



What is the plant biodiversity in a cultural landscape? A comparative, multi-scale and interdisciplinary study in olive groves and vineyards (Mediterranean France)



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ABSTRACT

In a context of agricultural intensification and increasing urbanization, the biodiversity of farmed landscapes is a key to improve the sustainability of agro-ecosystems. We seek to ascertain the plant biodiversity of farmed and abandoned vineyards and olive-groves and to identify the factors underlying it: natural and cultural; on local, landscape, and regional scales.

To do so, we recorded and calculated the floral biodiversity of 106 georeferenced plots and 121 plot edges distributed across 6 French Mediterranean terroirs, surveyed the practices and perception of 55 farmers, and mapped the landscapes of 20 communes in a GIS.

Statistical tests proved that richness and spatial diversity on plots are favored by local low intensity management integrating heritage and landscape objectives. The presence of edges augments the richness and diversity around vineyards. The highest value of spatial diversity was found using the terroir variable. Maximum richness is found in olive groves which are maintained by amateur gardeners and located in the middle of the urbanization gradient. The diversity of biological traits is listed according to: (a) an herbaceous diversity gradient explained by management; (b) a specialization gradient explained by landscapes and distance to large urban areas.

Our results draw perspectives to improve existing models of the links between agriculture, biodiversity, and landscape, considering cultural and geographical factors. They lead to recommendations regarding the management of landscapes based on local knowledge and good practices.

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1. Introduction

In a context of agricultural intensification and increasing urbanization, the biodiversity of farmed plots is a key to improve the sustainability of farmed landscapes and their provision of ecosystem services (Plieninger et al., 2014; Termorshuizen and Opdam, 2009; Van Zanten et al., 2014). This issue finds an echo in the hypothesis of this article, that there is a link between food products, the manner they are produced in specific areas known in France as ‘terroirs’, and the ecological quality and cultural resonance of rural landscapes (‘terroir’ corresponds to a territory distinguished by a crop associated with practices and landscapes,

INAO-INRA (2006)). This argument appears in European landscape research, programs of professional bodies and public policies (Buergi, 2002; Burlingame and Dernini, 2010; INAO-INRA, 2006; Luginbühl, 2012; UNESCO-SCBD, 2014). The biodiversity farmed landscapes can foster is also protected by specific public policies (Cambecèdes et al., 2012; MEDDE, 2014). In the Mediterranean region, olive and wine-growing landscapes offer two kinds of diversity, natural and cultural, they are thus expressions of this kind of agriculture. They are considered to be cultural landscapes, or “combined works of nature and man” with deep historical roots (ICOMOS, 2005; Loumou and Giourga, 2003; Luengo, 2011; Naveh, 1997; UNESCO-SCBD, 2014).

In rural landscapes shaped by agriculture, links between agriculture and biodiversity can be viewed from several different angles (Antrop, 2003; Poudevigne and Baudry, 2003). First, agriculture is a form of ecosystem disturbance, the intensity,

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regime, and spatial extension of which depends on farming practices and crop types (Van der Maarel, 1993). Second, the influence of economic variables on biodiversity is not easy to demonstrate (Zechmeister et al., 2003). Third, numerous studies have focused on how agricultural landscapes are perceived (examples: Boillat et al., 2004; Buijs et al., 2006; Tatoni, 1991); but few have demonstrated the role of cultural factors in shaping their biological traits (Cohen, 2003; Friedberg, 1997; Grésillon, 2009). As cultural factors interact with farmers or gardeners' practices, this role is indirect and consequently complex. In addition, certain types of agricultural systems considered to have "high nature value", such as extensive grasslands or olive groves located in natural areas, are associated with high biodiversity (Cohen et al., 2010; Hoogeveen et al., 2001; Poudevigne and Baudry, 2003). Given that they are established for many years, the functioning of groves should correspond somewhat to those of ecosystems which have experienced average to little disturbance (Bruggisser et al., 2010; Camarsa et al., 2010; Loumou and Giourga, 2003); this similarity is reflected in their biological traits (Pujadas-Salvá, 1986; Spanou et al., 2013). More generally, in their model linking agriculture, landscape and biodiversity, Le Roux et al. (2008) consider arboriculture to be an intermediary case positioned between intensive and extensive agro-ecosystems.

Studies of farmed landscape biodiversity most frequently are undertaken on a local scale in a specific region and involve a single crop type; they generally focus on functional groups which may improve crop production (auxiliary species) and are sensitive to intensification (Altieri, 1999; Hoffmann and Greef, 2003; Coutinot, 2012). Intensification is linked to agricultural practices, depending on their type, frequency and intensity (Nascimbene et al., 2013; Zechmeister et al., 2003). Among these practices, weeding and ploughing harm biodiversity more than mowing, sowing or grazing (Belo et al., 2009; Bruggisser et al., 2010; Cohen et al., 2010; Firbank et al., 2008; Gago et al., 2007; Hoffmann and Greef, 2003; Jauzein, 2001; McLaughlin and Mineau, 1995; pain in Durand et al., 2013; Sanguankeo and León, 2011). Fertilization and irrigation have a direct positive effect on herbaceous biomass and plant competition (Grime, 1979). The influence of the agriculture type, organic or conventional, is hard to isolate from other factors (Bruggisser et al., 2010). In addition, natural landscapes and ecological corridors surrounding agricultural plots, as well as small size of plots, are favorable to biodiversity (Belo et al., 2009; Chateil and Porcher, 2015; Fahrig et al., 2015; Fried et al., 2008; Le Roux et al., 2008). By contrast, the abandonment of olive groves and vineyards has a favorable short term effect on biodiversity, but it becomes unfavorable in the medium term due to competition mechanisms (Bonet and Pausas, 2004; Houssard et al., 1980; Potts et al., 2006).

On the scale of a century, the post-farming succession on abandoned terraced plots is influenced by fires, the destruction of walls, and later land use patterns (Boillat et al., 2004; Tatoni, 1991).

The role of abiotic factors has been studied in agro-ecosystems which have experienced less human-driven transformation (grasslands: Bennie et al., 2006; Cohen, 2003; Grime, 1979). Nascimbene et al. (2013) demonstrated the favorable effect of steep slopes with manual mowing; due to a lack of data on management, Allen et al. (2006) could not verify possible interactions between this parameter and soil types.

Comparative studies covering several regions or crop types are less frequent. Spanou et al. (2013) measured a similar level of diversity in both Greek vineyards and olive groves. Le Roux et al. (2008, for France) and Firbank et al. (2008, for Great Britain) propose a general model of agriculture, landscape and biodiversity relations, complementing the approach developed by McLaughlin and Mineau (1995, for Canada) and Hoogeveen et al. (2001, for Europe). Jauzein (2001) and Fried et al. (2008) demonstrated that agricultural intensification leads to an increase in generalist plants replacing messicole species. According to Mayfield et al. (2010), species loss related to intensification is not necessarily paired with a loss of functional diversity. The environmental filter effect has been studied along urbanization gradients, and is due to the reduction and fragmentation of habitats and selection pressure linked to management practices, which favor generalist species at the expense of specialist species (McKinney, 2006).

Our work focus on the environmental quality of olive-groves and vineyards by analyzing how plant biodiversity contributes to the services provided by these cultural landscapes. We compare six French Mediterranean terroirs presenting sufficiently diverse configurations to enable the first lessons to be drawn on a regional scale. In addition, heavy urbanization pressure on olive groves and vineyards presents an opportunity to verify the hypothesis concerning the effect of the environmental filter on the biodiversity associated with farmed landscapes (Angles, 2014). Our work has two original features: (1) we test factors at local, landscape and regional scales; and (2) in addition to agronomic, environmental and landscape factors, we also test cultural and socio-economic factors which generally are neglected in, or are disconnected from, studies of biodiversity (Allen et al., 2006; Durand et al., 2013). In fine, we assess the similarity of these groves and vineyards to ecosystems with average levels of disturbance, and we propose a model of vineyard and olive grove plant biodiversity which takes into account the actions and perceptions of society. These objectives are pursued through a holistic and interdisciplinary approach (Antrop, 2003).

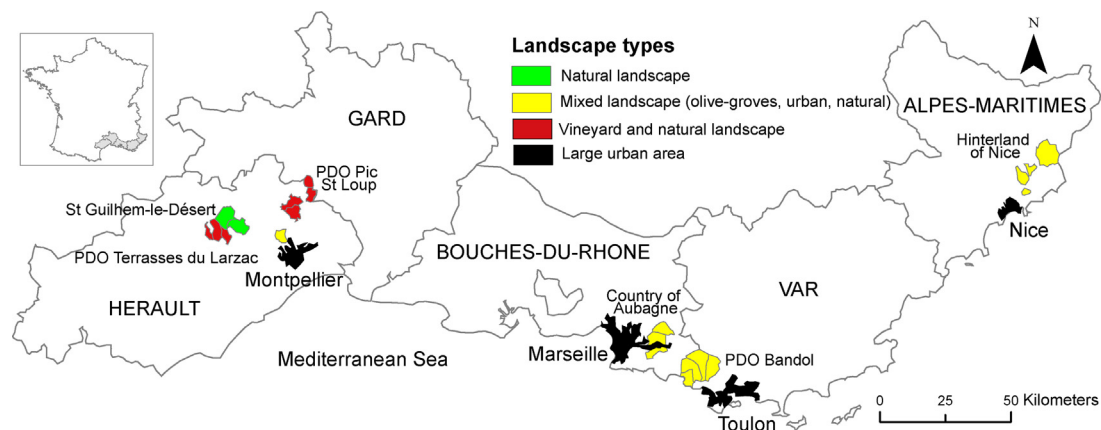


Fig. 1. Location map.

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