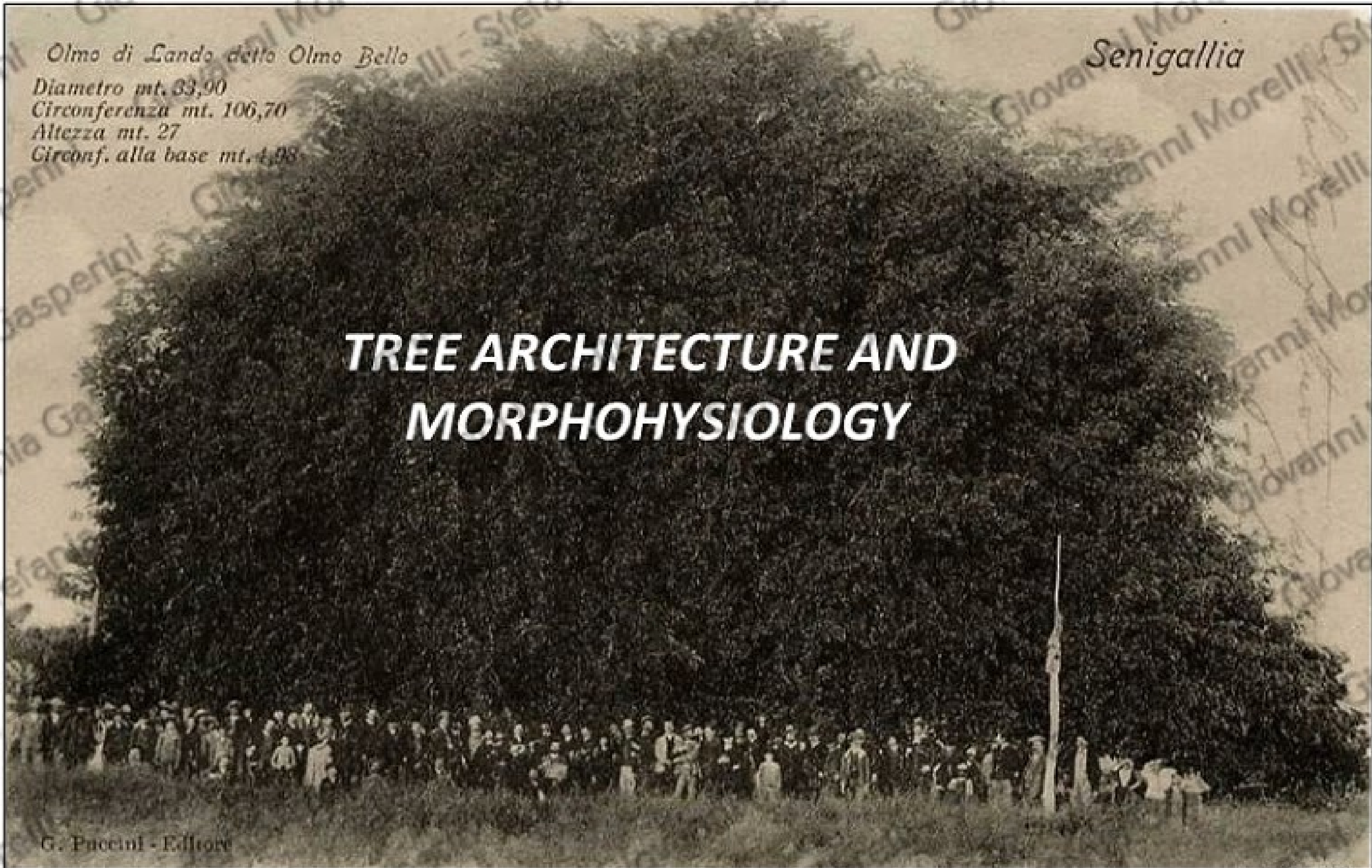
Barcham
The Tree Specialists

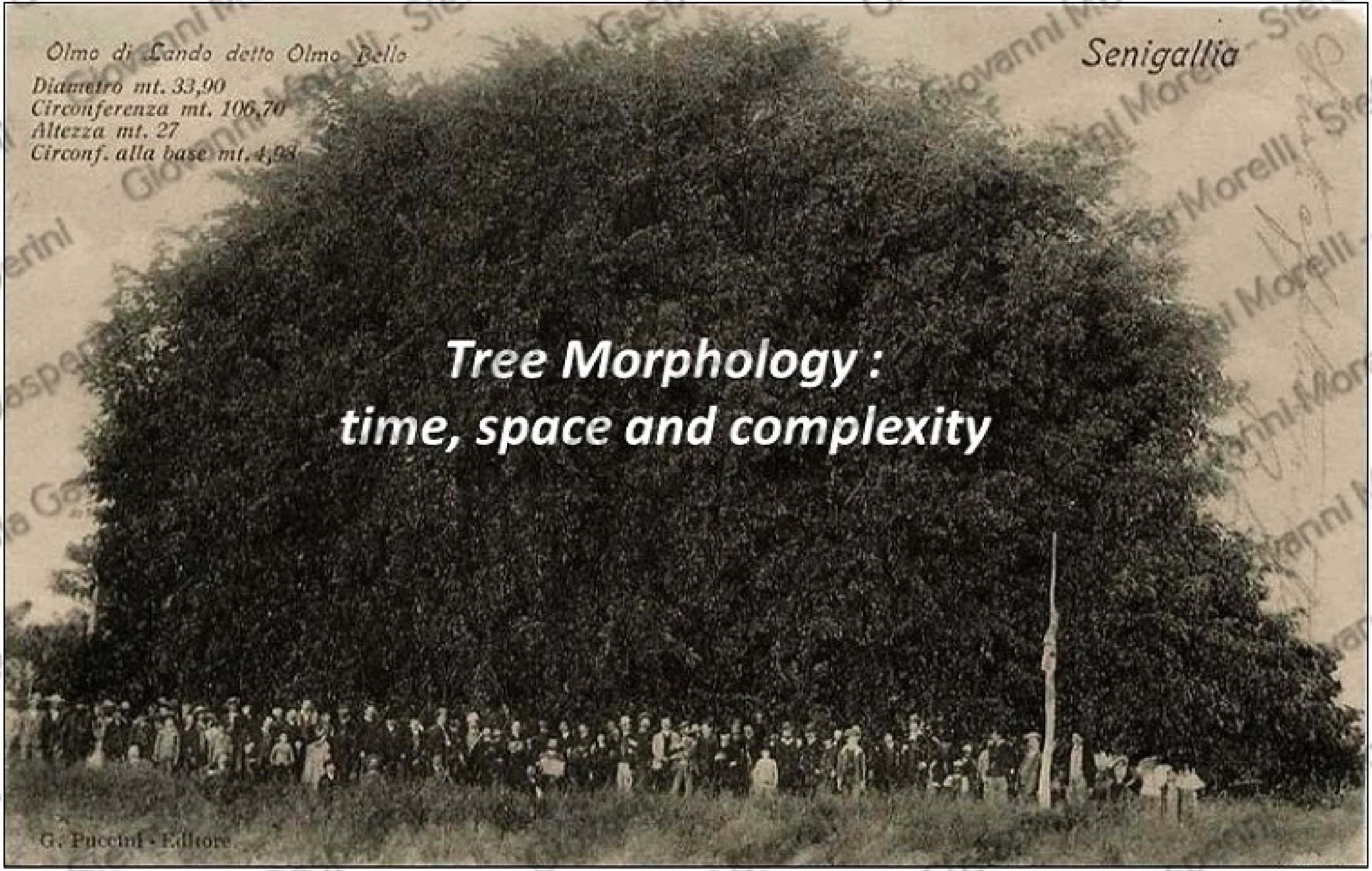
Progetto Verde AR.ES.

Seminar series No. 71
April 10th 2019



TREE ARCHITECTURE AND MORPHOHYSIOLOGY

Stefania Gasperini - Giovanni Morelli


Olmo di Lando detto Olmo Bello
Diametro mt. 33,90
Circonferenza mt. 106,70
Altezza mt. 27
Circonf. alla base mt. 4,98
Senigallia
Tree Morphology :
time, space and complexity
G. Puccini - Editore

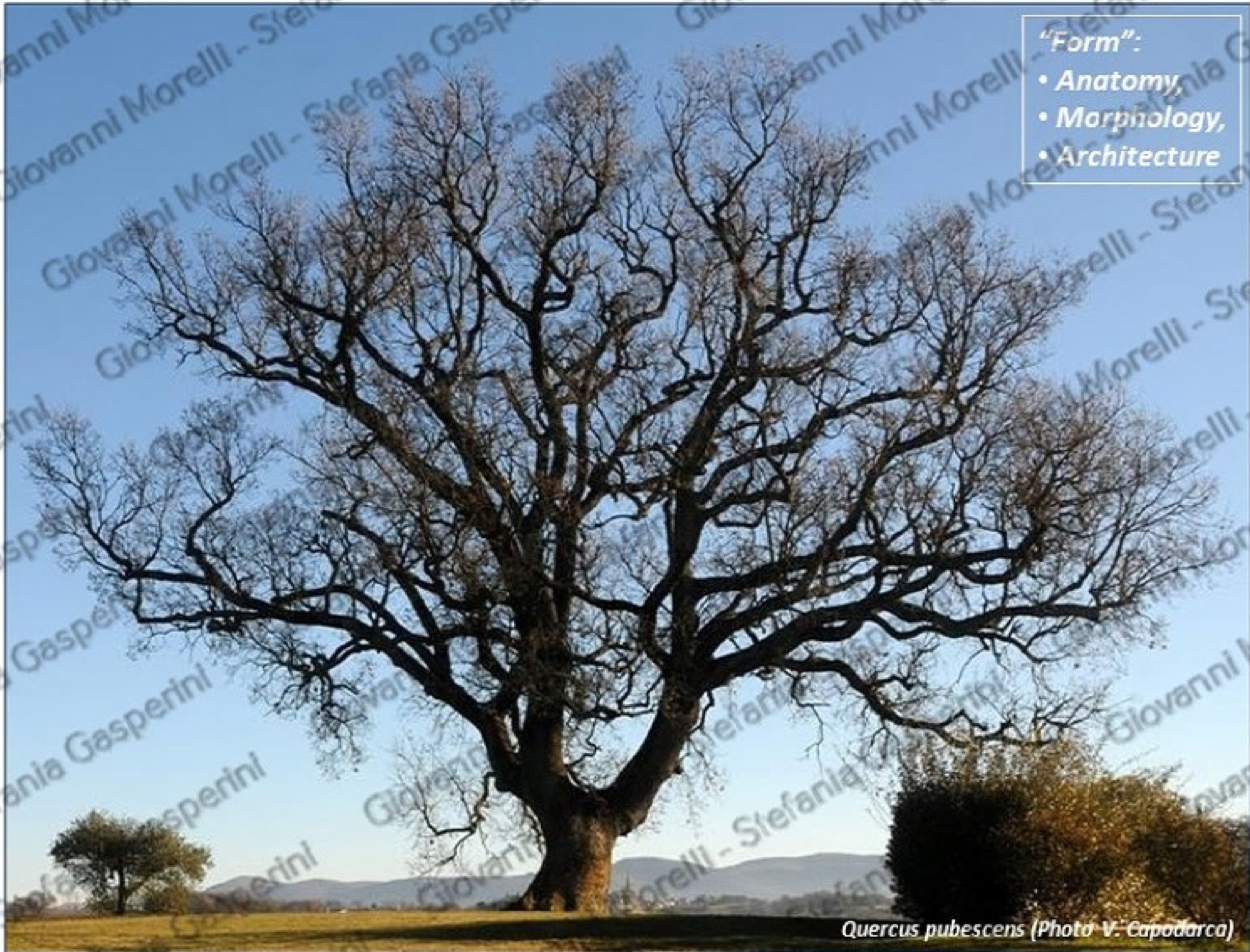
The tree form

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 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.

The Evolution of the form

Oak (Photo: T. Green)



Quercus pubescens (Photo V. Capodarca)

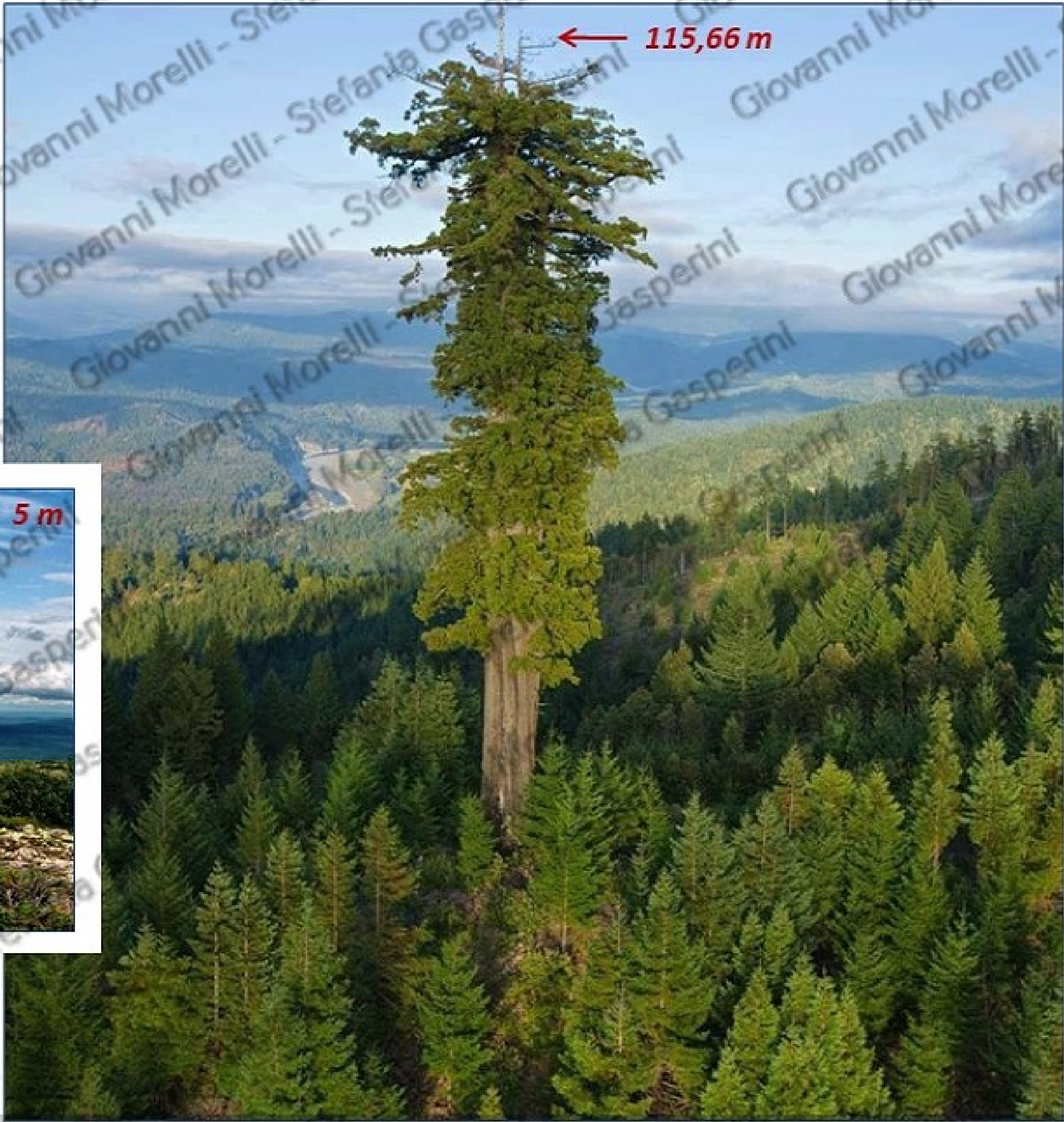
Describing the evolution: time, growth and development

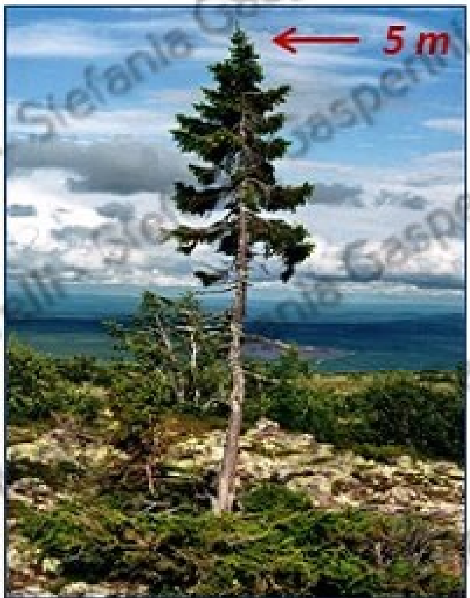
Conceptual issues: time

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

Conceptual issues: space and organisation

Conceptual issues: space and organisation





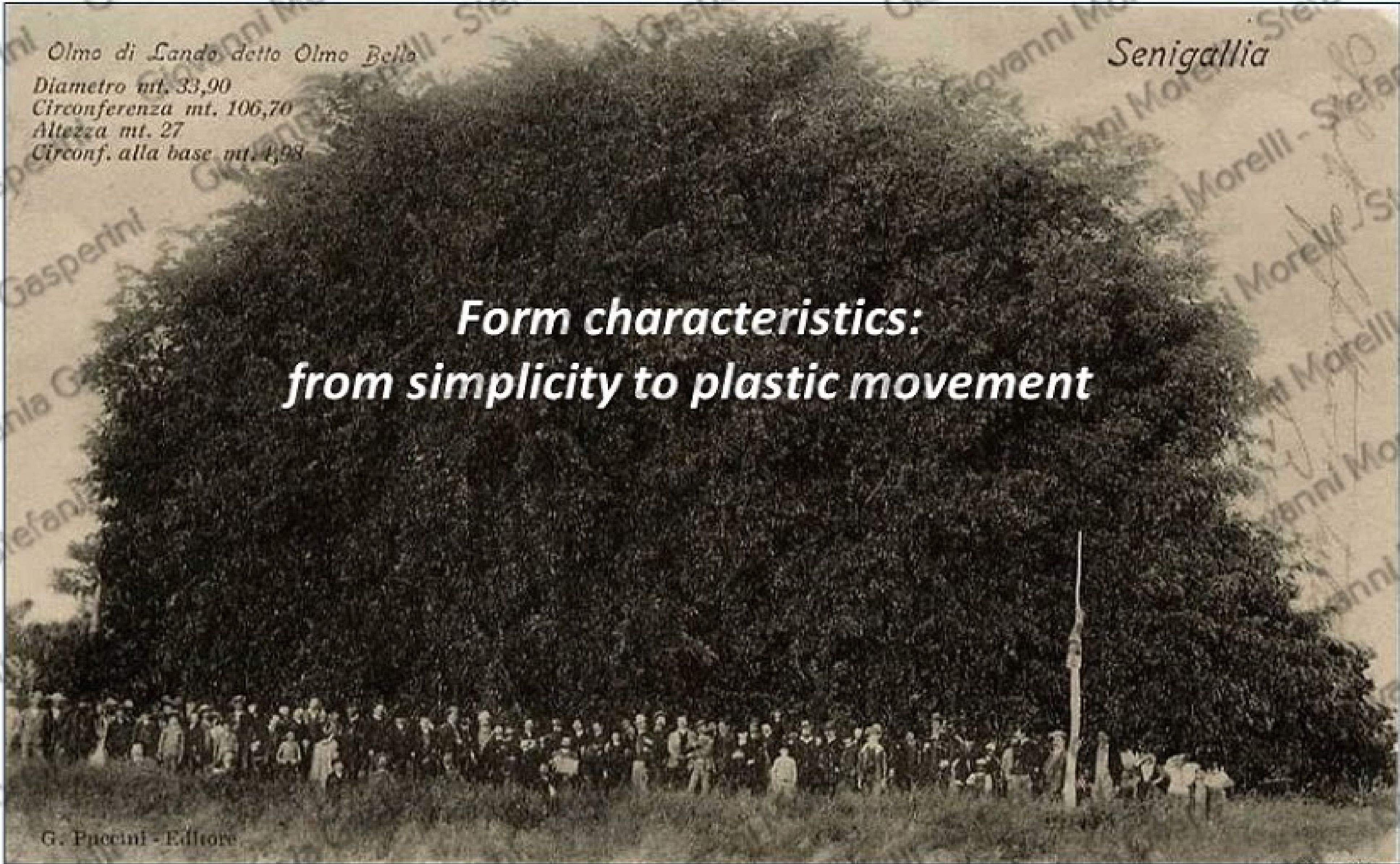
Picea abies (Old Tjikko); hight 5 m, estimated age 9560 years
Photo: Google

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

Dynamics and impermanence of the form: growth, development and modularity

Quercus pubescens. Photo V. Capodarca

Form characteristics: from simplicity to plastic movement

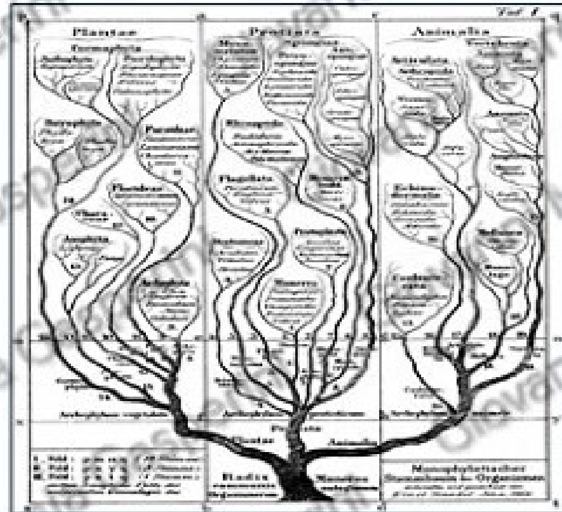


Characteristics of tree form: semplicity, hierarchy, complexity, directionality

Margherita Morelli:
"Tree"; 2011

Pacino di Buonaguida:
"Tree of life"; 1305-1310 ca.

F. Ughelli: "Albero et historia
of Counts of Marsciano"; 1667



E. Haeckel:
"Monophiletischer stammbaum";
Berlin 1866

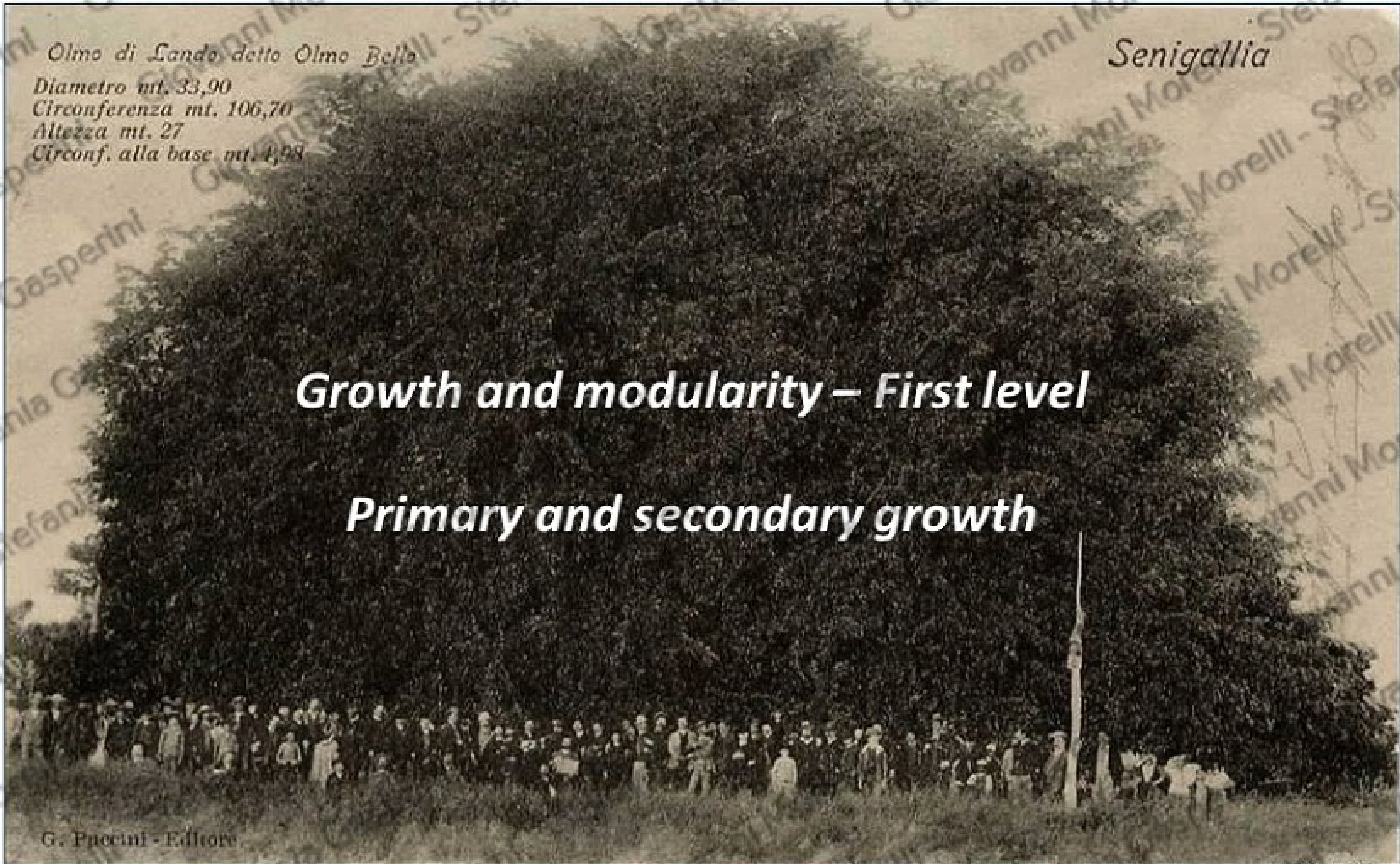
Immobility

Villa Verucchio (RN),
Franciscan Convent (sec. XIII)
Cypress of St. Francis
(planted in 1213?)

Plastic movement

The evolution of the form as a behaviour

Source USDA


Olmo di Lando detto Olmo Bello
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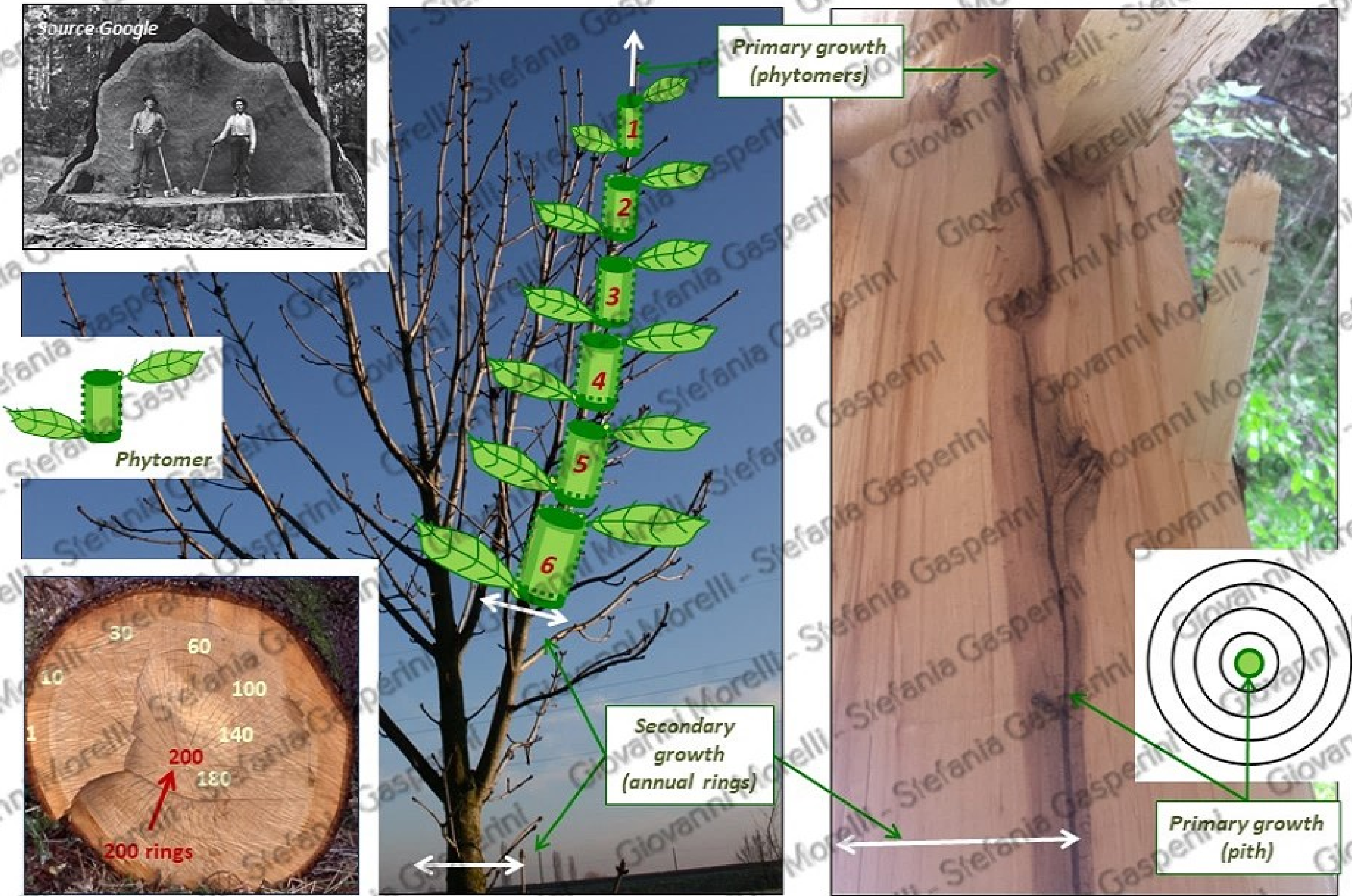
Circonferenza mt. 106,70
Altezza mt. 27
Senigallia
Growth and modularity – First level
Primary and secondary growth
G. Puccini - Editore

First level of modularity: Primary and secondary growth



Q. Pubescens (Photo G. Morelli)   Aesculus hippocastanum (Photo G. Morelli)   Acer saccharinum (Photo G. Morelli)

First level of modularity: Secondary growth

First level of modularity: Secondary growth

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

1 ring

10 rings

30rings

60 rings

100 rings

140 rings

180 rings

200 rings


Olmo di Lando detto Olmo Bello
Diametro mt. 33,90
Circonferenza mt. 106,70
Altezza mt. 27
Senigallia
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Branching

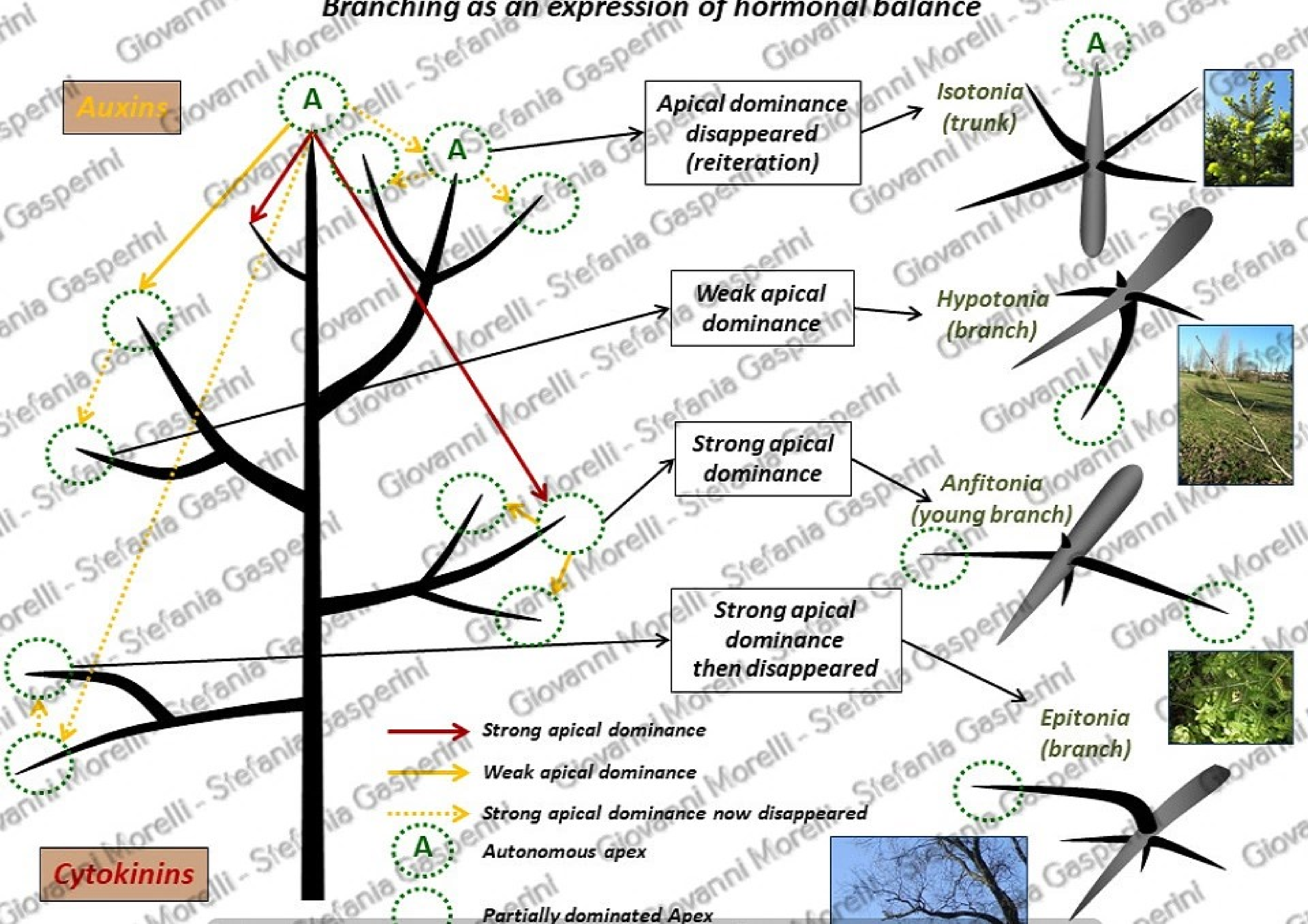
Branching

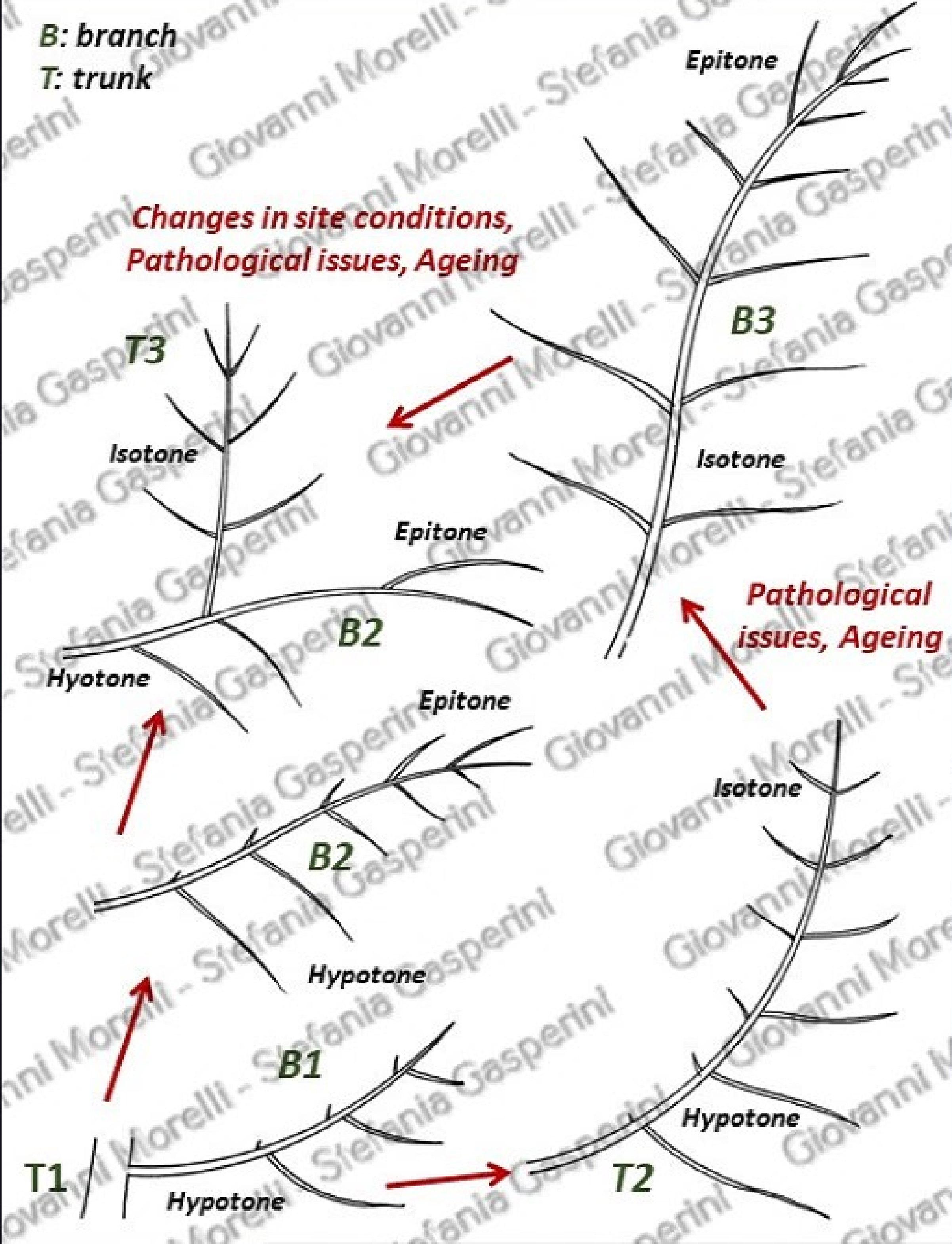
Primary growth
(phytomers)
1
2
3
4
5
6
1
2
3
Phytomer
Branching
Secondary
growth
(annual rings)

Branching

Branching as an expression of hormonal balance

Picea abies (Photo G. Morelli)


Branching as an expression of hormonal balance
Auxins
Cytokinins
A
Apical dominance disappeared (reiteration)
Weak apical dominance
Strong apical dominance
Strong apical dominance then disappeared
Isotonia (trunk)
Hypotonia (branch)
Anfitonia (young branch)
Epitonia (branch)
Strong apical dominance
Weak apical dominance
Strong apical dominance now disappeared
Autonomous apex
Partially dominated Apex



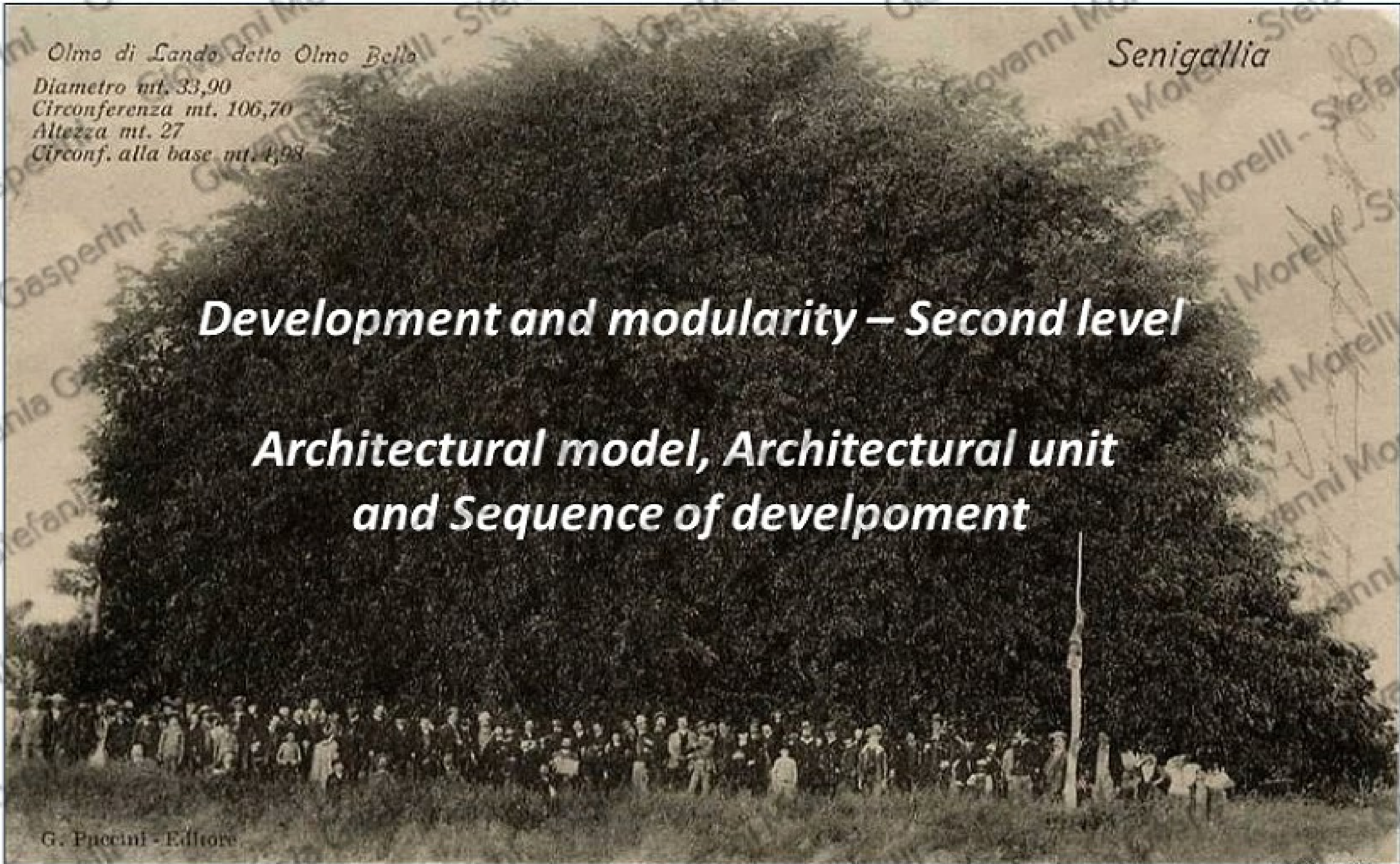
The Metamorphosis of the branches: from branch to trunk, round trip

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).

