Arboricultural ASSOCIATION

Crown & Canopy Management

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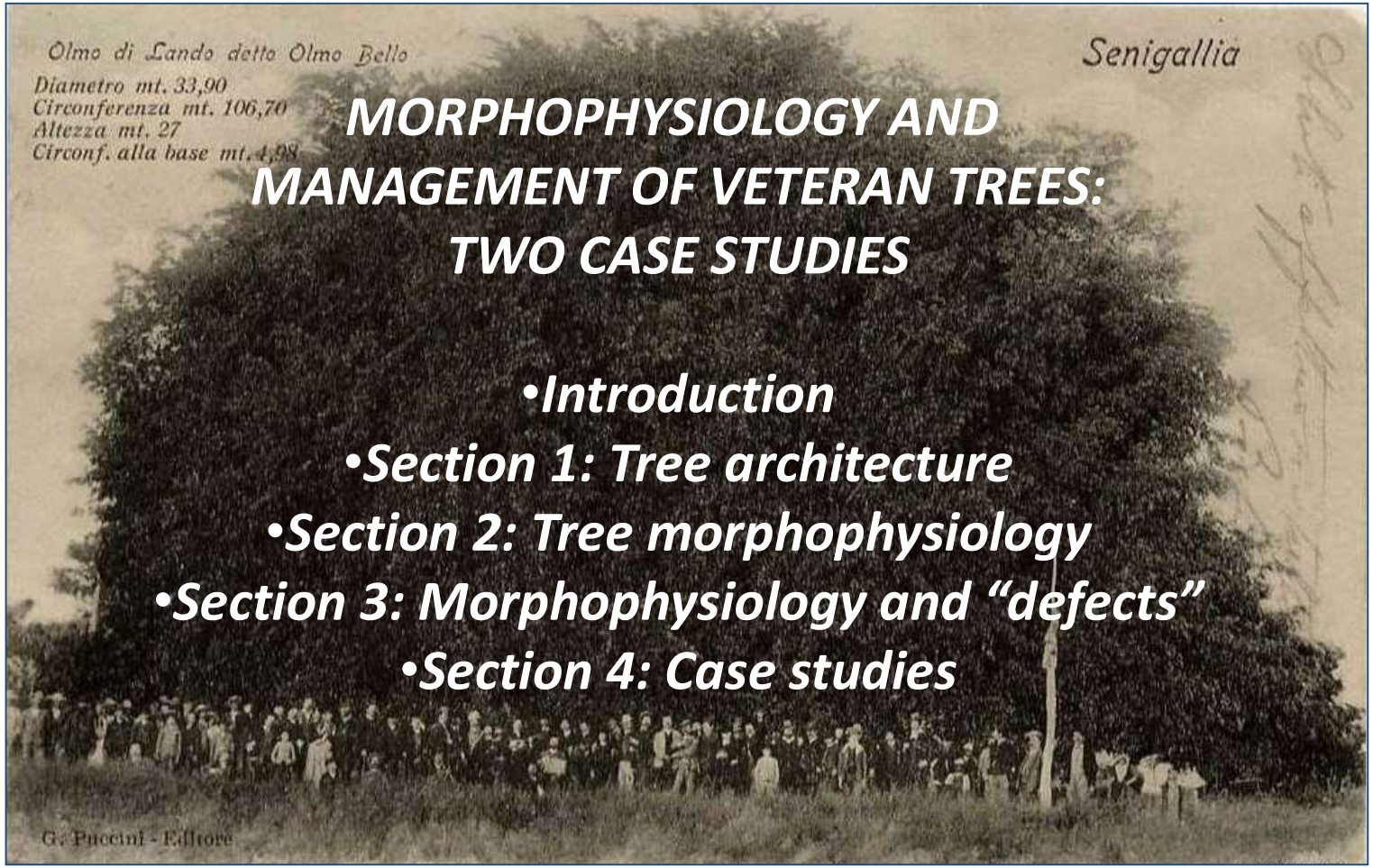
Progetto Verde



MORPHOPHYSIOLOGY AND MANAGEMENT OF VETERAN TREES: TWO CASE STUDIES

- Introduction
- Section 1: Tree architecture
- Section 2: Tree morphophysiology
- Section 3: Morphophysiology and “defects”
- Section 4: Case studies

Stefania Gasperini, Giovanni Morelli

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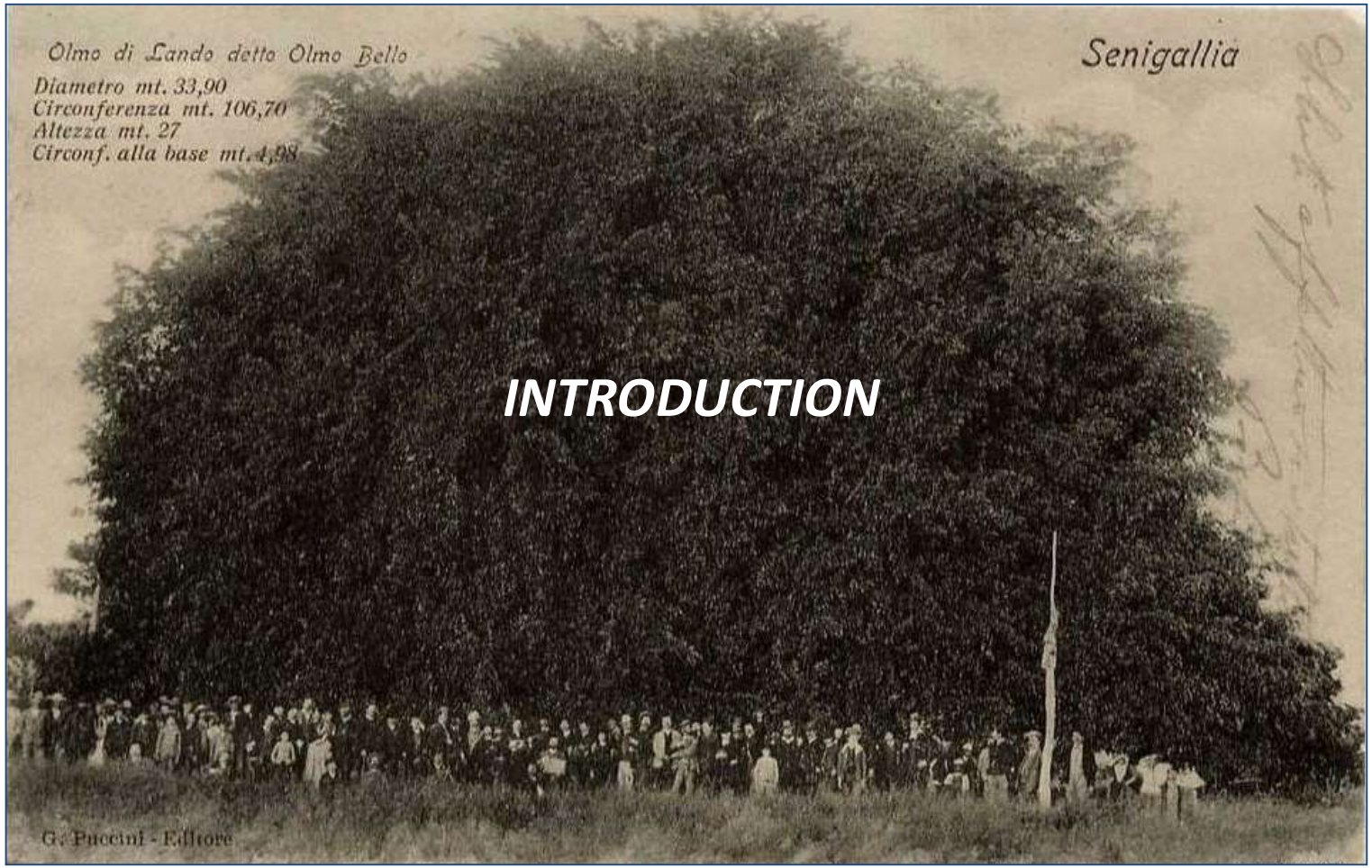
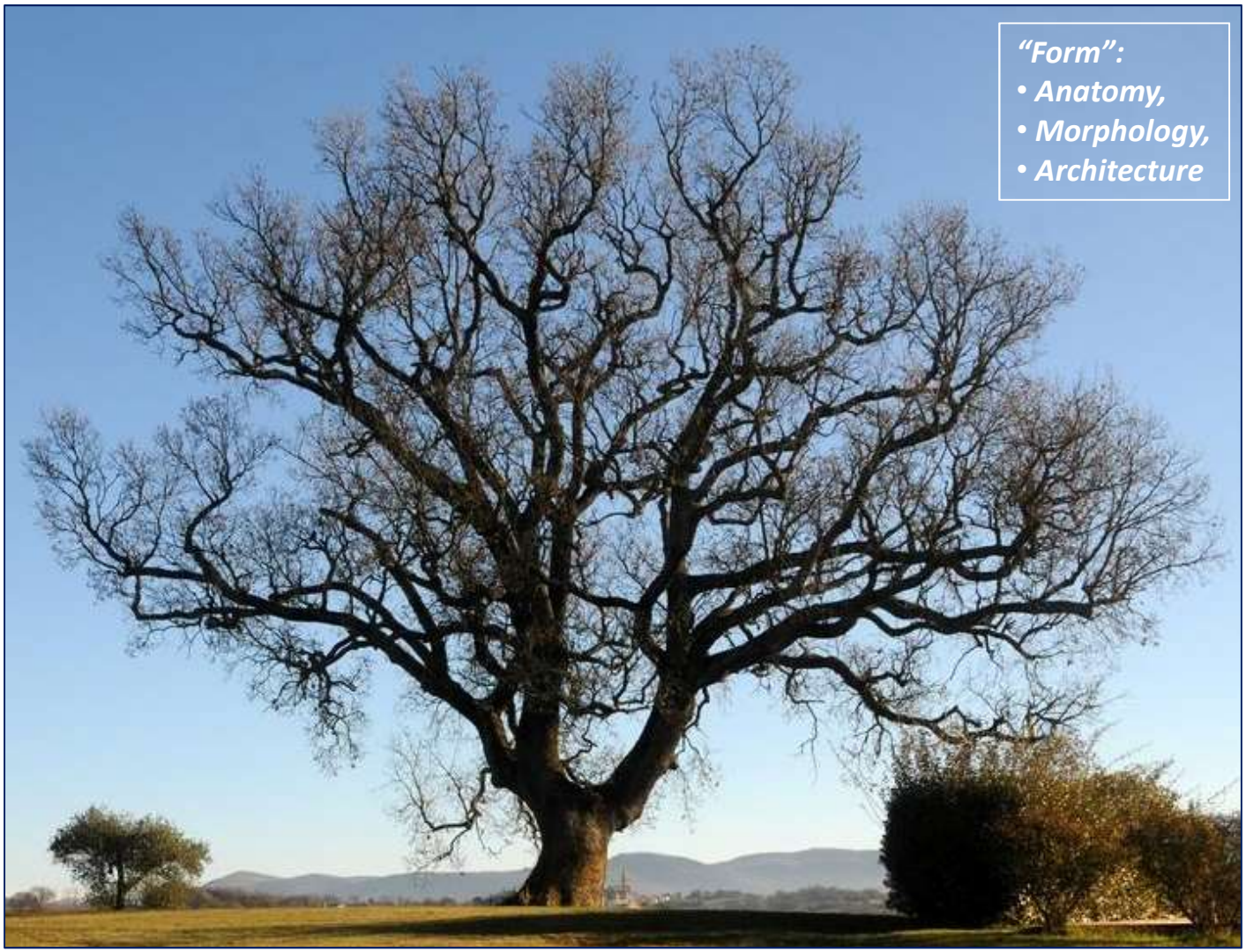


INTRODUCTION

The tree form



The tree form is the plastic, dynamic and transient expression of the relationship between the individual and the context. The study of the form allows us to outline the past of a tree, to describe its present and to foresee the future, by placing in morphological and functional relation its different anatomical regions in a logical and consequential way. The tree form is a language or, rather, the expressive form of its identity: the tree is its form.

Dynamics and changes of the form

Oak (Photo T. Green)

"Form":
- *Anatomy,*
- *Morphology,*
- *Architecture*

Quercus pubescens (Photo V. Capodarca)

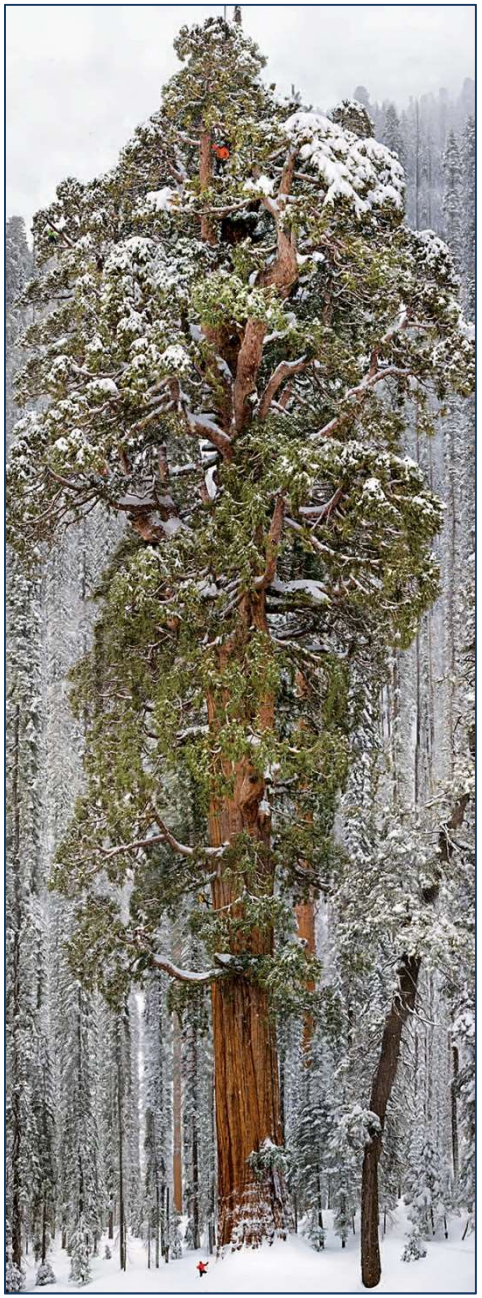
Dynamics and changes of the form: time, growth and development

Quercus pubescens. Photo V. Capodarca

Conceptual issues: time

Linden tree, Ludovico, Margherita e Max; Cavalese (TN)

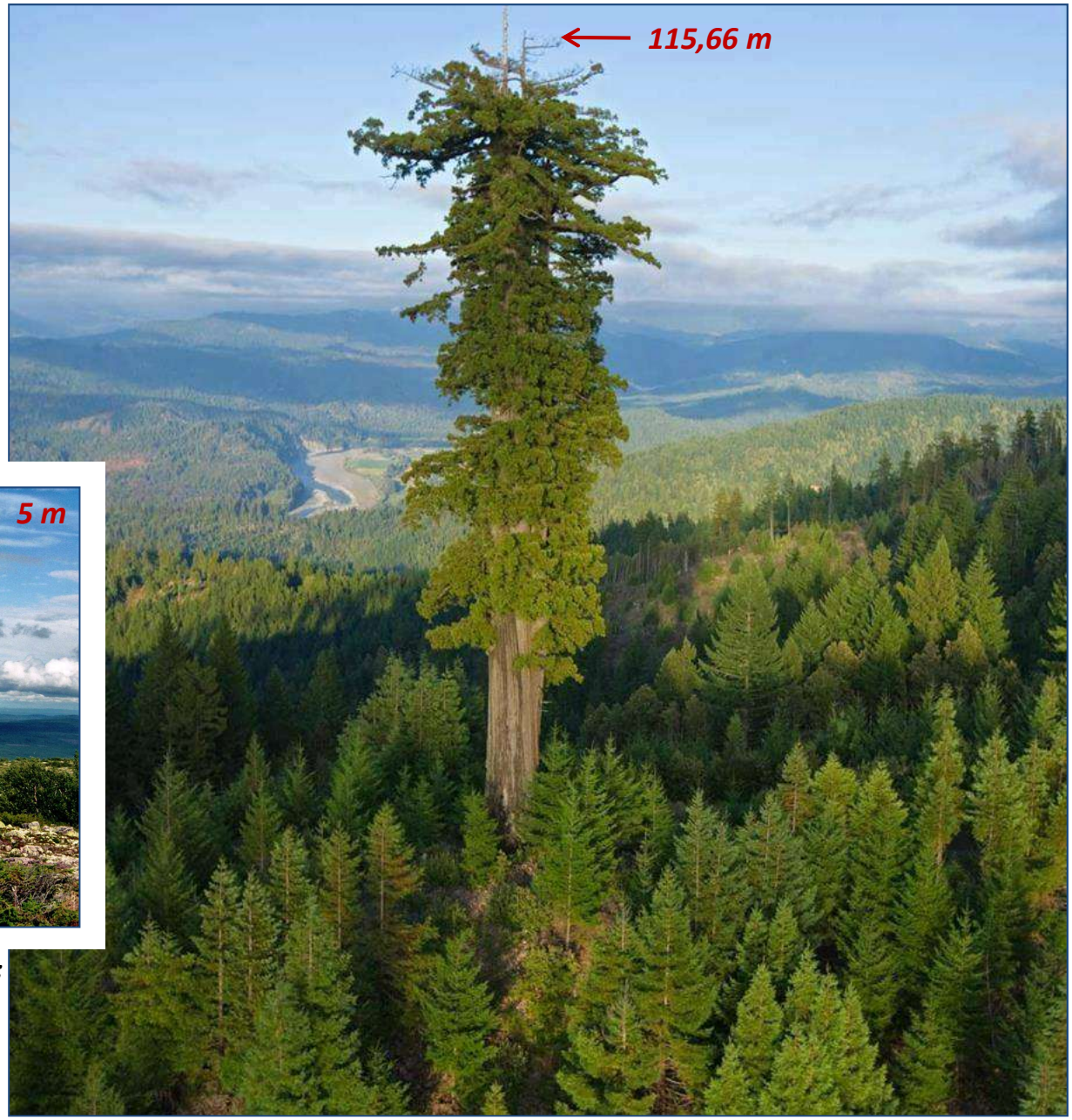
Conceptual issues: space and organisation



Source: National Geographic Society.

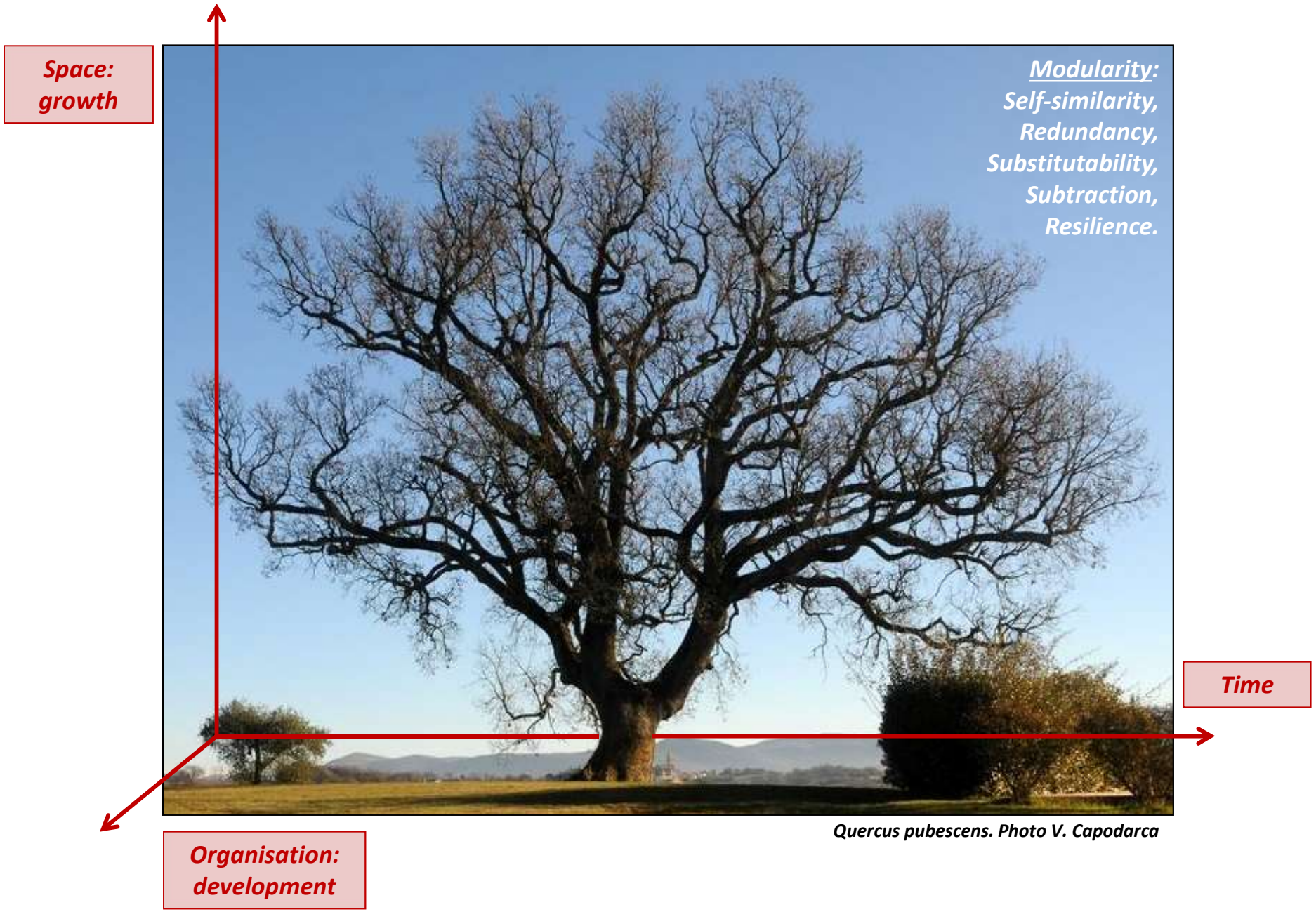
Conceptual issues: space and organisation

Picea abies (Old Tjikko); hight 5 m, estimated age 9560 years
Photo: Google



Sequoia sempervirens (Hyperion); hight 115,66 m, estimated age 2.500 years.
Photo: J. Janover

Dynamics and changes of the form: time, growth, development and modularity



Quercus pubescens. Photo V. Capodarca

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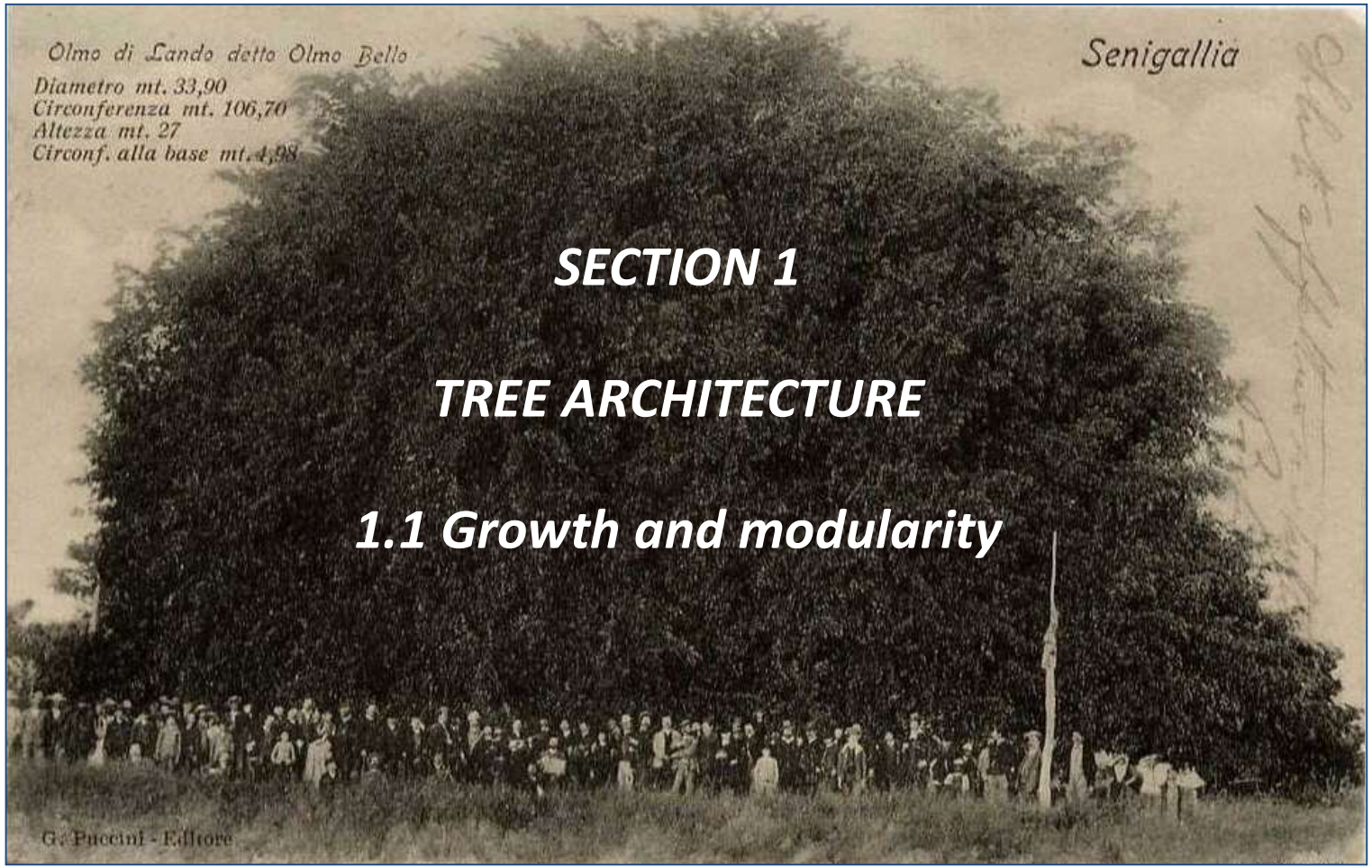
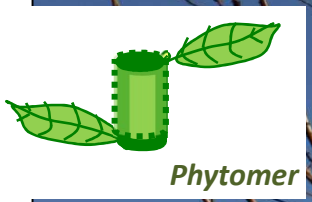


