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EFFECT OF AFFORESTATION BY INTRODUCED SPECIES IN THE OLD SWEET CHESTNUT (*CASTANEA SATIVA* MILLER) GROVES OF CEVENNES, SOUTHERN FRANCE, ON PLANT SPECIES DIVERSITY

Zuheir SHATER[*,**], Hélène GONDARD[**], Emilio AMORINI[***], François ROMANE[**]

Abstract

Until a few decades ago, in a large part of the Cevennes in the southern France, the landscape was mostly occupied by chestnut (*Castanea sativa* Miller) groves. A large part of these groves are now abandoned and have turned into forests and sometimes into coppice stands. But part of them have been afforested by introduced species (*Cedrus atlantica* (Endl.) Carrière, *Pseudotsuga menziesii* (Mirbel) Franco, *Pinus nigra* Arnold subsp. *laricio* (Poiret) Maire). We discuss the consequences of these changes on the plant species diversity in the understorey and compare them with the diversity existing in abandoned chestnut groves and native forests (*Pinus sylvestris* L., *Pinus nigra* Arnold subsp. *salzmannii* (Dunal) Franco), and in stands where the species was introduced more than a century ago (*Pinus pinaster* Aiton). The tested hypothesis of a higher diversity in the native species forest was not verified, the highest diversity occurred in *Cedrus atlantica* and the lowest in *Pseudotsuga menziesii*, i.e. in two introduced species. The results are discussed including the sample age of approximately 40 years (older samples do not presently exist). The consequences of these results on management are also discussed.

Key words: biodiversity, plant species diversity, afforestation, *Castanea sativa*, Cevennes, France, silviculture

VPLIV POGOZDOVANJA Z VNEŠENIMI DREVESNIMI VRSTAMI NA PESTROST RASTLINSKIH VRST V NASADIH PRAVEGA KOSTANJA (CASTANEA SATIVA MILLER) V CEVENNESIH, JUŽNA FRANCIJA

Izvleček

Še pred nekaj desetletji so velik del Cevennesov v južni Franciji poraščali predvsem nasadi pravega kostanja (Castanea sativa Miller). Velik del nasadov je danes opuščen; iz njih so nastali gozdovi ali parjevci. Del nasadov je bil pogozden z vnešenimi drevesnimi vrstami, kot so Cedrus atlantica (Endl.) Carrière, Pseudotsuga menziesii (Mirbel) Franco in Pinus nigra Arnold subsp. laricio (Poiret) Maire. V prispevku obravnavamo vpliv teh sprememb na pestrost rastlinskih vrst v spodnjem sloju sestoja; pestrost primerjamo s pestrostjo v opuščenih kostanjevih nasadih, naravnih gozdovih (Pinus sylvestris L., Pinus nigra subsp. salzmannii (Dunal) Franco) in v sestojih, kjer so bile vrste (npr. Pinus pinaster Aiton) vnešene že pred več kot stoletjem. S testi nismo potrdili hipoteze o večji pestrosti v naravnih gozdovih; največja pestrost je v sestojih, v katerih prevladuje Cedrus atlantica; najmanjša pa v sestojih, v katerih prevladuje Pseudotsuga menziesii (v obeh primerih gre za vnešeni drevesni vrsti). Podatke smo pridobili v sestojih, starih približno 40 let (starejši sestoji ne obstajajo). V prispevku so predstavljene tudi posledice sprememb na gospodarjenje s kostanjevimi sestoji.

Ključne besede: biotska pestrost, vrstna raznolikost, pogozdovanje, Castanea sativa, Cevennes, Francija, gojenje gozdov

[*] Dep.t of Forestry and Ecology, Faculty of Agronomy, Tichrine University, Lattaquia, Syria
[**] CNRS-CEFE (UPR 9056), 1919 route de Mende, 34293 Montpellier CEDEX 5, France
[***] Istituto Sperimentale per la Selvicoltura, Viale Santa Margherita 80, 52100 Arezzo, Italy

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VSEBINA

1 INTRODUCTION
UVOD

The problems involved in the forest management and conservation currently represent some of the world's greatest concerns; in particular, the notion of biodiversity occupies an important place in sustainable forest management. This concept has gained remarkable success especially after the signing of the convention of biodiversity in Rio de Janeiro in 1992. According to this convention, the maintenance of biodiversity and wood production should be regarded as equally valuable objectives.

In this context, scientific research can play an important role by presenting new knowledge about the function of biodiversity and the factors that can modify it, as well as by translating this knowledge into management rules (EHRLICH 1996, SIMBERLOFF 1999, FARRELL *et al.* 2000).

Human activities in general and forest practices in particular are among the factors that can disturb the forests and their biodiversity (FÜRHER 1990, BENGTSSON *et al.* 2000, LETACON / SELOSSE / GOSSELIN 2001). Planting and management of introduced forest species are among the practices whose effects on biodiversity can be considerable.

These practices can make structural and functional modifications in their new ecosystems by modifying stand structure and some physical and chemical characteristics (light, litter, etc.) (KERR 1999, ANDERSON *et al.* 2001), which could modify their biodiversity.