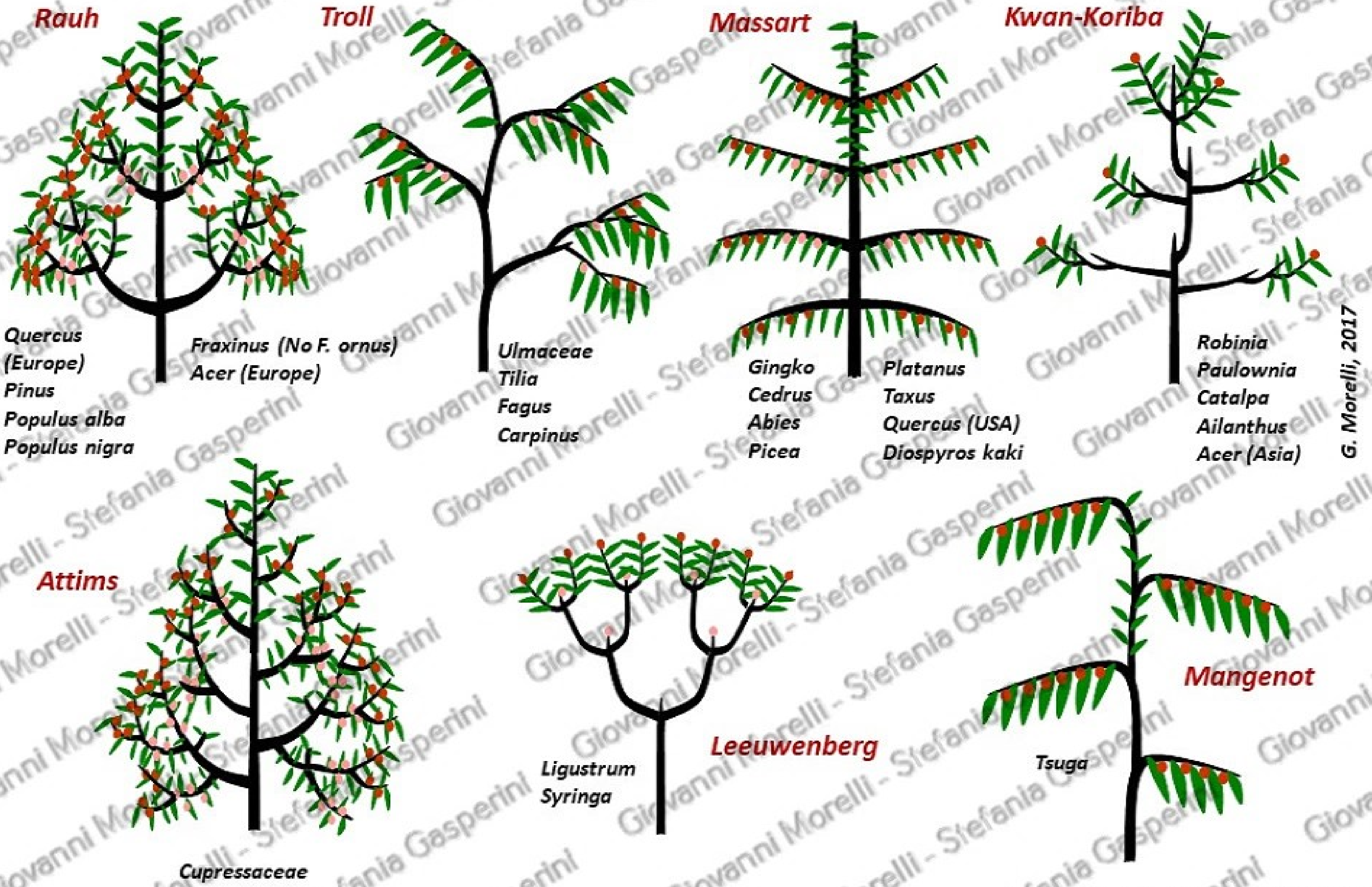
A totally horizontal branch (B2) will be a branch forever. Only hypotonic branches can evolve into trunks, while the epitones, can originate trunks only by total secondary reiteration (B1 to B2 + T3).
The trunks can regress to branches in specific situations (traumas, senescence or bad pruning), in this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



Development and modularity – Second level

Architectural model, Architectural unit and Sequence of develpoment

The "common denominator" of tree architecture: Architectural Models



Describing the architectural models

Criteria:

1. ***Single axis or branched axis;***

2. ***Equivalent Axes, trunk and branches differentiated or mixed axes***

3. ***Monopodial or sympodial trunk;***

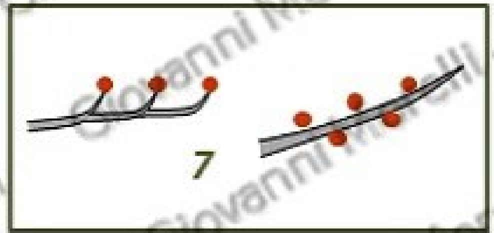
4. ***Rhythmic or continuous growth;***

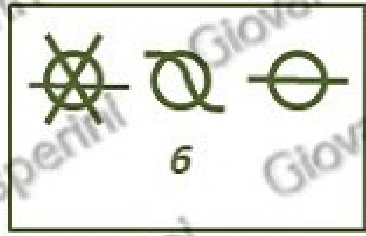
5. ***Lateral branches: orthotropic or plagiotropic;***

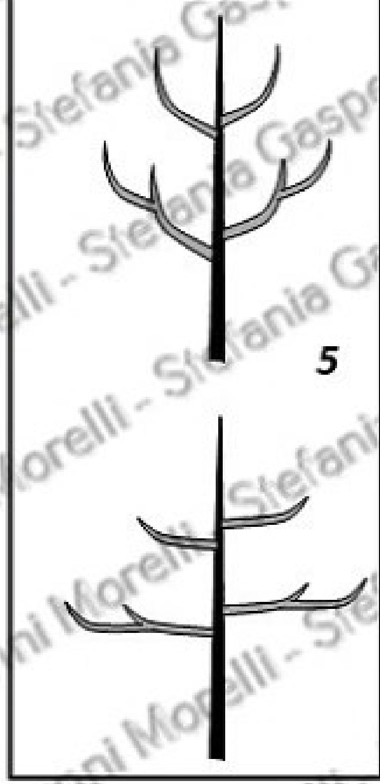
6. ***Phyllotaxis: spiral or verticillate, spirodistic or distic;***

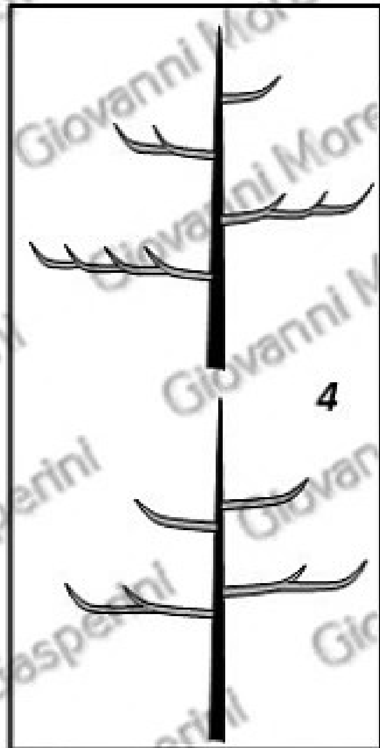
7. ***Flowers in a terminal or lateral position;***

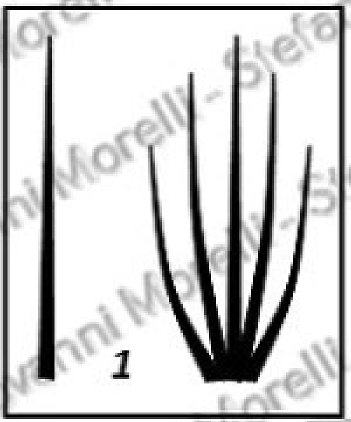
8. ***Monocarpic or polycarpic trees.***

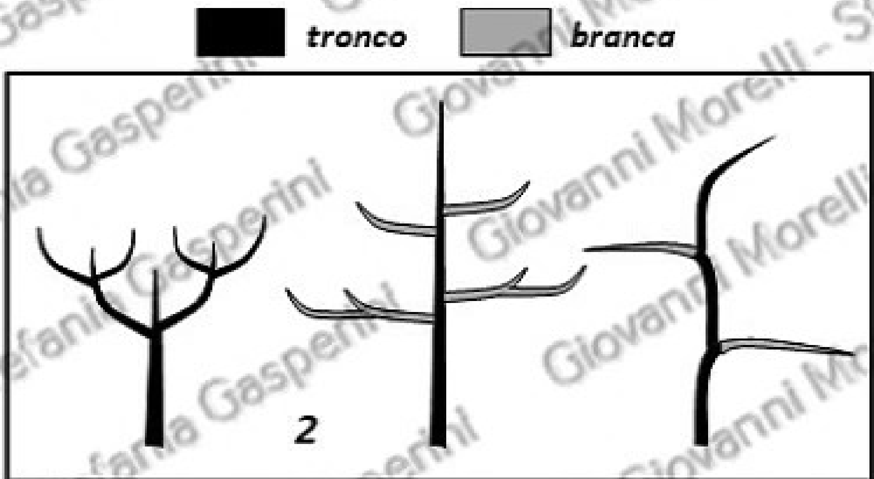












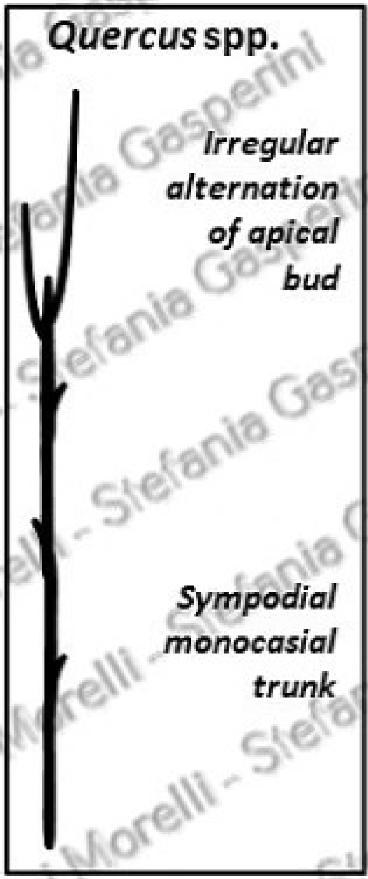
The phylogenetic level of the form: Rauh architectural model

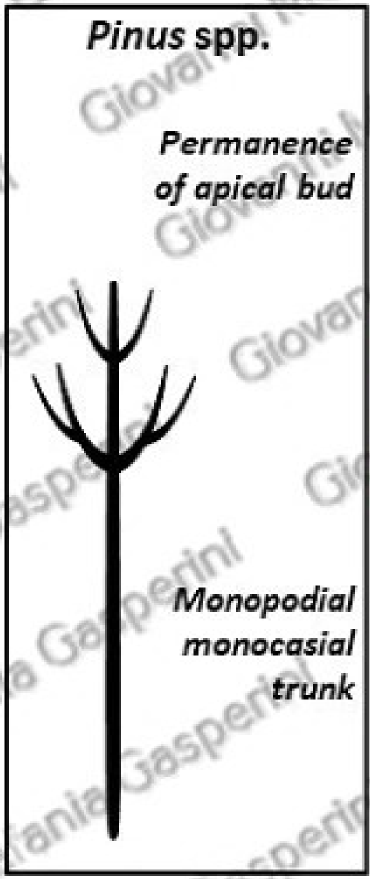
Trunk and branches differenciated only after flowering (lateral)

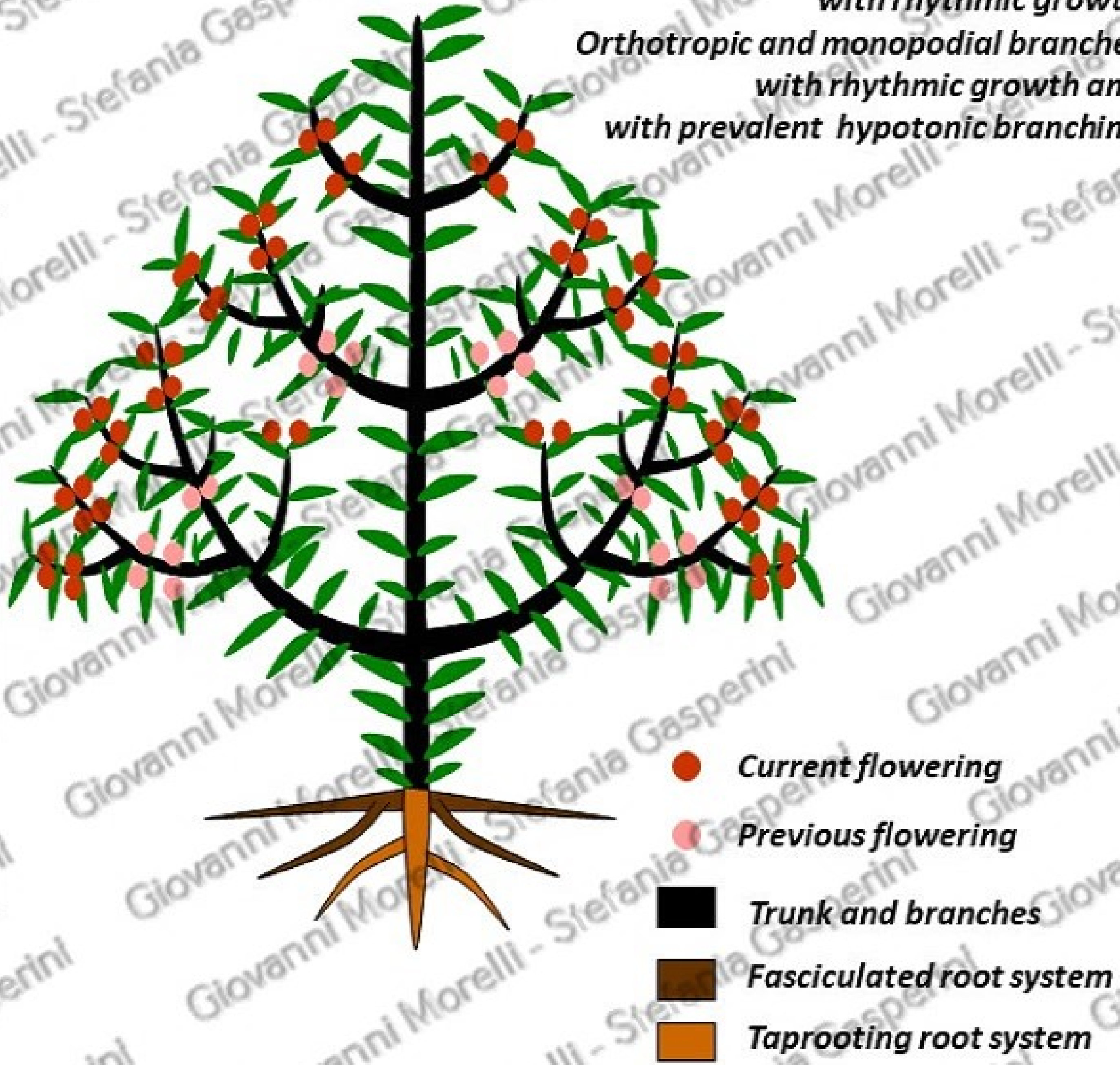
Spiral phyllotaxis

Orthotropic and monopodial/sympodial trunk with rhythmic growth

Orthotropic and monopodial branches with rhythmic growth and with prevalent hypotonic branching





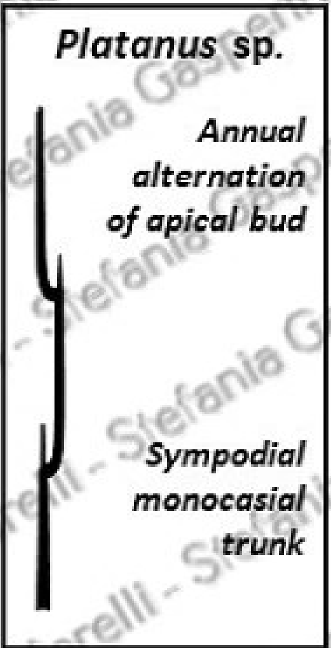


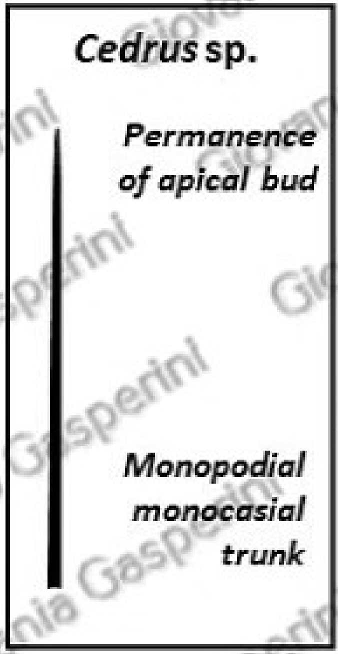
First root system usually from seed

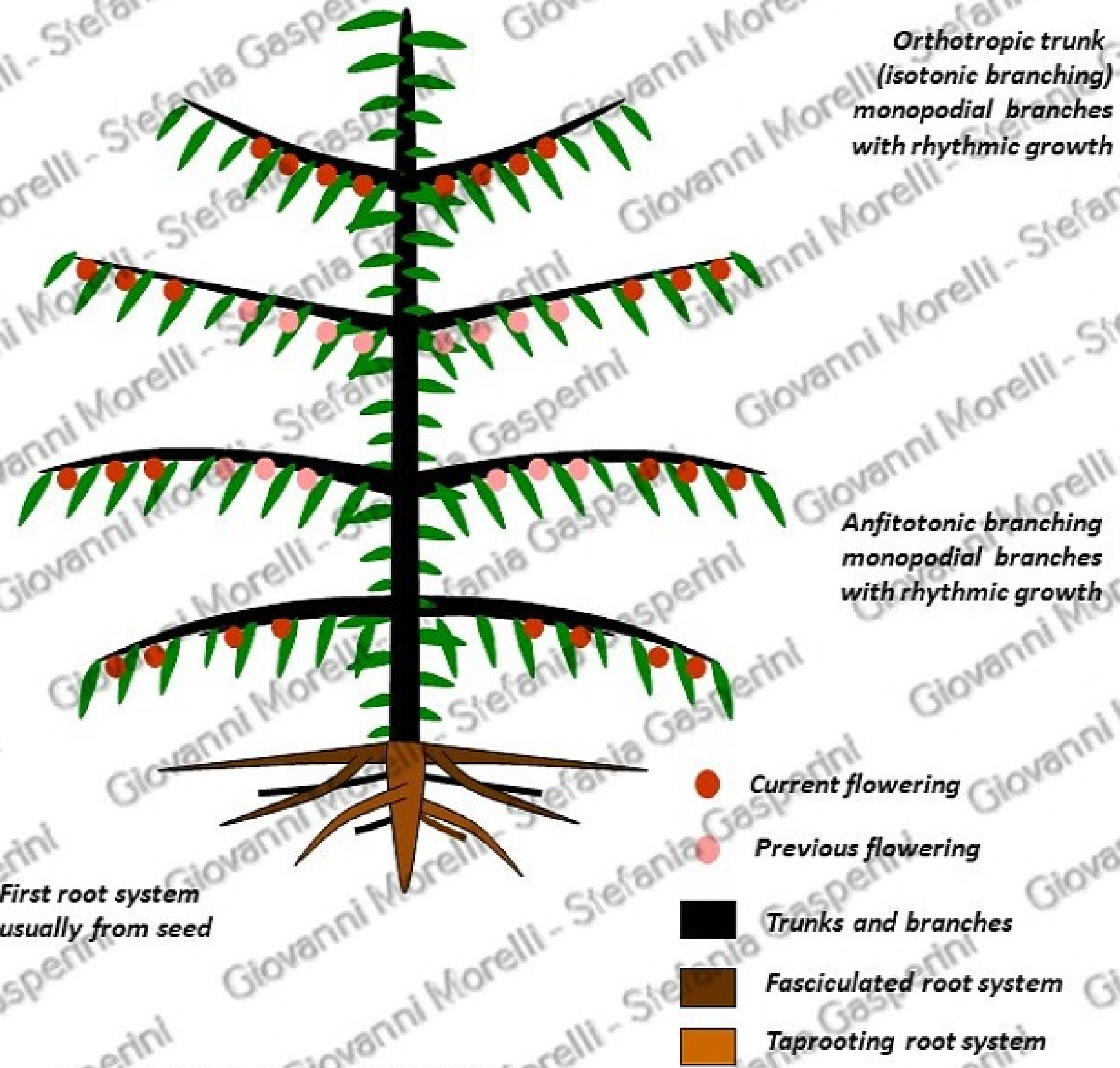
Source: P. Raimbault, (from F. Hallé); 2006

The philogenetic level of the form: Massart architectural model

Trunk and branches different both for the flowering (lateral on branches) and for the phyllotaxis (distic for the trunk and spiral for the branches)

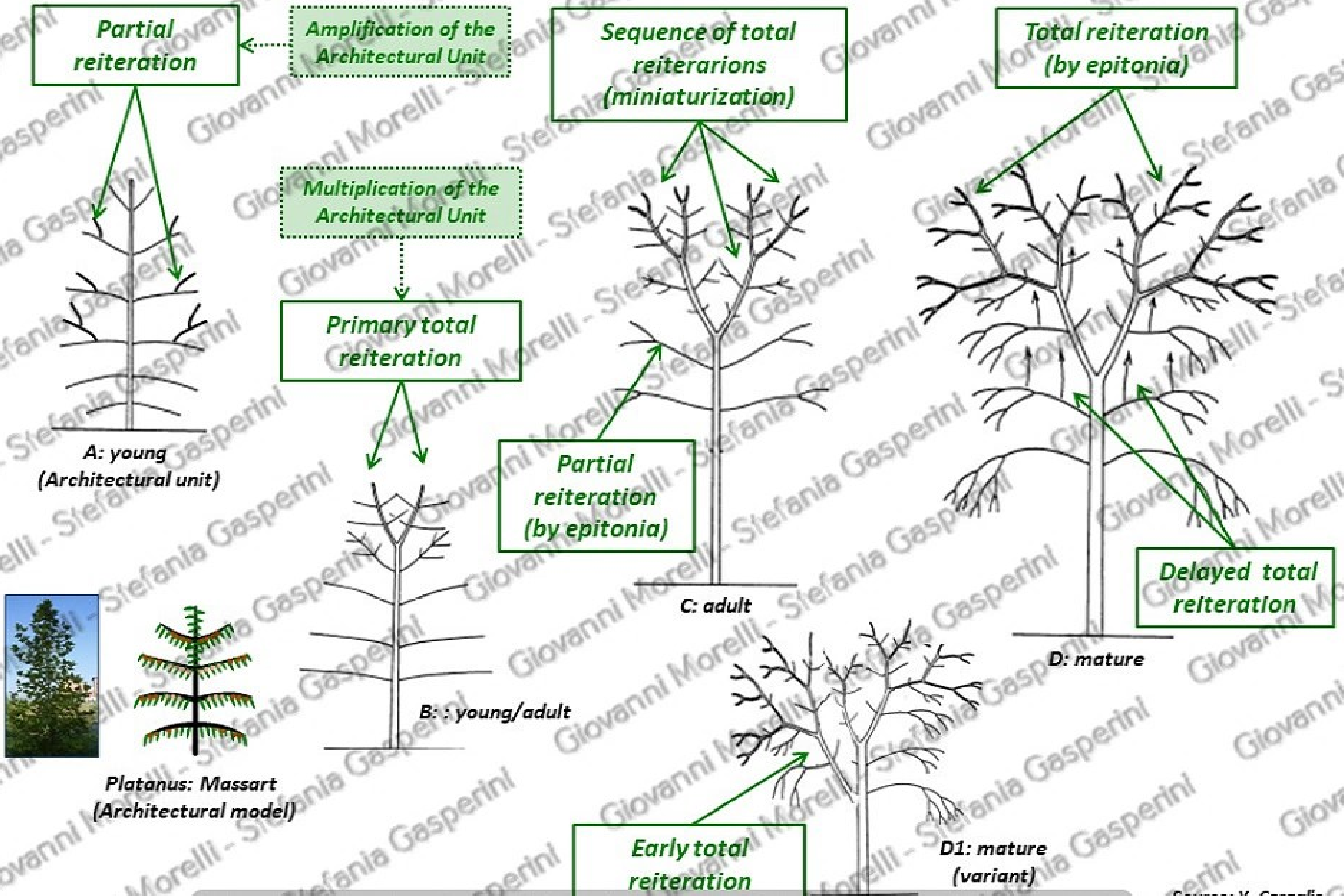






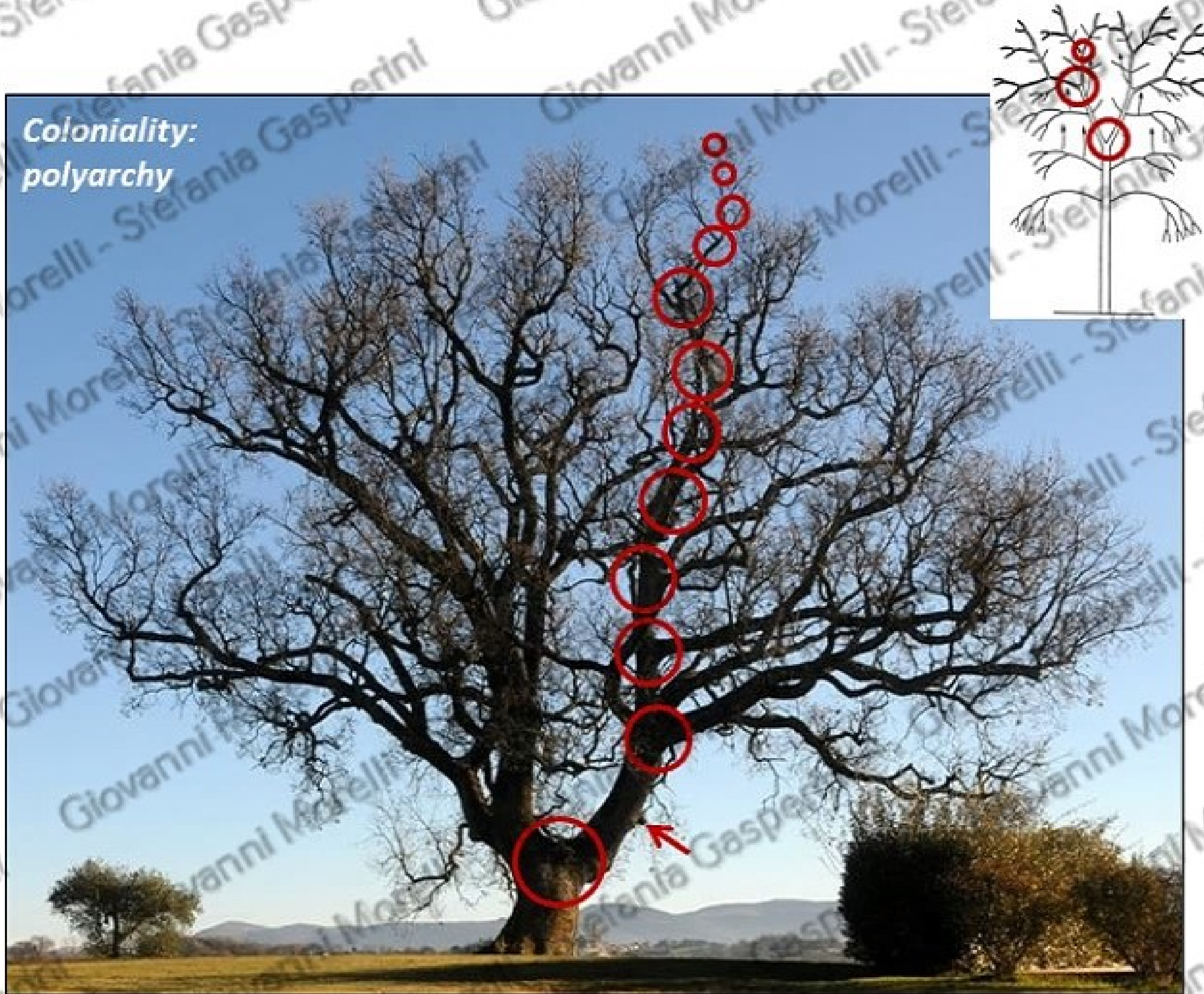
Source: D. Raimbault (da F. Hallé); 2006

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



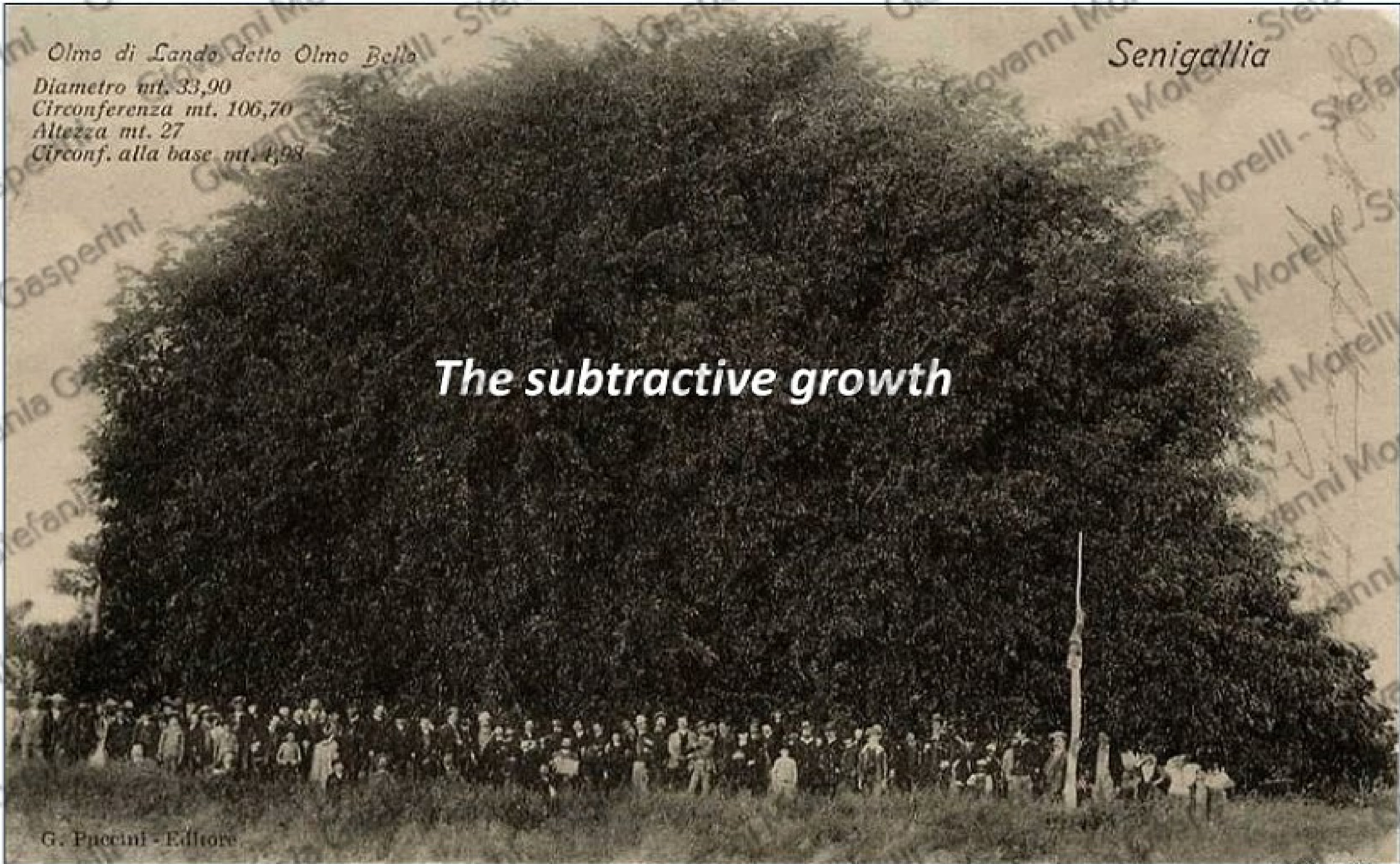
Species growth strategies: gigantism or coloniality

Picea abies.
Photo G. Morelli



Quercus pubescens. Photo: V. Capodarca

Total reiteration
(temporary or permanent polyarchy)


Olmo di Lando detto Olmo Bello
Senigallia
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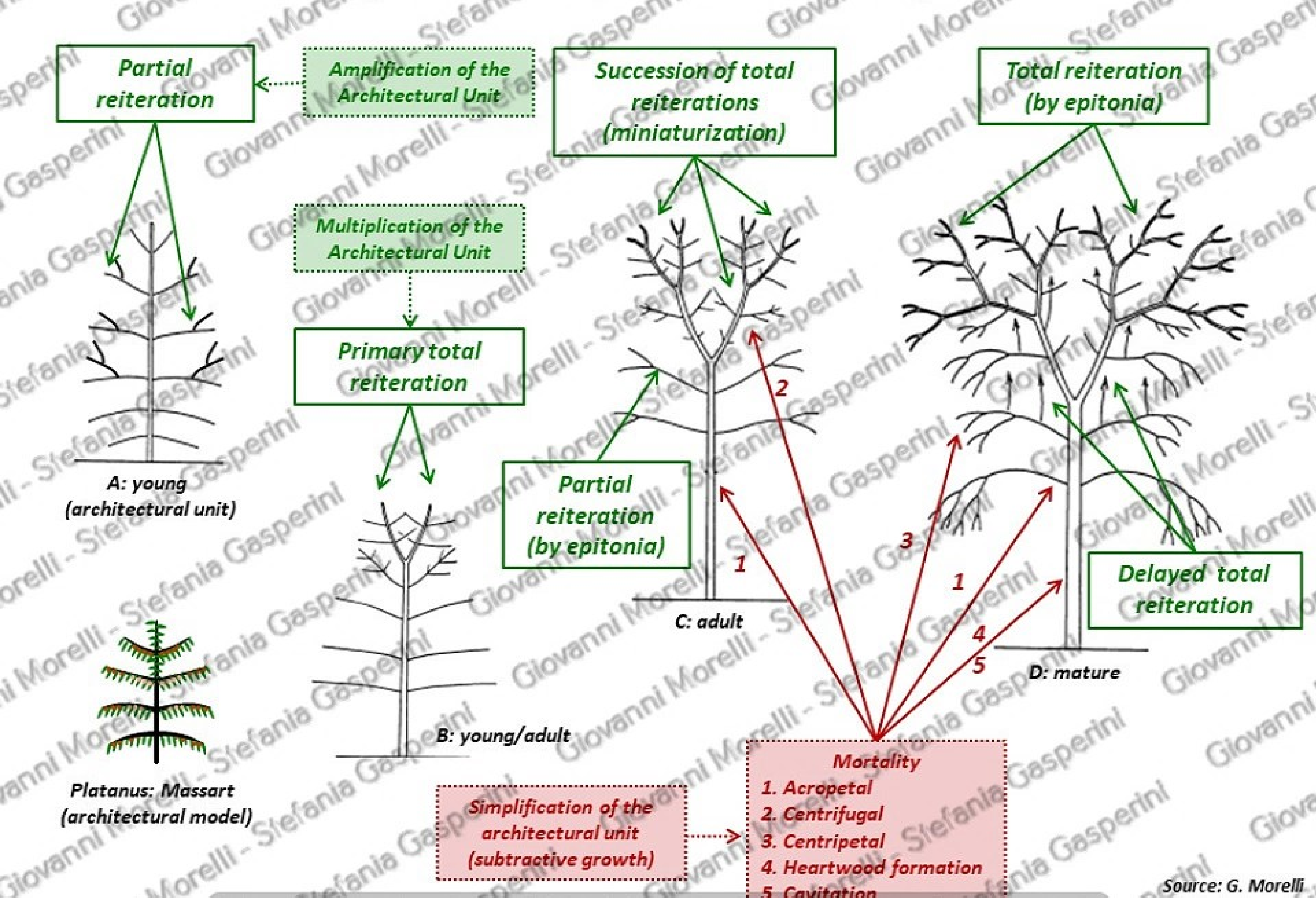
Circonf. alla base mt.
The subtractive growth
G. Puccini - Editore

Sequence of development and subtractive growth

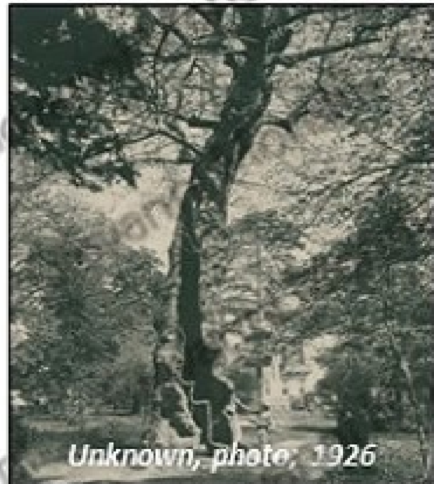


Consequences of modularity: the subtractive growth

Source N. Fay

Platanus orientalis (planted in 1680)
Botanic garden, Padova. Photo G. Morelli

C. Matsheg, watercolors; 1862

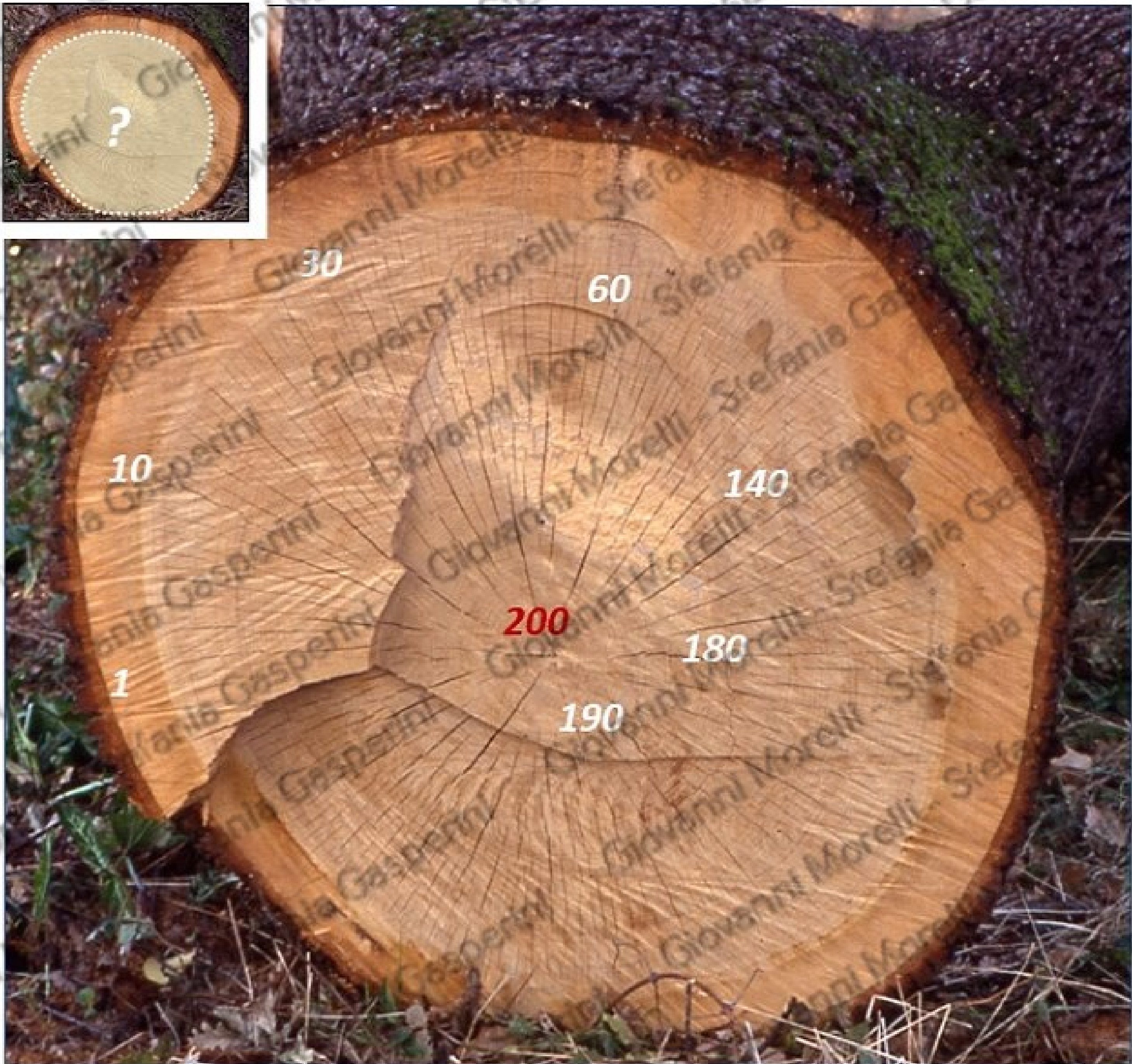


Unknown, photo; 1926

Unknown, photo; 1963

G. Morelli, 2018

Consequences of modularity: Dead or alive? Young or old?



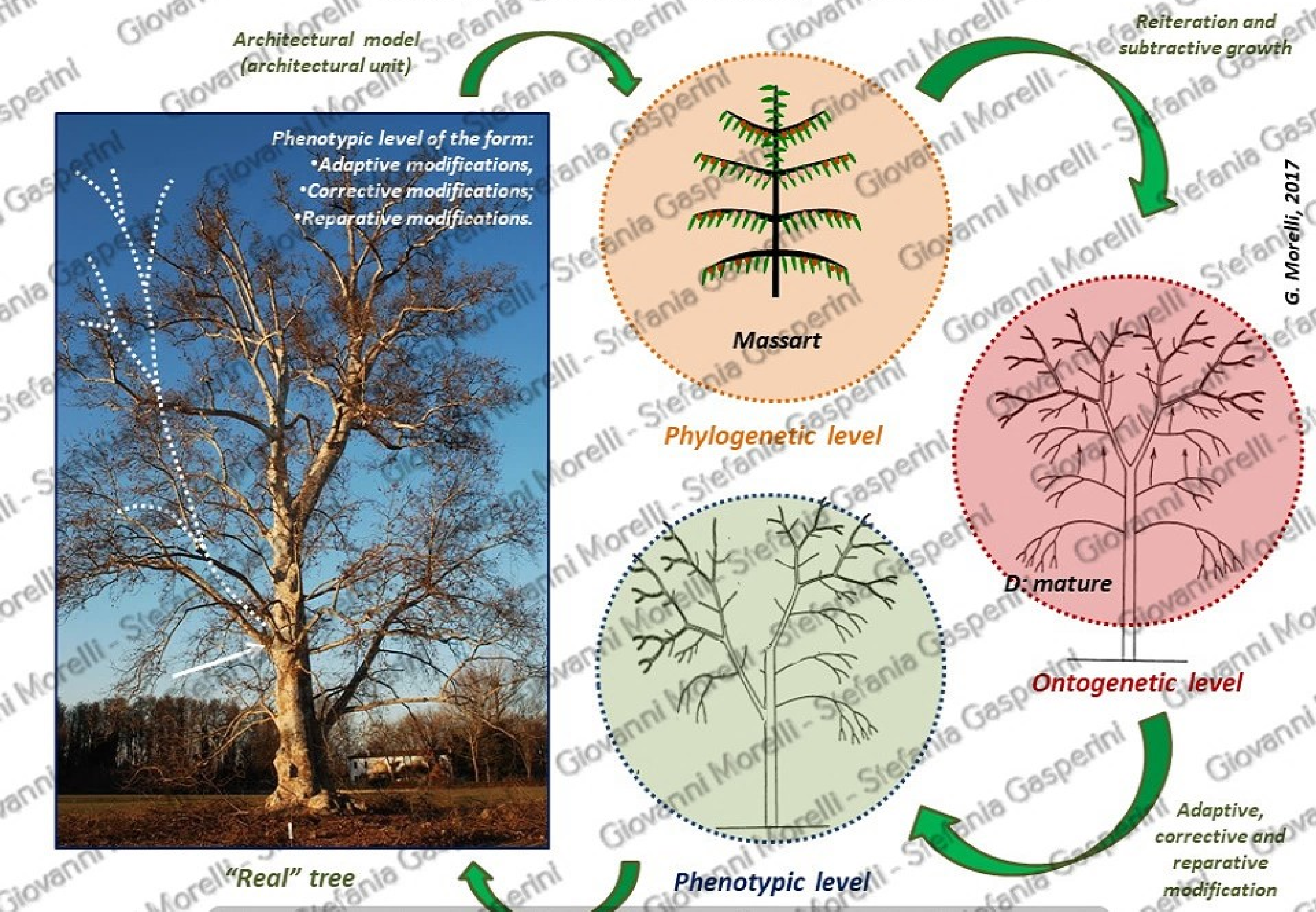
Q. pubescens (1810 - 2010):
200 years, 200 rings, maybe 30 rings of sapwood. Macerata

P. orientalis (1680 - 2019):
339 years, 20 rings of sapwood?
Botanic garden, Padova

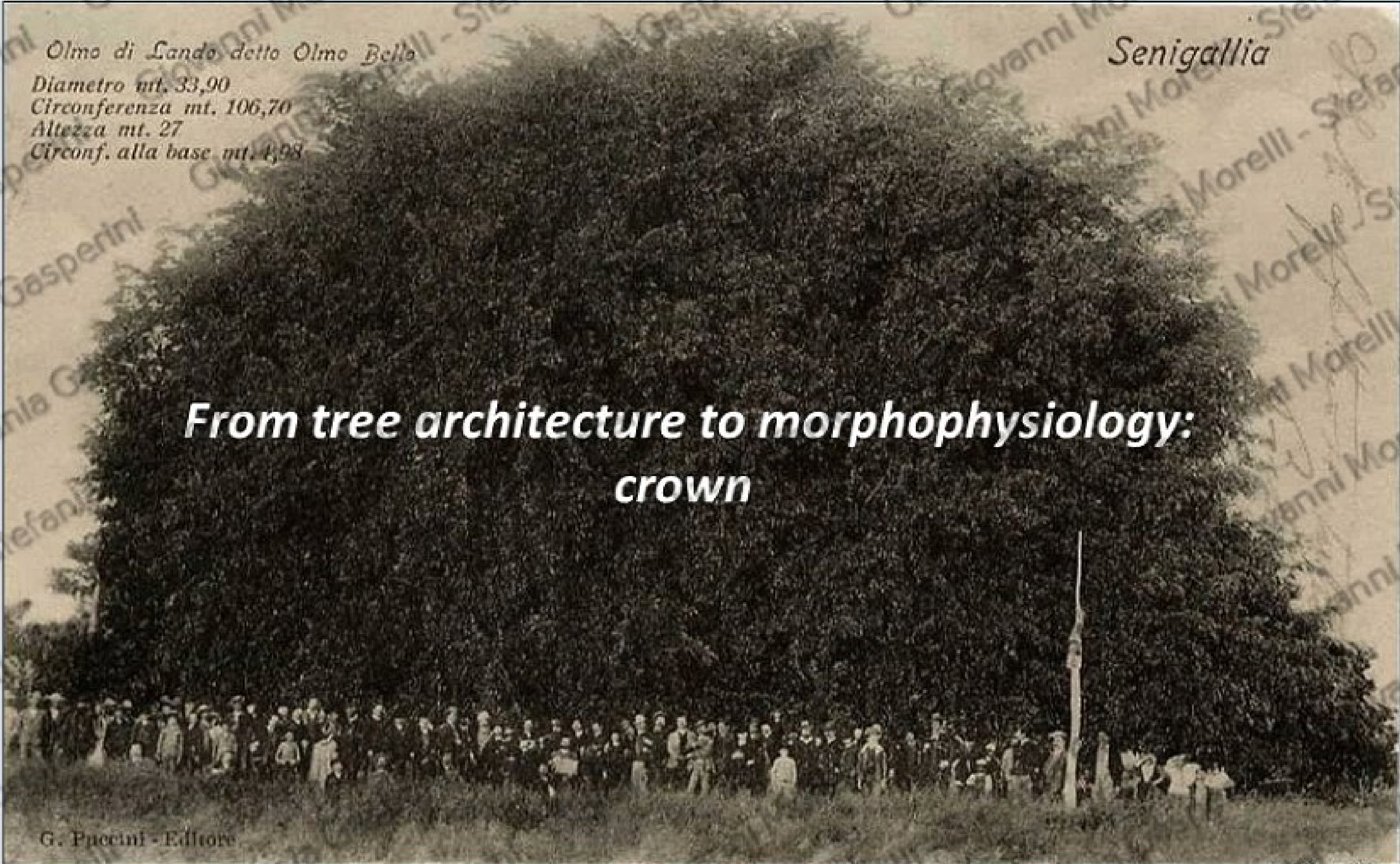
Platanus x acerifolia (1890 - 2000):
110 years, 20 rings of sapwood. Ferrara

Fonte: G. Morelli, 2018

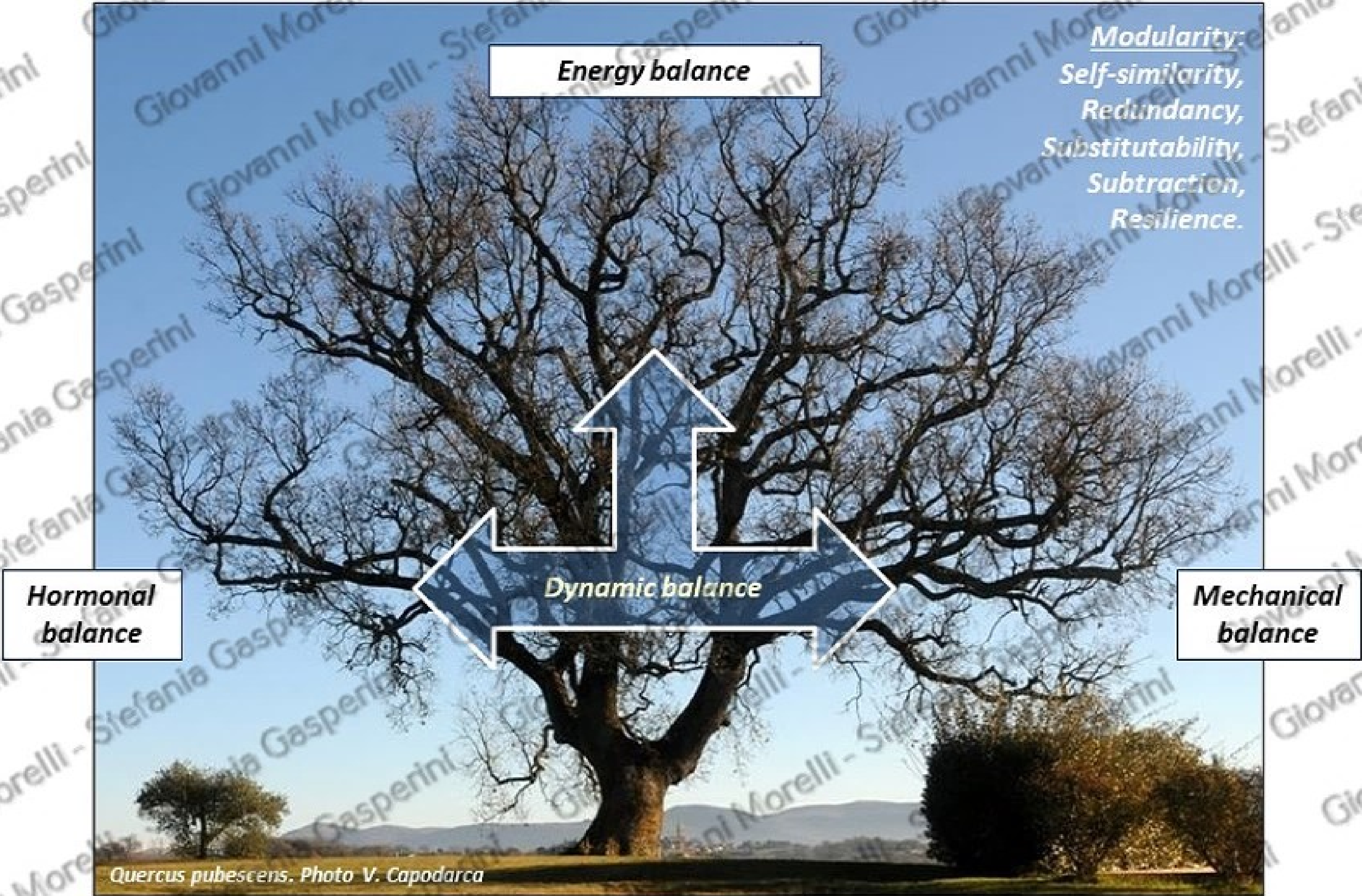
Development: the three levels of the form



