

2011-2020 sets as an objective the restoration of 15% of degraded ecosystems by 2020. This challenge raises at least two major questions: i) how to restore, and ii) how to measure restoration success of said ecosystems? Measurement of restoration success is necessary to assess the achievement of the objectives and to adjust management with regard to objectives. Numerous studies are being conducted to try to work out synthetic indices in order to assess the ecosystem diversity or integrity in the context of global change. Nevertheless, at the community level, there is no index that allows the assessment of community integrity regarding its restoration or resilience, despite the fact that a lot of indicators are used such as species richness, Shannon diversity, multivariate analyses or similarity indices. We have therefore developed two new indices explained in the third chapter, that give new insights into community states: 1) the first index, named the Community Structure Integrity Index, measures the proportion of the species abundance in the reference community represented in the restored or degraded community, and 2) the second index, named the Higher Abundance Index, measures the proportion of the species abundance in the restored or degraded community that is higher than in the reference community. We illustrated and discussed the use of these new indices with two examples: a recent restoration (2 years) of a Mediterranean temporary wetland (Camargue in France) in order to assess active restoration efficiency, and a recently disturbed pseudo-steppe plant community (La Crau area in France) in order to assess natural resilience of the plant community. The indices provide summarized information on the success of restoration, or on the resilience of the plant community, that both appear less positive than that measured with standard indicators. The indices also provide additional insights that are useful for management purposes: the Community Structure Integrity Index indicates whether the improvement of target species abundance is needed while the Higher Abundance Index indicates whether the control of non-target abundance is needed. These relatively simple indices developed on community composition and structure can provide a base for further indices focusing on ecosystem functioning or services.

If 15% of the degraded ecosystem have to be restored before 2020, research on how to restore the defined reference ecosystem is therefore of primary concern, not only at a small experimental scale but also at a large applicable scale. The objectives of the fourth chapter are to know if it is possible to restore a low productive species-rich ecosystem after intensive cultivation, and to determine which restoration techniques provide the best restoration result. Experiments were carried out within a 357ha rehabilitation project, aiming to recreate an herbaceous sheep-grazed habitat. We applied on the rehabilitated area i) nurse species seeding, ii) topsoil removal, iii) hay transfer, and iv) soil transfer to restore a steppe plant community with the last French Mediterranean steppe as a reference ecosystem. These four techniques, applied for the first time at a large scale on a Mediterranean herbaceous ecosystem were monitored for three years. The rehabilitation makes it pos-

sible to recover a large area dominated by grasses but with vegetation very different to that of the steppe. Even if some target species are successfully transferred with hay, a significant increase in the target species number was not achieved at the end of the third year. Nurse species seeding seems to provide a suitable area for target species colonization, but probable competition with grasses has to be monitored. The best results are obtained with topsoil removal and soil transfer, which made it possible to recover the species-richness and partially the composition of the steppe.

The research conducted for this thesis shows that current knowledge in ecological restoration makes it possible to restore at least partially some La Crau ecosystem components, but ought to lead us to understand the importance of *in situ* conservation of natural habitats as a better alternative to restore them after they were destroyed.

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**2012**

*Wood, bark and pith structure in trees and shrubs of Cyprus: anatomical descriptions and ecological interpretation*

417 p.

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**Jury** – Luca SEBASTIANI (P<sup>r</sup>, Scuola Superiore Sant'Anna, Pise, Italie), président ; Jan ČERMÁK (P<sup>r</sup>, université Mendel à Brno, République tchèque), rapporteur ; Carlo GIUPPONI (P<sup>r</sup>, université Ca' Foscari, Venise, Italie), rapporteur.

**Keywords:** ecological wood anatomy, ecological bark anatomy, pith, growth form, biomechanics, Mediterranean vegetation.

The anatomical structure of secondary xylem reflects features that have adapted by following multiple evolutionary pathways. There are numerous solutions to how wood biological functions are accomplished, but those are constrained by genetic capacity of each single taxon to evolve in particular evolutionary trajectories. The diverse successfully functioning wood anatomies found even in the same environment where plants with those types of wood grow are the results of this eco-evolutionary process. Through comparing taxa differing in habitat in which the plants grow, we are able to infer how that particular wood differs from, or is similar to, woods of unrelated species in the same growth form. This study looks at the anatomical

at wood, bark and pith anatomy of the woody species growing on the Island of Cyprus in the eastern Mediterranean Sea. The goals are to know the suites of anatomical characteristics in each species, to learn which growth forms exhibit more variability with changing site characteristics, and to infer the environmental factors responsible, over an evolutionary time frame, for these relationships.

Original samples for each species were collected during 3 field trips on Cyprus. About 270 species were collected, and 600 double stained (astra blue and safranin) slides were prepared for microscopic observation. New lists of anatomical features were developed for the specific needs of this research, especially for bark and pith anatomies. The described species represent almost the entire woody flora of the island. A great number of them have never been anatomically described before. The codified anatomical descriptions are a perfect base for wood anatomists interested to wood structure of single species or the range of anatomical patterns within the Eastern Mediterranean region, and also for archaeologist and palaeobotanists who determine wood remains, and for wood technologist who compare structures with physical wood properties.

In the ecological wood anatomy analysis we observed wood diffuse porous structure associated to woody chamaephytes. We detected semi-ring and ring porous xylems related to nanophanerophytes and phanerophytes. Rays features seem to be associate to space filling in wood, and the rays dimensional features seems to be constrained by vessels. In fact, rays became larger moving from woody chamaephytes to phanerophytes, and the numbers of rays per millimetre decrease moving from woody chamaephytes to phanerophytes, maybe allowing vessels to be greater in taller growth forms. Raylessness is clearly associated to woody chamaephytes. Rays composition varies from homogeneous in woody chamaephytes, to heterogeneous in nanophanerophytes and phanerophytes. The axial parenchyma was rare in woody chamaephytes, apotracheal in nanophanerophytes and mainly paratracheal in phanerophytes. Endemic species showed absence of axial parenchyma, raylessness, homogeneous rays, and did not show association to tension wood. A predominance of diffuse porous species was been recorded in dry/hot site, and presence of ring porous species in wet/cold sites. Diffuse porous structures were associated to rocky and sandy sites, and semi-ring porous woods to forest and shrublands habitats. Thick walled fibers species were associated to moist and ruderal habitats, thin walled fibers to forest and shrubland species. A clear trend was observed in fiber wall thickness vs. wood density: greater in the fiber wall thickness, greater is the wood density.

The bark anatomical features describe sieve tube morphology and distribution, sclerenchyma presence and arrangement, rays, phellem, phelloderm, crystals, secretory structures, and appearance under polarized light. Sieve tubes were typically arranged tangentially in nanophanerophytes but not in woody chamaephytes. Bark ray dilatation was noted in moist site species but lacking in endemic, shrubland, and forest species. Sclerenchyma tended to be lacking in woody chamaephytes, and in

endemic and dry site species. The tangential arrangement of fibers tended to be lacking in woody chamaephytes and Mediterranean species. The presence of prismatic crystals was associated with nanophanerophytes and phanerophytes, but not with endemic, shrubland, or forest species. Phloem homogeneity was associated with endemic species. Phellem homogeneity was associated with climbers, phanerophytes, and species of moist habitats. The association of sclerenchyma with life form suggests a biomechanical role, especially for young twigs. The level of endemism and the species' habitat were strongly linked to a number of bark features opening new fields of ecophysiological and ecophysiological investigation.

Wahbi JAOUADI

2011

*Écologie et dynamique de régénération de l'Acacia tortilis (Forsk.) Hayne subsp. raddiana (Savi) Brenan var. raddiana dans le parc national de Bouhedma (Tunisie)*

180 p.

*Thèse de doctorat en sciences agronomiques dans la spécialité Génie rural, Eaux et Forêts soutenue le 7 mai 2011 à l'Institut national agronomique de Tunisie (INAT), 43, av. Charles Nicolle, Tunis-Mahrajène 1082, Tunisie.*

**Jury** – Brahim HASNAOUI (Pr, université, Institut sylvo-pastoral de Tabarka, Tunisie), président. Mohamed Larbi KHOUIJA (directeur de recherche et chef Laboratoire d'écologie et amélioration sylvo-pastorale à l'Institut national de recherches en Génie rural, Eaux et Forêts (INGREF) de Tunis, Tunisie), directeur de thèse. Houcine SBEI (Pr, université, École supérieure d'agriculture de Mograne, Tunisie), rapporteur. Mohamed Sghaier ZAAFOURI (Pr, université et directeur de l'Institut supérieur des études technologiques, Béja, Tunisie), rapporteur. Zohra LILI CHABAANE (maître de conférences à l'Institut national agronomique de Tunisie, Tunisie), examinatrice.

**Mots clés** : *Acacia tortilis*, dynamique, régénération, aire d'occupation, télédétection, phénologie, stress osmotique, stress salin.

Les peuplements d'*Acacia tortilis* constituent, dans les zones arides tunisiennes, une entité particulière et un élément capital dans l'équilibre et le maintien des écosystèmes arides et désertiques et dans la lutte contre le phénomène de la désertification. Cette espèce a subi de nombreux problèmes surtout de régénération. Une étude sur l'écologie et la dynamique de régénération d'*Acacia tortilis* (Forsk.) Hayne subsp. *raddiana* (Savi) Brenan var. *raddiana* dans le parc national de Bouhedma a été effectuée pour diagnostiquer ces problèmes.

Nous avons commencé par une étude diachronique des cartes de végétation de 1973, 1985, 1995 et 2008 du parc