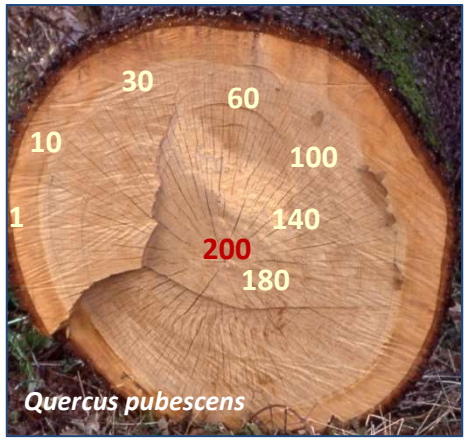
SECTION 1

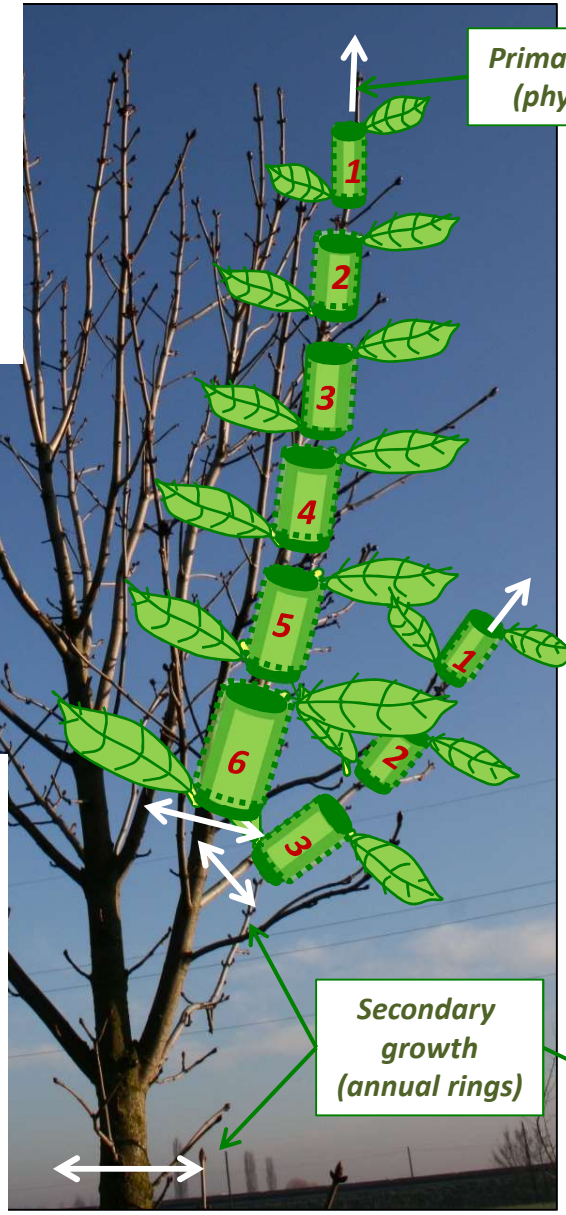
TREE ARCHITECTURE

1.1 Growth and modularity

Primary and secondary growth







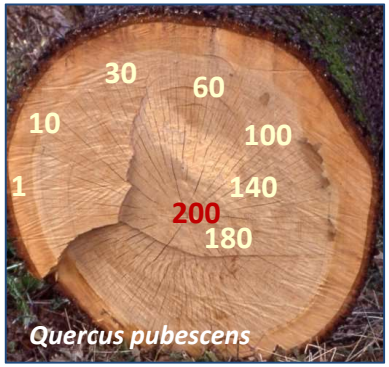
Aesculus hippocastanum, Ferrara (Italy)

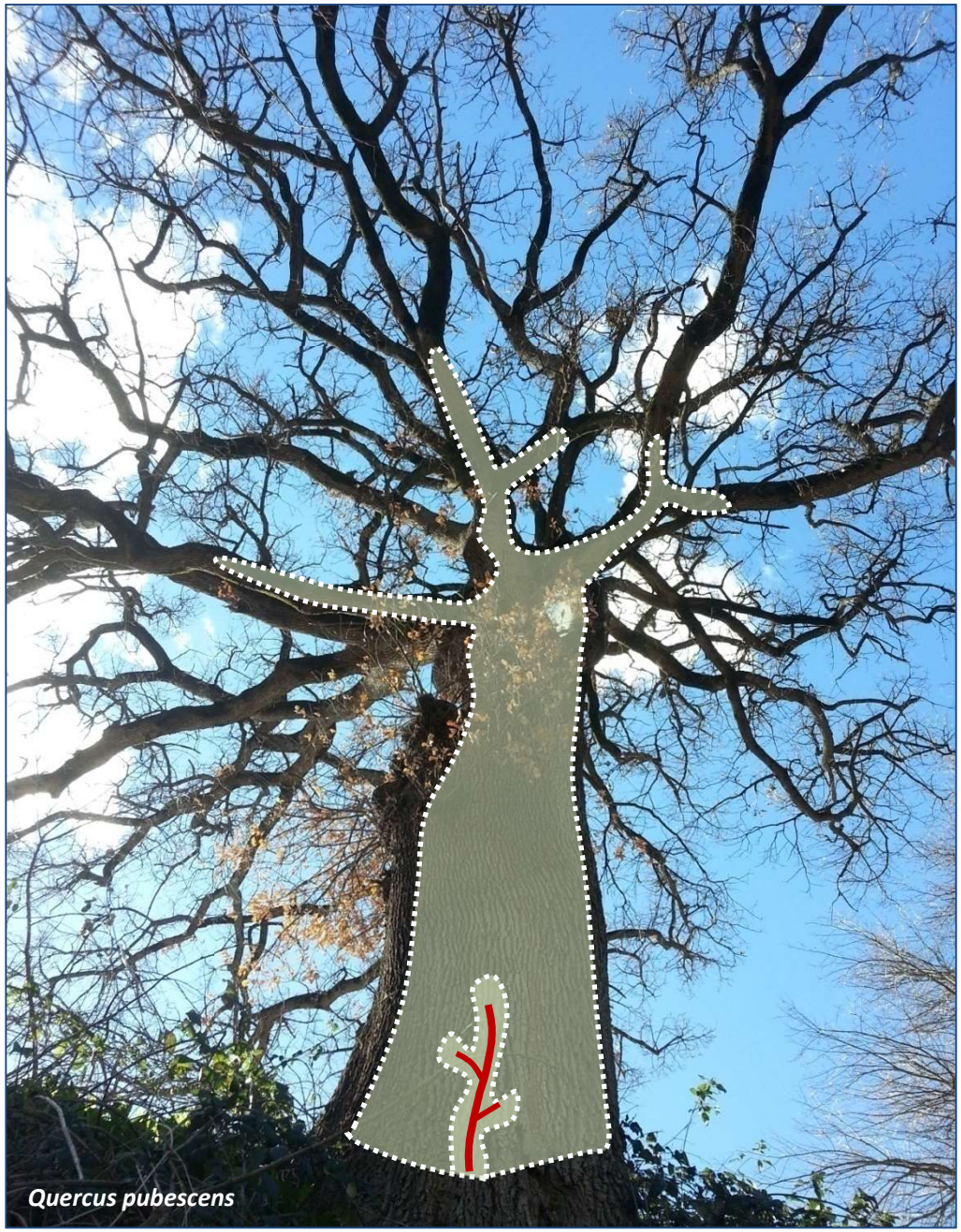
Acer saccharinum, Vermont (USA)

G. Morelli, 2018

Secondary growth

G. Penone: "Young tree carved Inside old tree"





1 ring

10 rings

30 rings

60 rings

100 rings

140 rings

180 rings

200 rings

G. Morelli, 2018

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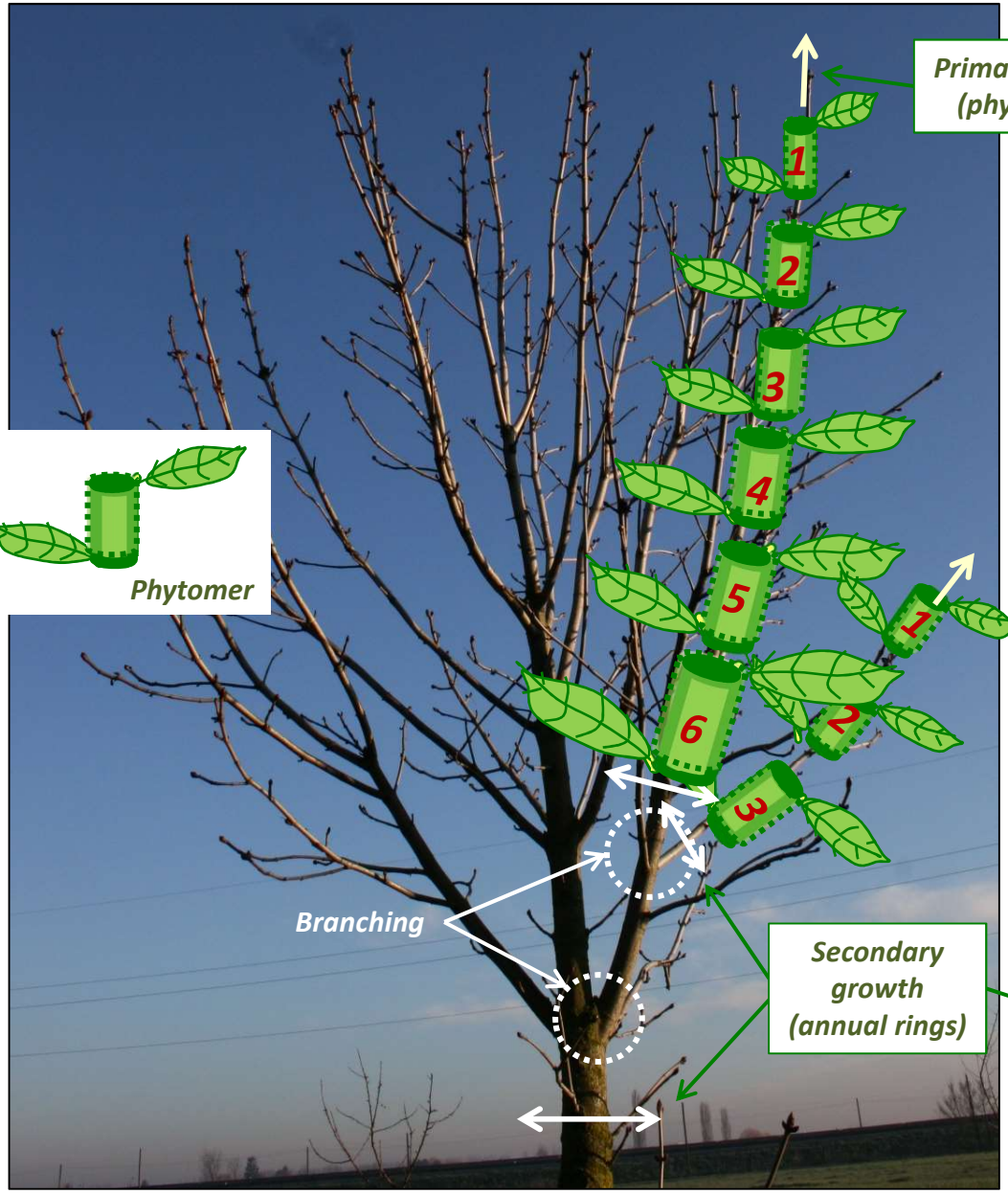
SECTION 1

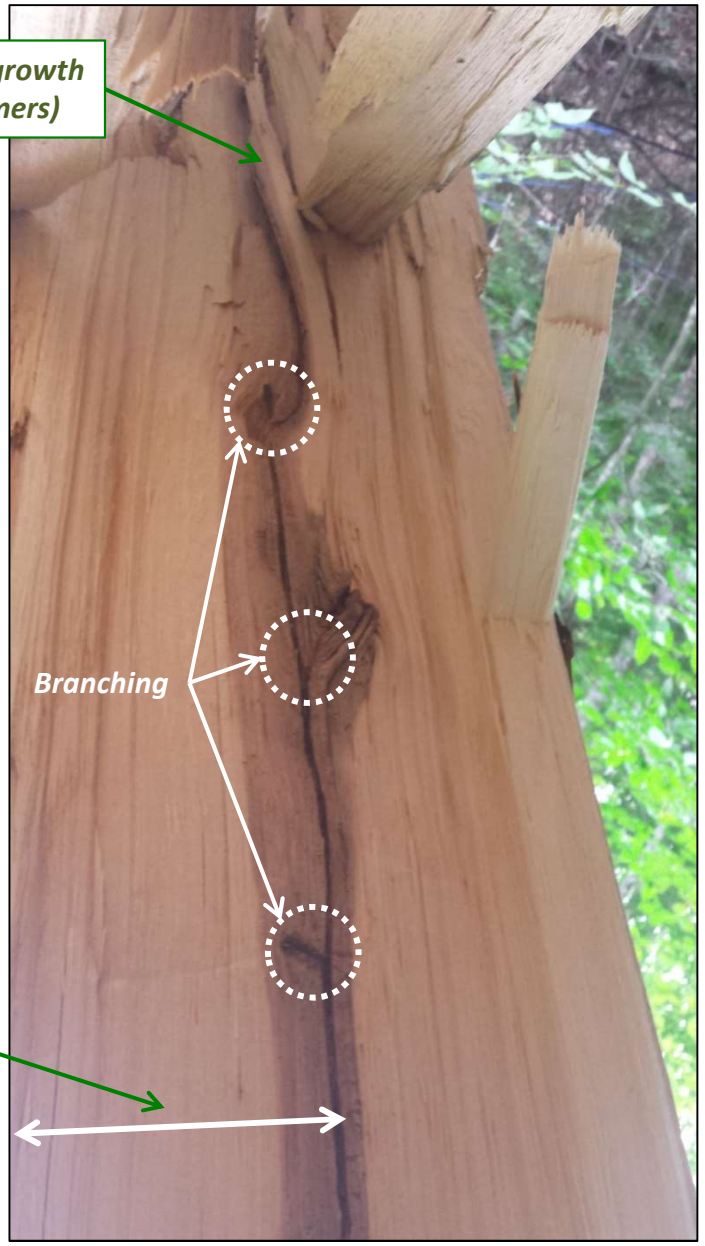
TREE ARCHITECTURE

1.2 Branching

Branching



Aesculus hippocastanum (Photo G. Morelli)

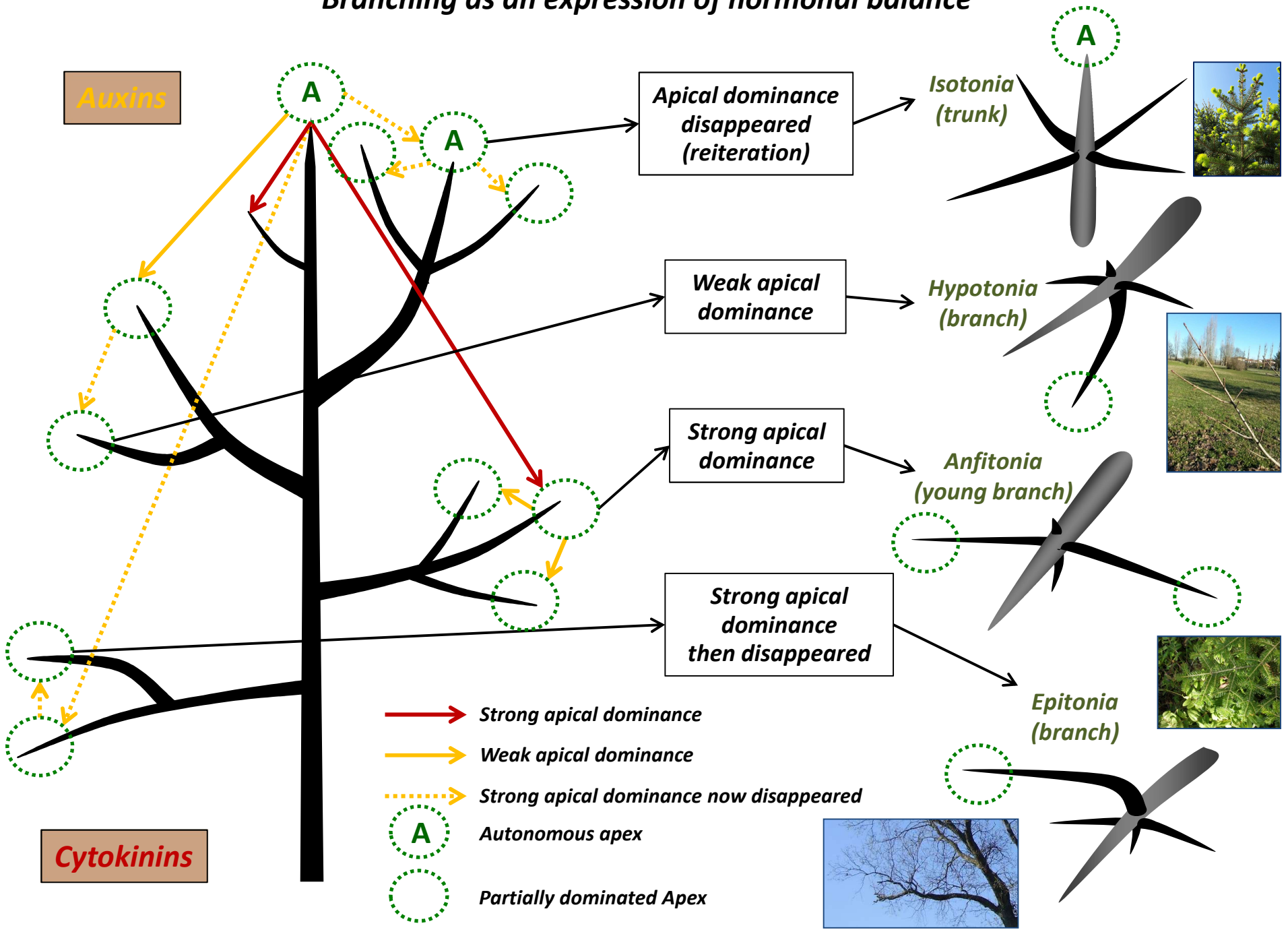


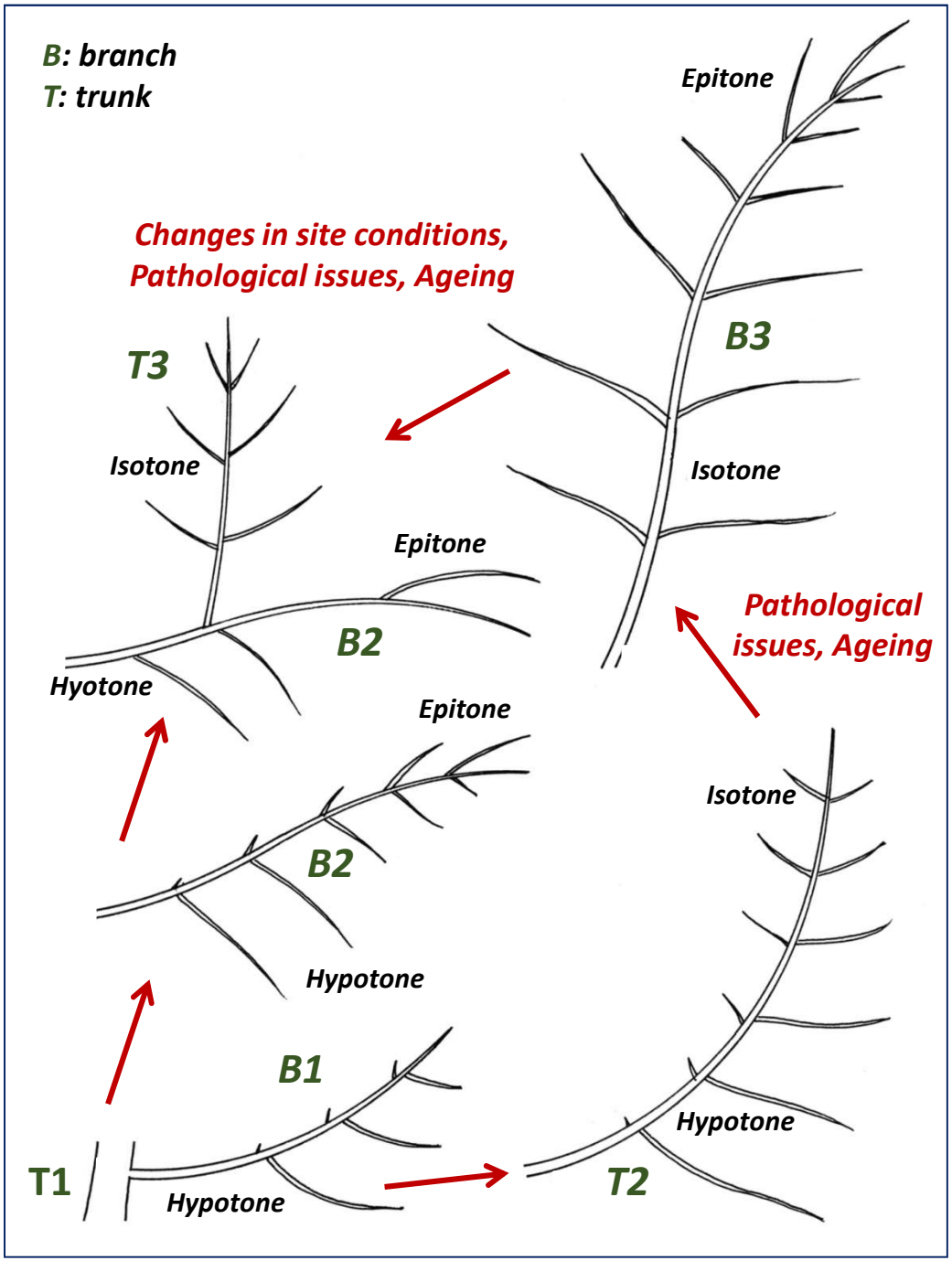
Acer saccharinum (Photo G. Morelli)

Branching as an expression of hormonal balance

Picea abies (Photo G. Morelli)

Branching as an expression of hormonal balance





The Metamorphosis of the branches: from branch to trunk, round trip

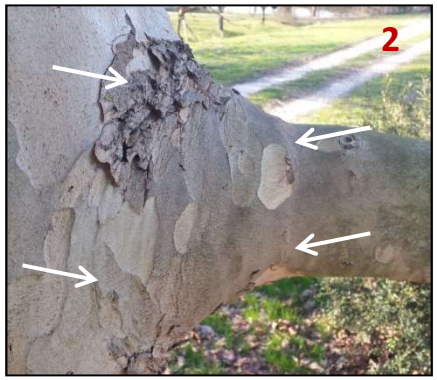
B: branch characterized by the asymmetrical development of lateral ramifications (epitonia or hypotonia). Can be horizontal, vertical or intermediate

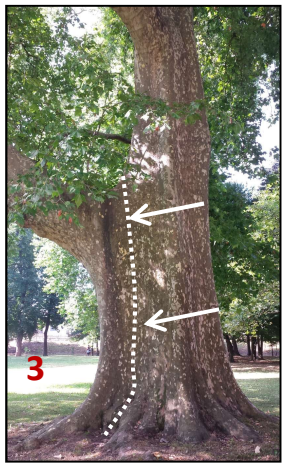
T: trunk, whose development of the ramifications is symmetrical (isotons) and tends mainly to verticality.
(T1: primary trunk, T2 e T3: secondary trunks).