This study falls under this context. It aims initially to analyze the consequences of afforestation by introduced forest species on plant species diversity. We compared plant species diversity in natural forests and plantations and in pure forests (without chestnut) and mixed forests (chestnut and one other forest species). Then we analyzed the relation between this diversity and some parameters related to the management of these plantations, such as the presence of chestnut in the understorey. The final objective was to attempt to propose some useful elements for considering biodiversity in forest management.

2 MATERIAL AND METHODS
MATERIAL IN METODE

The study was carried out in the Cevennes in southern France. The region is characterized by a Mediterranean climate with dry, warm summers and cool, humid winters (EMBERGER 1955). However, it is also marked by oceanic influences from the Atlantic that frequently alleviate potential drought conditions during the summer. We thus considered the climate transitional between Mediterranean and Oceanic. Mean annual precipitation is about 1.300 mm, mainly occurring in the months from October till March. The soil in this region is acidic resulting from schist and granite rocks (BOUSQUET / SABATIER 1985).

In this area, the chestnut (*Castanea sativa* Mill.) dominated the landscape for centuries, but since the end of the 19th century this region gradually became abandoned. Thus, the majority of the current chestnut stands are coppices resulting from abandoned groves. In recent decades, there have been important surfaces planted by foresters using introduced forest species, such as *Pseudotsuga menziesii* (Mirbel) Franco, *Pinus nigra* Arnold subsp. *laricio* (Poiret) Maire, *Cedrus atlantica* (Endl.) Carrière.

All plant species present in the understorey were recorded in these forest plantations and in natural forests like *Castanea sativa* (the most frequent species in the area), *Pinus sylvestris* L. and *Pinus nigra* Arnold subsp. *salzmannii* (Dunal) Franco (indigenous species), and *Pinus pinaster* Aiton (introduced into the area one century ago, it naturally invaded important surfaces in the area). At the time of the plantations' establishment, a certain number of chestnut trees were left, voluntarily or not, mixed with the introduced forest species. Thus, we studied the relation between plant species diversity and the presence of these trees with a rate of coverage between 20 and 30 %.

Plant species richness was measured in 91 circular plots of 400 m^2, sampled from the data of the I.F.N. (National Forest Inventory 1994, 2000) distributed as shown in Table 1. The sampling was carried out only in the northern exposures (north, north-east or north-west) where is the majority of the plantations with introduced forest species; the altitude of the sampled area ranged from 400 to 900 m. A list of species occurring in the set of the 91 plots is given in the appendix. From this list, it appeared that most of the species are

not "target" species, i.e. protected, endangered, etc. and that the biodiversity taken into account here is a "banal" diversity. Nevertheless, forest managers must take this diversity into account everyday and everywhere. To take into account the diversity of the target species would be another objective.

Table 1: Number and distribution of plots
Preglednica 1: Število in razporejenost ploskev

Species / *Vrsta*	Pure plots *Čiste ploskve*	Mixed plots *Mešane ploskve*	Number of plots *Število ploskev*
Castanea sativa	11	/	11
Pinus sylvestris	8	8	16
Pinus nigra subsp. *salzmannii*	4	4	8
Pinus pinaster	7	7	14
Pseudotsuga menziesii	10	6	16
Pinus nigra subsp. *laricio*	8	8	16
Cedrus atlantica	5	5	10
Total / *Skupaj*	53	38	91

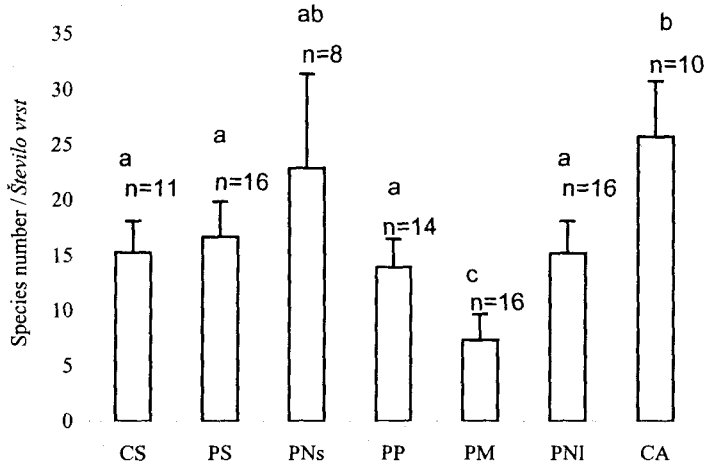
To calculate species diversity in each plot, we chose, among the many diversity indices available, the Shannon-Weaver index, which is easy to measure: $H' = -\Sigma_{i=1,n} p_i \log_{2(pi)}$ where p_i is the abundance ratio of species (i) in each plot, and n = species number in the plot (PIELOU 1975). Total plant cover was estimated by the Braun-Blanquet method (BRAUN / FURRER 1913), which consists of assigning an abundance-dominance coefficient to each species recorded in each plot. Statistical analyses, used to compare mean species richness and mean species diversity between planted forests and natural forests, were based on the non-parametric Kruskal-Wallis test and the Mann-Whitney test (FALISSARD 1996).