From tree architecture to morphophysiology: crown

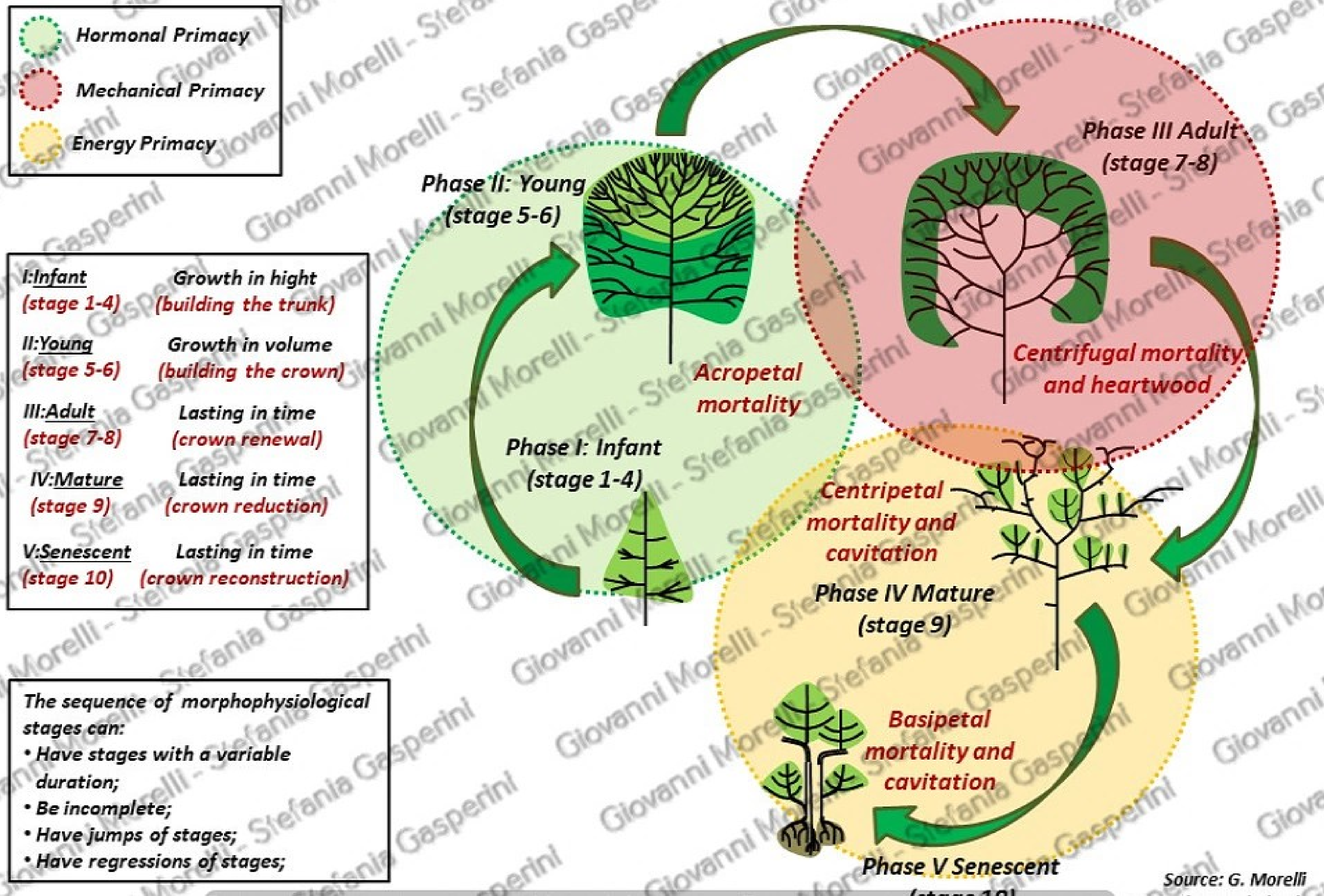


The form as an expression of a dynamic balance



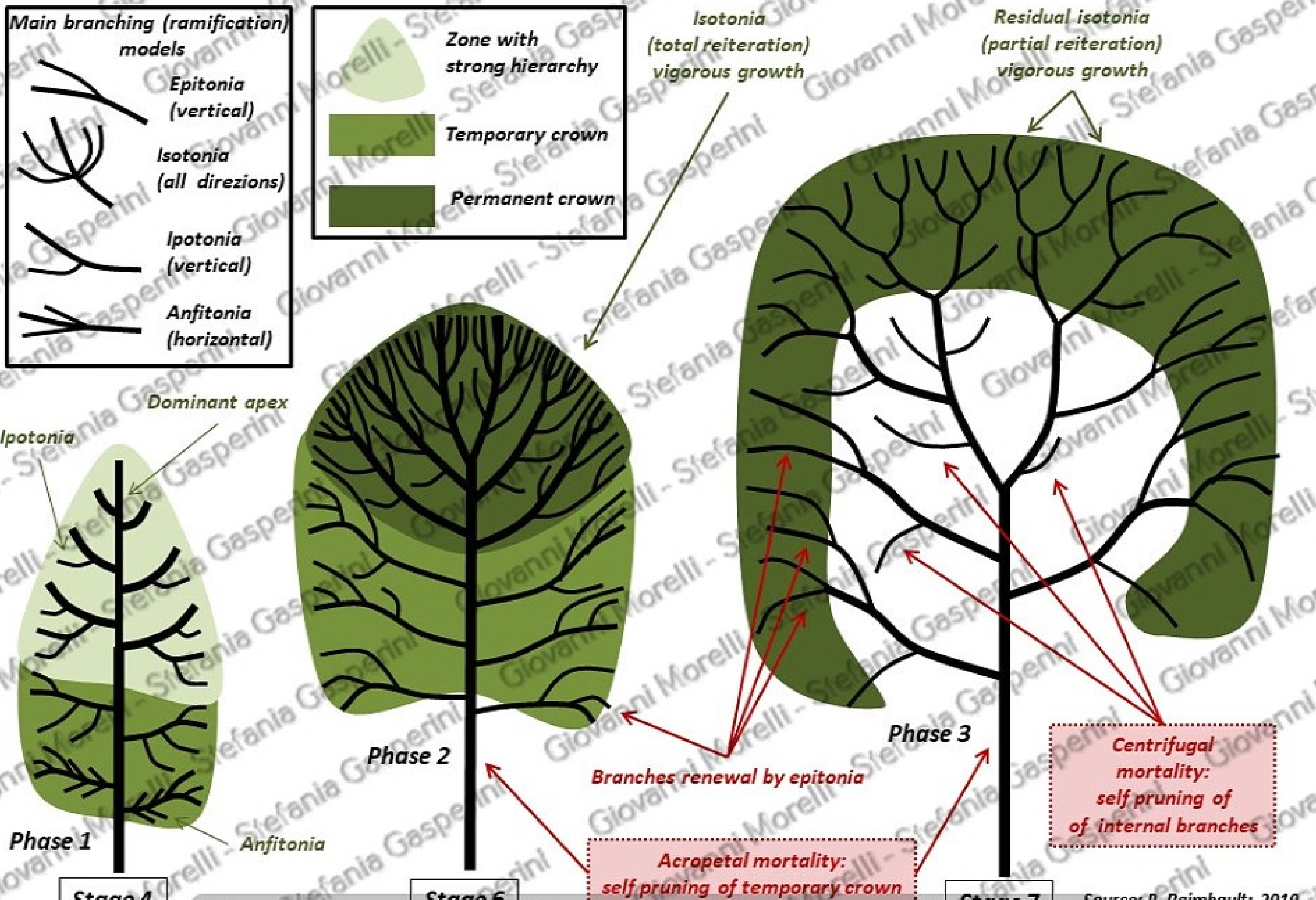
Source: G. Morelli; 2012

The form as an expression of a dynamic balance



Source: G. Morelli

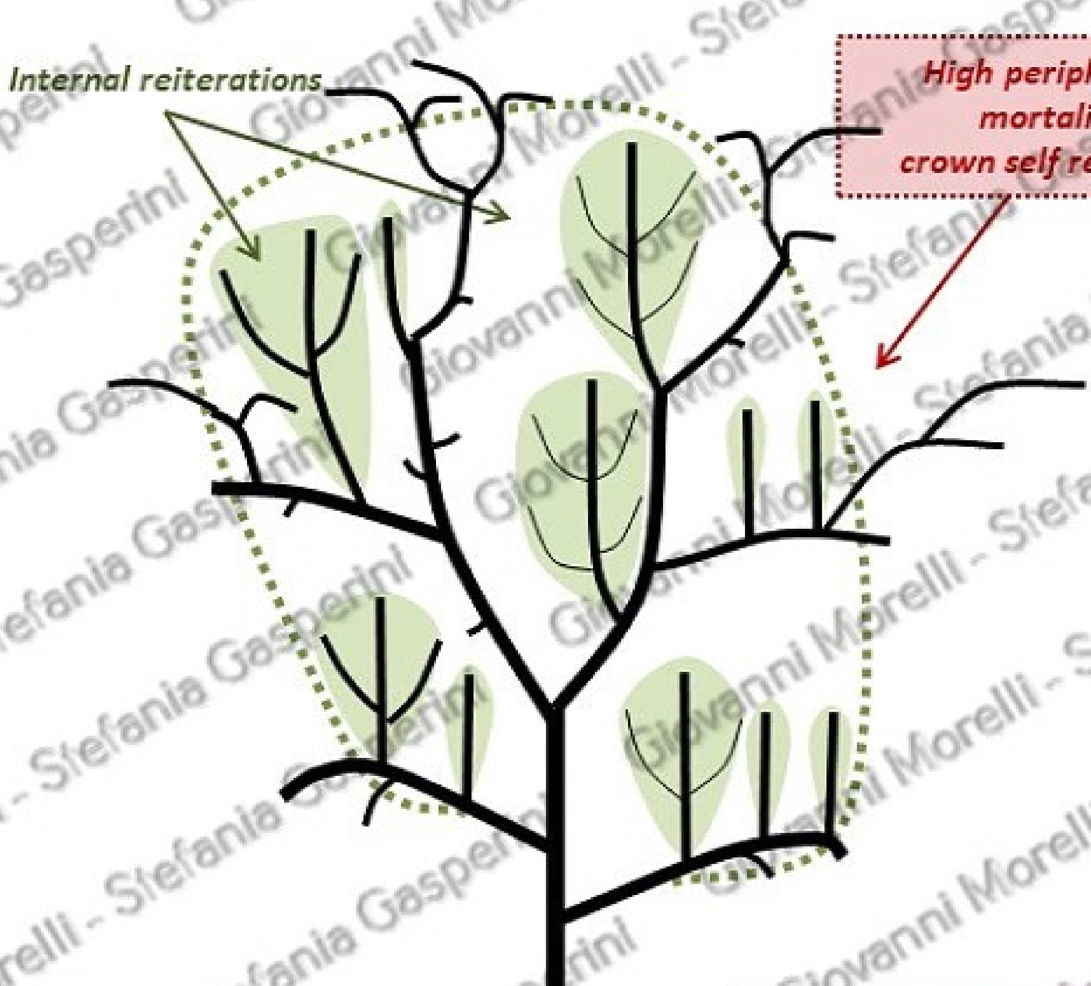
Crown evolution in polyarchy species (Tilia sp.): from Stage 1 to Stage 8

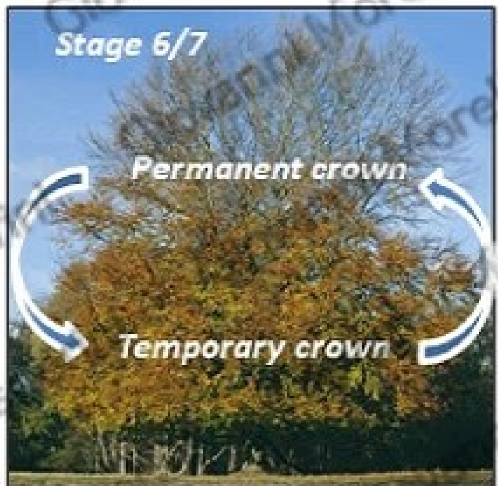


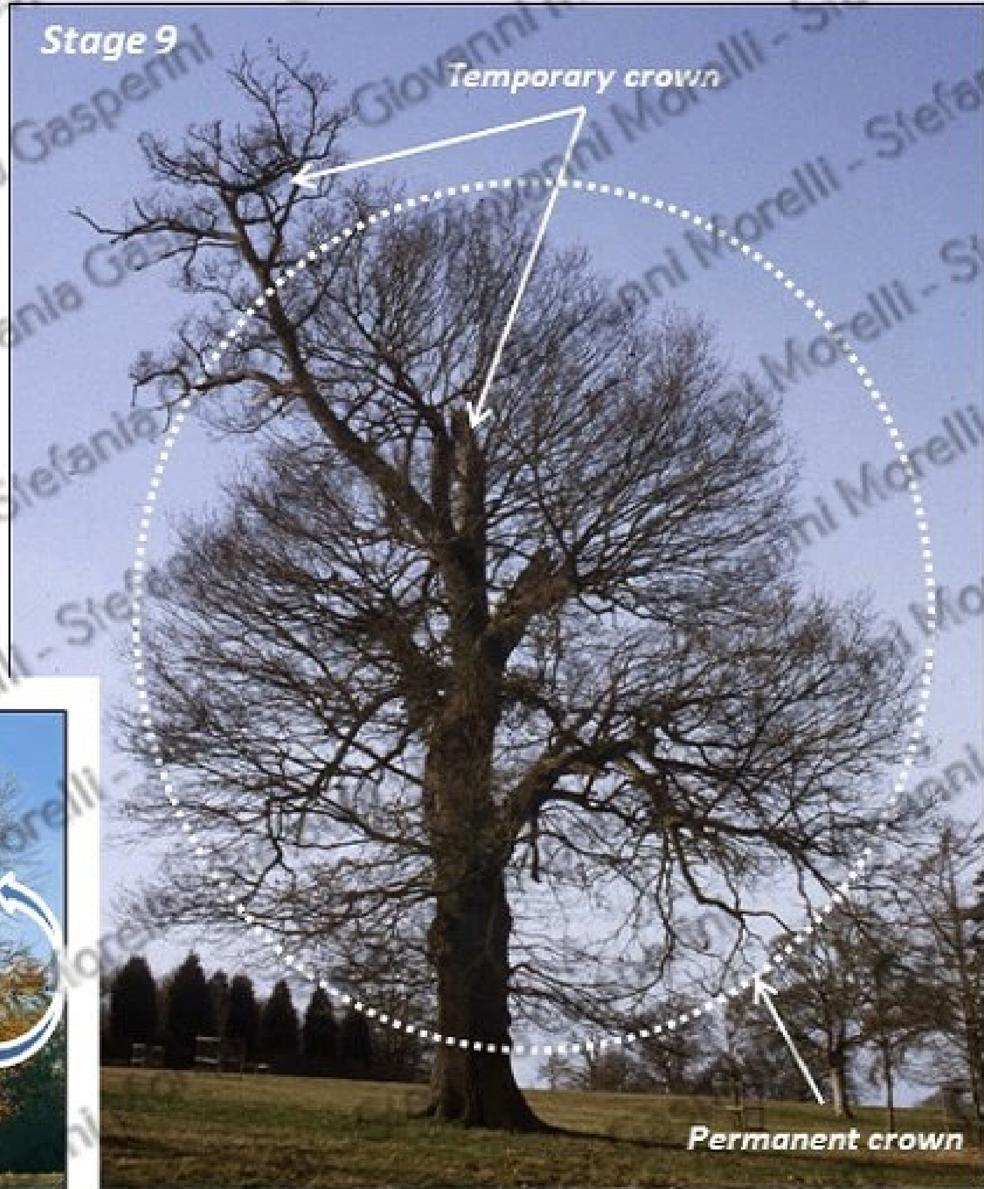
Crown centrifugal mortality (internal self pruning) from Stage 1 to Stage 8

Collybia velutipes on C. australis, Milano

Crown evolution in polyarchy species (Tilia sp.): get to Stage 9 through physiological evolution





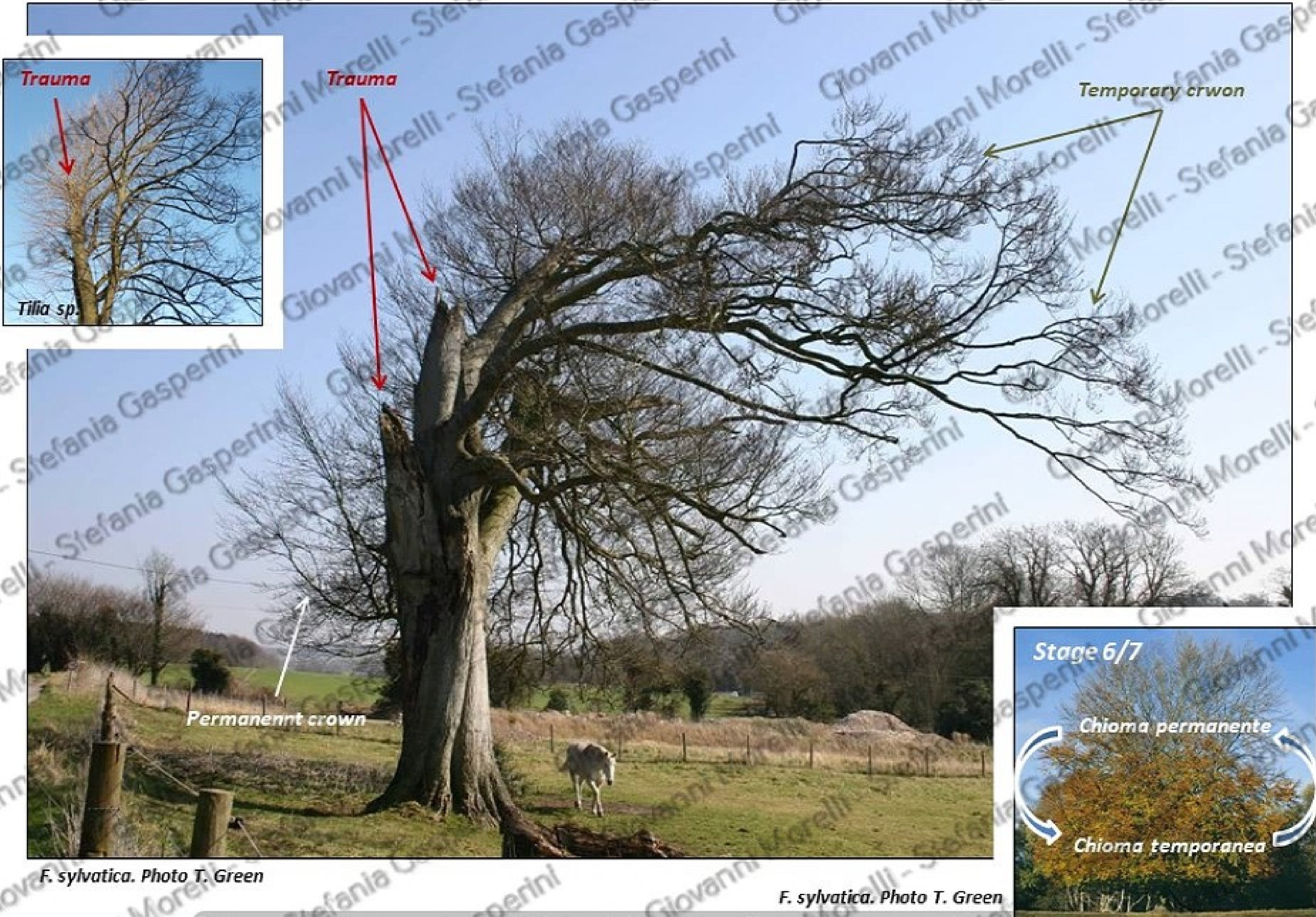


Source: P. Raimbault, 2010

F. sylvatica. Photo Ted Green

Quercus. Photo Ted Green

Crown evolution in polyarchy species (Tilia sp.): get to Stage 9 after a trauma



F. sylvatica. Photo T. Green

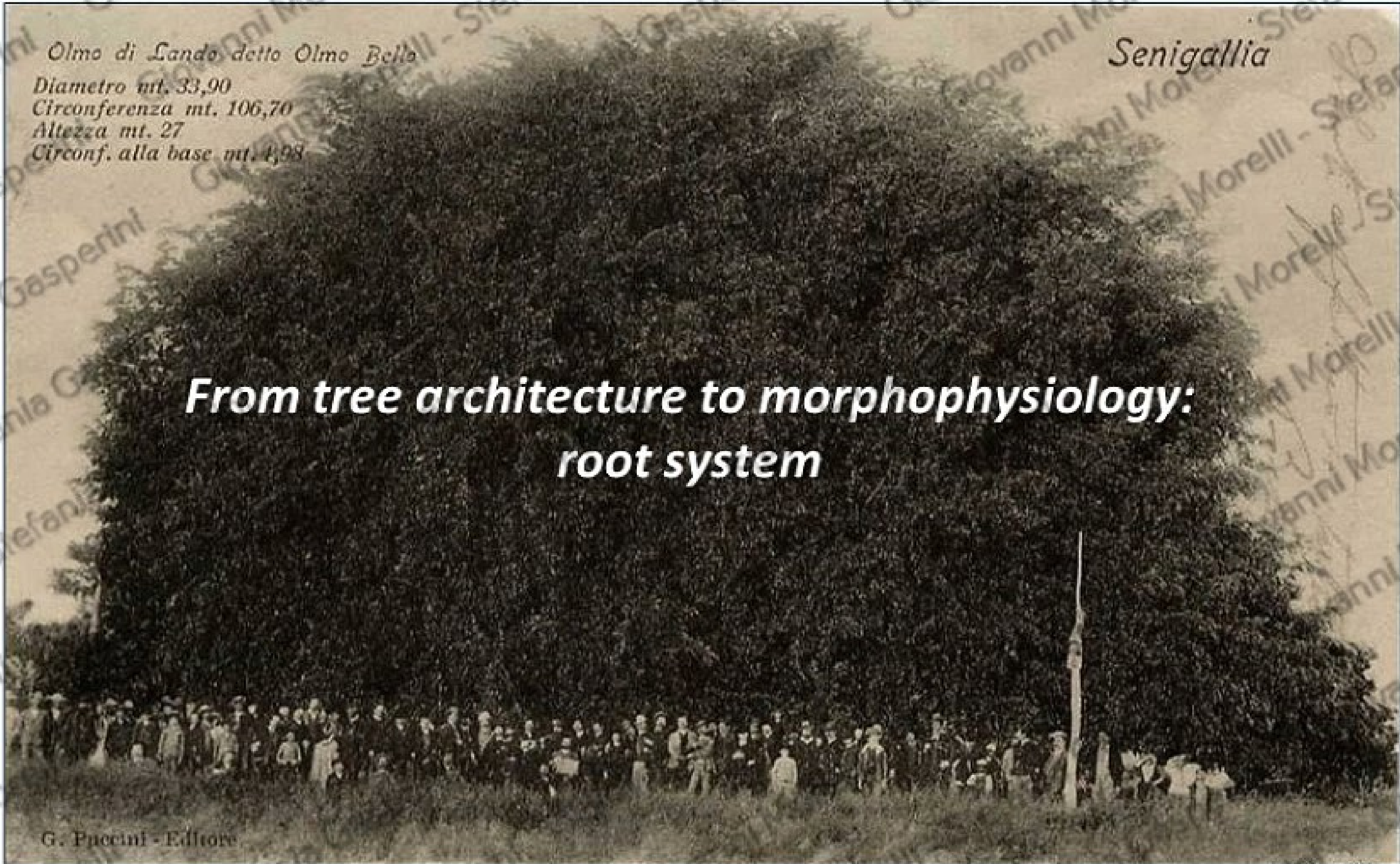
F. sylvatica. Photo T. Green

Crown evolution in polyarchy species: get to Stage 9 through pathological evolution

Robinia pseudoacacia. Fonte G. Morelli

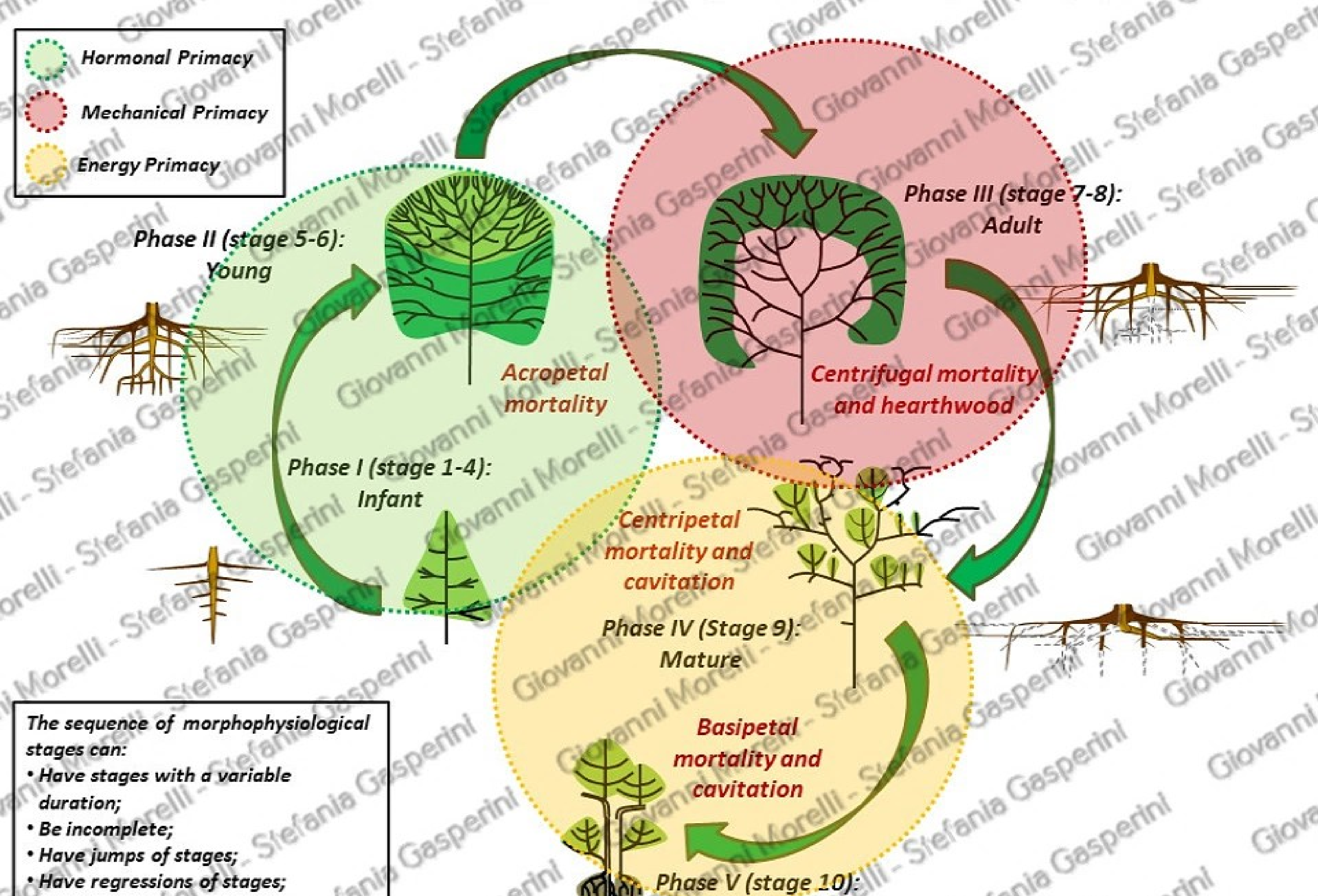
F. sylvatica. Photo T. Green

P. fraxinea. Photo G. Morelli

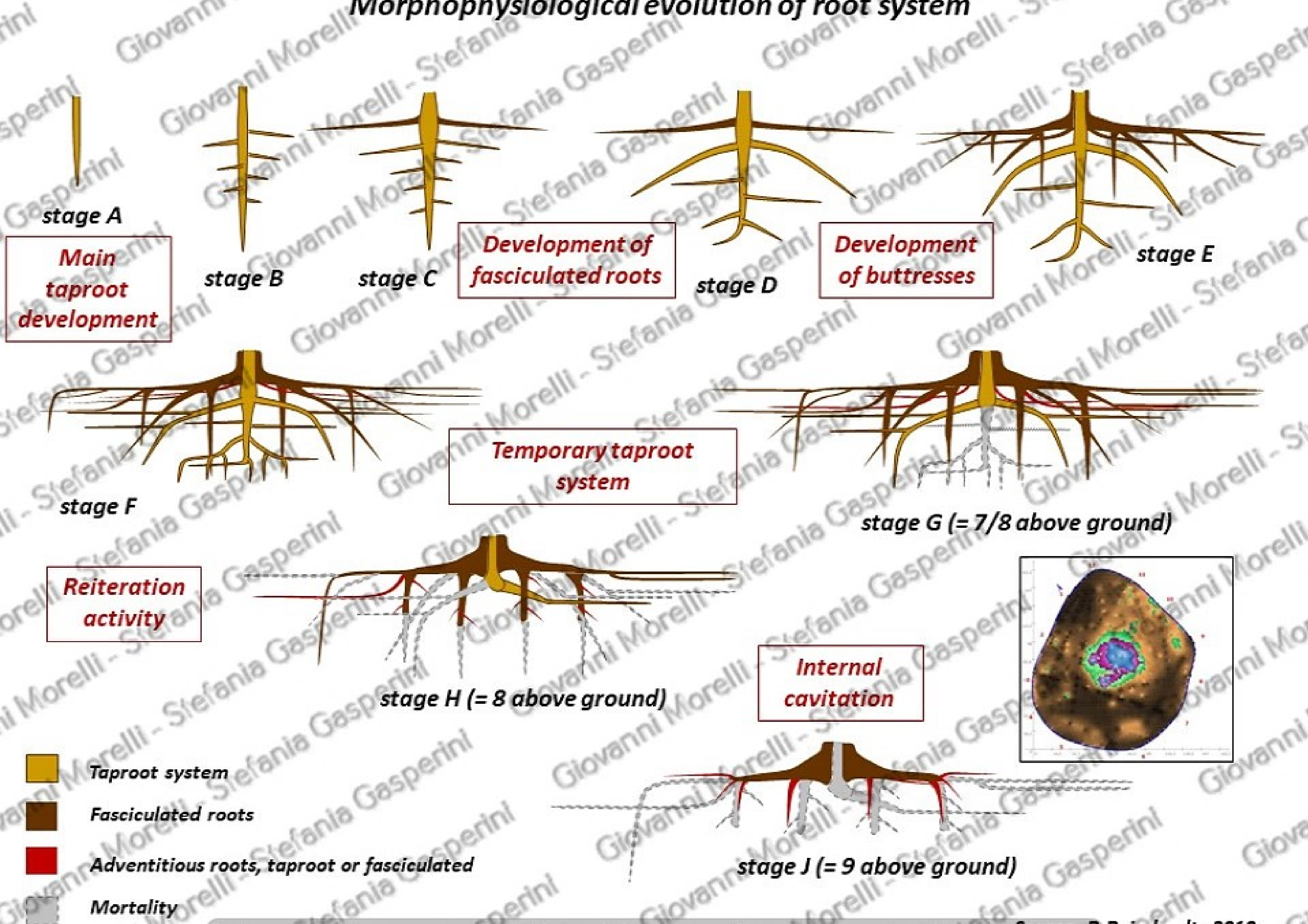


From tree architecture to morphophysiology: root system

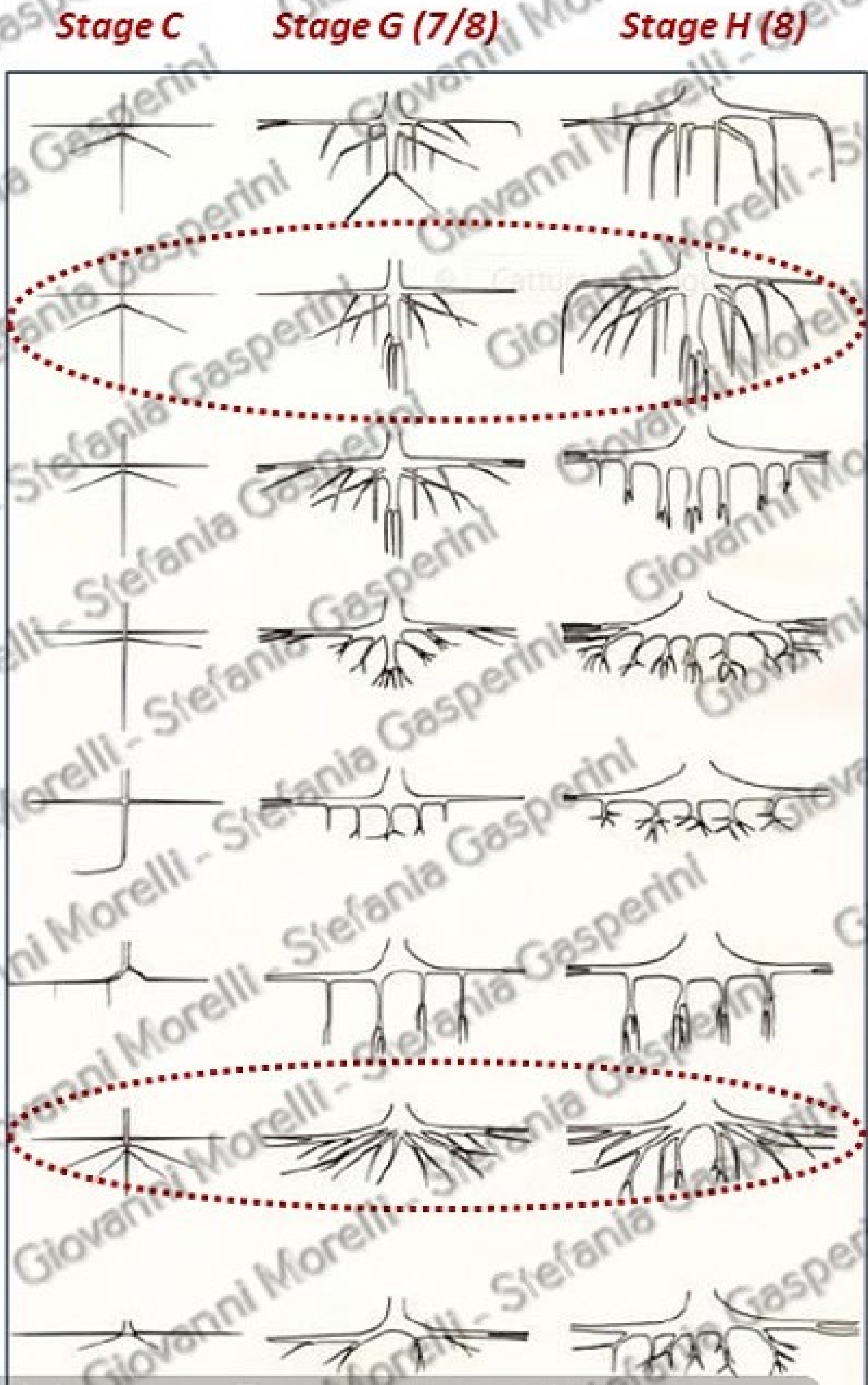
From balance to form: Phases and Stages of development in polyarchy species



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


Morphophysiological evolution of root system
stage A
Main taproot development
stage B
stage C
Development of fasciculated roots
stage D
Development of buttresses
stage E
stage F
Temporary taproot system
stage G (= 7/8 above ground)
Reiteration activity
stage H (= 8 above ground)
Internal cavitation
stage J (= 9 above ground)
Taproot system
Fasciculated roots
Adventitious roots, taproot or fasciculated
Mortality

Morphophysiological evolution of root system related to the species



Cupressus macrocarpa (Massart)

Pinus sylvestris (Rauh)

Abies alba (Massart)

Sequoia sempervirens (Rauh/Massart)

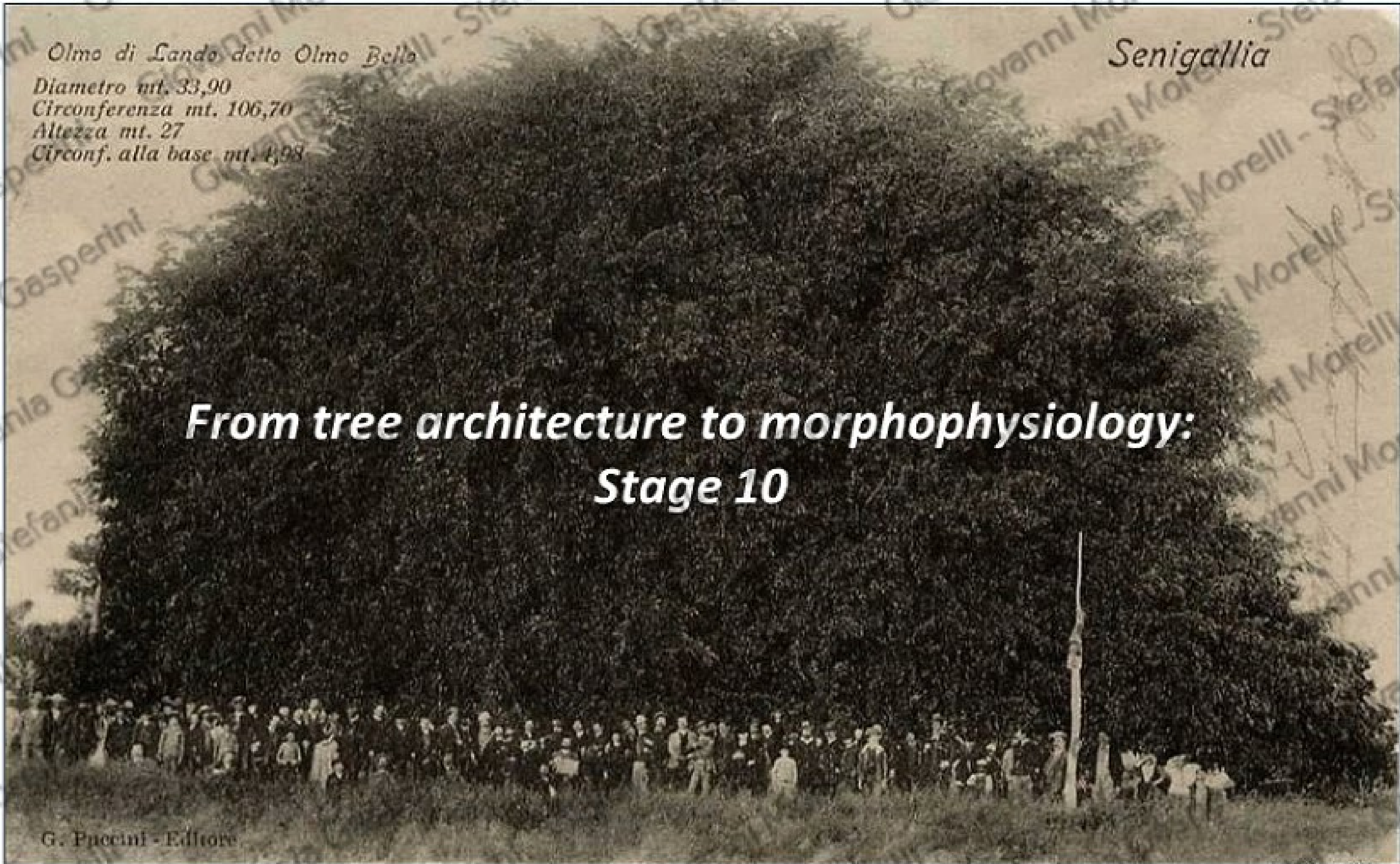
Fraxinus excelsior (Leeuwenberg di Rauh)

Picea abies (Rauh)

Tilia cordata (Troll)

Gleditschia triacanthos (Kwan-Koriba)

P. Raimbault; 2003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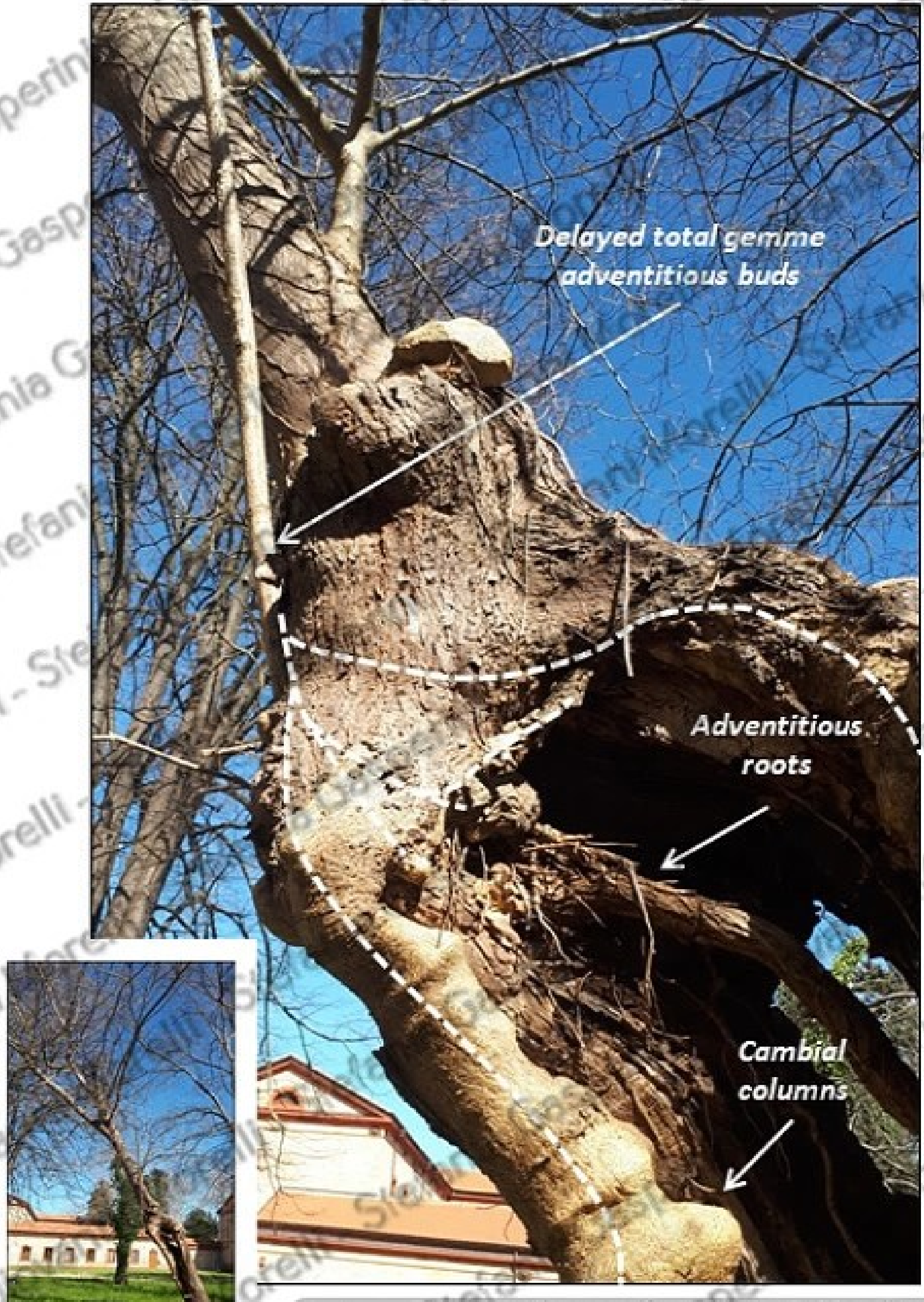
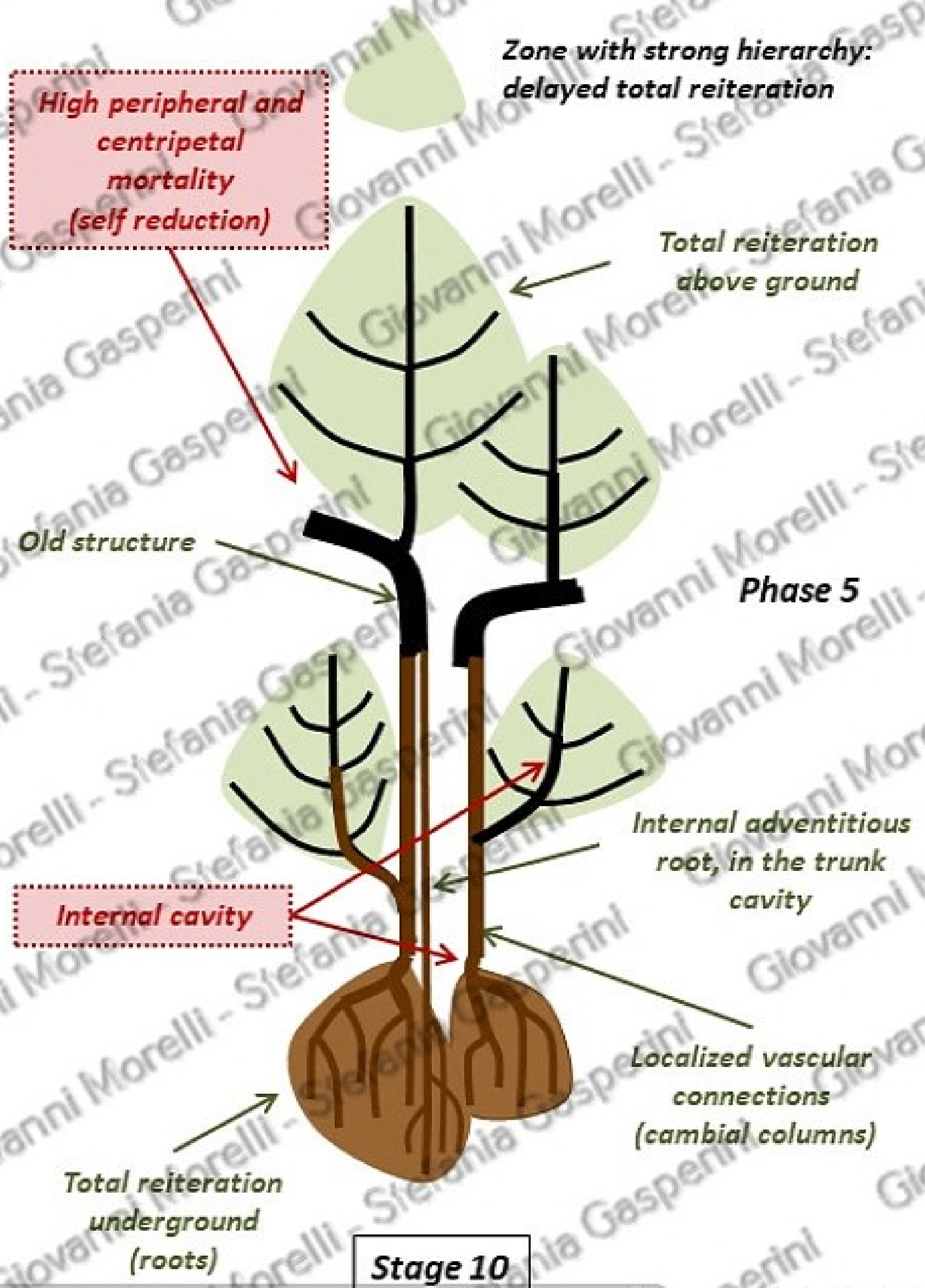
Senigallia
From tree architecture to morphophysiology:
Stage 10
G. Puccini - Editore