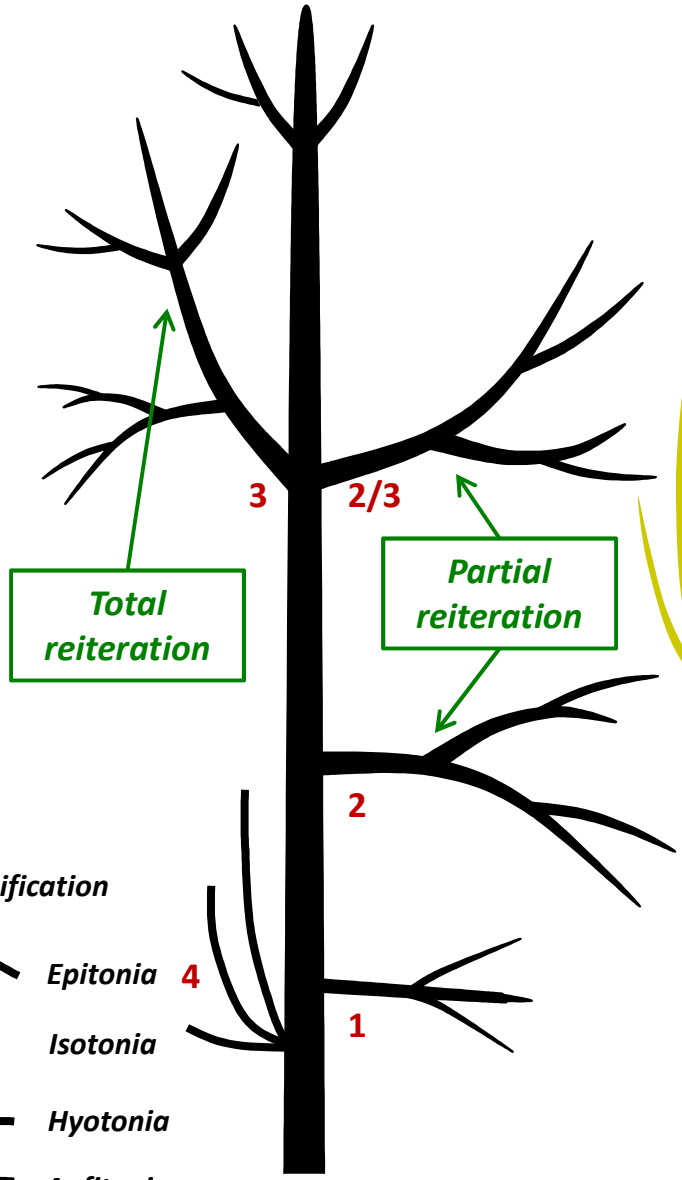
The evolution of the branch in trunk is a physiological process (primary total reiteration) that can occur only when it is still vertical (from B1 to T2).

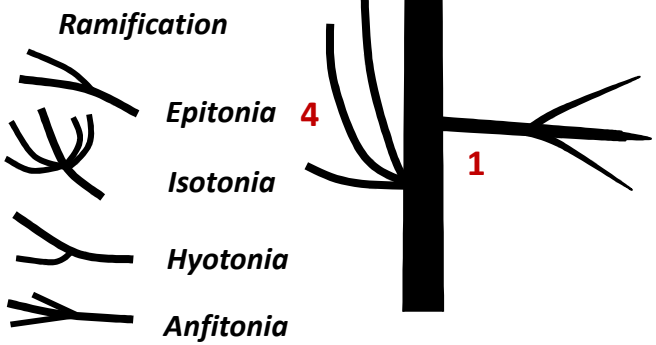
A totally horizontal branch (B2) will be a branch forever. Only hypotonic branches can evolve into trunks, while the epitones, can originate trunks only by total secondary reiteration (B1 to B2 + T3).
The trunks can regress to branches in specific situations (traumas, senescence or bad pruning), in this case becoming forcibly branches, epitonic and plagiotropic (from T2 to B3).

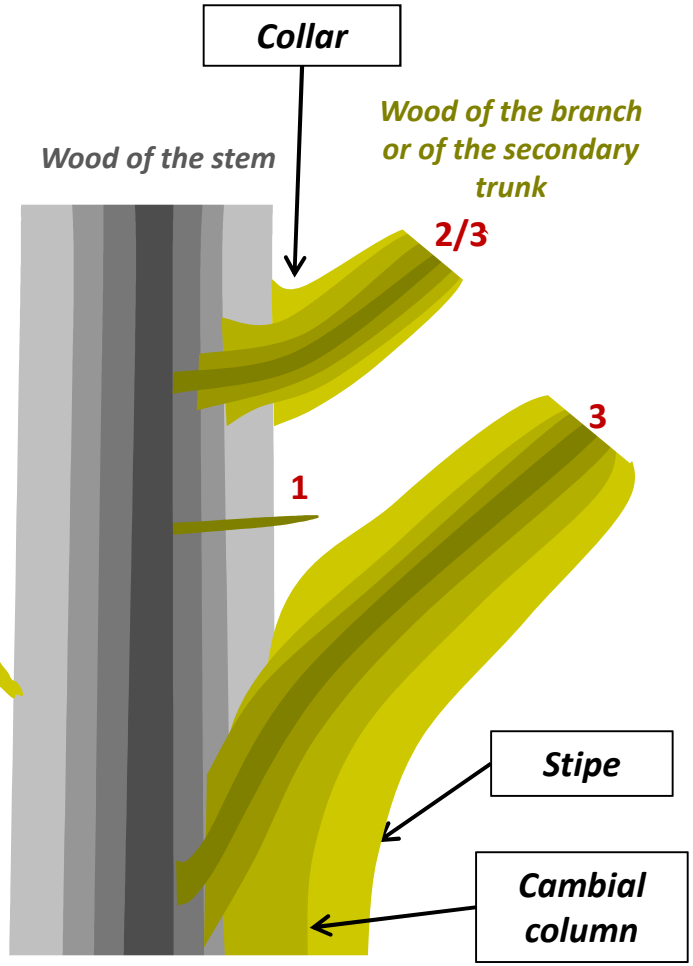
Hierarchy of ramifications and connection with the stem











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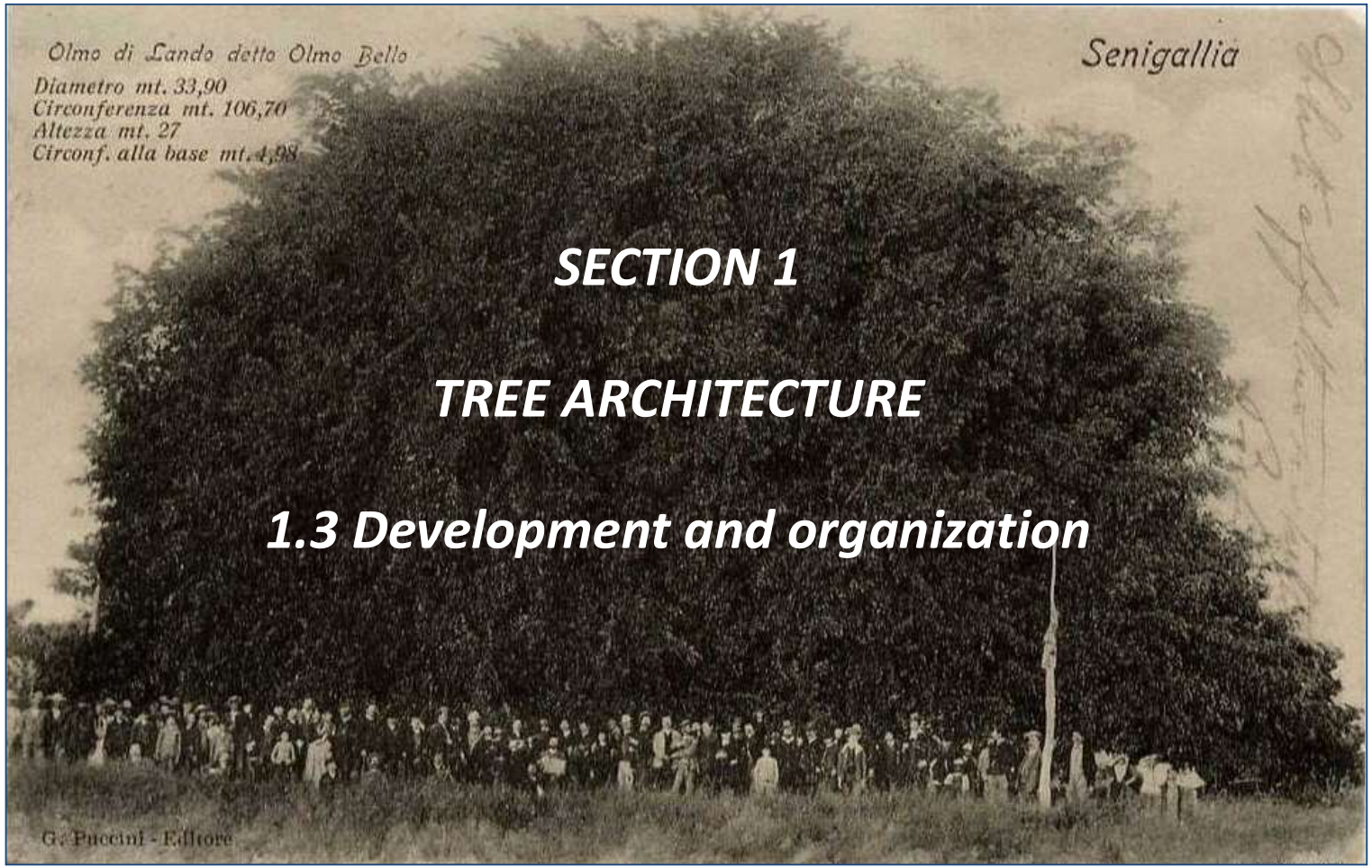
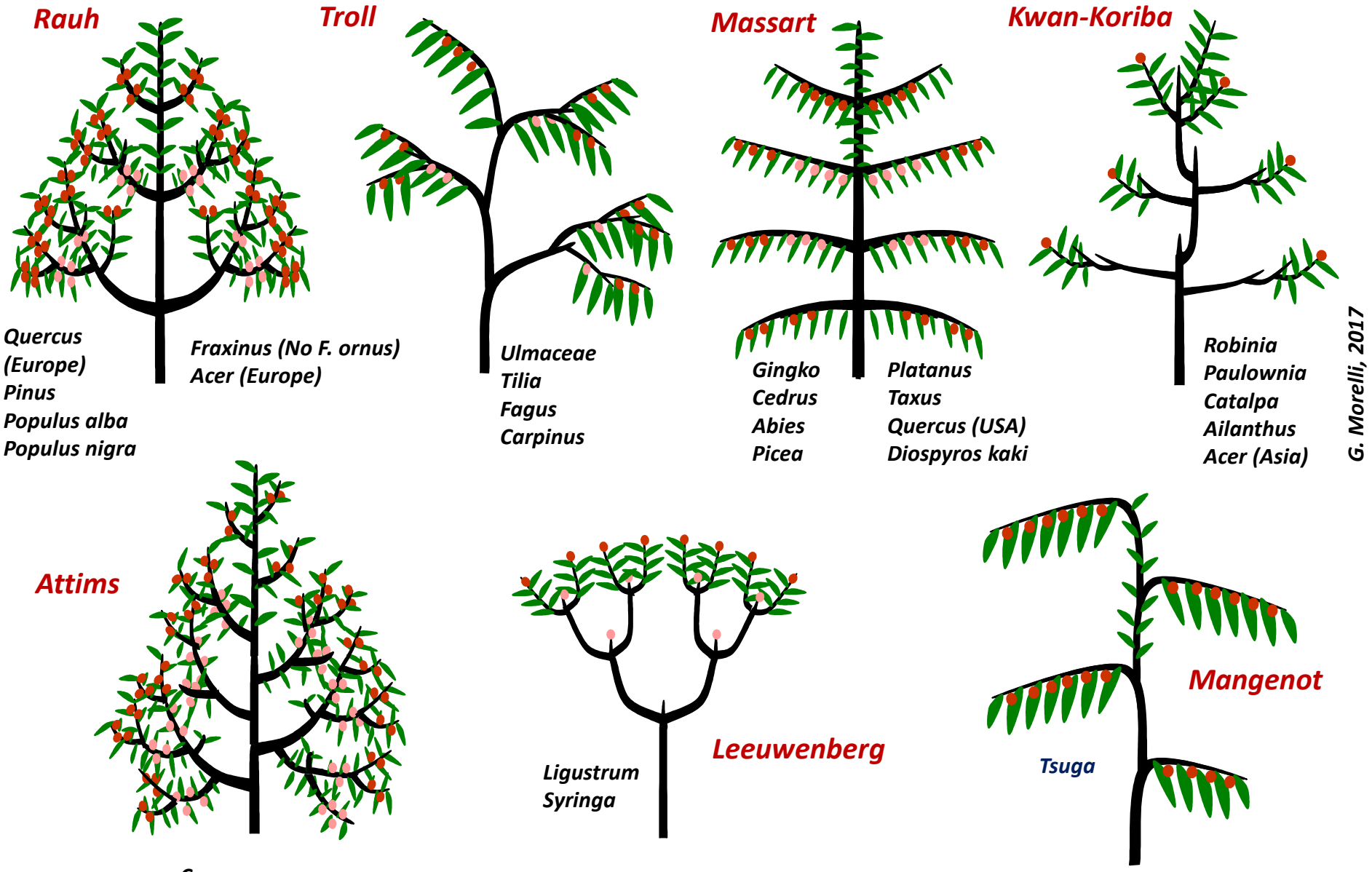


SECTION 1

TREE ARCHITECTURE

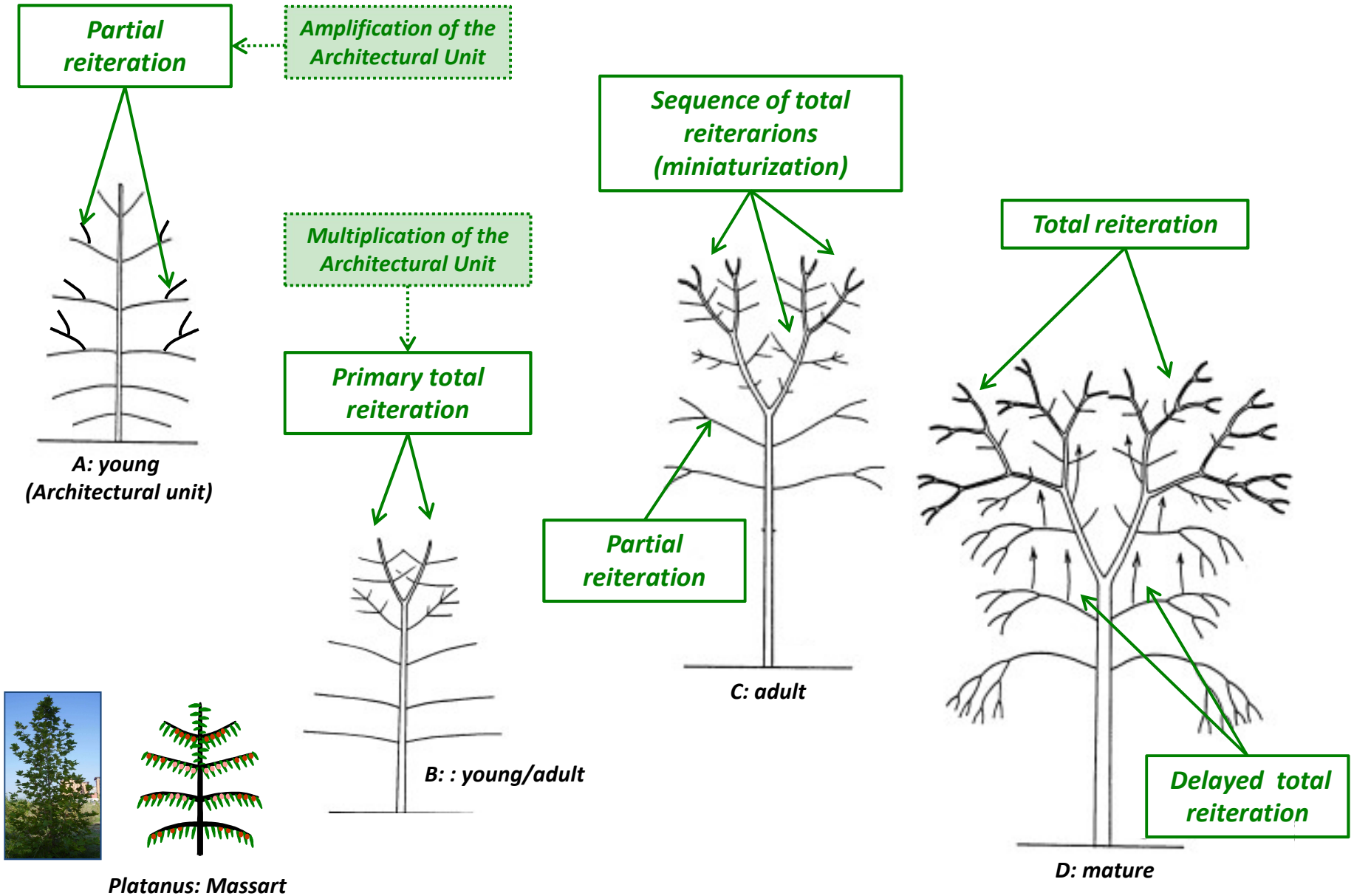
1.3 Development and organization

The "common denominator" of tree architecture: Architectural Models



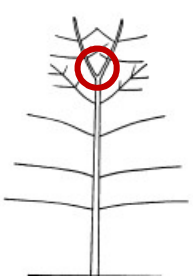
Source: P. Raimbault (from F. Hallé); 2010

Modularity - second level: the architectural unit and the sequence of development

