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Adaptation of cork oak (Quercus suber L.) forests in Algerian western region facing climate change
Zaira Souidi, H. Larbi, A. Hamimed et S. Kattar ............................................................. 1-9

Abstract: West Algerian cork oak forest stands are mainly found in the Hafir (Tlemcen), Nesmoth (Mascara) and M'sila (Oran) forests, while some remnants still persist in the provinces of Mostaganem, Tiaret, Sidi Bel Abbes, Relizane and Ain Témouchent. These formations are nowadays of great interest from an ecological and phytoecological point of view due to their very different morphological aspects. This variation relies to an adaptive flexibility of the species to adapt to habitat (climate) or genome (hybridization) changes. Preservation remains necessary and even indispensable in terms of its impact on biodiversity. In this context we examined the morphometric characteristics of the different Q. suber stands located in the western Algerian region and whose systematic and taxonomic position remains uncertain. We are particularly interested in the quantitative and qualitative aspects of these stands, taking into account two variables related to the station (habitat) and variables related to trees (structural and architectural parameters). Morphological and biometrical observations on leaves and acorns were made in four different stations representing the major cork oak stands in the region. The evaluation method was based on a random collection of leaves and acorns in areas of 0.04 ha including an average of 12 to15 trees each. As a whole about 400 trees were sampled. Five characters (length, width, number of spines, number of stomata and leaf area) of the leaves were identified and measured, and three characters (length, diameter and weight) for acorns. The analysis showed a noticeable inter- and intra-populations variation in these parameters. This led us to confirm the presence of different populations of Quercus suber. The marked polymorphism of this species corresponds to its high adaptability to environmental conditions that would result in a variety of responses of leaves and acorns to these conditions. We observed that the populations in drier areas have narrower leaves with longer spines and lighter and smaller acorns.

Invasion of a natural Quercus suber stand in Algeria by Acacia mearnsii originating from Australia
Imène Boudiaf, Arifa Beddiar, Christine Le Roux, Yves Prin, Robin Duponnois ..... 11-14

Abstract: Acacia mearnsii (De Wild) is an Australian native leguminous tree, which has been introduced since 1970 into the cork oak forest of El Kala National Park (PNEK), north-eastern Algeria. Because of its development, this acacia is a threat to cork oak (Quercus suber L.). This work aims to study the effect of the A. mearnsii and Q. suber in mono- and co-culture conditions in soils collected from non-invaded sites, recently invaded or completely invaded and analyze its effect on the Quercus growth and arbuscular mycorrhizal (AM) of the two plants in controlled conditions. The results show a negative effect of acacia on cork oak growth, depending on the soil type, but no difference according to the conditions of mono- or co-cultivation. Acacia plants grown in soil from the totally invaded site are more colonized by arbuscular mycorrhizal fungi than those of the two other studied stands. Concerning cork oak, root mycorrhizal colonization rates by AM fungi is very low since this species forms predominantly ectomycorrhizal associations.
Effect of fires recurrent on landscape degradation, health deterioration and reduction of cork production in the cork oak forest of Hafir-Zarieffet (Tlemcen, Algeria)
Rachid Tarik Bouhraoua, A. Bouazaoui, Belkhir Dehane, Latifa Belhoucine et Mohamed Gheffar

Abstract: Repeated fires recorded for a long time in the cork oak forest of Hafir Zarieffet have economic consequences translating into reduction of cork production (75%) and environmental transformation in natural high forest, clear copse or low sported maquis rich in underwood, vulnerable to fires. Stands having survived to series of violent fires show signs of resistant decline and become unproductive. After fire, young trees restore very quickly their crown.

Post-fire state of two cork oak stands (Zarieffet and Hafir) in northwestern Algeria
Belkheir Dehane, Rachid Bouhraoua, Latéfa Belhoucine

Abstract: Two pairs of cork-oak stands survivors from two different fires were studied. In Hafir two stands (PI1 and PI2) survived a fire in 2004 and in Zarieffet two others (PI1 and PI2) a fire in 2007. The results showed that growth of cork after trunk burning depends on the thickness of the cork at the time of fire. The percentage of very damaged and damaged "mother" layers was higher in Hafir (57%) than in Zarieffet (40% of the total). The average cork caliber measured in lines (1 line = 2.256 mm) exceeds 13.81 lines (31.17 ± 1.90 mm) in Hafir and less than 10 lines in Zarieffet (22.15 ± 2.46 mm). Cork quality produced by these trees looks healthy since only the outer surface of the bark is burned. The quality index Q is better in Hafir stands (PI1: 10.20; PI2: 6.69) than in Zarieffet (PI1: 5.92; PI2: 6.92). 66% of cork trees can produce stoppers cork in Hafir versus only 48% in Zarieffet.

Pedologic characteristics and fungi community in unmanaged cork oak forest soil of two Mediterranean regions: Sardinia and Tunisia
Maria Daria Fumi, Valeria Mazzoleni, Elisa Novelli, Roberta Galli, Matteo Busconi, Mohamed Blaghen, Abdennaceur Hassen, Andrew Hursthouse, Iain McLellan, Agostino Pintus, Pino Angelo Ruiu, Cristina Silva Pereira, Adélia Varela

Abstract: The soil of unmanaged cork oak forests located both in Sardinia and in Tunisia was characterized. Soil samples were collected in both areas at the depth of 0-10 cm, to determine the pedologic characteristics [humidity, pH, total organic carbon (TOC), total nitrogen (N) and texture] and the fungi community. The data were tested for significance with analysis of variance (ANOVA) techniques. The soils of the two studied areas were significantly different as far as pH, TOC % and Sand content are concerned. The texture of Sardinia soil was mainly classified as “sandy-loam” and the Tunisian ones as “sandy-clay-loam”. Concerning the fungi community in Sardinia soil, the most frequent fungi genera were Trichoderma, Penicillium and Paecilomyces. In Tunisian soil the dominant genus was Penicillium followed by the genus Aspergillus.