Tree evolution in polyarchy species: Stage 10 and reconstruction

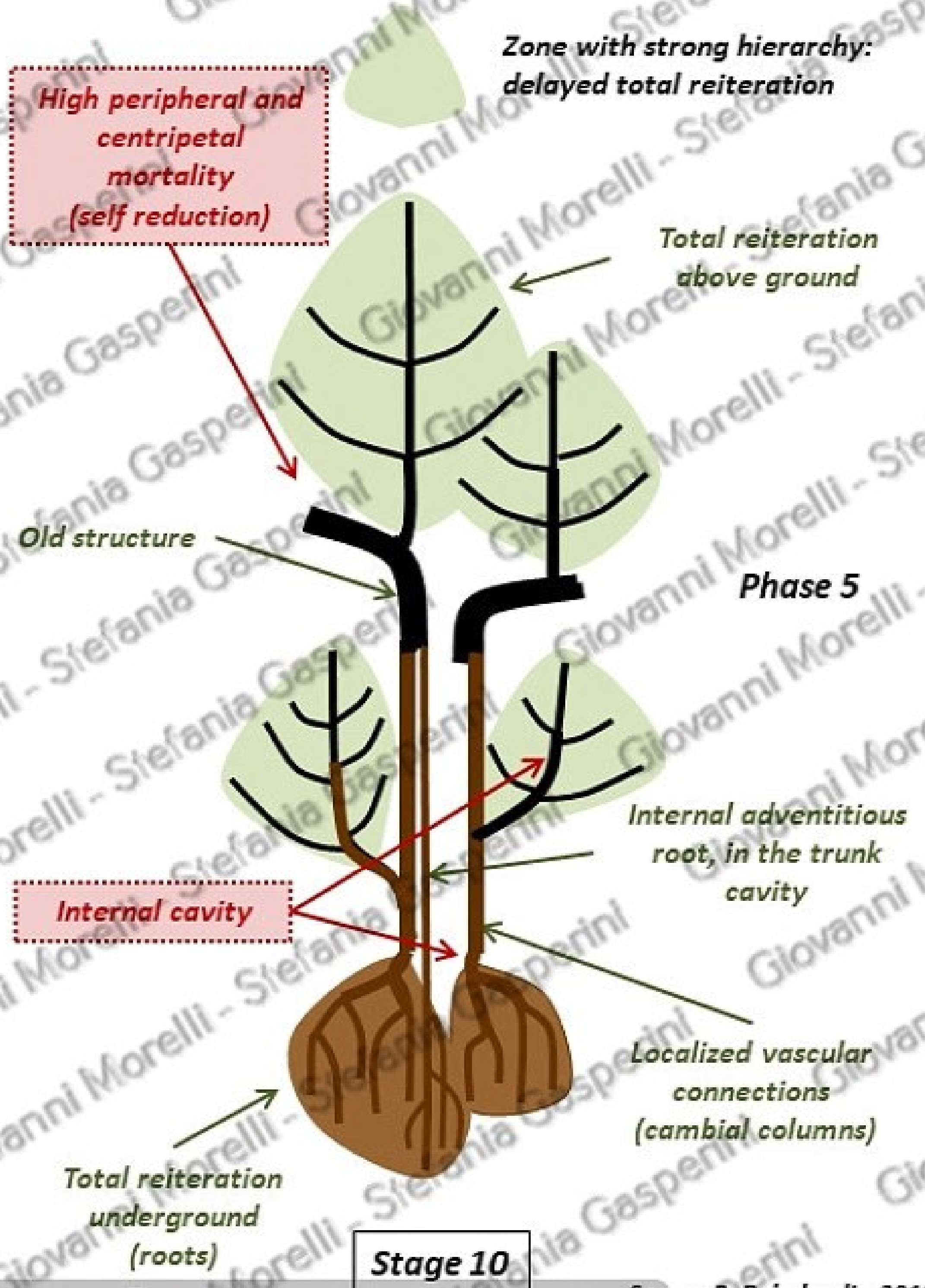




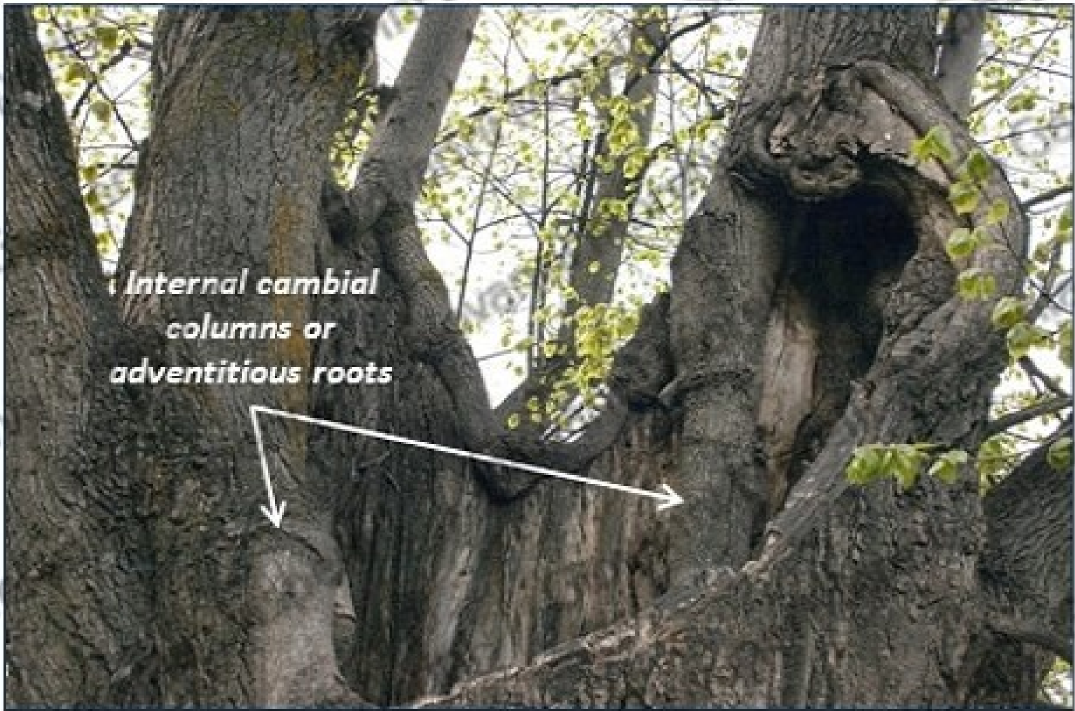
Tree evolution in polyarchy species: Stage 10 and reconstruction

Robinia pseudoacacia. Photo G. Sani

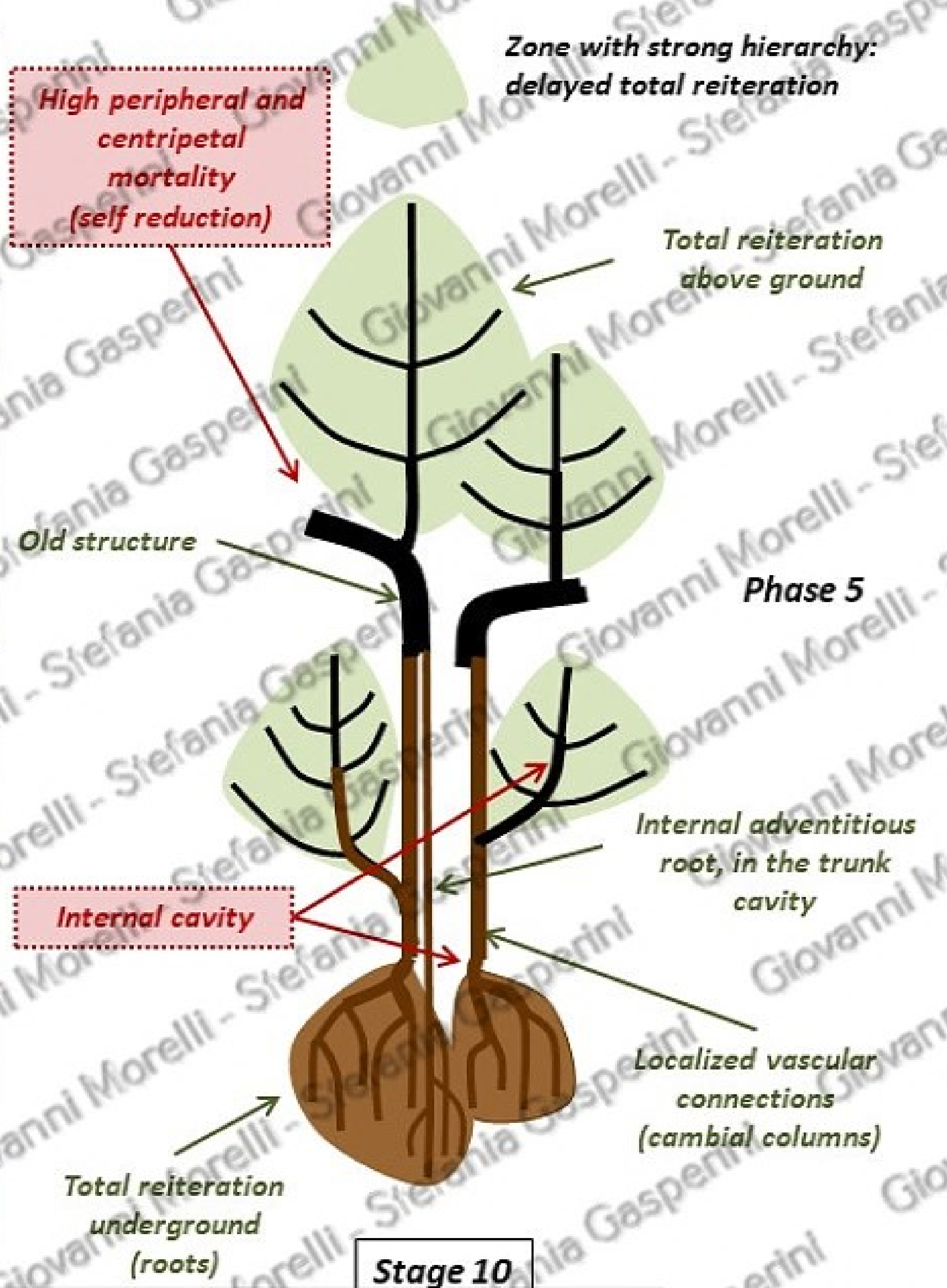
Tilia sp. Source Pisa today



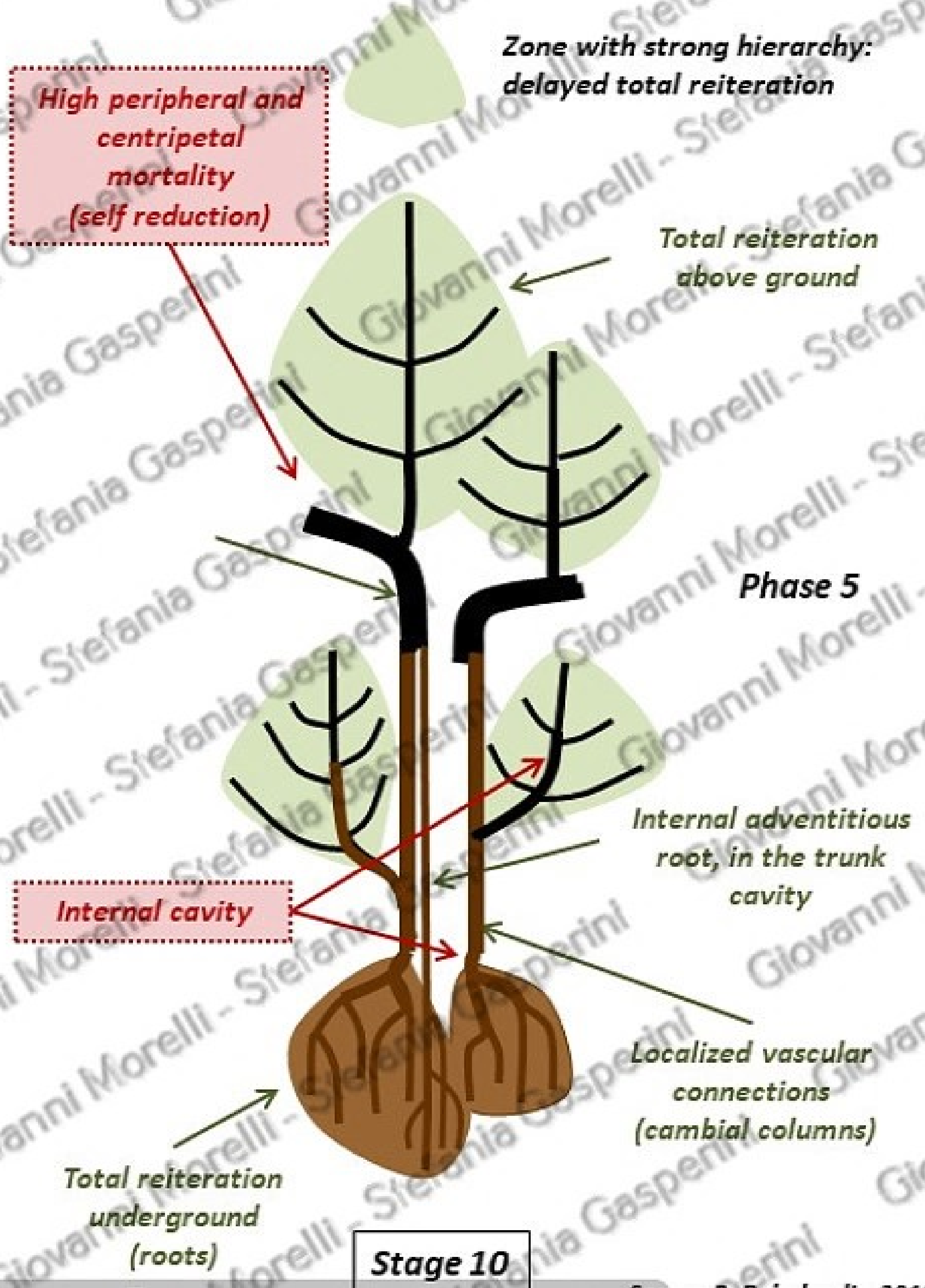
Tree evolution in polyarchy species: Stage 10 and reconstruction



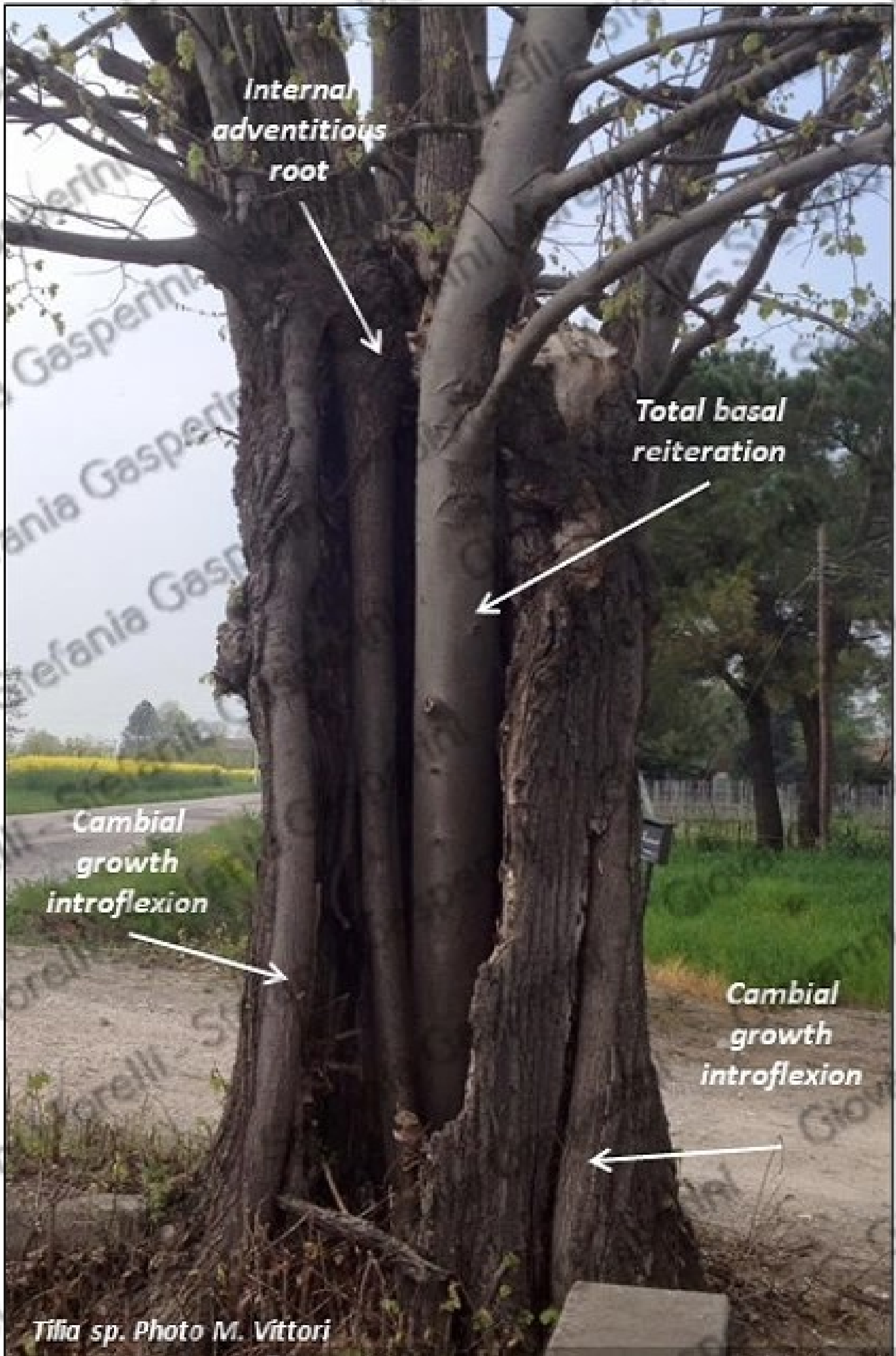
Tilia sp. Photo G. Morelli

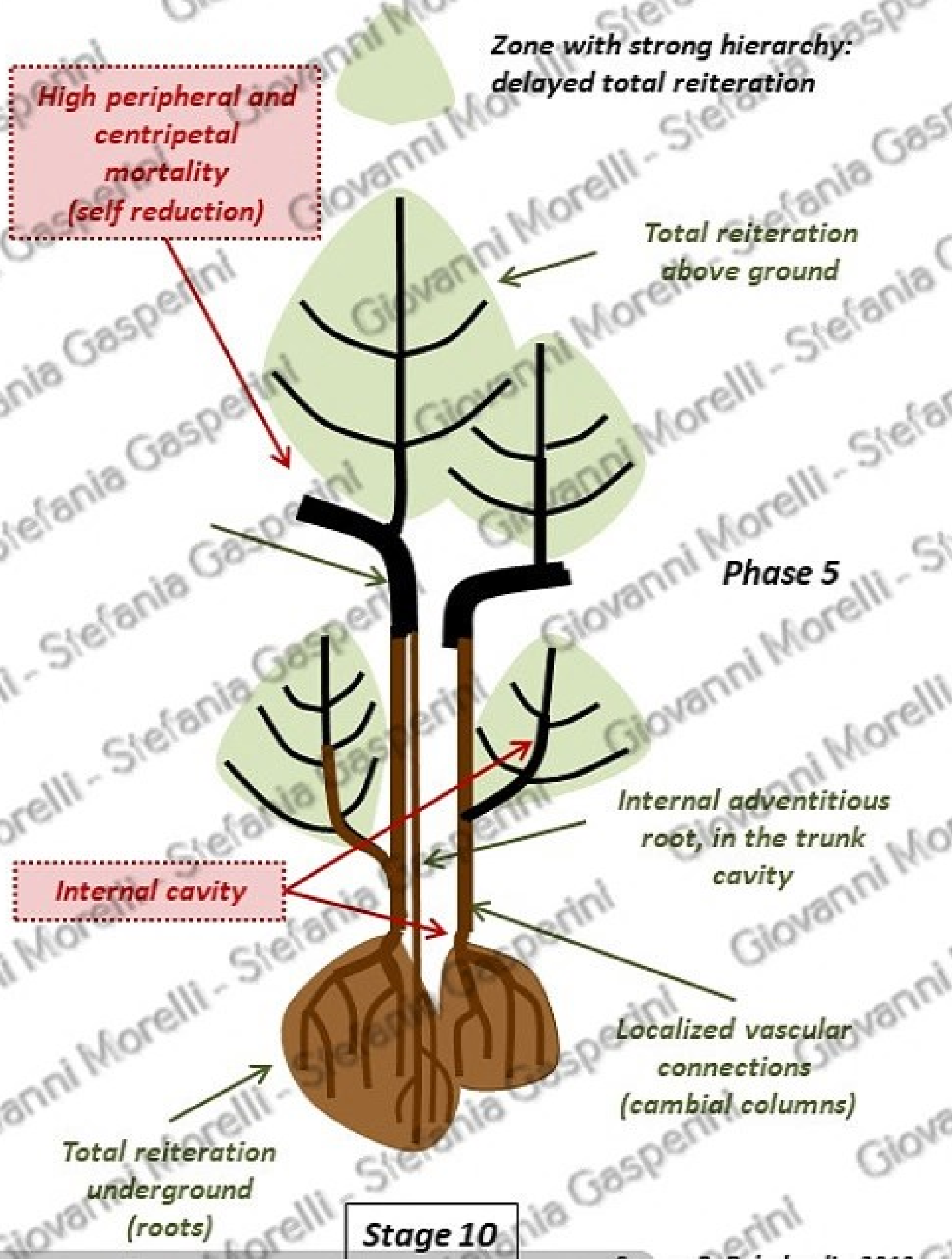


Tree evolution in polyarchy species: Stage 10 and reconstruction

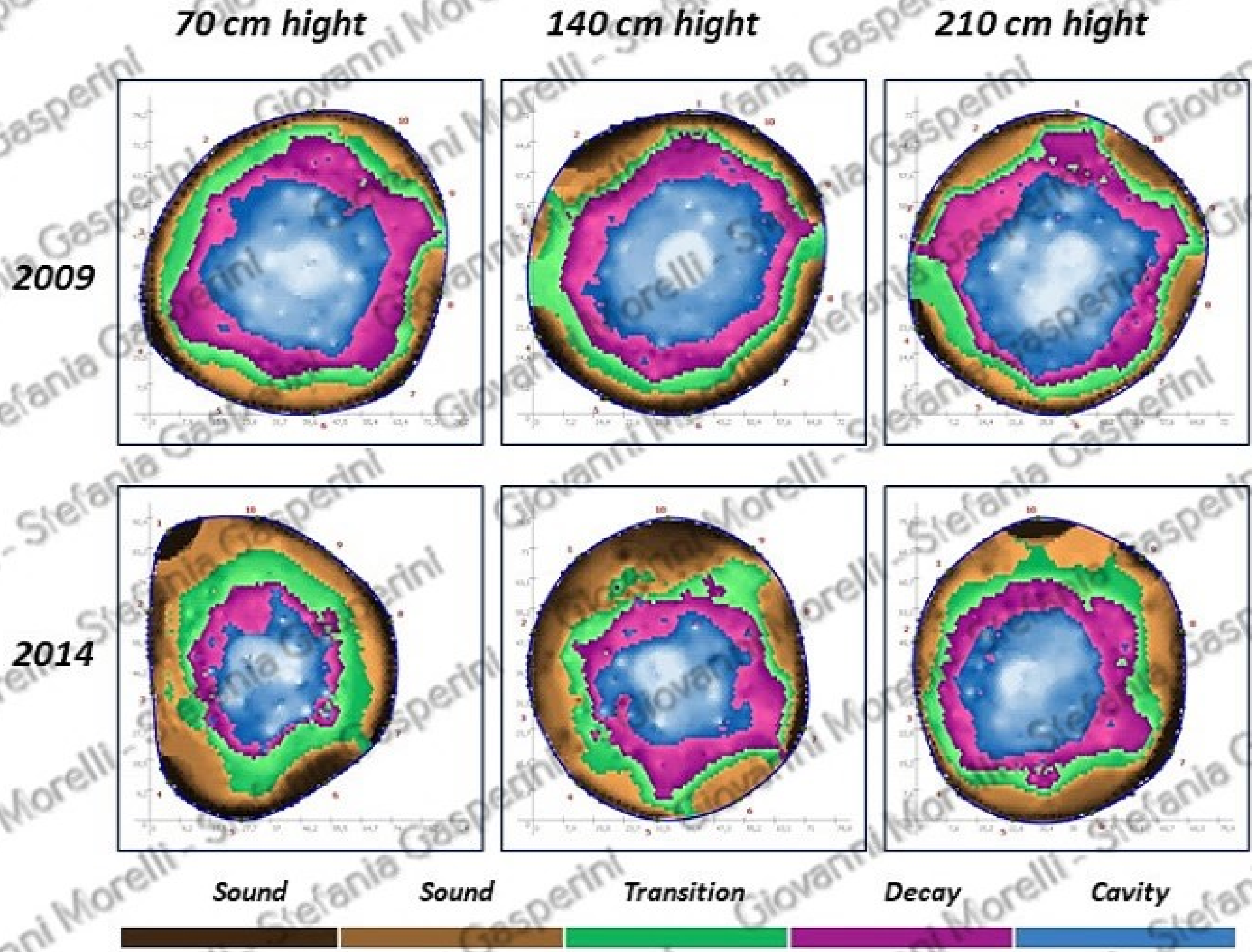


Tree evolution in polyarchy species: Stage 1 and reconstruction 0



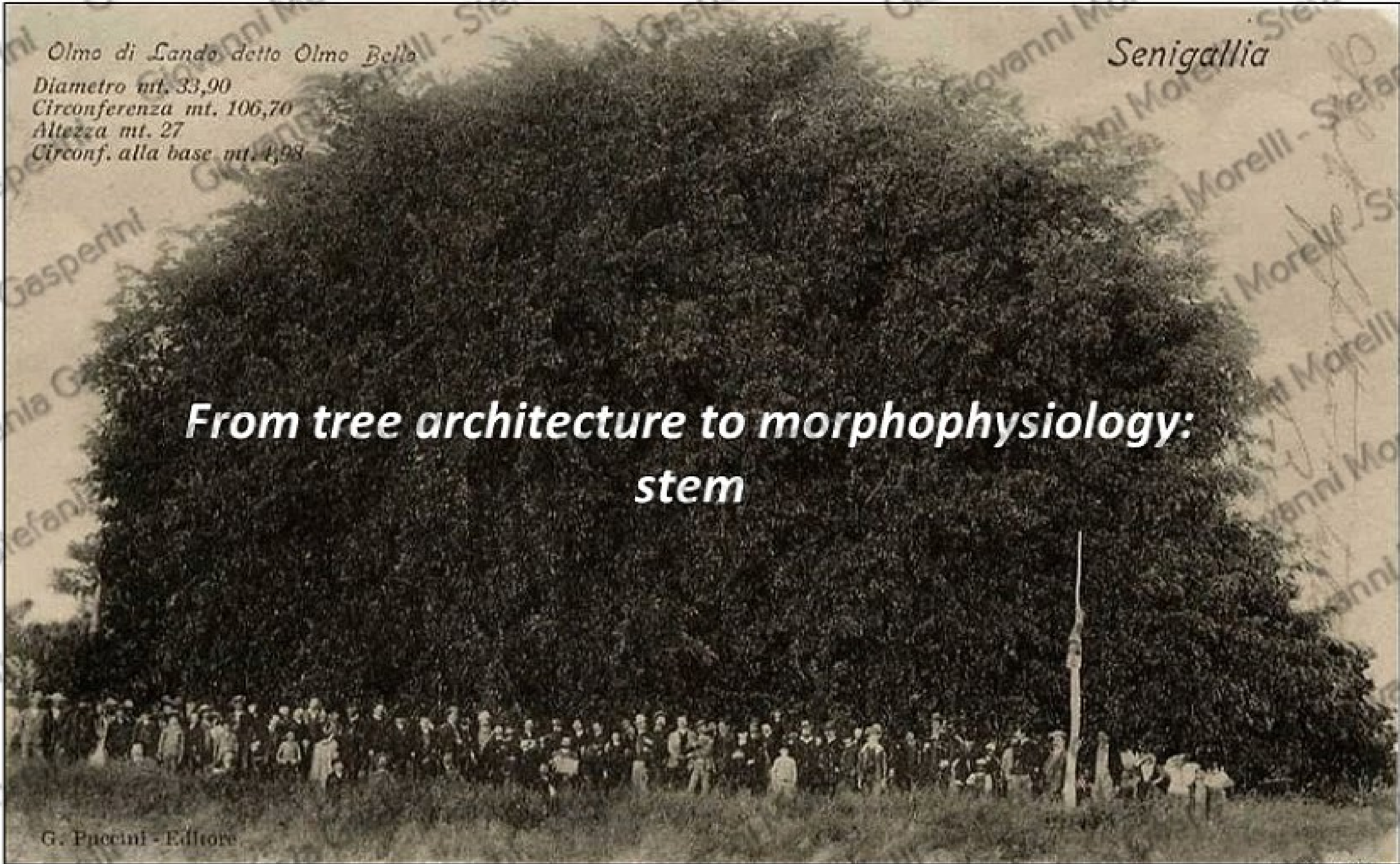


The reintegration of the individual: cavity, cambial columns and cambial bridges

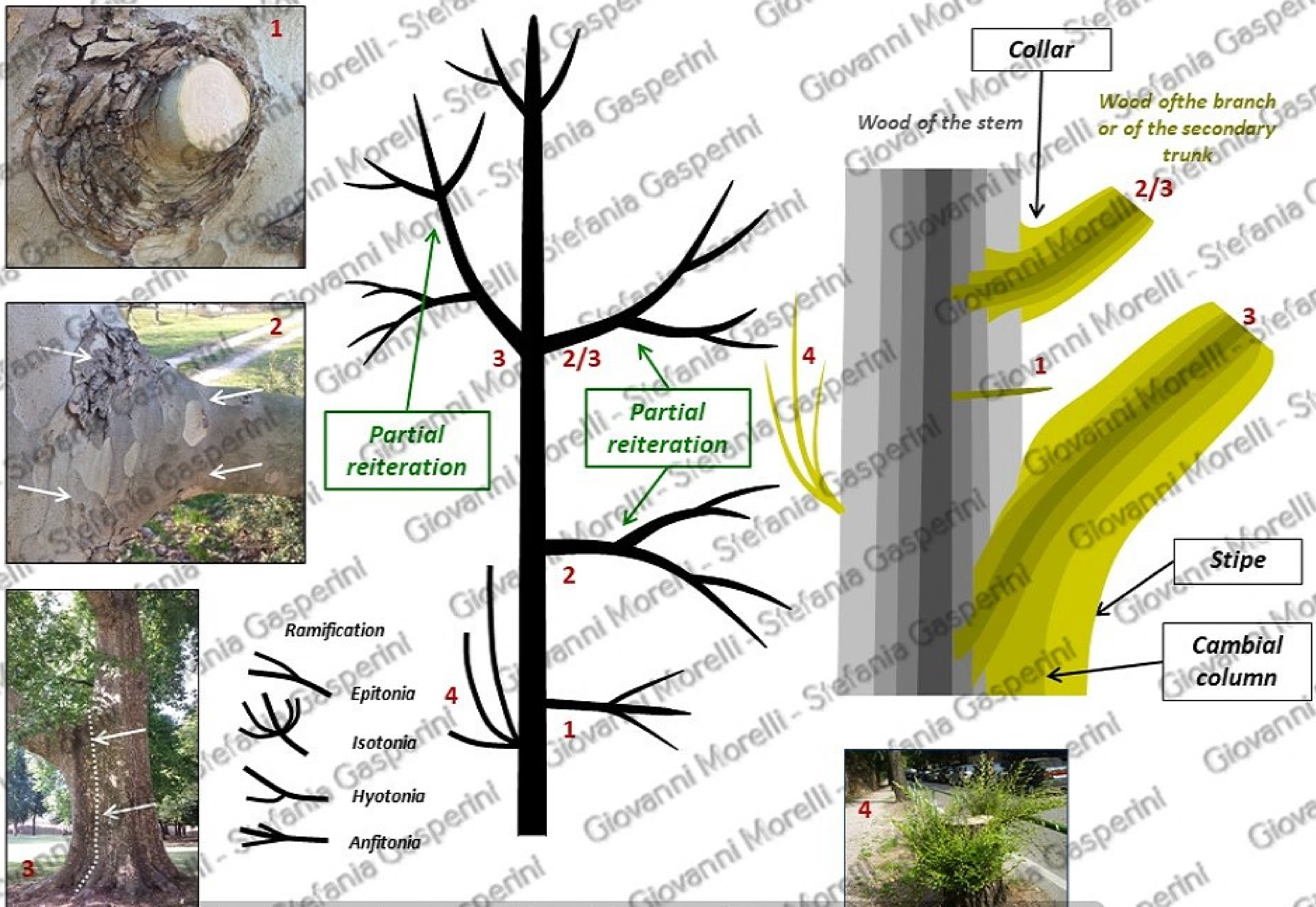


Tomograms of Sophora japonica; Piazza Capitaniato, Padova

From tree architecture to morphophysiology: stem

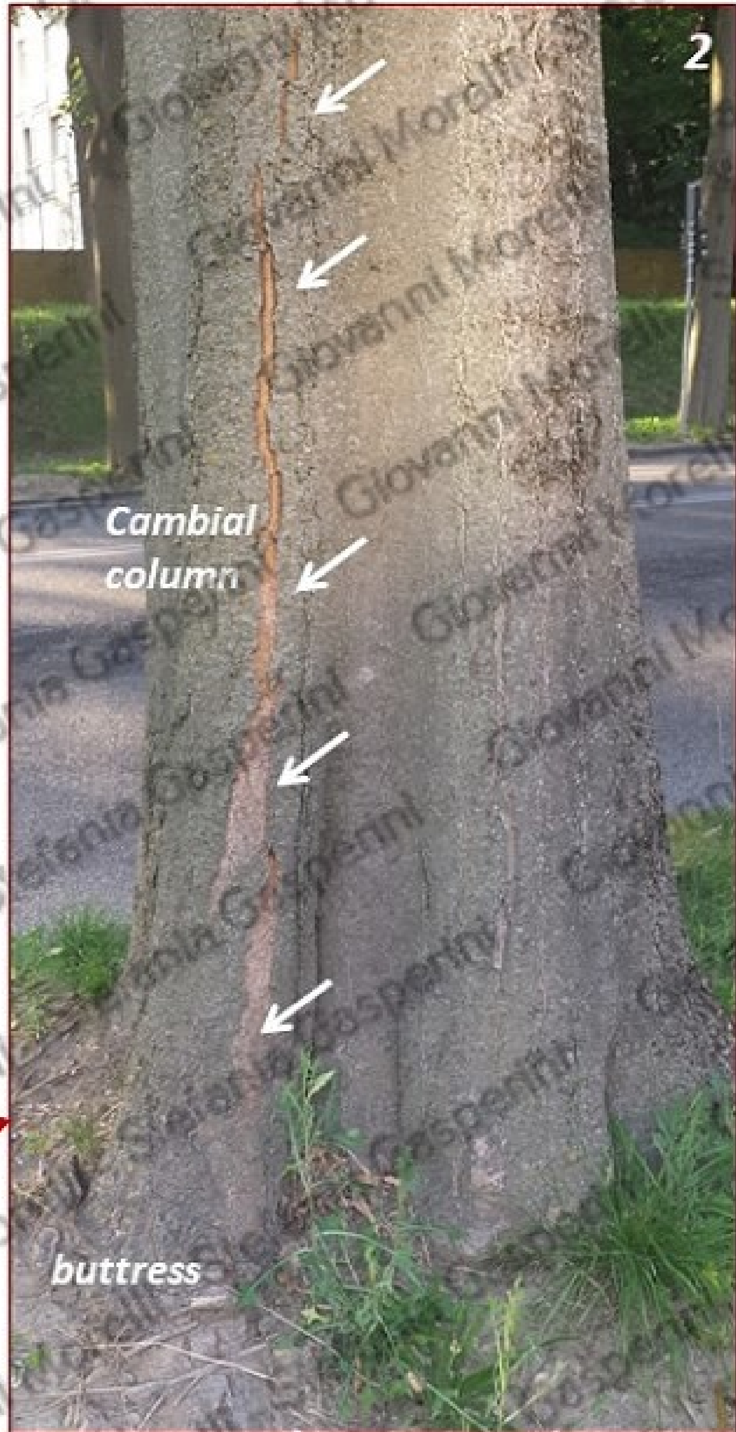


Hierarchy of ramifications and connection with the stem



Secondary trunks and stem morphology: cambial columns

Celtis australis. Photo G. Morelli

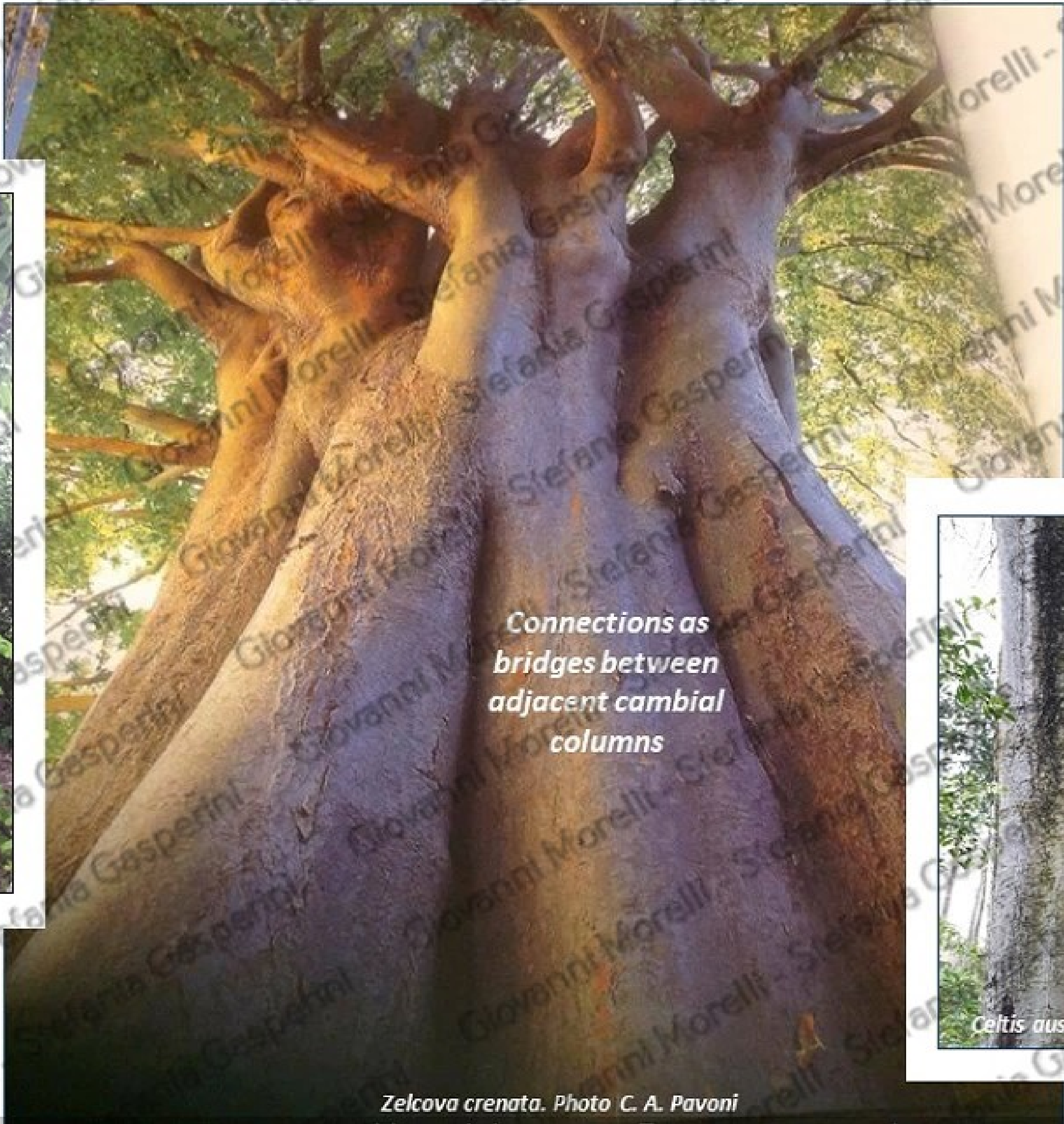


Secondary trunks and stem morphology: cambial columns

Celtis australis. Photo G. Morelli

Secondary trunks and stem morphology: cambial bridges

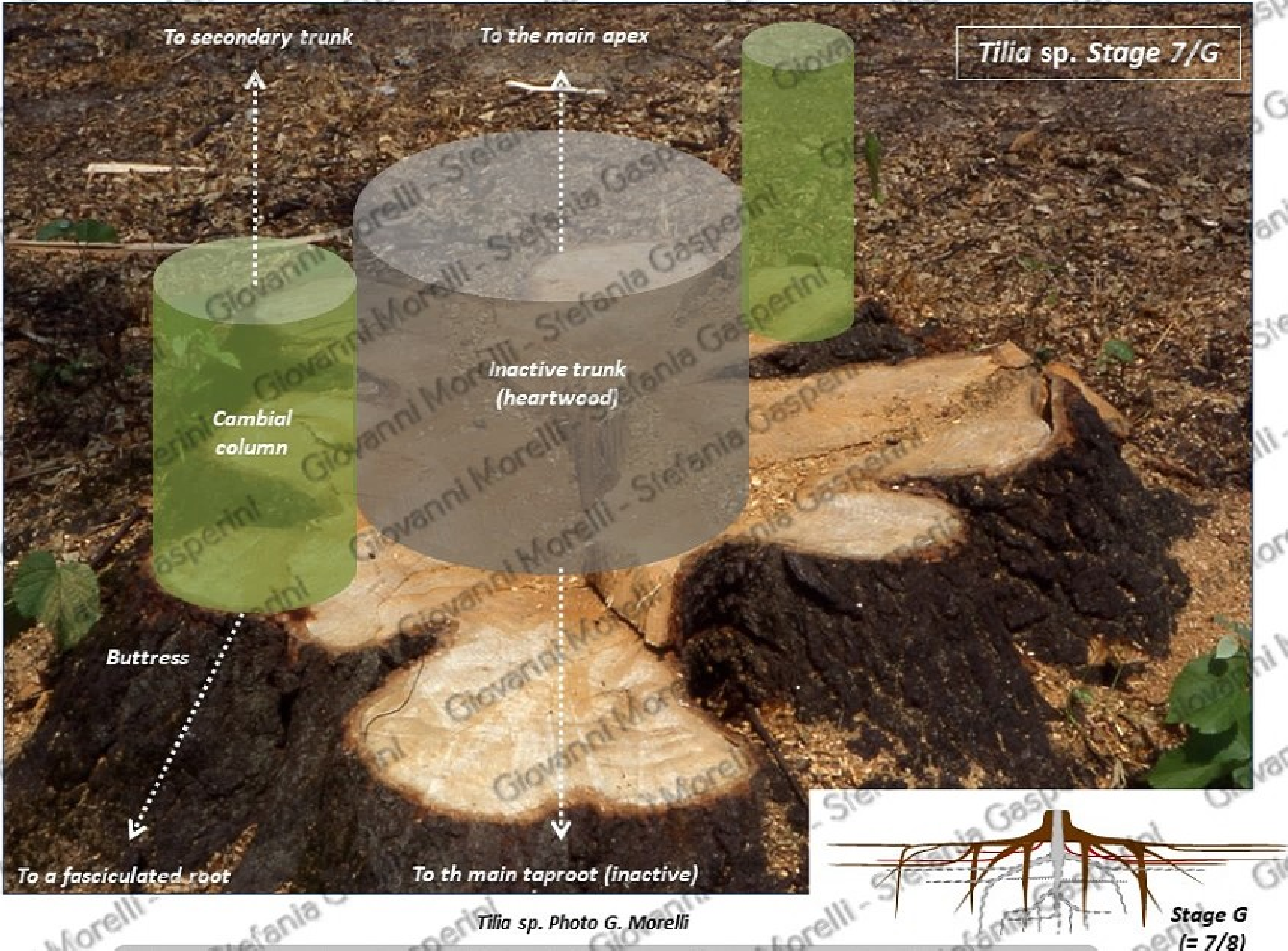
Aesculus hippocastanum. Photo G. Morelli



Zelcova crenata. Photo C. A. Pavoni

Celtis australis. Photo G. Morelli

Secondary trunks and stem morphology: buttresses



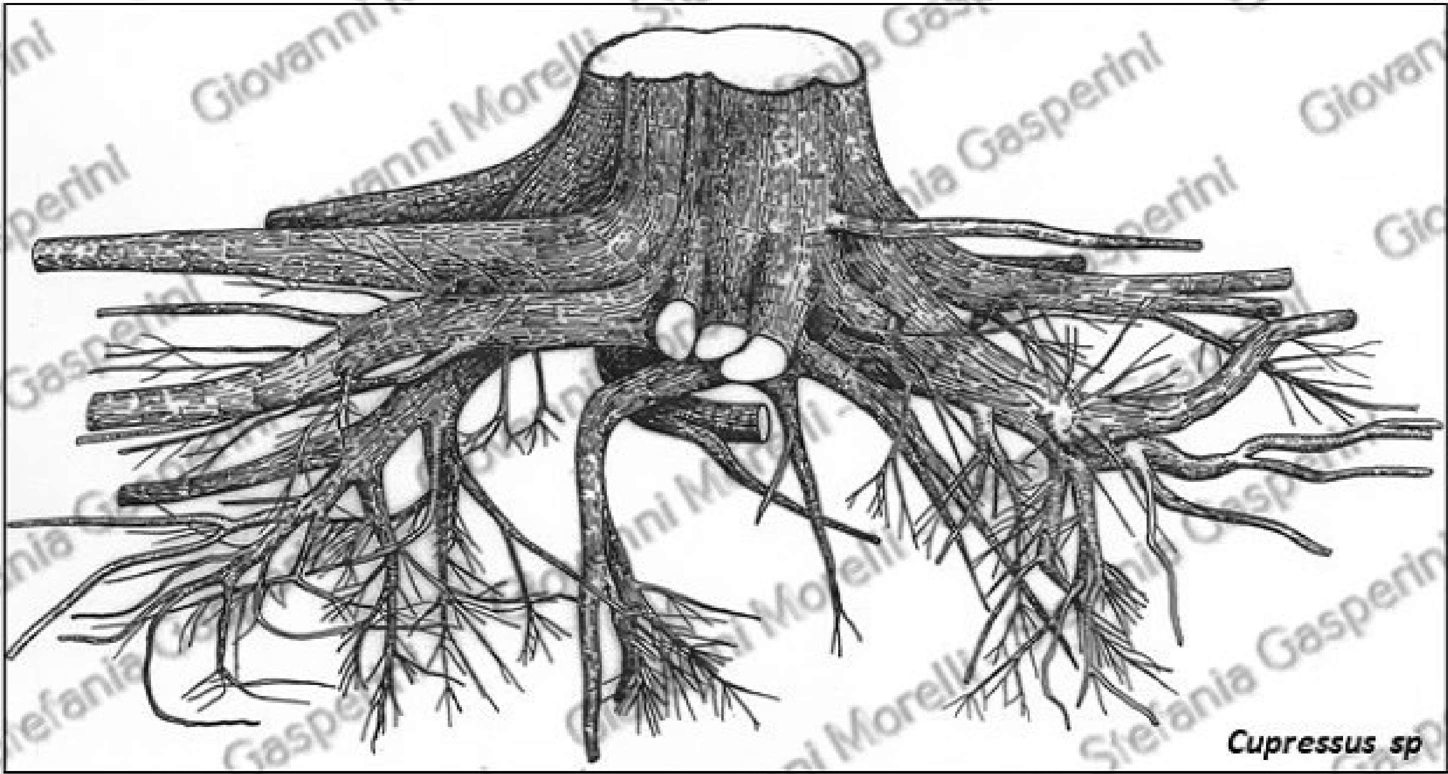
Tilia sp. Photo G. Morelli

Secondary trunks and stem morphology: cavities

Tilia* sp. *Stage 8/J

Stadio J
(= 9)