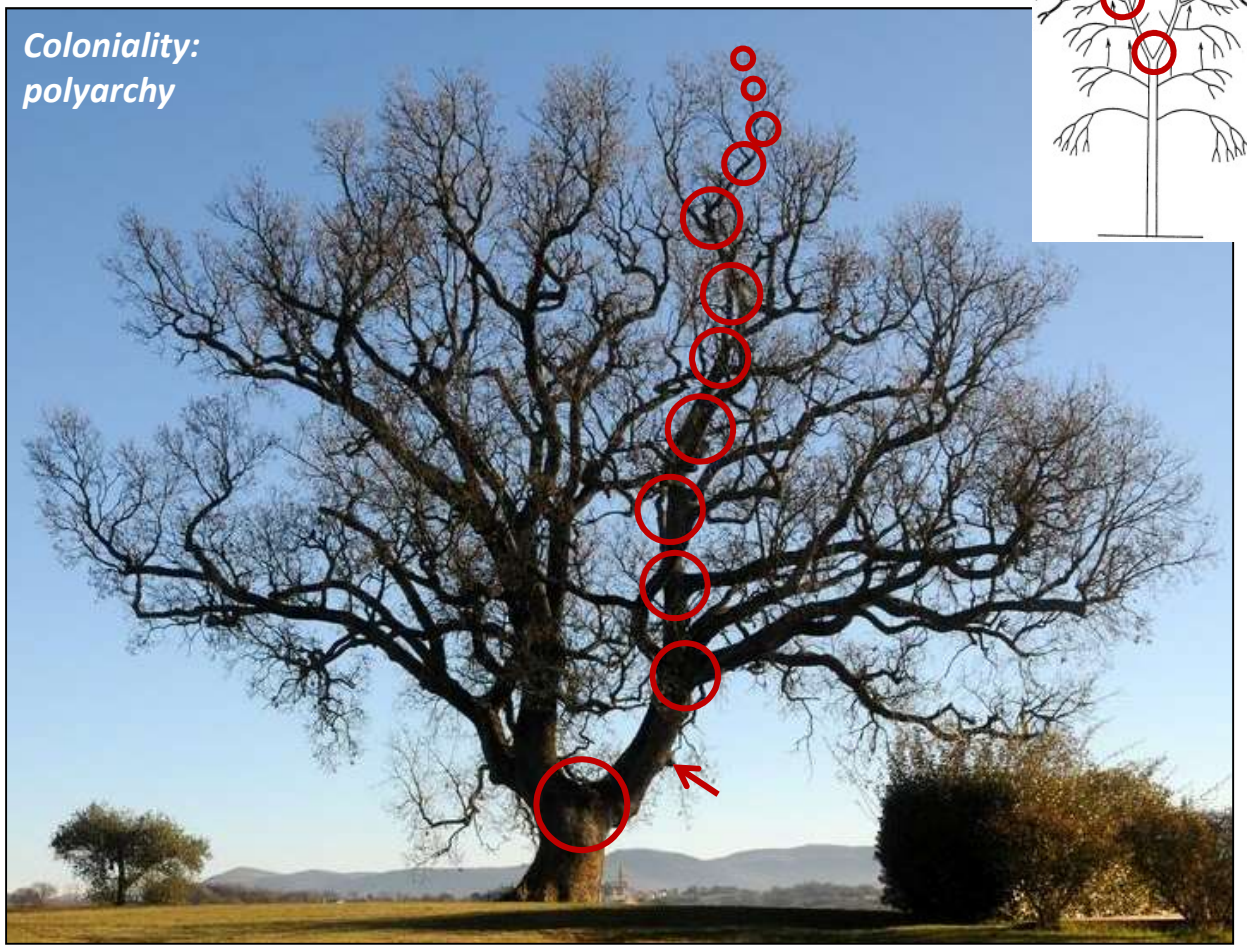


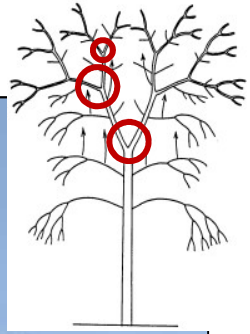
Source: Y. Caraglio

Species growth strategies: gigantism (unitary) or coloniality



Picea abies.
Photo G. Morelli

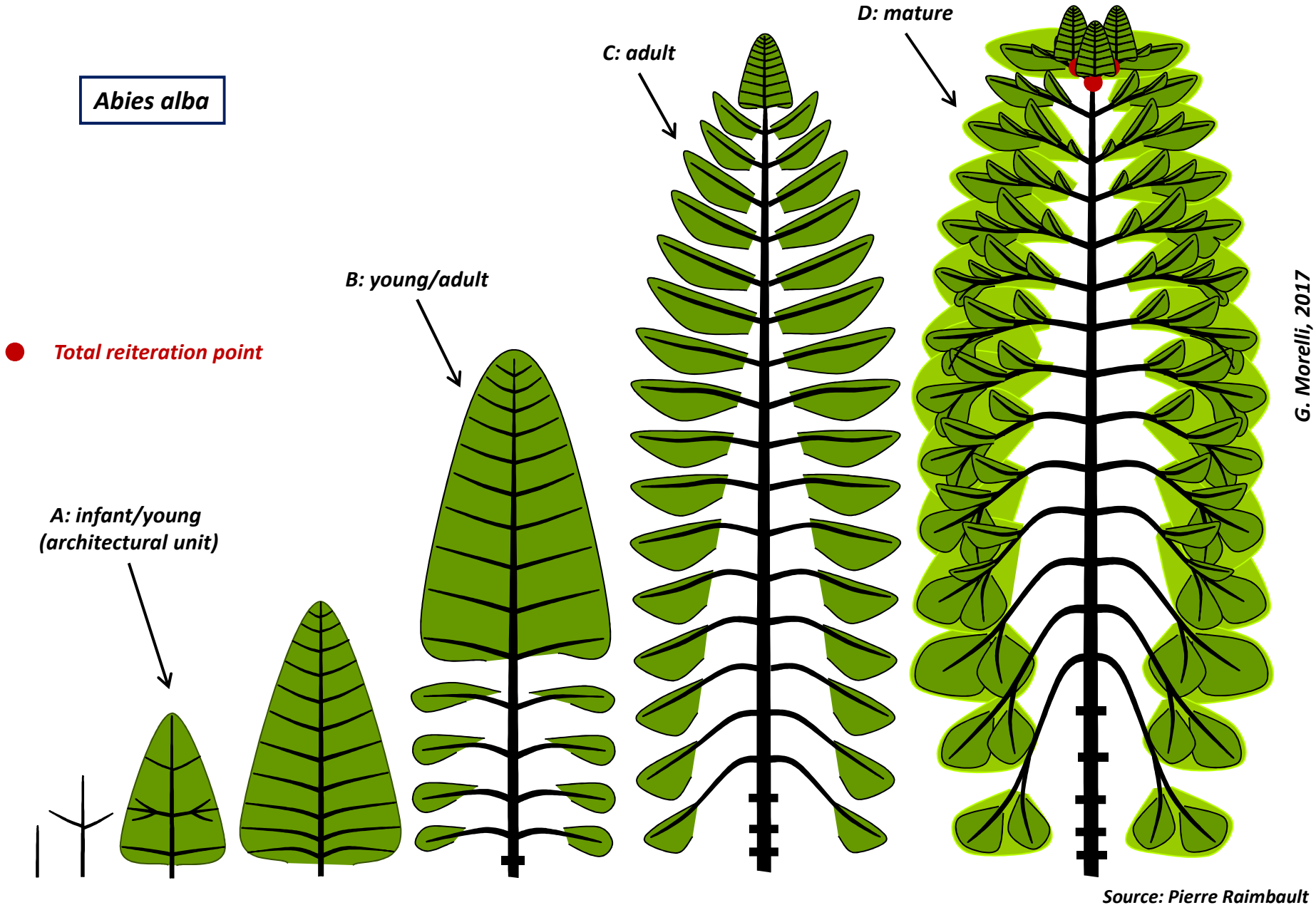




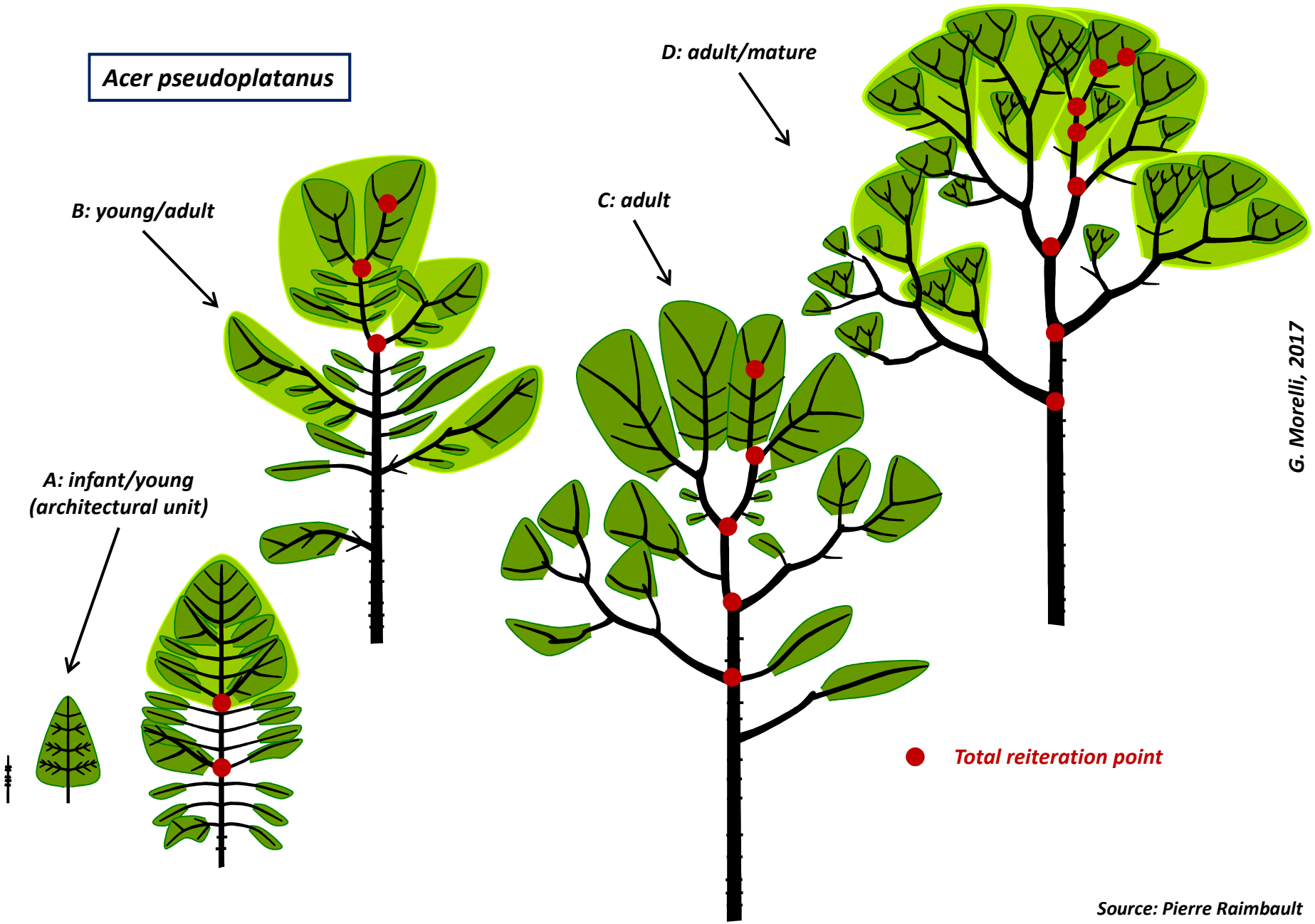
Quercus pubescens. Photo: V. Capodarca

Total reiteration
(temporary or permanent polyarchy)

Species growth strategies: gigantism (hierarchy)



Species growth strategies: amplification (polyarchy)



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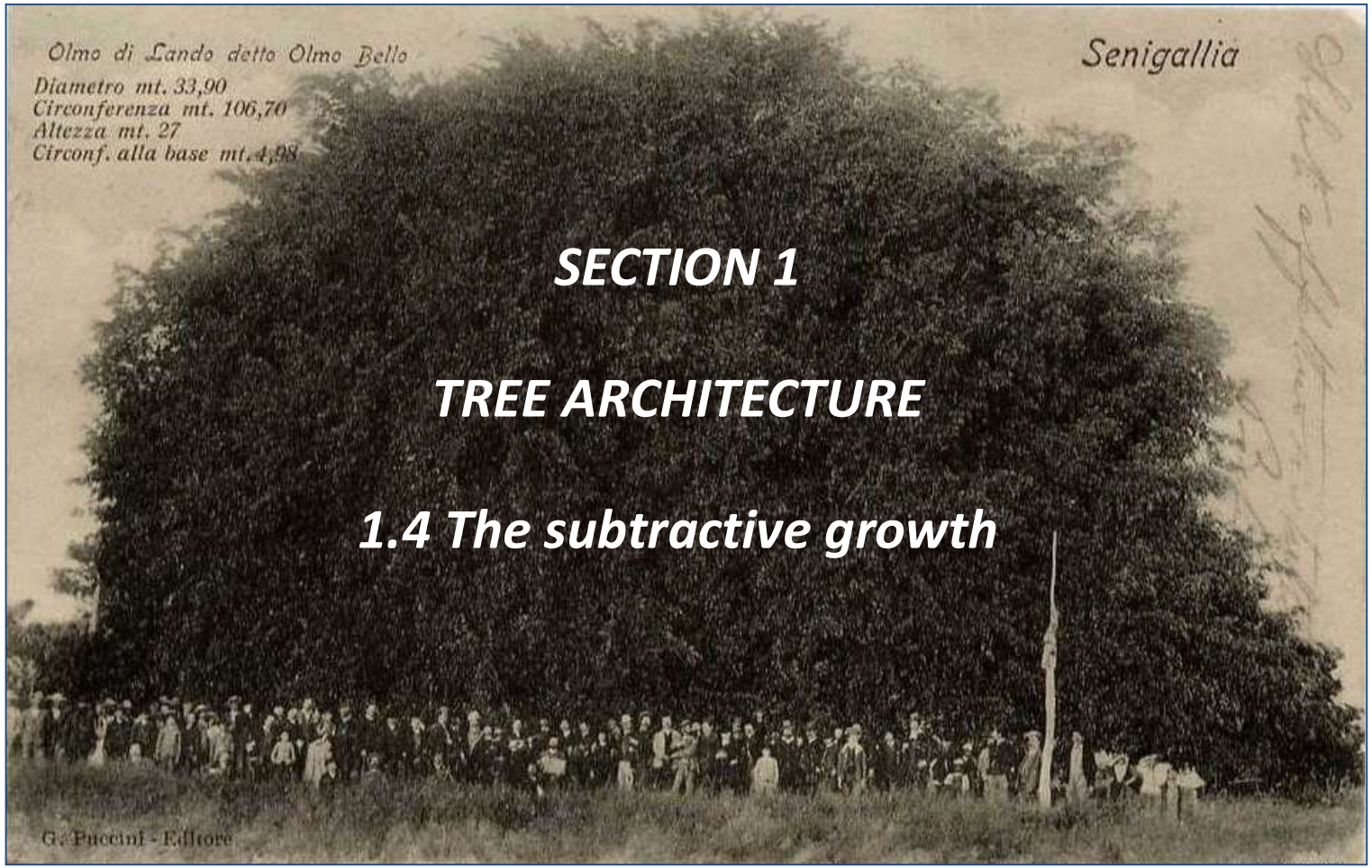
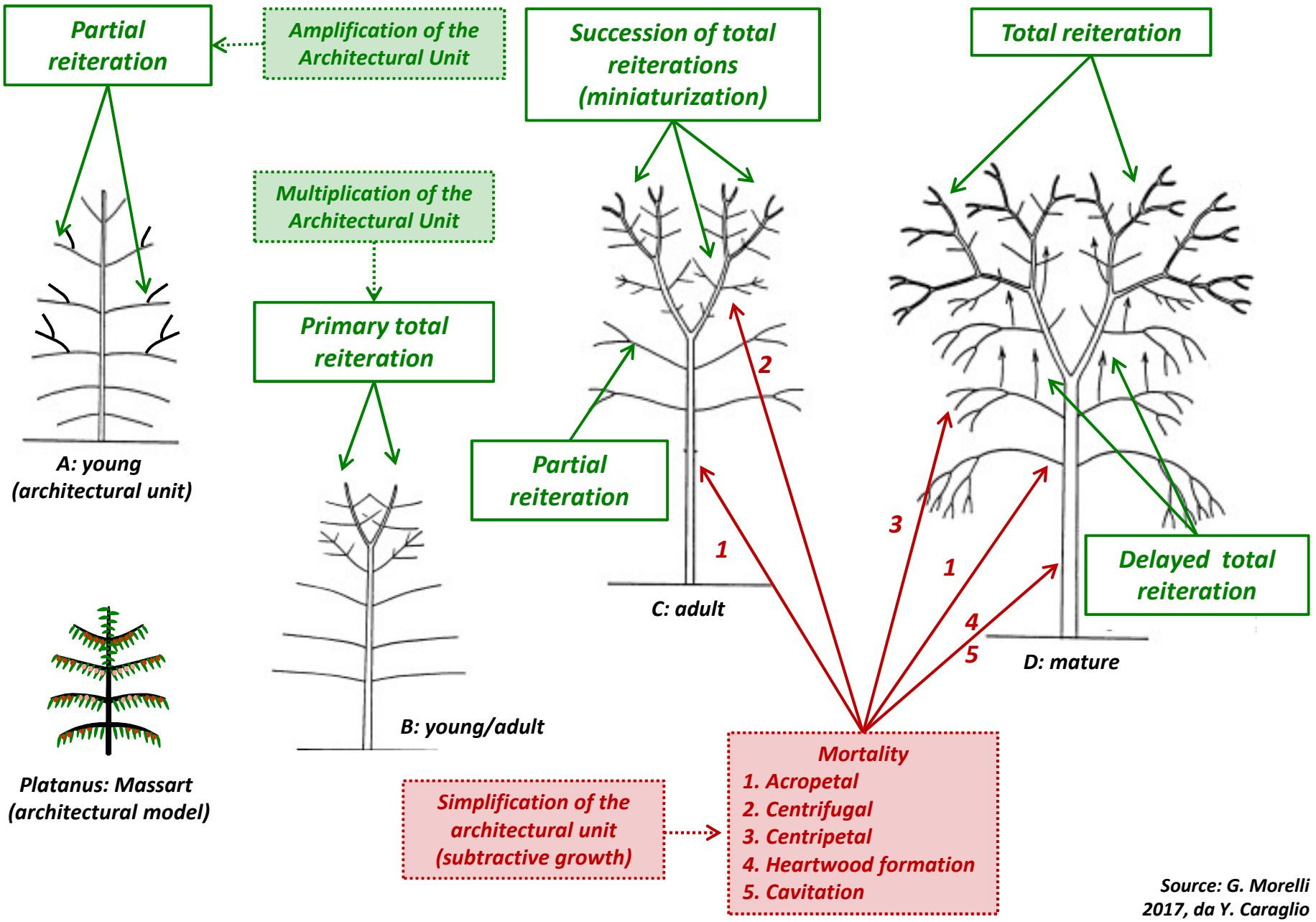


SECTION 1

TREE ARCHITECTURE

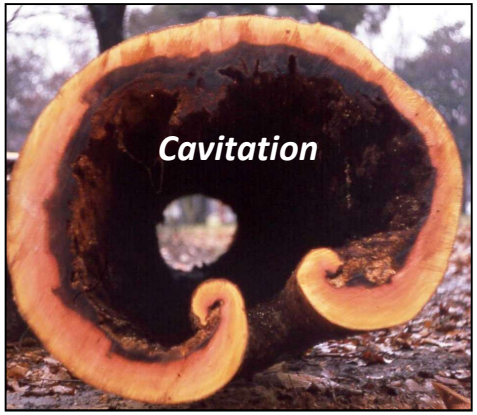
1.4 The subtractive growth

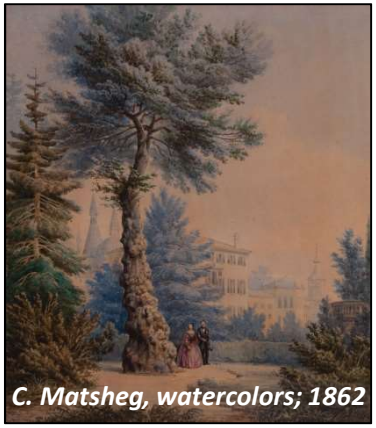
Sequence of development and subtractive growth

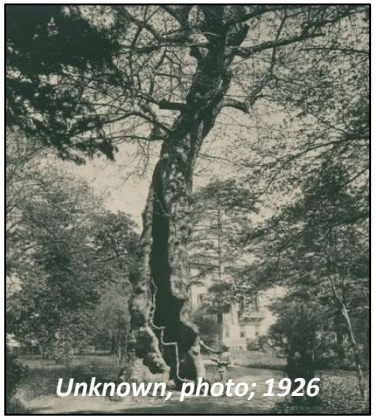


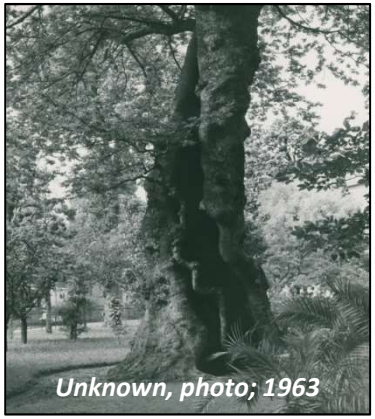
Source: G. Morelli 2017, da Y. Caraglio

Consequences of modularity: the subtractive growth









G. Morelli, 2018

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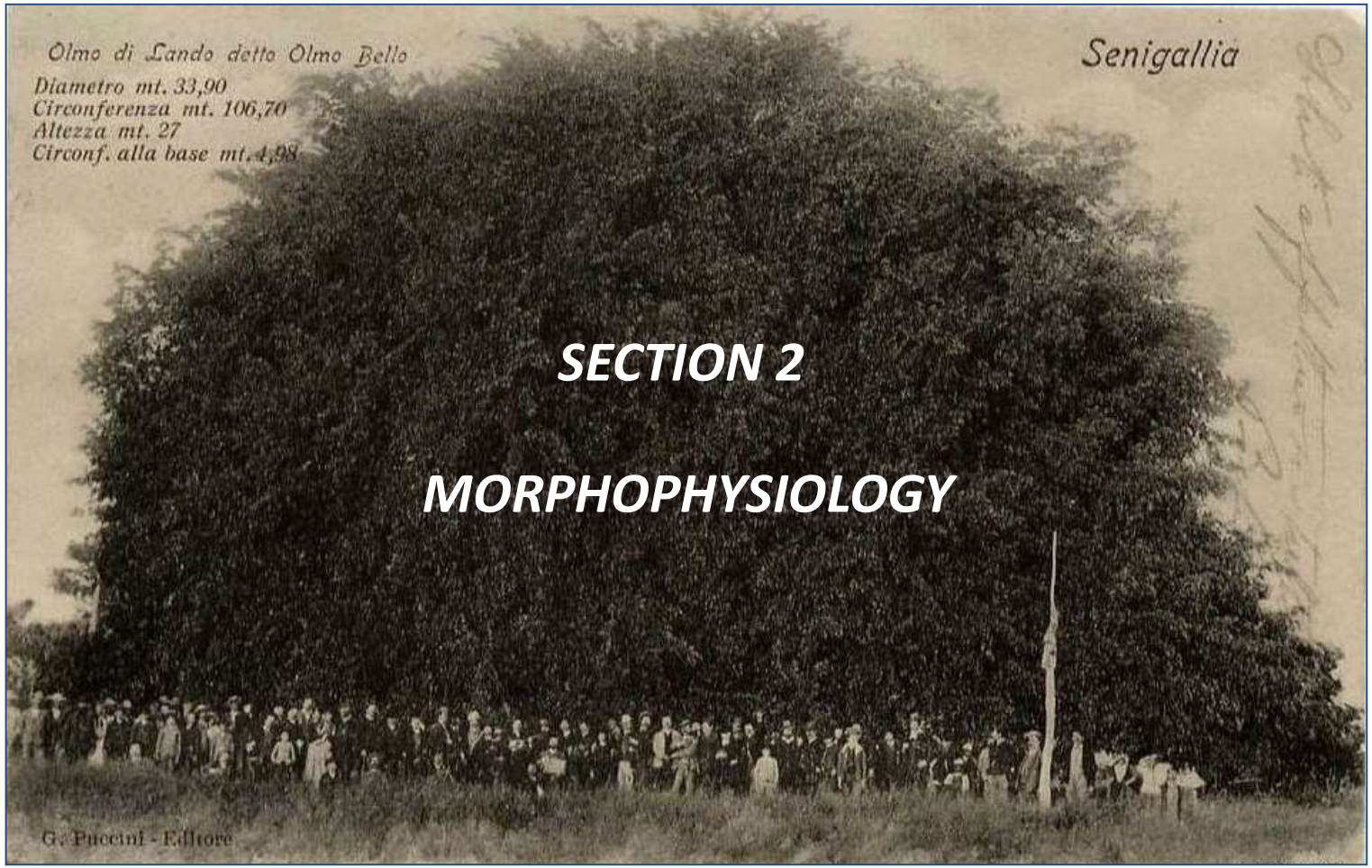
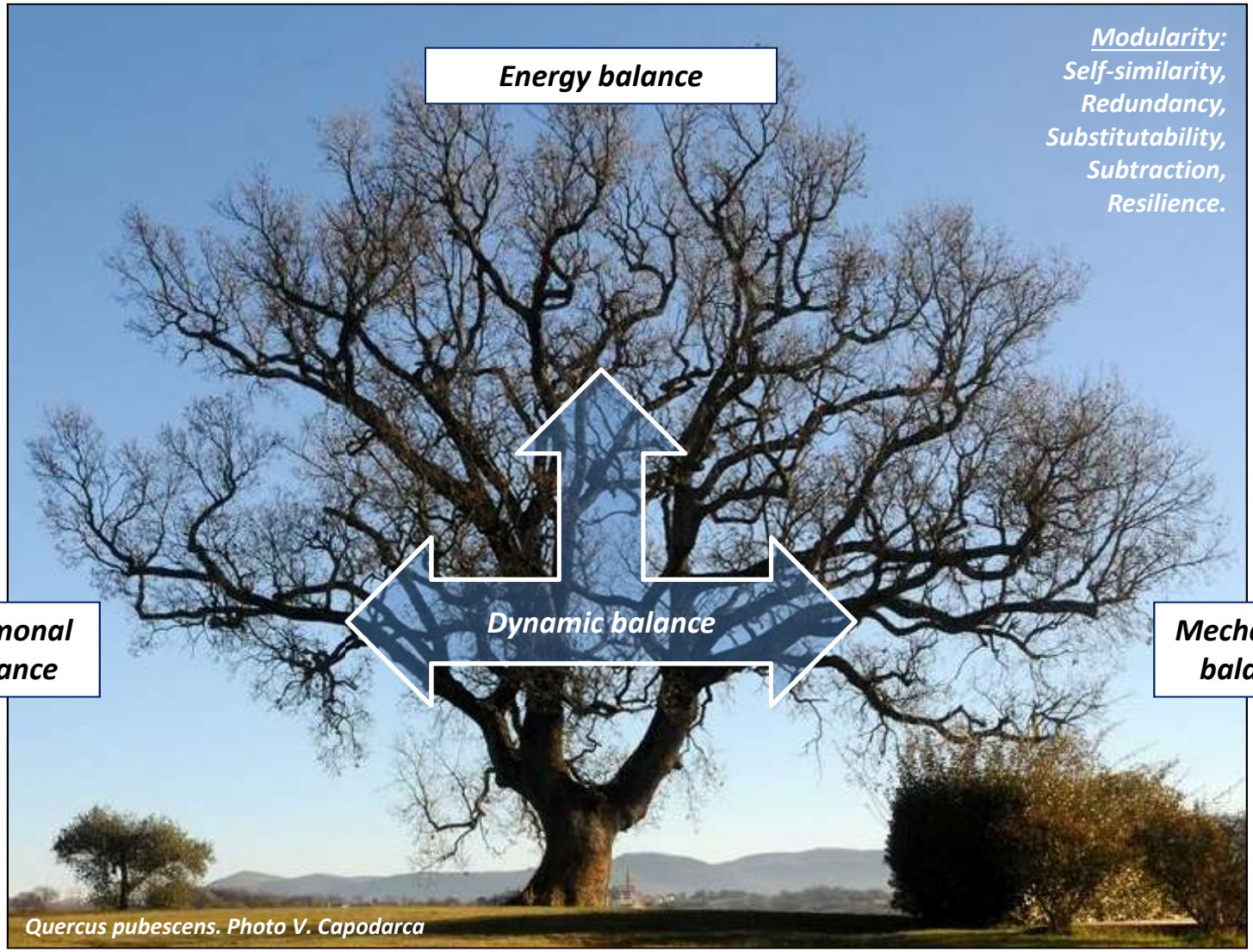