Results of the use of shelters in cork oak (Quercus suber L.) reforestation in Sardinia
Pino Angelo Ruiu, Agostino Pintus

Abstract: The artificial reforestations using Quercus suber L. are widely distributed in Sardinia and the authors have previously conducted a series of studies in a reforestation of Q. suber L., established in 2001, by using individual protection shelters of different types and heights. The overall results were positive, the shelters having reduced the mortality and favoured the growth of seedlings.

In fall 2006, the individual protections were removed without other modification of the experimental plots in order to follow the evolution of the seedlings; the data for the period 2006-2012 are analyzed in this paper. Pluviometric data show that the trend of rainfall was nearly always higher than the historical average, with some years particularly rainy. The data analysis shows that the control seedlings, grown without individual protection shelters, continue to have a significantly higher mortality. The greater height values were observed in plants protected by shelters 60. After protection removing, the seedlings protected by 120 cm shelters, have suffered from 2007 to 2009 stunting. The increase in diameter was higher in seedlings grown with Tubex...
60 and Arboplus 60, while control plants exhibited the lowest growths, confirming the results obtained in 2006. The ipso-diametric ratio decreased in all the modalities, in particular for plants protected by shelters 120 cm, highlighting the achievement of a balance between growth in height and in diameter. The use of individual protection shelters, originally created to avoid damage by animals, has demonstrated its effectiveness in reducing seedling mortality and improved their development, especially when using 60 cm shelters.

**Waterbird detritus impair seedling root growth in a unique centenarian cork oak population: implications for forest regeneration**


*Abstract:* Field studies have shown than soil-mediated effects of nesting wading birds may be a main cause of the decline of centenarian cork oaks (*Quercus suber* L.) in the Doñana Biological Reserve (SW Spain). The aim of this work was to experimentally investigate whether soil modification by bird detritus significantly affected the first stages of development of *Q. suber*. Seedlings were growing under controlled conditions in three types of natural soils with different levels of wading bird influence. Our results showed that main root length was strongly reduced by bird influence. Bird-influenced soils significantly decreased both the above-ground and the below-ground seedling dry biomass. Guano seems to harm primary root meristem stopping the main root growth, which becomes thickened (root stunting). This impedes the quick initial main root growth that this species usually exhibits prior to shoot emergence. Since the presence of a well-developed main root is essential to explore deep soil layers and extract additional water over the dry season, we predict that guano-affected seedlings will suffer a higher mortality in summer. We concluded that even low levels of wading bird influence could strongly hamper cork oak regeneration in the studied area. Thus, both natural and assisted cork oak regeneration will fail in these bird-influenced soils.

**The phenomenon of creeping plants: an obstacle to the regeneration of cork oak in Tunisia**

Boutheina Stiti, Najib Elabidi, Ahlem Romdhani, Ali El Khorchani, Abdelhamid Khaldi

*Abstract:* Given the difficulty of natural regeneration, assisted regeneration by planting was adopted as a solution to attenuate the decline of Tunisian cork oak. However, observations made in the planted perimeters with cork oak revealed a phenomenon that hinders the growth in height: the presence of creeping plants, without apical dominance during several years. Our study aimed to estimate, for the first time, the extent of this phenomenon and to find explanations in order to propose solutions. In 6 perimeters, planted between 1995 and 1999 and visited in 2013, the survival rate has been assessed and the percentage of creeping among living cork oak seedlings was determined. A dendrometric characterization of these perimeters was performed. The average survival rate, estimated at 77%, varies from 34% to 100% depending on perimeter. The percentage of creeping plants varies between 18 and 100%, result which reflects the extent of this phenomenon. Hypotheses have been advanced to explain this phenomenon and treatments will be tested in an attempt to reduce its extent.

**Relationship between health index (SI) and cork growth index (Iac) in two Algerian cork oak stands: M’Sila (W. Oran) and Zariefet (W. Tlemcen)**

Belkheir Dehane, Rachid Bouhraoua, Latéfa Belhoucine

*Abstract:* The health state of the crown top and the rate of cork growth are the two most commonly used parameters to describe the vitality of forest trees. These measures have been applied for the first time to silver fire (in Jura, France) to assess the relationship between crown top state, radial growth and stand state. Regarding the cork oak, this is the first time that the annual growth of the cork is directly related to defoliation (240 trees), by using two indices: cork
growth (Iac) and health state of the stand (IS). At Zarieffet, a mountain cork oak forest, the slow cork growth induces stable oscillations of Iac around 1. The stability of growth goes with an annual fluctuation of the health index, the trees passing upon the respective states: “healthy”, “weak” and “decaying”. Multiple correlations showed a strong negative relationship ($r = -0.85$) between the two variables in the three Zarieffet stands. At MSila, a coastal oak forest, two different situations were highlighted. In stands (P1, P2, P3) of the Sheikh Khalifa canton characterized by a dominance (60%) of healthy trees (SI < 1.5), correlation between IS and Iac is weak ($r = -0.31$). Any improvement/deterioration of tree health leads to a negligible variation of growth index, which oscillate around 1. In the other hand, in decaying stands (SI > 2.1) (P4, P5, P6) dominated by trees of decline classes 3 and 2, the relationship between IS and Iac is strongly negative($r =-0.74$). This explains why the growth index significantly increases or decreases after any improvement or decline of the tree health index.

**Evaluation of the thickness and quality of reproduction cork in the cork oak forest of Bellif, northwest Tunisia**

*Boutheina Stiti, Hela Hasni, Sameh Ben Rjab, Abdelhamid Khaldi* .......................... 69-73

**Abstract:** Despite the economic importance of cork, research on its production and quality is rare in Tunisia. In order to improve the management of the reproduction cork production, cork growth and quality were assessed in the Bellif forest, located in the north west of Tunisia. 16 plots were selected and 5 trees were sampled in each one. The study was carried out on cork plates of 20x20 cm, collected from the sampled trees. The porosity was measured by direct observation of lenticels through a magnifying glass. Density, moisture content, thickness and annual increment of cork were determined. The cork mean thickness was estimated to 41.4 mm. More than 50% of the samples belonged to suitable commercial capping classes (above 27 mm). The cork samples present a high mean density equal to 296.15 kg/m$^3$ which decreases their quality. Analyzed samples of cork are classified in the category of regular, medium porous cork, characterized by the presence of yellow stains.

**Bad cork removing: a dangerous factor that may affect the generating surface of the cork and the cork oak decline**

*Mohamed Lahbib Ben Jamâa* ................................................................. 75-79

**Abstract:** The decline of cork oak is a worrying phenomenon in most Mediterranean countries. It is difficult to explain the origin and the causes of this phenomenon. In Tunisian cork oak forests the damage resulting from debarking operations occur more by the deterioration of trunks as crowns. Damages are usually noted on the trunks (canker, fungi, and injuries). These damages have led at short term a considerable losses cork production by reducing the corky surface and loss of growth of cork (40%). But in the long term, these bad practices can compromise the strength of cork forests elsewhere and therefore their future. The present work focuses on the poor quality of the cork removal and its impact on tree vigor and generator cork surface. It explains that it is possible to minimize the damage through a good training and an increase in workers’ wages.

**Phytosanitary status of oaks forests in France**

*Bernard Boutte* .................................................................................................................. 81-89

**Abstract:** Oaks cover nearly 40% of the French forest surface (6 million hectares including 3.6 of Sessile and Pedunculate oaks). Deciduous (Sessile, Pedunculate, Downy oaks...) and evergreen species (Holm, Cork oaks...) are present on the national territory. The monitoring performed by the Département de la Santé des Forêts (Health Forest Service) and its official partners allows establishing the current sanitary situation of the oak forests for the last decade. This survey is based on various observation tools: network of permanent or semi-permanent plots, quadrats observations, specific monitoring of some forest, for the main problems (defoliators, declines, powdery mildew...) as well as on data from health monitoring and official survey. The main results of these observations are presented using maps, graphs… as well as a synthesis on French oak-forests health.
Phytosanitary state of Ouled Bechih cork forests in the region of Souk-Ahras, Northeast Algeria
Hiba Daas, Rym Ghanem, Yasmine Adjami, Mohamed Laid Ouakid, Abdlekrim Tahraoui

Abstract: The cork forests of eastern Algeria know the last few years, serious damage due to many factors. Considering the lack of knowledge about the cork oak forests of high mountains in eastern Algeria, we initiated a study to assess the phytosanitary state of Ouled Bechih cork forests in Souk-Ahras. The study was conducted in 3 different sites (M’Ghassel, Kef-M’kasser and Gliàa) during the years 2010, 2011 and 2012. 40 trees were randomly selected in each site. We have made dendrometric measures to each selected tree, and also did phytosanitary surveys that involve examining the canopy, and the trunk. The different studied descriptors were recorded by classes according their presence on the tree. The calculation of decline index during three seasons indicates a good safe sanitary state, except for site Kef-M’kasser which presents a beginning of decline during 2010 (ID = 1.67). However, we have noted an improvement in the next two years (ID = 1.42 in 2011 and ID = 1.37 in 2012).

We also noted traces of xylophagous insects on 26.66% of M’ghassel’s trees in 2010 and the rate increases to 36.66% in 2012. Traces are also present on 5% of Gliàa’s trees in 2010 up to 57.5% in 2012, while on Kef M’kasser’s trees holes are only observed on 2.5% in 2010 and 7.5% in 2012. The percentage of trees with injuries increases during the three years of study; it went from 20% to 50% Gliàa and from 32.5% to 65% in Kef M’kasser, but M’ghassel seems less affected than the others sites (10% in 2010 and 26.66% in 2012). Blackish seeps affect mainly Kef M’kasser’s trees, (45% of the trees in 2010 and 67.5% in 2012), and the biggest crevasses are found on Gliàa’s trees (60% during the three years). The acorns production is abundant and the quality of the cork remains good during the three years of study. All descriptors were compared using a Factorial Correspondence Analysis (FCA) to determine the weight of each factor in the recorded variability.

Health status of the cork oak stands of Annaba region:
Case of the Hedough forest (Algeria)
Hamza Saadi, Mohamed Laid Ouakid, Yasmine Adjami, Rym Ghanem

Abstract: Health problems of Algerian cork forests back to the beginning of the last century following the emergence of the phenomenon of decline. The cork oak forests of Eastern Algeria escape this situation. We set up in 2010-2011 two permanent observation stations (Sidi-El-Temmam and Berouaga) in the Edough forest to study the health status and different decline factors of cork oak. We conducted dendrometric measures (girth taken at 1.30 m from the ground, tree height and height of first branches), and cork statements (height and number of debarking, debarking coefficient) on 80 trees. During the fall of 2011 we evaluated the health status of the stands by examining crown and trunk, bark and subcortical area. Trees have on average 10 m high, 1.5 m in circumference, 1.8 m in debarking heigth. Over 52% have a low defoliation and 30% low leaf discoloration; calculated decay index indicates a stand at the beginning of decline (Id = 1.80). The lichenous flora (fruticose lichens and foliose) is present on all the trunks. Few trees have carbonaceous crusts, runny or dehiscent cork surfaces while insect holes are visible over 80% of the sampled trees. Human impact remains limited despite 30% of the trees present injuries.

Preliminary observations on the spread of “charcoal canker” disease in an artificial cork oak stand in Algeria
Hadjer Smahi, Latifa Belhoucine, Rachid Tarik Bouhraoua

Abstract: A phytopathological study was carried out between March and July 2013 in an artificial cork oak stand located in M’Sila’s forest, northwest of Algeria, affected by Biscogniauxia mediterranea, fungus causing “charcoal canker” disease. In this article are given the first results of investigations aimed to describe the observed infections, to isolate the pathogen involved and characterize its morphological and physiological features, and to evaluate the disease’s spread in the cork oak forest. The results showed an infection rate of 4% affecting
mainly stripped trees in 2007 and decaying ones. Laboratory’s results showed that *B. mediterranea* grows well at temperatures usually prevailing in the cork oak stand of M’Sila and therefore supporting the diffusion of its infections.

**Biodiversity of *Phytophthora* species in declining Mediterranean oak forests**  
_Bruno Scanu, Benedetto T. Linaldeddu, Salvatore Seddaiu, Clizia Sechi, Antonio Franceschini_  
_109-115_

**Abstract:** *Phytophthora* is the major genus within the Oomycota, which includes primary parasites of fine roots and causal agents of root and collar rots and bark cankers of hundreds of tree and shrub species worldwide. Since 2009, extensive dieback and mortality of Mediterranean oaks caused by root loss and root rot have been reported in Sardinia (Italy). Between 2010 and 2012, sixteen oak stands were investigated to establish whether *Phytophthora* species were associated with these decline events. Soil samples from declining trees were collected and baited using oak leaflets. In addition, bark samples were taken from lesions and cankers present on stems and roots. Isolations were made using SMA selective medium for *Phytophthora*. Isolates were identified using both morphological analysis and DNA-based techniques. Eight *Phytophthora* species were detected: *P. cinnamomi*, *P. citrophthora*, *P. cryptoea*, *P. europaea*, *P. gonapodyides*, *P. psychrophila*, *P. quercina* and *P. uliginosa*. These are the first records worldwide of *P. citrophthora*, *P. cryptoea*, *P. quercina* and *P. psychrophila* on Quercus suber, and of *P. europaea* and *P. uliginosa* on Mediterranean oaks. *Phytophthora cinnamomi* was the most frequently isolated species. The oak-specific *P. quercina* was detected at four sites where it was causing extensive dieback of both *Q. ilex* and *Q. suber* trees. The implication of these findings on Mediterranean oak forests health is discussed.

**Comparative aggressiveness of *Phytophthora* spp. to Mediterranean oaks**  
_Salvatore Seddaiu, Clizia Sechi, Benedetto T. Linaldeddu, Antonio Franceschini, Bruno Scanu_  
_117-124_

**Abstract:** Since 2009, an increasing decline of Mediterranean oak forests and its association with several *Phytophthora* spp. has been reported in Sardinia. Although some of these species have been shown to be involved in oak decline in central Europe, their role in the aetiology of Mediterranean oak decline is little understood. Therefore, this study was aimed to assess the comparative aggressiveness of seven *Phytophthora* spp. in infecting roots and mature bark of *Quercus ilex*, *Q. pubescens* and *Q. suber*. Roots of 2-year-old oak seedlings of these oak species were inoculated through soil infestation and the reduction of the root system assessed after 4 months. Phloem tissues of mature trees were inoculated with plugs of *Phytophthora* mycelium, incubated at 20 °C for five weeks and lesion area measured. On all inoculated seedlings, *P. cinnamomi* was the most aggressive species, capable of causing extensive lesions and cankers on the main roots. *Quercus ilex* was the most susceptible species, whereas *Q. pubescens* showed to be more resistant to all *Phytophthora* species. Interestingly, *P. quercina*, *P. psychrophila* and *P. uliginosa*, also proved their pathogenicity towards *Q. ilex*, *Q. pubescens* and *Q. suber*, causing a significant reduction of the root system. *Phytophthora cinnamomi* and *P. citrophthora* were the most aggressive species in colonising the inner bark of all three oak species. *Phytophthora psychrophila* and *P. quercina* were less aggressive and did not differ statistically from the control. These results suggest the direct involvement of several *Phytophthora* species in the decline of Mediterranean oaks.

**Screening of potential biofumigant plants against the root pathogen**  
_Phytophthora cinnamomi_  
_Pedro Ríos, Sara Obregón, Antonio de Haro, María Esperanza Sánchez_  
_125-132_

**Abstract:** The *in vitro* effectiveness of 15 potential biofumigant species belonging to the genera *Sinapis*, *Diplotaxis*, *Cardaria*, *Brassica*, *Eruca*, *Lepidium*, *Armoracia* and *Erucastrum*, has been tested to inhibit mycelial growth of *Phytophthora cinnamomi*, which represents the main causal agent of *Quercus* root rot in oak-rangeland ecosystems in southern Spain. The above-ground part of the selected plants was harvested, frozen and lyophilized. Cultures of the pathogen were
exposed to volatile compounds released by the rehydrated plant material at different doses. Plants belonging to *Diplotaxis*, *Armoracia* and *Brassica* genera reached a total inhibition of the mycelial growth, showing a fungicidal action against *P. cinnamomi*. A high degree of inhibition (> 80%) was also obtained by *Lepidium*, *Eruca*, *Erucastrum* and *Sinapis*, but these plants exhibited only a fungistatic action. Two species with different glucosinolate profiles, *Diplotaxis erucoides* (rich in Sinigrin) and *Lepidium sativum* (rich in aromatic GSLs), were tested for their ability to reduce the viability of the pathogen in the soil. Natural soil from a rangeland was artificially infested with resistant spores of *P. cinnamomi* (650 chlamydospores per gram of dry soil) and transferred to plastic containers containing the biofumigant materials and incubated at 25 °C in the dark. After 1 day, 4 days or 8 days of incubation, soils were analysed by plating soil-water suspensions in selective NARPH medium and resulting *P. cinnamomi* colonies counted. *Diplotaxis erucoides* was the most effective biofumigant, significantly decreasing the viability of resistant spores in the soil. Plants containing high levels of the aliphatic GSL Sinigrin should be considered as potential biofumigants to be used in soils infested by *P. cinnamomi*.