Organisation of cambium and heartwood formation: taproot, root flare and stem



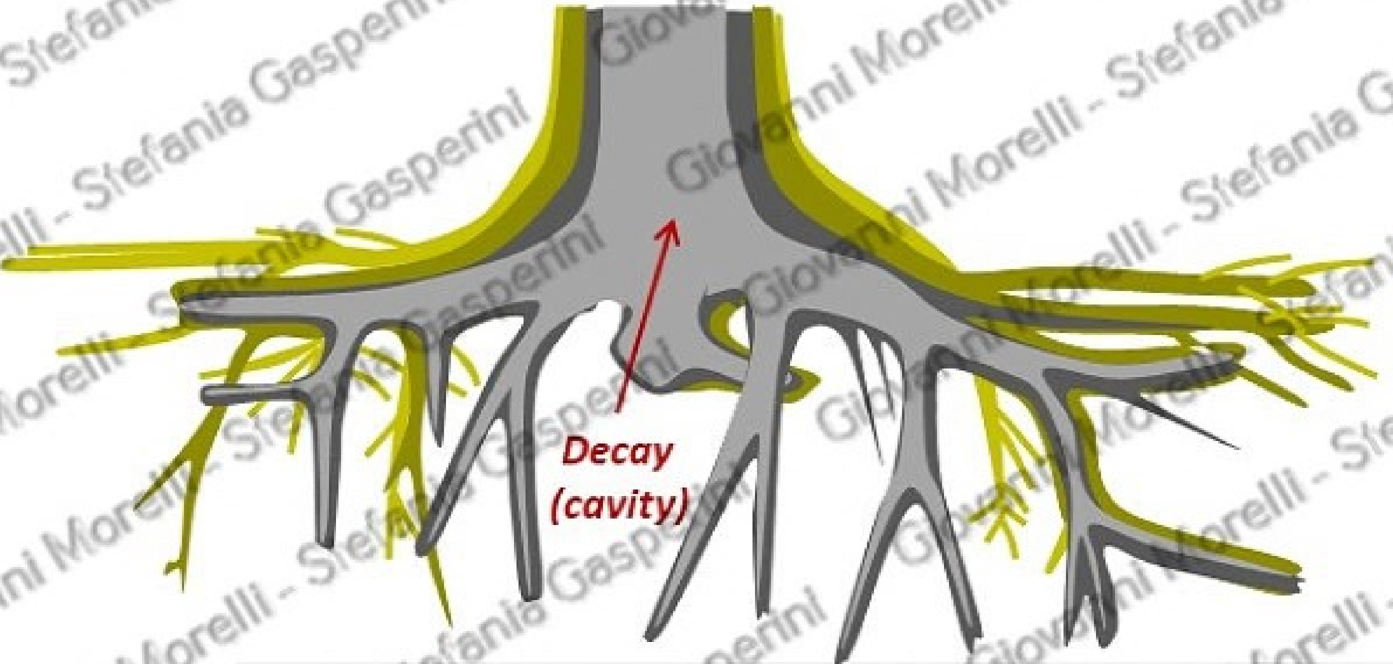
Formazione of overlapped systems made by the cambium:

4° generation (vital/living)

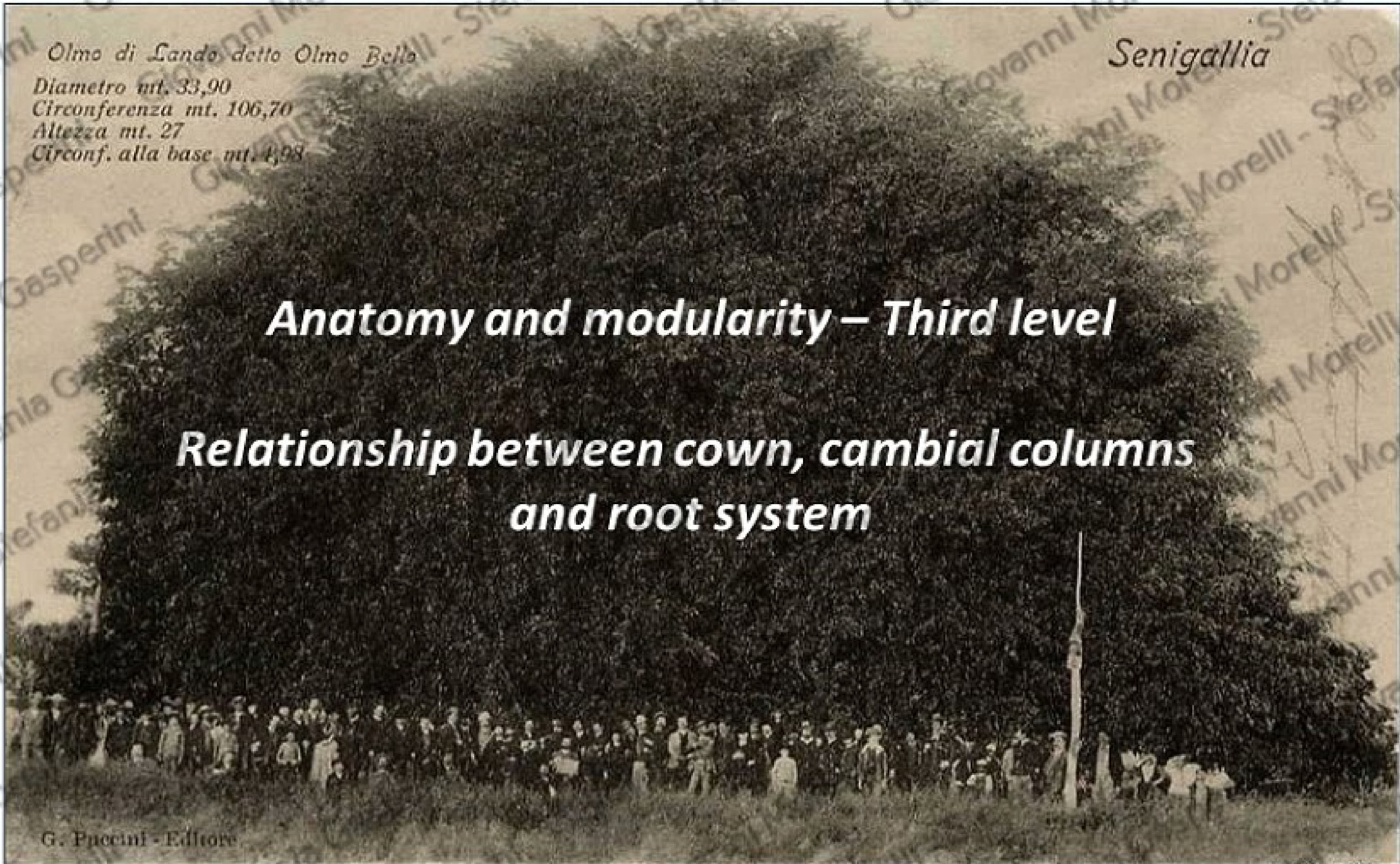
3° generation (vital/living)

2° generation (inactive/dead)

1° generation (inactive/dead /decayed)



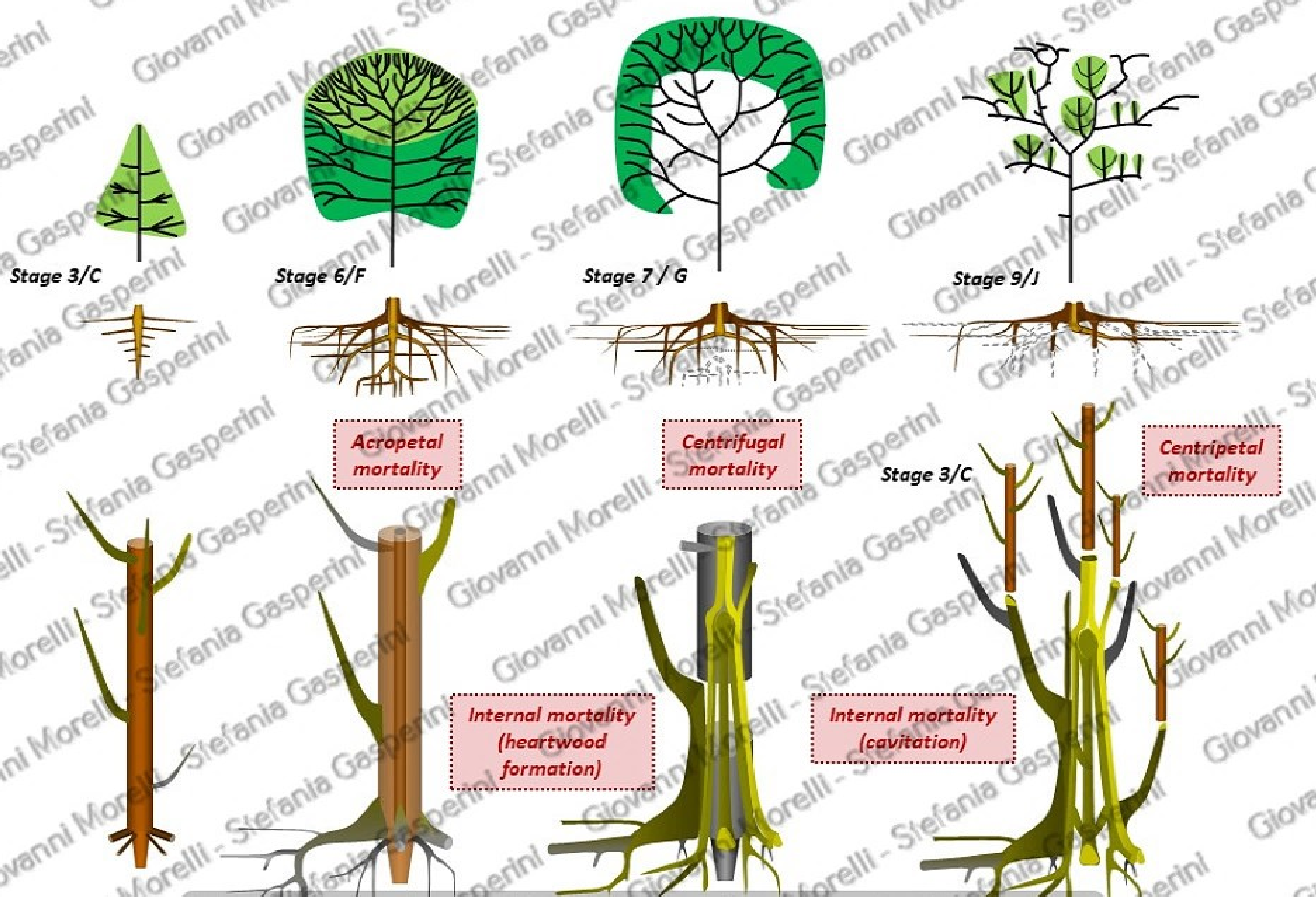
Each generation corresponds to one or more "streams" of total reiteration in the canopy



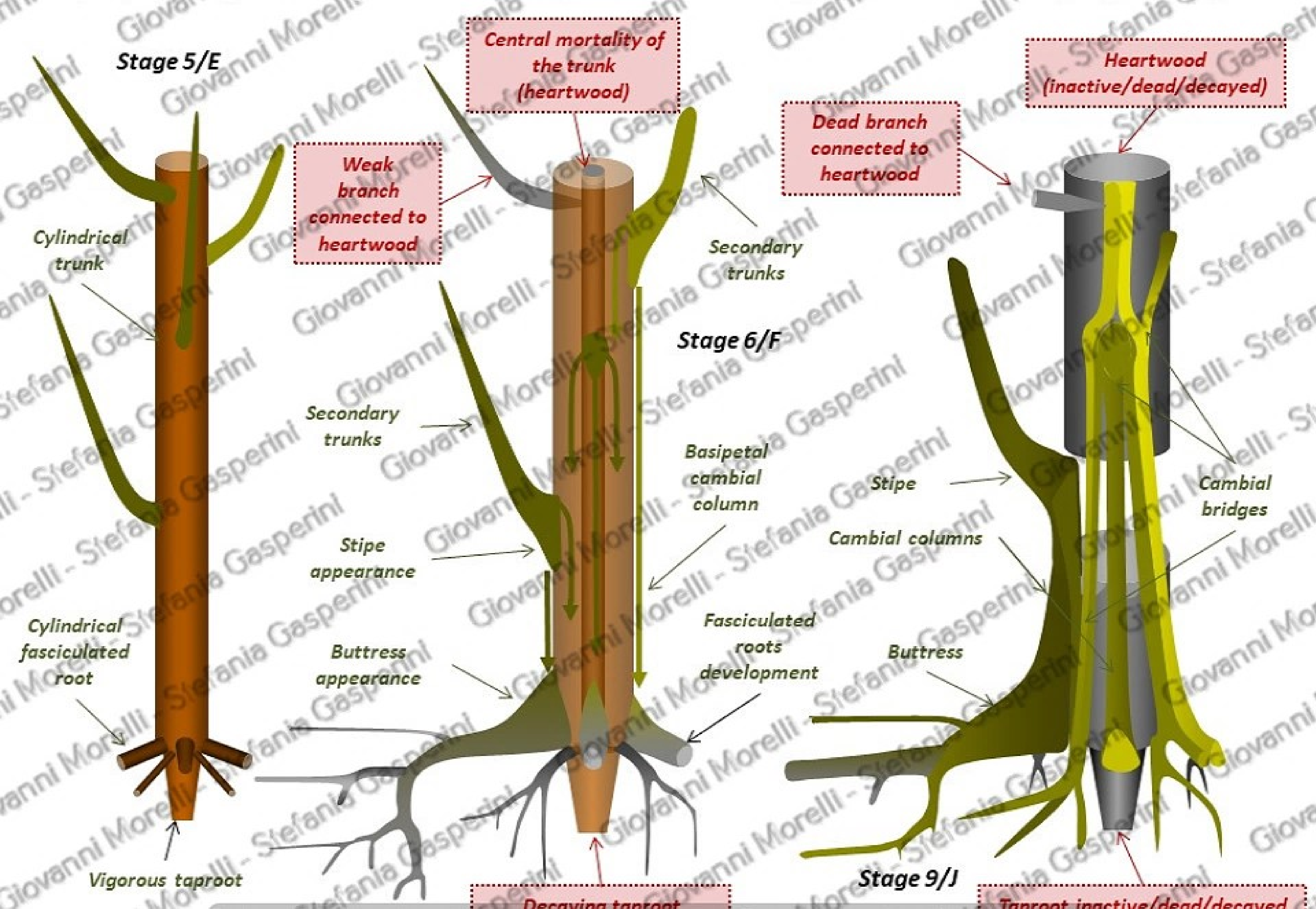
Anatomy and modularity – Third level

Relationship between cown, cambial columns and root system

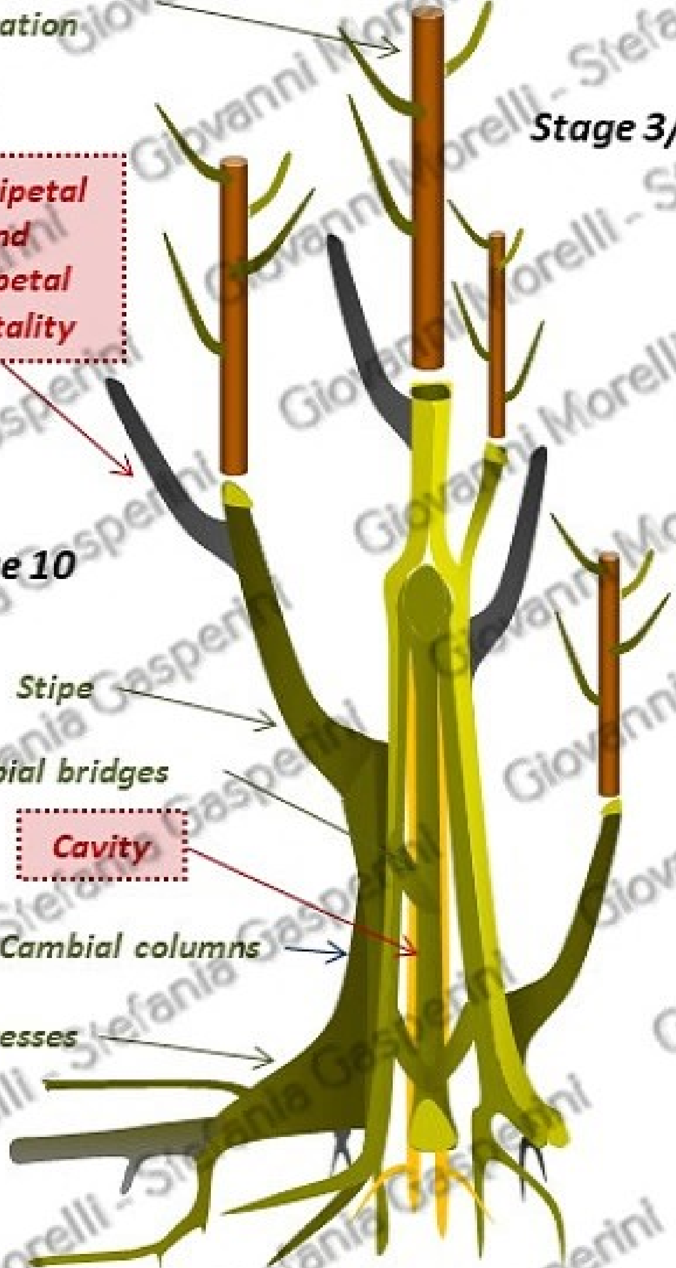
Morphophysiological analysis: relationship between crown, stem and roots in polyarchy species

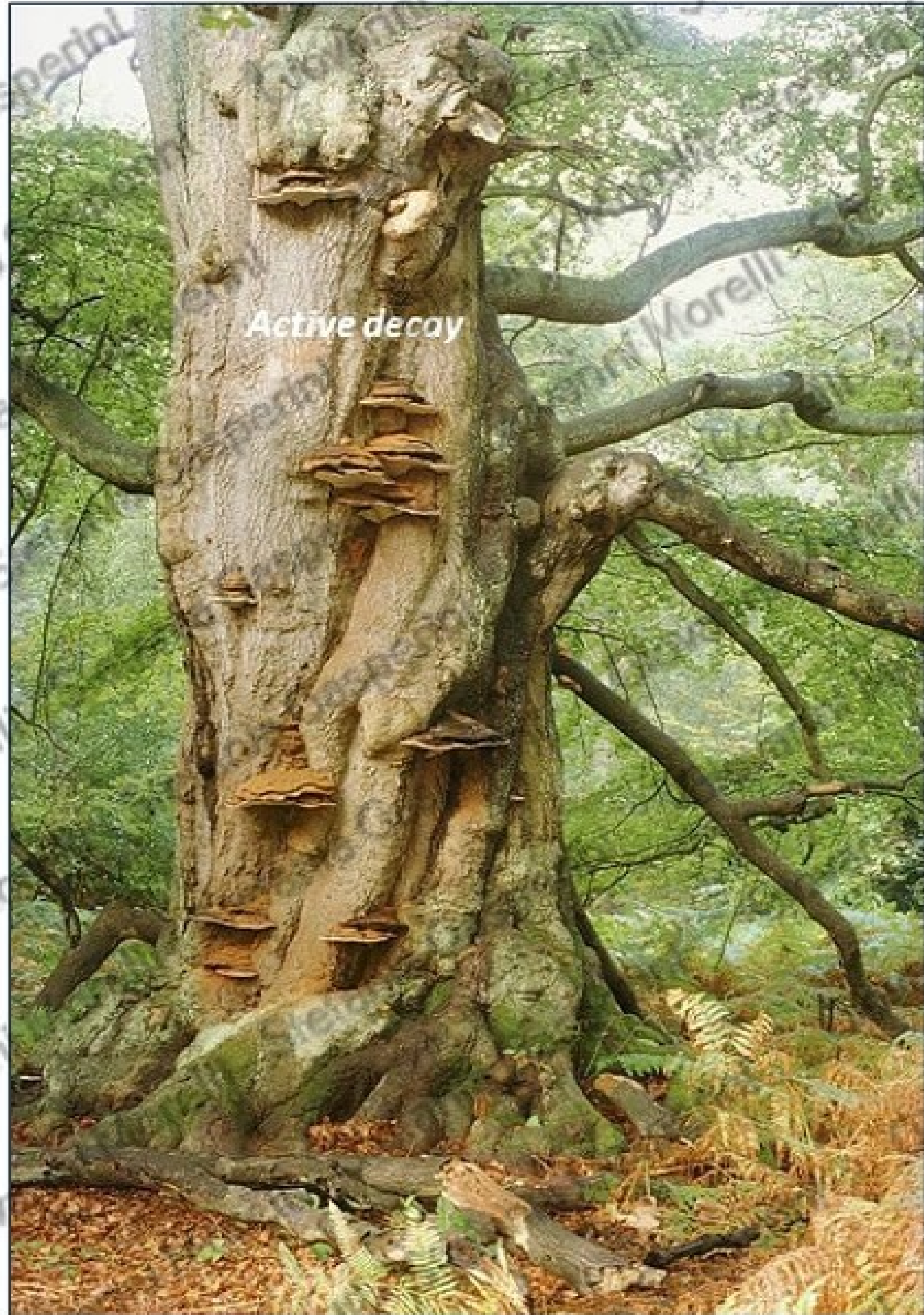


Morphophysiological analysis: relationship between crown, stem and roots in polyarchy species



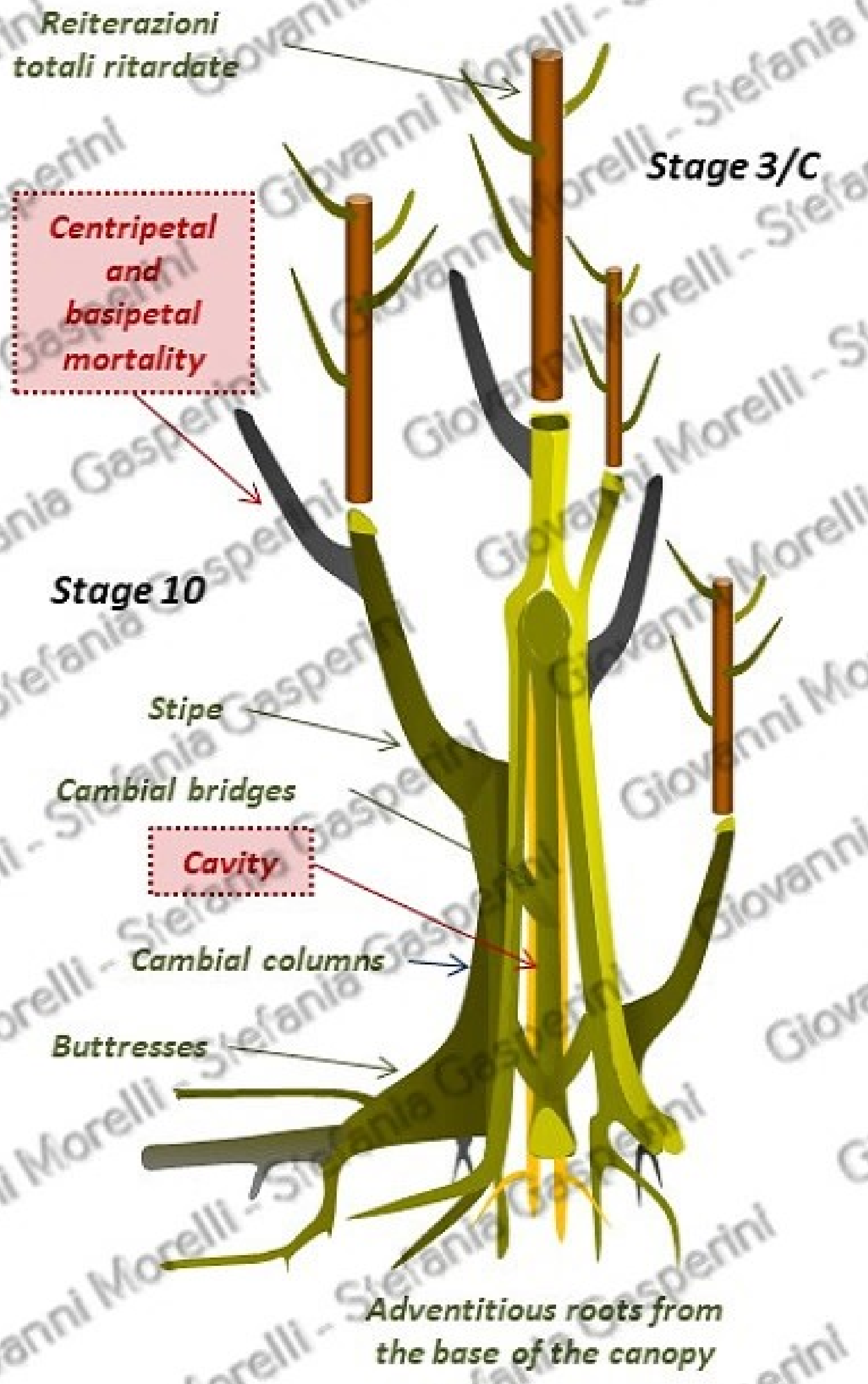
Morphophysiological analysis: relationship between crown, stem and roots in polyarchy species

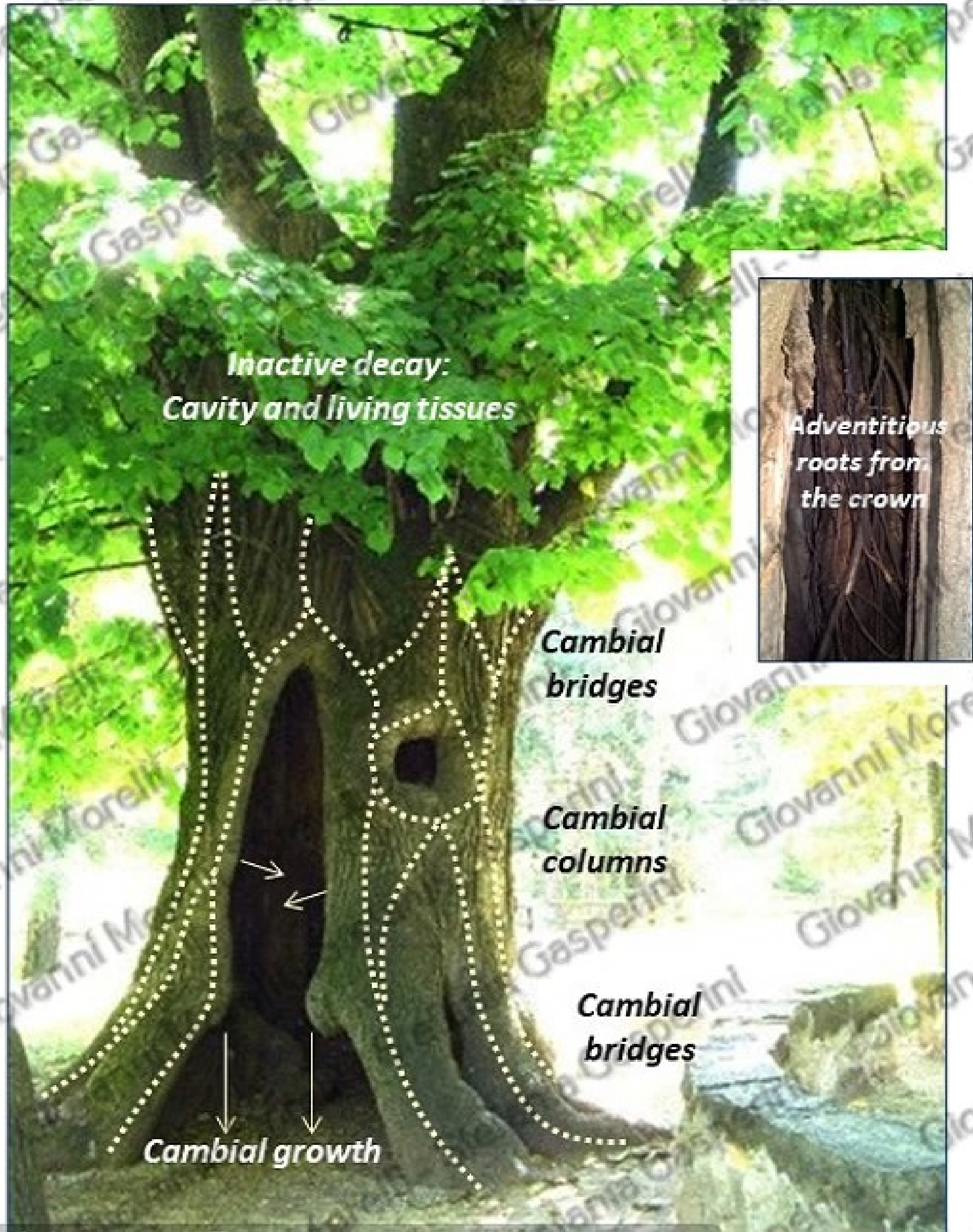


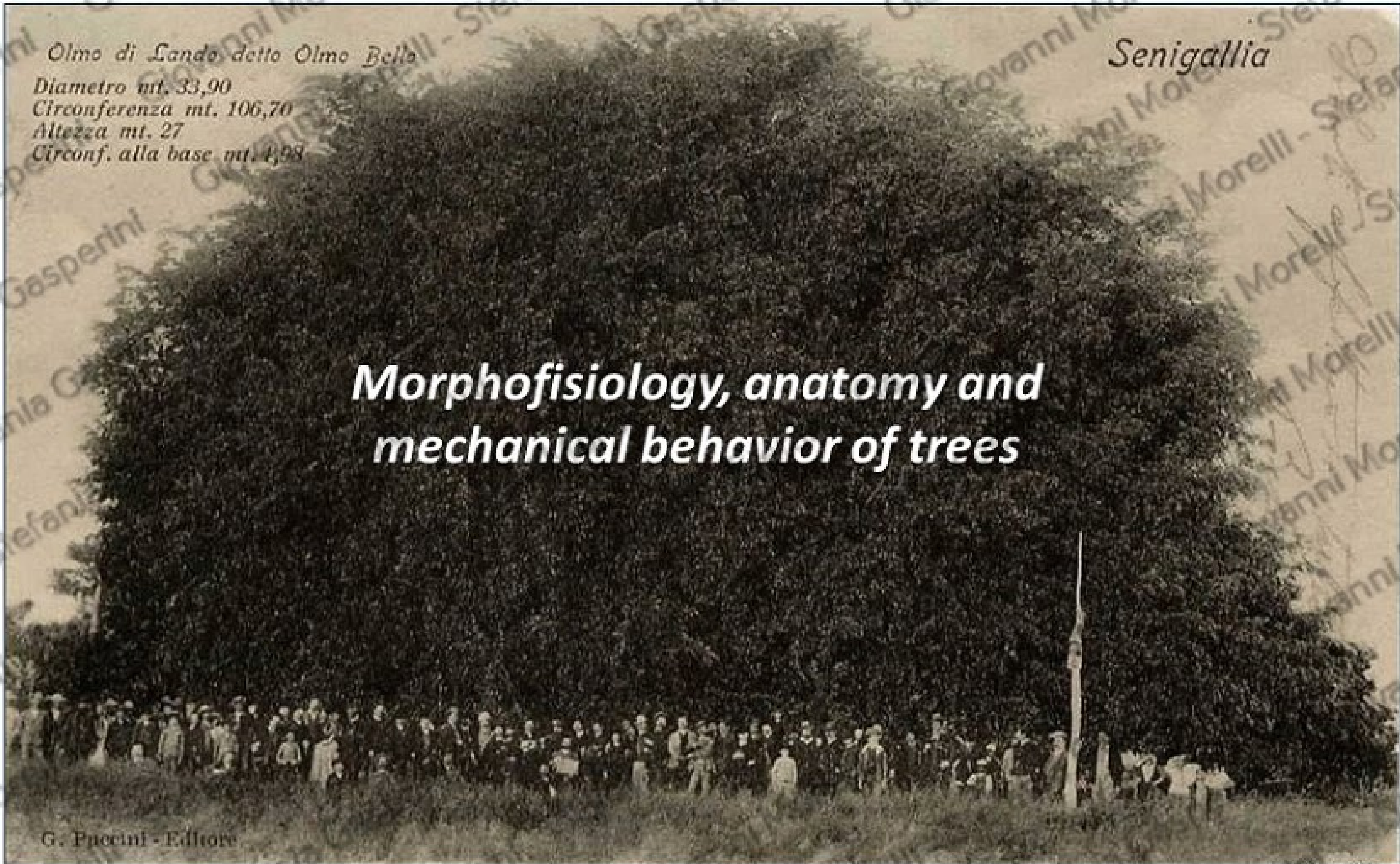


Fagus sylvatica with Ganoderma applanatum. Source T. green

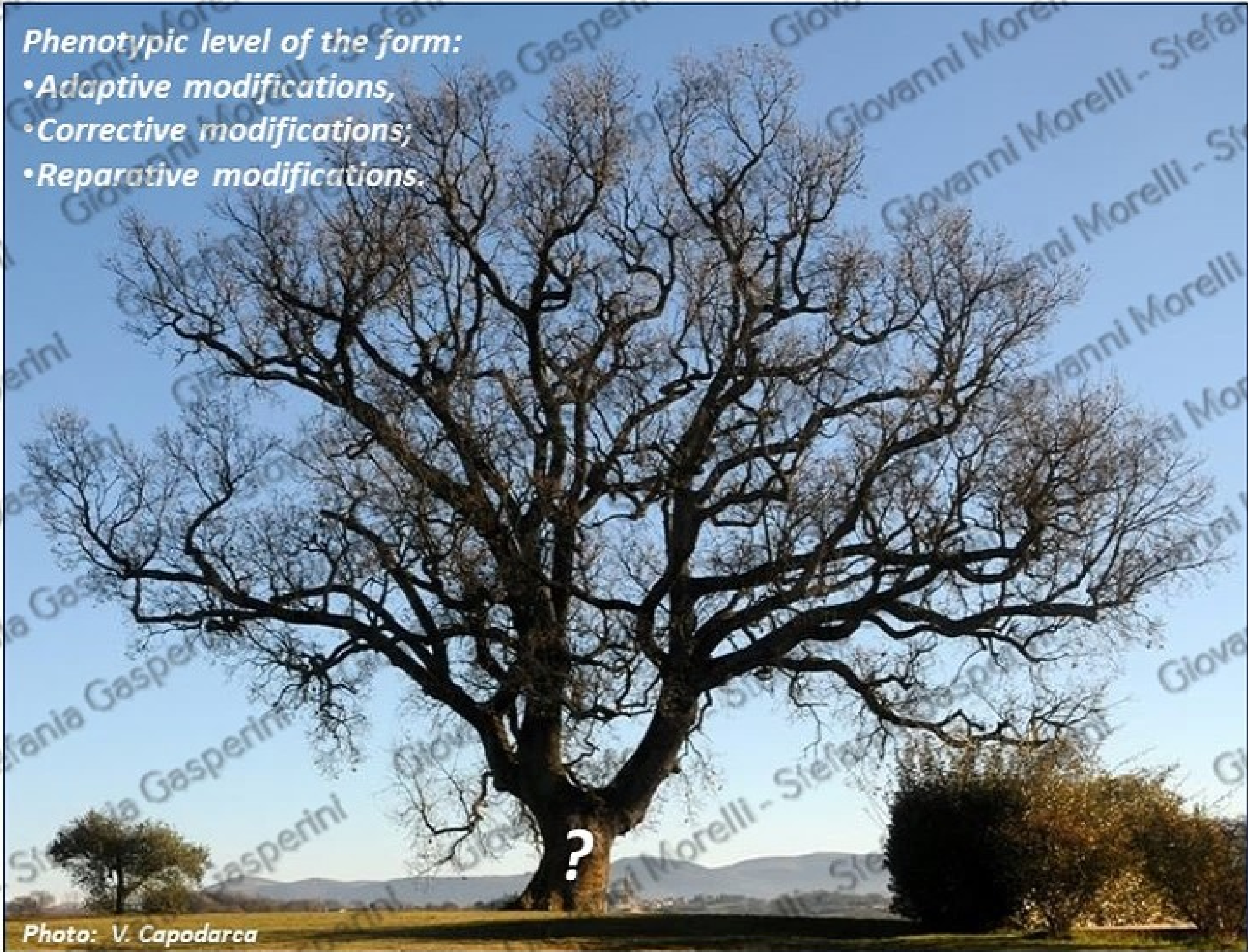
The stage 10 of a tree






Olmo di Lando detto Olmo Bello
Diametro mt. 33,90
Circonferenza mt. 106,70
Altezza mt. 27
Circonf. alla base mt.
Senigallia
Morphofisiology, anatomy and mechanical behavior of trees
G. Puccini - Editore

Phenotypic level of the form and «defects»



G. Morelli, 2017

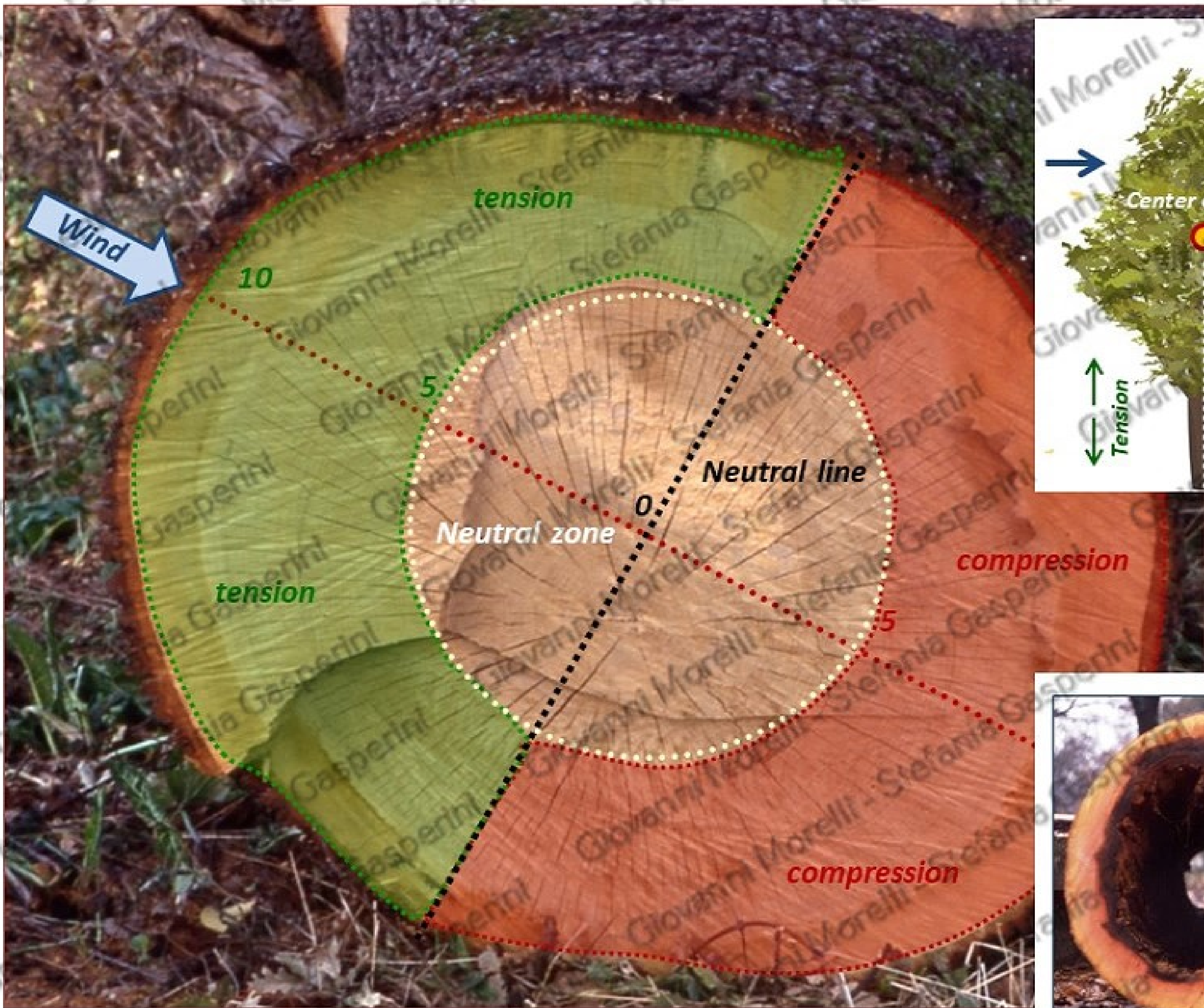
A defect represents any kind of negative difference compared to a perceived norm.
A "structural defect", for a specific context of growth, represents any architectural, morphological, anatomical environmental anomaly able to increase the likelihood of failure.
(Morelli 2016, From National Tree Safety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

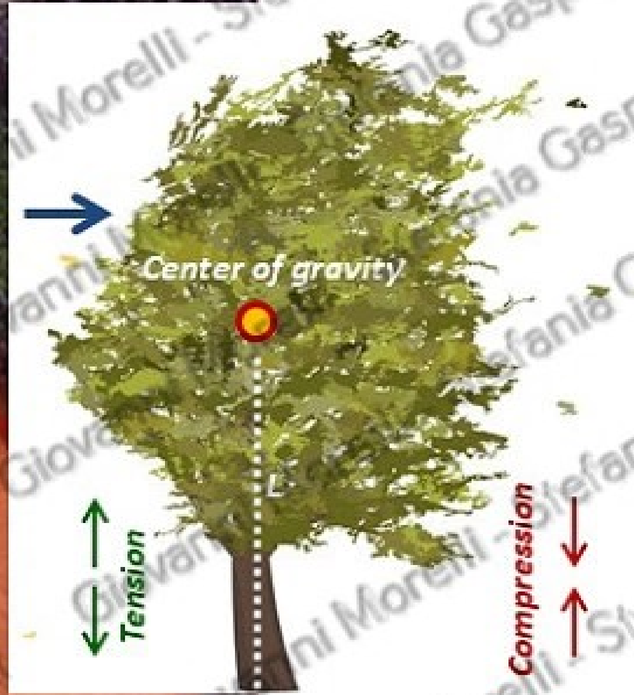
The ambiguity of the defect: What about cavity?

G. Morelli, 2017

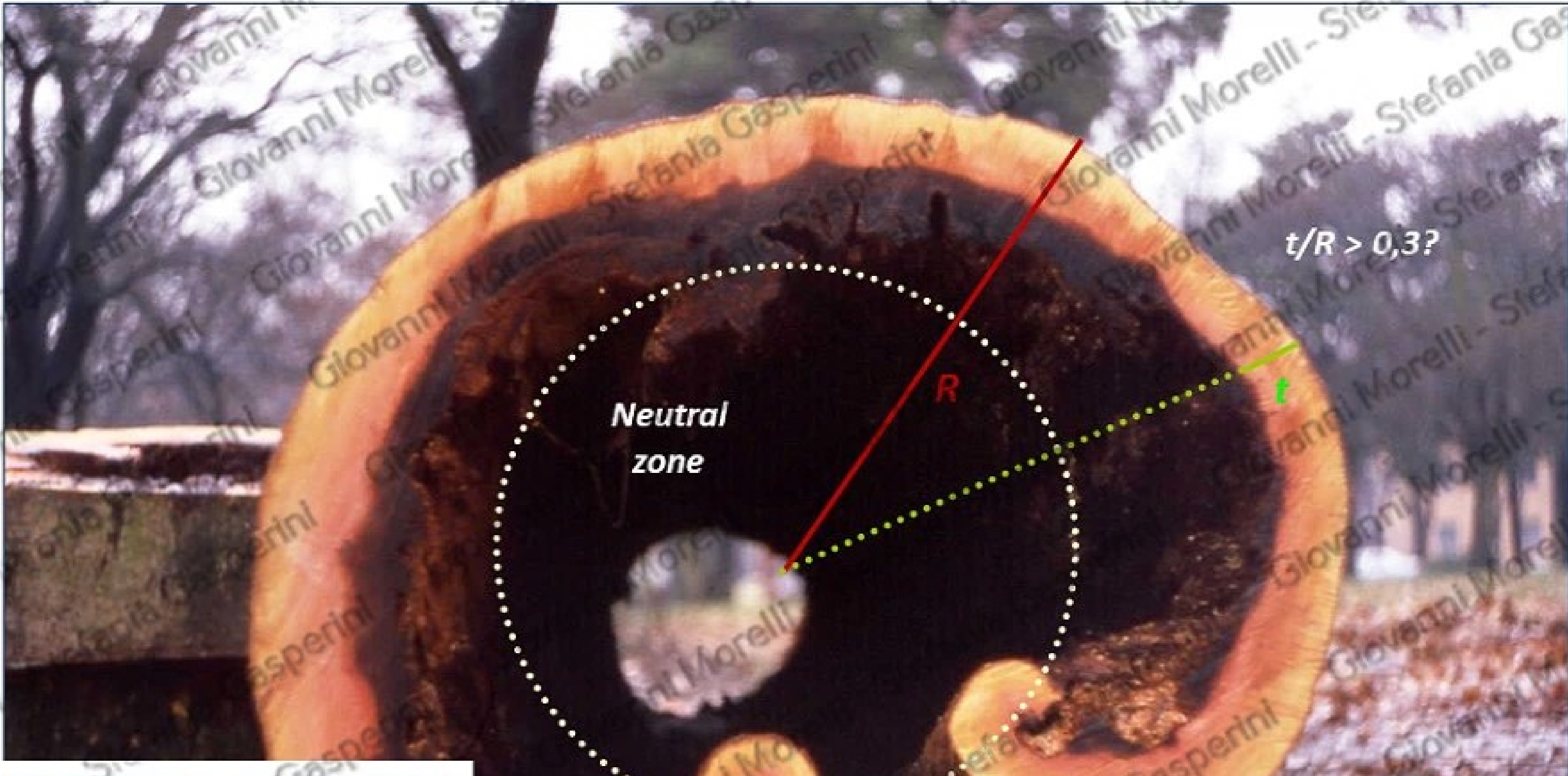
Source: Google

To stand up: the art of cavitation



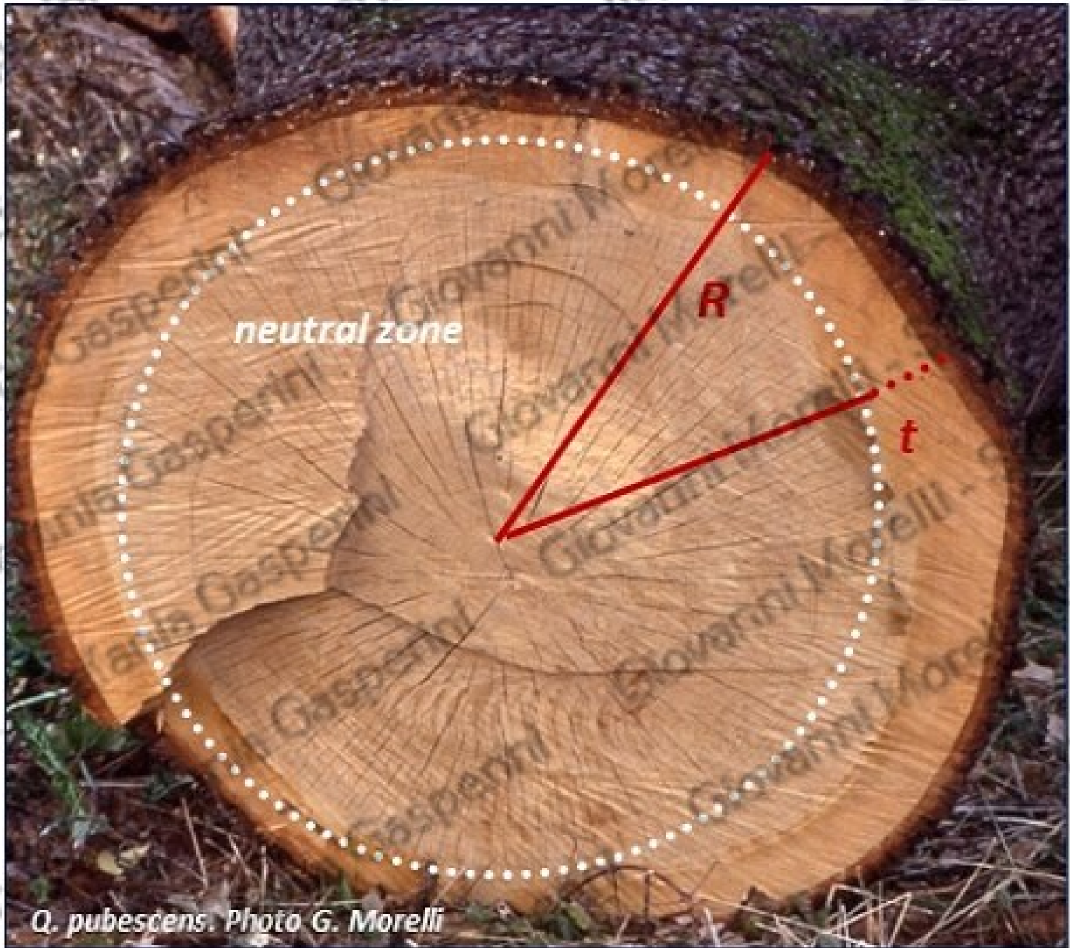


To stand up: the art of cavitation

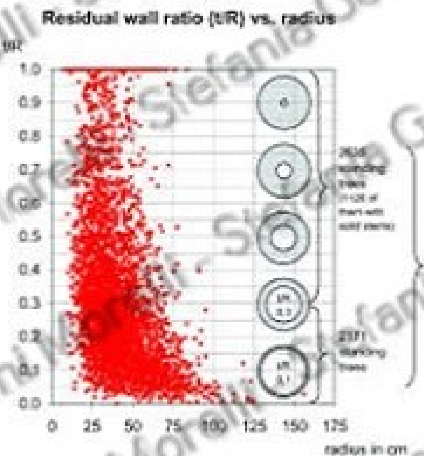


Tree as a pole...