SECTION 2

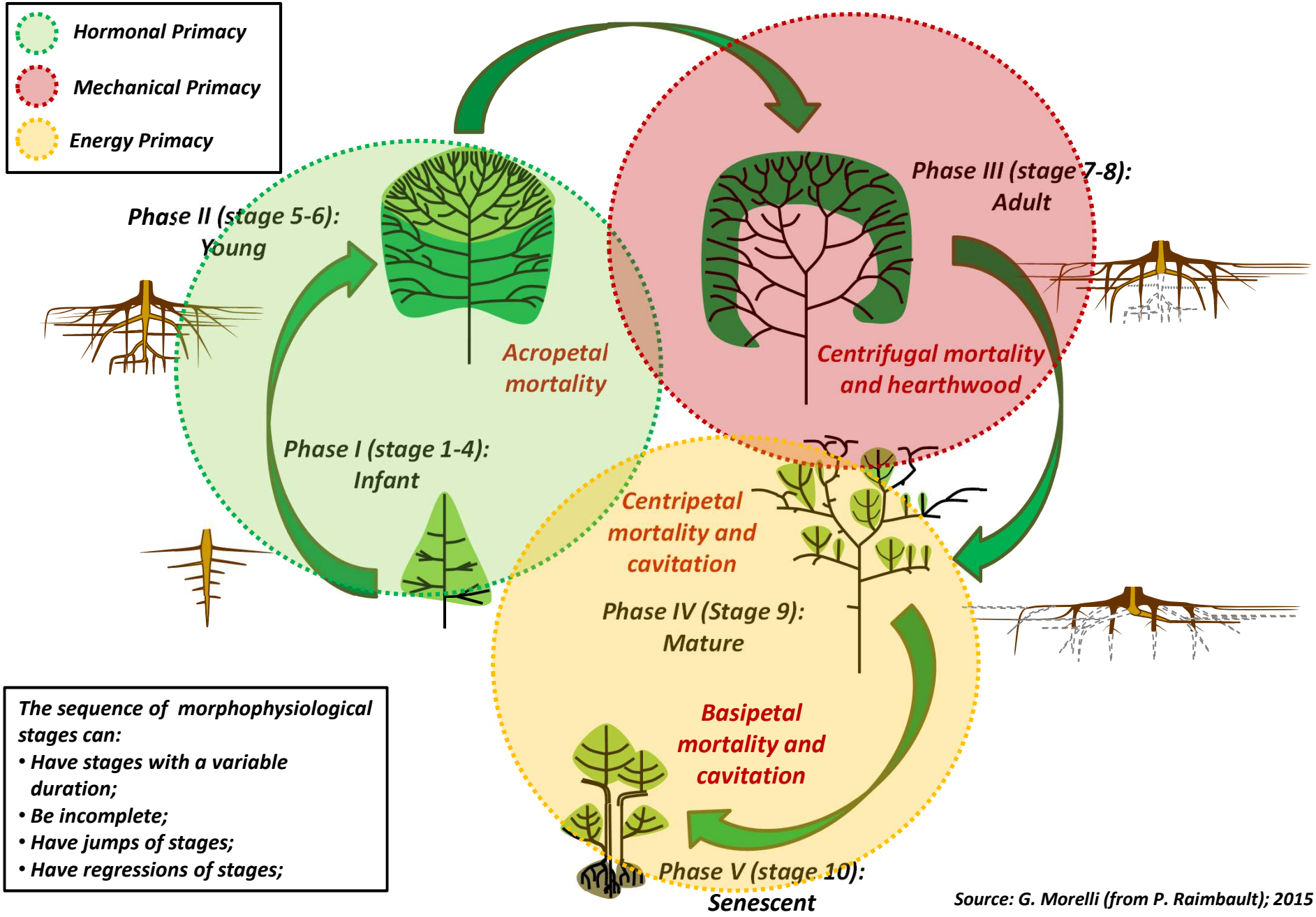
MORPHOPHYSIOLOGY

The form as an expression of a dynamic balance



Source: G. Morelli; 2012

From balance to form: Phases and Stages of development in polyarchy species

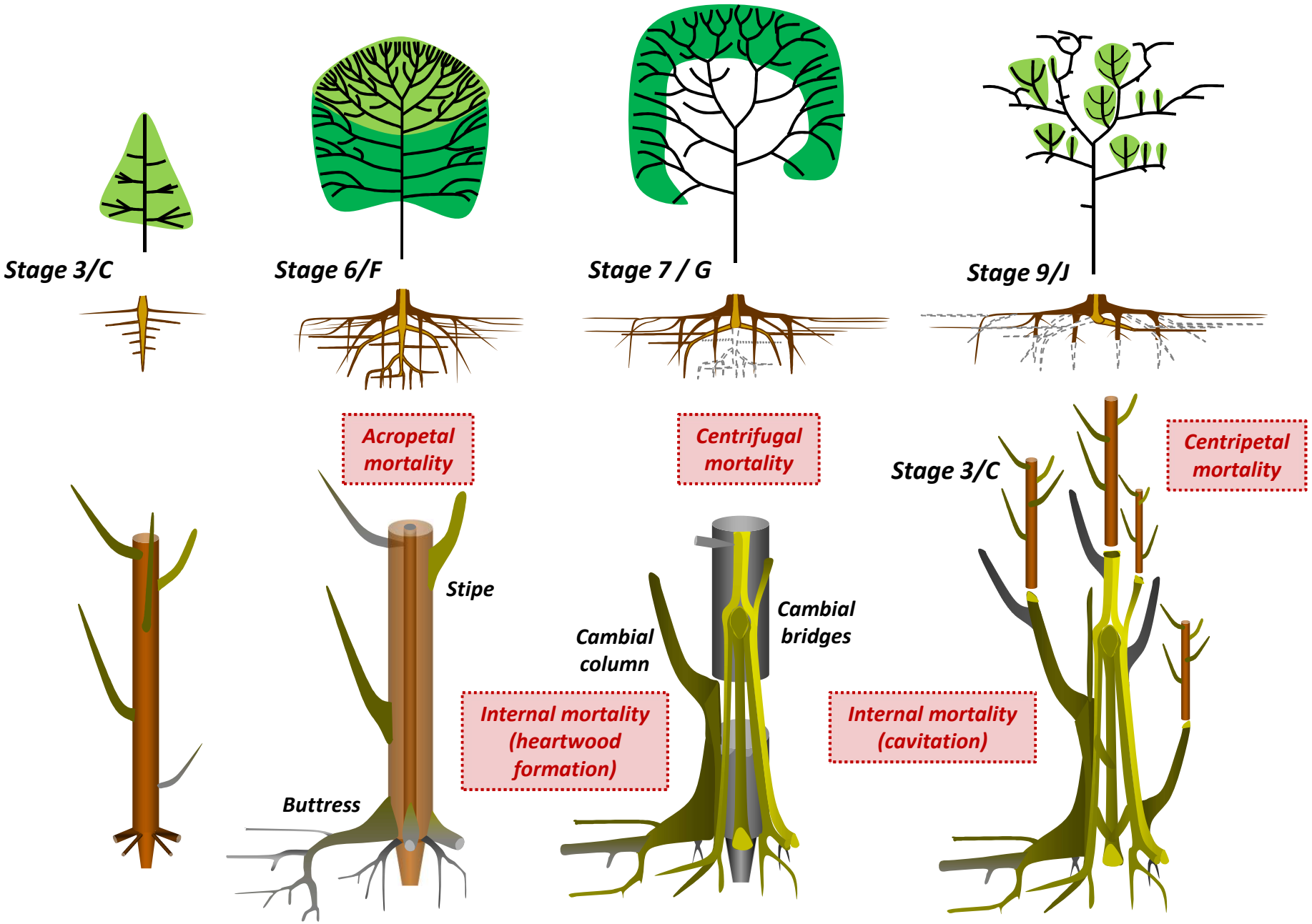


The sequence of morphophysiological stages can:

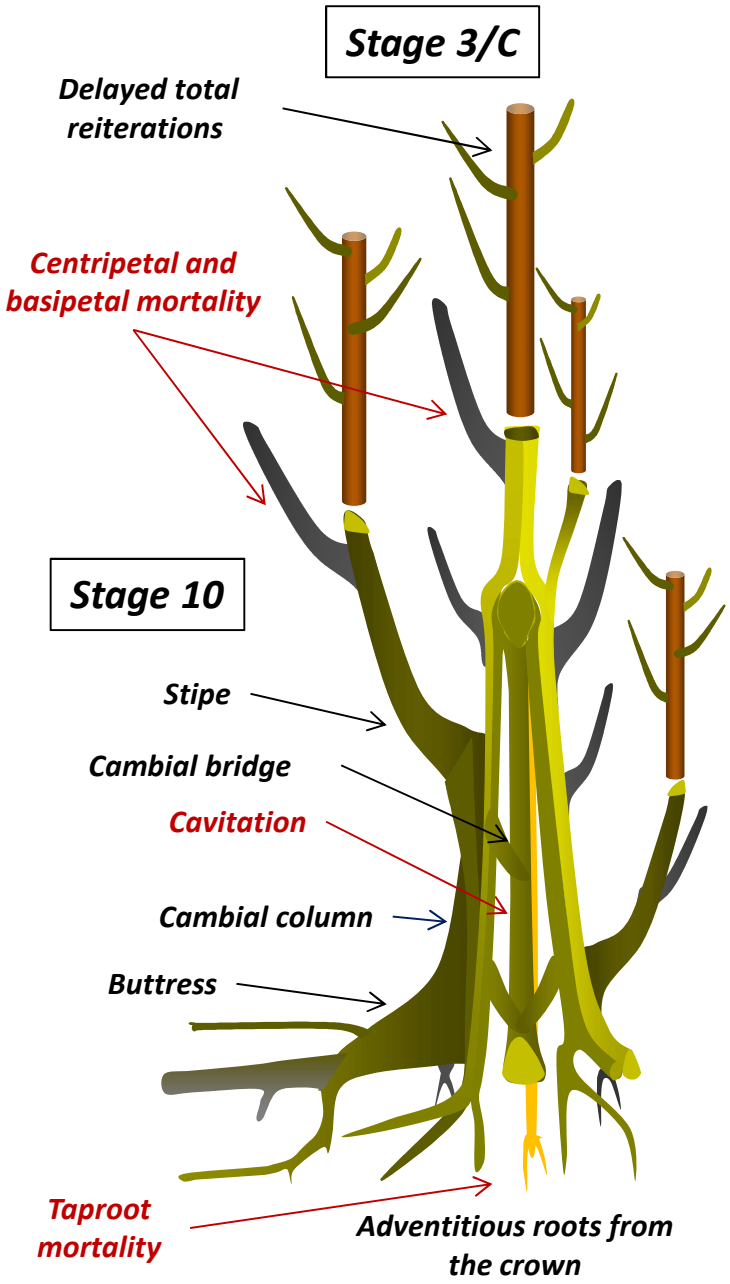
- *Have stages with a variable duration;*
- *Be incomplete;*
- *Have jumps of stages;*
- *Have regressions of stages;*

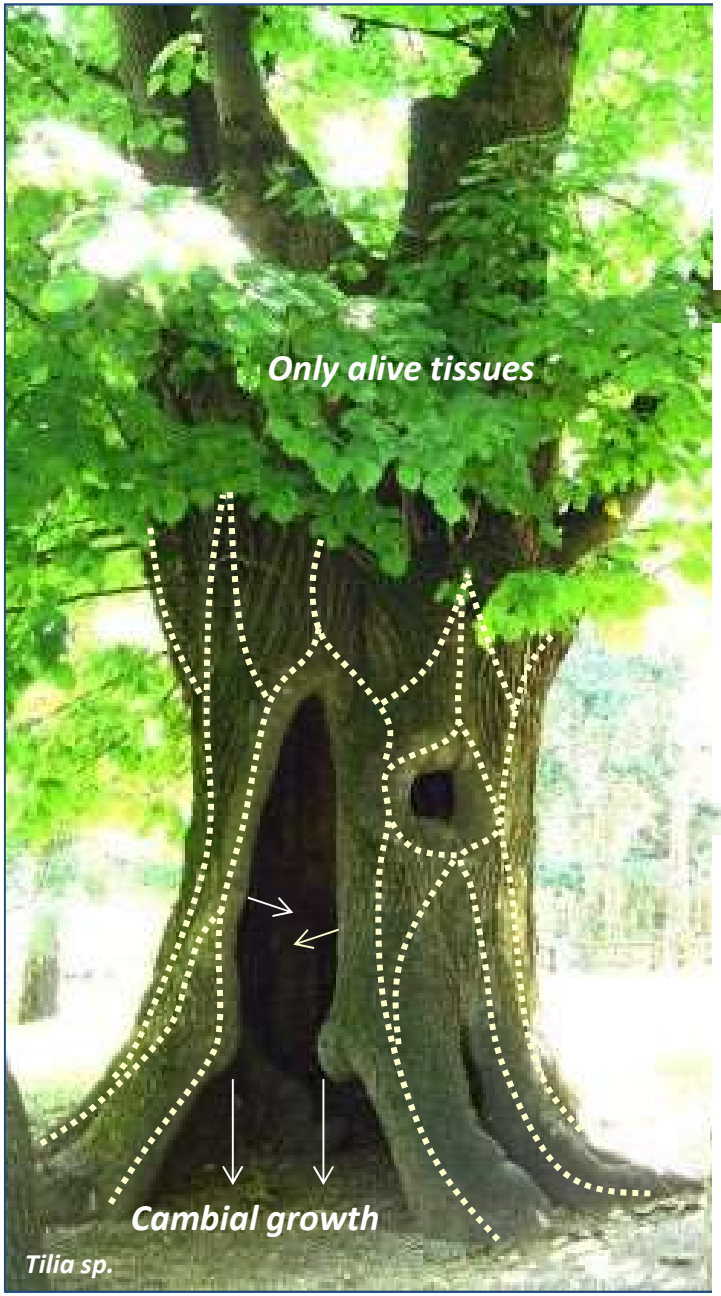
Source: G. Morelli (from P. Raimbault); 2015

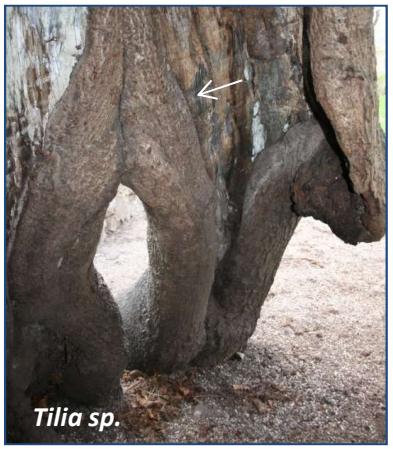
Relationship between crown, stem and roots in polyarchy species



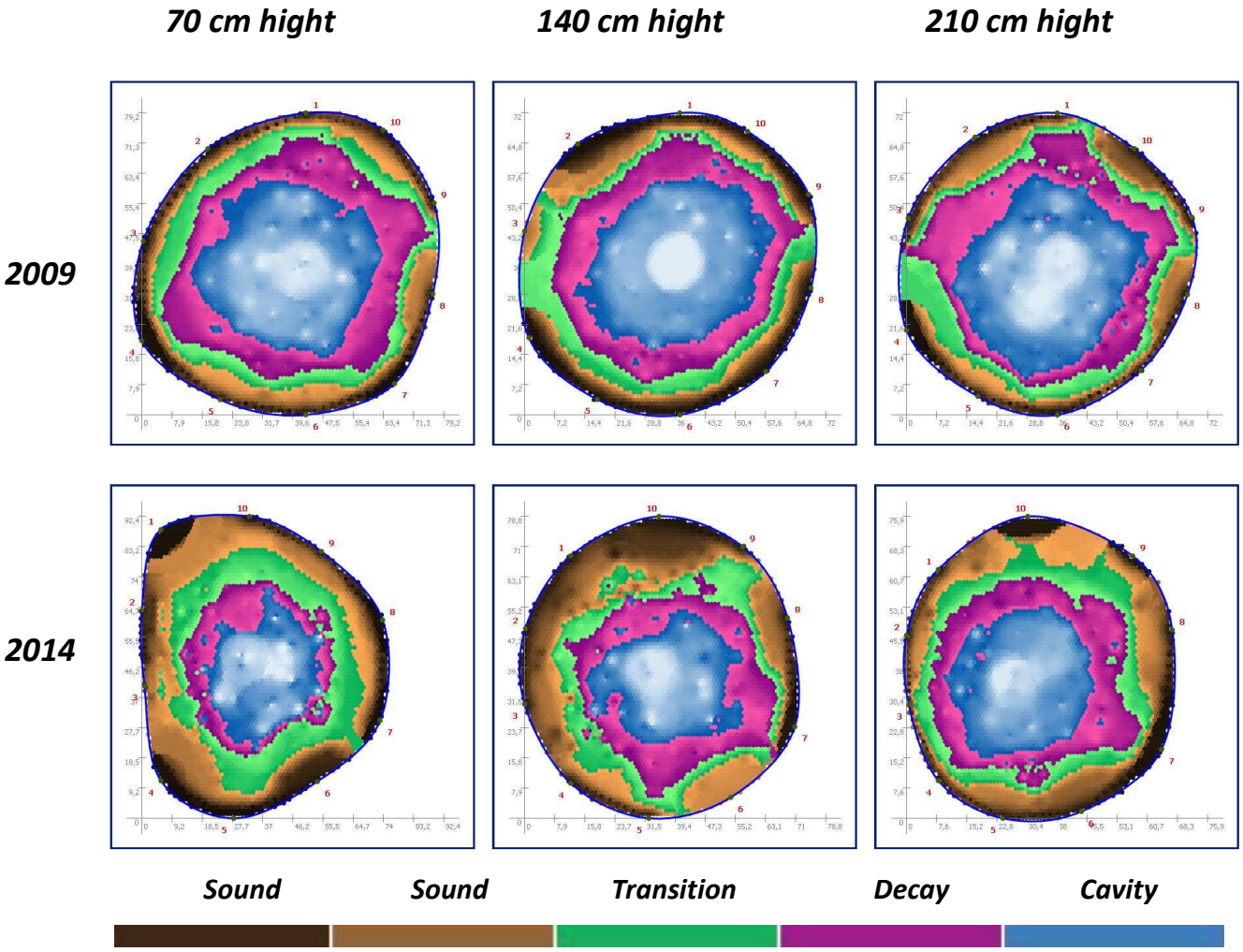
Stage 10 in polyarchy species: the reintegration of the individual



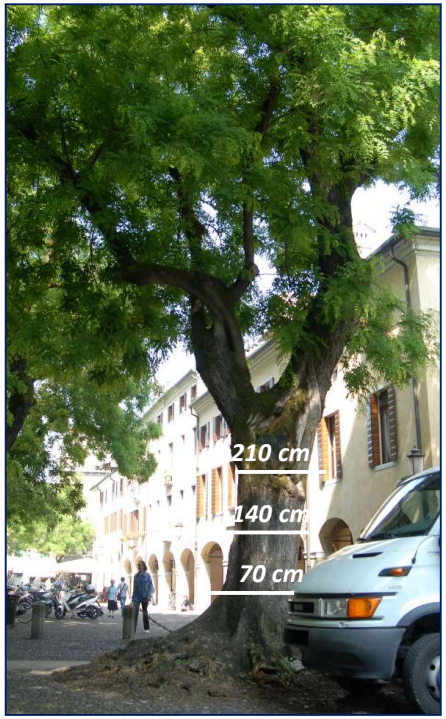




The reintegration of the individual: cavity, cambial columns and cambial bridges



Tomograms of Styphnolobium japonicum; Piazza Capitaniato, Padova



G. Morelli, 2017

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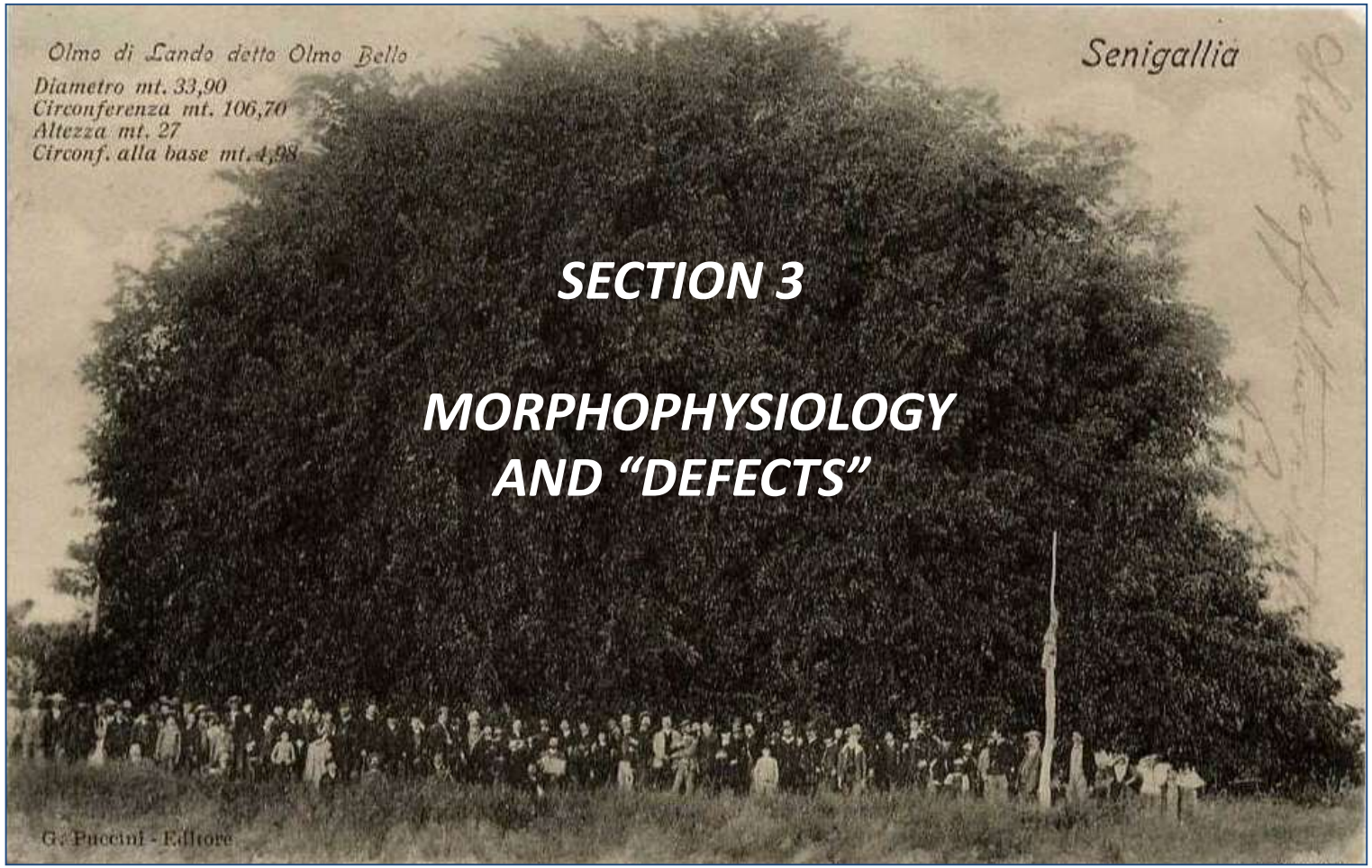


SECTION 3

MORPHOPHYSIOLOGY AND "DEFECTS"

Phenotypic level of the form and «defects»

G. Morelli, 2017

A defect represents any kind of negative difference compared to a perceived norm.
A "structural defect", for a specific context of growth, represents any architectural, morphological, anatomical environmental anomaly able to increase the likelihood of failure.
(Morelli 2016. From National Tree Safety Group)

The ambiguity of the defect: What about cavity?



