11,000	
R^2	**0,819**	**p<0.006**
R^2 ajusté	0,736	
MCE	73,227	
RMCE	8,557	
MAPE	24,021	
DW	2,591	
Cp	6,000	
AIC	77,590	
SBC	82,590	
PC	0,379	

Model:

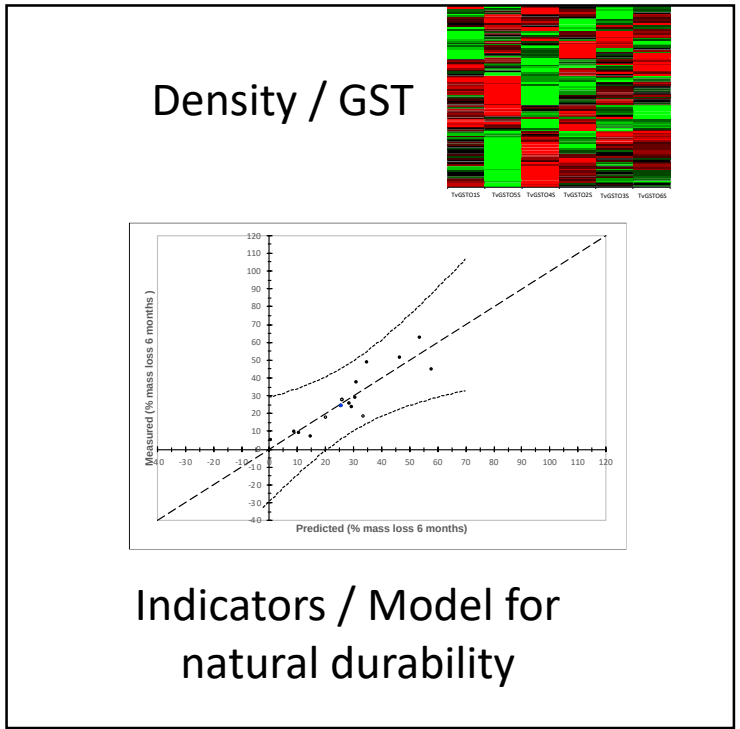
$$\% \text{ predicted mass loss} = 45 - (30 * WD) + (5*\Sigma\Delta TdA) - (1{,}3*\Sigma\Delta TdD) - (4{,}6*\Sigma\Delta TdTE) - (4{,}5*\Sigma\Delta TdW)$$

Take home messages

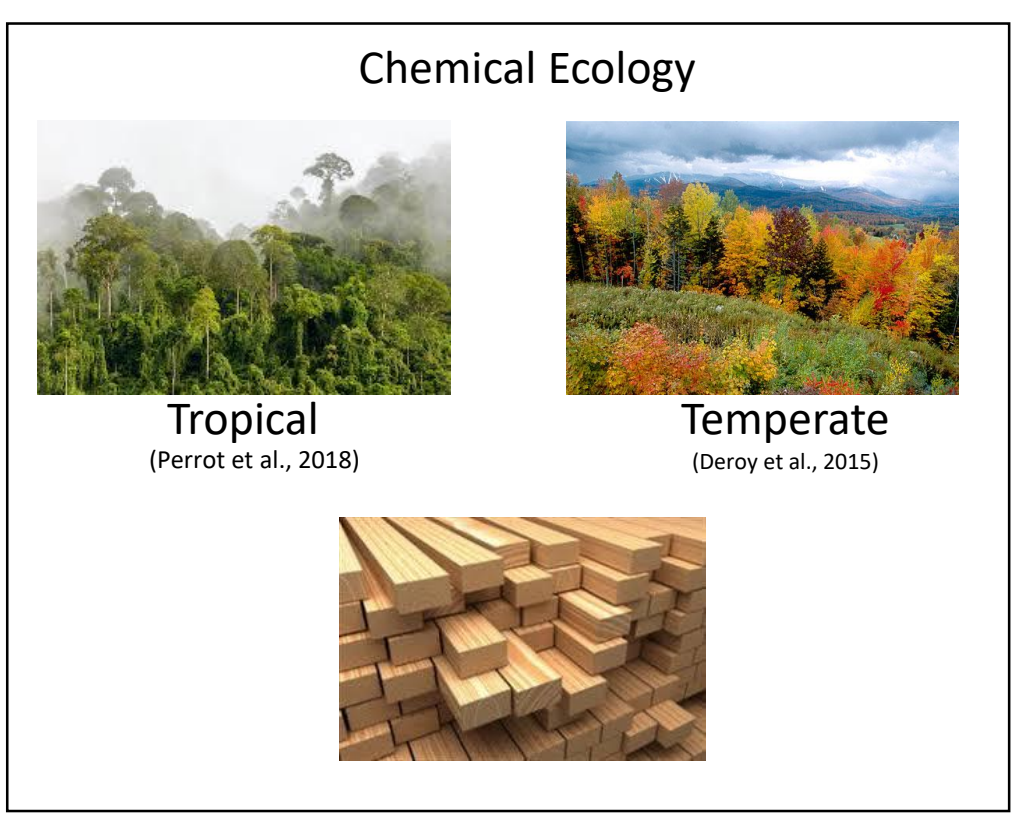
Wood : important in the adaptation of wood decaying fungi



adaptation of wood decaying fungi: useful to study wood properties



Tools?



T. Perrot, G. Salzet, F. Saiag, M. Morel-Rouhier, E. Gelhaye

N. Amusant,
J Beauchene

M. Schwartz, C. Didierjean, F. Favier,
G. Mulliert, E. Auber

S. Dumarçay , P. Gérardin

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