The evaluation of plant species diversity-by-diversity indices remains a descriptive approach and it does not allow obtaining information about the functional aspect of the ecosystem. The characterization of species by their life traits allows approaching plant species diversity in a more functional way. Indeed, the life traits are regarded as an expression of the evolutionary adaptation of the plants to the environment (ORSHAN 1982) and, in certain measurements, of the ecosystem function (ORSHAN 1953, MILLER 1982, SCHULZE 1982, FLORET *et al.* 1987, ROMANE 1987). So, the life form of each species was assigned according to RAUNKIAER's (1934) system using local plant guides, the available scientific literature and field observations. This widely-

used system of classification is based on the position of the main regeneration bud and indicates an overall life history strategy for surviving the 'worst' season of the year, when the plant is at highest risk of freezing, drought, or other catastrophe. We retained six types: therophyte (TH), geophyte (G), chamaephyte (CH), hemicryptophyte (H), phanerophyte (P) and nanophanerophyte (NP).

3 RESULTS
REZULTATI

Plant species diversity according to the dominant forest species: The results showed that plant species diversity in the plantations of introduced species was comparable with that of the other stands, except for *Pseudotsuga menziesii* where the diversity was very low and statistically different from the other stands (Figure 1). The results obtained by using the Shannon index are similar to those obtained with plant species richness (Figure 2).



Legend / *Legenda*: Confidence intervals at 5 % / *Interval zaupanja 5 %*; CS = *Castanea sativa*; PS = *Pinus sylvestris*; PNs = *Pinus nigra* subsp. *salzmannii*; PP = *Pinus pinaster*; PM = *Pseudotsuga menziesii*; PNl = *Pinus nigra* subsp. *laricio*; CA = *Cedrus atlantica*; n = number of plots / *število ploskev*. The significantly different averages ($p<0.01$; Mann-Whitney test) are inidicated by different letters / *Značilno različna povprečja ($p<0,01$; Mann-Whitney test) so označena z različnimi črkami*

Figure 1: Plant species richness according to the dominant forest species

Slika 1: Pestrost rastlinskih vrst glede na glavno drevesno vrsto

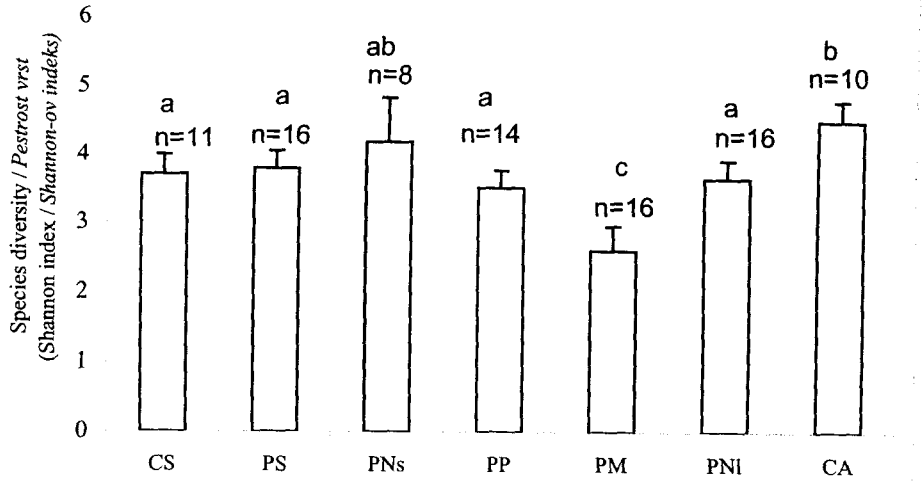


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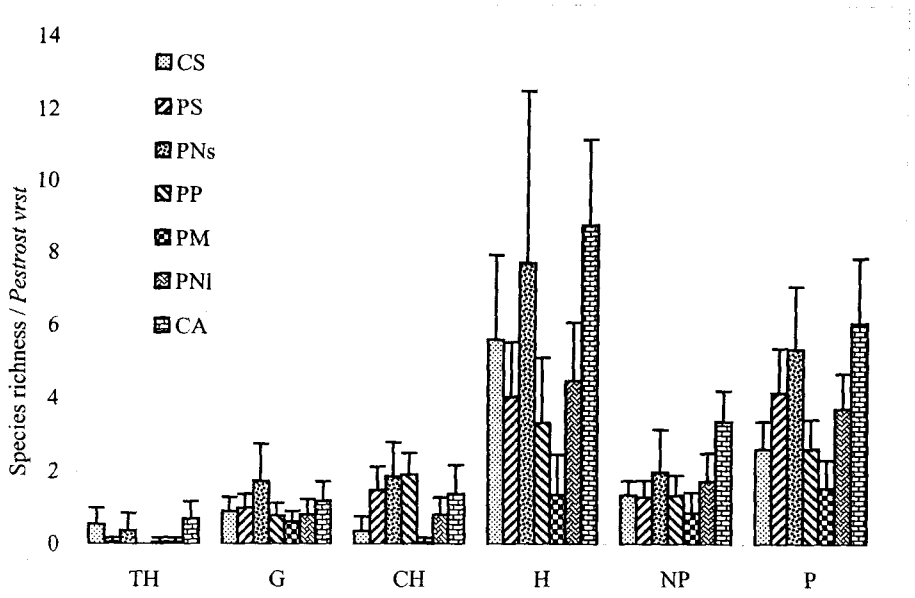
Figure 2: Plant species diversity (Shannon index) according to the dominant forest species

Slika 2: Pestrost rastlinskih vrst (Shannonov indeks) glede na glavno drevesno vrsto

The analysis of the plant species richness in terms of life forms showed a predominance of hemicryptophytes, phanerophytes and nanophanerophytes and a very weak presence of therophytes compared to the other life forms ($p<0,05$: Mann-Whiteny Test) (Figure 3).