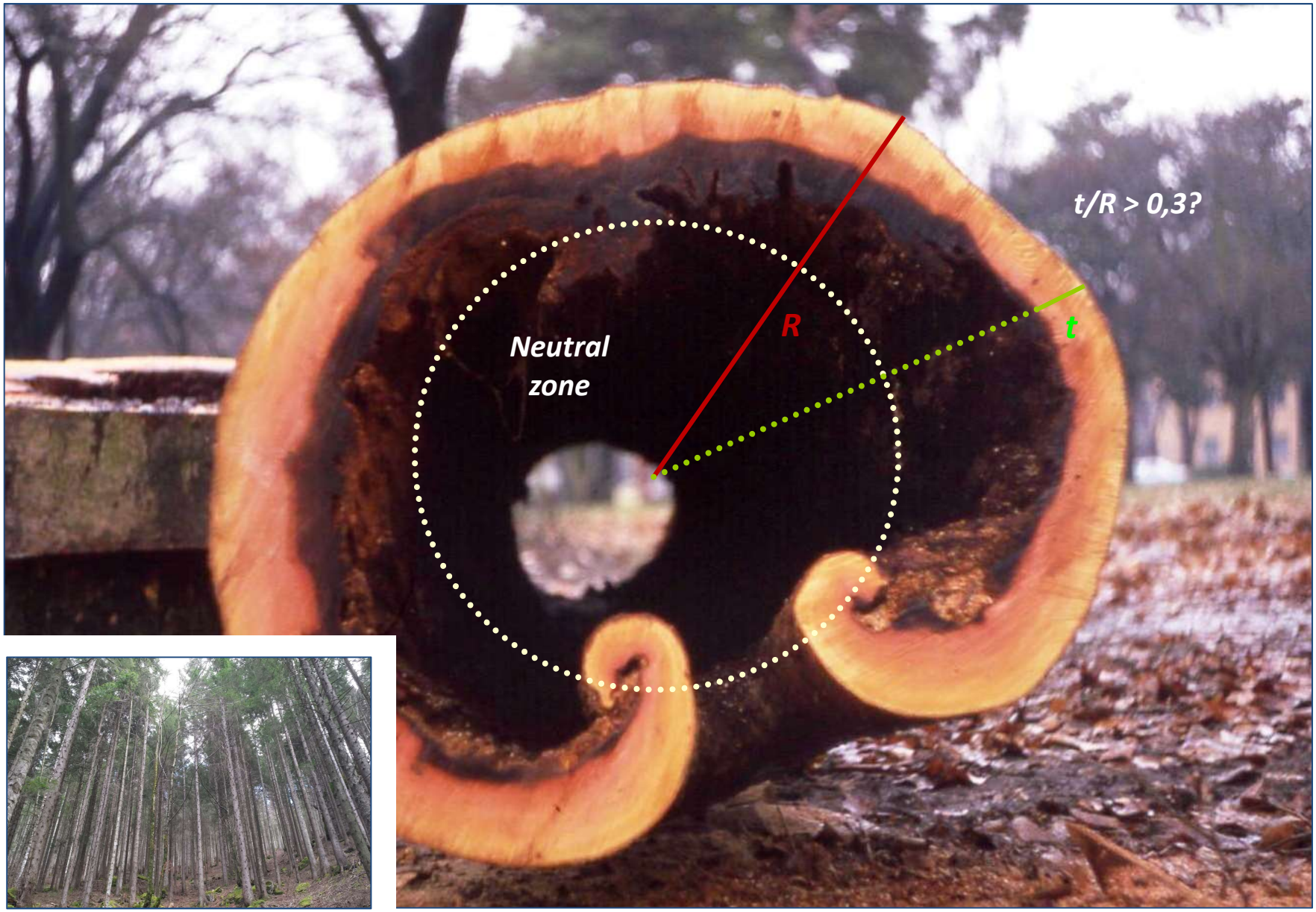





G. Morelli, 2017

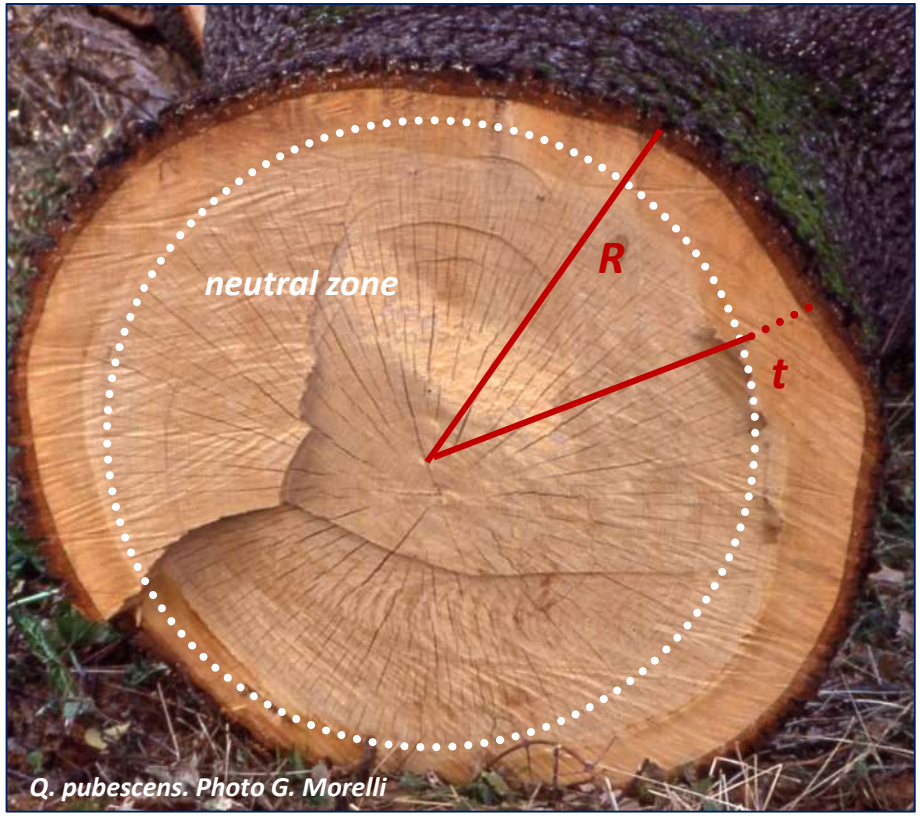
Source: Google

To stand up: the art of cavitation

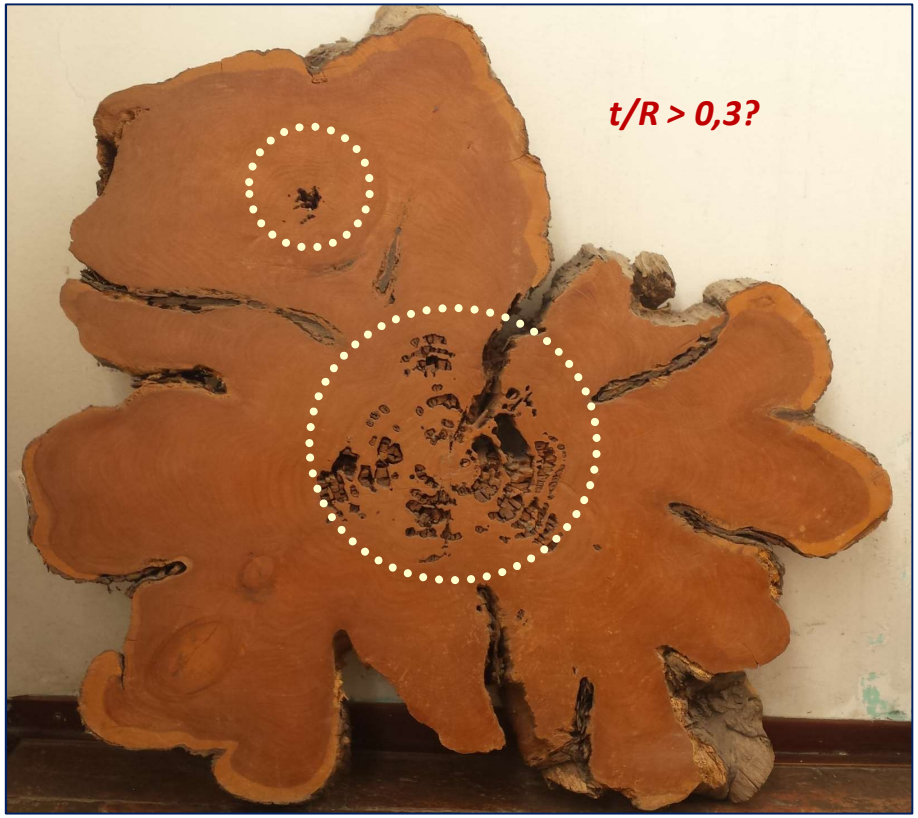


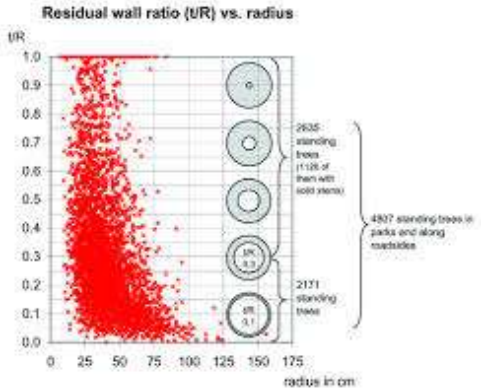
Tree as a pole...

Structural implications of morphophysiological evolution of the stem



Q. pubescens. Photo G. Morelli





Source K. Mattheck


P. abies. Photo G. Morelli

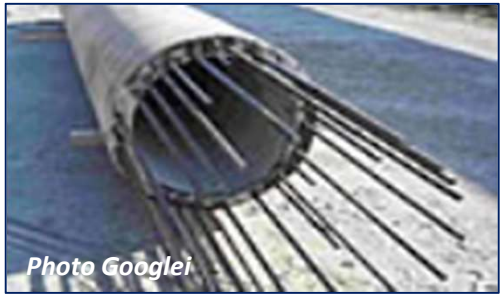
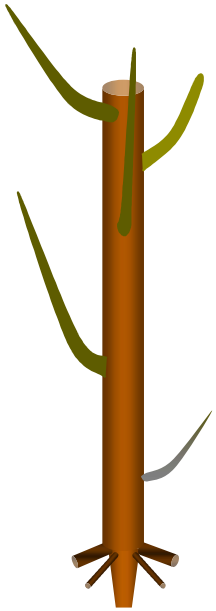
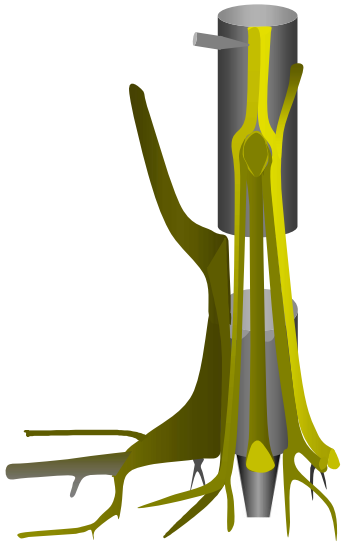


Photo Googlei

Structural implications of morphophysiological evolution of the stem

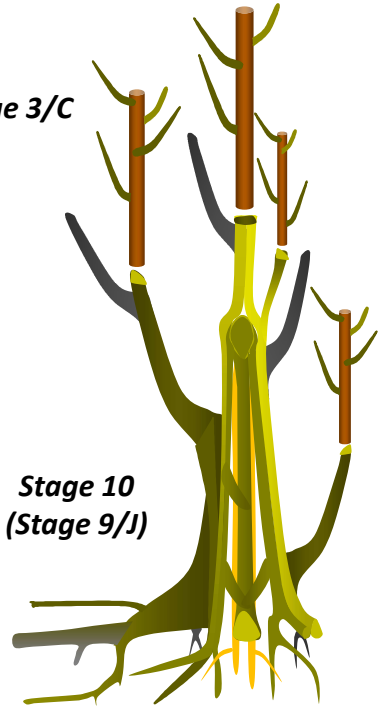
Structural implications of morphophysiological evolution of the stem

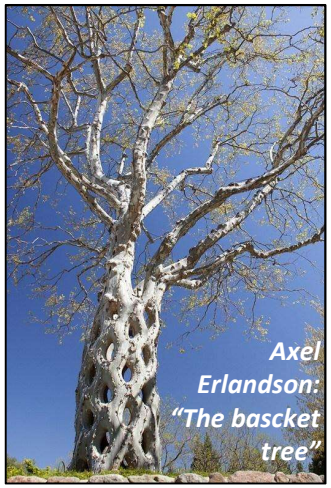




Stage 3/C

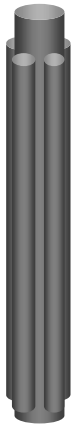
Stage 10
(Stage 9/J)



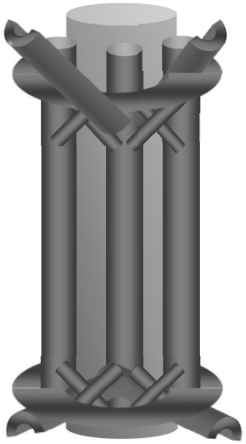


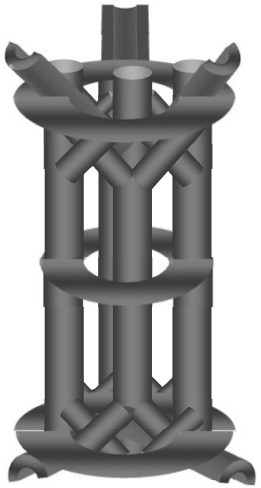
Stage 5/E

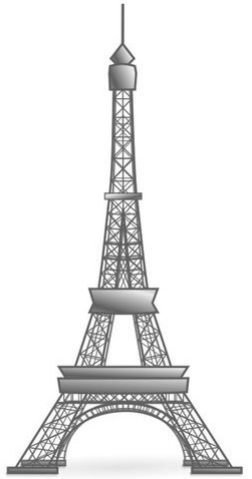
Stage 6/F



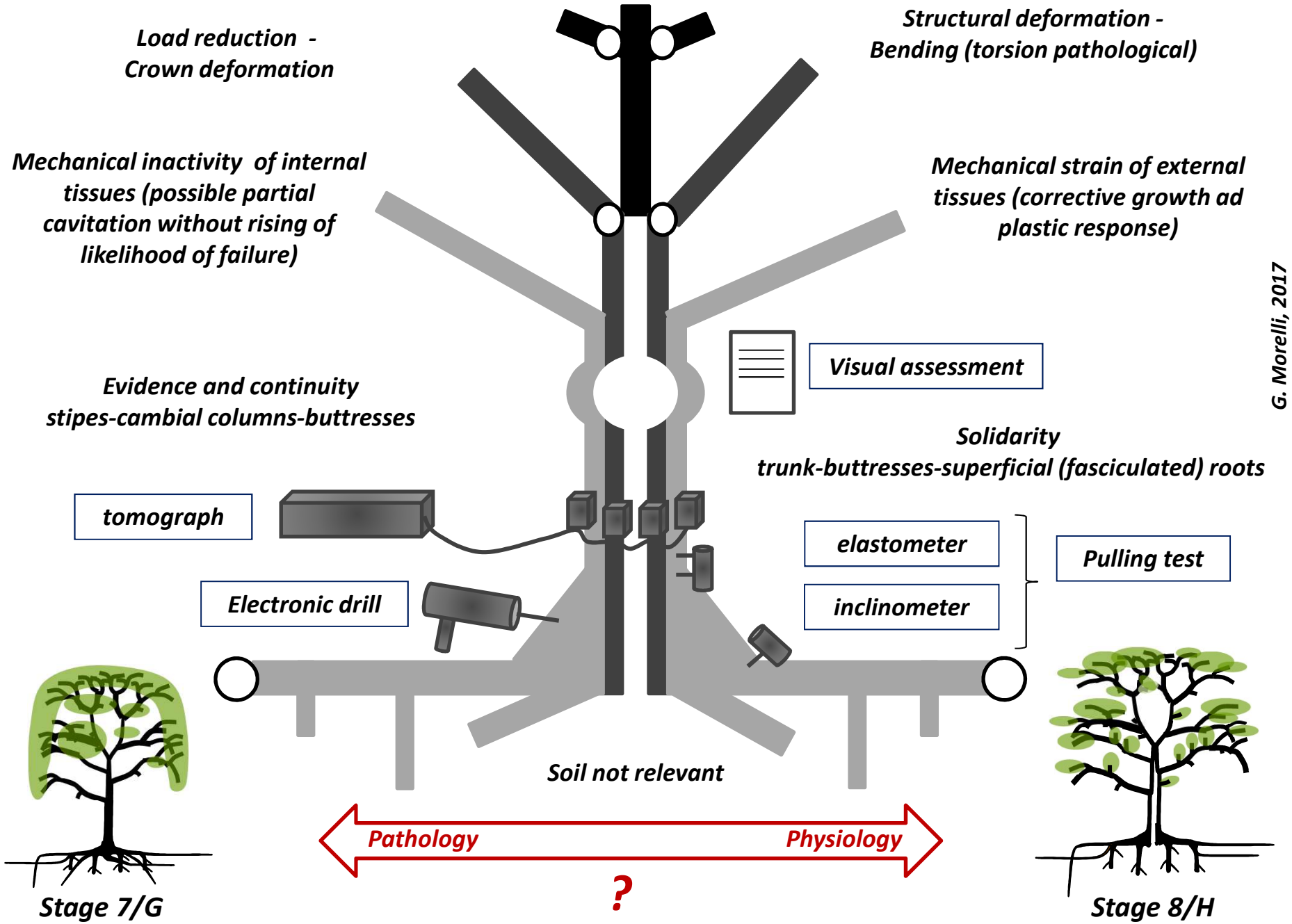
Stage 8 (9)/ H (J)







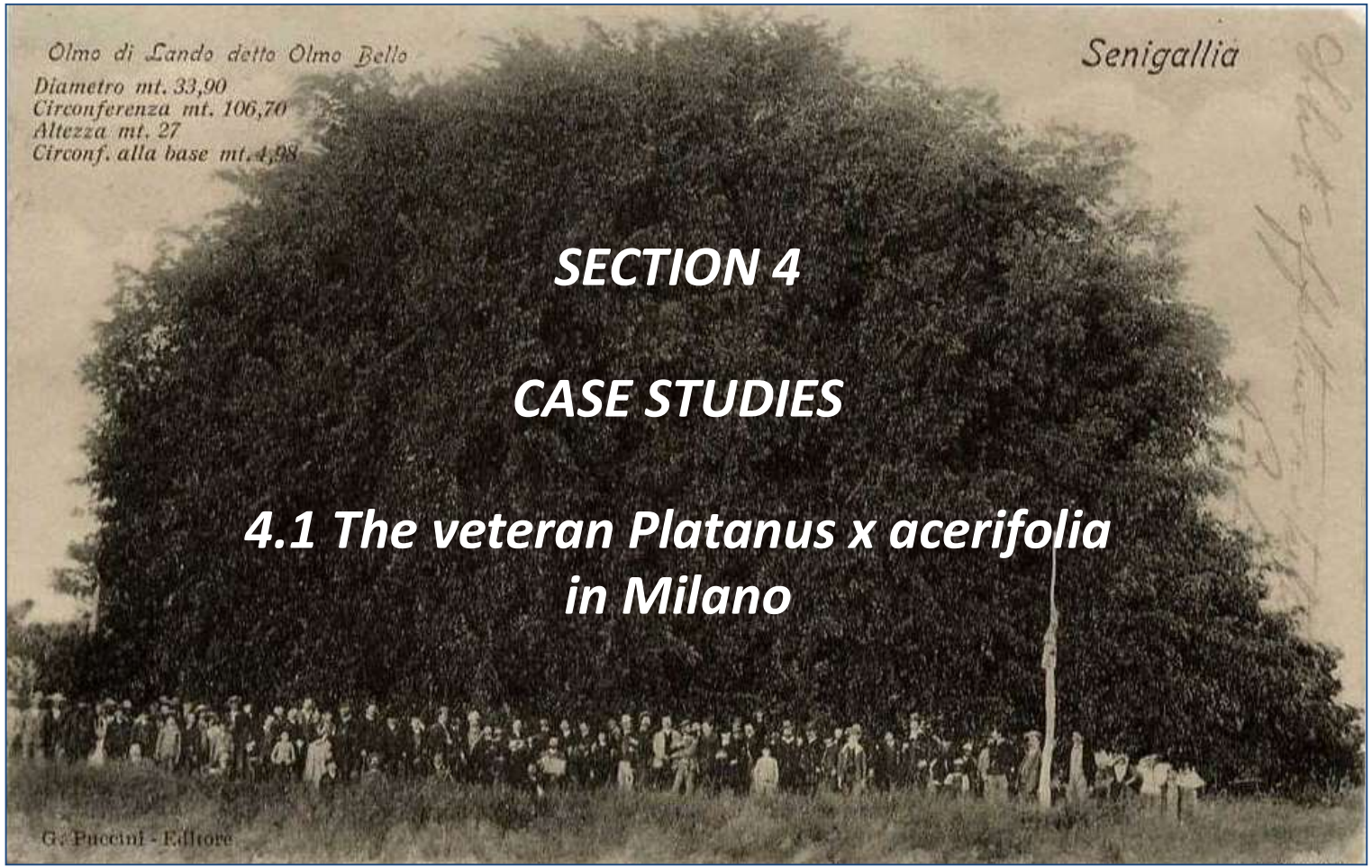
From the defects to the stability assessment in polyarchical species trees



Crown & Canopy Management

Working with nature

8-11 September 2019 Exeter, UK

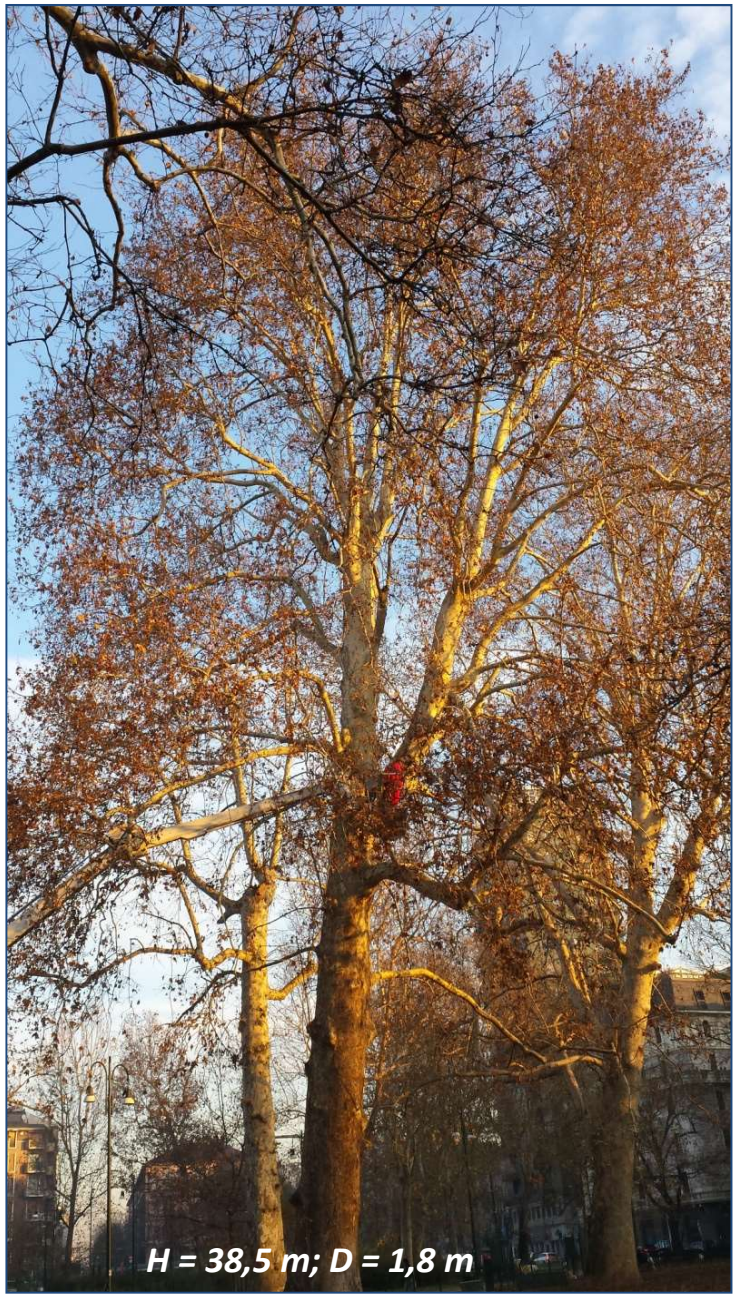


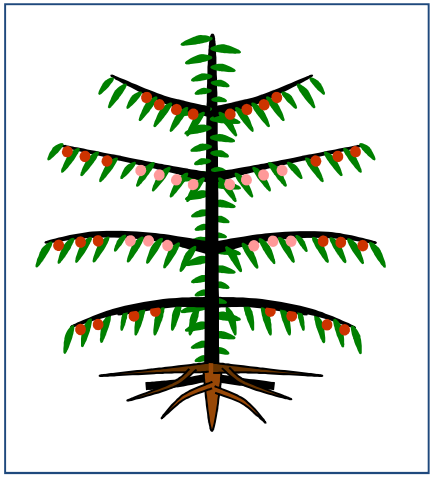
SECTION 4

CASE STUDIES

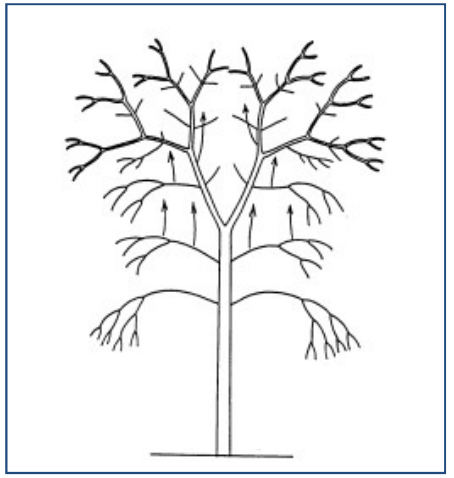
4.1 The veteran Platanus x acerifolia in Milano

