Forest Ecology and Management 286 (2012) 183–191

Contents lists available at SciVerse ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Effects of reforestation with *Quercus* species on selected arthropod assemblages (Isopoda Oniscidea, Chilopoda, Coleoptera Carabidae) in a Mediterranean area

Francesco Baini [a,*], Monica Pitzalis [a], Stefano Taiti [c], Augusto Vigna Taglianti [d], Marzio Zapparoli [b], Marco A. Bologna [a]

[a] *Dipartimento di Biologia Ambientale, Università degli Studi Roma Tre, Viale Marconi 446, 00146 Roma, Italy*
[b] *Dipartimento per la Innovazione nei Sistemi Biologici, Agroalimentari e Forestali, Università degli Studi della Tuscia, Via San Camillo de Lellis, 00100 Viterbo, Italy*
[c] *Istituto per lo Studio degli Ecosistemi, CNR, Via Madonna del Piano 10, 50019 Sesto Fiorentino (FI), Italy*
[d] *Dipartimento di Biologia e Biotecnologie "C. Darwin", Università degli Studi di Roma Sapienza, Viale dell'Università 32, 00185 Roma, Italy*

ARTICLE INFO

Article history:
Received 26 March 2012
Received in revised form 26 August 2012
Accepted 27 August 2012
Available online 17 October 2012

Keywords:
Soil fauna
Assemblages
Pitfall trapping
Anthropogenic habitats
Central Italy

ABSTRACT

Arthropod assemblages (Isopoda Oniscidea, Chilopoda, Coleoptera Carabidae) were studied in three 20-year-old reforestations with native oak species (holm-oak *Quercus ilex*, Turkey-oak *Quercus cerris*, and downy-oak *Quercus pubescens*) and in a natural mixed oak forest (*Q. cerris* and *Quercus frainetto*) in Latium (central Italy). The three reforested areas had been previously used for agricultural purposes. Samples were collected monthly by pitfall traps for a period of 1 year (March 2009–February 2010). Structural parameters and the arthropod assemblage compositions of the four studied areas were compared. The effects of the different forest types and the influence of environmental variables on the activity density of each species were analyzed, with particular emphasis to forest species. Contrary to centipedes and ground beetles, woodlice showed lower values of richness, diversity and equitability in reforestations than in the natural forest. According to Canonical Correspondence Analysis, forest species of woodlice and centipedes resulted mainly associated with forests characterized by a high structural heterogeneity (natural forest and reforestation with *Q. pubescens*). In these two forests the activity density of centipede forest species is mainly influenced by the coverage of both shrub and leaf litter layer, and woodlice forest species only by the coverage of the latter. The ground beetle forest species were mainly associated with forests characterized by low structural heterogeneity and an almost total closure of the canopy throughout the year (reforestation with *Q. ilex*). However, some ground beetle forest species are present also in the natural forest. Our results suggest that reforestations with different native broadleaf species belonging to the local "potential" vegetation can contribute to the conservation of the diversity of forest arthropod assemblages in the extremely fragmented agricultural landscape of the middle Tyrrhenian area.

1. Introduction

The last two centuries can be characterized by major industrial development in all parts of Europe, but also by conservation and gradual restoration of European forest cover through various reforestation projects, mainly in the second half of 20th century. After World War II, large reforestation efforts were made in many European countries to compensate for past deforestation and to achieve timber self-sufficiency (Gold, 2003). The growth of forest areas has slowed down since the early 1970s in all sub-regions, except in Western Europe where the extension of human settlements contributed to a lower growth of forest cover (Gold, 2003). In the last two decades the European Community has strongly supported reforestation in all EU countries, with the primary purpose of ensuring a greater number of trees planted than cut (Güthler et al., 2002).

About 700,000 ha of conifers (species of *Pinus*, *Picea*, *Abies*, *Larix* and *Pseudotsuga*) were planted throughout Europe since the eighties, even outside their natural range of distribution (Güthler et al., 2002). They were considered stress-tolerant, easier to propagate, and having higher quality of wood compared to native deciduous trees. Tree species of the non-native genus *Eucalyptus* have been also widely used in northern Mediterranean countries, particularly in Portugal and Spain (Corona et al., 2008).

These policies have stimulated the development of several studies on the dynamics of colonization of reforested areas by different taxonomic groups of soil fauna, mostly arthropods, e.g. woodlice (Isopoda Oniscidea) (Scheu et al., 2003; Huhta, 2002; Vilisics et al., 2007), centipedes (Chilopoda) (Scheu et al., 2003; Huhta

* Corresponding author.
E-mail address: fran.baini@gmail.com (F. Baini).

0378-1127/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.foreco.2012.08.042

and Raty, 2005), spiders (Araneae) (Finch, 2005; Finch and Szumelda, 2007), springtails (Collembola) (Barrocas et al., 1998; Huhta and Raty, 2005) and ground beetles (Coleoptera Carabidae) (Day and Carthy, 1988; Baguette and Gerard, 1993; Niemelä et al., 1993; 1994; Spence et al., 1996; Butterfield, 1997; Elek et al., 2001; Magura et al., 2002, 2003, 2005, 2010; Finch, 2005). In these studies, assemblages were compared each other or to those of natural forests, in order to evaluate the effects of reforestation on local biodiversity and the ability of these non-native habitats to sustain populations of pristine forest species.

In different regions of Europe, conifers or *Eucalyptus* spp. reforestations affect the structure and composition of soil arthropod assemblages, specifically the species with restricted ecological range and low adaptability (Niemelä et al., 1996; Magura et al., 2000; Finch 2005).

Recently, many EU countries have also shown increasing interest on reforestations with native broadleaf trees (Kazda and Pichler, 1998). Around 570,000 ha of forest areas were reconstituted throughout Europe since the nineties using mostly species of the genera *Populus*, *Alnus*, *Betula*, *Carpinus*, *Fagus* and *Quercus* (Picard, 2001). Planting native broadleaf trees could enhance local biodiversity and environmental services better than exotic conifer species (IUCN, 2004).

The knowledge on the ecological effects of reforestations with broadleaf native species on soil arthropod assemblages is scarce (Dunger et al., 2001; Salamon et al., 2008) and limited to artificial woods with *Quercus* spp. in some areas of Atlantic Europe (Dekoninck et al., 2008). For example, Dekoninck et al. (2008), comparing ant assemblages in reforestations with *Quercus* spp. which differ in history, age and management, noted that the number of ant forest species is low although there were clear changes in species composition with forest developmental stage, even after 25 years from planting. Planting of trees and natural succession, with or without management, resulted mostly in open habitat species, and only some species from forest and wet grassland colonize new forests. Female reproductive cast members (gynes) of forest species sometimes reached new forest sites from nearby mature forests, but apparently they were unable to start a colony. These findings were related to the lack of appropriate vegetation structure and litter characteristics, which affects the forest ant fauna, more than the dispersal of ant gynes.

This research was aimed at testing soil arthropod assemblages of three different monospecific reforestations with *Quercus* spp. in a Mediterranean area, in comparison to each other and to a contiguous natural oak forest dominated by *Quercus cerris* and *Quercus frainetto*. The analysis was performed considering: (i) differences among values of activity density and assemblage structural parameters (species richness, S; diversity as Shannon-Wiener information index, H'; equitability, J'); (ii) differences among the species composition of assemblages; (iii) effects of the different forest types and influence that environmental variables have on the abundance of each species, with particular emphasis to those strictly related to forest habitat.

2. Materials and methods

2.1. Study area

The “Castel di Guido” Estate (part of the “Litorale Romano” State Natural Reserve) is located along the Tyrrhenian coast of central Italy, near Rome (Latium). This area is characterized by a typical Mediterranean climate, referable to the Xerotheric Bioclimatic Region of Latium (Thermo-Mediterranean/Meso-Mediterranean Climate Subregion; Blasi, 1994). It extends for over 2000 ha and ranges from 10 to 80 m a.s.l. Pedological analyses revealed the presence of a series of sedimentary layers deposited 0.9–0.1 mya during the middle-higher Pleistocene (Bellotti et al., 1993; Marra, 1993). The landscape mosaic is shaped by the presence of various Mediterranean microclimates that support plant communities considerably different from each other (Bartolucci et al., 2004). Data concerning phytosociological associations in this area were published by Corona (2001).

2.2. Sampling sites

Samplings were carried out in four sites (see also Table 1), one in a natural woodland representative of the natural forests of the area, three in *Quercus* species artificial plots each inside three different greater *Quercus* spp. reforested areas of about 4 ha (Blasi, 1994; Corona, 2001):

I. NAT (41°52′1.08″N, 12°17′21.01″E; 60 m a.s.l.): a native mixed oak forest in an area of some 3 ha, with *Q. cerris* and *Q. frainetto* as dominant tree species. These deciduous trees provide an abundant coverage to the underlying plant layers during the spring-summer months (March to September). The canopy is sometimes discontinuous due to some trees that fell down. The shrub layer is complex in terms of floristic composition (*Malus sylvestris*, *Crataegus monogyna*, *Cornus mas*, *Sorbus domestica*, *Phillyrea latifolia*) and structure, while the herbaceous layer is dominated by a compact and homogeneous stratum of *Ruscus aculeatus*. The leaf litter layer is thick.
II. Q_PUB (41°53′.1.92″N, 12°17′41.34″E; 40 m a.s.l.): a 20 years old monospecific reforestation with *Quercus pubescens* in an area of some 1.5 ha, subrectangular in shape, with maximum length 176 m and maximum width 100 m. The canopy provides homogeneous coverage to the underlying plant layers only in the spring-summer months (March to September). The shrub layer is well structured and dominated by *Rubus ulmifolius*, and the herbaceous one is characterized by the presence of a dense stratum of *Hedera helix*. The leaf litter layer is moderately thick.
III. Q_ILE (41°52′56.94″N, 12°17′15.48″E; 58 m a.s.l.): a 20 years old monospecific reforestation with *Q. ilex* in an area of some 1.5 ha, subrectangular, with length 138 m and width 120 m. The canopy of this evergreen sclerophyll provides a complete coverage to the underlying layers all year round. Contrary to the two preceding sites, the shrub and the herbaceous layers are almost absent. The leaf litter layer is thick.
IV. Q_CER (41°53′37.63″N, 12°16′.31.70″E; 66 m a.s.l.): a 20 years old monospecific reforestation with *Q. cerris* in an area of some 1.5 ha, subrectangular, with length 148 m and width 121 m. The canopy provides homogeneous coverage to the underlying layers only in the spring-summer months (March to September). The shrub layer consists of scattered individuals of *R. ulmifolius*, and the herbaceous one is almost absent. The litter layer is thick.

The small size of forest patches did not allow a proper replication at habitat level. However, studies conducted in nearby areas have shown that these fragments are appropriate for a reliable characterization of the specific composition of soil arthropod assemblages (Vigna Taglianti et al., 2001, Pitzalis et al., 2005, Trucchi et al., 2009).

2.3. Field sampling

Arthropods were sampled using pitfall traps (95 mm in diameter, 500 ml in volume) containing 150 ml of wine vinegar and some