For each life form, especially the dominant ones (hemicryptophytes, phanerophytes and nanophanerophytes), plant species richness showed the same results obtained with simple species richness: namely, that plant species diversity in the plantations of introduced species was comparable with that of the other stands, except for *Pseudotsuga,* where this diversity was very low and statistically different from the other stands ($P < 0,001$: Mann-Whiteny Test) (Figure 3). In the plantations of this species, the plant species richness in terms of NP, H, P and G were comparable whereas CH and TH were completely absent ($p<0,001$: Mann-Whiteny Test) (Figure 3).



Legend / *Legenda*: Confidence intervals at 5 % / *Interval zaupanja 5 %*; CS = *Castanea sativa*; PS = *Pinus sylvestris*; PNs = *Pinus nigra* subsp. *salzmannii*; PP = *Pinus pinaster*; PM = *Pseudotsuga menziesii*; PNl = *Pinus nigra* subsp. *laricio*; CA = *Cedrus atlantica*

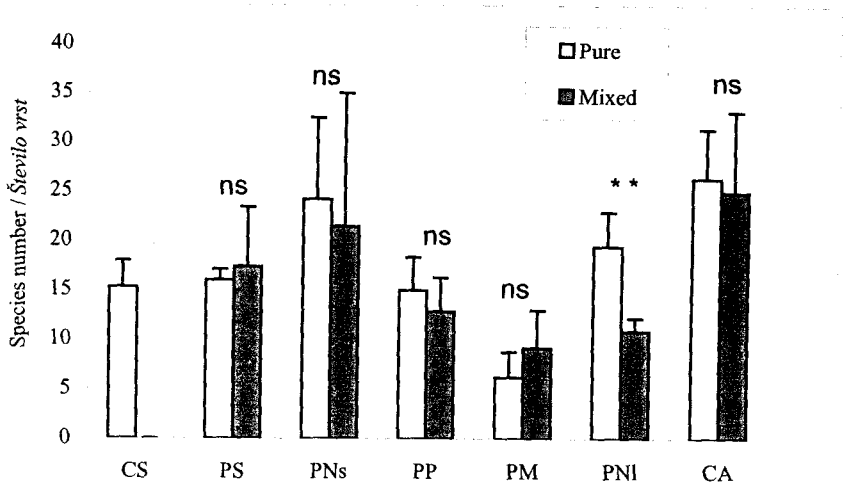
Figure 3: Plant species richness in term of life forms

Slika 3: Pestrost rastlinskih vrst glede na življenjsko obliko

Plant species diversity according to the presence of chestnut in the understorey: At the time of the establishment of the plantations, a certain number of chestnut trees were left, mixed with the introduced species. Therefore, we studied the relation between plant species diversity and the presence of these trees with a rate of coverage between 20 and 30 %. The management of these plantations could be interesting from an economic as well as ecological point of view.

The results showed that for each forest species the presence of chestnut in the understorey did not have an influence on plant species diversity except for *Pinus nigra* subsp. *laricio* where species richness decreased in the presence of chestnut in the understorey (Figure 4).

The presence of chestnut in understorey did not show a considerable effect on species richness in terms of life forms except again for *Pinus nigra* subsp. *laricio* where the pure forests were richer in hemicryptophytes than those mixed with chestnut (Figure 5).



Legend / *Legenda*: Confidence intervals at 5 % / *Interval zaupanja 5 %*; CS = *Castanea sativa*; PS = *Pinus sylvestris*; PNs = *Pinus nigra* subsp. *salzmannii*; PP = *Pinus pinaster*; PM = *Pseudotsuga menziesii*; PNl = *Pinus nigra* subsp. *laricio*; CA = *Cedrus atlantica*; n = number of plots / *število ploskev*. The significantly different averages ($p<0.01$; Mann-Whitney test) are inidicated by asterisk / *Značilno različna povprečja ($p<0,01$; Mann-Whitney test) so označena z zvezdicami*

Figure 4: Plant species richness according to the presence or absence of chestnut in the understorey

Slika 4: Pestrost rastlinskih vrst glede na prisotnost oziroma odsotnost kostanja v spodnjem sloju

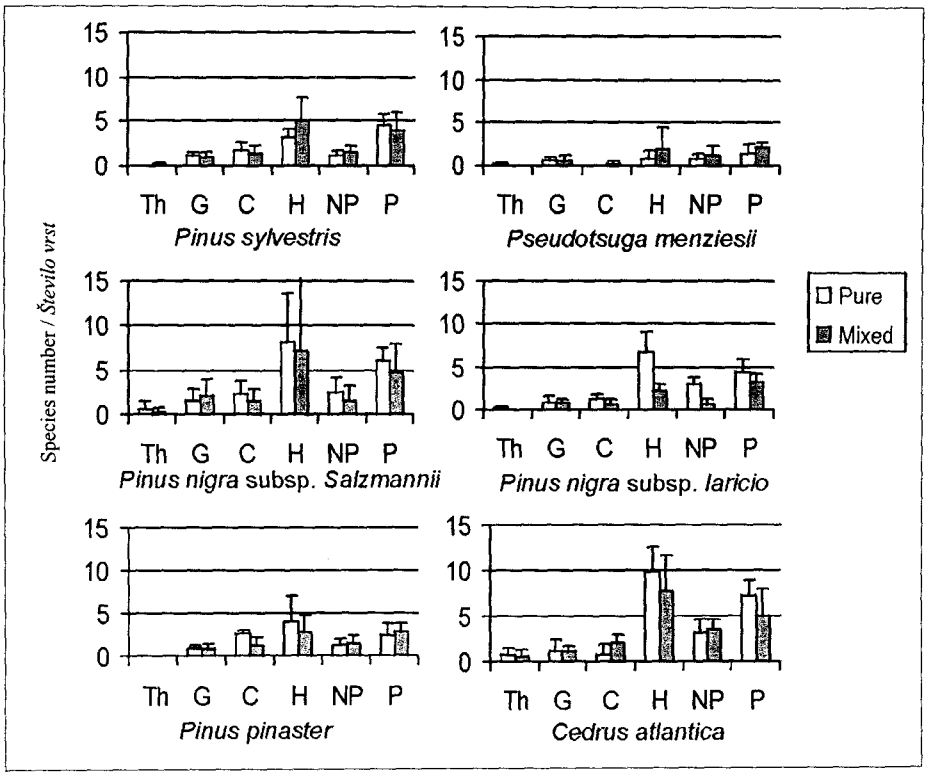


Figure 5: Plant species richness in terms of life forms according to the presence of chestnut in the understorey for each dominant forest species

Slika 5: Pestrost rastlinskih vrst po življenjskih oblikah glede na prisotnost kostanja v spodnjem sloju (za vse glavne drevesne vrste)

4 DISCUSSION
RAZPRAVA

The analysis of the consequences of planting of introduced forest species on plant species diversity, our study showed that the introduced forest species did not decrease plant species diversity compared to the indigenous types of vegetation. Only in the *Pseudotsuga menziesii* plantations plant species diversity was very low using indices such as species richness or the Shannon-Weaver index. Plant species diversity in the plantations of the other introduced species (*Pinus nigra* subsp. *laricio* and *Cedrus*

atlantica) was comparable with that in the natural forests of indigenous species or of species introduced in the distant past (*Pinus sylvestris, Pinus salzmannii, Castanea sativa and Pinus pinaster*). Nevertheless, we have to say here that we have only considered species richness (i.e., the species number) without taking into consideration the 'quality' of the species from a botanical point of view.

The analysis of species richness in terms of life forms did not show differences between the indigenous and the introduced species. Hemicryptophytes, nanophanerophytes and phanerophytes were the forms that dominated in the forests of all the studied forest species regardless of origin.

Although the introduced forest species are often associated with a low diversity (LYNCH / WHIGHAM 1984, MACDONALD *et al.* 1988, RICHARDSON / MACDONALD / FORSYTH 1989, WESTMAN 1990, SYKES 2001, DESPAIN 2001), it is urgent to establish further research in this field before criticizing the plantations of introduced species (WHITEHEAD 1982). According to KIRBY (1988) and PETERKEN (2001), the mechanisms behind the changes in understorey vegetation, associated with the introduced forest species, are not perfectly understood and are difficult to evaluate.

Thus, it is necessary, before any conclusion, to study further the causes of the low diversity in the *Pseudotsuga* plantations, where the Leaf Area Index (LAI) is one of the highest (within the chestnut plots) and to try to know the practices associated with plantation and management of each species, which are likely to explain a part of this diversity. Some preliminary results have suggested that plant species richness could be related to the "light" and the vegetation structure. Indeed, a significant negative link has been found between the LAI and the plant species richness in each set of plots (the higher the LAI, the lower the species richness), but not in the chestnut and *Pinus salzmannii* sets of plots (SHATER 2001). These results did not imply that LAI is the active factor since LAI could be linked to other factors like temperature, soil moisture, etc.

The presence of chestnut in the understorey, mixed with the dominant forest species, with a rate of coverage between 20 and 30 %, did not have an influence on plant species diversity. This makes it possible to retain chestnut trees in these plantations with

economic and ecological advantages as described by LANIER (1992) and RAMEAU (1999).

5 POVZETEK

Ideja o biotski pestrosti zavzema vse pomembnejše mesto v okviru koncepta trajnostnega gospodarjenja z gozdovi.

Koncept biotske pestrosti je bil sprejet in je zaživel s podpisom konvencije o biotski pestrosti (Rio de Janeiro, 1992). Konvencija določa, da sta ohranjanje biotske pestrosti in proizvodnja lesa enakovredna cilja pri gospodarjenju z gozdom.

Naloga znanstveno-raziskovalnega dela je predstaviti nova spoznanja o biotski pestrosti in dejavnikih, ki nanjo vplivajo, ter prenos tega znanja v prakso gospodarjenja z gozdovi (EHRLICH 1996, SIMBERLOFF 1999, FARRELL et al. 2000).

Dejavnosti ljudi, predvsem pa gospodarjenje z gozdom lahko negativno vpliva na gozd in njegovo pestrost (FÜRHER 1990, BENGTSSON et al. 2000, LeTACON / SELOSSE / GOSSELIN 2001). Sadnja in gospodarjenje z vnešenimi drevesnimi vrstami sta ukrepa, ki lahko bistveno vplivata na biotsko pestrost.

Ukrepi lahko s spreminjanjem strukture sestoja in nekaterih fizičnih ter kemičnih značilnosti (npr. svetloba, opad) povzročijo spremembe strukture in funkcionalnosti ekosistemov (KERR 1999, ANDERSON et al. 2001), kar lahko vpliva na njihovo biotsko pestrost.

Z raziskavo smo želeli analizirati vpliv pogozdovanja z vnešenimi drevesnimi vrstami na biotsko pestrost in analizirati povezavo med biotsko pestrostjo ter nekaterimi parametri, ki so odvisni od gospodarjenja z nasadi. Končni cilj raziskave je pripraviti smernice za gospodarjenje z gozdovi ob upoštevanju biotske pestrosti.

Raziskavo smo opravili na območju Cevennesov (južna Francija), kjer je pravi kostanj (Castanea sativa Miller) stoletja poglavitno oblikoval podobo pokrajine; le-to so ob

koncu 19. stoletja ljudje začeli postopoma zapuščati. Danes prevladujejo med kostanjevimi sestoji panjevci, ki izvirajo iz opuščenih nasadov. Poleg tega so gozdarji v preteklih desetletjih pogozdili velike površine z vnešenimi drevesnimi vrstami (Pseudotsuga menziesii (Mirbel) Franco, Pinus nigra Arnold subsp. Laricio Maire, Cedrus atlantica (Endl.) Carrière).

Najprej smo v nasadih z vnešenimi drevesnimi vrstami s pomočjo različnih indeksov pestrosti (vrstna raznolikost in Shannonov indeks itd.) na opisen način ocenili pestrost rastlinskih vrst. Nato smo analizirali še pestrost glede na življenjske oblike.

Pestrost smo primerjali s pestrostjo v kostanjevih panjevcih in v sestojih, ki sicer ne pokrivajo večjih površin, a jih tvorijo avtohtone drevesne vrste (Pinus nigra subsp. salzmanii (Dunal) Franco, Pinus sylvestris L.). Poleg tega smo opravili tudi primerjavo s pestrostjo v sestojih obmorskega bora (Pinus pinaster Aiton), ki je bil vnešen že pred sto leti, a se je uspešno širil in danes pokriva že precejšen delež površin.

Ugotovili smo, da je pestrost rastlinskih vrst v nasadih primerljiva s pestrostjo v drugih sestojih. Izjema so sestoji duglazije, kjer je pestrost značilno nižja (sliki 1 in 2).

Analizirali smo tudi razmerje med pestrostjo rastlinskih vrst in parametri, povezanimi z načinom gospodarjenja v nasadih (npr. prisotnost kostanja v spodnjem sloju in zgradba gozda).

1. *Prisotnost kostanja v spodnjem sloju. Ob osnovanju nasadov so v sestojih ob vnešenih drevesnih vrstah ostala tudi posamezna kostanjeva drevesa. Tako smo preučevali razmerje med pestrostjo rastlinskih vrst in prisotnostjo kostanjevih dreves, ki zavzemajo 20 do 30 % površinski delež. Če pri gospodarjenju upoštevamo tudi ta drevesa, so takšni nasadi zanimivi tako z ekonomskega kot z ekološkega vidika. Rezultati raziskave so pokazali, da prisotnost kostanja v spodnjem sloju sestoja v splošnem ne vpliva na pestrost rastlinskih vrst (slika 4), kar je lahko zanimivo za gospodarjenje s temi sestoji. To dejstvo namreč omogoča ohranjanje mešanosti sestoja, ki prinaša ekonomske in ekološke prednosti, kot jih opisujeta že LANIER (1992) in RAMEAU (1999).*

2. *Zgradba gozda. Raziskava je pokazala, da zgradba sestoja (predvsem dendrometrijski parametri, npr. gostota, temeljnica) vpliva na količino svetlobe, ki prispe do tal. Količina svetlobe, merjena na osnovi ocene indeksa listne površine (LAI), vpliva na pestrost rastlinskih vrst v zeliščnem sloju.*

Na osnovi dobljenih rezultatov je smiselno razmišljati, kakšno gostoto in temeljnico sestoja je potrebno (z vidika zagotavljanja zadovoljive pestrosti) vzdrževati za posamezne drevesne vrste. Rezultati so ponovno opozorili na pomemben vpliv redčenja na pestrost.

Podatke o življenjskih oblikah (RAUNKIAER 1934) smo uporabili kot indeks funkcije ekosistema. Na osnovi rezultatov smo ugotovili prevlado hemikriptofitov, fanerofitov in nanoferofitov; v primerjavi z ostalimi življenjskimi oblikami smo ugotovili zelo majhno prisotnost terofitov (sliki 3 in 5).

Glavni pomislek glede predstavljenih rezultatov se nanaša na starost sestojev (okoli 40 let), v katerih smo opravili raziskave. V starejših sestojih bi lahko bili rezultati drugačni (npr. razlike v pestrosti rastlinskih vrst v sestojih z vnešenimi in naravnimi drevesnimi vrstami). Razlike bi lahko bile predvsem posledica sprememb v zgradbi, do katerih prihaja med staranjem sestoja.

Predstavljeni rezultati in ugotovitve so lahko zanimivi za povečanje pestrosti rastlinskih vrst v nasadih.

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7 APPENDIX
PRILOGA

Appendix 1: List of the plant species recorded in the 91 plots afforested by introducing species in the old sweet chestnut groves of the Cevennes (France)

Priloga 1: Seznam rastlinskih vrst, popisanih na 91 ploskvah, ki so bile pogozdene s tujerodnimi drevesnimi vrstami v nekdanjih kostanjevih nasadih v Cevennesu (Francija)

Plant species / *Vrsta*	Family / *Družina*	# plots *št. ploskev*
Abies alba Miller	Pinaceae	3
Acer campestre L.	Aceraceae	3
Acer platanoides L.	Aceraceae	3
Acer pseudoplatanus L.	Aceraceae	2
Amelanchier ovalis Medicus.	Rosaceae	2
Arbutus unedo L.	Ericaceae	4
Arenaria montana L.	Caryophyllaceae	12
Arrhenatherum elatius (L.) P. Beauv. Ex J. &C.Presl	Gramineae	1
Asperula sp.	Rubiaceae	1
Asplenium adiantum-nigrum L.	Aspleniaceae	5
Asplenium septentrionale (L.) Hoffm.	Aspleniaceae	1
Asplenium trichomanes L.	Aspleniaceae	3
Avenula bromoides (Gouan) H. Scholz	Gramineae	1
Betula pendula Roth.	Betulaceae	9
Brachypodium pinnatum (L.) Beauv.	Gramineae	3
Brachypodium sylvaticum (Hudson) Beauv.	Gramineae	5
Bromus sterilis L.	Gramineae	1
Calamintha nepeta (L.) Savi.	Labiatae	1
Calluna vulgaris (L.) Hull.	Ericaceae	35
Cardamine hirsuta L.	Cruciferae	1
Carex flacca Schreber	Cyperaceae	4
Castanea sativa Miller	Fagaceae	89
Cedrus atlantica (Endl.) Carrière	Pinaceae	11
Celtis australis L.	Ulmaceae	1
Centaurea jacea L.	Compositae	2
Centaurea pectinata L.	Compositae	15
Cephalanthera rubra (L.) L.C.M. Richard	Orchidaceae	4
Ceterach officinarum DC.	Aspleniaceae	1
Cistus salvifolius L.	Cistaceae	3
Clematis flammula L.	Ranunculaceae	1
Clematis vitalba L.	Ranunculaceae	6
Clinopodium vulgare L.	Labiateae	1
Conopodium majus (Gouan) Loret	Umbelliferae	2
Conyza canadense (L.) Cronq.	Compositae	1
Corylus avellana L.	Corylaceae	1
Crataegus monogyna Jacq.	Rosaceae	14
Crepis capillaris (L.) Wallr.	Compositae	1
Cytinus hypocystis (L.) L.	Rafflesiaceae	1
Cytisus scoparius (L.) Link	Leguminosae	49
Dactylis glomerata L.	Gramineae	3

Appendix 1: (continuation)
Priloga 1: (nadaljevanje))

Plant species / *Vrsta*	Family / *Družina*	# plots *št. ploskev*
Danthonia decumbens (L.) DC.	Gramineae	1
Deschampsia flexuosa (L.) Trin.	Gramineae	38
Digitalis purpurea L.	Scrophulariaceae	2
Dryopteris filix-mas (L.) Schott	Aspidiaceae	1
Epilobium angustifolium L.	Onagraceae	1
Epilobium lanceolatum Sebastiani & Mauri	Onagraceae	5
Epipactis atrorubens (Hoffm.) Besser	Orchidaceae	3
Erica arborea L.	Ericaceae	6
Erica cinerea L.	Ericaceae	37
Erica scoparia L.	Ericaceae	4
Euphorbia cyparissias L.	Euphorbiaceae	1
Fagus sylvatica L.	Fagaceae	4
Festuca arvernensis Auquier, Kerguelen et Markgr.-Dannenb.	Gramineae	7
Festuca ovina L.	Gramineae	61
Festuca rubra L.	Gramineae	6
Fragaria vesca L.	Rosaceae	2
Fraxinus excelsior L.	Oleaceae	31
Galeopsis ladanum L.	Labiatae	4
Galium divaricatum Pourret ex Lam.	Rubiaceae	1
Galium mollugo L.	Rubiaceae	9
Galium rotundifolium L.	Rubiaceae	1
Genista pilosa L.	Leguminosae	20
Genista scorpius (L.) DC.	Leguminosae	2
Hedera helix L.	Araliaceae	32
Hieracium maculatum Group	Compositae	14
Hieracium murorum group	Compositae	31
Hieracium umbellatum L.	Compositae	21
Hippocrepis comosa L.	Leguminosae	1
Holcus lanatus L.	Gramineae	3
Hypericum humifusum L.	Guttiferae	1
Ilex aquifolium L.	Aquifoliaceae	13
Jasione montana L.	Campanulaceae	1
Juglans regia L.	Juglandaceae	1
Juniperus communis L.	Cupressaceae	15
Lathyrus linifolius (Richard) Bässler subsp. *Montanus* (Bernh.) Bässler	Leguminosae	1
Laurus nobilis L. (not native)	Lauraceae	4
Ligustrum vulgare L.	Oleaceae	1
Limodorum abortivum (L.) Swartz	Orchidaceae	1
Linaria repens (L.) Miller	Scrophulariaceae	3
Listera ovata (L.) R. Br.	Orchidaceae	2
Logfia arvensis (L.) J. Holub	Compositae	1
Lonicera periclymenum L.	Caprifoliaceae	9
Luzula campestris (L.) DC.	Juncaceae	2
Luzula multiflora (Retz.) Lej.	Juncaceae	5
Malus sylvestris Miller (not native)	Rosaceae	2
Medicago lupulina L.	Leguminosae	1
Moehringia trinervia (L.) Clairv.	Caryophyllaceae	3

Appendix 1: (continuation)
Priloga 1: (nadaljevanje))

Plant species / *Vrsta*	Family / *Družina*	# plots *št. ploskev*
Monotropa hypopitys L.	Pyrolaceae	10
Mycelis muralis (L.) Dumort.	Compositae	3
Orobanche elatior Sutton	Orobanchaceae	1
Phillyrea angustifolia L.	Oleaceae	4
Phillyrea latifolia L.	Oleaceae	2
Phyteuma spicatum L.	Campanulaceae	2
Pinus nigra Arnold subsp. *Laricio* (Poiret) Maire	Pinaceae	24
Pinus nigra Arnold subsp. *Salzmannii* (Dunal) Franco	Pinaceae	8
Pinus pinaster Aiton	Pinaceae	23
Pinus sylvestris L.	Pinaceae	26
Plantago lanceolata L.	Plantaginaceae	1
Plantago subulata L. var. *Holosteum* Scop.	Plantaginaceae	1
Platanthera bifolia (L.) L.C.M. Richard	Orchidaceae	1
Poa nemoralis L.	Gramineae	20
Polypodium vulgare L.	Polypodiaceae	6
Potentilla recta L.	Rosaceae	2
Primula veris L.	Primulaceae	1
Prunus avium L.	Rosaceae	24
Prunus spinosa L.	Rosaceae	5
Pseudotsuga menziesii (Mirbel) Franco (fl non spontanée)	Pinaceae	25
Pteridium aquilinum (L.) Kuhn	Hypolepidaceae	50
Pyrus amygdaliformis Vill.	Rosaceae	2
Quercus ilex L.	Fagaceae	66
Quercus petraea (Mattuschka) Liebl.	Fagaceae	11
Quercus pubescens Willd.	Fagaceae	35
Ranunculus bulbosus L.	Ranunculaceae	1
Rhamnus alaternus L.	Rhamnaceae	2
Rosa canina L.	Rosaceae	23
Rosa micrantha Borrer ex Sm.	Rosaceae	2
Rubia peregrina L.	Rubiaceae	13
Rubus ulmifolius Schott	Rosaceae	41
Ruscus aculeatus L.	Liliaceae	1
Salix caprea L.	Salicaceae	1
Sanguisorba minor Scop.	Rosaceae	1
Sedum reflexum L.	Crassulaceae	2
Sedum sediforme (Jacq.) Pau	Crassulaceae	1
Sedum telephium L. subsp. Telephium	Crassulaceae	1
Senecio adonidifolius Loisel.	Compositae	3
Senecio jacobea L.	Compositae	1
Seseli montanum L.	Umbelliferae	1
Silene italica (L.) Pers.	Caryophyllaceae	2
Silene nutans L.	Caryophyllaceae	7
Solidago virgaurea L.	Compositae	23
Sorbus aria (L.) Crantz	Rosaceae	14
Sorbus aucuparia L.	Rosaceae	3
Sorbus torminalis (L.) Crantz	Rosaceae	3
Tamus communis L.	Dioscoreaceae	1
Taraxacum officinale group	Compositae	3

Appendix 1: (continuation)
Priloga 1: (nadaljevanje))

Plant species / *Vrsta*	Family / *Družina*	# plots *št. ploskev*
Teucrium scorodonia L.	Labiatae	40
Tilia platyphyllos Scop.	Tiliaceae	3
Umbilicus rupestris (Salisb.) Dandy	Crassulaceae	3
Urospermum dalechampii (L.) Scop. Ex F.W. Schmidt	Compositae	1
Urtica dioica L.	Urticaceae	1
Vaccinium myrtillus L.	Ericaceae	1
Verbascum thapsus L.	Scrophulariaceae	1
Veronica officinalis L.	Scrophulariaceae	4
Viburnum tinus L.	Caprifoliaceae	3
Vicia sativa L. subsp. *nigra* (L.) Ehrh	Leguminosae	4
Vincetoxicum hirundinaria Medicus	Asclepiadaceae	1
Viola odorata L.	Violaceae	2
Viola reichenbachiana Jordan ex Boreau	Violaceae	10