Structural implications of morphophysiological evolution of the stem



Q. pubescens. Photo G. Morelli




P. abies. Photo G. Morelli

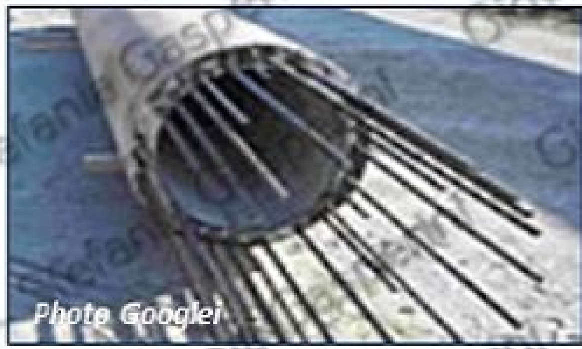
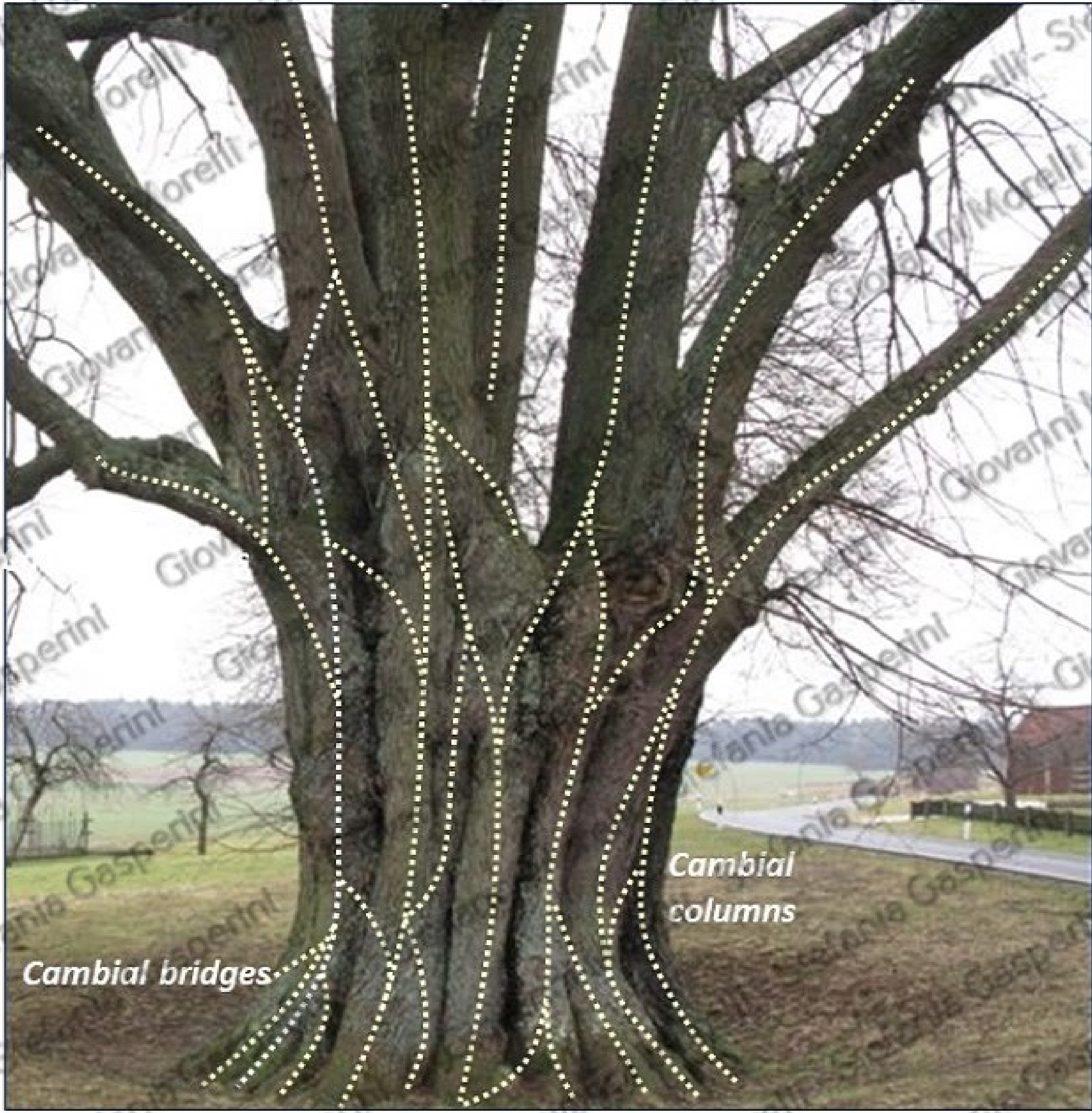


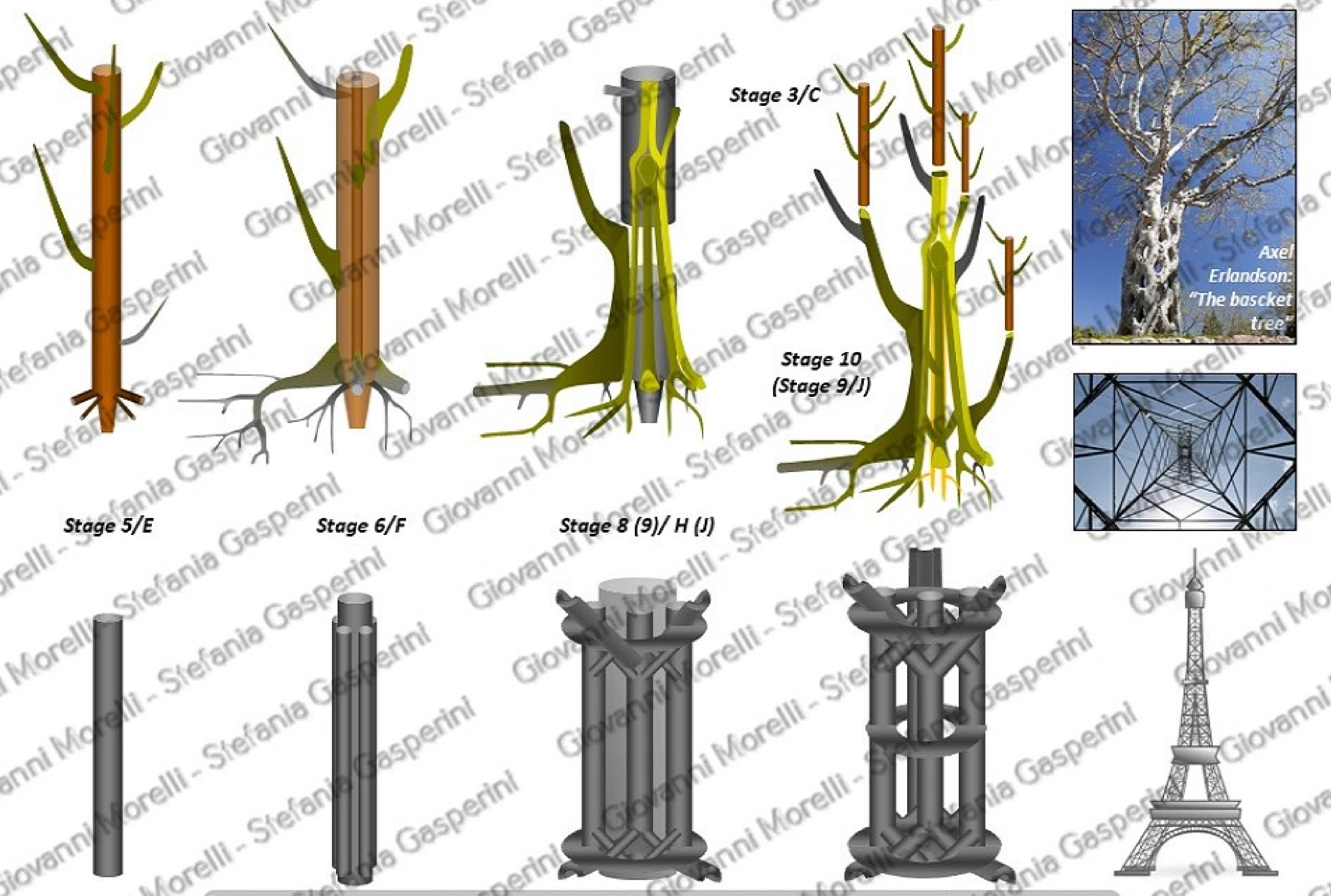
Photo Google

To stand up: the art of cavitation

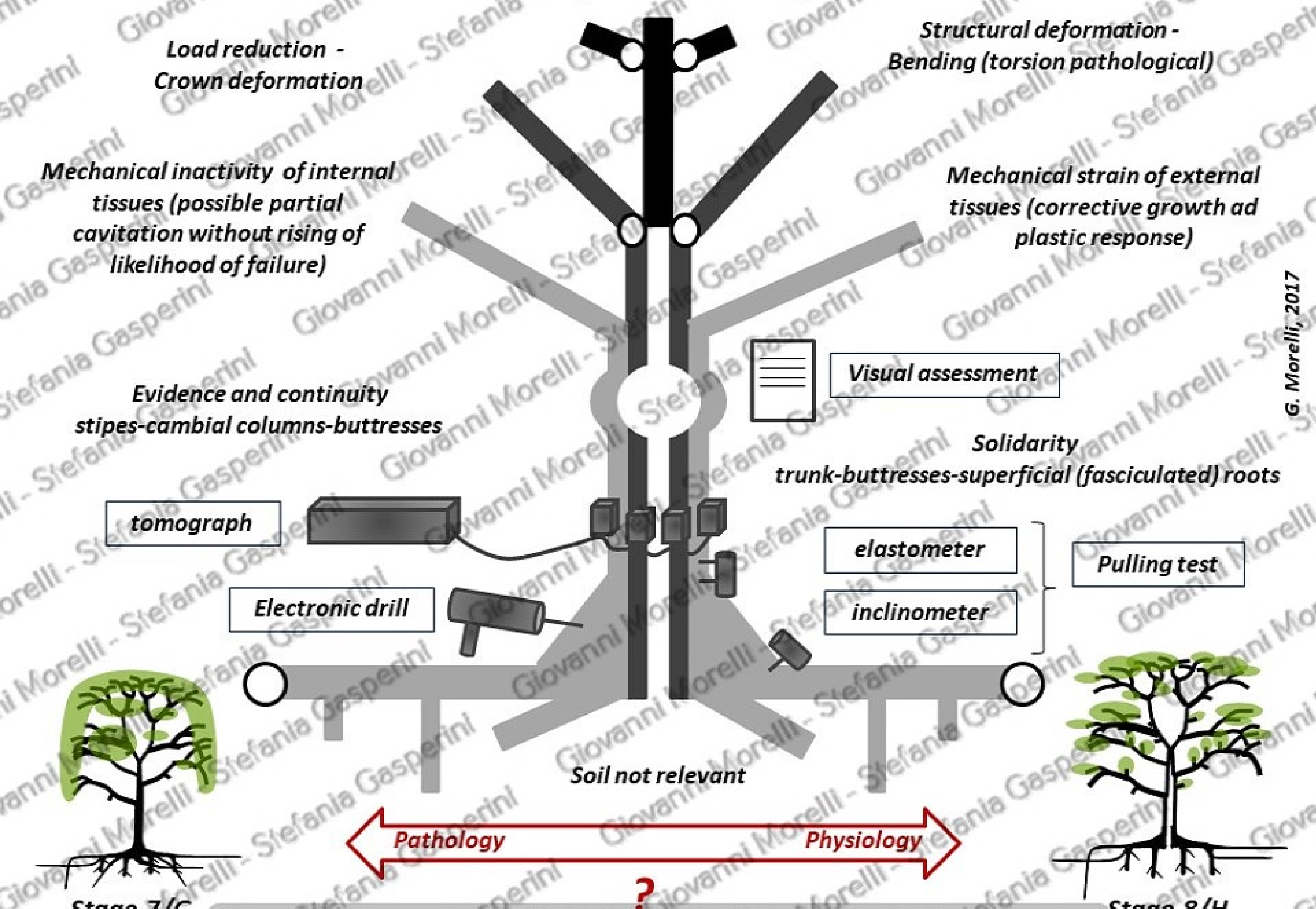


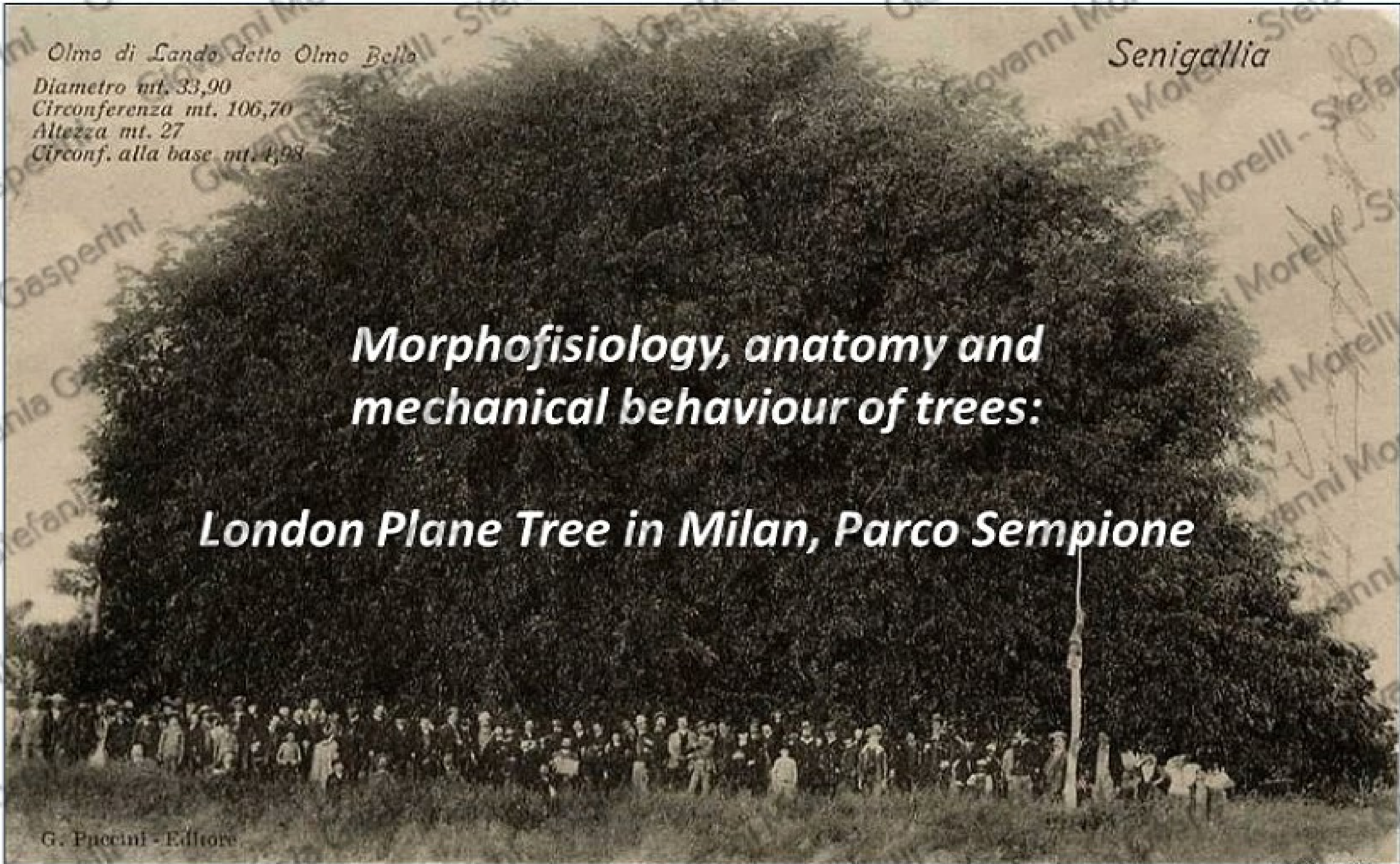
"Russenlinde": Breitenlesau, Bayern (Germany)

Structural implications of morphophysiological evolution of the stem



From the defects to the stability assessment in polyarchical species trees




Olmo di Lando detto Olmo Bello
Diametro mt. 33,90
Circonferenza mt. 106,70
Altezza mt. 27
Circonf. alla base mt.
Senigallia
Morphofisiology, anatomy and mechanical behaviour of trees:
London Plane Tree in Milan, Parco Sempione
G. Puccini - Editore

The phylogenetic level of the form: Massart architectural model

Trunk and branches different both for the flowering (lateral on branches) and for the phyllotaxis (distic for the trunk and spiral for the branches)

Orthotropic trunk (isotonic branching) monopodial branches with rhythmic growth

Anfitotonic branching monopodial branches with rhythmic growth

First root system usually from seed

Platanus sp.

Annual alternation of apical bud

Sympodial monocasial trunk

Current flowering

Previous flowering

Trunks and branches

Fasciculated root system

Taprooting root system

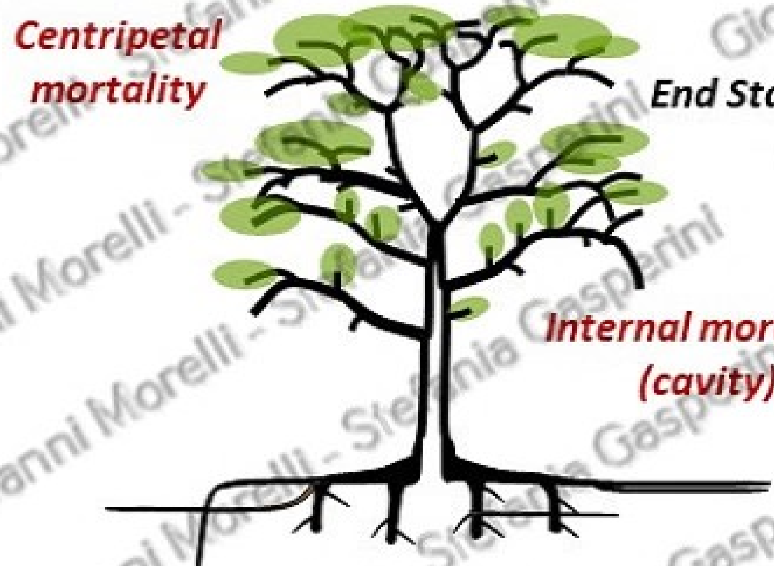
Source: P. Raimbault (da F. Hallé); 2006

The phylogenetic level, ontogenetic level of the form and morphophysiology

Massart Model

D: Mature

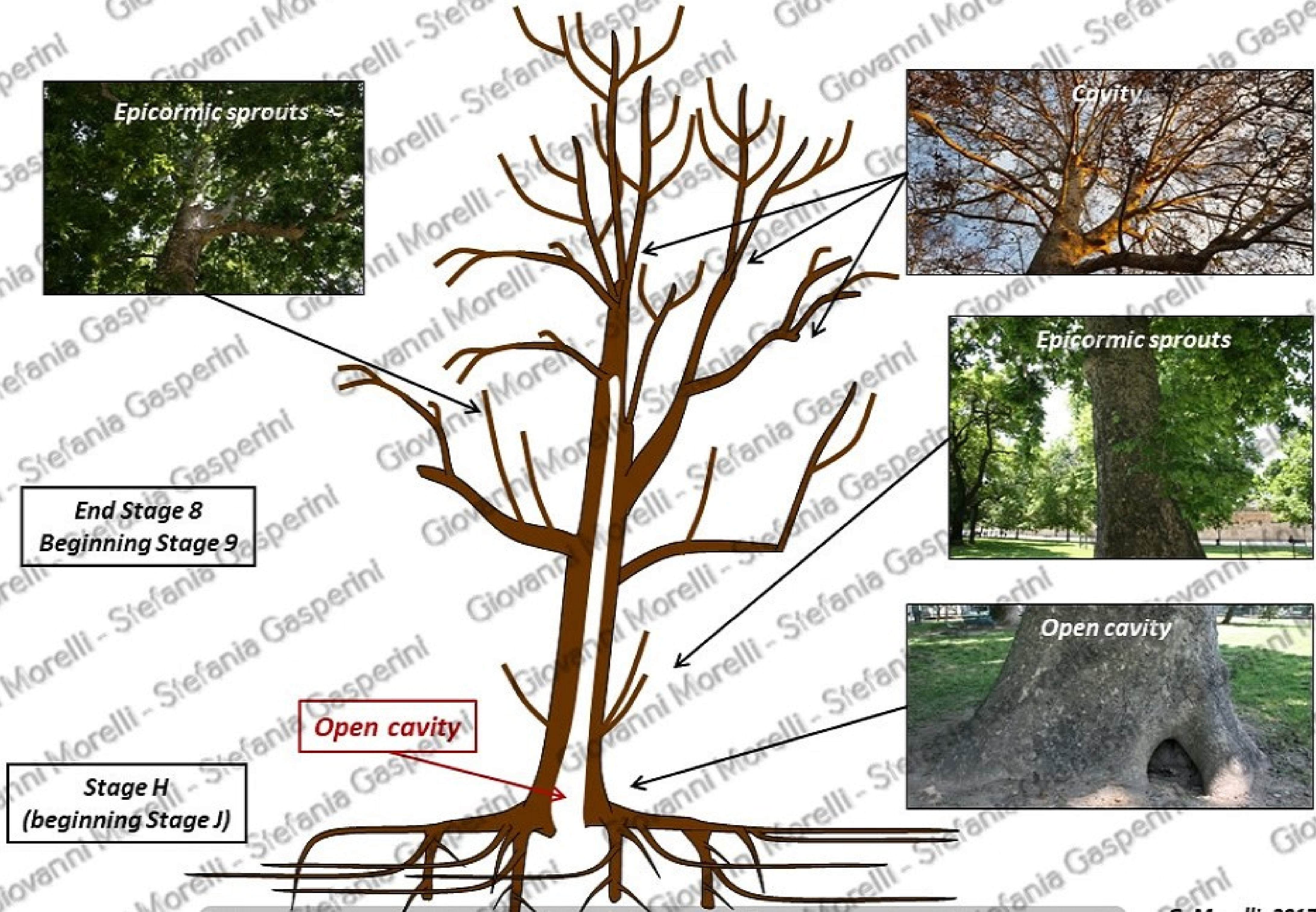
G. Morelli, 2017



Stage H (end)

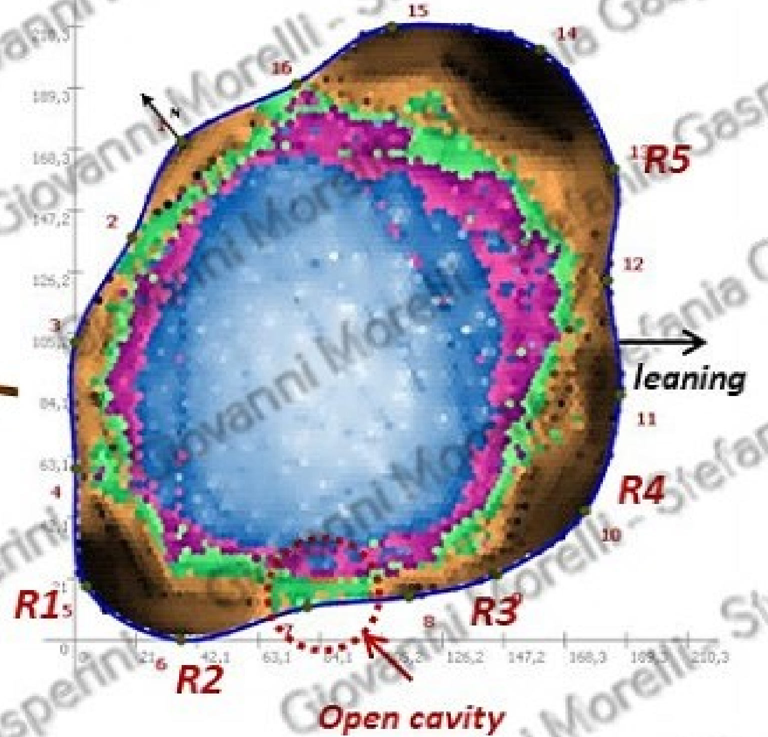
G. Morelli, 2016

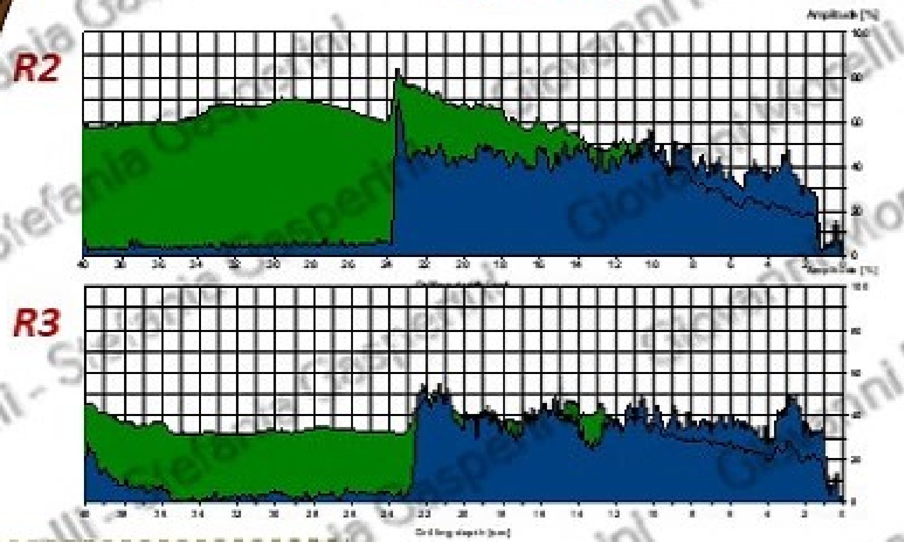
Visual assessment: looking for clinic features



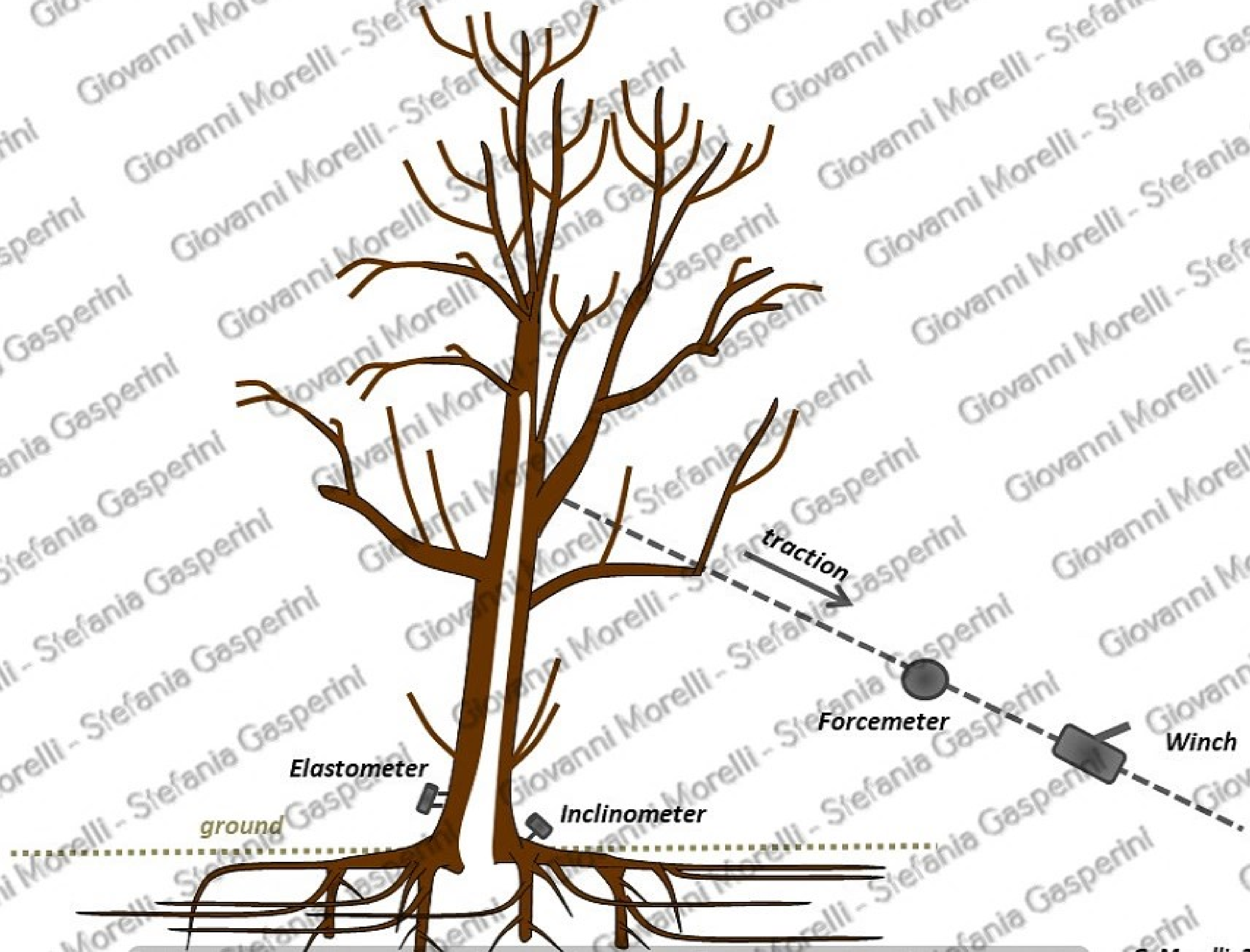
Advanced assessment: electronic drill and sonic tomograph

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





Advanced assessment: pulling test



Advanced assessment: pulling test

Analisi del carico del vento secondo DIN 1055-4

ARIES

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: 693 cm
Diametro del fusto ‖ [illegible] 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: 0,25
Frequenza propria: 0,45 Hz
Diminuzione di smorzamento: 0,8
Fattore di forma: 0,8

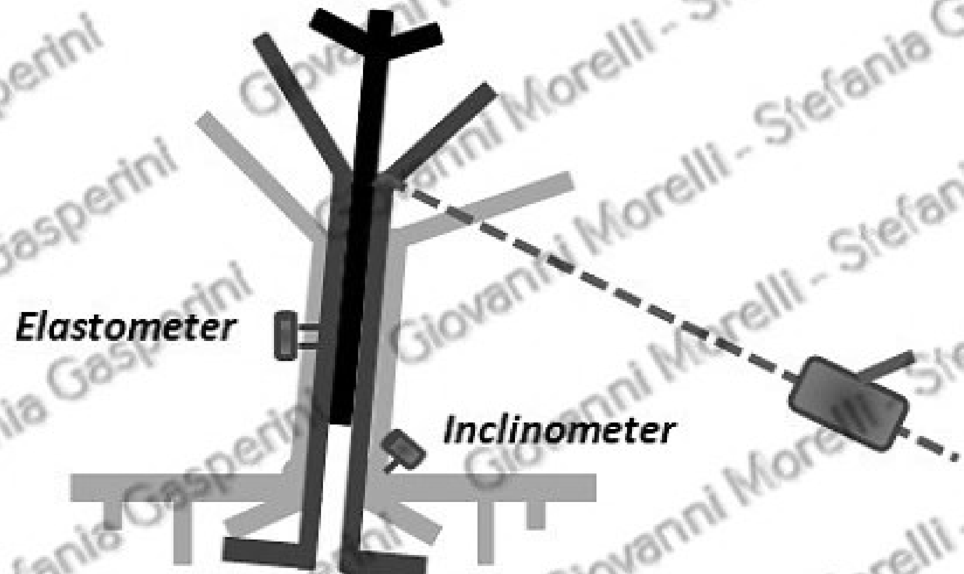
Parametri del luogo applicati
Zona di vento: Bft 12
Valore della velocità progettuale del vento: 22,5 m/s
Densità dell'aria: 1,27 kg/m³
Categoria di terreno: Zona suburbana
Esponente profilo del vento: 0,22
Fattore di prossimità per effetti del vento vicino al terreno: 1
Fattore per l'esposizione: 1,00

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

> 1.5



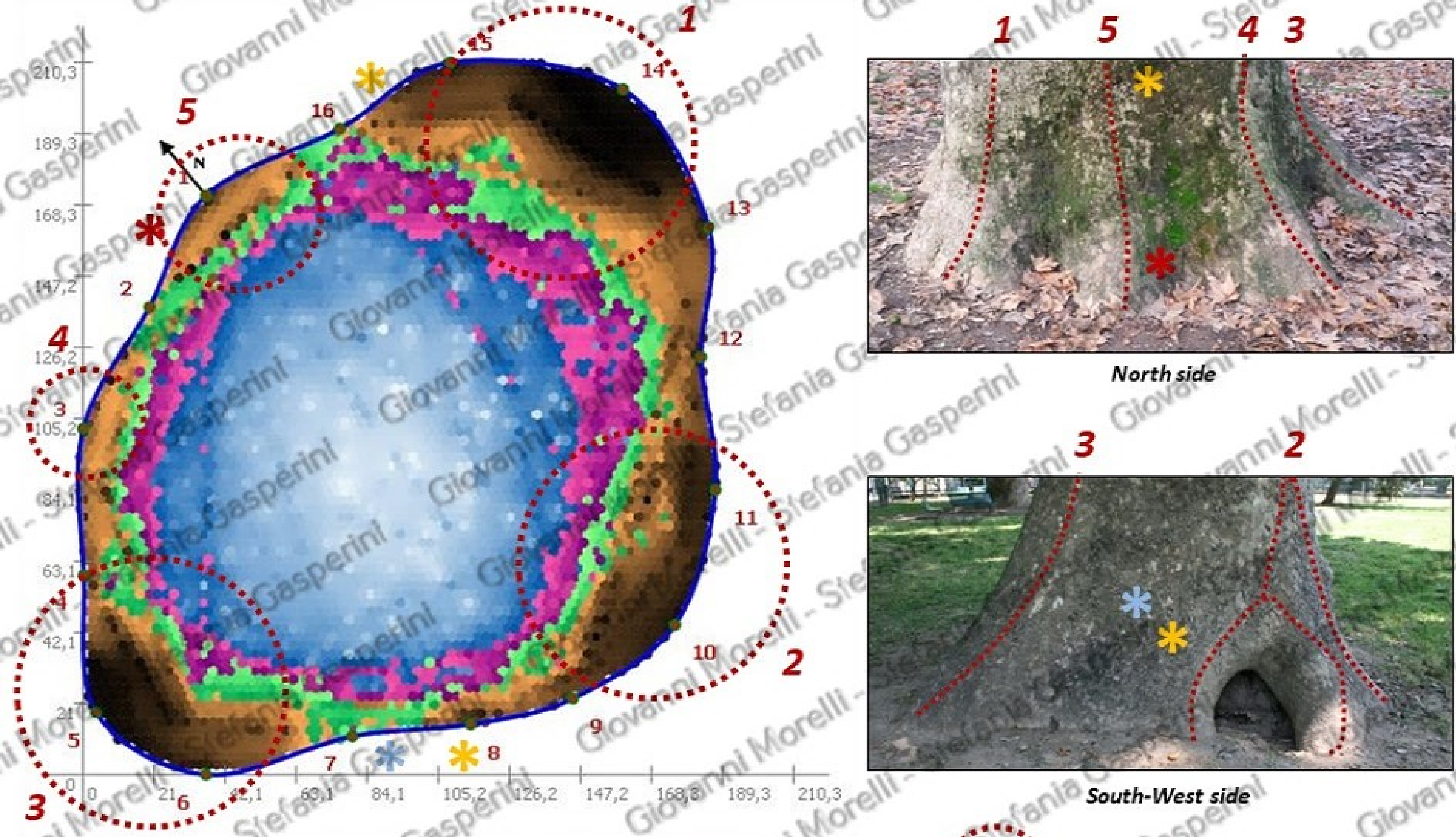
Basic safety factor:
6.8

Tipping stability safety factor:
10.64, 4.14, 2.43, 1.85

Breaking stability safety factor:
1.72, 3.59, 1.76, 3.49

G. Morelli 2014

Integrated assessment: tomograph and pulling test outcomes



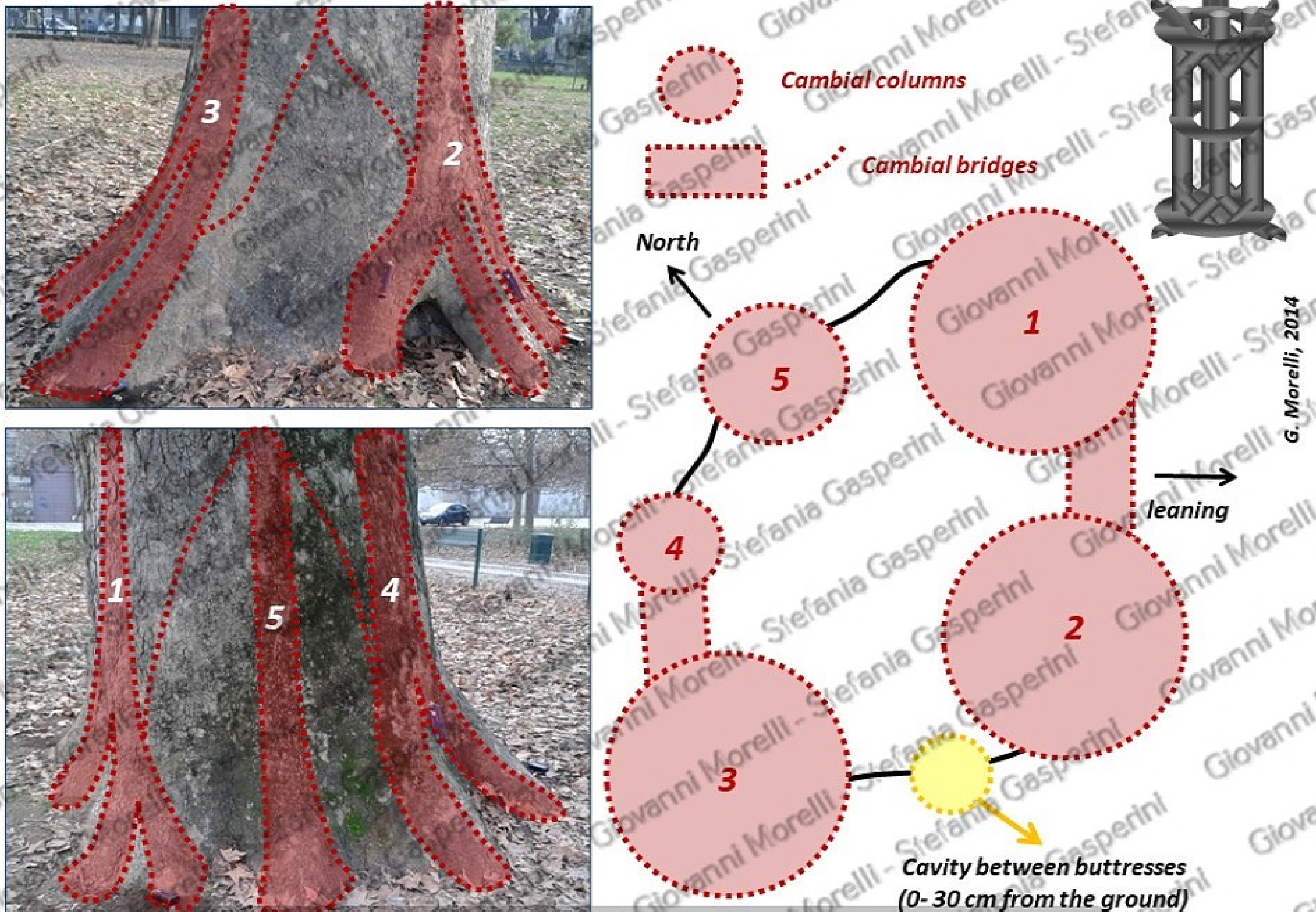
* *Lowest breaking stability safety factors (1.72 e 1.76)*

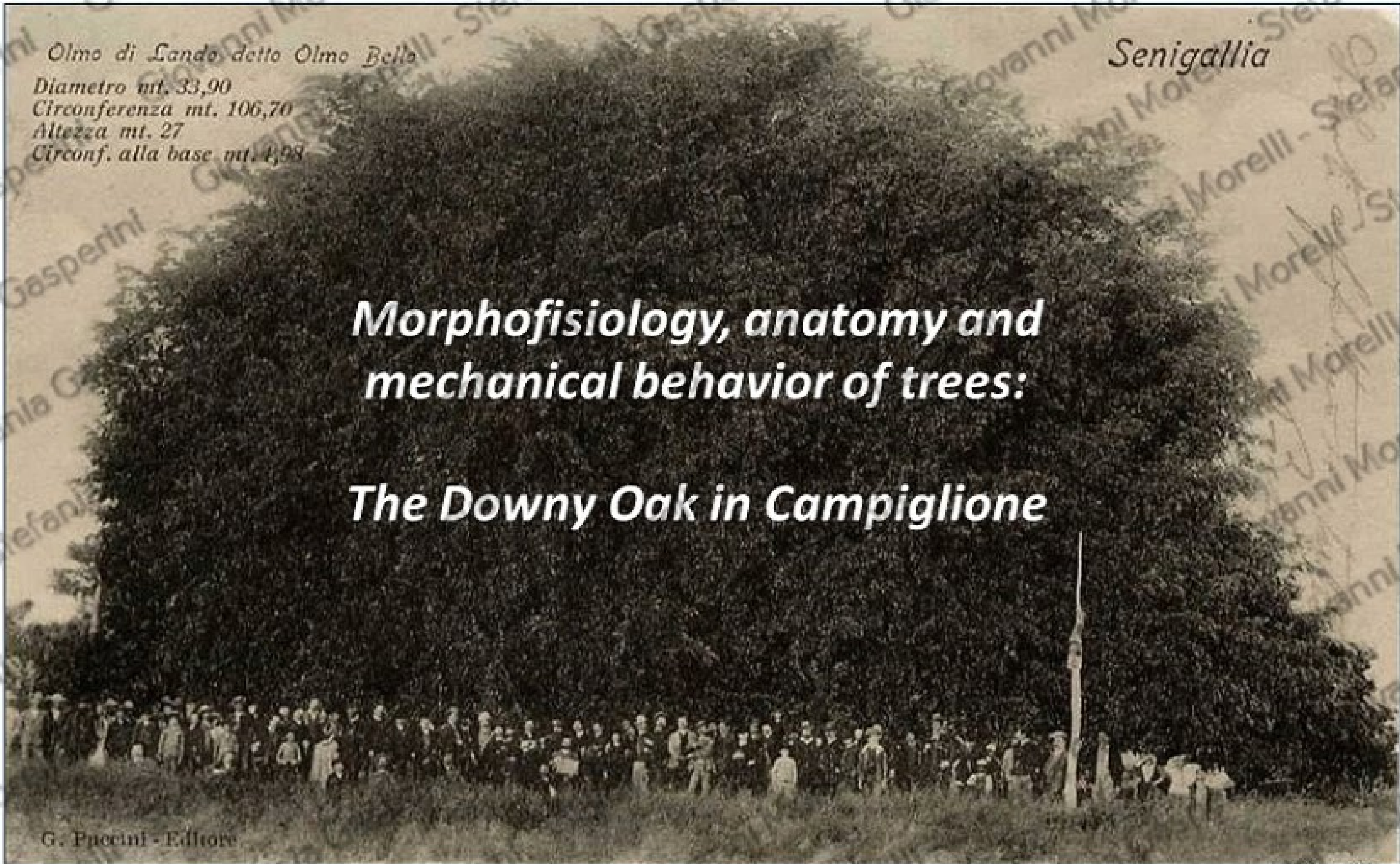
* *Lowest tipping stability safety factor (1.85)*

1 *Cambial columns*

1 Cambial columns

Integrated assessment: tomograph and pulling test outcomes




Olmo di Lando detto Olmo Bello
Diametro mt. 33,90
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Altezza mt. 27
Circonf. alla base mt.
Senigallia
Morphofisiology, anatomy and
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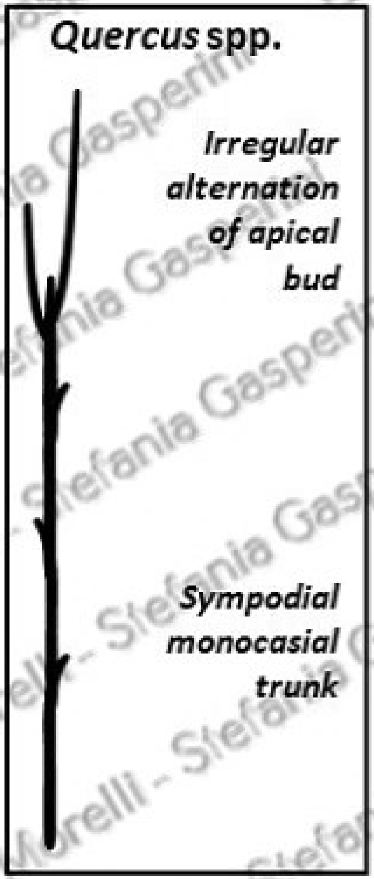
The Downy Oak in Campiglione
G. Puccini - Editore

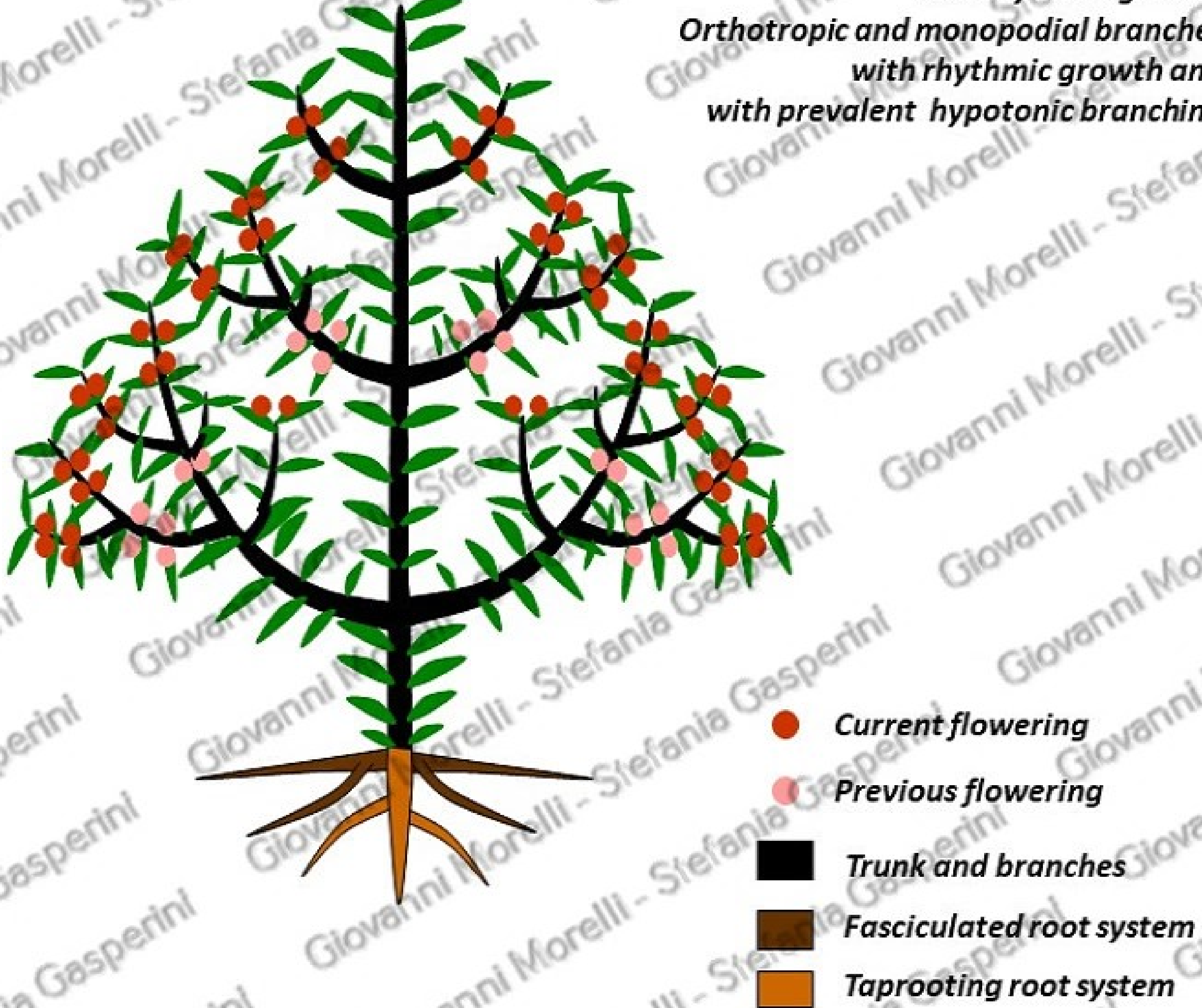
The phylogenetic level of the form: Rauh architectural model

Trunk and branches differenciated only after flowering (lateral)

Spiral phyllotaxis

Orthotropic and monopodial/sympodial trunk with rhythmic growth
Orthotropic and monopodial branches with rhythmic growth and with prevalent hypotonic branching





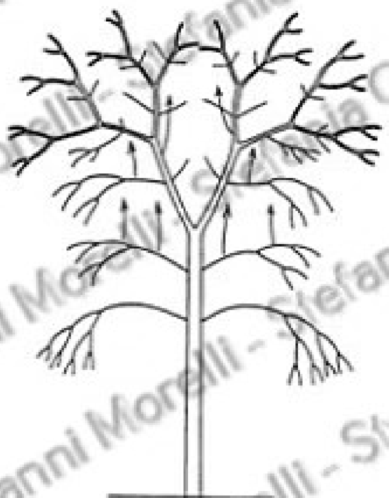
First root system usually from seed

Source: P. Raimbault, (from F. Hallé); 2006

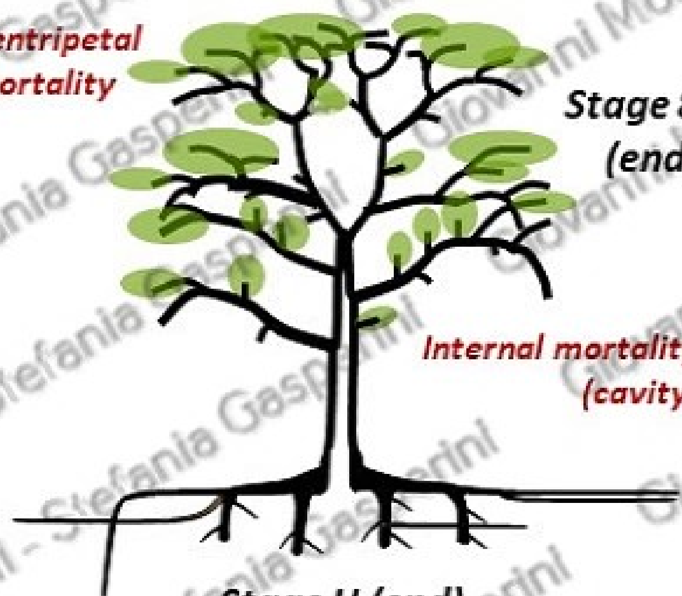
The Downy Oak in Campiglione

The ontogenetic level of the form: the end of Stage 8/H

Rahu model



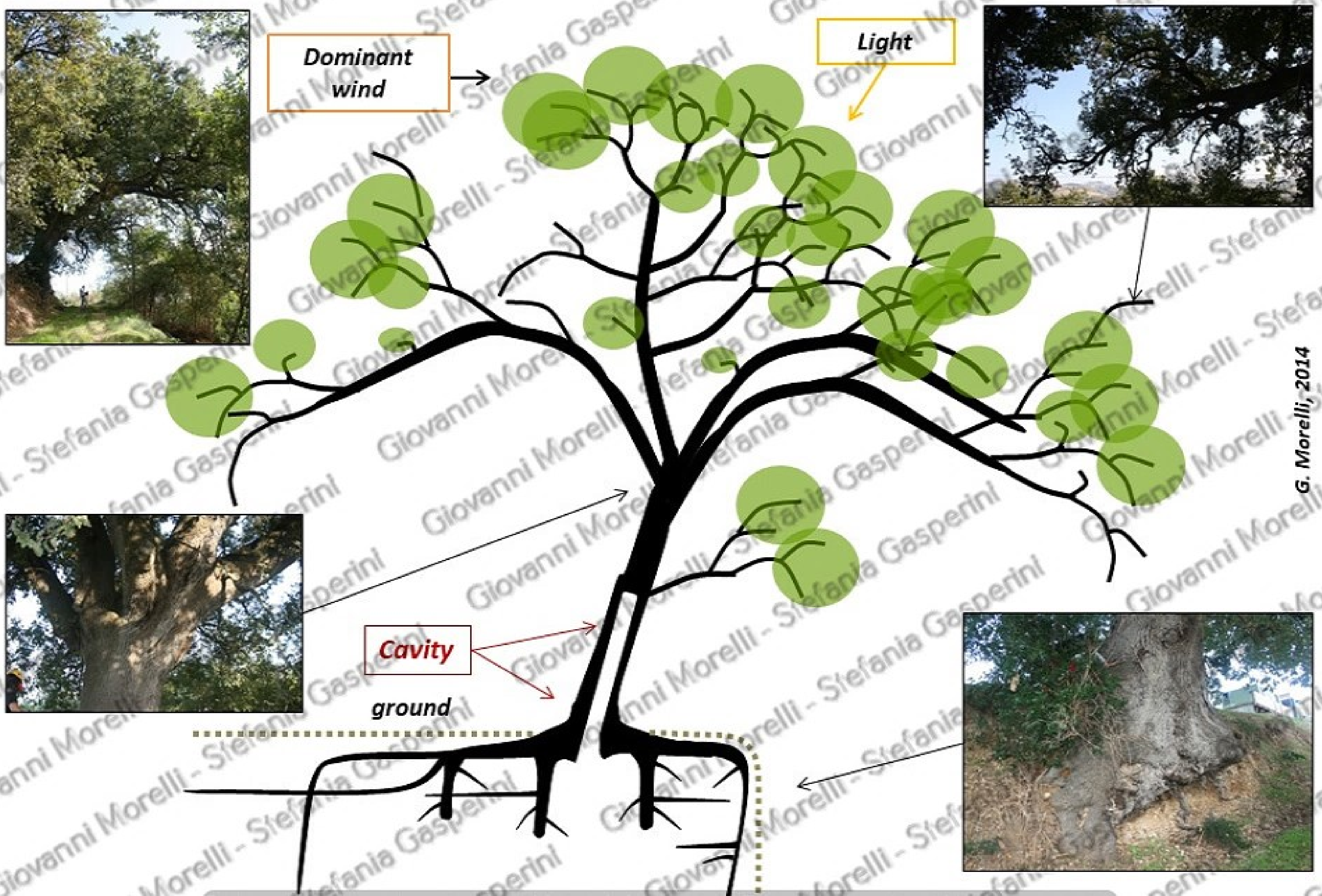
D: Mature



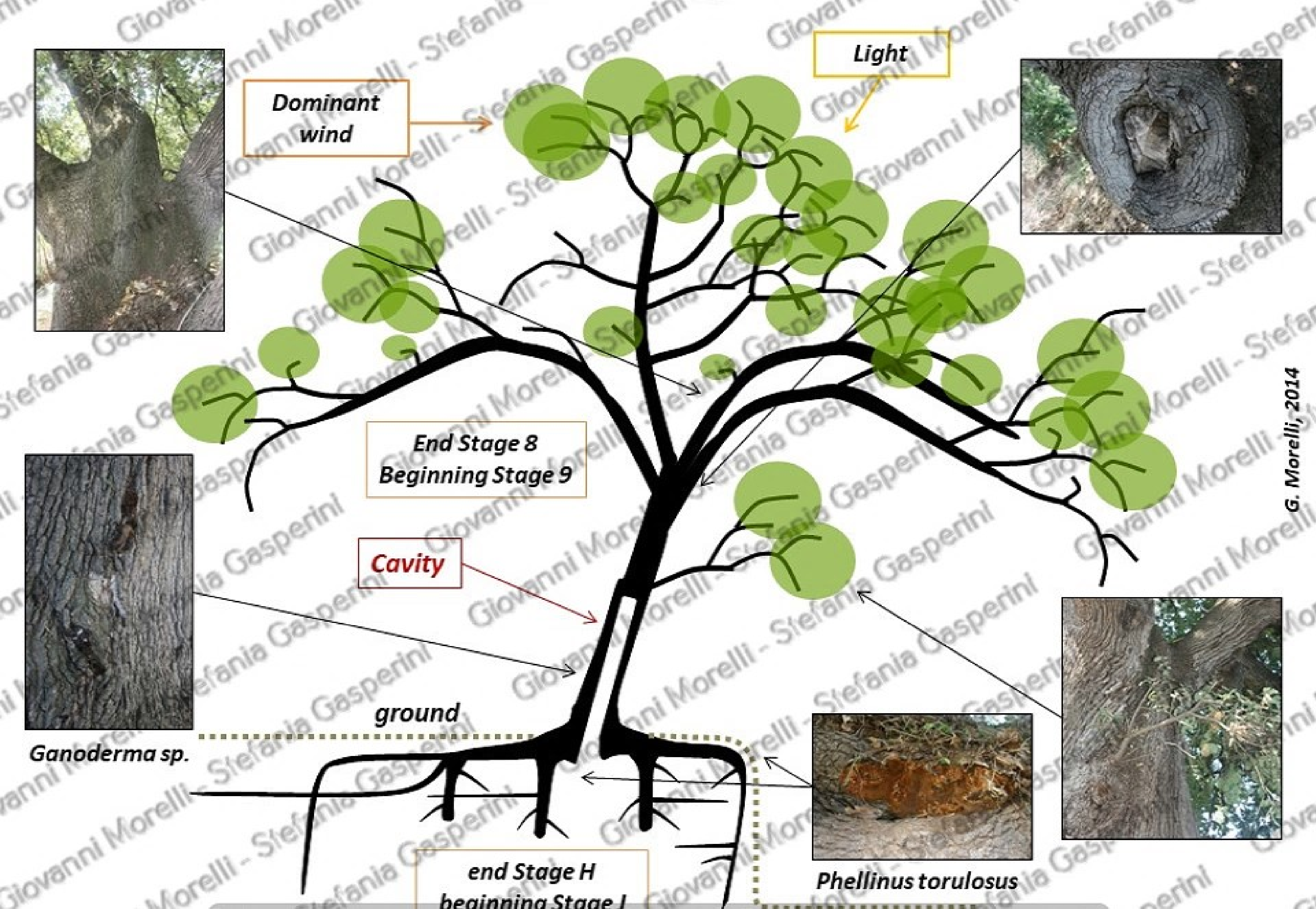
Stage H (end)

G. Morelli, 2014

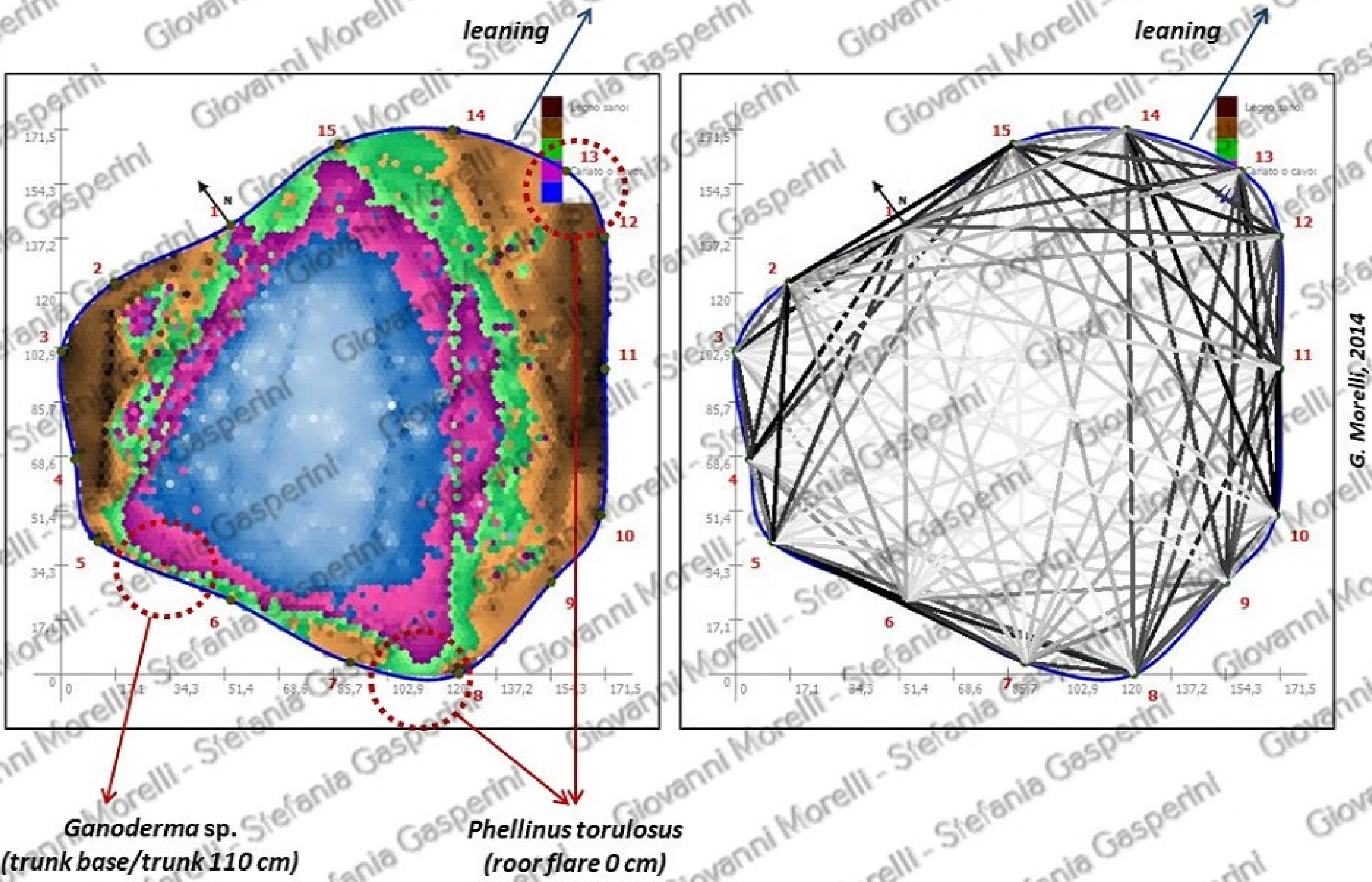
The phenotypic level of the form : adaptive, corrective and reparative modifications



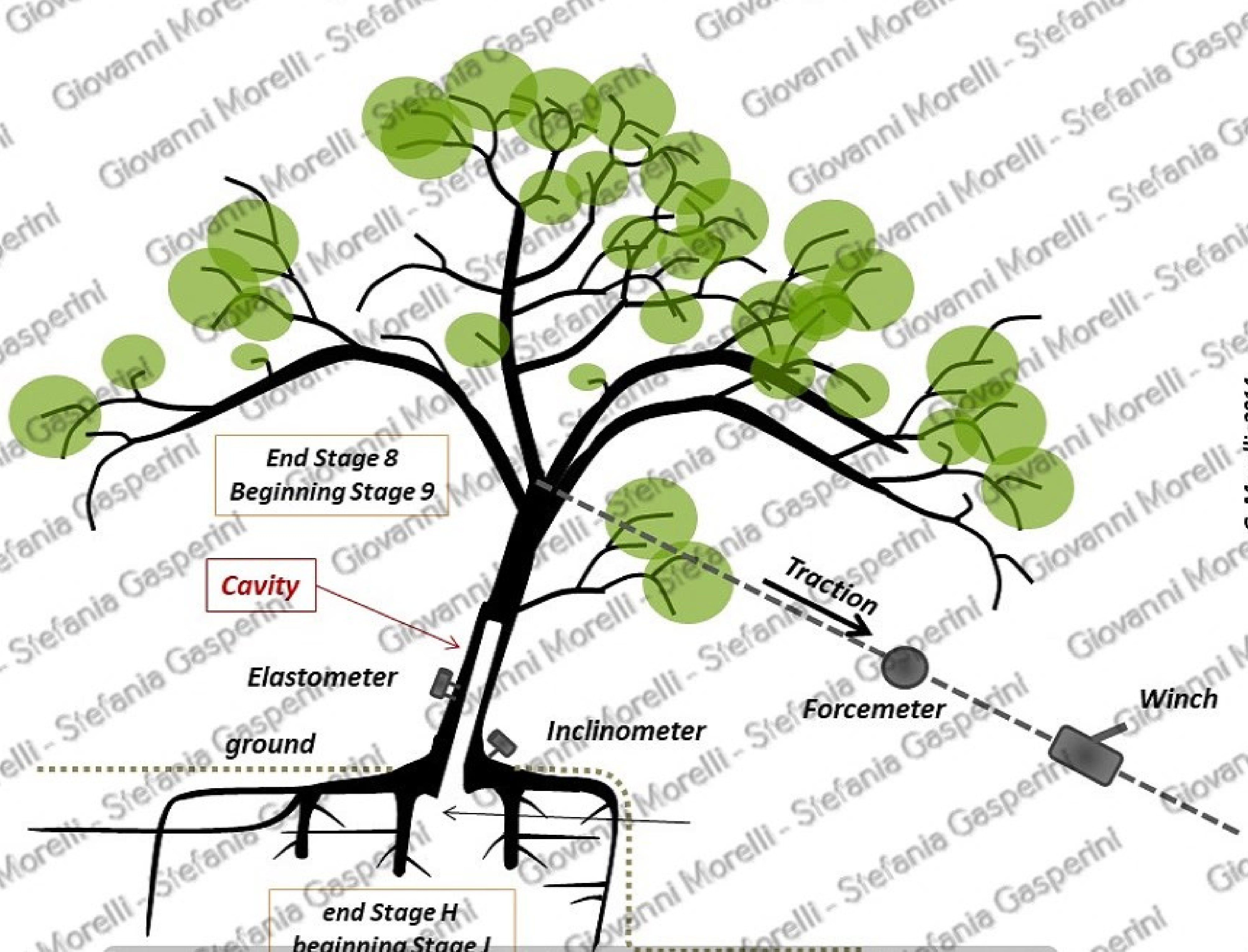
Visual assessment: looking for clinic features



Sonic tomograph analysis of the Downy Oak in Campiglione (trunk base 60 cm)



Pulling test of the Downy Oak in Campiglione



Pulling test of the Downy Oak in Campiglione

Analisi del carico del vento secondo DIN 1055-4

ARBES.

Progetto		Luogo N. dell'albero	001
Nome progetto	Loc. Campiglione	Località Campiglione	
Numero progetto		63900 Fermo, Italia	
Data del test	22/10/13	Altitudine sul livello del mare	319 m

Dati dell'albero		Proprietà del materiale applicate	
Specie	Quercus pubescens	secondo	Quercus robur
Circonferenza del fusto	515 cm	Fonte	Stuttgart
Diametro del fusto	127 cm	Resistenza a compressione	28 MPa
in 1 m di altezza	133 cm	Modulo di elasticità	6900 MPa
Spessore della corteccia	4 cm	Limite di elasticità	0,41 %
Altezza dell'albero	16,7 m	Densità del legno verde	1,03 g/cm³

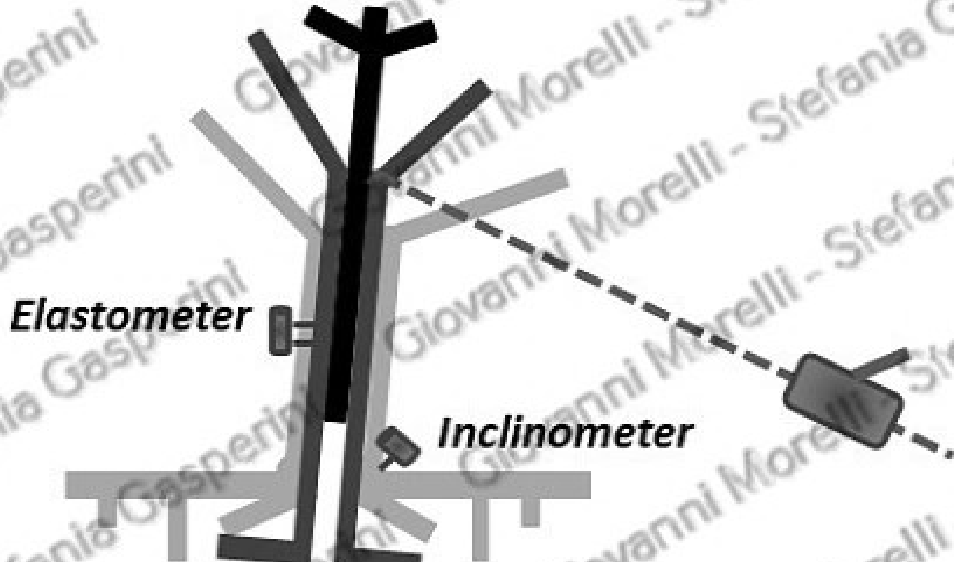
Sagoma della chioma

Direzione del carico	NE
Analisi dell'area di superficie	
Base della chioma	3,9 m
Altezza effettiva	11,6 m
Area della superficie totale	290 m²
Eccentricità della chioma	1,32 m
Parametri strutturali applicati	
Resistenza aerodinamica	0,25
Frequenza propria	0,8 Hz
Diminuzione di smorzamento	0,7
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	1,24 kg/m³
Terreno	Campagna
Esponente profilo del vento	0,16
Fattore di prossimità per effetti del vento vicino al terreno	1
Fattore per l'esposizione	1,00

Risultati

Analisi del carico del vento		Analisi statica dell'albero	
Pressione media del vento	21,6 kN	Peso proprio dell'albero	16,1 t
Fattore di reazione alle raffiche	2,03	Livello di cavità critico	95 %
Centro di carico	9 m	Spessore della parete critico	4 cm
Momento torcente	58 kNm	assumendo una parete residua integra	
Carico del vento	396 kNm	**Fattore di sicurezza di base**	12,2

> 1.5



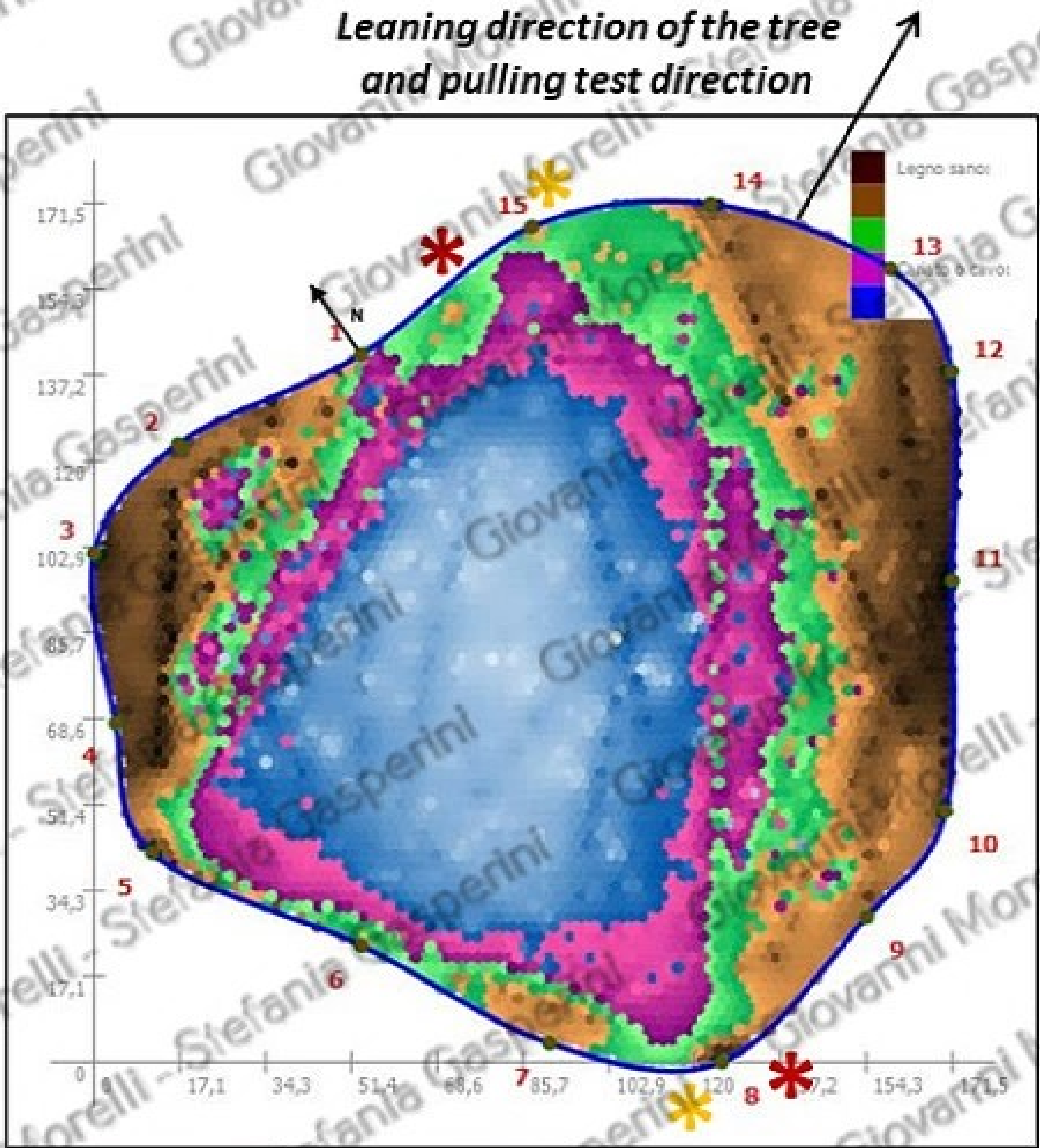
G. Morelli, 2014

Basic safety factor:
12.2

Tipping stability safety factor:
20.52, 3.18, 6.66, 13.23

Breaking stability safety factor:
12.77, 6.69, 5.03, 8.66

Integrated assessment: tomograph and pulling test outcomes



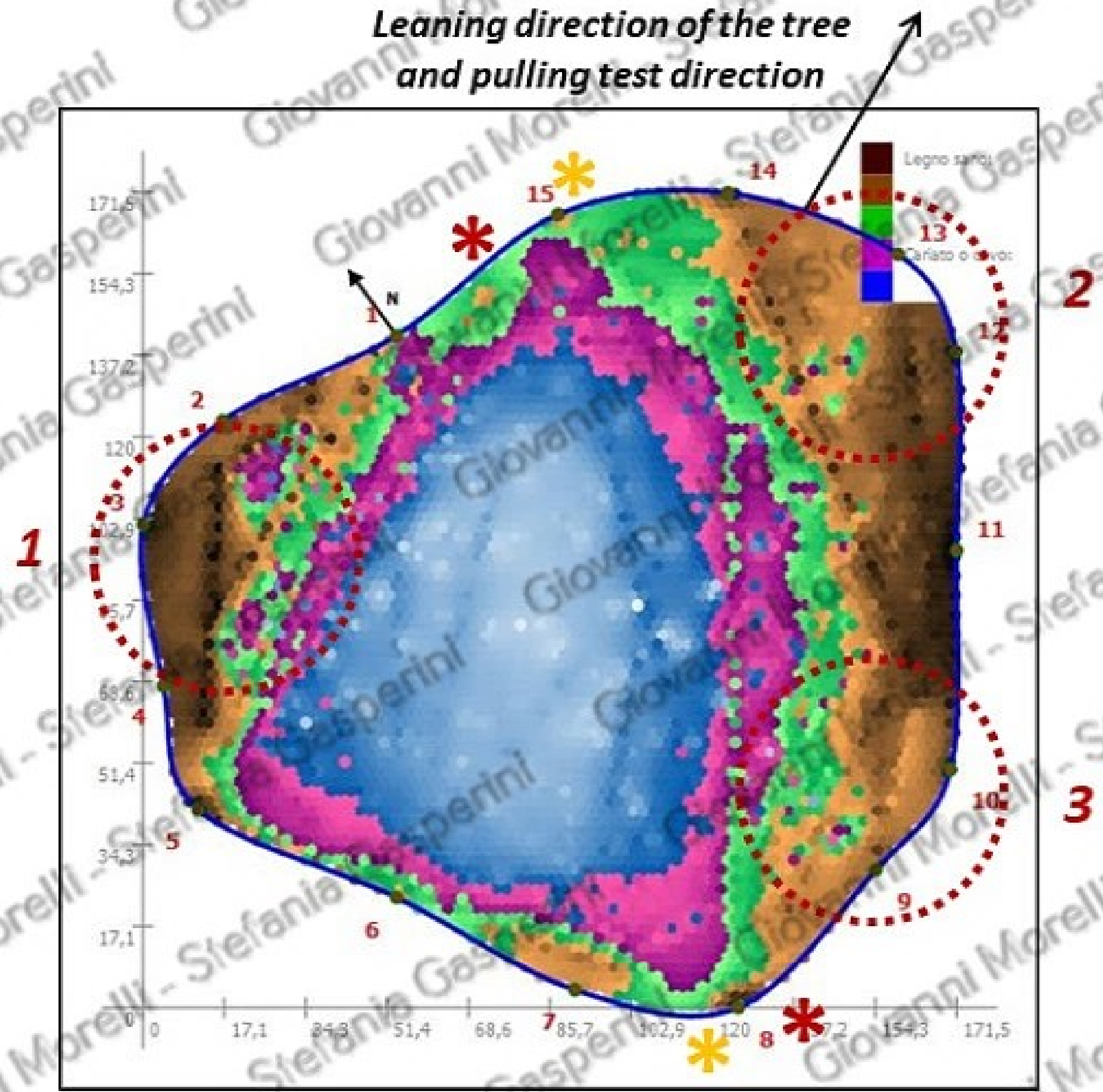
Lowest breaking stability safety factors

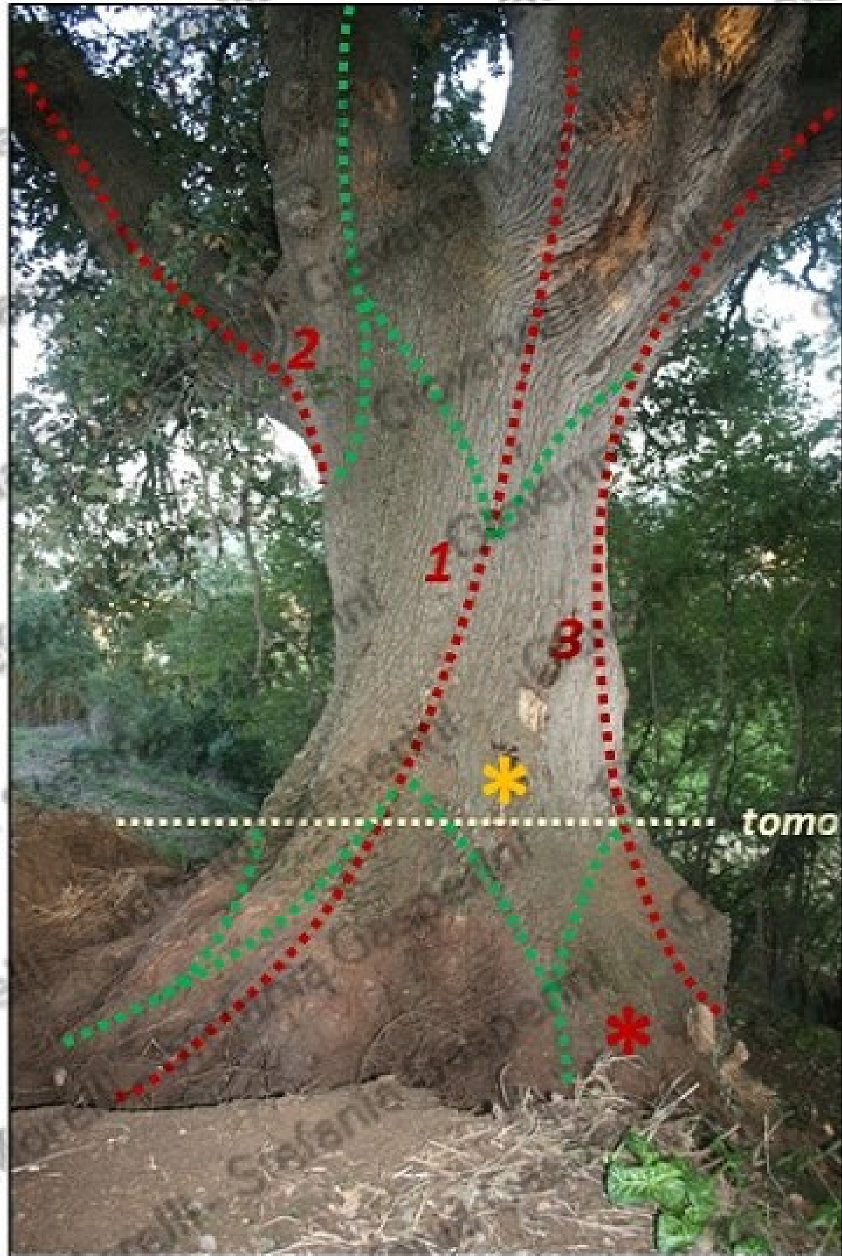
Lowest tipping stability safety factor

G. Morelli, 2014

South-South/West side

Integrated assessment: tomograph, pulling test outcomes and morphophysiological analysis





G. Morelli, 2014

South-South/West side

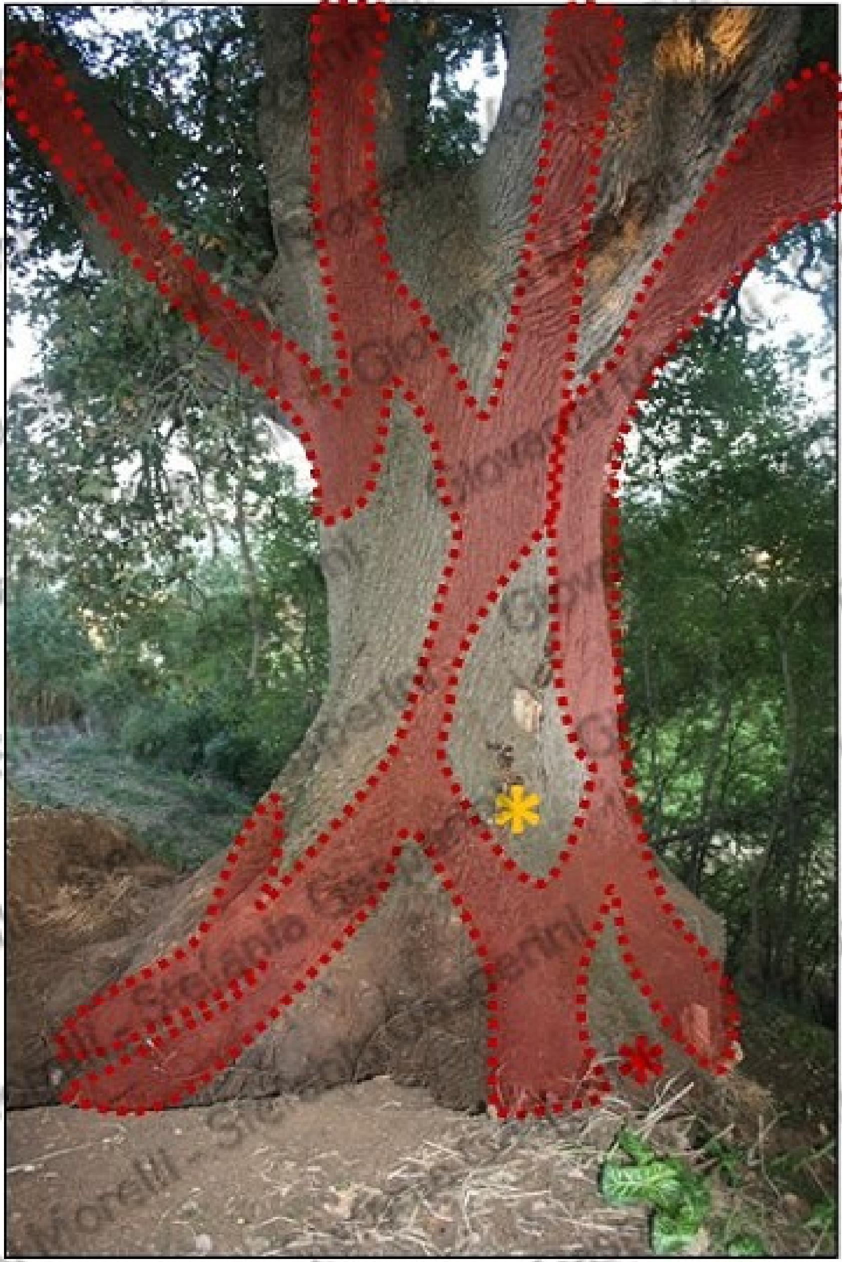
* Lowest breaking stability safety factors

* Lowest tipping stability safety factor

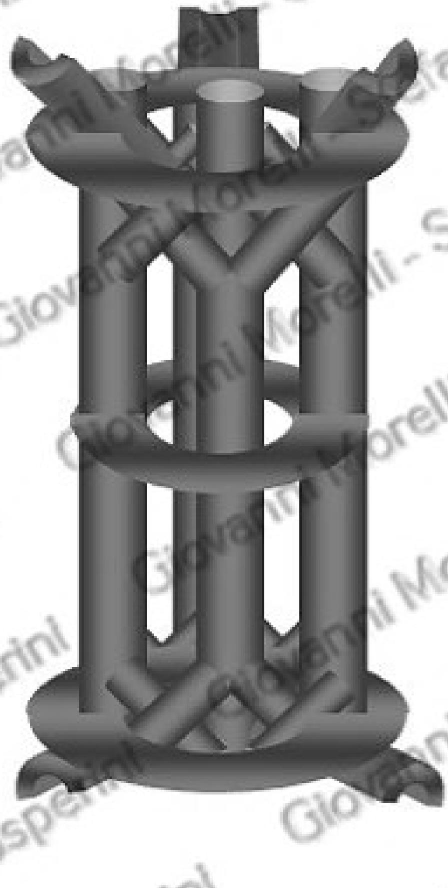
Cambial columns

Secondary cambial columns/cambial bridges

Integrated assessment: tomograph, pulling test outcomes and morphophysiologicial analysis



Stage 8/H
(9/J)

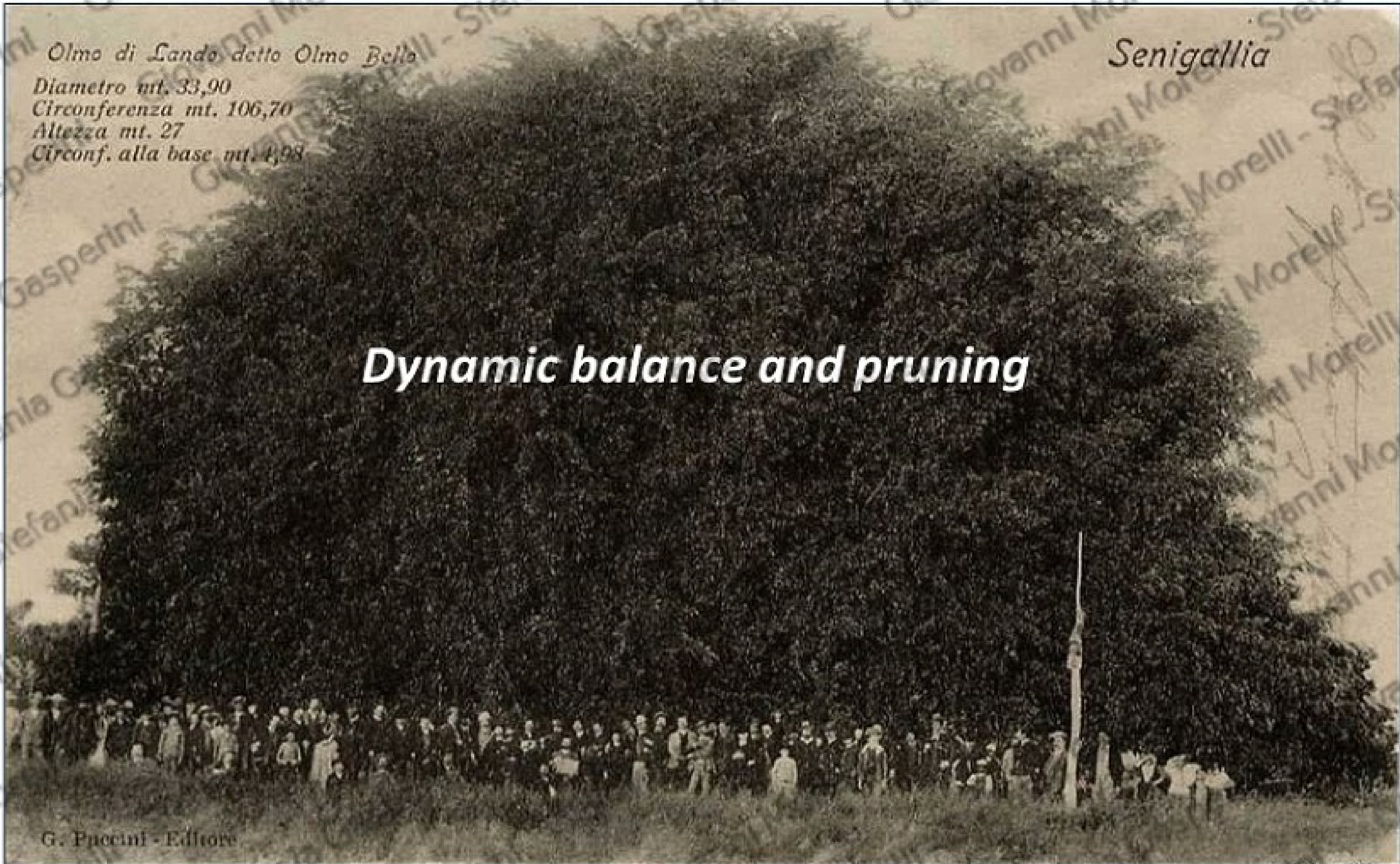


G. Morelli, 2014

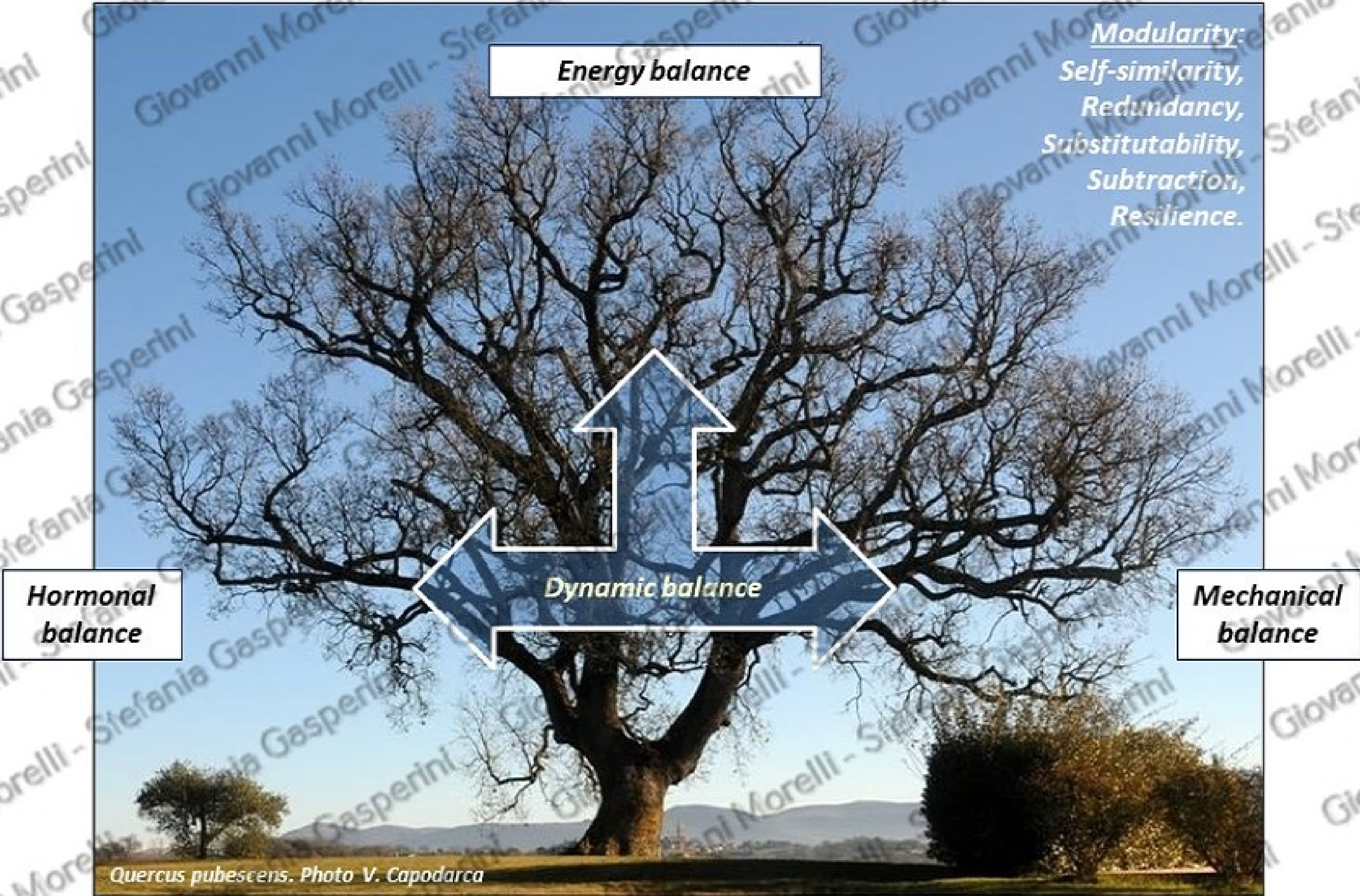
* *Lowest breaking stability safety factors*

* *Lowest tipping stability safety factor*

Dynamic balance and pruning



The form as an expression of a dynamic balance



Source: G. Morelli; 2012

Morphophysiologic relativization of pruning in polyarchic species

Energy imbalance

The spiral of decline

Decline spiral model;

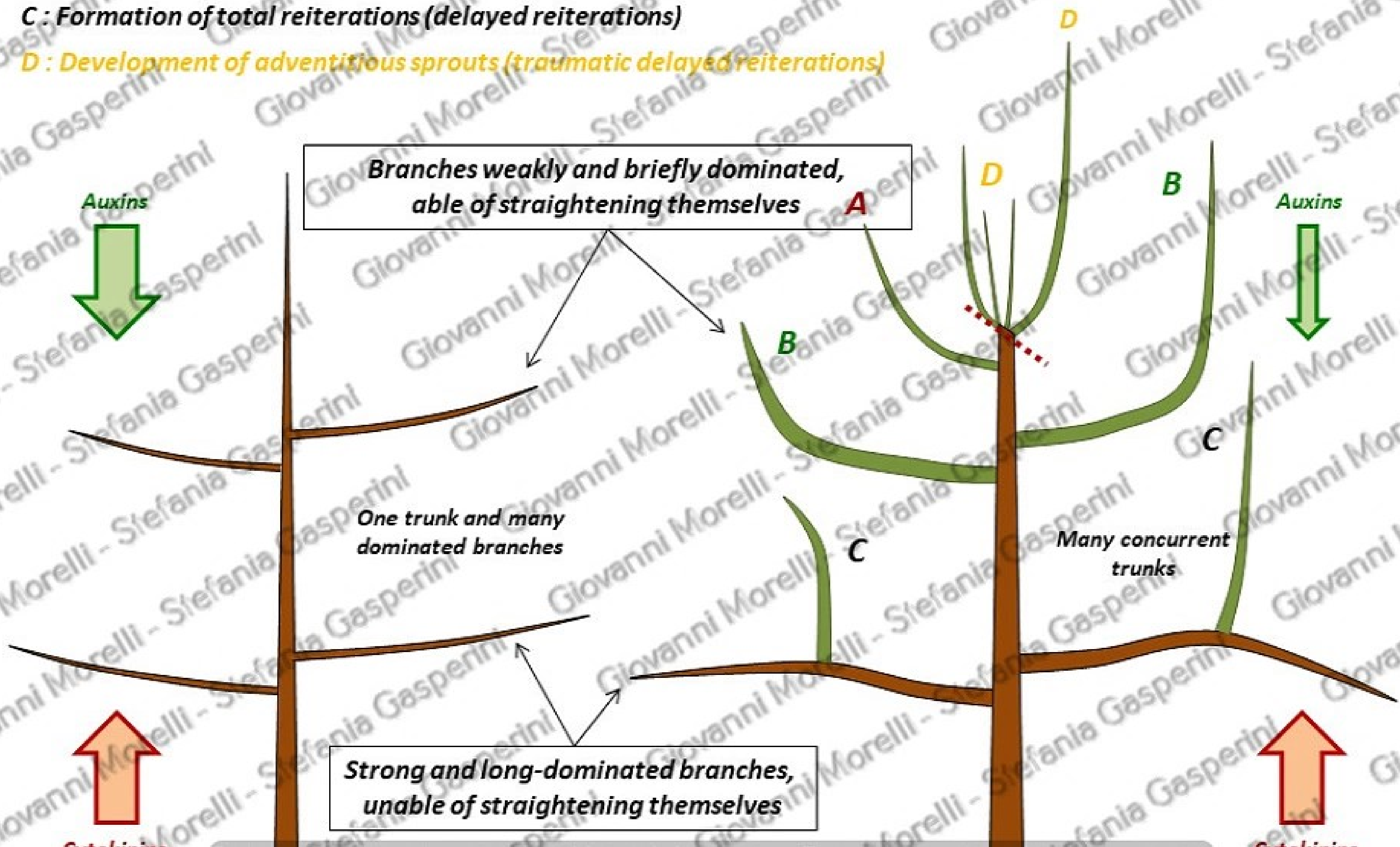
Hormonal imbalance

A : Total straightening of young branches (simultaneous reiterations)

B : Straightening of the end of the adult branches (simultaneous reiterations)

C : Formation of total reiterations (delayed reiterations)

D : Development of adventitious sprouts (traumatic delayed reiterations)



Hormonal imbalance in trees with strong hierarchy

Total reiteration of a branch

trauma (about 20 years ago)

Simultaneous total reiteration at the end of a branch

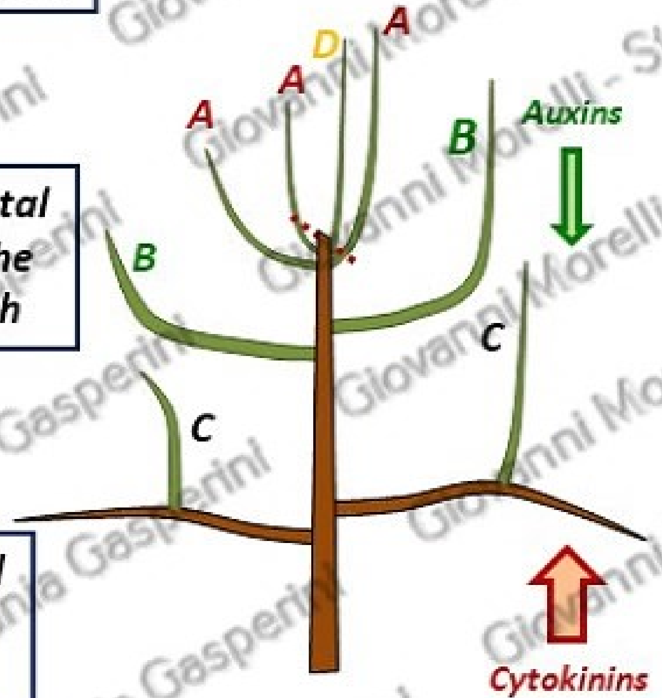
Delayed total reiteration on a branch

A : Total straightening of young branches (simultaneous reiterations)

B : Straightening of the end of the adult branches (simultaneous reiterations)

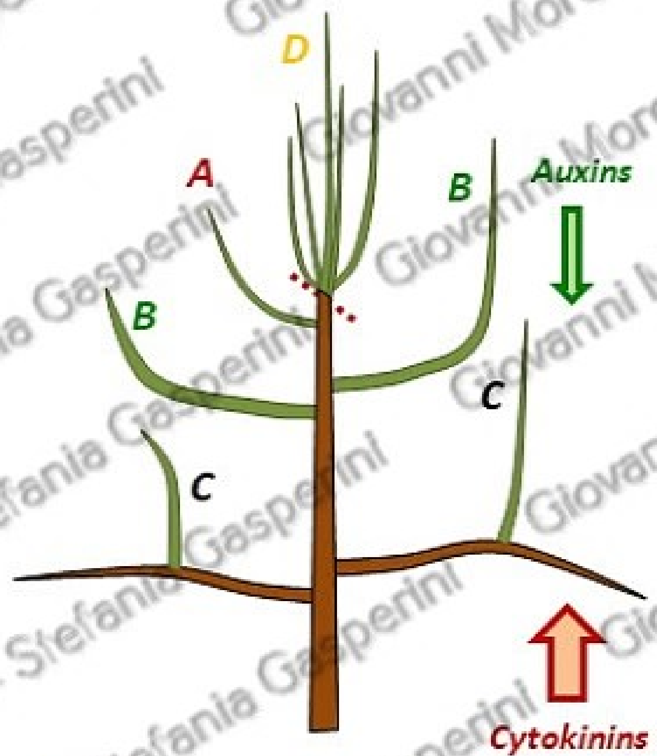
C : Formation of total reiterations (delayed reiterations)

D : Sviluppo di vegetazione avventizia (reit. ritardate traumatiche)

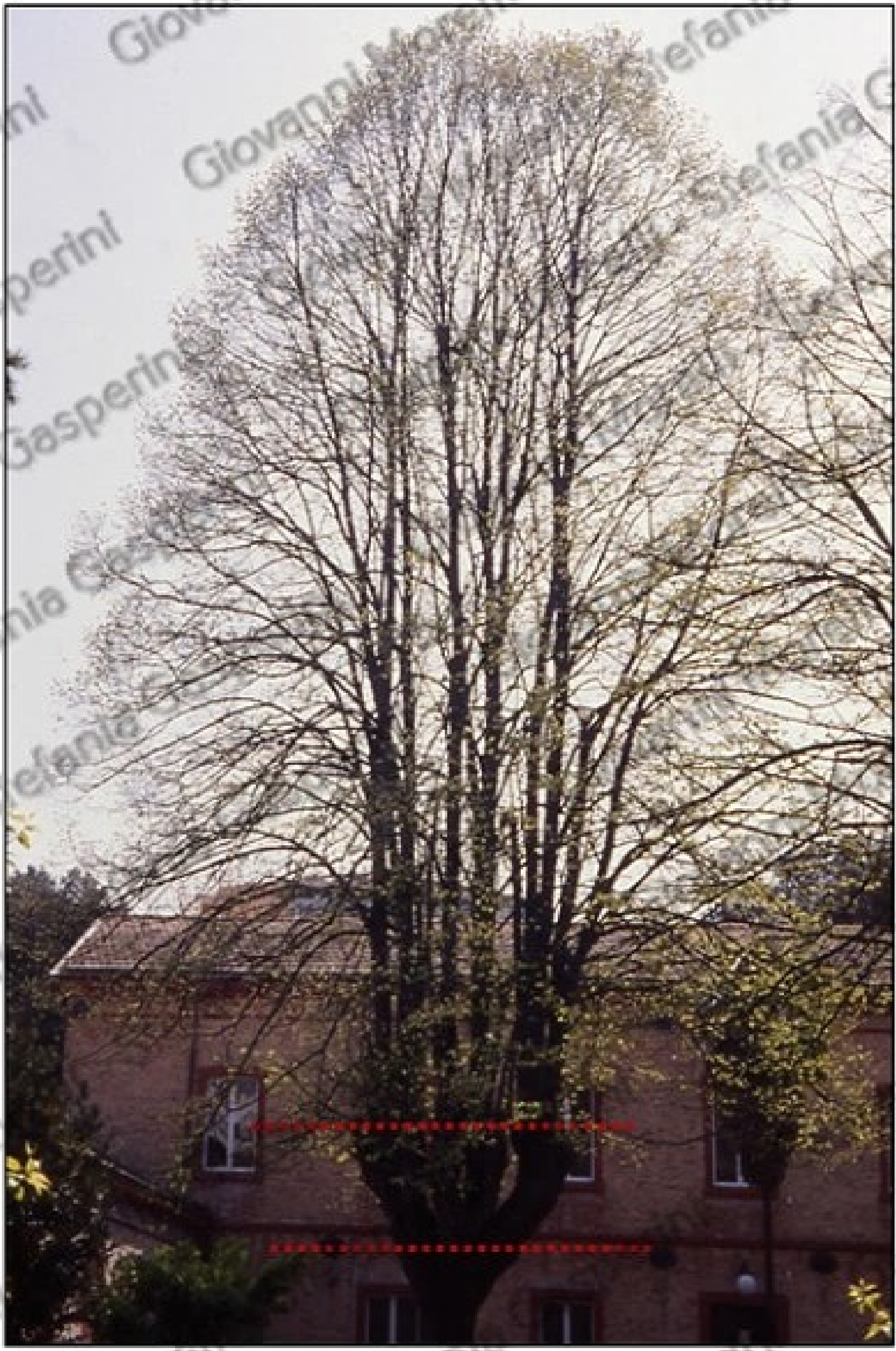


Hormonal imbalance in polyarchic trees

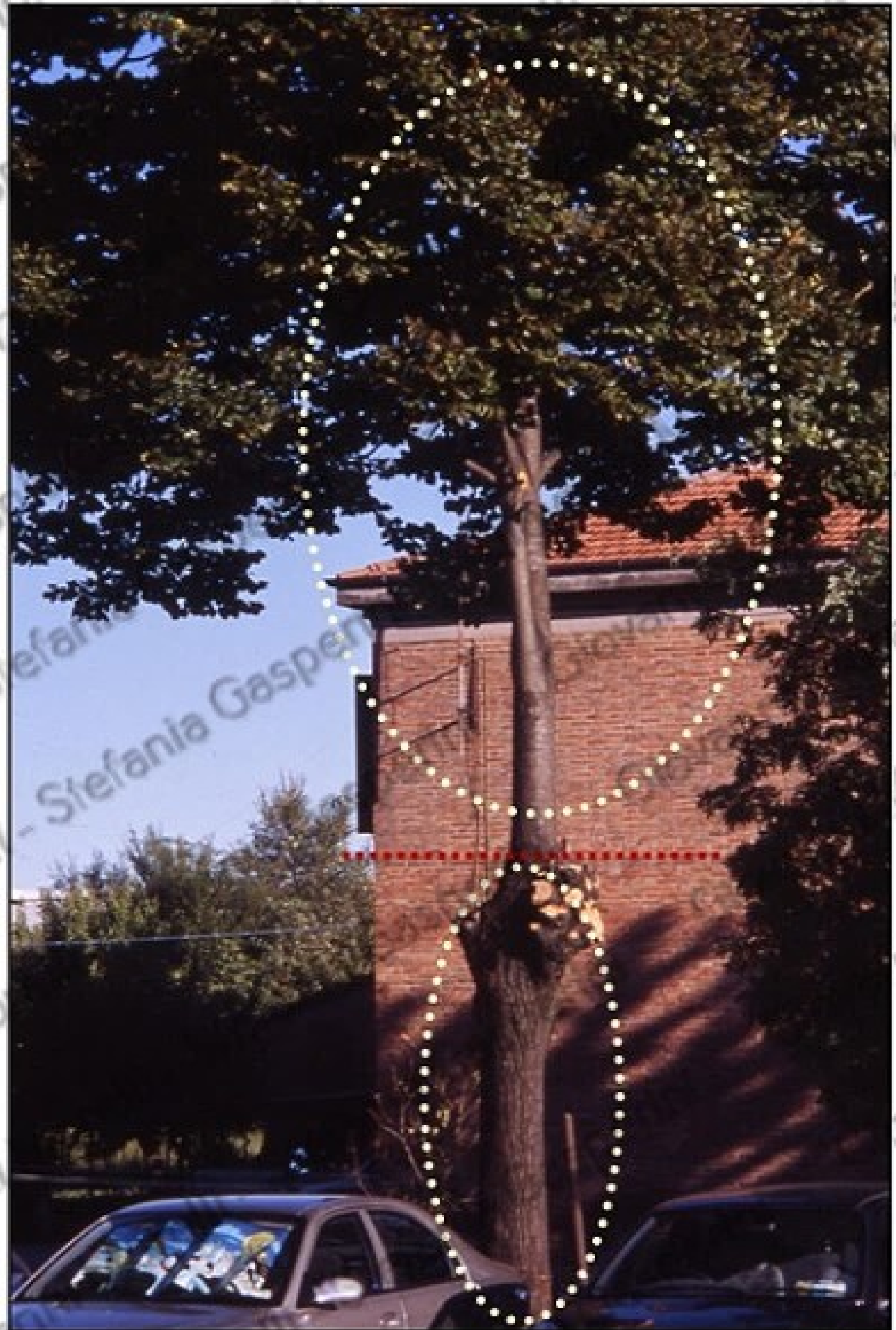
D : Development of adventitious sprouts
(traumatic delayed reiterations)



Hormonal imbalance: evolution of adventitious sprouts and second clonality

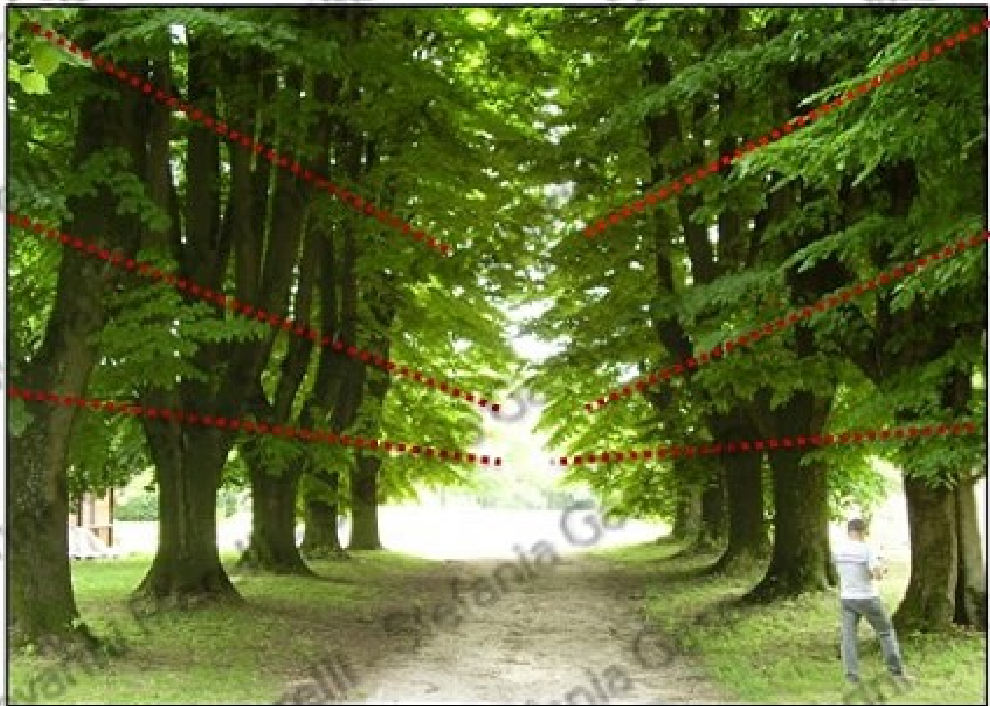


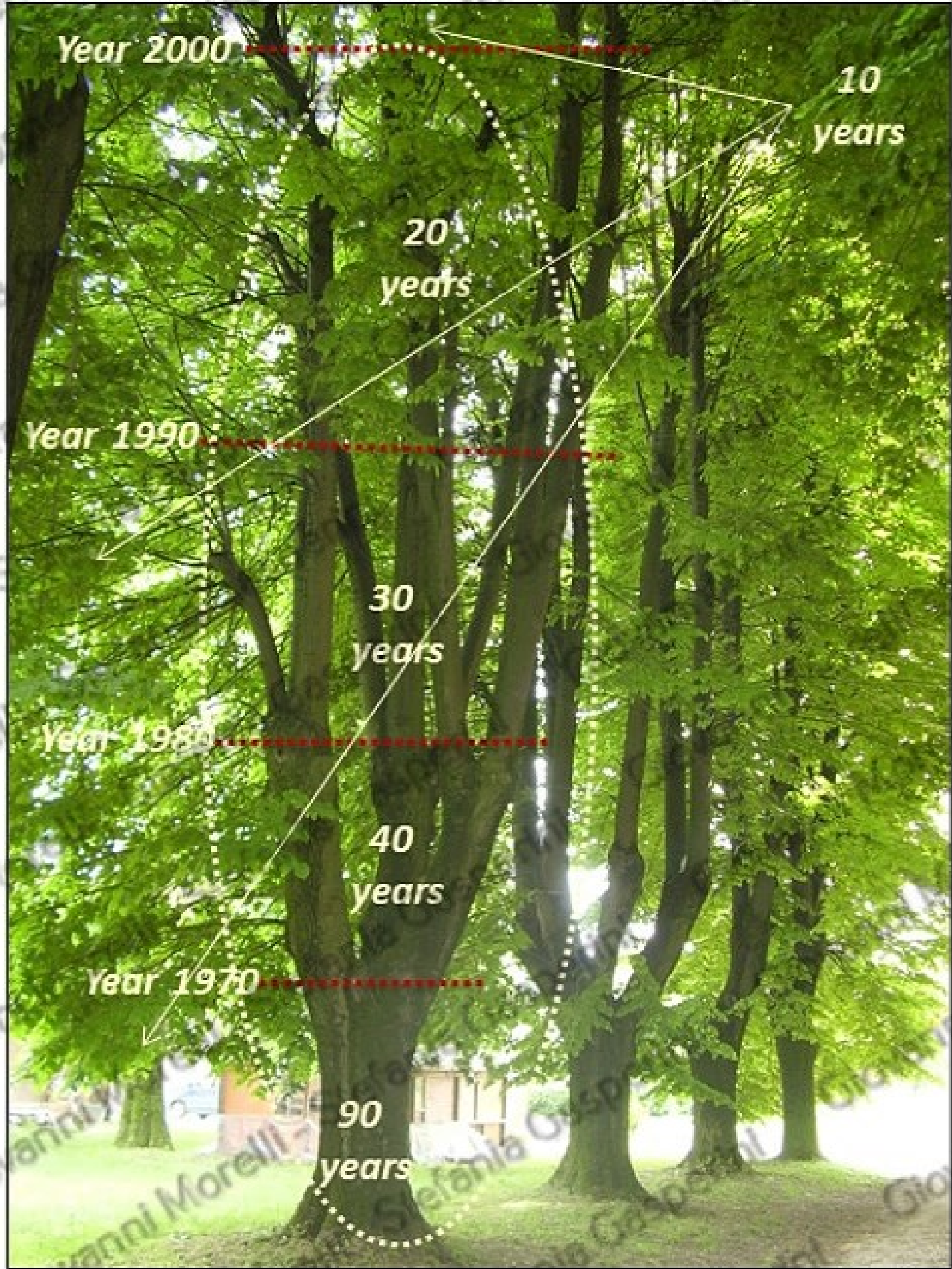
Tilia, Ancona



Tilia, Ferrara

Hormonal imbalance: evolution of adventitious sprouts and second clonality





Tilia: Moglia (MN), June 2010

Hormonal imbalance: evolution of adventitious sprouts, second clonality and second hierarchy

Tilia, Ferrara 2013

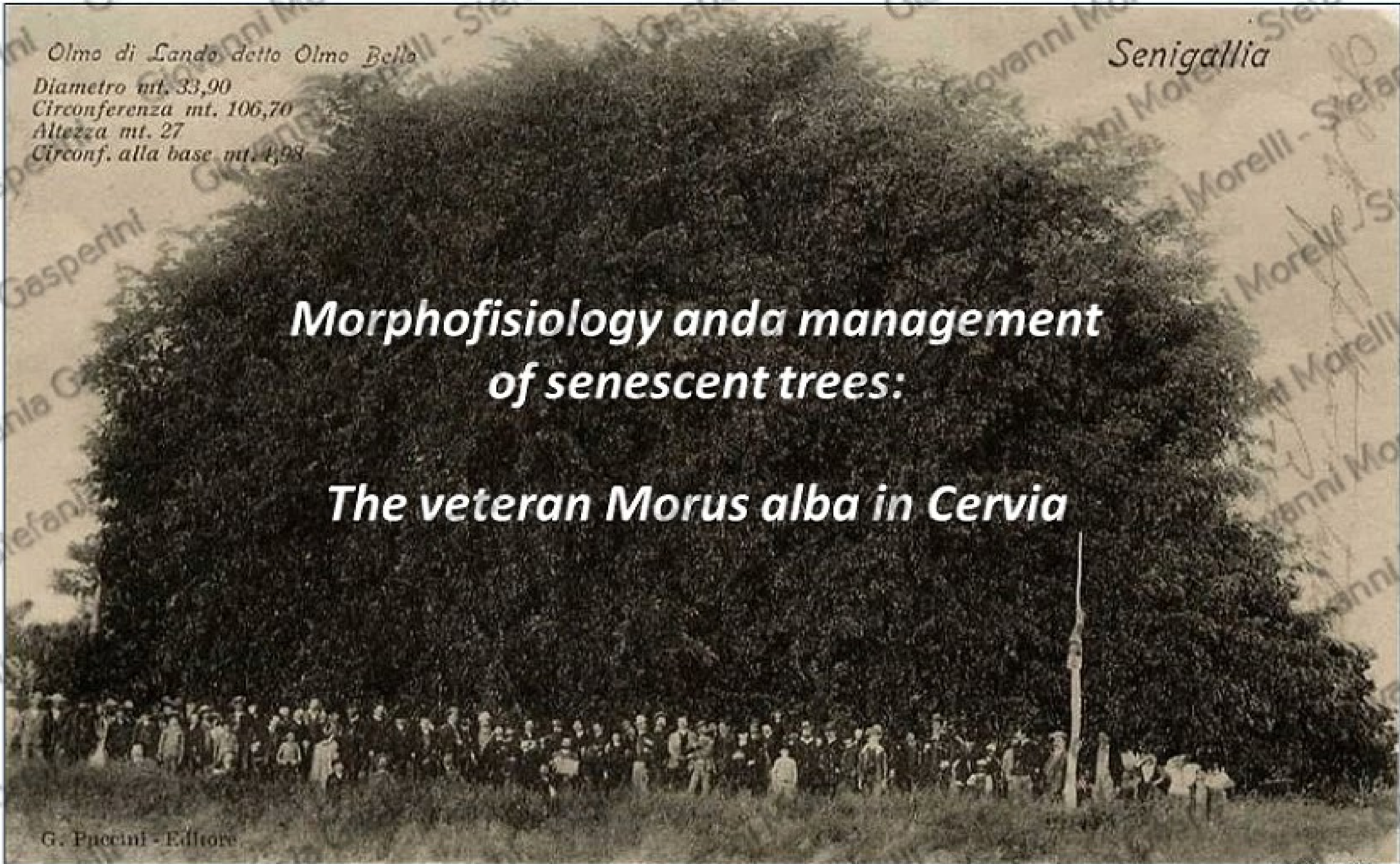
Does anybody remember? The reconstruction of the London Plane trees of Piazza Martiri in Reggio Emilia

February 2008

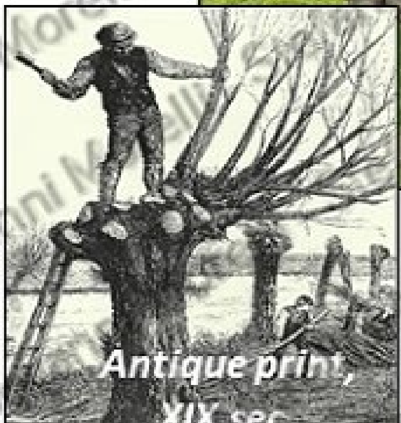
June 2008

February 2009

February 2019


Olmo di Lando detto Olmo Bello
Diametro mt. 33,90
Circonferenza mt. 106,70
Altezza mt. 27
Circonf. alla base mt.
Senigallia
Morphofisiology anda management
of senescent trees:
The veteran Morus alba in Cervia
G. Puccini - Editore

The Morus alba in Cervia



Antique print, XIX sec.

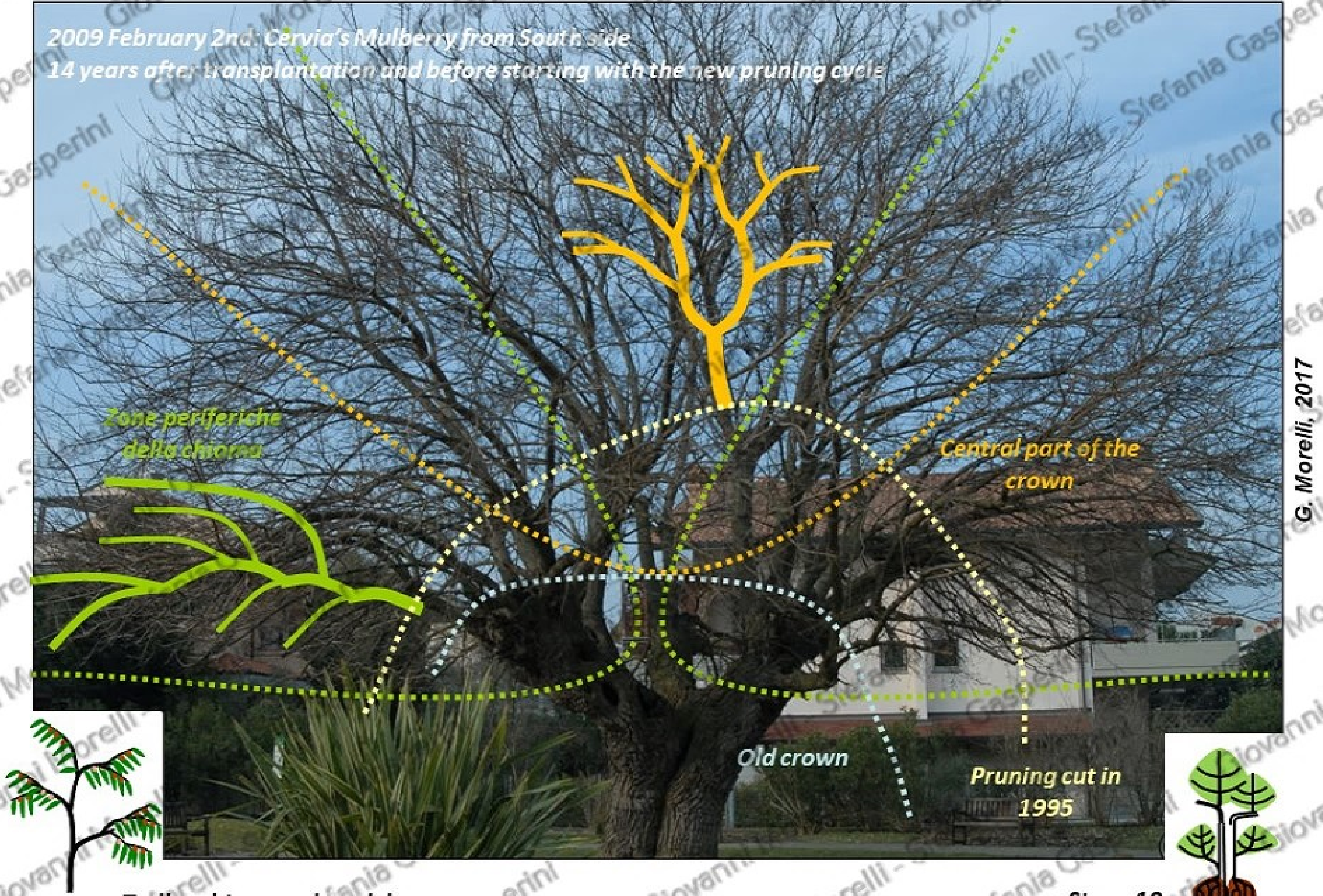
1995, transplanting

2009

G. Morelli, 2017

Assessment: morphophysiological and structural analysis

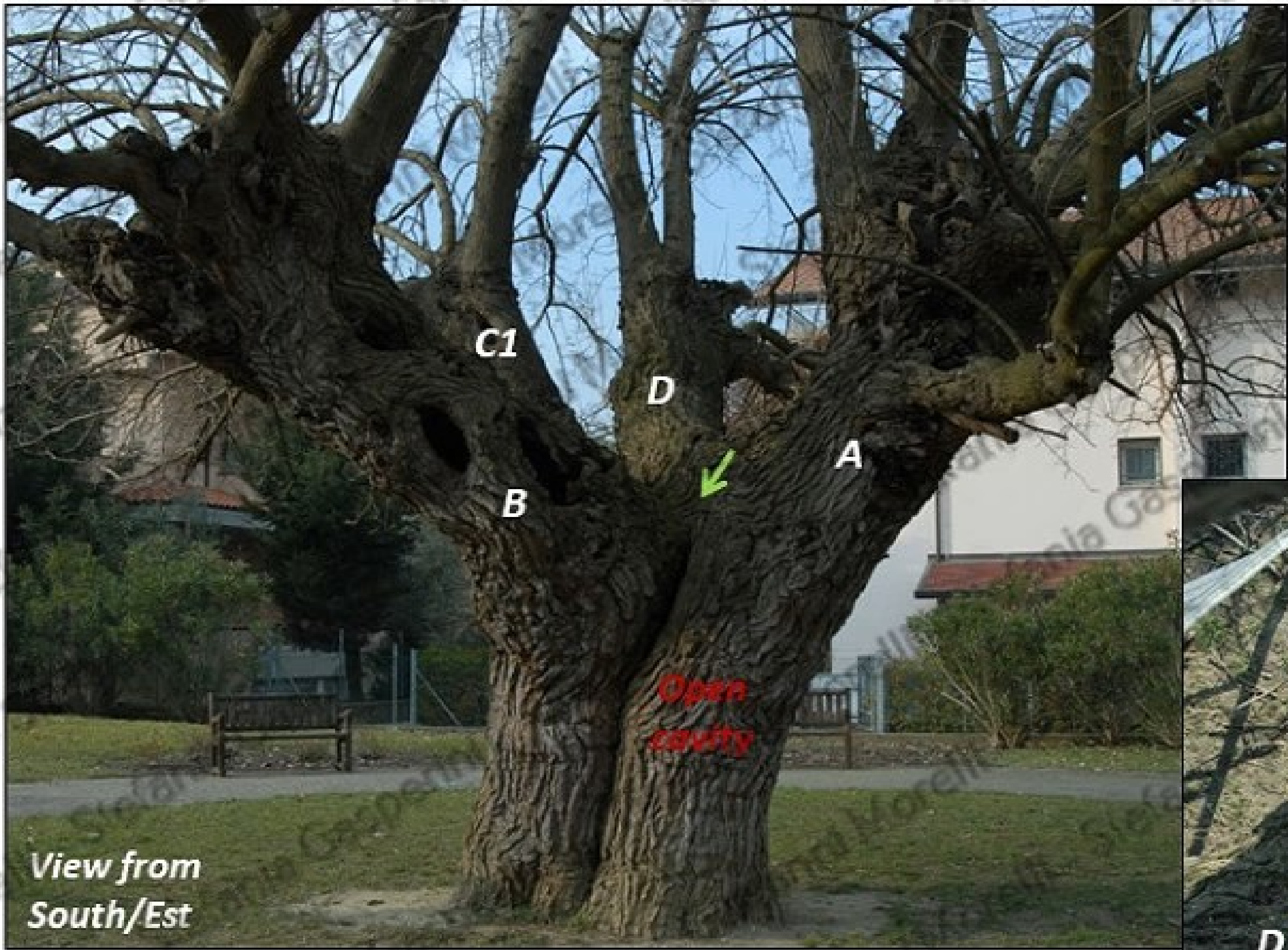
Assessment: morphophysiological and structural analysis

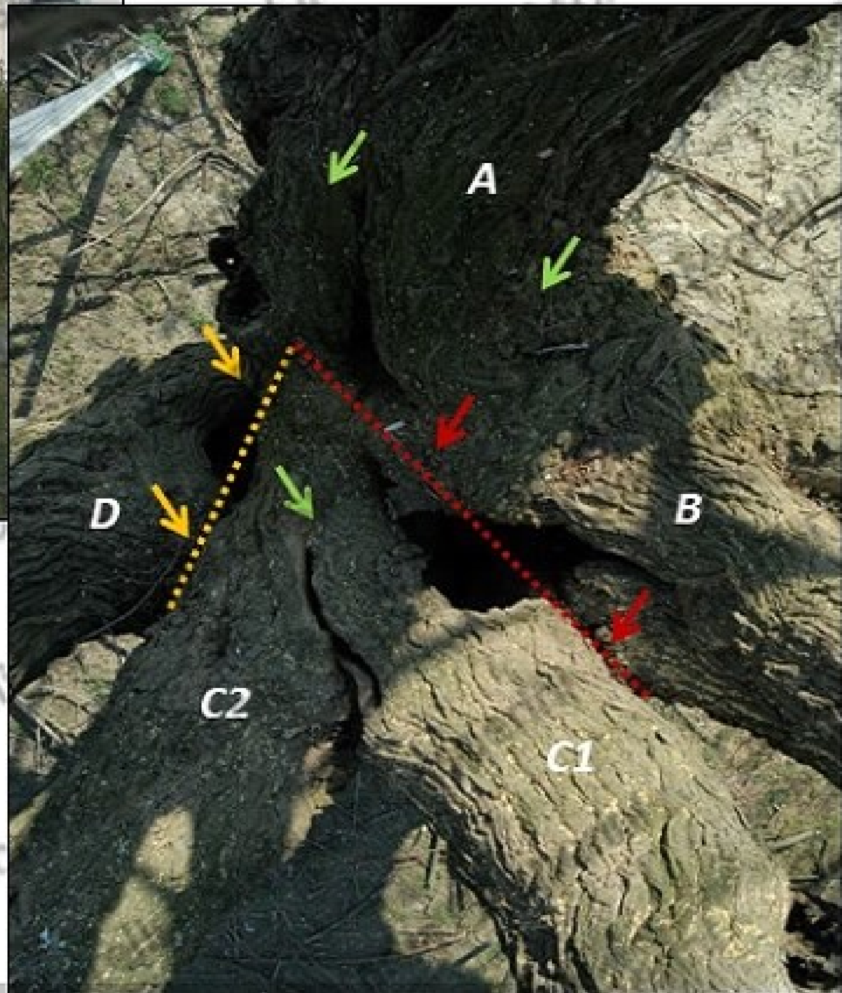


Troll architectural model

Stage 10

Assessment: morphophysiological and structural analysis



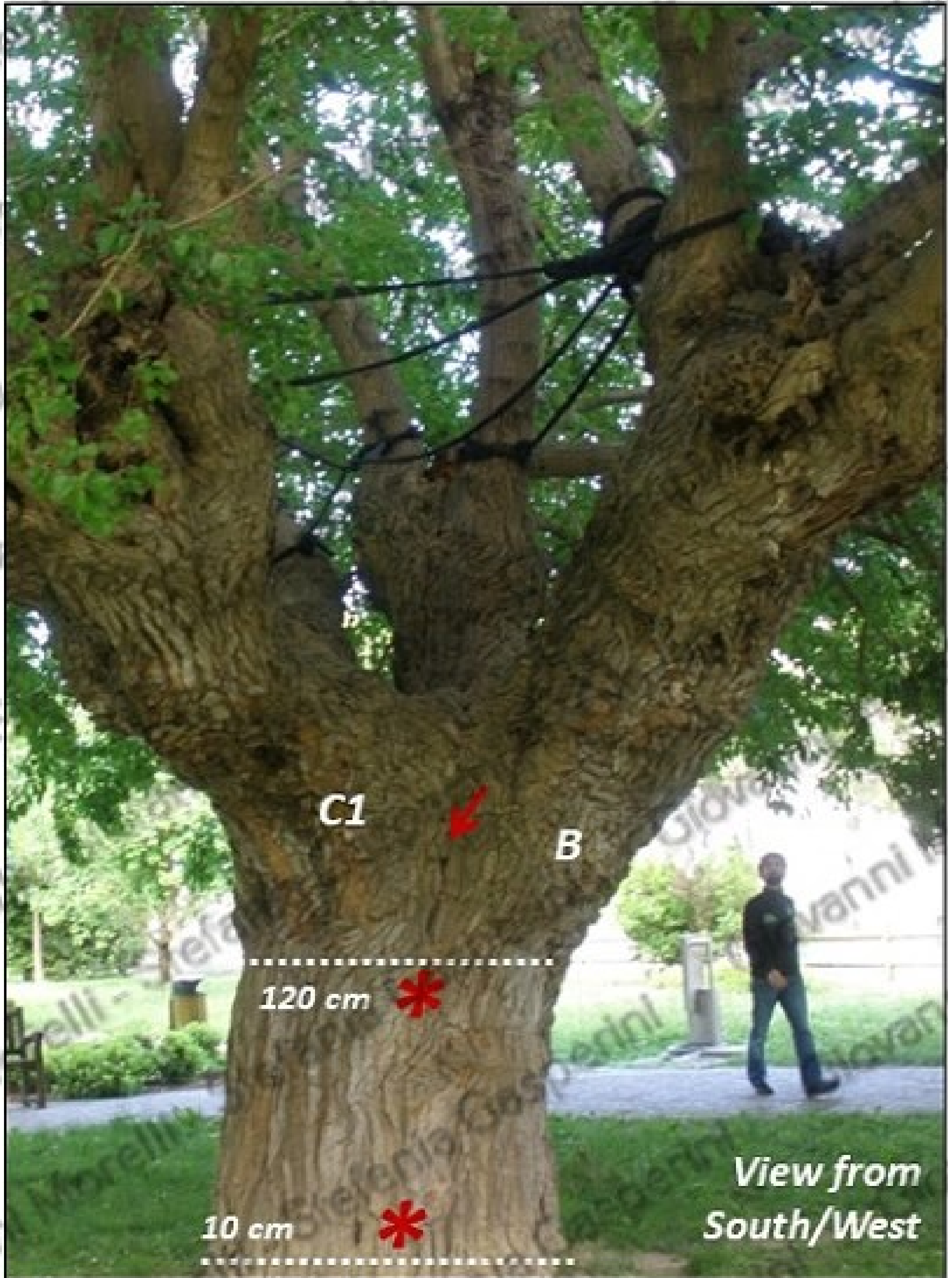


G. Morelli, 2017

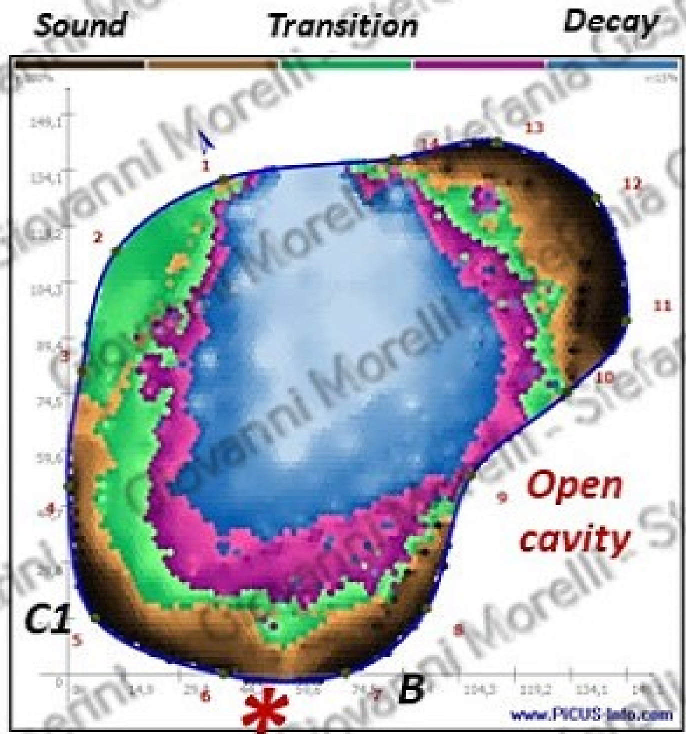
- Strong cambial bridge
- Weak cambial bridge
- Almost absent cambial bridges

A, B, C1, C2, D   Main cambial columns

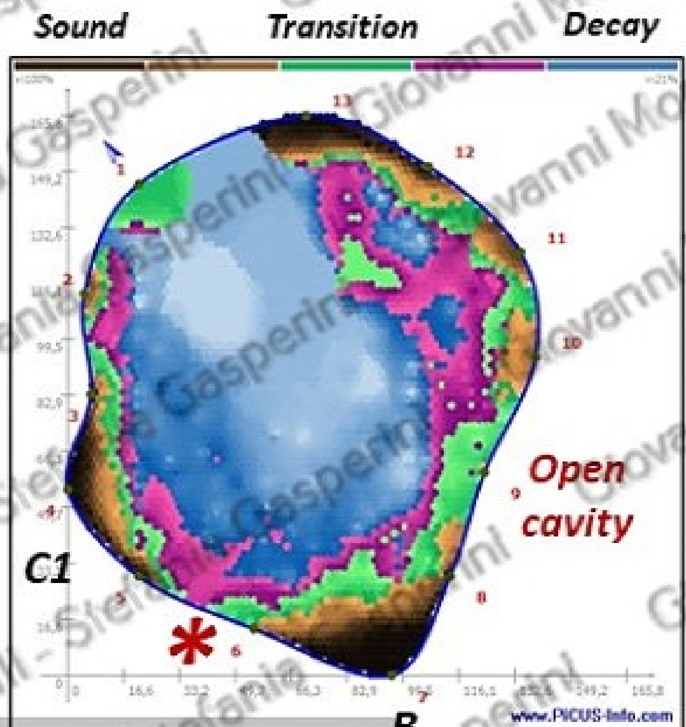
Assessment: morphophysiological and structural analysis



Sonic tomography 120 cm from the ground



Sonic tomography 10 cm from the ground



G. Morelli, 2017

* **Weak points**

B, C1 **Main cambial columns**

✓ **Almost absent cambial bridges**

Structural failure

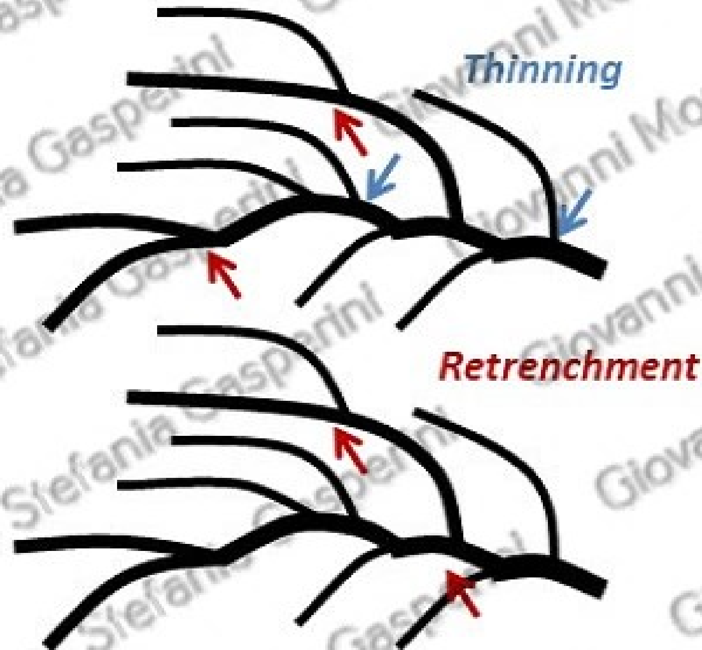
G. Morelli, 2017

* **Weak points**

↙ **Almost absent cambial bridges**

A, B, C1, C2, D **Main cambial columns**

First step: pruning



G. Morelli, 2017

Treeclimber: Stefano Tadioli, Company: Coop. Deltambiente

Second step: a metal support for the old Mulberry

G. Morelli, 2017

Project of Studio Ingegneri Associati, Ferrara

Third step: improving cambial activity and root treatments

60% soil;
20% volcanic rock;
20% mulch.

G. Morelli, 2017

Air spade® and treatments: Stefano Tedioli, Company: Coop. Deltambiente