**Soil changes associated to the decline of Quercus suber trees**

*Jara Dominguez-Begines, Lorena Gómez-Aparicio, José Manuel Ávila, Ana Pozuelos, María Esperanza Sánchez, Luis Ventura García* .................................. 133-137

**Abstract:** Plant species can change biotic or abiotic soil properties with implications for the growth and survival of the own plant community. These plant-soil feedback processes could play an important role in determining the abundance and coexistence of species in plant communities. We evaluated the existence of plant-soil feedback processes in two declining *Quercus suber* forests at SW Spain: an open woodland with high abundance of the soil-borne pathogen *Phytophthora cinnamomi*, and a closed forest with low abundance of the same pathogen. In particular, a greenhouse experiment was conducted in order to evaluate the effects of *Q. suber* decline on conspecific seedling growth via soil changes, and to determine the nature (biotic vs. abiotic) of these soils changes. *Q. suber* acorns were sown in pots filled with soil cores collected in the two study sites under *Q. suber* adult trees of three health categories: healthy, defoliated, and dead. Half of each soil type was sterilized to separate biotic vs abiotic effects on seedling performance. After 4 months, shoot and root dry biomass of the seedlings were measured. Seedling growth did not vary among soil types collected in the open woodland. However, it was positively affected by soil sterilization, suggesting the existence of a net negative effect of the soil microorganism community. In the closed forest, seedling growth in soils collected under dead trees was much lower than in soils collected under healthy trees. In this case, soil sterilization did not affect seedling growth, suggesting a mainly effect of adverse abiotic factors. Overall, the results revealed that the decline and mortality of *Q. suber* trees induce biotic and abiotic soil changes that decrease the growth of conspecific seedlings. These changes could imply a competitive disadvantage for this species, with negative consequences for the maintenance of its abundance.

**Control of Phytophthora cinnamomi by soil application of calcium fertilizers in a Dehesa ecosystem in Spain**

*Maria S. Serrano, Ramón Leal, Paolo De Vita, Pilar Fernández-Rebollo, María Esperanza Sánchez* .................................................. 139-143

**Abstract:** Dehesa Los Bueyes is an open woodland located at Huelva province (southern Spain), mainly composed by mature *Quercus ilex* suffering the root rot disease caused by the soilborne pathogen *Phytophthora cinnamomi* with high levels of tree mortality recorded. The pathogen was firstly isolated from soil and root samples from symptomatic oaks analyzed 12 years ago. Field experiments to prevent the spreading of the disease were conducted at Los Bueyes by soil application of calcium fertilizers. Three plots (200x50 m) were marked and treated with CaCO$_3$ (3000 kg/ha) or CaSO$_4$ (3500 kg/ha), remaining unfertilized the third plot (control). Soil samples were taken in three different points per plot in autumn 2011, just before fertilizations, and in late spring and autumn 2012. The evolution of the inoculum density of *P. cinnamomi* in the soil was
assessed by extension of soil suspensions on NARPH selective medium and counting of
_P. cinnamomi_ colonies obtained, but significant differences were not achieved. Inoculum infectivity was evaluated by baiting (eucalyptus leaves) on soil-water suspensions (1:40).
Samples taken in spring 2012 showed significantly lower levels of infectivity in fertilized plots compared with control samples, but this reduction remained only for CaSO$_4$ in samples taken in autumn 2012. Consequently, fertilization with CaSO$_4$ appears as the best option to minimize oak root infections.

**Comparative soil water conditions for oomycete infections on Quercus suber**

Mario González, María S. Serrano, María Esperanza Sánchez .......................... 145-148

**Abstract:** The root rot caused by the soilborne oomycetes _Phytophthora cinnamomi_ and _Pythium spiculum_ is the main cause of mortality for cork oaks in southern Spain. How both pathogens are able to infect oak roots at the same plot or even adjacent trees is an important point for control. One year-old seedlings were infected and submitted to different soil water regimes: continuous flooding, periodical flooding (2 days per week) and standard watering. Different inocula (water suspensions of resistant spores) were prepared: chlamydospores of _P. cinnamomi_, oospores of _Py. spiculum_ and a mix of both pathogens. Eight plants (replicates) per water regime and inoculum were transferred to plastic pots, each one containing 3 l of infested or uninfested (control) fertilized peat. Uninfested plants were exposed at the same hydric conditions than infested ones. All the plants were incubated in an acclimatized greenhouse and severity of foliar symptoms was weekly evaluated on a 0-4 scale (0 = 0-10% of symptomatic leaves, 4 = total wilt). Root symptoms were assessed at the end of each treatment following a similar 0-4 scale. _Phytophthora cinnamomi_ appeared as a pathogen highly virulent to cork oak, causing disease symptoms at any soil water content tested, from total flooding (100%) to 38% of soil water content. In contrast, _Py. spiculum_ acted as cork oak pathogen only in unflooded soils and only when there was no competition with _P. cinnamomi_.

**Comparison of fungi associated with Platypus cylindrus F. (Coleoptera: Platypodidae) in Tunisian and Portuguese cork oak stands**

Amani Bellahirech, Maria Lurdes Inácio, Luis Bonifácio, Filomena Nóbrega, Edmundo Sousa, Mohamed Lahbib Ben Jamâa .......................................................... 149-156

**Abstract:** The oak pinhole borer, _Platypus cylindrus_, is one of the few ‘ambrosia beetles’ found in Mediterranean basin countries. Attacks of this insect are related to cork oak decline in the majority of stands, particularly in Portugal, while in Tunisia the insect is less widespread. Ambrosia beetles bore into xylem of their host trees and construct galleries to lay eggs and breed in the wood. The larvae feed on specific fungi, known as ‘‘ambrosia fungi’’ that are transported by the adult insects to newly colonized trees, and cultivated on the wall of the galleries. The objective of this work is to compare the mycobiota associated with _P. cylindrus_ in Portugal and Tunisia aiming to discuss its role in tree decline considering the different cork oak forest management in both countries, with different intensity levels of exploitation. Logs of infested cork oak trees were collected from seven stands located in the Western North of Tunisia (Ain Beya, Ain Sarouia, Babouch, Belif, Hamdia, Mzara and Oued Zen) during 2011. In Portugal, the samples were taken in 2007 from four stands in the two main cork producing provinces, Alentejo and Ribatejo. Insects were retrieved from infested logs and fungi isolation was made both from the insects and their galleries. A considerable fungal diversity was found in the material studied, reflected in the values of the Shannon-Weaver ecological diversity index. Fungi belonging to the genera _Acremonium_, _Biscogniauxia_, _Botryosphaeria_, _Fusarium_, _Gliocladium_, _Ophiostoma sensu lato_ (Ophiostomatales), _Scytalidium_ and _Trichoderma_ were isolated from the material of Portugal and Tunisia but in different proportions. Ophiostomatales were found as the main symbiotic fungi of _P. cylindrus_ in both countries, confirming the stability of this association and its possible role in cork oak colonization and decline.
Preventive control of Diplodia canker affecting Quercus suber in southern Spain

Maria Angeles Romero, María S. Serrano, Juan José Jiménez, Paolo De Vita, Ramón Leal, Aránzazu Ávila, Antonio Trapero,
Maria Esperanza Sánchez ................................................................. 157-165

Abstract: After the no inclusion of Benomyl in the EU Pesticide Database, new alternatives to prevent Diplodia canker disease affecting cork oaks were needed in southern Spain. In summer 2006 a first field experiment was carried out in a cork oak rangeland at Seville province. Six chemical products effective in vitro, plus a biological product (Trichoderma) were sprayed to recently peeled cork oak trunks in a randomized blocks experimental design. Three years after treatments, cork oaks sprayed with Pyraclostrobin, Difenoconazole, Carbondazim, Copper-Calcium Sulphate and Thyophanate-methyl showed a significant decrease in number and length of trunk lesions in comparison with untreated trees. A second field trial was performed in summer 2007 at Cádiz province under a wetter environment, spraying systemic fungicides and Trichoderma immediately after cork extraction or 24 h after. Two years and a half after treatments only Thyophanate-methyl was effective when sprayed just after peeling. Finally, a third set of sprayings were made in summer 2010 under the wet conditions of Cádiz. Thyophanate-methyl, Copper-Calcium Sulphate and a mix of both fungicides were applied to trunks immediately after peeling, and 2.5 years after spraying, the preventive effectiveness of both fungicides was confirmed, although no synergistic effect of the mixture was achieved.

Susceptibility of three Mediterranean oak species to Diplodia corticola infection

Salvatore Seddaiu, Olizia Scehi, Bruno Scanu, Antonio Franceschini,
Benedetto T. Linaldeddu ................................................................. 167-170

Abstract: The Botryosphaeriaceae represent a cosmopolitan family of economically important fungal pathogens infecting woody plants. In particular, a member of this family namely Diplodia corticola represents a serious threat to oak trees worldwide. In this paper, we present the results of a study about the susceptibility of three Mediterranean oak species to infection of two genetically distinct lineages of D. corticola.

Chemical composition and antifungal activity of Thymus algeriensis, Mentha pulegium, Mentha rotundifolia and Artemesia herba-alba essential oil against Biscogniauxia mediterranea, agent of cork oak charcoal canker in Tunisia

Meriem Zouaoui Boutiti; Nesrine Tinsa, Joana Henriques and
Chokri Massaoud ................................................................. 171-179

Abstract: Biscogniauxia mediterranea (De Not.) Kuntze associated with the decline of Quercus suber has been reported in many forests in many regions of the Mediterranean basin. This pathogen causes charcoal canker on the trunk. B. mediterranea was noted in Tunisian cork oak forests since 1967 causing damage mainly after a long drought period. At present, there are no effective means of controlling this pathogen and the need to define suitable measures in order to control its infections in forest has become a priority. In this regard, essential oils may be a good candidate, as they are in general considered minimum-risk pesticides. There is a lack of research on the use of essential oils in forest and in nursery. Therefore, the objective of this work is to evaluate in vitro the antifungal activity of the essential oil extracted from Thymus algeriensis, Mentha pulegium, M. rotundifolia and Artemesia herba-alba against B. mediterranea using the disk diffusion methods on PDA plates. The essential oils were tested at different concentrations. Sixteen compounds, representing 91.73% of the total essential oil, were identified by chromatography analysis from T. algeriensis. The principal constituent is α-pinene (26.11%). Twenty four compounds, representing 98.3% of the total essential oil, were identified from M. pulegium. The principal constituent is pulegone (62.24%). The essential oil of M. rotundifolia consists of 24 compounds representing 90.3% of the total compounds. The principal constituent is rotundifolone (65.33%). The essential oil of A. herba-alba consists of 21 compounds of the total essential oil. The principal constituent is β-thujone (30.05%). The pure essential oil of A. herba-alba showed a strong inhibitory effect on the mycelial growth of B. mediterranea by
more than 60% comparing to T. algeriensis, M. pulegium and M. rotundifolia. The activities of the essential oil were associated to the major compound of oils. Our results may provide a basis for the development of new control strategies of B. mediterranea on Q. suber.

Dynamics of ectomycorrhizal communities in Sardinian cork oak stands
Salvatore Seddaiu, Enrico Lancellotti, Antonio Franceschini ...................... 181-185
Abstract: The dynamic of ectomycorrhizal communities was investigated in three cork oak areas characterized by different geologic substrate (granitic, basaltic, trachytic), which are representative of the Sardinian cork oak surface. In each area three cork oak stands differing in management system (natural, grazed, grazed with soil tillage for sowing annual forage crops) were selected. For each of the nine geological substrate-management system combination, a rectangular transect was established for spring and autumn sampling. In each period, 10 soil samples were collected and all ectomycorrhizae observed were identified based on both morphology and molecular analysis.

The results showed that the diversity of ectomycorrhizal fungal communities changes in stands with different management types, regardless of the geological substrate. In particular, the richness in fungal species decreased when human pressure increased. A further erosion of diversity was detected in cork oak stands subjected to soil tillage for sowing of annual forage crops. These findings highlight the ability of ectomycorrhizal community to tolerate a certain degree of human pressure, but also the harmful consequence of overexploitation on ectomycorrhizal community diversity.

Nutritional indices of Orgyia trigotephras Boisduval, 1829 (Lepidoptera, Lymantriidae) on five shrub species
Olfa Ezzine, Yaussra Mannai, Said Nouira, Mohamed Lahbib Ben Jamâa ....... 187-194
Abstract: Orgyia trigotephras is an important defoliator of oaks, mainly Quercus suber and Q. coccifera, but also of several other western Mediterranean shrub species. This work aims to study nutritional indices: relative ingestion rate (IRR), approximate digestibility (AD), efficiency of assimilated food (ECD), efficiency of conversion of ingested food (ECI) and relative growth rate (RGR) of O. trigotephras on five shrub species (Q. coccifera, Pistacia lentiscus, Erica multiflora, Erica arborea and Phylleria media). On each plant species, we conducted six repetitions. In each repetition, 10 larvae were used. A total of 300 fourth instar larvae was tested. Each larva was placed individually in a Petri dish (Ø = 9 cm) and weighed at the beginning and the end of the test. Two leaves from each shrub species were removed, weighed and placed in front the larva. After 3 days, the unconsumed foliage and the faeces produced by each larva were dried in an oven at 95 °C for 24 hours before being weighed. Results showed that IRI is high when larvae feed on Q. coccifera (0.4 mg/mg/h) and P. lentiscus (0.35 mg/mg/h) but lower when they feed on other shrub species. An important DA ratio was observed in all tested shrub species; 96% for larvae fed with Phylleria and 86% for those fed on Q. coccifera. High mortality (80%) was noted for larvae fed on Phylleria media and a lower one (28.33%) when fed on Q. coccifera. A better efficiency in conversion of ingested and digested food was observed when larvae feed on Q. coccifera (ECI = 10.56% et ECD = 12.37%) regardless to the other species (ECI between 2 et 4%, ECD between 2 et 5%). The important relative growth rate observed for larvae fed on Q. coccifera (0.031 mg/mg/h) confirms that O. trigotephras is an oak pest. However, on Ph. media, TRC = 0.005 mg/mg/h. This result showed that Orgyia has a relatively high plasticity to host plant changing. Studying the impact of secondary metabolites (tannins) on the development of O. trigotephras should provide important data to better understand the interaction between the insect and its host plants.

Cynipini species (Hymenoptera, Cynipidae) dangerous or potentially dangerous on oak forest
Juli Pujade-Villar ................................................................. 195-203
Abstract: Cynipidae are Hymenoptera which cause malformations in different vegetal organs, although some of them have lost the capacity to make the galls themselves being inquilines of...
other cynipid galls. A review of the Cynipidae species potentially harmful for the Mediterranean oak forests is made. The harmful Cynini species worldwide are pointed out and why some species producing very similar galls do not damage Quercus is discussed. The most important morphological features and the biology these species are presented. The risks to the plants are discussed in terms of organs bearing the galls.

Two years of efficacy trials with different Bacillus thuringiensis sv kurstaki formulations against Lymnantria dispar and Malacosoma neustria

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Abstract: Lymnantria dispar L. (Lepidoptera: Erebidae) and Malacosoma neustria L. (Lepidoptera: Lasiocampidae) are the main cork oak forest defoliators in Sardinia. To contain their infestations over large areas, the use of entomopathogenic microorganisms such as Bacillus thuringiensis serovar kurstaki (Btk) is the presently available option. However, the features of the microbial control agent formulations represent a key factor for the success of application programs and a continuous management of insect resistance can be achieved through the rotation or combination of different bioinsecticidal formulations based on diverse microbial strains.

The results of two years efficacy trials with different formulations of Btk, conducted in 2012 and 2013 in a cork oak forest in North-Western Sardinia, are reported. In the first year, trials were carried out on a M. neustria population, while in the second year a mixed population of L. dispar and M. neustria was involved. Trials included two formulations of Btk strain EG 2348 (Rapax® and Rapax Experimental) in comparison with two other commercial formulations (Foray 48B® and Delfin®).

Both formulations of Btk strain EG 2348 proved to be effective in controlling the two pest species, showing a forest protection potential comparable to that of the reference products, Foray 48B® and Delfin®, containing spores and insecticidal Cry proteins of strains HD-1 and SA-11, respectively.

The defoliation levels, 2 weeks after treatment applications, were significantly higher in untreated control trees than in treated ones. Mean percent defoliation, according to the Guidelines for Evaluation of Crown in the Mediterranean Region, in the untreated trees reached 75%, while it was below 10% for Rapax® at both rates, Foray 48B® and Delfin® in both years. For Rapax Experimental, the percent defoliation exceeded 10% reaching 17.5% in 2013 when applied at 1.0 l/ha.

Testing naturally repulsive plant species against gypsy moth attacks

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Abstract: The gypsy moth, Lymnantria dispar, is known as an important agent of hardwood forest defoliation in the northern hemisphere. Field observations in Corsica showed that caterpillars did not attack three hardwood species: Olea europaea (olive), Fraxinus ornus (flowering ash) and Ficus carica (common fig). Bioassays were conducted in the laboratory to test the toxic and/or repellent effect of these tree species on gypsy moth caterpillars. Control species were oaks (Quercus ilex, pubescens and robur). Three larval instar groups were tested (L1-L2, L3-L4, and L5-L6). The first group was tested in boxes on fresh cut leaves, the others directly on young trees, the caterpillars being maintained in insect-proof system. Larval nutrition and development were recorded every two days. The results confirm the observations made in Corsica: larvae on anti-feedant species did not molt to the next larval stage and died of starvation (leaves were not consumed). This confirms that the anti-feedant tree species had a negative impact on gypsy moth caterpillars. Incidentally, it was also observed that larval development could be negatively affected when host plants are water stressed. Additional chemical studies should be conducted in order to identify and isolate the molecules responsible for this anti-feedant, repulsive and/or toxic effect.
Genetic variation in Sardinian populations of the Green oak leaf roller
*Tortrix viridana* L. (Lepidoptera, Tortricidae)

**Giuseppe Serra, Giovanni Battista Maestrale, Mariella Baratti, Andrea Lentini ...** 221-225

**Abstract:** A preliminary analysis of COI and COII (1875 bp) gene variability was carried out in Sardinian populations of the Green oak leaf roller *Tortrix viridana*. The aim of the study was to investigate the genetic structure and mitochondrial haplotype variation in populations associated with deciduous (*Quercus pubescens*) and evergreen (*Q. suber* and *Q. ilex*) oaks. Forty-four haplotypes out of 87 individuals were found: three haplotypes showed a high frequency (23%, 16% and 10%) and were largely shared among populations. Hierarchical AMOVA showed no significant differentiation grouping populations for geographic areas or oak species, in spite of significant divergences structuring populations for different duration in egg development (early- vs late-hatching). However a high haplotype diversity (H = 0.94) and a low nucleotide diversity (π = 0.004) have been observed.

Preliminary investigations to possible introduction of *Entomophaga maimaiga* in Sardinia

**Mario Contarini, Pietro Luciano, Daniela Pilarska** ................................................................. 227-233

**Abstract:** The fungus *Entomophaga maimaiga* Humber, Shimazu and Soper (Entomophthorales: Entomophthoraceae) is a virulent and very host specific pathogen of the gypsy moth *Lymantria dispar* L., capable of causing epizootics also when the defoliator is at low population density. This fungus, originally described from the Asian gypsy moth, was introduced in the last decades of the 1900’s in the USA and Bulgaria where now it is well established causing high levels of mortality of gypsy moth larvae. The possible presence of *E. maimaiga* was recently investigated in Sardinia, Italy. The fungus is not present in the island so we decided (after obtaining the permit from the Ministero delle Politiche Agricole Alimentari e Forestali) to start bioassays to confirm its effectiveness against Sardinian larvae of *L. dispar*. Two methodologies were followed: 1) gypsy moth larvae were exposed to contaminated soil containing *E. maimaiga* azygospores; 2) larvae were sunk for three seconds in a water suspension containing *E. maimaiga* azygospores. The mortality caused by the fungus during our bioassays was 4.16% in 2012 and 3% in 2013 for the first method and 4.7% for the second method used only in 2013. We are currently verifying the action of the fungus against other lepidopteran larvae in order to avoid negative effects for the environment and lay foundations for the introduction of *E. maimaiga* in Sardinia.


**Wafa Habbachi, D. Habes, M. L. Ouakid, J. P. Farine, A. Bairi** ........................................ 235-243

**Abstract:** Although numerous works were treating the way of life and the behavior of forest insects, little were dedicated to the cockroaches, in particular to *Loboptera decipiens* which remains at the moment a slightly known species. *L. decipiens* is a forest cockroach, recognized by brilliant black color with a white border around the body in adult age. It constitutes a link mattering in the forest food chain. We studied the distribution of *L. decipiens* in cork oak forest North Eastern Algeria by regular harvests of a series of square 1m² surfaces. *L. decipiens* is present in all sites surveyed, it abounds in the forests of cork oak of coasts (cork forests of the National Park of El Kala "PNEK" – Tarf) and mountains (cork forests of Edough to Seraidi – Annaba) while the cockroach populations are less important (low density) in the forests of Ouled Bechih to Machrouha – Souk Ahras. Environment and food behavior of *L. decipiens* are badly known. The physicochemical analysis of cork oak litter shows that this insect participates actively in the ground primary decomposition. Attractiveness was determined thanks to olfactometric tests; the results show that *L. decipiens* is strongly attracted by fresh leaves’ extracts of cork oak realized in hexane and in dichloromethane solvents.