The philogenetic level, ontogenetic level of the form and morphophysiology

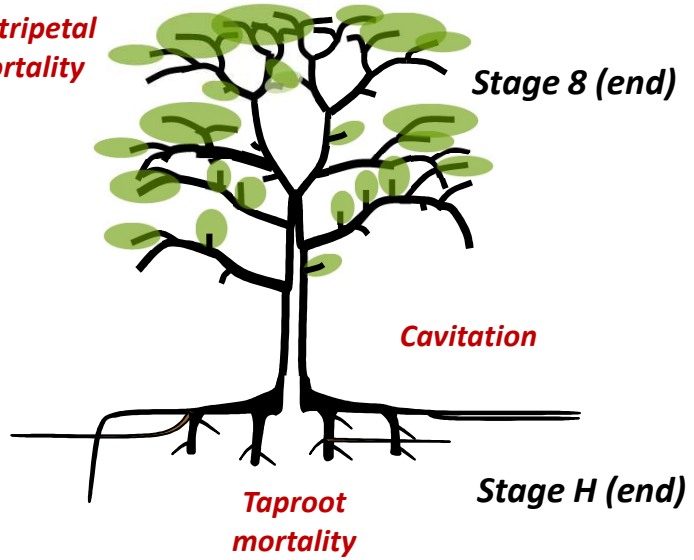




Massart Model

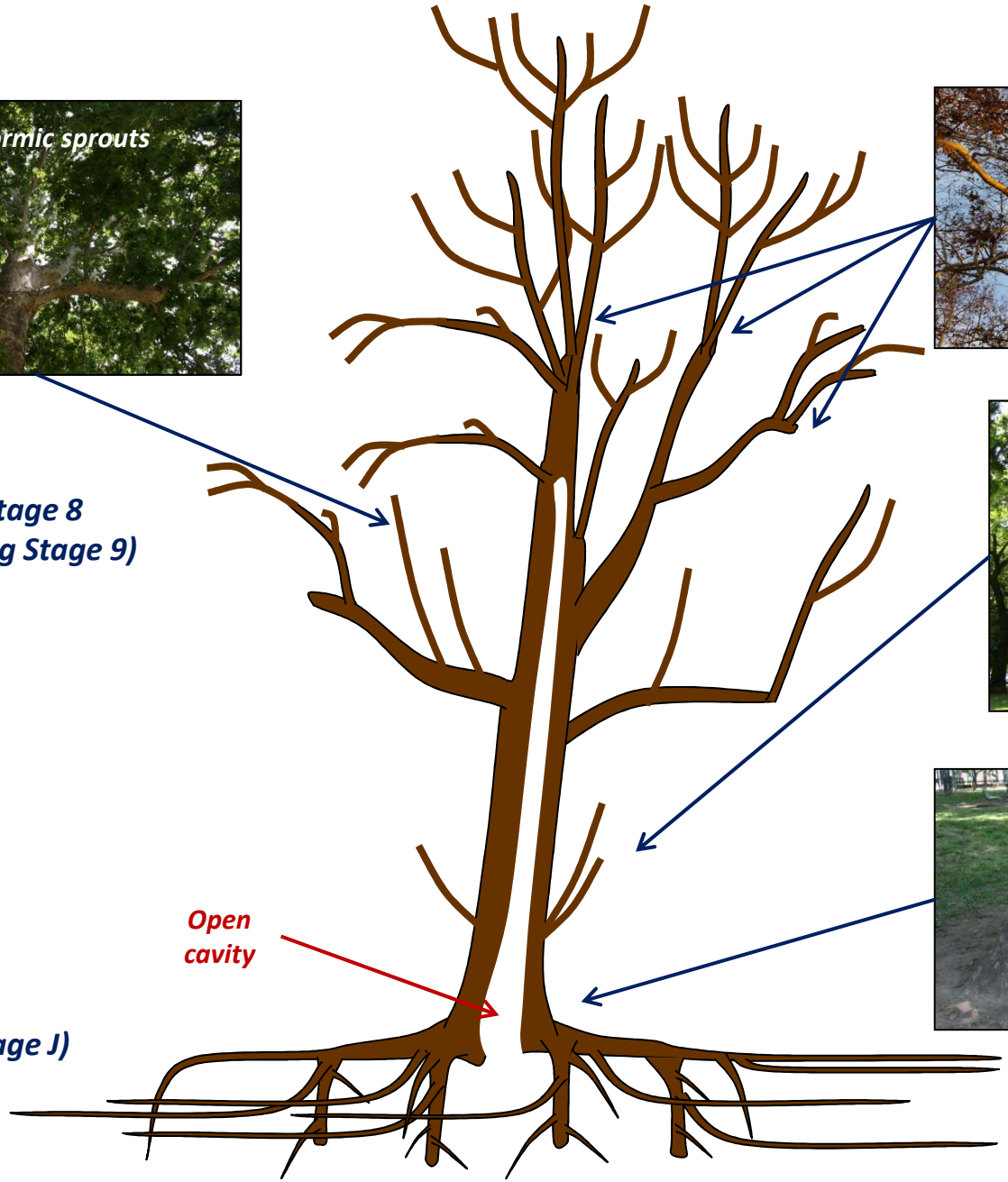


D: Mature



G. Morelli, 2017

Visual assessment: looking for clinic features



End Stage 8 (beginning Stage 9)

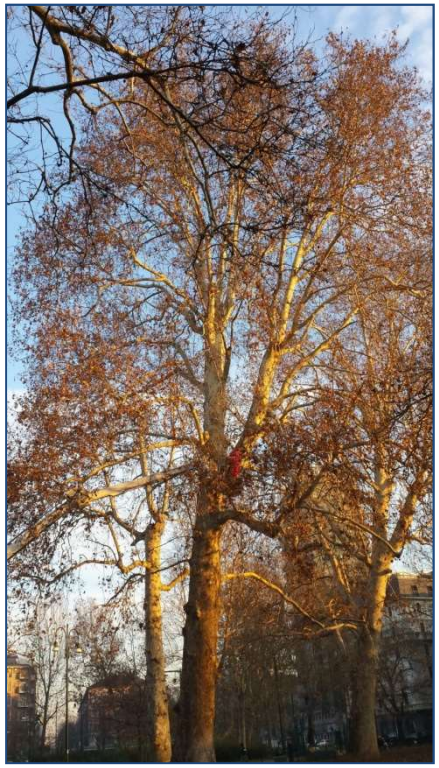
Open cavity

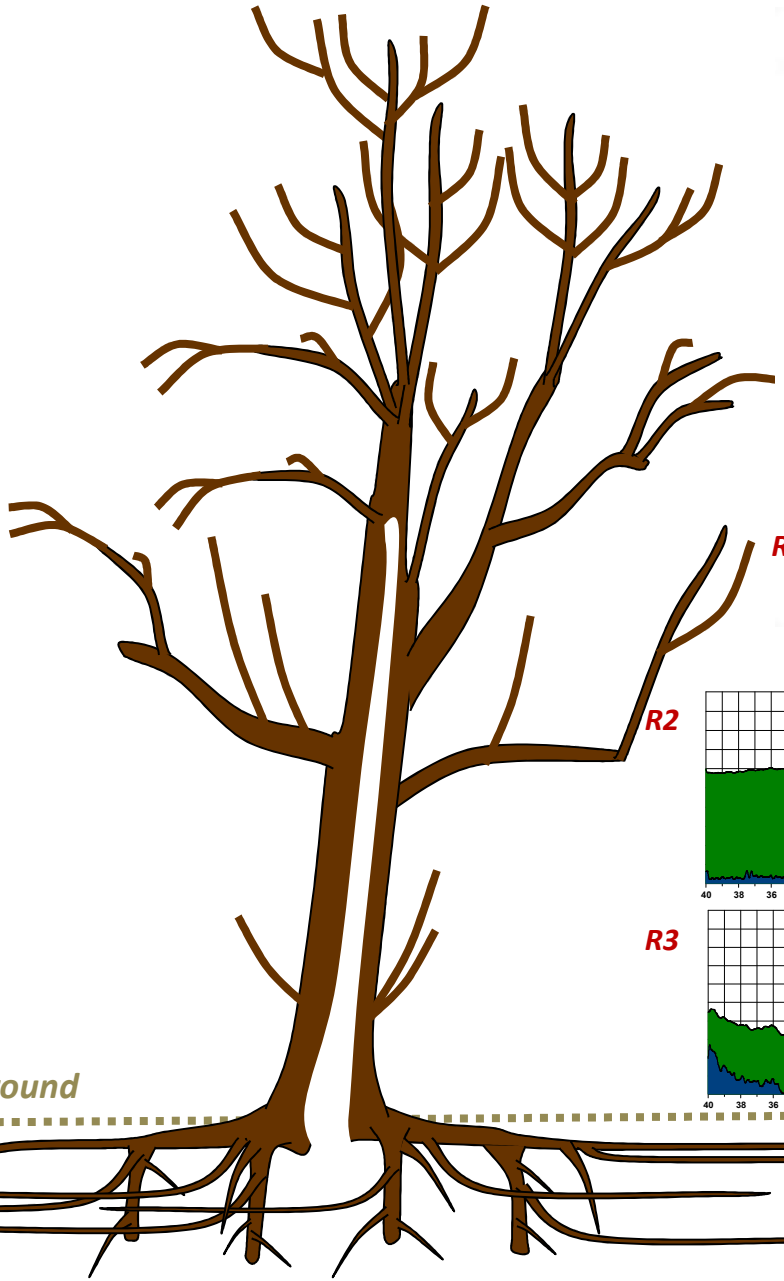
Stage H (beginning Stage J)

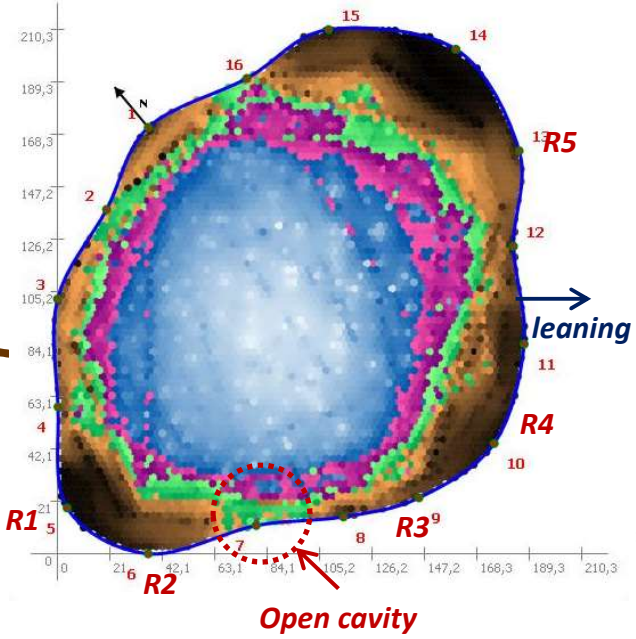
G. Morelli, 2017

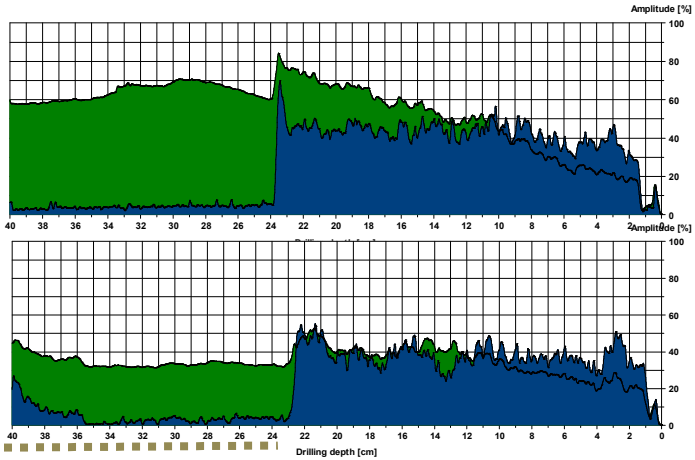
Advanced assessment: electronic drill and sonic tomograph

H = 38,5 m; D = 1,8 m



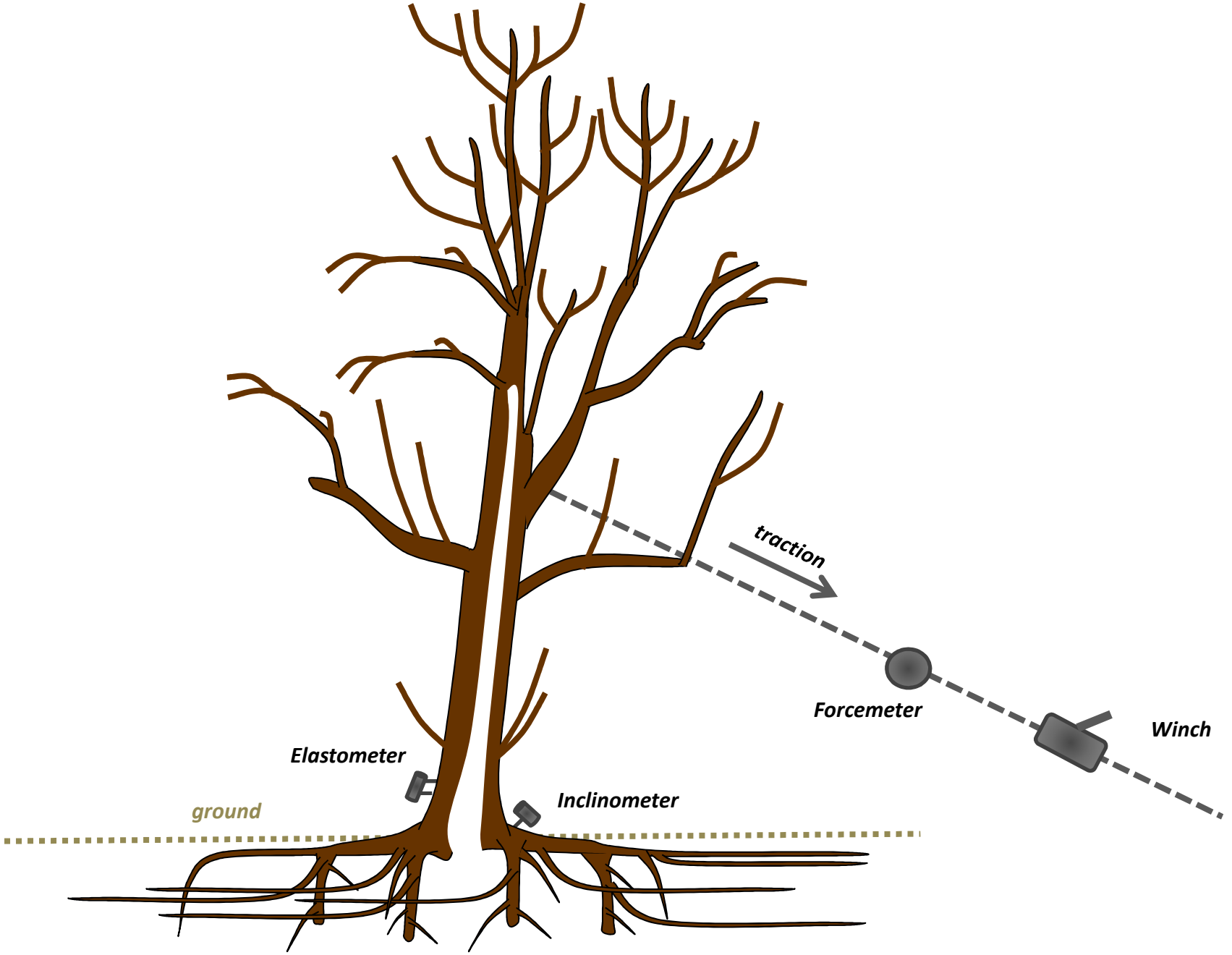






G. Morelli, 2017

Advanced assessment: pulling test



G. Morelli, 2017

Advanced assessment: pulling test

Analisi del carico del vento secondo DIN 1055-4

Progetto

Nome progetto	Coges_dic14	
Numero progetto		
Data del test	12/12/2014	

Luogo **N. dell'albero** 55607

Parco Sempione Sgambatoio

20145 Milano, Italia

Altitudine sul livello del mare 122 m

Dati dell'albero

Specie		Platanus x acerifolia	
Circonferenza del fusto		593	cm
Diametro del fusto	∥	188	cm
in 1 m di altezza	⊥	211	cm
Spessore della corteccia		2	cm
Altezza dell'albero		**38,5**	**m**

Proprietà del materiale applicate

secondo	Platanus x acerifolia	
Fonte	Stuttgart	
Resistenza a compressione	27	MPa
Modulo di elasticità	6250	MPa
Limite di elasticità	0,43	%
Densità del legno verde	0,92	g/cm³

Sagoma della chioma

Direzione del carico NE

Analisi dell'area di superficie

Base della chioma	6,2	m
Altezza effettiva	25,6	m
Area della superficie totale	772	m²
Eccentricità della chioma	4,99	m

Parametri strutturali applicati

Fattore di resistenza aerodinamica	0,35	
Frequenza propria	0,45	Hz
Diminuzione di smorzamento	0,8	
Fattore di forma	0,8	

Parametri del luogo applicati

Zona di vento	Bft 12	
Valore della velocità progettuale del vento	22,5	m/s
Densità dell'aria	1,27	kg/m³
Categoria di terreno	Zona suburbana	
Esponente profilo del vento	0,22	
Fattore di prossimità per effetti del vento vicino al terreno	1	
Fattore per l'esposizione	1,00	

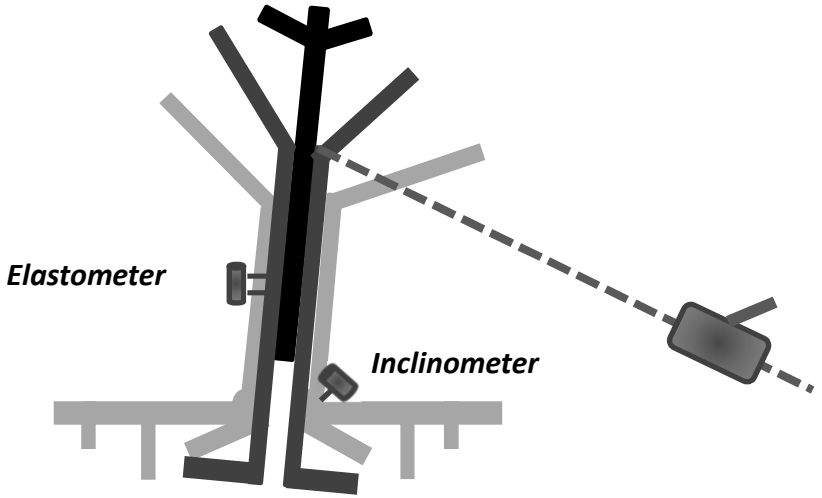
Risultati

Analisi del carico del vento

Pressione media del vento	51,3	kN
Fattore di reazione alle raffiche	2,16	
Centro di carico	22,5	m
Momento torcente	554	kNm
Carico del vento	**2495**	**kNm**

Analisi statica dell'albero

Peso proprio dell'albero	81,1	t
Livello di cavità critico	95	%
Spessore della parete critico	5	cm
assumendo una parete residua integra		
Fattore di sicurezza di base	**6,8**	



G. Morelli, 2017

Basic safety factor:

6.8

Tipping stability safety factor:

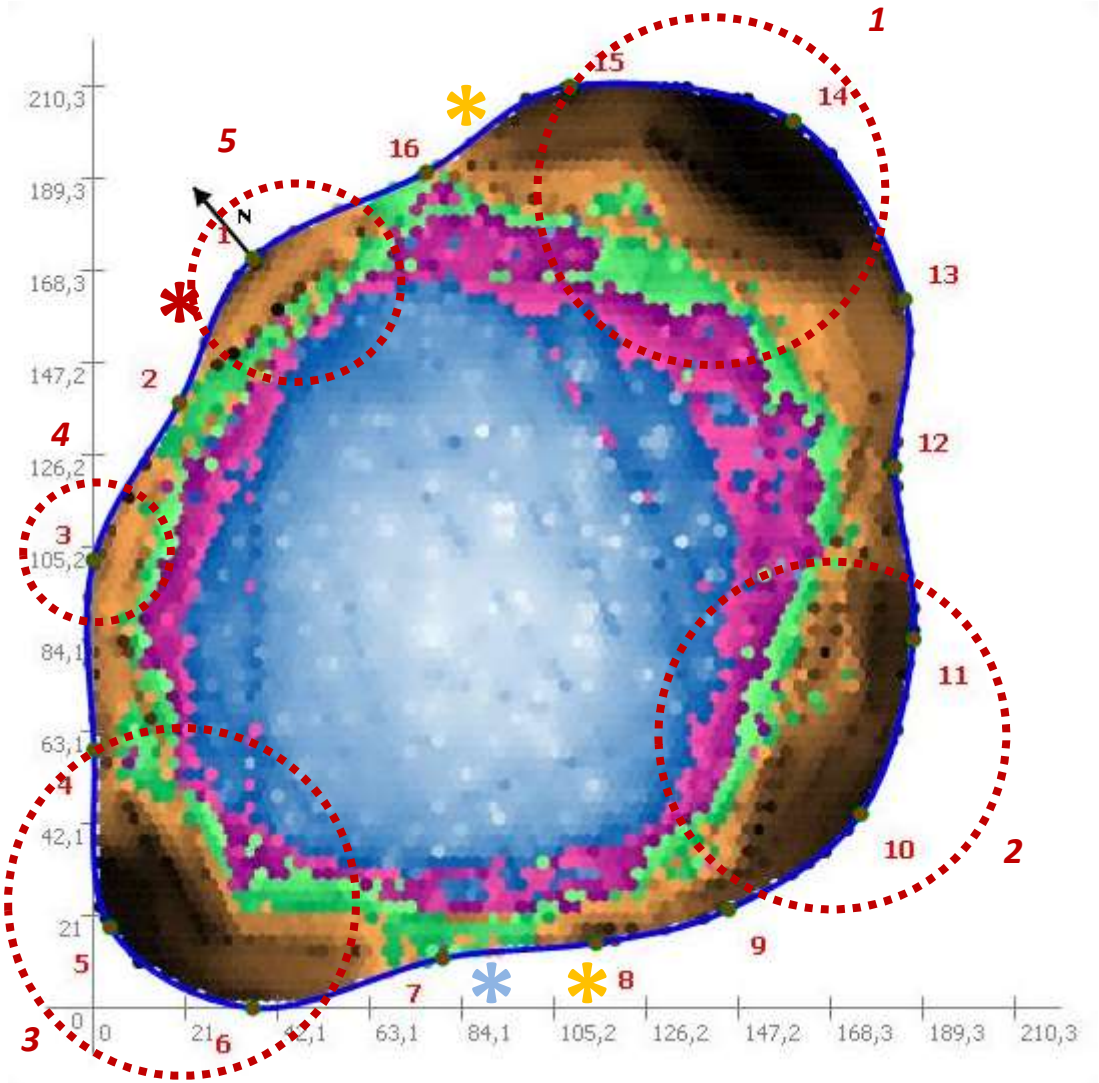
10.64, 4.14, 2.43, 1.85

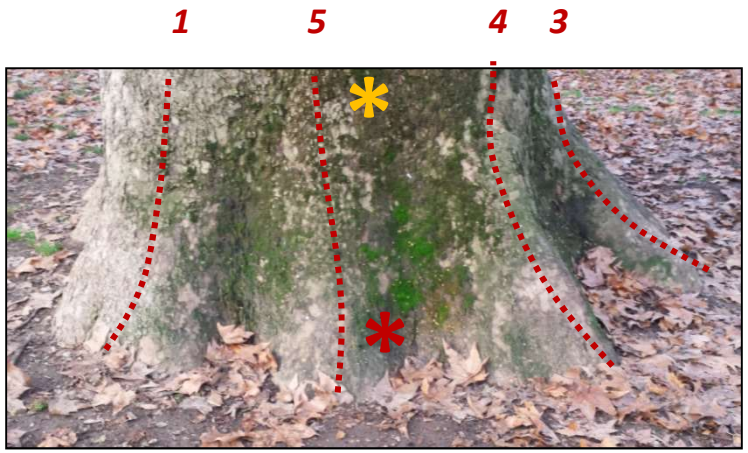
Breaking stability safety factor:

1.72, 3.59, 1.76, 3.49

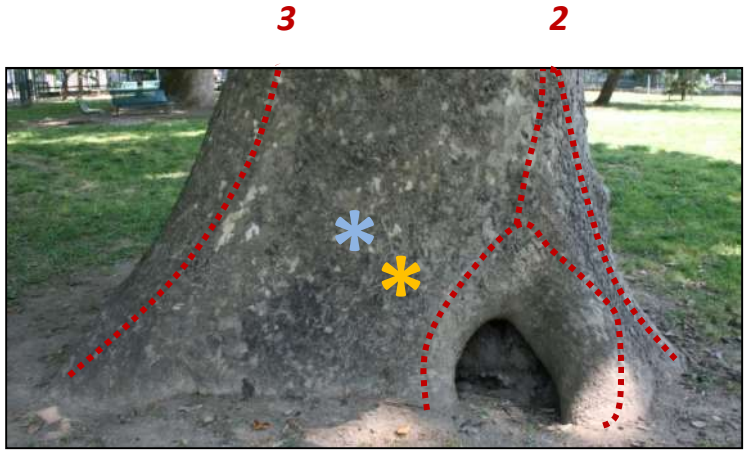
> 1.5

Integrated assessment: tomograph and pulling test outcomes





North side



South-West side

G. Morelli, 2017

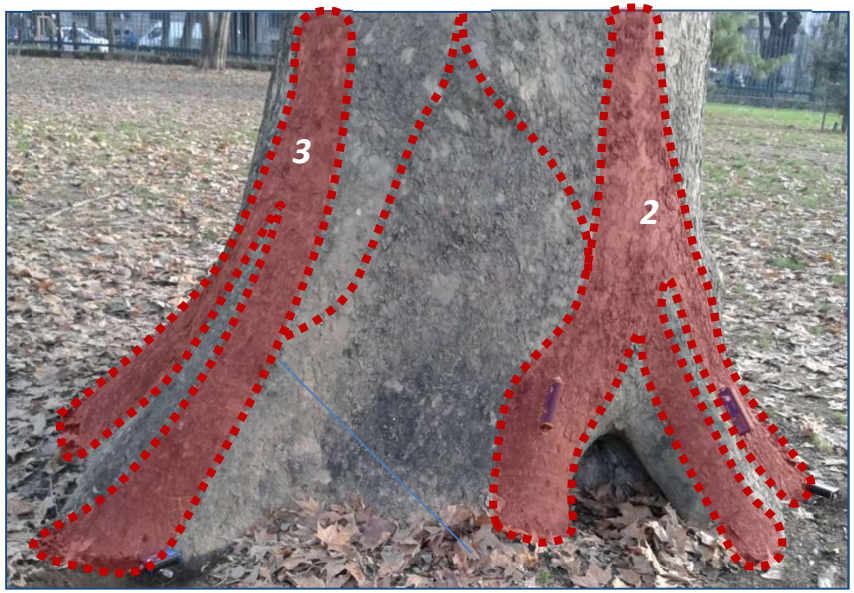
Lowest breaking stability safety factors (1.72 e 1.76)

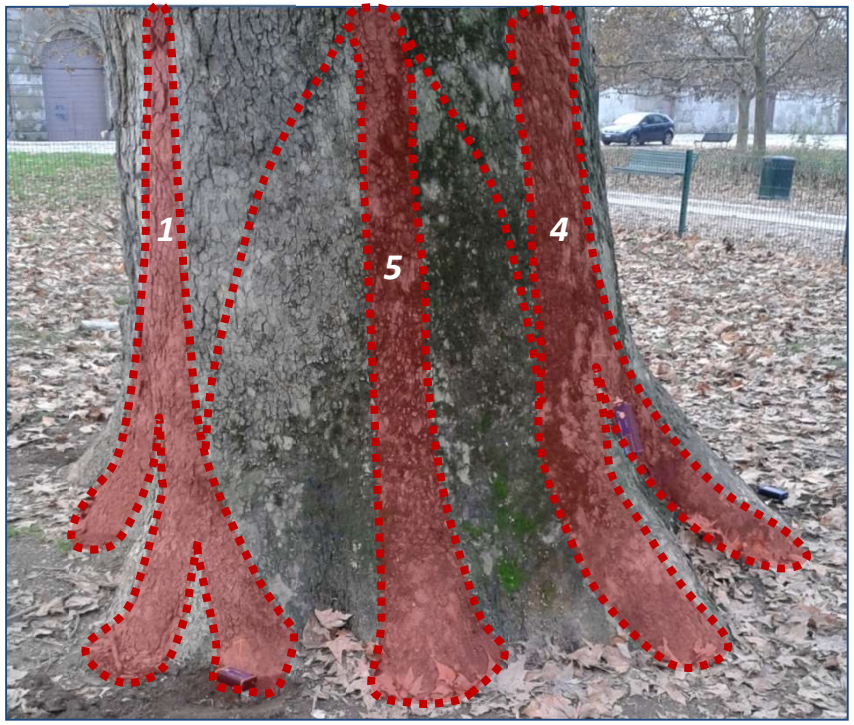
Lowest tipping stability safety factor (1.85)

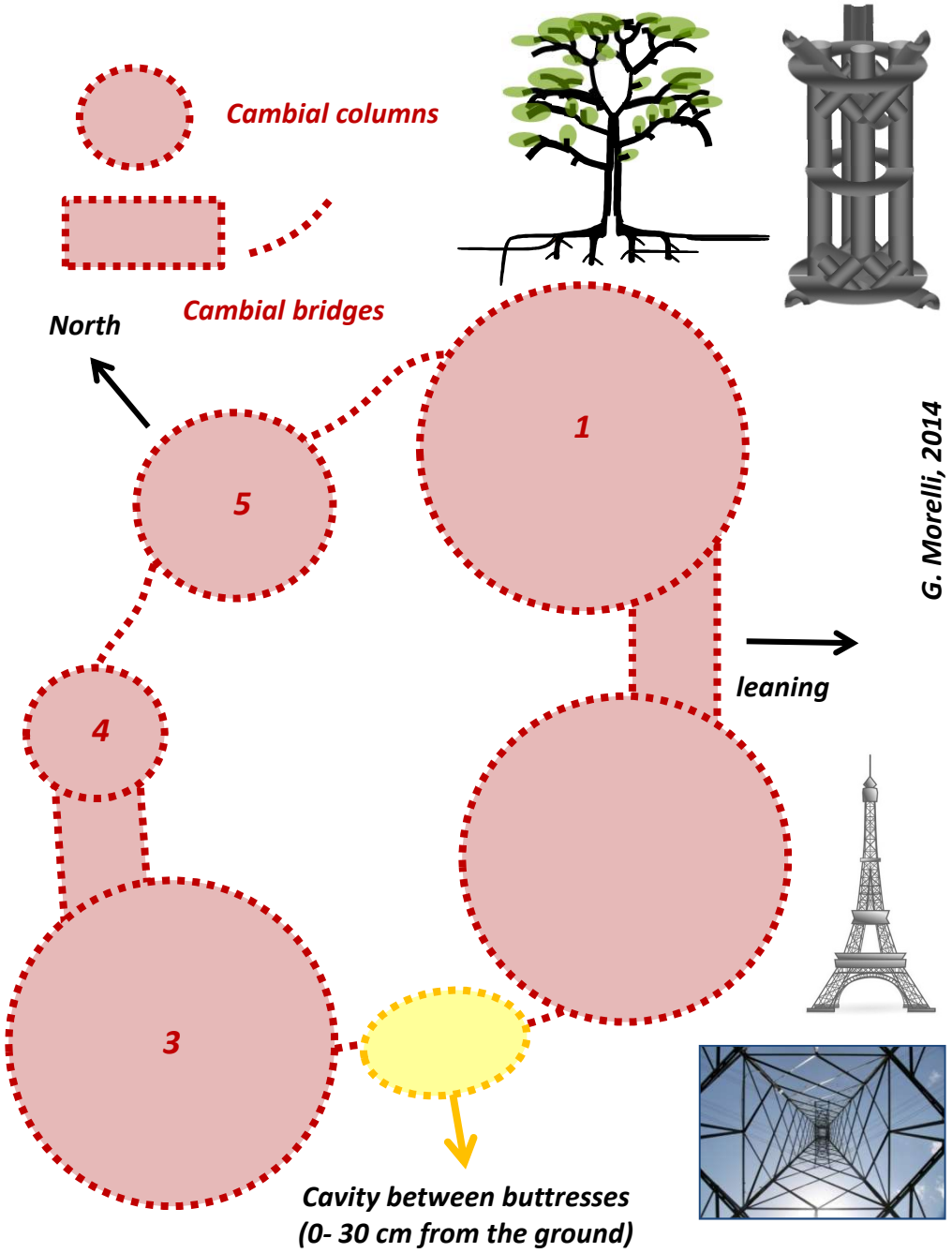
1 *Cambial columns*

1 *Cambial columns*

Integrated assessment: tomograph and pulling test outcomes



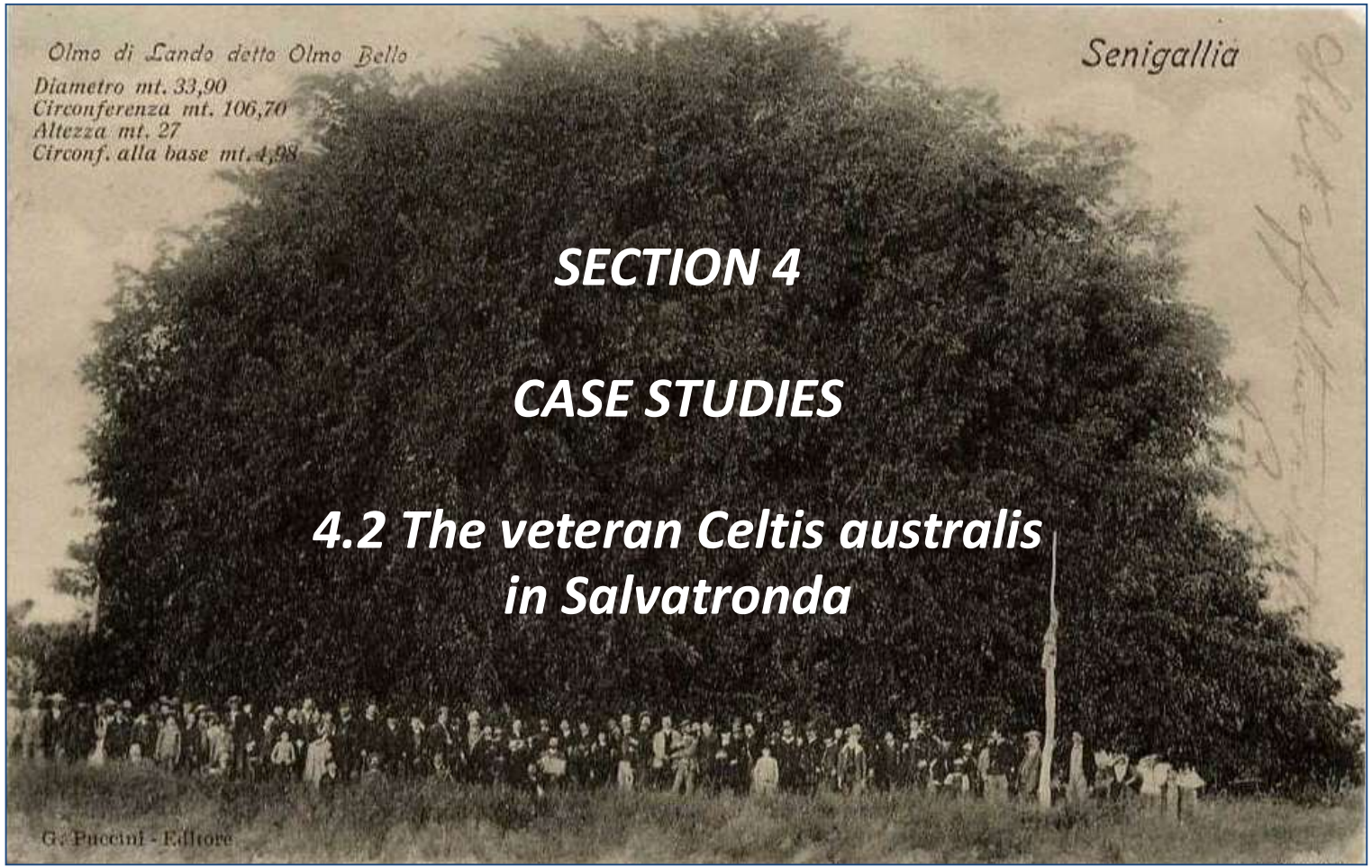




Crown & Canopy Management

Working with nature

8-11 September 2019 Exeter, UK

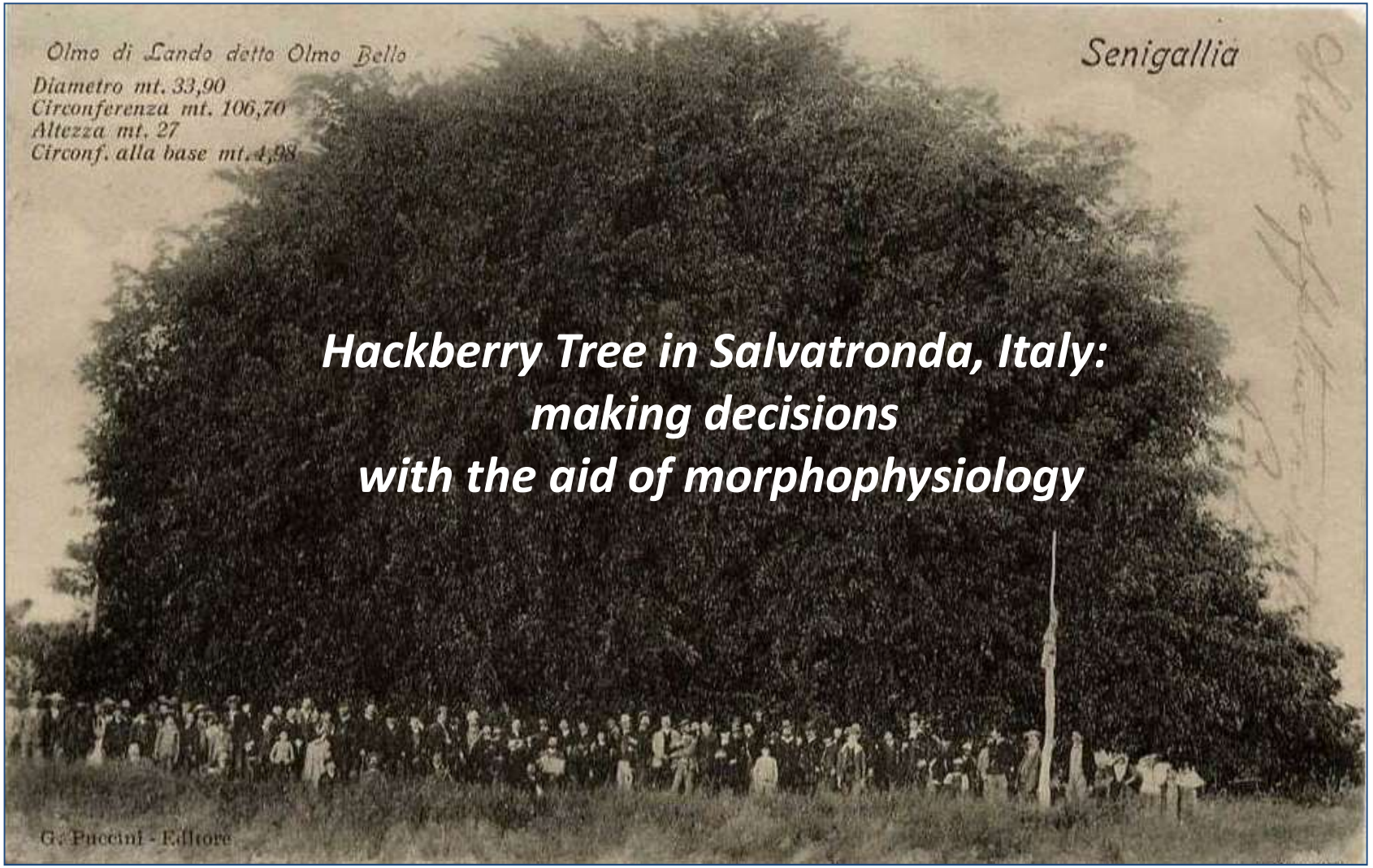


SECTION 4

CASE STUDIES

4.2 The veteran Celtis australis in Salvatronda

2018 ISA Annual International Conference
6 August 2018 Columbus, OH



Hackberry Tree in Salvatronda, Italy: making decisions with the aid of morphophysiology

«El Schieson» of Salvatronda

1788

1885?

Scheda n. 124

EL SCHIESON DI SALVATRONDA

Nome scientifico della specie: ***Celtis australis* L.**
Nome comune: **Bagolaro**
Località: **Loc. Salvatronda - Via Centro**
Altitudine s.l.m.: **36 m**
Comune: **Castelfranco Veneto**
Coordinate topografiche. Tavoletta I.G.M.: **Vedelago F.° 38 III S.O. 32T QR 650 624**
Ubicazione e descrizione del luogo: **l'albero cresce in mezzo alla strada, accanto alla chiesa di Salvatronda.**

Rilievi dendrometrici:

Circonferenza ad 1,3 m: **3,00 m**
Altezza dell'albero: **13,50 m**
Ampiezza della chioma nelle quattro direzioni: **Nord 5,20 m - Est 5,40 m - Sud 5 m - Ovest 6,80 m**
Altezza d'inserzione della chioma: **3 m**
Età presunta: **100 -÷- 150 anni**
Note: **fusto eretto; chioma folta e regolarmente espansa.**

* * * * *

Condizioni fitosanitarie: **buone. Presenta due cavità nel fusto, di cui solo una è stata curata**
Destinazione: **ornamentale**
Classi di segnalazione: **A2, A4a**

* * * * *

Proprietario: **Comune di Castelfranco Veneto**
Data della rilevazione: **3 agosto 1988**
Rilevatore: **Tiziana Fasan - Paolo Battistel**
Altre note: **è riconosciuto come un Grande Albero da tutti gli abitanti della località.**

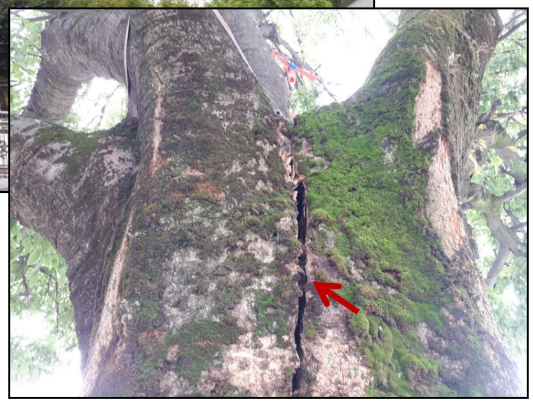
L'ombroso bagolaro svolge anche la poco nobile funzione di spartitraffico.

248

1988

G. Morelli, 2018

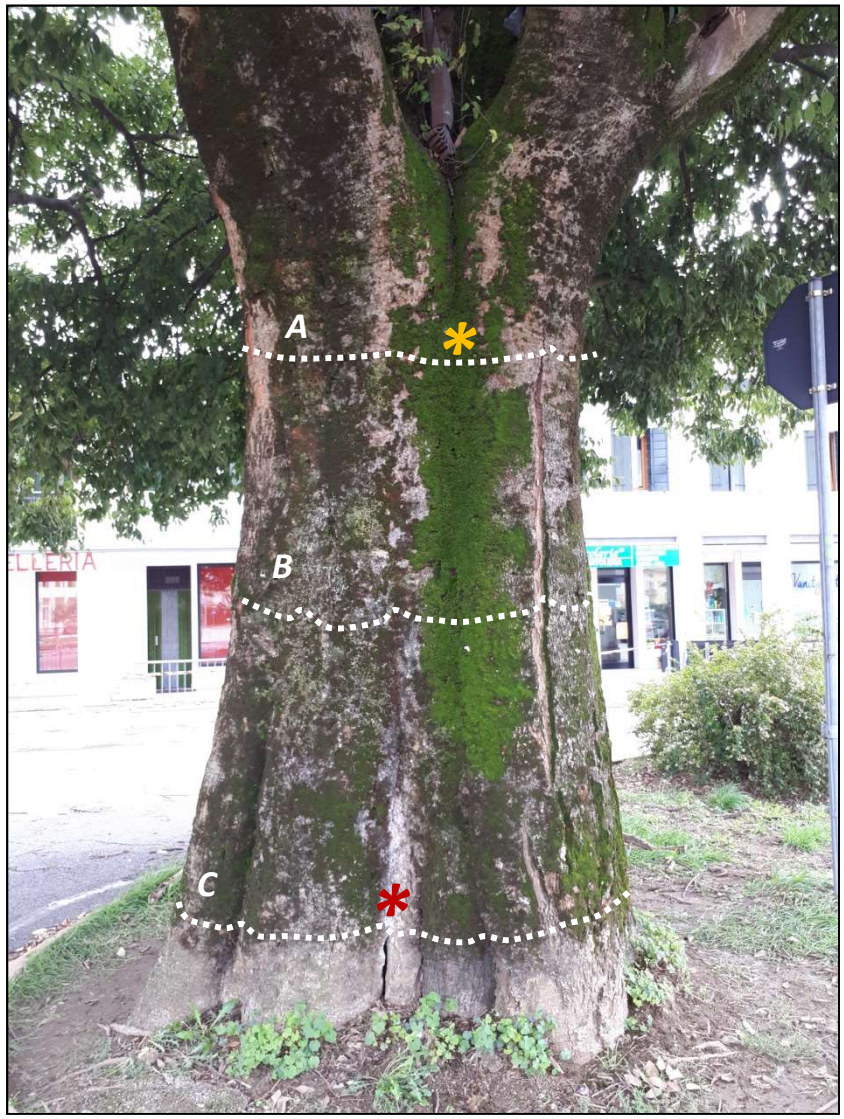
The crown and the failure



Almost absent cambial bridges

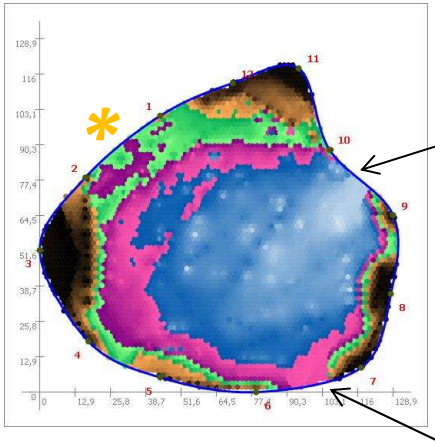
G. Morelli, 2018

Tomographic analysis



✱ *Open cavity* ✱ *Included bark*

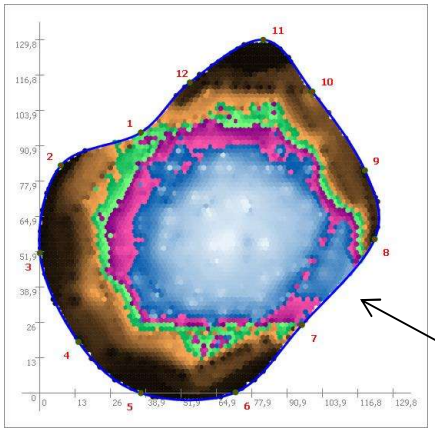
A



Recent breackage (not in the picture)

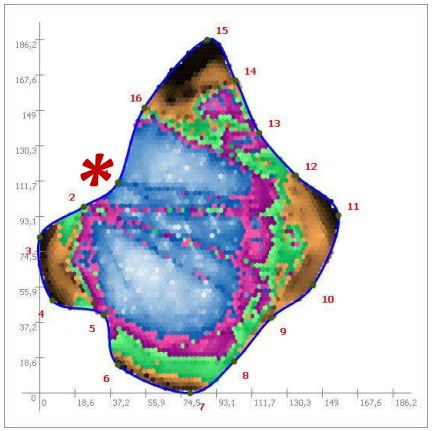
Recent breackage (not in the picture)

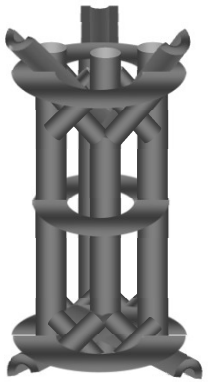
B



Open cavity (not in the picture)

C





G. Morelli, 2018

Making decisions: technical knowledge, economical aspects and cultural peculiarities

G. Morelli, 2018

Source: Internet

Arborists and tree climbers: