



Invasió de pastures de muntanya per bàlec (*Cytisus balansae* ssp *europaeus*): patrons espacials i efectes sobre el segrest de carboni

Francesc Montané Caminal

ADVERTIMENT. La consulta d'aquesta tesi queda condicionada a l'acceptació de les següents condicions d'ús: La difusió d'aquesta tesi per mitjà del servei TDX (www.tdx.cat) ha estat autoritzada pels titulars dels drets de propietat intel·lectual únicament per a usos privats emmarcats en activitats d'investigació i docència. No s'autoritza la seva reproducció amb finalitats de lucre ni la seva difusió i posada a disposició des d'un lloc aliè al servei TDX. No s'autoritza la presentació del seu contingut en una finestra o marc aliè a TDX (framing). Aquesta reserva de drets afecta tant al resum de presentació de la tesi com als seus continguts. En la utilització o cita de parts de la tesi és obligat indicar el nom de la persona autora.

ADVERTENCIA. La consulta de esta tesis queda condicionada a la aceptación de las siguientes condiciones de uso: La difusión de esta tesis por medio del servicio TDR (www.tdx.cat) ha sido autorizada por los titulares de los derechos de propiedad intelectual únicamente para usos privados enmarcados en actividades de investigación y docencia. No se autoriza su reproducción con finalidades de lucro ni su difusión y puesta a disposición desde un sitio ajeno al servicio TDR. No se autoriza la presentación de su contenido en una ventana o marco ajeno a TDR (framing). Esta reserva de derechos afecta tanto al resumen de presentación de la tesis como a sus contenidos. En la utilización o cita de partes de la tesis es obligado indicar el nombre de la persona autora.

WARNING. On having consulted this thesis you're accepting the following use conditions: Spreading this thesis by the TDX (www.tdx.cat) service has been authorized by the titular of the intellectual property rights only for private uses placed in investigation and teaching activities. Reproduction with lucrative aims is not authorized neither its spreading and availability from a site foreign to the TDX service. Introducing its content in a window or frame foreign to the TDX service is not authorized (framing). This rights affect to the presentation summary of the thesis as well as to its contents. In the using or citation of parts of the thesis it's obliged to indicate the name of the author.



Invasió de pastures de muntanya per bàlec (*Cytisus balansae ssp europaeus*): patrons espacials i efectes sobre el segrest de carboni

Memòria presentada per **Francesc Montané Caminal** per optar al títol de Doctor per la Universitat de Barcelona dins del Programa Biologia de les Plantes en Condicions Mediterrànies, Bienni 2004-2006, del Departament de Biologia Vegetal de la Universitat de Barcelona, i duta a terme al Centre Tecnològic Forestal de Catalunya.

Dr. Pere Casals Tortras
(Director de tesi)

Dr. V. Ramón Vallejo Calzada
(Tutor)

Francesc Montané Caminal
(Autor)

Solsona, novembre de 2009

5. BIBLIOGRAFIA

- Adler PB, Raff DA i Lauenroth WK. 2001. The effect of grazing on the spatial heterogeneity of vegetation. *Oecologia* 128: 465-479.
- Aerts R, Boot RGA i Vanderaart PJM. 1991. The relation between above- and belowground biomass allocation patterns and competitive ability. *Oecologia* 87:551-559.
- Alpert P, Bone E i Holzapfel C. 2000. Invasiveness, invasibility and the role of environmental stress in the spread of non-native plants. *Perspectives in Plant Ecology, Evolution and Systematics* 5: 52-66.
- Améztegui A i Coll L. 2009. Análisis cartográfico de los procesos de colonización y densificación del pino negro en el Pirineo catalán. *Actas del 5º Congreso Forestal Español. Montes y sociedad: saber qué hacer.* 13 pàg.
- Archer S, Boutton TW i Hibbard KA. 2001. Trees in grasslands: biogeochemical consequences of woody plant expansion, pàg. 115-137. En: *Global Biogeochemical Cycles in the Climate System* (E-D Schulze, SP Harrison, M Heimann, EA Holland, J Lloyd, IC Prentice, D Schimel, eds.). Academic Press, San Diego.
- Archer S, Boutton TW i McMurtry CR. 2004. Carbon and nitrogen storage in a savanna landscape: field and modeling perspectives, pàg. 359-373. En: *Global Environmental Change in the Ocean an on the land* (H. Kawahata and H. Koizumi, eds.). Kluwer Academic Publishing, Dordrecht, Netherlands.
- Archer S, Schimel DS i Holland EA. 1995. Mechanisms of shrubland expansion: land use, climate or CO₂? *Climatic Change* 29: 91-99.
- Baraza E, Zamora R i Hódar JA. 2006. Conditional outcomes in plant-herbivore interactions: neighbours matter. *Oikos* 113: 148-156.
- Batllori E. 2008. *Avaluació regional de la dinàmica recent de l'ecòtò bosc subalpí-prats alpins als Pirineus.* Tesi Doctoral. Universitat de Barcelona, Departament d'Ecologia.
- Batllori E, Camarero JJ, Ninot JM i Gutierrez E. 2009. Seedling recruitment, survival and facilitation in alpine *Pinus uncinata* tree line ecotones. Implications and potential responses to climate warming. *Global Ecology and Biogeography* 18: 460-472.

- Batllori E i Gutierrez E. 2008. Regional tree line dynamics in response to global change in the Pyrenees. *Journal of Ecology* 96: 1275-1288.
- Beniston M. 2003. Climatic change in mountain regions: a review of possible impacts. *Climatic Change* 59: 5-31.
- Bertness MD i Callaway R. 1994. Positive interactions in communities. *Trends in Ecology and Evolution* 9: 191-193.
- Bisigato AJ, Bertiller MB, Ares JO i Pazos GE. 2005. Effect of grazing on plant patterns in arid ecosystems of Patagonian Monte. *Ecography* 28: 561-572.
- Bol R, Bolger T, Cully R i Little D. 2003. Recalcitrant soil organic materials mineralize more efficiently at higher temperatures. *Journal of Plant Nutrition and Soil Science* 166: 300-307.
- Bolòs O i Vigo J. 1984. La flora dels Països Catalans. Volums I-IV. Ed. Barcino, Barcelona.
- Bond WJ i Keeley JE. 2005. Fire as a global “herbivore”: the ecology and evolution of flammable ecosystems. *Trends in Ecology and Evolution* 20: 387-394.
- Bond WJ, Woodward FI i Midgley GF. 2005. The global distribution of ecosystems in a world without fire. *New Phytologist* 165: 525-538.
- Bourdin F. 2007. Etude de la dynamique des landes subalpines à genêt purgatif, dans les Pyrénées leridanes (Espagne), au cours de la seconde moitié du XXème siècle. Travail de Recherche. ENITA Clermont-Ferrand.
- Braun-Blanquet J. 1948. La végétation alpine des Pyrénées Orientales. Monografía de la Estación de Estudios Pirenaicos y del Instituto Español de Edafología, Ecología y Fisiología Vegetal. Barcelona.
- Breshears DD. 2006. The grassland-forest continuum: trends in ecosystem properties for woody plant mosaics? *Frontiers in Ecology and the Environment* 4: 96-104.
- Briggs JM, Knapp AK, Blair JM, Heisler JL, Hoch GA, Lett MS i McCarron JK. 2005. An ecosystem in transition: causes and consequences of the conversion of mesic grassland to shrubland. *BioScience* 55: 243-254.
- Brooker RW, Maestre FT, Callaway RM, Lortie CL, Cavieres LA, Kunstler G, Liancourt P, Tielbörger K, Travis JMJ, Anthelme F, Armas C, Coll L, Corcket E, Delzon S, Forey E, Kikvidze Z, Olofsson J, Pugnaire F, Quiroz CL, Saccone P, Schiffers K, Seifan M, Touzard B i Michalet R. 2008. Facilitation in plant communities: the past, the present and the future. *Journal of Ecology* 96:18-34.

- Brown JR i Archer S. 1999. Shrub invasion of grassland: recruitment is continuous and not regulated by herbaceous biomass or density. *Ecology* 80: 2385-2396.
- Burke ICV, Reiners WAU i Schimel DSV. 1989. Organic matter turnover in a sagebrush steppe landscape. *Biogeochemistry* 7: 11-31.
- Busqué J, Méndez S i Fernández B. 2003. Estructura, crecimiento y aprovechamiento de pastos de puerto cantábricos invadidos o no por lecherina (*Euphorbia polygalifolia*). *Pastos* 33: 283-303.
- Callaway RM. 2007. Positive interactions and interdependence in plant communities. Springer.
- Camarero JJ i Gutiérrez E. 2004. Pace and pattern of recent treeline dynamics: response of ecotones to climatic variability in the Spanish Pyrenees. *Climatic Change* 63: 181-200.
- Canadell J, Lloret F i López-Soria L. 1991. Resprouting vigour of two mediterranean shrub species after experimental treatments. *Vegetatio* 95: 119-126.
- Cantó P i Rivas-Marínez S. 2002. *Cytisus oromediterraneus* y *Cytisus balansae* (Cytiseae, Leguminosae) dos especies europeas. *Lazaroa* 23: 3-6.
- Castro J, Zamora R, Hódar JA i Gómez JM. 2004. Seedling establishment of a boreal tree species (*Pinus sylvestris*) at its southernmost distribution limit: consequences of being in marginal Mediterranean habitat. *Journal of Ecology* 92: 266-277.
- Cernusca A, Tenhunen J, Tappeiner U, Rosset M, Bahn M, Bayfield R, Siegwolf R, Fillat Estaqué F, Gruber W i Chemini C. 1996. ECOMONT: Ecological effects of land use changes on European terrestrial mountain ecosystems. *Pirineos* 147-148: 145-172.
- Chapin FS, Matson PA i Mooney HA. 2002. Principles of terrestrial ecosystem ecology. Springer.
- Chapin, FS, Sala O i Huber-Sannwald E. 2001. Global Biodiversity in a Changing Environment: Scenarios for the 21st Century. Springer-Verlag, New York.
- Chapin FS, Walker BH, Hobbs RJ, Hooper DU, Lawton JH, Sala OE i Tilman D. 2000a. Biotic control over the functioning of ecosystems. *Science* 277: 500-504.
- Chapin FS, Zavaleta ES, Eviner VT, Naylor RL, Vitousek PM, Reynolds HL, Hooper DU, Lavorel S, Sala OE, Hobbie SE, Mack MC i Díaz S. 2000b. Consequences of changing biodiversity. *Nature* 405: 234-242.

- Connell JH i Slatyer RO. 1977. Mechanisms of succession in natural communities and their role in community stability and organization. *American Naturalist* 111: 1119-1144.
- Cornelissen JHC, Lavorel S, Garnier E, Díaz S, Buchmann N, Gurvich DE, Reich PB, ter Steege H, Morgan HD, van der Heijden MGA, Pausas JG i Poorter H.. 2003. A handbook of protocols for standardised and easy measurement of plant functional traits worldwide. *Australian Journal of Botany* 51: 335-380.
- Cornwell WK, Cornelissen JHC, Amatangelo K, Dorrepaal E, Eviner VT, Godoy O, Hobbie SE, Hoorens B, Kurokawa H, Pérez-Harguindeguy N, Quested HM, Santiago LS, Wardle DA, Wright IJ, Aerts R, Allison SD, van Bodegom P, Brovkin V, Chatain A, Callaghan TV, Díaz S, Garnier E, Gurvich DE, Kazakou E, Klein JA, Read J, Reich PB, Soudzilovskaia NA, Vaieretti MV i Westoby M 2008 Plant species traits are the predominant control on litter decomposition rates within biomes worldwide. *Ecology Letters* 11: 1065-1071.
- Daget P i Poissonet J. 1971. Une méthode d'analyse phytologique des prairies. Criteres d'application. *Annales Agronomiques* 22: 5-41.
- Dale MRT. 1999. Spatial pattern analysis in plant ecology. Cambridge University Press.
- Dale MRT i Blundon DJ. 1991. Quadrat covariance analysis and the scales of interspecific association during primary succession. *Journal of Vegetation Science* 2: 103-112.
- Day KJ, John EA i Hutchings MJ. 2003. The effects of spatially heterogeneous nutrient supply on yield, intensity of competition and root placement patterns in *Briza media* and *F. ovina*. *Functional Ecology* 17: 454-463.
- Debussche M, Escarré J i Lepart J. 1980. Changes in mediterranean shrub communities with *Cytisus purgans* and *Genista scorpius*. *Vegetatio* 43: 73-82.
- DeFries RS, Foley JA i Asner GP. 2004. Land-use choices: balancing human needs and ecosystem function. *Frontiers in Ecology and the Environment* 2: 249-257.
- De Knegt HJ, Groen TA, Van De Vijver ADM, Prins HHT i Van Langevelde F. 2008. Herbivores as architects of savannas: inducing and modifying spatial vegetation patterning. *Oikos* 117: 543-554.
- Díaz S i Cabido M. 1997. Plant functional types and ecosystem function in relation to global change. *Journal of Vegetation Science* 8: 463-474.

- Dieckmann D, Law R i Metz JAJ. 2000. The geometry of ecological interactions. Simplifying spatial complexity. Cambridge University Press.
- Dullinger S, Dirnbock T i Grabherr G. 2003. Patterns of shrub invasion into high mountain grasslands of the Northern Calcareous Alps, Austria. Arctic, Antarctic and Alpine Research 35: 434-441.
- European Environment Agency (Ed.). 1999. Environment in the European Union at the turn of the century, offprint, Windows on Europe: the spatial dimension. 88 pàg. European Environmental Agency, Copenhagen.
- Fang J, Chen A, Peng C, Zhao S i Ci L. 2001. Changes in woodland biomass carbon storage in China between 1949 and 1998. Science 292: 2320-2322.
- Fang C, Smith P, Moncrieff JB i Smith JU. 2005. Similar response of labile and resistant soil organic matter pools to changes in temperature. Nature 433: 57-59.
- Foley JA, DeFries R, Asner GP, Barford C, Bonan G, Carpenter SR, Chapin FS, Coe MT, Daily GC, Gibbs HK, Helkowski JH, Holloway T, Howard EA, Kucharik CJ, Monfreda C, Patz JA, Prentice IC, Ramankutty N i Snyder PK. 2005. Global consequences of land use. Science 309: 570- 574.
- Gallardo A i Merino J. 1993. Leaf decomposition in two mediterranean ecosystems of Southwest Spain: influence of substrate quality. Ecology 74: 152-161.
- García D, Zamora R, Gómez JM, Hódar JA. 2001. Frugivory at *Juniperus communis* depends more on population characteristics than on individual attributes. Journal of Ecology 89: 639-647.
- Garcia-Pausas J, Casals P, Camarero L, Huguet C, Sebastià MT, Thompson R i Romanyà J. 2007. Soil carbon storage in mountain grasslands of the Pyrenees: effects of climate and topography. Biogeochemistry 82: 279-289.
- Garcia-Pausas J, Casals P, Camarero L, Huguet C, Thompson R, Sebastià MT i Romanyà J. 2008. Factors regulating carbon mineralization in the surface and subsurface soils of Pyrenean mountain grasslands. Soil Biology & Biochemistry 40: 2803-2810.
- Garcia-Ruiz JM, Lasanta T, Ruiz-Flano P, Ortigosa L, White S, González C i Martí C. 1996. Land-use changes and sustainable development in mountain areas: a case study in the Spanish Pyrenees. Landscape Ecology 11: 267-277.
- Gartner TB i Cardon ZG. 2004. Decomposition dynamics in mixed-species leaf litter. Oikos 104: 230-246.

- Germino MJ, Smith WK i Resor AC. 2002. Conifer seedling distribution and survival in an alpine-treeline ecotone. *Plant Ecology* 162: 157-168.
- Gill DS i Marks PL. 1991. Tree and shrub seedling colonization of old fields in central New York. *Ecological Monographs* 61: 183-205.
- Gómez-Aparicio L, Valladares F, Zamora R i Quero JL. 2005. Response of tree seedlings to the abiotic heterogeneity generated by nurse shrubs: an experimental approach at different scales. *Ecography* 28: 757-768.
- González JR, Trasobares A, Palahí M, i Pukkala T. 2007. Predicting stand damage and tree survival in burned forests in catalonia (North-east Spain). *Annals of Forest Science* 64: 733-742.
- Gracia M, Montané F, Piqué J i Retana J. 2007. Overstory structure and topographic gradients determining diversity and abundance of understory shrub species in temperate forests in central Pyrenees (NE Spain). *Forest Ecology and Management* 242: 391-397.
- Gross N, Suding KN i Lavorel S. 2007. Leaf dry matter content and lateral spread predict response to land use change for six subalpine grassland species. *Journal of Vegetation Science* 18: 289-300.
- Guo LB i Gifford RM. 2002. Soil carbon stocks and land use: a meta analysis. *Global Change Biology* 8: 345-360.
- Hedgpeth JW. 1993. Foreign invaders. *Science* 261: 34-35.
- Heisler JL, Briggs JM i Knapp AK. 2003. Long-term patterns of shrub expansion in a C4-dominated grassland: fire frequency, and the dynamics of shrub cover and abundance. *American Journal of Botany* 90: 423-428.
- Hibbard KA, Archer S, Schimel DS i Valentine DW. 2001. Biogeochemical changes accompanying woody plant encroachment in a subtropical savanna. *Ecology* 82: 1999-2011.
- Hibbard KA, Schimel DS, Archer S, Ojima DS i Parton W. 2003. Grassland to woodland transitions: integrating changes in landscape structure and biogeochemistry. *Ecological Applications* 13: 911-926.
- Hobbie SE. 1992. Effects of plant species on nutrient cycling. *Trends in Ecology and Evolution* 7: 336-339.
- Holland EA, Parton WJ, Detling JK i Coppock DL. 1992. Physiological responses of plant populations to herbivory and their consequences for ecosystem nutrient flow. *American Naturalist* 140:685-706.

- Hooper DU i Vitousek PM. 1997. The effects of plant composition and diversity on ecosystem processes. *Science* 277: 1302-1305.
- House J, Archer S, Breshears DD, Scholes RJ i NCEAS Tree-Grass Interactions Participants. 2003. Conundrums in mixed woody-herbaceous plant systems. *Journal of Biogeography* 30: 1763-1777.
- Hovstad KA i Ohlson M. 2008. Physical and chemical effects of litter on plant establishment in semi-natural grasslands. *Plant Ecology* 196: 251-260.
- Huntly N. 1991. Herbivores and the dynamics of communities and ecosystems. *Annual Review of Ecology and Systematics* 22: 477-503.
- Jackson RB, Canadell J, Ehleringer JR, Mooney HA, Sala OE i Schulze ED. 1996. A global analysis of root distributions for terrestrial biomes. *Oecologia* 108: 389-411.
- Jackson RB, Banner JL, Jobbágy EG, Pockman WT i Wall DH. 2002. Ecosystem carbon loss with woody plant invasion of grasslands. *Nature* 418: 623-626.
- Jobbágy EG i Jackson RB. 2000. The vertical distribution of soil organic carbon and its relation to climate and vegetation. *Ecological Applications* 10: 423-436.
- Jordano P. 1993. Geographical ecology and variation of plant-seed disperser interactions: southern Spanish junipers and frugivorous trushes. *Vegetatio* 107-108: 85-104.
- Jurena PN i Archer S. 2003. Woody plant establishment and spatial heterogeneity in grasslands. *Ecology* 84: 907-919.
- Kalbitz K i Kaiser K. 2008. Contribution of dissolved organic matter to carbon storage in forest mineral soils. *Journal of Plant Nutrition and Soil Science* 171: 52-60.
- Kayll AJ i Gimingham CH. 1965. Vegetative regeneration of *Calluna vulgaris* after fire. *Journal of Ecology* 53: 729-734.
- Kirschbaum MUF. 2000. Will changes in soil organic carbon act as a positive or negative feedback on global warming? *Biogeochemistry* 48: 21-51.
- Knorr W, Prentice IC, House JI i Holland EA. 2005. Long-term sensitivity of soil carbon turnover to warming. *Nature* 433: 298-301.
- Knox KJE i Clarke PJ. 2006. Fire season and intensity affect shrub recruitment in temperate sclerophyllous woodlands. *Oecologia* 149: 730-739.
- Kolb A, Alpert P, Enters D i Holzapfel C. 2002. Patterns of invasion within a grassland community. *Journal of Ecology* 90: 871-881.

- Lal R, Kimble JM, Follett RF i Stewart BA. 2000. Assessment methods for soil carbon. CRC Press, Boca Raton, FL.
- Lavorel S, O'Neill RV i Robert HG. 1994. Spatio-temporal dispersal strategies and annual plant species coexistence in a structured landscape. *Oikos* 71: 75-88.
- Lett MS, Knapp AK, Briggs JM i Blair JM. 2004. Influence of shrub encroachment on aboveground net primary productivity and carbon and nitrogen pools in a mesic grassland. *Canadian Journal of Botany* 82: 1363-1370.
- Levin SA. 1992. The problem of pattern and scale in ecology. *Ecology* 73: 1943-1967.
- Liao JD. 2004. Woodland development and soil carbon and nitrogen dynamics and storage in a subtropical savanna ecosystem. Tesi Doctoral. Texas A&M University.
- Liao JD, Boutton TW i Jastrow JD. 2006. Storage and dynamics of carbon and nitrogen in soil physical fractions following woody plant invasion of grassland. *Soil Biology and Biochemistry* 38: 3184-3196.
- Liebold AM i Gurevitch J. 2002. Integrating the statistical analysis of spatial data in ecology. *Ecography* 25: 553-557.
- Lieth HFH. 1978. Patterns of Primary Productivity in the Biosphere. Hutchinson Ross, Stroudsberg, PA.
- Lloret F i López-Soria L. 1993. Resprouting of *Erica multiflora* after experimental fire treatments. *Journal of Vegetation Science* 4: 367-374.
- McCarron JK, Knapp AK i Blair JM. 2003. Soil C and N responses to woody plant expansion in a mesic grassland. *Plant and Soil* 257: 183-192.
- McDaniel PA i Munn LC. 1985. Effect of temperature on organic carbon-texture relationships in Mollisols and Aridisols. *Soil Science of America Journal* 49: 1486-1489.
- McKinley DC i Blair JM. 2008. Woody plant encroachment by *Juniperus virginiana* in a mesic native grassland promotes rapid carbon and nitrogen accrual. *Ecosystems* 11: 454-468.
- McKinley DC, Norris MD, Blair JM i Johnson LC. 2008. Altered ecosystem processes as a consequence of *Juniperus virginiana* L. encroachment into North American tallgrass prairie. A: Western North American *Juniperus* communities. A dynamic vegetation type (Ed. Van Auken O.W.). Springer. pàg. 170-187.

- Milbau A, Stout JC, Graae BJ i Nijs I. 2009. A hierarchical framework for integrating invasibility experiments incorporating different factors and spatial scales. *Biological Invasions* 11: 941-950.
- Moreno JM i Oechel WC. 1993. Demography of *Adenostoma fasciculatum* after fires of different intensities in Southern California Chaparral. *Oecologia* 96: 95-101.
- Neeman G, Lahav H i Izhaki I. 1992. Spatial pattern of seedlings 1 year after fire in a mediterranean pine forest. *Oecologia* 91: 365-370.
- Nelson TA i Boots B. 2008. Detecting spatial hot spots in landscape ecology. *Ecography* 31: 556-566.
- Newingham BA, Boquien G, Choler P i Callaway RM. 2005. Effects of *F. paniculata* on the compensatory growth response of *Centaurea uniflora* in the French Alps. *Plant Ecology* 176: 237-244.
- Ninot JM, Carrillo E, Batllori E, Carreras J, Ferré A i Gutiérrez E. 2005. Vegetation patterns across the timberline ecotone in the eastern Pyrenees. XVII International Botanical Congress. Viena (Austria).
- Olff H, Vera FWM, Bokdam J, Bakker ES, Gleichman JM, de Maeyer KD i Smit R. 1999. Shifting mosaics in grazed woodlands driven by the alternation of plant facilitation and competition. *Plant Biology* 1: 127-137.
- Palmier C, Tosca C i Vignes D. 1990. Importance de l'enracinement sur les conditions de concurrence des groupements prairiaux de l'étage subalpin des Pyrénées Centrales. *Botanica-Pirenaico Cantabrica; Monografías del Instituto Pirenaico de Ecología* 5: 415-430.
- Parker IM i Reichard SH. 1997. Critical issues in invasion biology for conservation science. A: Fiedler PL i Kareiva PM (Ed.). *Conservation biology for the coming decade*. Chapman & Hall, New York.
- Paruelo JM, Jobbagy EG, Sala OE, Lauenroth WK i Burke IC. 1998. Functional and structural convergence of temperate grassland and shrubland ecosystems. *Ecological Applications* 8: 194-206.
- Pasche F, Armand M, Gouaux P, Lamaze T i Pernon A. 2004. Are meadows with high ecological and patrimonial value endangered by heathland invasion in the French central Pyrenees? *Biological Conservation* 118: 101-108.
- Paul EA, Morris SJ, Conant RT i Plante AF. 2006. Does the acid hydrolysis-incubation method measure meaningful soil organic carbon pools? *Soil Science Society of America Journal* 70: 1023-1035.

- Pérez-Harguindeguy N, Díaz S, Cornelissen JHC, Vendramini F, Cabido M i Castellanos A. 2000. Chemistry and toughness predict leaf litter decomposition rates over a wide spectrum of functional types and taxa in central Argentina. *Plant and Soil* 218: 21-30.
- Picket STA i White PS. 1985. The ecology of natural disturbance and patch dynamics. Academic Press.
- Pons P, Lambert B, Rigolot E i Prodon R. 2003. The effects of grassland management using fire on habitat occupancy and conservation of birds in a mosaic landscape. *Biodiversity and Conservation* 12: 1843-1860.
- Poron A, Escaravage N i Lamaze T. 2007. Complementarity in mineral nitrogen use among dominant plant species in a subalpine community. *American Journal of Botany* 94: 1778-1785.
- Prentice IC. 1986. Vegetation responses to past climatic variation. *Vegetatio* 67: 131-141.
- Prescott CE. 2005. Decomposition and mineralization of nutrients from litter and humus. In: Nutrient acquisition by plants. An ecological perspective. H BassiriRad (Ed). Springer-Verlag, pàg. 15-41.
- Quevedo L, Rodrigo A i Espelta JM. 2007. Post-fire resprouting ability of 15 non-dominant shrub and tree species in Mediterranean areas of NE Spain. *Annals of Forest Science* 64: 883-890.
- Rasse DP, Rumpel C i Dignac MF. 2005. Is soil carbon mostly root carbon? Mechanisms for a specific stabilisation. *Plant and Soil* 269: 341-356.
- Rigolot E, Lambert B, Pons P i Prodon R. 2002. Management of a mountain rangeland combining periodic prescribed burnings with grazing: impact on vegetation. A: Trabaud L. i Prodon R. (Eds), *Fire and Biological Processes*, Backhuys publishers, Leiden, The Netherlands, pàg. 325-337.
- Rivas Martínez S. 1963. Estudio de la vegetación y flora de las sierras de Guadarrama y Gredos. *Anales del Instituto Botánico A.J. Cavanilles*. Tomo XXI, Fascículo 1. Consejo Superior de Investigaciones Científicas. Madrid.
- Roques KG, O'Connor TG, i Watkinson AR. 2001. Dynamics of shrub encroachment in an African savanna: relative influences of fire, herbivory, rainfall and density dependence. *Journal of Applied Ecology* 38: 268-280.

- Roura-Pascual N, Pons P, Etienne M i Lambert B. 2005. Transformation of a rural landscape in the eastern Pyrenees between 1953 and 2000. *Mountain Research and Development* 25: 252-261.
- Rovira P i Vallejo VR. 2002. Labile and recalcitrant pools of carbon and nitrogen in organic matter decomposing at different depths in soil: an acid hydrolysis approach. *Geoderma* 107: 109-141.
- Rozas V. 2003. Regeneration patterns, dendroecology, and forest-use history in an old-growth beech-oak lowland forest in Northern Spain. *Forest Ecology and Management* 182: 175-194.
- Rusch G i Fernández-Palacios JM. 1995. The influence of spatial heterogeneity on regeneration by seed in a limestone grassland. *Journal of Vegetation Science* 6: 417-426.
- Sala OE, Chapin FS, Armesto JJ, Berlow E, Bloomfield J, Dirzo R, Huber-Sanwald E, Huenneke LF, Jackson RB, Kinzig A, Leemans R, Lodge DM, Mooney HA, Oesterheld M, Poff NL, Sykes MT, Walker BH, Walker M i Wall DH. 2000. Global biodiversity scenarios for the year 2100. *Science* 287: 1770-1774.
- Sanz-Elorza M, Dana ED, González A, Sobrino E. 2003. Changes in the high-mountain vegetation of the Central Iberian peninsula as a probable sign of global warming. *Annals of Botany* 92: 273-280.
- Schlesinger WH. 1997. *Biogeochemistry: An analysis of global change*. Academic Press, New York.
- Shaw MR i Harte J. 2001. Control of litter decomposition in a subalpine meadow-sagebrush steppe ecotone under climate change. *Ecological Applications* 11: 1206-1223.
- Silver WL i Miya RK. 2001. Global patterns in root decomposition: comparisons of climate and litter quality effects. *Oecologia* 129: 407-419.
- Six JL, Conant RTL, Paul EAL i Paustian KL. 2002. Stabilization mechanisms of soil organic matter: Implications for C-sequestration of soils. *Plant and Soil*: 241: 155-176.
- Smit C, Béguin D, Buttler A i Müller-Schärer H. 2005. Safe sites for tree regeneration in wooded pastures: a case of associational resistance? *Journal of Vegetation Science* 16: 209-214.
- Smit C, Den Ouden JAN i Müller-Schärer H. 2006. Unpalatable plants facilitate tree sapling survival in wooded pastures. *Journal of Applied Ecology* 43: 305-312.

- Smith DL i Johnson L. 2003. Expansion of *Juniperus* in the Great Plains: changes in soil organic carbon dynamics. Global Biogeochemical Cycles 17: 1062.
- Smith DL i Johnson L. 2004. Vegetation-mediated changes in microclimate reduce soil respiration as woodlands expand into grasslands. Ecology 85: 3348-3361.
- Sousa WP. 1984. The role of disturbance in natural communities. Annual Review of Ecology and Systematics 15: 353-391.
- Tan ZX, Lal R, Izaurrealde RC i Post WM. 2004. Biochemical protected soil organic carbon at the North Appalachian experimental watershed. Soil Science 196: 423-433.
- Theurillat J-P i Guisan A. 2001. Potential impact of climate change on vegetation in the European Alps: a review. Climatic Change 50: 77-109.
- Throop HL i Archer SR. 2007. Interrelationships among shrub encroachment, land management, and litter decomposition in a semidesert grassland. Ecological Applications 17: 1809-1823.
- Turner MG. 1989. Landscape ecology: the effect of pattern on process. Annual Review of Ecology and Systematics 20: 171-197.
- Turner MG, Baker WL, Peterson CJ i Peet RK. 1998. Factors influencing succession: lessons from large, infrequent natural disturbances. Ecosystems 1: 511-523.
- Van Auken OW. 2000. Shrub invasions of North American semiarid grasslands. Annual Review of Ecology and Systematics 31: 197-215.
- Van Auken OW. 2008. Western North American *Juniperus* communities: a dynamic vegetation type. Springer.
- Van Auken OW. 2009. Causes and consequences of woody plant encroachment into western North American grasslands. Journal of Environmental Management 90: 2931-2942.
- Van Uytvanck J, Maes D, Vandenhante D i Hoffmann M. 2008. Restoration of woodpasture on former agricultural land: the importance of safe sites and time gaps before grazing for tree seedlings. Biological Conservation 141: 78-88.
- Vitousek PM. 1994. Beyond global warming: ecology and global change. Ecology 75: 1861-1876.
- Vitousek PM, D'Antonio CM, Loope LL i Westbrooks R. 1996. Biological invasions as global environmental change. American Scientist 84: 468-478.

- Vivanco L i Austin AT. 2006. Intrinsec effects of species on leaf litter and root decomposition: a comparison of temperate grasses from North and South America. *Oecologia* 150: 97-107.
- Watt AS. 1947. Pattern and process in the plant community. *Journal of Ecology* 35: 1-22.
- White PS i Jentsch A. 2001. The search for generality in studies of disturbance and ecosystem dynamics. *Progress in Botany* 62: 399-450.
- Wijesinghe DK i Handel SN. 1994. Advantages of clonal growth in heterogeneous habitats: an experiment with *Potentilla simplex*. *Journal of Ecology* 82: 495-502.
- Xiong S i Nilsson C. 1999. The effects of plant litter on vegetation: a meta-analysis. *Journal of Ecology* 87: 984-994.
- Yarranton GA i Morrison RG. 1974. Spatial dynamics of a primary succession: nucleation. *Journal of Ecology* 62: 417-427.